Mitteleuropäische Biomassekonferenz

Central European Biomass Conference

Tagungsband Proceedings

22. bis 24. Jänner 2020, Graz, Österreich

22nd to 24th January 2020, Graz, Austria

6. Mitteleuropäische Biomassekonferenz CEBC 2020

Eine Veranstaltung von:

Exklusivpartner der Veranstaltung:

Premiumpartner der Veranstaltung:

Mit freundlicher Unterstützung von:

Mit Unterstützung vom

Bundesministerium Nachhaltigkeit und Tourismus

CEBC digital
Videos, Fotos und Präsentationen finden Sie nach der Konferenz unter www.cebc.at

ISBN 978-3-9504380-4-8

Impressum: Österreichischer Biomasse-Verband, Franz Josefs-Kai 13, A-1010 Wien; Inhalt: Autoren der Beiträge; Redaktion: Corinna Gabauer, M.A; Gestaltung: Wolfgang Krasny; Druck: Print Alliance HAV Produktions GmbH, Druckhausstraße 1, 2540 Bad Vöslau; Erscheinungstermin: 01/2020; Der Inhalt des Tagungsbandes wurde mit größter Sorgfalt erstellt, für die Richtigkeit, Vollständigkeit und Aktualität der Inhalte können wir jedoch keine Gewähr übernehmen.

6. Central European Biomass Conference CEBC 2020

An event by:

Exklusive partners of the event::

Premium partners of the conference::

Supported by:

In cooperation with:

Mit Unterstützung vom

Bundesministerium Nachhaltigkeit und Tourismus

CEBC digital
After the conference, you will find videos, photos and presentations on www.cebc.at.

ISBN 978-3-9504380-4-8

Imprint: Austrian Biomass Association, Franz Josefs-Kai 13, A-1010 Vienna, Austria; Contents: Authors of the abstracts; Editor: Corinna Gabauer, M.A, Design: Wolfgang Krasny; Printed by: Print Alliance HAV Produktions GmbH, Druckhausstraße 1, 2540 Bad Vöslau; Publication date: 01/2020; the content of the conference proceedings has been created with great care, however, for the correctness, completeness and topicality of contents we can not take any responsibility.

Bioenergie auf dem Weg zur Nummer eins – EU-Staaten legen Ausbaupfade fest

Der **Österreichische Biomasse-Verband**, die **Landwirtschaftskammer Steiermark** und die **BEST Bioenergy and Sustainable Technologies GmbH** veranstalten in Kooperation mit dem Messe Congress Graz vom 22.- 24. Jänner 2020 die **6. Mitteleuropäische Biomassekonferenz (CEBC 2020).** Mit dem Abkommen bei der Weltklimakonferenz 2015 in Paris erfolgte der Startschuss zur globalen Energiewende. Fünf Jahre später legen nun die Nationalstaaten ihre Pläne bis 2030 bzw. 2050 vor, zudem gilt es die vergangene Periode zu bewerten. Bioenergie ist und bleibt eine der bedeutendsten erneuerbaren Energieformen und hat das Potenzial, sich zur Nummer eins aller Energieträger in Europa zu entwickeln.

Grüne Strategien im Mittelpunkt

Die VeranstalterInnen tragen den aktuellen Entwicklungen der Politik Rechnung und legen besonderen Fokus auf den möglichen Beitrag der Biomasse in den Bereichen Wasserstoff, Biokohle, Advanced Biofuels sowie Bioökonomie. Zwei Sonderschwerpunkte des Programmes sind:

- eine **100 Prozent erdölfreie Landwirtschaft** und
- die Strategien zu **Greening the Gas.**

Auch die traditionellen Bereiche der Wärme- und Stromerzeugung kommen nicht zu kurz. Die **CEBC 2020** bietet einen Überblick über die neuesten politischen, wirtschaftlichen und technologischen Entwicklungen mit dem Fokus auf Rohstoffverfügbarkeit, Logistik, Umweltauswirkungen, Marktentwicklungen, der Integration in das Energiesystem, der industriellen Anwendung, sowie politischen Handlungserfordernissen.

Leitveranstaltung des Bioenergiesektors

Die mehrmals mit dem Congress Award Graz ausgezeichnete Leitveranstaltung der mitteleuropäischen Biomassebranche besitzt eine Strahlkraft weit über Österreich hinaus. Mit mehr als 1.300 TeilnehmerInnen aus etwa 50 Nationen zählt die im Drei-Jahres-Rhythmus ausgerichtete Konferenz zu den größten Bioenergieveranstaltungen weltweit. Die zeitgleich stattfindende „Häuslbauer-Messe" stellt mit dem Schwerpunkt Energiebereitstellung in Gebäuden und rund 40.000 BesucherInnen eine hervorragende Ergänzung dar.

Thementage, Exkursionen und umfangreiches Rahmenprogramm

Das Programm der **CEBC 2020** besteht aus über 250 wissenschaftlichen Vorträgen. Posterpräsentationen bieten weitere spannende Erkenntnisse. Ein eigener Pellettag in Kooperation mit **proPellets Austria**, die Highlights der Bioenergieforschung des **BMVIT**, der Halbtag Biogas in Kooperation mit dem **Kompost und Biogas Verband** und der Forsttag der Wintertagung des **Ökosozialen Forums** mit dem Schwerpunkt Bioökonomie erweitern den qualitativen Rahmen der Veranstaltung. Vielseitige Exkursionen und zahlreiche AusstellerInnen spannen den Bogen von der Theorie zur Praxis. Mit dem traditionellen Abendempfang des Bürgermeisters und der Landesregierung in der **Alten Universität Graz** und dem heuer erstmals stattfindenden **„Bioenergie-Heurigen"** wird auch dieses Mal wieder ein besonderer Fokus auf die Vernetzung der TeilnehmerInnen gelegt.

Wir freuen uns darauf, Sie im Jänner 2020 auf der **6. Mitteleuropäischen Biomassekonferenz (CEBC 2020)** begrüßen zu dürfen!

Franz Titschenbacher
Präsident des Österreichischen Biomasse-Verbandes

Elisabeth Köstinger
Bundesministerin für Nachhaltigkeit und Tourismus

Hermann Hofbauer
TU Wien, Vorsitzender des Wissensch. Komitees

Ingmar Höbarth
Geschäftsführer des Klima- und Energiefonds

Bioenergy on its way to the pole position – EU-member states set their expansion plans

The **Austrian Biomass Association**, the **Agricultural Chamber of Styria** and **BEST Bioenergy and Sustainable Technologies** are hosting the **6th Central European Biomass Conference (CEBC 2020)**, in cooperation with the Messe Congress Graz from January 22nd to 24th, 2020 in Graz. The agreement of the United Nations Climate Change Conference, held in 2015 in Paris, marked the starting point of the global energy transition. Five years later, the nation states are now presenting their plans until 2030 and 2050, respectively. This further serves as an opportunity to assess the past period. Bioenergy remains to be one of the most important forms of renewable energy and strikes with its potential to become the number one source of energy in the future.

Green strategies as the center of attention

The organizers of the CEBC take prior events into account and place their emphasis on the potential contribution of biomass in the areas of green gas, hydrogen, biochar and advanced biofuels, as well as bioeconomy, particularly. The thematic priority lies on

- a **100% petroleum-free agriculture** and
- **Greening the gas strategies**

Traditional topics such as heat and power generation will, of course, not be neglected. The CEBC provides its participants with an overview of the latest political, economic and technological developments with an additional focus on raw material availability, industrial application, integration into the energy system, transformation technologies, environmental impacts, logistics, market outlooks and policy requirements for the development of renewable energy.

Leading event in the bioenergy sector

The conference has been awarded with the Congress Award Graz several times and has consistently maintained its internationally approved reputation. Connecting more than 1,300 participants from over 50 nations, the triannually held conference belongs to the largest bioenergy industry events worldwide. The simultaneously held "Häuslbauer-trade fair", with its emphasis on the provision of energy in the building sector, reaching out to approximately 40,000 visitors, offers an excellent addition to the conference.

Theme days, excursions and an extensive supporting programme

The programme of the CEBC 2020 impresses visitors with a selection of more than 250 scientific lectures. In addition, numerous poster presentations will provide further insights into the current state of bioenergy. The Pellet Day, in cooperation with **proPellets Austria**, the presentation of the „Highlights of the bioenergy research", hosted by **BMVIT**, the Biogas Day, run by the **Kompost und Biogas Verband** and the Forest Day of the Winter Meeting of the **Ökosoziale Forum** expand the qualitative frame of the conference. Numerous excursions to bioenergy destinations and the representation of the leading companies in the sector link the theoretical approach of the conference to practical applications. The traditional conference dinner, held in the **Old University of Graz**, the reception by the mayor of Graz and the daily open **„Bioenergy-Heurigen"** reception serve as excellent networking opportunities.

We are looking forward to welcoming you at the **6th Central European Biomass Conference (CEBC 2020)!**

Franz Titschenbacher
President of the Austrian Biomass Association

Elisabeth Köstinger
Federal Minister for Sustainability and Tourism

Hermann Hofbauer
TU Wien, Chairman of the Scientific Committee

Ingmar Höbarth
CEO of the Klima- und Energiefonds

das klima hat zukunft

klima+ energie fonds

Neue Wege für Klimaschutz und Energieeffizienz – Zero Emission Austria

www.klimafonds.gv.at

HOME IS,
WHERE THE ENERGY IS.

For us home is more than just a place or a feeling.

Green power

Green home

ENERGIE STEIERMARK

For us home means being close and responsible. This is where we produce green energy for the country. From water, wind and sun. This is where our 1700 employees live and work. They know its every corner and region. They make sure that safety, service and ideas have a face. And a name. Because our energy is where we're at home. **www.e-steiermark.com**
www.facebook.com/energiesteiermark

Programm der 6. Mitteleuropäischen Biomassekonferenz 2020

Uhrzeit	Mittwoch, 22. Jänner	Donnerstag, 23. Jänner	Freitag, 24. Jänner
08:00	Registrierung	Registrierung	Registrierung
09:00	Pellettag; BEST Tag; Biogastag; Exk. I: Biomassekleinfeuerungen; Exk. II: Effiziente Nahwärmeanlagen; Exk. III: Sektorkopplung und Bioenergie; Exk. IV: Innovative KWK-Anlagen; Exk. V: Bioökonomie; Exk. VI: Forschung und Entwicklung	Wissenschaftliche Eröffnung (Saal 1)	PB 9; PB 10; PB 11; WS Lignin; Wintertagung; WS: Highlights der Bioenergieforschung; IEA Task 44
10:00			
11:00		Politische Eröffnung (Saal 1)	PB 12; PB 14; PB 13
12:00			
13:00		Mittagessen & Posterpräsentation	Mittagessen & Posterpräsentation
14:00		PB 1; PB 2; PB 3; PB 4; IEA-Task 32; WS Landwirtschaft; WS Keep Warm/Clean Air	PB 15; PB 17; PB 16; WS Biokohle; Wintertagung; WS: Highlights der Bioenergieforschung
15:00			
16:00		PB 5; PB 6; PB 8; PB 7	PB 18; PB 20; PB 19
17:00			
Raum	5 8 6	5 6 8 9 7 3 1	6 7 8 4 5 1 9
19:00	Get-together in der Aula	Konferenzdinner in der Alten Universität	
20:00			

Exkursionen · Plenarsitzung · Parallelblöcke & Workshops

Programme of the 6th Central European Biomass Conference CEBC 2020

Time	Wednesday, 22nd of January	Thursday, 23rd of January	Friday, 24th of January
08:00	Registration	Registration	Registration
09:00	Pellet Day; BEST Day; Biogas Day; Exc. I: Small biomass boilers; Exc. II: Efficient district heating plants; Exc. III: Sector coupling and bioenergy; Exc. IV: Innovative CHP-plants; Exc. V: Bioeconomy; Exc. VI: Research and Development	Scientific Opening (Room 1)	PS 9; PS 10; PS 11; WS Lignin; Winter meeting; WS: Highlights of bioenergy research; IEA Task 44
10:00			
11:00		Political Opening (Room 1)	PS 12; PS 14; PS 13
12:00			
13:00		Lunch break & Poster presentation	Lunch break & Poster presentation
14:00		PS 1; PS 2; PS 3; PS 4; IEA-Task 32; WS Agriculture; WS Keep Warm/Clean Air	PS 15; PS 17; PS 16; WS Biochar; Winter meeting; WS: Highlights of bioenergy research
15:00			
16:00		PS 5; PS 6; PS 8; PS 7	PS 18; PS 20; PS 19
17:00			
Room	5 8 6	5 6 8 9 7 3 1	6 7 8 4 5 1 9
19:00	Get-together in the Auditorium	Conference Dinner at the Old University	
20:00			

Excursions · Plenary Session · Parallel Sessions & Workshops

Programmübersicht

Mittwoch, 22. Jänner 2020

ab 08:00 **Registrierung**

07:45–18:30 **Exkursionen I–VI,** S. 16-17

09:00–17:00 Mitteleuropäischer Pellettag,
Saal 5, S. 20

09:00–15:00 BEST Tag,
Saal 8, S. 24

13:30–17:00 Biogas Tag,
Saal 6, S. 21

ab 18:00 **Get-together**

Donnerstag, 23. Jänner 2020

ab 08:00 **Registrierung**

09:00–12:30 **Plenarsitzungen,**
Saal 1, S. 25

12:30–13:30 **Mittagspause** und
Posterpräsentation

13:30 - 17:00 WS: Saubere Luft und effiziente Heizwerke,
Saal 1, S. 225

13:30 - 17:00 WS: IEA-Task 32,
Saal 7, S. 227

13:30 - 17:10 WS: Erdölfreie Land- und Forstwirtschaft,
Saal 3, S. 226

13:30–15:00 **PB 1, Saal 5,** S. 228
Polygeneration & Grüne Treibstoffe

13:30–15:00 **PB 2, Saal 6,** S. 228
Upgrading & Charakterisierung von Biomassebrennstoffen I

13:30–15:00 **PB 3, Saal 8,** S. 229
Konzepte & Wertschöpfungsketten einer biobasierten Bioökonomie

13:30–15:00 **PB 4, Saal 9,** S. 229
Fortschritte bei der Festbettvergasung und Nutzung von Biokohle

15:00–15:30 **Kaffeepause** &
Posterpräsentation

15:30–17:00 **PB 5, Saal 5,** S. 230
Grünes Gas (powered by Energie Steiermark)

15:30–17:00 **PB 6, Saal 6,** S. 230
Upgrading & Charakterisierung von Biomassebrennstoffen II

15:30–17:00 **PB 7, Saal 9,** S. 231
Thermochemische & thermokatalytische Verfahren

15:30–17:00 **PB 8, Saal 8,** S. 231
Integrierte Bioraffinerie- und Biogaskonzepte

20:00 **Konferenzdinner**

Freitag, 24. Jänner 2020

ab 08:00 **Registrierung**

09:00 - 17:00 Wintertagung des Ökosozialen Forums,
Saal 5, S. 238

09:00 - 15:00 Highlights der Bioenergieforschung 2020 des BMVIT,
Saal 1, S. 239

09:00–12:30 WS Lignin,
Saal 4, S. 237

09:30 - 13:30 WS: IEA Task 44,
Saal 9, S. 234

09:00–10:30 **PB 9, Saal 6,** S. 236
Sekundärmaßnahmen zur Reduktion der Emissionen aus der BM-Verbrennung und Vergasung

09:00–10:30 **PB 10, Saal 7,** S. 236
Dekarbonisierung industrieller Prozesse und der Energieversorgung

09:00–10:30 **PB 11, Saal 8,** S. 237
Die Zukunft grüner Treibstoffe & grünen Gases

10:30–11:00 **Kaffeepause** &
Posterpräsentation

11:00–12:30 **PB 12, Saal 6,** S. 240
Herausforderungen für Multi-Fuel-Feuerungen mit niedrigsten Emissionen

11:00–12:30 **PB 13, Saal 8,** S. 240
Bioenergie und biobasierte Ökonomie in Europa

11:00–12:30 **PB 14, Saal 7,** S. 241
Bioenergie in der Praxis

12:30–13:30 **Mittagspause** &
Posterpräsentation

13:30 - 17:30 WS Biokohle,
Saal 4, S. 235

13:30–15:00 **PB 15, Saal 6,** S. 242
Fortschrittliche Methoden und traditionelle Technologien

13:30–15:00 **PB 16, Saal 8,** S. 242
Nachhaltigkeit von Bioenergie- und Bioökonomiewertschöpfungsketten I

13:30–15:00 **PB 17, Saal 7,** S. 243
Logistik

15:00–15:30 **Kaffeepause** &
Posterpräsentation

15:30–17:00 **PB 18, Saal 6,** S. 244
Technologien für dezentrale Biomasse-KWKs

15:30–17:00 **PB 19, Saal 8,** S. 244
Nachhaltigkeit von Bioenergie- und Bioökonomiewertschöpfungsketten II

15:30–17:00 **PB 20, Saal 7,** S. 245
Bereitstellung, Speicherung und Verteilung von Biowärme

Vortragssprache im Detailprogramm gekennzeichnet: Vortragssprache **Englisch** | Vortragssprache **Deutsch** | **Simultanübersetzung**

Programme Overview

Wednesday, 22nd of January, 2020

from 08:00 on: **Registration**

07:45–18:30 **Excursions I–VI,** p. 16-17

09:00–17:00 Pellet Day,
Room 5, p. 20

09:00–15:00 BEST Day,
Room 8, p.24

13:30–17:00 Biogas Day,
Room 6, p. 21

from 18:00 on: **Get-together**

Thursday, 23rd of January 2020

from 08:00 on: **Registration**

09:00–12:30 **Plenary sessions,**
Room 1, p. 25

12:30–13:30 **Lunch break** and
Poster presentation

13:30 - 17:00 WS: Clean Air and efficient district heating plants,
Room 1, p. 225

13:30 - 17:00 WS: IEA-Task 32,
Room 7, p. 227

13:30 - 17:10 WS: Petroleum-free agriculture and forestry,
Room 3, p. 226

13:30–15:00 **PS 1, Room 5,** p. 228
Polygeneration & Green Fuels

13:30–15:00 **PS 2, Room 6,** p. 228
Upgrading & Characterization of solid biomass fuels I

13:30–15:00 **PS 3, Room 8,** p. 229
Concepts and value chains of a biobased economy

13:30–15:00 **PS 4, Room 9,** p. 229
Advances in fixed bed gasification and in biochar utilization

15:00–15:30 **Coffee break** &
Poster presentation

15:30–17:00 **PS 5, Room 5,** p. 230
Green Gas (powered by Energie Steiermark)

15:30–17:00 **PS 6, Room 6,** p. 230
Upgrading & Characterization of solid biomass fuels II

15:30–17:00 **PS 7, Room 9,** p. 231
Thermochemical and thermocatalytical processes

15:30–17:00 **PS 8, Room 8,** p. 231
Integrated biorefinery and biogas concepts

20:00 **Conference dinner**

Friday, 24th of January, 2020

from 08:00 on: **Registration**

09:00 - 17:00 Winter meeting of the Ökosoziale Forum,
Room 5, p. 238

09:00 - 15:00 Highlights of bioenergy research 2020 (powered by BMVIT),
Room 1, p. 239

09:00–12:30 WS Lignin,
Room 4, p. 237

09:30 - 13:30 WS: IEA Task 44,
Room 9, p. 234

09:00–10:30 **PS 9, Room 6,** p. 236
Secondary measures for the reduction of emissions from biomass combustion and gasification

09:00–10:30 **PS 10, Room 7,** p. 236
Decarbonization of industrial processes and energy supply

09:00–10:30 **PS 11, Room 8,** p. 237
The future of green transportation fuels and green gas

10:30–11:00 **Coffee break** &
Poster presentation

11:00–12:30 **PS 12, Room 6,** p. 240
Challenges for multi-fuel and lowest emissions combustion systems

11:00–12:30 **PS 13, Room 8,** p. 240
Bioenergy and biobased bioeconomy in Europe

11:00–12:30 **PS 14, Room 7,** p. 241
Bioenergy in practice

12:30–13:30 **Lunch break** &
Poster presentation

13:30 - 17:30 WS Biochar,
Room 4, p. 235

13:30–15:00 **PS 15, Room 6,** p. 242
Advanced methods meet traditional technologies

13:30–15:00 **PS 16, Room 8,** p. 242
Sustainability of bioenergy and bioeconomy value chains I

13:30–15:00 **PS 17, Room 7,** p. 243
Logistics

15:00–15:30 **Coffee break** &
Poster presentation

15:30–17:00 **PS 18, Room 6,** p. 244
Technologies for decentral bioelectricity production

15:30–17:00 **PS 19, Room 8,** p. 244
Sustainability of bioenergy and bioeconomy value chains II

15:30–17:00 **PS 20, Room 7,** p. 245
Supply, storage and distribution of bioheat

Language marked in the detailed programme: Language **English** | Language **German** | **Simultaneous translation**

Eschlböck

BIBER wood chippers www.eschlboeck.at

sustainable energy production

technologie for professional use
disc or drum chippers
perfect fine or course chips
for any purpose

Value added from your region

Ecological heat and electricity from wood

ÖKOENERGIE

Wood gasification plants in the low power range - highly profitable solutions for the modern heat supply

- Electrical power rating: 18 kW | 50 kW
- Areas of application: industry, local and district heating, hotels, spas and agriculture
- CO_2-neutral energy production from sustainable resources
- Wood chips/pellets with 30 % moisture content without sieving
- Fully automatic operation
- Short payback times

TÜV AUSTRIA

Conformity assessment according to Directive 2006/42/EC for GGV wood gas combined heat and power plant

greenfingers.at

GLOCK Ökoenergie GmbH I Bengerstraße 1 I 9112 Griffen/Austria I Phone: +43 2247 90300-600 I E-Mail: office@glock-oeko.com GLOCK-OEKO.COM

Inhaltsverzeichnis

Table of contents

Messe Congress Graz: Saalaufteilung

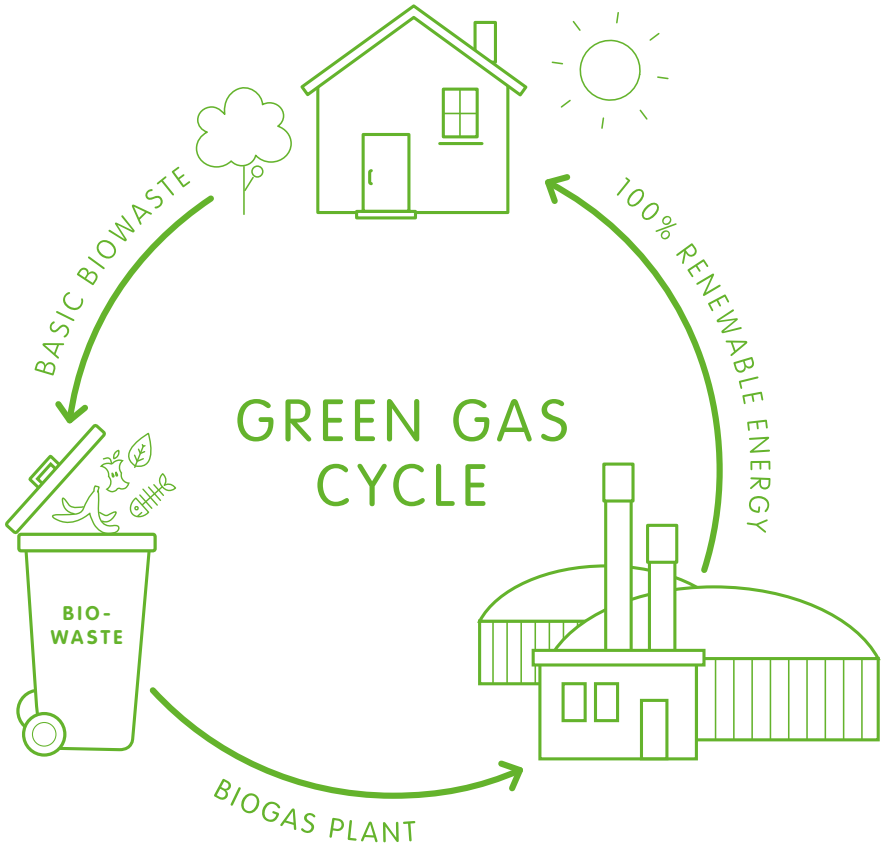
Die Räumlichkeiten der **6. Mitteleuropäischen Biomassekonferenz CEBC 2020** befinden sich im 1. Stock des Messe Congress Graz. Nach der Registrierung beim Haupteingang gelangen Sie über die Rolltreppe zu den Konferenzsälen.

Messe Congress Graz: Floor map

The rooms for the **6th Central European Biomass Conference (CEBC 2020)** are located on the 1st floor of the Messe Congress Graz. After passing the registration at the main entrance you can access the conference rooms via the escalator next to the registration.

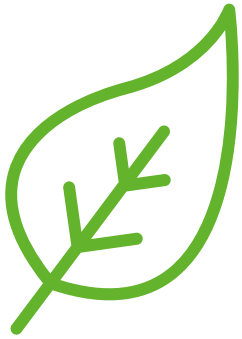
FACT-CHECKING GREEN GAS

Green gas = Biomethane = 100 % renewable



Green gas: your partner in the energy revolution

CO_2-neutral green gas, free of respirable dust, can replace environmentally friendly natural gas equally protecting the climate and providing the ideal renewable energy partner. Authorised offices monitor the quantity supplied on an annual basis, similar to green electricity. Energy suppliers can offer these quantities of renewable gas to their customers. This green gas can also be stored in large quantities.



Step on renewable gas!

Natural gas customers can switch easily without the need for any conversion, continuing to use existing heating systems as usual.
For further information go to www.e-netze.at or dial +43 (0)316 90555

ENERGIE NETZE STEIERMARK

Ein Unternehmen der ENERGIE STEIERMARK

EGGER
PowAir®
CLEANING

Mobile bioenergy system cleaning throughout Europe
24 hours a day
7 days a week (24/7)

Save up to 26% on renewable sources of energy through EGGER-DENGEL-EFFEKT®

From England to Italy, from Spain to the Russian border technical cleaning with PowAir by Egger PowAir Cleaning GmbH. The Egger PowAir cleaning team offer a mobile service throughout Europe - 24/7.

Just phone or email us.

TÜV-certified cleaning-method. Since 2014. State of the Art 2019/2020.

Extract from the TÜV report: ***The „Egger-Dengel-Effekt®" smoothes and compresses the surface after cleaning which makes it more resistant.***

0% Water - 0% slag as an abrasive - 0% brushing –
100% cleaning - 100% GREEN

- TÜV SCC safety certification
- DIN ISO 9001
- DIN 14001 certified
- OHSAS 18001 certified
- ISO 50001 energy management system
- CBRE/Shell Security Certificate
- IFBEC
- UN Global Compact
- atmosfair – 100% CO2-footprint offset

FLATRATE UNIT PRICE ALL INCLUSIVE THROUGHOUT EUROPE:
no extra call-out fees - no hidden costs - no nasty surprises

Egger PowAir Cleaning GmbH

toll free number :
00800-CLEANING
00800-25326464

phone +43 6225 28810
office@eggerpowair.com
www.eggerpowair.com

froling
besser heizen

PLUS X AWARD®
honoured as:
BEST
BRAND
OF THE YEAR
2019

INNOVATIVE SOLUTIONS FROM 7 TO 1500 KW.

Awarded several times.




- Pellet boilers
- Firewood boilers
- Wood chip boilers
- Firewood and pellet boilers
- Fixed-bed gasifier systems

www.froeling.com **Tel. 07248 / 606 - 0**

Programm Teil 1

Exkursionen, Plenarsitzung, Pellettag, Biogas-Halbtag, BEST Tag

Teil 2 finden Sie ab Seite 224

Programme Part 1

Excursions, Plenary session, Pellet Day, Biogas-Day, BEST Day

Part 2 you will find from page 224 on

Exkursionen

Mittwoch 22 Jänner

Exkursion I
Biomassekleinfeuerungen

08:00 Abfahrt Messe Congress Graz Parkplatz
09:00 - 11:00 **Posch GmbH**
- Innovationen bei Holzspaltern und Kreissägen

12:45 **Mittagessen** bei KWB
14:00 - 17:00 **KWB – Kraft und Wärme aus Biomasse**
- Fertigung von Biomassekesseln

18:30 Ankunft Messe Congress Graz

Exkursion II
Effiziente Nahwärmeanlagen

08:00 Abfahrt Messe Congress Graz Parkplatz
09:30 - 11:00 **Nahwärme Eibiswald eGen**
- 2,7 MW Heizwerk
  2.500 m² thermische Solaranlage
  700 kW Rauchgaskondensation

12:00 **Mittagessen**
14:00 - 16:00 **Fernwärme Leibnitz 100% Carbon free**
- 4,8 MW Heizwerk
  0,4 MW Rauchgasreinigung und Wärmerückgewinnung
  Abwärme Integration, Demonstrator für Österreich im Rahmen des Green Energy Labs

16:30 - 18:00 **Nahwärme Fernitz GmbH**
- 1,5 MW Heizwerk
  Rauchgaskondensation
  BHKW Biogas

18:30 Ankunft Messe Congress Graz

Exkursion III
Sektorkopplung und Bioenergie

08:00 Abfahrt Messe Congress Graz Parkplatz
09:30 - 11:30 **Mayr-Melnhof-Holz Holding AG**
- KWK, Pellets, Säge

13:00 **Mittagessen**
14:30 - 15:30 **Hackervorführung Eschlböck GmbH**
16:00 - 18:00 **Sappi Austria Produktions-GmbH & Co KG**
- Integriertes Energiekonzept und Fernwärmeauskopplung

18:30 Ankunft Messe Congress Graz

Exkursion IV
Innovative KWK-Anlagen

08:00 Abfahrt Messe Congress Graz Parkplatz
09:45 - 11:45 **Bioenergiezentrum GmbH**
- HKW Klagenfurt Ost
  10 MW el., 50 MW th

12:00 **Mittagessen** Mochoritsch Griffen
13:45 - 15:45 **Glock Ökoenergie GmbH**
- Holzgas, KWK-Anlagenbau
  Fernwärme Griffen

18:00 Ankunft Messe Congress Graz

Excursions

Wednesday 22 January

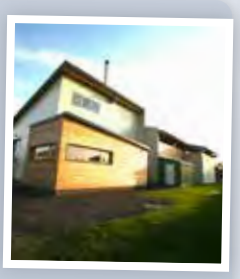
Excursion I
Small biomass boilers

08:00 Departure from Messe Congress Graz parking lot
09:00 - 11:00 **Posch GmbH**
- Innovations in wood splitters and circular saws

12:45 **Lunch** at KWB
14:00 - 17:00 **KWB – Power and warmth from biomass**
- Production of biomass boilers

18:30 Arrival at Messe Congress Graz

Excursion II
Efficient district heating plants



08:00 Departure Messe Congress Graz parking lot
09:30 - 11:00 **Nahwärme Eibiswald eGen**
- 2,7 MW heating plant
  2.500 m² thermic solar collector
  700 kW flue gas condensation

12:00 **Lunch**
14:00 - 16:00 **Fernwärme Leibnitz 100% Carbon free**
- 4,8 MW heating plant
  0,4 MW Flue gas cleaning and heat recovery
  waste heat integration, demonstrator for Austria as a part of the Green Energy Labs

16:30 - 18:00 **Nahwärme Fernitz GmbH**
- 1,5 MW heating plant
  flue gas condensation
  BHKW biogas

18:30 Arrival at Messe Congress Graz

Excursion III
Sector coupling and bioenergy

08:00 Departure from Messe Congress Graz parking lot
09:30 - 11:30 **Mayr-Melnhof-Holz Holding AG**
- CHP, pellets, saw

13:00 **Lunch**
14:30 - 15:30 **Wood chipper demonstration Eschlböck GmbH**
16:00 - 18:00 **Sappi Austria Produktions-GmbH & Co KG**
- integrated energy concept and district heating extraction

18:30 Arrival at Messe Congress Graz

Excursion IV
Innovative CHP-plants

08:00 Departure from Messe Congress Graz parking lot
09:45 - 11:45 **Bioenergiezentrum GmbH**
- CHP Klagenfurt Ost
  10 MW el., 50 MW th

12:00 **Lunch** at Mochoritsch Griffen
13:45 - 15:45 **Glock Ökoenergie GmbH**
- Wood gas, CHP-plant construction

Fernwärme Griffen
18:00 Arrival at Messe Congress Graz

Exkursionen

Mittwoch 22 Jänner

Exkursion V
Bioökonomie

08:00 Abfahrt Messe Congress Graz Parkplatz

09:30 - 10:30 **Tschiggerl Agrar, Halbenrain**
- Maisspindel-Erntetechnik, rechtliche Grundlagen, thermische und stoffliche Maisspindelnutzung etc.

10:30 - 11:30 **Südoststeirische Pelletierungsgenossenschaft eGen**
- Pelletierung von agrarischer Biomasse

11:30 - 12:15 **Verfeuerung von agrarischen Brennstoffen mit Schneckenbrennertechnologie**

12:30 **Mittagessen**

14:00 - 15:00 **Stoffliche Nutzungsmöglichkeiten agrarischer Reststoffe in der Praxis**
- Nutzung von Spelzen, Traubentrester, etc.

15:45 - 17:00 **Biomethan-Einspeiseanlage Strass**
- Strass „Greening the Gas" - Kläranlage mit Methanisierung

18:30 Ankunft Messe Congress Graz

Exkursion VI
Forschung und Entwicklung

08:00 Abfahrt Messe Congress Graz Parkplatz

08:30 - 10:00 **Energie Graz**
- Solares Speicherprojekt Helios Graz

10:30 - 12:00 **KELAG Wärme GmbH**
- Biogene Gärwärme für das Brauquartier Puntigam

12:00 **Mittagessen** Brauhaus Puntigam

14:00 - 15:00 **BEST – Bioenergy and Sustainable Technologies GmbH**
15:15 - 16:15 **LEC – Large Engines Competence Center**
16:30 - 17:30 **CEET – Institut für Chemische Verfahrenstechnik und Umwelttechnik**

18:00 Ankunft Messe Congress Graz

Organisatorisches: Der Treffpunkt ist um 07:45 Uhr bei der Konferenzregistrierung. Die Abfahrt für die Exkursionen erfolgt vom Parkplatz des Messe Congress Graz.
Vortragssprache: deutschsprachige Führung mit englischsprachiger Begleitung

Excursions

Wednesday 22 January

Excursion V
Bioeconomy

08:00 Departure from Messe Congress Graz parking lot

09:30 - 10:30 **Tschiggerl Agrar, Halbenrain**
- Corn cob harvest technology, legal issues, thermic and und material corn cob use

10:30 - 11:30 **Südoststeirische Pelletierungsgenossenschaft eGen**
- Pelleting of agricultural biomass

11:30 - 12:15 **Burning of agraric fuels with screw burner technology**

12:30 **Lunch**

14:00 - 15:00 **Material uses of agricultural residues in practice**
- Use of husks, grape marc, etc.

15:45 - 17:00 **Biomethane – Infeed plant Strass**
- Strass „Greening the Gas" - Sewage plant with methanation

18:30 Arrival at Messe Congress Graz

Excursion VI
Research and Development

08:00 Departure from Messe Congress Graz parking lot

08:30 - 10:00 **Energie Graz**
- Solar storage project Helios Graz

10:30 - 12:00 **KELAG Wärme GmbH**
- Biogenic fermentation heat for the brewing district Puntigam

12:00 **Lunch** at Brauhaus Puntigam

14:00 - 15:00 **BEST – Bioenergy and Sustainable Technologies GmbH**
15:15 - 16:15 **LEC – Large Engines Competence Center**
16:30 - 17:30 **CEET – Institut für Chemische Verfahrenstechnik und Umwelttechnik**

18:00 Arrival at Messe Congress Graz

Organisation: The meeting point is at 07:45 at the conference registration. Departure starts from the parking lot at the Messe Congress Graz.
Language: German speaking guides with English speaking support

ENERGY IS A CIRCLE.

We close it.

SYNCRAFT®
Das Holzkraftwerk.

POLYTECHNIK
Biomass Energy

POLYTECHNIK - The Experts for climate protection and for Energy Production from Biogenic Solid Fuels

55 Years of Experience

- More than 3.200 installations, active all over the globe
- Experience with more than 200 different types of solid fuel

All Forms of Energy

- Boiler plants for heating and process heating
- Grate firing - boiler outputs of 300 kW to 30,000 kW
- Warm water, hot water, steam, thermal oil, cooling, energy
- Carbonisation plants

POLY-H.E.L.D. Combustion Technology with Output Ranges of 400 kW - 1500 kW

Proven Technology

- Counterflow system with integrated grate
- Performance capacities of
  400 / 600 / 1000 / 1500 kW

Flexible Use of Raw Materials

- Forest chips, waste wood, waste wood from landscape conservation, agricultural waste, briquettes, pellets, fuel water content of up to 45% by weight

Efficient and Clean

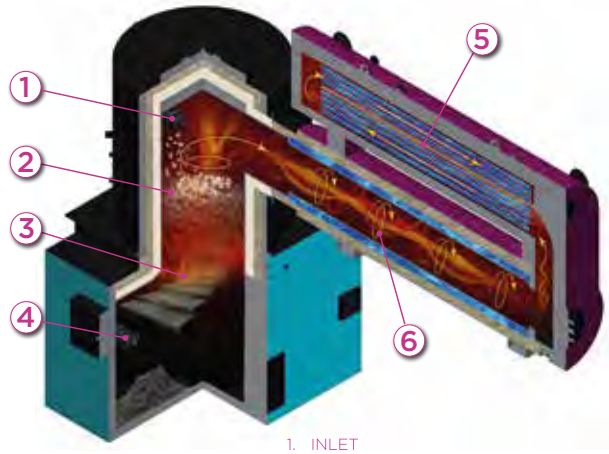
- Efficiency >= 92%
- Low internal energy consumption
- Low NO_x and dust emissions even without filter

Flexible Application

- Process heat
- Heating
- Energy
- Warm water
- Hot water
- Steam
- Thermal oil

Flexible Operation

- Quick controls, control range of 25% - 100%



1. INLET
2. FUEL BED
3. GASIFIER GRATE
4. ASH REMOVAL
5. HEAT EXCHANGER
6. SPECIAL LOW-NOX BURNER

POLYTECHNIK Luft-und Feuerungstechnik GmbH
Hainfelderstrasse 69, 2564 Weissenbach, Österreich
office@polytechnik.at, www.polytechnik.com, Tel. +43 (0) 2672 890-0, Fax. +43 (0) 2672 890-13

Mitteleuropäischer Pellettag, Saal 5, 9:00 – 17:00

Pelletproduktion & -verbrauch in Mittel- und Osteuropa – aktuelle Entwicklungen und Ausblick

Vortragssprache **Englisch**

Mittwoch 22 Jänner

„Mit der Dringlichkeit der CO_2 Reduktion steigt international das Interesse an Pellets als klimafreundlichem Energieträger. Der Pellettag gibt einen Überblick über die aktuellen Entwicklungen in Mittel- und Osteuropa."

Chairman: Christian Rakos, *Geschäftsführer proPellets Austria*

09:00 **Eröffnung**

Block 1: Marktentwicklung

09:20 **Die Entwicklung internationaler Pelletmärkte**
Gilles Gauthier, *Bioenergy Europe, Belgien*

09:40 **Der polnische Pelletmarkt**
Agnieszka Keczkowska, *Biomass Media Group, Polen*

10:00 **Pelletproduktion und Pelletnutzung am Balkan**
Branko Glavonjic, *Universität Belgrad, Serbien*

10:30 **Kaffeepause**

11:00 **Der russische Pelletmarkt**
Alexander Afanasyev, *Peltrade, Großbritannien*

11:20 **Trends auf dem italienischen Pellet- und Ofenmarkt**
Annalisa Paniz, *AIEL, Italien*

11:40 **Der deutsche Pelletmarkt**
Martin Bentele, *Deutscher Energieholz- und Pellet-Verband, Deutschland*

12:00 **Der österreichische Pelletmarkt**
Christian Rakos, *proPellets Austria, Österreich*

12:30 **Mittagspause & Posterpräsentation**

Block 2: Wandelnde Umwelten

13:30 **Europäische Energiepolitik – aktuelle Entwicklungen und mögliche Auswirkungen**
Nathalie Hemeleers, *Bioenergy Europe, Belgien*

13:50 **NGO-Kampagnen gegen Pellets**
Nino Aveni, *Bioenergy Europe, Belgien*

14:10 **Potenziale und Grenzen des Single-Pellet-Press-Konzepts zur Bewertung von Biomasse und zur Prozessgestaltung**
Wilfried Pichler, *Holzforschung Austria, Österreich*

15:00 **Kaffeepause**

Block 3: Technologische Fortschritte und Qualitätsmanagement

15:30 N.N.

15:50 **Verbrennung mit extremer Luftstufung: Die neue Technologie für mittelgroße Kessel der Firma Polytechnik**
Lukas Schirnhofer, *Polytechnik, Österreich*

16:10 **Pelletnutzung in Afrika: Optimierung eines Kochofens für die emissionsarme nachhaltige Nutzung von Pellets aus landwirtschaftlichen Reststoffen**
Robert Scharler, *Technische Universität Graz, Österreich*

16:30 **ENplus Revision – kürzliche Verbesserungen des weltführenden Pelletzertifizierungssystems**
Elena Dumitru, *European Pellet Council, Belgien*

17:00 **Ende**

EUROPEAN PELLET COUNCIL – A NETWORK OF BIOENERGY EUROPE

EN plus

pro»pellets Austria

Central European Pellet Day, Room 5, 9:00 – 17:00

Pellet production & usage in Central and Eastern Europe – current developments and future outlook

Language **English**

Wednesday 22 January

„With the urgency of reducing CO_2, international interest in pellets as a climate-friendly energy source is increasing. The Pellet Day gives an overview of the current developments in Central and Eastern Europe."

Chairman: Christian Rakos, *CEO of proPellets Austria*

09:00 **Opening**

Session 1: Market development

09:20 **The development of international pellet markets**
Gilles Gauthier, *Bioenergy Europe, Belgium*

09:40 **The Polish pellet market**
Agnieszka Keczkowska, *Biomass Media Group, Poland*

10:00 **Pellet production and pellet usage on the Balkan**
Branko Glavonjic, *University of Belgrad, Serbia*

10:30 **Coffee break**

11:00 **The Russian pellet market**
Alexander Afanasyev, *Peltrade, Great Britain*

11:20 **Recent trends in the Italian pellet and stove market**
Annalisa Paniz, *AIEL, Italy*

11:40 **The German pellet market**
Martin Bentele, DEPV *Deutscher Energieholz- und Pellet-Verband, Germany*

12:00 **The Austrian pellet market**
Christian Rakos, *proPellets Austria, Österreich*

12:30 **Lunch break & Poster presentation**

Session 2: Changing Environments

13:30 **European Energy Policy – current developments and possible effects**
Nathalie Hemeleers, *Bioenergy Europe, Belgium*

13:50 **NGO-Campaigns against pellets**
Nino Aveni, *Bioenergy Europe, Belgium*

14:10 **Potential and limitations of the single-pellet-press concept for biomass assessment and process design**
Wilfried Pichler, Holzforschung Austria, Austria

15:00 **Coffee break**

Session 3: Technology advances and quality management

15:30 N.N.

15:50 **Extreme combustion staging: the new technology for medium scale boilers by Polytechnik**
Lukas Schirnhofer, *Polytechnik, Austria*

16:10 **Pellet use in Africa: Optimization of a cooking stove for the low-emission sustainable use of pellets from agricultural residues**
Robert Scharler, *Technical University of Graz, Austria*

16:30 **EN-plus Revision – recent improvements of the world leading pellet certification system**
Elena Dumitru, *European Pellet Council, Belgium*

17:00 **End**

EUROPEAN PELLET COUNCIL – A NETWORK OF BIOENERGY EUROPE

EN plus

pro»pellets Austria

Biogastag, Saal 6, 13:30 – 17:00

Die Rolle von Biogas im Zeithorizont eines Jahrzehnts

„Die Bioökonomie und die Kreislaufwirtschaft sind mit der Biogastechnik als effizienteste Form der Reststoffverwertung zur Energie- und Düngeproduktion eng verbunden."

Chairman: Bernhard Stürmer, *Geschäftsführer des Kompost & Biogas Verband Österreich*

Vortragssprache **Deutsch**

Mittwoch 22 Jänner

13:30 **Beginn**

Organische Abfälle aus dem Tourismus für die Erzeugung von Biogas – Charakterisierung, Potenziale und Herausforderungen
Marco Johannes Wehner, *Universität Innsbruck, Österreich*

BioFlock – Einsatz biologischer und nachhaltiger Flockungsmittel zur Gärresteaufbereitung
Wolfgang Gabauer et al., *Universität für Bodenkultur, Österreich*

Modellierung und Steuerung von Biogasanlagen für eine bedarfsgerechte Biogaserzeugung
Lena Peters et al., *Hochschule Emden/Leer, Deutschland*

Biogasaufbereitung durch chemische Absorption mit Aminosäuresalzlösungen
Nelson Soto et al., *Universität Stuttgart, Deutschland*

15:00 **Kaffeepause**

Registersystem zur Administration von Bewegungen erneuerbarer Gase
Stefanie Königsberger, *AGCS, Österreich*

Tanksystem als Kompaktanlage – Leasingmodell wie etwa ein Presscontainer
Michael Meirer*, *MEIKO GREEN Waste Solutions, Österreich*

Biogaswirtschaft – neue Konzepte zur Biotonnenvergärung
Guntram Bock, *Pöttinger, Österreich*

Erkenntnisse aus 10 Jahren Arbeitskreis
Bernhard Stürmer, *Kompost & Biogas Verband Österreich, Österreich*

17:00 **Ende**

** angefragt*

Biogas Day, Room 6, 13:30 – 17:00

The role of biogas within a decade

„Bioeconomy and the circular economy are closely linked with biogas technology as the most efficient form of waste recycling for energy and fertilizer production."

Chairman: Bernhard Stürmer, *CEO of the Kompost & Biogas Verband Österreich*

Language **German**

Wednesday 22 January

13:30 **Opening**

Organic waste from tourism for biogas production – characterization, potential and challenges
Marco Johannes Wehner, *University of Innsbruck, Austria*

BioFlock – Use of biological and sustainable flocculants for preparing digestate
Wolfgang Gabauer et al., *University of Natural Resources and Life Sciences, Austria*

Modelling and control of biogas plants for a demand-driven biogas production
Lena Peters et al., *Hochschule Emden/Leer, Germany*

Biogas Upgrading by chemical absorption with amino acid salt solutions
Nelson Soto et al., *University Stuttgart, Germany*

15:00 **Coffee break**

Register system for the administration of movements of renewable gases
Stefanie Königsberger, *AGCS, Austria*

The tank system as a compact system – leasing model such as a press container
Michael Meirer*, *MEIKO GREEN Waste Solutions, Austria*

Biogas economy – new concepts for organic waste collection fermentation,
Guntram Bock, *Pöttinger, Austria*

Findings from 10 years of work group
Bernhard Stürmer, *Kompost & Biogas Verband Österreich, Austria*

17:00 **End**

** requested*

KLAGENFURT
Biomass Capital of Europe!

„The city with a **carbon-free** future"

- Two strong partners – Stadtwerke Klagenfurt AG and Bioenergie Kärnten.
- Stadtwerke Klagenfurt AG is one of Carinthia's most important infrastructure companies in the areas of electricity, heat, gas and water.
- Bioenergie Kärnten supplies 27,000 households with CO2-free district heating at its locations in the east, south and north of Klagenfurt.
- 40,000 households are supplied with green electricity from biomass.
- 50% reduction in CO2 in Klagenfurt due to green electricity and district heating from biomass.
- The common goal is to further improve the quality of life and the air quality in Klagenfurt and to make Klagenfurt a model city in bioenergy production through the use of cutting-edge technology.

Our energy is supplied by nature

STW Stadtwerke Klagenfurt

BIO ENERGIE KÄRNTEN

DI Erwin Smole
STW Vorstand

Mag. Harald Tschurnig
STW Vorstand

DI(FH) Markus Poppe
GF Bioenergie Kärnten

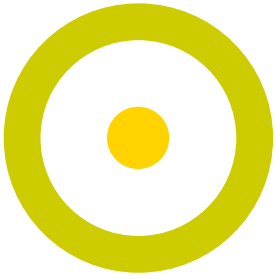
Ing. Johann Moser
GF Bioenergie Kärnten

The biggest renewable energy source in the world: Mother Nature

Nature never runs out of energy. Flora and fauna renew themselves every day, creating bio mass as they do, which is wonderful for us to use to generate fuel, electricity and heat. Renewable raw materials, our sun, wind, water and energy efficiency, are the backbone of a sustainable and conscientious use of our resources. Talk to us about renewable energy – the most natural thing in the world.

RENEWABLE ENERGY

ING. LEO RIEBENBAUER



www.riebenbauer.at . office@riebenbauer.at . T 03339 25 113

BEST Tag

Vortragssprache **Englisch**

Saal 8, 09:00 – 15:00

„Das COMET-Zentrum BEST (vormals BIOENERGY 2020+) präsentiert ausgewählte Highlights aus aktuellen Forschungsprojekten."

Chairman: Walter Haslinger, *BEST, Österreich*

09:00 **Block 1: Überwindung technologischer Herausforderungen bei der Biomasseverbrennung- und vergasung**

Individuelles Wärmemanagement im Wohnzimmer, Manuel Schwabl, *Area Fixed Bed Conversion Systems*

Beeinflussung der Ascheeigenschaften in Festbettverbrennungssystemen, Stefan Retschitzegger, *Area Fixed Bed Conversion Systems*

NO_x Modellierung und Emissionsreduktion, Michael Essl, *Area CFD Modelling and Simulation*

Die virtuelle Biomassebefeuerung, Kai Schulze, *Area CFD Modelling and Simulation*

Einfluss der aschebildenden Elemente biogener Reststoffe auf Wirbelschichtkonversionsprozesse, Katharina Fürsatz, *Area Fluidized Bed Conversion Systems*

11:00 **Block 2: Beiträge einer biobasierten Ökonomie**

Produktflexibilität der Biomassedampfvergasung durch die Veredlung des Produktgases und Syntheseprozesse, Matthias Binder, *Area Fluidized Conversion Systems*

Integration der Biomassedampfvergasung in die bestehende Infrastruktur der Papier- und Zellstoffindustrie, Thomas Karel, *Area Fluidized Bed Conversion Systems*

Mittwoch 22 Jänner

Valorisierung ungenutzter Abfallströme der Papier- und Zellstoffindustrie und der Tierkörperverwertung – Herstellung von technischen Enzymen, Markus Ortner, *Area Bioconversion and Biogas Systems*

Herausforderungen und aktuelle Ergebnisse in der Mikroalgenforschung, Katharina Meixner, *Area Bioconversion and Biogas Systems*

Treibstoffe für die Dekarbonisierung des Transportsektors – Länderschwerpunkt auf Finnland, Schweden, Deutschland, USA und Brasilien, Doris Matschegg, *Area Sustainable Supply and Value Chains*

12:30 **Mittagspause & Posterpräsentation**

13:30 **Block 3: Fortschrittliche Methoden für die Entwicklung von Wertschöpfungsketten und Regelung von Technologien und Energiesystemen**

Entwicklung von Wertschöpfungsketten aus verschiedenen Rohstoffen, Monika Enigl, *Area Sustainable Supply and Value Chains*

Optimierungsbasierte Planung von Energiesystemen, Michael Zellinger, *Area Smart and Microgrids*

Lab zur Entwicklung von Regelungsalgorithmen für zellulare Energiesysteme/Microgrids, Stefan Aigenbauer, *Area Smart and Microgrids*

Modullares Energiemanagementsystem für Multi-Energie-Systeme, Daniel Muschik, *Area Automation and Control*

Modellbasierte Schätzung des Rauchgasmassenstroms in Biomassefeuerungen, Helmut Niederwieser, *Area Automation and Control*

BEST Day

Language **English**

Room 8, 09:00 – 15:00

„The COMET-Center BEST (formerly BIOENERGY 2020+) presents selected highlights from current research projects."

Chairman: Walter Haslinger, *BEST, Austria*

09:00 **Session 1: Overcoming barriers in biomass combustion and gasification**

Individual heat management in the living room, Manuel Schwabl, *Area Fixed Bed Conversion Systems*

Modification of ash properties in fixed bed combustion systems, Stefan Retschitzegger, *Area Fixed Bed Conversion Systems*

NO_x modelling and emission reduction, Michael Essl, *Area CFD Modelling and Simulation*

Virtual biomass combustion plant, Kai Schulze, *Area CFD Modelling and Simulation*

Influence of ash forming elements of biogenic residues on the performance of fluidized bed conversion, Katharina Fürsatz, *Area Fluidized Bed Conversion Systems*

11:00 **Session 2: Contributions to the biobased bioeconomy**

Product flexibility from biomass steam gasification applying gas upgrading and synthesis processes, Matthias Binder, *Area Fluidized Conversion Systems*

Wednesday 22 January

Integrating steam gasification into established infrastructure in the pulp and paper industry, Thomas Karel, *Area Fluidized Bed Conversion Systems*

Valorisation of untapped industrial waste streams from the pulp & paper and rendering industry – production of technical enzymes, Markus Ortner, *Area Bioconversion and Biogas Systems*

Challenges and recent results in microalgae research, Katharina Meixner, *Area Bioconversion and Biogas Systems*

Biofuels for transport decarbonisation – Country specific assessments for Finland, Sweden, Germany, USA, and Brazil, Doris Matschegg, *Area Sustainable Supply and Value Chains*

12:30 **Lunch break & Poster presentation**

13:30 **Session 3: Advanced methods for the establishment and control of value chains, technologies and energy systems**

How to create value chains from different feedstocks, Monika Enigl, *Area Sustainable Supply and Value Chains*

Optimization based planning of energy systems, Michael Zellinger, *Area Smart and Microgrids*

Test bed for the development of control algorithms for cellular energy systems/microgrids, Stefan Aigenbauer, *Area Smart and Microgrids*

A modular energy management system for multi-energy systems, Daniel Muschik, *Area Automation and Control*

Model-based estimation of the flue gas mass flow in biomass furnaces, Helmut Niederwieser, *Area Automation and Control*

Plenarsitzungen

Simultanübersetzung Saal 1, 09:00 – 12:30

Donnerstag 23 Jänner

Klimaschutz & Bioenergie

09:00 Wissenschaftliche Eröffnung

Moderation: Ingmar Höbarth, *Geschäftsführer Klima- & Energiefonds*

Eröffnungsstatements:
- **Simone Schmiedtbauer**, *EU-Abgeordnete*
- **Siegfried Nagl,** *Bürgermeister von Graz*
- **Hannes Tuohiniitty,** *Präsident Bioenergy Europe*
- **Armin Egger,** *Geschäftsführer MCG*

Klimakrise: Die Rolle der Waldbewirtschaftung
Hubert Hasenauer, *Rektor Universität für Bodenkultur*

Nachhaltige Biomasse-Potenziale für den Klimaschutz
André Faaij, *Universität Groningen*

Holzgas und Holzdiesel: Vom Labor in den Markt
Hermann Hofbauer, *Technische Universität Wien*

„Bionenergie ist ein wesentlicher Eckpfeiler für die Bewältigung der Klimakrise. Sie unterstützt die nachhaltige Waldbewirtschaftung, stellt den Löwenanteil der erneuerbaren Energie und ermöglicht die fossilfreie Produktion von Holzprodukten."

Franz Titschenbacher, *Präsident ÖBMV & LK Steiermark*

11:00 Politische Eröffnung

Moderation: Andreas Jäger, *ORF-Journalist & Meteorologe*

Eröffnungsstatements:
- **Franz Titschenbacher**, *Präsident Österreichischer Biomasse-Verband*
- **Johann Seitinger,** *Agrarlandesrat Steiermark*
- **Elisabeth Köstinger,** *Bundesministerin, BMNT*
- **Manfred Pachernegg,** *Geschäftsführer Energienetze Steiermark*

Impuls-Vortrag:
Die unterschätzte Klimakrise
Andreas Jäger, *ORF-Journalist & Meteorologe*

Podiumsdiskussion:
Greening the Strategies: Bioenergie als Schlüssel zu Wald- und Klimaschutz

Franz Titschenbacher, *Präsident ÖBMV und LK Steiermark*
Karin Enzenhofer, *WWF Österreich*
Katharina Rogenhofer, *Klimavolksbegehren*
Elisabeth Köstinger, *Bundesministerin, BMNT*
Hubert Hasenauer, *Rektor Universität für Bodenkultur*
Hannes Tuohiniitty, *Präsident Bioenergy Europe*
Manfred Pachernegg, *Energienetze Steiermark*



Plenary Sessions

Simultaneous translation Room 1, 09:00 – 12:30

Thursday 23 January

Climate protection & bioenergy

09:00 Scientific Opening

Host: Ingmar Höbarth, *CEO of Klima- & Energiefonds*

Opening Statements:
- **Simone Schmiedtbauer**, *EU-Representative*
- **Siegfried Nagl,** *Mayor of Graz*
- **Hannes Tuohiniitty,** *President of Bioenergy Europe*
- **Armin Egger,** *CEO of MCG*

Climate Crisis: The role of forest management
Hubert Hasenauer, *Headmaster of BOKU*

Sustainable biomass potentials for climate protection
André Faaij, *University of Groningen*

Gas and fuels from wooden biomass: From the laboratory on the market
Hermann Hofbauer, *Technical University of Vienna*

„Bioenergy is an essential milestone for coping with the climate crisis. It supports forest management, provides the lion share of renewable energy and enables a fossil-free production of wood products."

Franz Titschenbacher, *President of ABA & LK Styria*

11:00 Political Opening

Host: Andreas Jäger, *ORF-Journalist & Meteorologist*

Opening Statements:
- **Franz Titschenbacher**, *President Austrian Biomass Association*
- **Johann Seitinger,** *Agricultural Councilor of Styria*
- **Elisabeth Köstinger,** *Federal Minister, BMNT*
- **Manfred Pachernegg,** *CEO of the Energienetze Styria*

Lecture:
The underestimated climate crisis
Andreas Jäger, *ORF-Journalist & Meteorologist*

Panel discussion:
Greening the Strategies: Bioenergy as the key to forest and climate protection

Franz Titschenbacher, *President ABA & LK Styria*
Karin Enzenhofer, *WWF Austria*
Katharina Rogenhofer, *Klimavolksbegehren*
Elisabeth Köstinger, *Federal Minister, BMNT*
Hubert Hasenauer, *Headmaster of BOKU*
Hannes Tuohiniitty, *President of Bioenergy Europe*
Manfred Pachernegg, *CEO of the Energienetze Steiermark*



Drei Partner – eine gemeinsame Vision

„Fernwärmelieferung von Sappi für Graz“

sappi

bioenergie.at
Ihr Plus in Wärme.

ENERGIE GRAZ

Eindampfanlage Papierfabrik Sappi

Fernwärmeleitungsbau Bioenergie

Pump- und Regelgebäude Graz

Erfolgreiche Projektumsetzung seit 2016

- ✓ Nutzung der Abwärme der Papierfabrik Sappi zur Fernwärmeversorgung
- ✓ Branchenübergreifende Kooperation und Know-how Austausch
- ✓ 300.000 MWh Wärmelieferung seit 11/2016
- ✓ 82.000 Tonnen CO_2-Einsparung seit 11/2016

Ausbau durch zusätzliche Abwärmenutzung

- ⊕ Nutzung zusätzlicher Niedertemperatur-Abwärme
- ⊕ Effizienzverbesserung durch Einsatz einer Industrie-Wärmepumpe
- ⊕ Ausbau der Wärmelieferung auf 240.000 MWh pro Jahr ab 2020/2021
- ⊕ Dadurch 70.000 Tonnen jährliche CO_2-Einsparung

Klimafreundliche Wärme für Graz

Bioenergie Fernwärme BWS GmbH I 03144 / 71 207 - 0 I office@bioenergie.at I **www.bioenergie.at**

HARGASSNER

HEATING TECHNOLOGY FOR BIOMASS

CHANGE TO BIOMASS NOW

BENEFIT FROM LOWEST HEATING COSTS

HARGASSNER - YOUR SPECIALIST FOR
PELLETS, WOODLOG & WOODCHIP-BOILERS

T: +43 (0) 77 23 / 52 74 - 0, www.hargassner.at

Lösungen nach Maß.
Begeisterung inklusive
Österreichweit.

kelag
Energie & Wärme

Energy is our passion

Sustainable. Innovative. Dependable.
Relying on experience and passion we are one of the leading companies in the utilization of industrial waste heat and bioenergy and provide more and more people with our products – from single-family homes to industrial enterprises. For a sustainable and dependable all-around care throughout Austria.

T: 05 0280 2800
office@kew.at
www.kew.at
/KelagEnergie

KELAG Energie & Wärme GmbH – Zentrale
St. Magdalener Straße 81, 9524 Villach
Wien | Salzburg | Linz | Innsbruck | Graz | Villach

13:30–17:00 Uhr

Biogastag

Die Rolle von Biogas im Zeithorizont eines Jahrzehnts

01:30 pm–05:00 pm

Biogas Day

The role of biogas within a decade

Biogas Upgrading by Chemical Absorption with Amino Acid Salt Solutions

Nelson Felipe Rincón Soto
University of Stuttgart
Institute of Combustion and Power Plant Technology (IFK)
Pfaffenwaldring 23
70569 Stuttgart, Germany,
nelson.rincon@ifk.uni-stuttgart.de

Co-Authors: Marc Oliver Schmid, Günter Scheffknecht

One possible use of biogas is its direct conversion to electricity in on-site cogeneration units at the location of the biogas production. As most of the biogas plants are located in rather rural areas, one of the major drawbacks of this form of utilization is the insufficient use of the generated heat. To improve efficiency, biogas could also be fed into the national gas grid and could be converted into electricity at locations which feature heat sinks. To inject the biogas into the national gas grid it has to be upgraded, meaning that the carbon dioxide (CO_2) must be removed. Nowadays, several upgrading technologies such as pressure swing adsorption, pressurized water scrubbing, or scrubbing with amines, e.g., monoethanolamine (MEA) are applied for this purpose. As commonly used amines, e.g., MEA, DEA, MDEA are produced on a crude-oil base and tend to degrade under certain process conditions, potential alternative aqueous solvents such as solutions of amino acid salts must be considered. They feature the same chemical functional groups and can react selectively with CO_2 in the same way as conventional amines do. Amino acids are natural, non-toxic products, which can be biotechnologically produced by fermentation.

Based on laboratory investigations on CO_2 equilibrium data, the heat of reaction, reaction kinetics, and their stability; selected amino acid salts were investigated in the pilot-scale chemical scrubber plant ABIGAIL at the IFK. The plant consists of an absorption and a desorption column as well as of an external reboiler. The plant is operated with synthetic gas, which is recycled, allowing the investigation of wide operation conditions concerning the overall gas flow and the CO_2 input concentration. The desorber is equipped with random packing material; whereas the packing material of the absorber column is easily exchangeable. Random packing in the absorber was selected for current experiments. The solvent can be injected at four different heights along the absorption column, simulating different overall absorber-heights and allowing detailed investigations. The thermal energy input for solvent regeneration is adjustable up to 60 kW. The plant is completely automated and equipped with a large number of measurement ports for temperature, pressure, liquid and gas fluxes and gas concentration, which are recorded continuously. Gas flows of the plant can be adjusted up to 76 m^3/h and liquid flows up to 500 l/h. These vast ranges allow the investigation of various solvents at their optimum operation conditions (Adjustment of optimum liquid-to-gas, L/G ratio at the simultaneously optimum fluid dynamic operational point of the packed column).

In the proposed contribution operational data for the CO_2-chemical absorption at different process conditions will be shown for 30 wt.-% aqueous MEA solution as a benchmark for commonly used solvents. The results will be compared to the performance of selected amino acid salts solutions. Results of the plant operation with the different solvents will be shown as a function of the CO_2 concentration, the L/G ratio, and the thermal energy input for solvent regeneration. The comparison will focus on the impact of the inlet-CO_2 partial pressure, the absorber temperature, the thermal energy input and the L/G ratio. The overall energy consumption of the process and the effect on process design (e.g., the height of absorber) will be further discussed.

Modelling and control of biogas plants for a demand-driven biogas production

Lena Peters
University of Applied Sciences Emden/Leer, EUTEC Institute
Constantiaplatz 4
26723 Emden, Germany
b lena.peters@hs-emden-leer.de

Co-Authors: Priv.-Doz. Dr. habil. F. Uhlenhut a, Dr. P. Biernacki a, Prof. Dr. S. Steinigeweg

Limited fossil resources and the climate change require a more efficiently and environmentally friendly energy production. Hence, the energy policy concept of Germany provides that in future the electricity will be covered mostly by renewable energies. Because wind and solar energy sources depend on weather conditions fluctuations in energy supply will occur. Energy storage systems and systems for demand-driven energy production will be essential to cover the residual load rises. For example, predictive models for the residual load rises make it possible to adapt the operation of biogas plants to the demand. But the technical possibilities for a flexible operation of biogas plants are currently underutilized.

Therefore, the development and application of a demand-driven feeding management is the topic of the research project “Flexibla” at the University of Applied Sciences Emden/Leer. Within the project a rigorous dynamic process model based on the Anaerobic Digestion Model No. 1 (ADM1) is used to analyse the flexible operation of biogas plants for covering the residual load rises. This model was optimised and an operation concept for a demand-driven energy production was worked out. For that, the feeding amount and composition of available substrates was adapted to the energy demand by a controller.

Within batch experiments and the Weender analysis the degradation kinetics, biogas production and ingredients of different substrates were examined. For this, mainly substrates were used that are fast degradable and thus lead to a rapid biogas production. The measurement results were used to determine the model input parameters and to calibrate the process model. By lab fermentation the model was validated.

The lab experiments showed the different biogas production rates of the substrates. Especially for the flexibilisation, substrates with a high degradation rate are important, since a rapid reaction to fluctuations of power demand is necessary. With the process model it was calculated how a flexible operation of biogas plants can be used to produce methane amounts that match an exemplary residual load rise of a local energy supplier. By adapting the feeding times, the substrate composition and amounts, this profile could be almost completely covered. Moreover, different combinations of substrates and different combinations of flexible and continuous operation were simulated.

All in all, the results show that it is possible to operate biogas plants flexibly with an individual and intelligent feeding programme to follow mid- and long-term trends such as weekly trends and seasonal differences, but not short-term trends.

Funding: The authors would like to thank the European Regional Development Fund (ERDF) for the financial support within the research project “Flexibla – Flexible operation of biogas and biomethane plants”.

Erkenntnisse aus 10 Jahren Arbeitskreis Biogas

Bernhard Stürmer
Kompost & Biogas Verband Österreich
Schwedenplatz 2/20-21
1010 Wien, Austria
stuemer@kompost-biogas.info

Arbeitskreise sind Gruppen von LandwirtInnen mit gleichem Produktionsschwerpunkt. Wobei sich die Arbeitskreis-TeilnehmerInnen zusammenschließen, um betriebliches Wissen auszutauschen um in weiterer Folge den Betrieb strategisch und operativ weiterentwickeln zu können. Neben diesem Wissenstransfer unterstützen BeraterInnen die Arbeitskreise durch Schwerpunktinformationen. Derzeit nehmen über 4.700 Betriebe in rund 280 Arbeitskreisen das Informationsaustausch-Angebot in Anspruch (Arbeitskreisberatung, 2019).

Seit dem Jahr 2009 ist auch der Arbeitskreis Biogas ein fixer Bestandteil des Weiterbildungsangebots. Da die Erhebung von produktionstechnischen und wirtschaftlichen Daten ein wesentlicher Bestandteil der Kontrolle und Verbesserung des Betriebserfolgs ist, werden auch im Arbeitskreis Biogas eine Reihe von Daten gesammelt und aufbereitet. Auch wenn die Geschichte von Biogas in Österreich eine lange ist, hat sich der Biogassektor mit dem ersten bundesweiten Ökostromgesetz deutlich verändert (Stürmer, 2017). Daher konnten erst nach dem Vollbetrieb der ersten Biogasanlagen auf Basis von nachwachsenden Rohstoffen erste wichtige Kennzahlen abgeleitet werden (vgl. zB. Hopfner-Sixt, 2005; Walla, 2006). Mit dem Arbeitskreis Biogas kann nun auf eine 10jährige Datenreihenfolge zurückgegriffen werden, mithilfe derer die Entwicklung dieses Sektors aufgezeigt werden kann.

Je nach Jahr wurden Daten von 120 bis 140 Biogasanlagen vollständig erhoben. Dabei sind deutliche Verschiebungen beim Substrateinsatz zu erkennen. Stammten 2010 noch 72% des Biogases von Ackerpflanzen, sank dieser Anteil 2017 auf 58%. Im Gegenzug stieg der Anteil an Reststoffen der Landwirtschaft und an biogenen Abfällen von 18% auf 31%. Trotz Anstieg dieser Substratfraktionen konnten die Volllaststunden, seit Inbetriebnahme der Anlagen, kontinuierlich gesteigert werden. Auch der Brennstoffnutzungsgrad, ein Maß für die Effizienz der Biogasanlage, stieg von anfänglich unter 60% auf über 65% im Jahr 2017 an.

Im Zeitraum 2002 bis 2017 haben die Biogasanlagen des Arbeitskreises Biogas insgesamt 290 Mio. € investiert. Dies entspricht bei einer Hochrechnung auf alle österreichischen Biogasanlagen über 400 Mio. €. Der Großteil der Investitionen (78%) wurde dabei aus dem Inland bezogen. Laut Koller (2016) haben mit knapp 40% die Bauarbeiten (Hochbau, Tiefbau und sonstiger Bau) den größten Anteil unter den Investitionsgütern und -dienstleistungen. Es folgen elektrische Ausrüstungen (19%) und Maschinen (13%). In den letzten Jahren machte der Anteil des Substrates rund 55% der variablen Kosten aus. Im Zeitraum zwischen 2002 und 2017 gaben die österreichischen BiogasanlagenbetreiberInnen insgesamt rund 580 Mio. € für Substrate aus. Die Wartungs- und Instandhaltungskosten beliefen sich in diesem Zeitraum auf insgesamt 405 Mio. €. Durch die politische und damit rechtliche Unsicherheit in den Jahren 2016 und 2017 stiegen die Wartungs- und Instandhaltungskosten deutlich an, wobei gelichzeitig das Investitionsvolumen deutlich sank. Die Arbeitserlediungskosten auf den Anlagen beliefen sich im Zeitraum 2002 bis 2017 auf knapp 140 Mio. € womit rund 310 Arbeitsplätze geschaffen wurden.

13:30–15:00 Uhr

Parallelblock 1

Polygeneration & Grüne Treibstoffe

01:30 pm–03:00 pm

Parallel Session 1

Polygeneration & Green Fuels

Thermodynamic modelling and analysis of a biomass based polygeneration plant producing bio-oil, electricity, heat and fertilizer

René Kofler
DTU Mechanical Engineering
Technical University of Denmark
Kgs. Lyngby, 2800, Denmark
renekof@mek.dtu.dk

Co-Author: Lasse R. Clausen

The transition to a fossil fuel free society imposes different challenges, including the security of electricity supply, the supply of fuels for the transport sector and the heat supply. Combining bio-refineries with heat and power production is an interesting approach, providing a single, flexible solution for these challenges.

Within this work, a biomass based polygeneration plant based on an already proven technology is studied. The system is able to co-produce heat, power, bio-oil and fertilizer. The plant consists of a LT-CFB (low temperature circulating fluid bed) gasifier coupled with a ceramic filter, a zeolite-based deoxygenation, a tar-condenser and a gas engine.

The LT-CFB gasification process was originally developed at DTU and was subsequently scaled up by a Danish energy company. The gasifier has been designed specifically to gasify biomass resources with high contents of low melting ash compounds such as straw, manure fibres, sewage sludge, organic waste etc. The process is based on separate pyrolysis and gasification reactors with an inert stream of particles (sand and ash) circulating to transfer heat from the gasification process to the pyrolysis reactor. The ash or biochar extracted can be further used as fertilizer.

The product gas of the LT-CFB gasifier is upgraded in two steps. In the first step, the particles are removed from the produced gas in a ceramic candle filter. The second step is the deoxygenation of the gas phase tar in a zeolite based catalytic reactor. The reduction of bio-oil oxygen content is required for efficient use of the oil and for improving the oil properties.

After the zeolite unit, the bio-oil is extracted from the gas by cooling and condensation. The bio-oil can be further treated in an oil refinery for the use as transport fuels, such as gasoline and diesel. The remaining gas is burned in an internal combustion engine, producing electricity and heat.

In this work, a thermodynamic model of the polygeneration system was developed based on experimental data from the different components of the plant. The model was used to analyze and optimize the system. The analysis considered the heat integration within the plant and different operation modes of the LT-CFB gasifier, e.g. for maximum bio-oil production and maximum electricity production.

To-Syn-Fuel: The demonstration of advanced fuels from sustainable biomass

Nils Jäger
Fraunhofer UMSICHT
Fraunhofer Institute for Environmental, Safety, and Energy Technology
An der Maxhütte 1
92237 Sulzbach-Rosenberg, Germany
nils.jaeger@umsicht.fraunhofer.de

Co-Authors: Johannes Neidel, Jan Grunwald, Stefan Eder, Andreas Apfelbacher, Robert Daschner, Andreas Hornung

Some of the world's most pressing challenges are related to climate, energy, and mobility. Biogenic residues could be one element for a sustainable and economic transition in these areas. Also, the utilization of biogenic residues into advanced liquid or gaseous fuel production can significantly reduce disposal problems and contribute to independence from fossil fuels and non-sustainable biomass without any competition between food and animal feed biomass. Fraunhofer UMSICHT proved with the development of the Thermo-Catalytic-Reforming (TCR®) that the material utilization of biogenic residues into EN-conform products is state of the art and already successfully demonstrated in laboratory and pilot scales. To bring the technology closer to the market, the project TO-SYN-FUEL was started in May 2017 with 12 partners from five different countries across Europe. The project is funded by European Horizon 2020 research program, and the target is the demonstration and process validation at near-commercial scale.

TO-SYN-FUEL is an integrated approach and combines three core technologies in one plant: TCR®, pressure swing adsorption (PSA), and hydrodeoxygenation (HDO). The integration of these technologies with up- and downstream processes generate green hydrogen and liquid fuels according to the European standards EN228 (gasoline) and EN590 (diesel).TCR® technology converts a broad range of residual biomass like digestate or municipal and industrial sewage sludge into three main products: carbonisate, H_2-rich synthesis gas, and oil. The hydrogen is separated from the TCR® syngas in the PSA. The compressed hydrogen and the crude TCR® oil are fed in the HDO unit. The removal of heteroatoms in the oil such as sulfur, nitrogen and oxygen in the HDO process generates a high quality liquid fuel mixture. In a further step, the HDO oil can be fractionated into a diesel or gasoline equivalent.

Within the TO-SYN-FUEL project, dried sewage sludge will be tested as feedstock. The project is adopting a holisitc approach including environmental and social sustainability mapping. This project will mark the first pre-commercial scale deployment of the technology processing 2100 tonnes of dried sewage sludge into 210,000 liters of liquid biofuels and up to 30,000 kg of green hydrogen. The demonstration phase of the integrated TCR/PSA/HDO plant will start in 2020 at the site location in Hohenburg, Germany.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grand agreement No 745749.

EN-Fuels from solid waste biomass by catalytic hydrogenation of bio-oil produced by thermocatalytic reforming TCR®

Jan Grunwald
Fraunhofer UMSICHT
Fraunhofer Institute for Environmental, Safety, and Energy Technology,
An der Maxhütte 1
92237 Sulzbach-Rosenberg, Germany

Co-Authors: Andreas Hornung, Robert Daschner, Andreas Apfelbacher

Due to the Paris climate change agreement, the replacements of fossil oil as well as CO_2 mitigation are important aims. To avoid the conflict of the use of agricultural land in terms of cultivation of energy crops and food, biological waste and biological residues is the targeted material for applied bioenergy conversion. Thermo-Catalytic Reforming (TCR®) is a promising conversion technology for the production of liquid bio-fuels. The TCR®-process combines intermediate pyrolysis and catalytic reforming of the generated intermediate pyrolysis products. The process is a proven technology to convert biological wastes and residues into hydrogen rich syngas, high quality oil, and char free of volatiles. The lower heating value (LHV) of the TCR®-oil is 34 MJ/kg and the LHV of the TCR®-gas 14 MJ/m^3 (Feedstock: digestate).

The TCR®-oil offers considerable advantages like low water content (<2 wt%), low oxygen content (5 – 9 wt.%), and high carbon content (up to 80 wt.%). The most crucial advantage, the thermal stability of the TCR®-oils, allows thermal downstream processing. Hydrogen from TCR®-gas can be extracted and can be used for the upgrading processes of TCR®-oil. The produced hydrogen, which is present in excess from the TCR® process, can be used for the hydrogenation or as a green hydrogen resource for other applications as the process produces more hydrogen than required for the hydrogenation. Beside the thermochemical conversion of biomass a downstream key component is the catalytic hydrogenation of the TCR® oil removing the heteroatoms like nitrogen, sulfur and oxygen in order to generate high quality renewable hydrocarbons fulfilling EN standards or to generate green chemicals. The LHV of the hydrogenated bio-oil increases up to 42 MJ/kg. This valorization step by hydrogenation is the focus of this research report. For an optimization and scale up of the hydrotreating process different catalyst under varying process conditions are tested using a lab scale batch reactor. The results of these lab scale experiments will be used for the continuous flow pilot plan.

Purpose of the research project is to investigate process conditions like pressure, temperature and catalyst behavior to convert TCR®-oil into EN fuels. Starting from the conversion of various kinds of biological waste into high quality bio-oil, hydrogen rich gases (up to 50 vol.%), and a volatile free carbon rich solid phase by TCR®, the afterwards, catalytically hydrogenation at higher temperatures and pressures of the TCR® oils is the crucial part for the production of the EN fuels. The hydrogen required for the hydrogenation, can be extracted from the TCR®-gas. The continuous flow pilot plant can hydrogenate up to 3 liters per hour.

The prerequisite for the hydrogenation of the TCR®-oil are the outstanding qualities like the thermal stability and the low water and oxygen content. These properties allow a successful thermal processing. In terms of the hydrogenation products, the final product composition depends on the catalyst used and for that various industrial catalysts were tested to optimize and varying the product composition.

Employing the TCR® process and catalytic hydrogenation of bio-oil, the production of fuels or chemicals like alkanes and aromatics has been proven. The product composition depends strongly on the catalyst applied. Additionally, the product can be distilled generating a 60:40 mixture renewable gasoline and diesel meeting the standards EN 228 and EN 590.

Chemical Looping Gasification – A Novel Process for the Sustainable Production of Biofuels

Paul Dieringer
Technical University of Darmstadt
Institute for Energy Systems and Technology
Otto-Berndt-Str. 2
64206 Darmstadt
Paul.Dieringer@est.tu-darmstadt.de

Co-Authors: Falko Marx, Jochen Ströhle, Bernd Epple

In light of the current challenges in terms of climate protection and energy transition, novel, sustainable and yet competitive processes and technologies in the energy, transport, and industry sector are urgently needed.

Within the scope of the EU-funded Horizon 2020 project CLARA, consisting of thirteen international members including universities, research institutes, and industry partners, an efficient technology for the production of liquid fuels based on chemical looping gasification (CLG) of biogenic residues is being developed. The major objective is to further investigate and test CLG up to 1 MW_{th} scale in an industrially relevant environment. Furthermore, the project aims at devising and optimizing innovative, cost-efficient technologies for biomass pre-treatment and syngas cleaning. These novel process steps will be supplemented by established fuel synthesis technologies (i.e. Fischer-Tropsch process & hydrocracking), yielding the full biomass-to-biofuel process chain, which will be investigated during pilot tests.

The major advantage of the suggested process is that through the cyclic reduction and oxidation of the oxygen carrier deployed in CLG, no air separation unit (ASU), commonly needed for oxygen-driven gasification processes, is required. Moreover, a novel combination of an amine and caustic wash, promising major reductions in CAPEX and OPEX, when compared to the established Rectisol® process, is deployed for acid gas removal.

By focusing on biological non-food-grade precursors, CLARA contributes not only to a sustainable shifting from fossil to renewable resources, but also facilitates the large-scale economic production of biofuels, without detrimental effects on food availability and prices arising. This aspect, in combination with the projected advances in terms of process scalability, CO_2-reduction potential (negative emission via BECCS/U) and biofuel costs (no ASU & novel syngas cleaning concept), makes the process investigated within the scope of CLARA an auspicious candidate for future thermochemical conversion processes.

During the presentation held in the course of the *6. Central European Biomass Conference,* the suggested process chain and the associated innovative technologies will be presented, before current findings and a short outlook will be given. Here, the main focus will be placed upon the novel gasification technology.

13:30–15:00 Uhr

Parallelblock 2

Upgrading & Charakterisierung von Biomassebrennstoffen I

01:30 pm–03:00 pm

Parallel session 2

Upgrading & Characterization of biomass fuels I

Torrefaction/Carbonization: What are today's offers to the market?

Michael Wild
International Biomass Torrefaction Council
Place du Champ de Mars
1050 Brussels
michael@wild.or.at
http://ibtc.bioenergyeurope.org

Torrefaction of biomass to produce a superior solid biofuel has been highly promoted in the last decade. The hype around 2010 was followed by disillusionment caused by weak performance of the loudest promotors of the technology but also by reduction of thermal capacity and biomass demand by European utilities and/or delayed implementation of national biomass co-firing programs. Now, almost a decade later torrefaction is getting in full swing of commercialization. The current development leaves little doubt that these technologies and the resulting fuels will strengthen their position in the global biomass-to-energy value chain in the next years.

In the presentation an update on existing plants respectively plants in the pipeline around the globe will be provided. Further topics discussed: Where is the current demand and how can it develop. What are results of comparative studies to other solid biomass fuels, mostly White Wood Pellets in terms of M&E balance and GHG emissions along the supply chains. Rounding off the presentation on status of torrefaction a glimpse on feedstock flexibility and other than pure energy applications for the product will be provided.

Mobile pellet production – innovation driven revolution of the biomass process chain

Martin Weigl
Holzforschung Austria
Franz Grill Straße 7
1030 Vienna, Austria
w.pichler@holzforschung.at

Co-Authors: Wilfried Pichler, Josef Schaider, Ludwig Schaider, Christian Freilach

A wide range of applications for several kinds of biomass is limited by inefficient logistics. High water content and low bulk density usually limit biomass logistics. After ten years of development of the Symmetric-Double-Ring (SDR) pellet press, mobile pellet production is currently facing a market revolution. The SDR was fully integrated within the Schaider Pelletec D 8.0, producing 8 tons high value agro-pellets per hour directly on the field. The product is stabilised for storage and significantly increased in bulk density. This enables cost efficient transport to a wide range of applications e.g. for energy use, biorefinery, or animal feed.

The SDR is an alteration of a conventional ring die press, whereas the roller got replaced by an inner ring die. This enables pellets discharge towards two directions, giving a significantly increased output at narrow space of a mobile pellet unit. By using exhaust heat from the engine for drying and conditioning of the biomass, production is extremely energy and cost efficient. The specific energy uptake depends on the biomass resource, typically leading to 20 to 30 kWh per tonne of agro-pellets. Production costs can be held easily underneath 40 € per tonne.

This research demonstrates the physical model behind the SDR press development as well as results from field trials done with first commercial unit on the market. Energy uptake, process stability and product quality are demonstrated.

References:
Winner of the ACR-Kooperationspreis 2018: https://www.youtube.com/watch?v=O1N-mDcsIXg
Nomination for the Houskapreis 2019: https://www.youtube.com/watch?v=IJR8id3gzzM

Valorization of forestry residues as solid fuels using slow pyrolysis

Marta Martins
CERENA
Instituto Superior Técnico
Av. Rovisco Pais 1
1049-001 Lisboa, Portugal
marta.oliveira.martins@tecnico.ulisboa.pt

Co-Authors: Mandal Amélia Lemos, Francisco Lemos, H. Pereira

Forest residues are bulky and have high moisture content. These characteristics make collection transportation and processing of these materials in energy applications difficult and expensive, since biomass has a relatively low bulk density as well as energy density. Pre-treatment of solid biomass by torrefaction can improve its properties and generates a solid product (charcoal) with lower moisture content, higher bulk density, higher heating value, better microbial stability, more hydrophobic and better grindable than the raw biomass.

[1] Torrified biomass can replace coal in domestic and industrial applications, with the additional advantage of being renewable.

[2] Moreover, the collection and use of these forestry wastes (e.g shrubs) may also result in increased safety of forest stands against fire. In this work, slow pyrolysis experiments have been carried out by thermal analysis coupled with differential scanning calorimetry, in inert atmosphere at varying torrification temperatures (200°C, 250°C, 300°C e 350°C) and reaction times (30, 60 and 90 min). The same experiments were also reproduced in a lab-scale reactor. After the torrefaction process, the heating value of the samples was determined using the TG/DSC apparatus under combustion conditions. Morphological changes before and after thermal analysis were evaluated by microscopy techniques. The results showed that torrefaction is a promising way to reduce the mass while maintaining the energy content of shrub biomass.

Process Simulations of Vacuum Drying Technologies for Woodchips

Václav Marek
University of West Bohemia in Pilsen
Regional Technological Institute
30100 Pilsen, Czech Republic
marekv06@rti.zcu.cz

Modern production process of biomass operates with material in many structures and qualities. Basic identification of quality and mechanical properties is defined by structure and humidity. Presented research is focused on wooden biomass, especially on woodchips. Characteristic properties of woodchips are following: shape of chips, humidity of chips and the kind of wood. All technological applications of woodchips deal with humidity of input material. Pelleting, briquetting and combustion of woodchips solve problems of high humidity of input material. The process of wooden biomass drying is significantly expensive. What motivates the research of vacuum drying technology is the reduction of drying costs and energy consumption. Vacuum drying technology is commonly used process in production of timber goods. This technology is not suitable for woodchips drying. Energetic behaviour, processing method and drying speeds make woodchip drying and timber-goods drying different. Technology progression and required technologies are motivated by the demand of efficient drying with respect to energy recuperation, amount of required material and level of output humidity.

The development of vacuum drying technology for woodchips began by prototype of single-dose dryer. This technology uses single dose, filled with woodchips and heated by source of hot air. The vacuum condition decreases the drying temperature and causes critical condition of humidity in the woodchips. Vacuum drying of the woodchips is characterised by high requirements for a vacuum pump technology. Evaporation of water in the vacuum condition causes extreme rise of volume flow which is sucked by the vacuum pump. The temperature and the heat content also influent the pump function. The heat transfer to the mass of woodchips is defined by particle movements, isolation layers and the volume flow of heating medium. The development progressed to continuous process option. The continuous processing in the vacuum condition defined a new overall design and due to overall optimization the drying capacity was enlarged. The present research examines a way of direct contact of heating medium in the vacuum condition, which eliminates the resistance between the medium and woodchips. The new vacuum technology operates with large amount of the input heat, the constant under pressure in the workspace and the high recuperation of input heat. The developed technology was compared with tested prototype of single dose vacuum dryer. The developed prototype device already produces woodchips for a briquetting machine.

The simulation of the woodchip drying in vacuum condition is not a trivial issue. The heat transfer and the mass flow is commonly described by coefficients and predicted dependencies. Generally, CFD or FEM simulation are characterised by a high costs of the computation. It is necessary to optimize the methodology of the computation to reach the required accuracy with respect to affordable costs. New methods should be implemented to calculation process. One of these methods is macro-element computation. The computation process is divided into two statements: prediction and simulation. The prediction provides basic data in the beginning of the design and the simulation provides precise results for the verification of detail design. An accuracy of results is influenced mostly by the defined boundary condition. The definition of boundary conditions is a significant problem of non-homogeneous materials, natural materials, sawdust etc. Due to that the verification and the validation is necessary. Prototype measurements of the first single-dose vacuum dryer provided vital data. The measurements by an infrared camera verified functions and provided data about heat transfers. The post-processing of measurements combined with CFD/FEM simulation provides data about hidden inner heat transfers.

This research paper reviews goals of the woodchips drying development with emphasis on used calculations and simulations. The methodology of a computation is also described and partial problems of simulations are solved. The comparison with measurement results provides a real description of the technology.

13:30–15:00 Uhr

Parallelblock 3

Konzepte und Wertschöpfungsketten einer biobasierten Bioökonomie

01:30 pm–03:00 pm

Parallel session 3

Concepts and value chains of a biobased bioeconomy

Advanced Biofuel from Waste Wood Integrated in the Steel Industry

Maria Hingsamer
Joanneum Research
Elisabethstraße 18/II, 8010 Graz, Austria
maria.hingsamer@joanneum.at

Co-Authors: Ingrid Kaltenegger, Gerfried Jungmeier, Wim Van der Stricht, Jo Sluijsmans, Stephan Claes, Filip Johnsson, Markus Hadler

Within the H2020 project TORERO (**TOR**efying wood with **E**thanol as a **R**enewable **O**utput: large-scale demonstration), a cost-, resource-, and energy-efficient technology concept for producing bioethanol from a wood waste feedstock, fully integrated in a large-scale, industrially functional steel mill is demonstrated. Wood waste is converted to biocoal by torrefaction, biocoal replaces fossil powdered coal in a steel mill blast furnace. Carbon monoxide and hydrogen in blast furnace exhaust fumes is microbially fermented to bioethanol, while material and energy loops of the process are closed to a very large degree. Every steel mill that implements this concept will be able to produce approx. 80 million litres of bioethanol per year by using 120,000 t of waste wood per year. This project creates a value chain for wood waste, which currently has no high value applications. TORERO technology can be used to upgrade existing facilities of the steel sector. TORERO demonstrates the first implementation of a technology concept for creating and using torrefied wood for the production of bioethanol, fully integrated in a large-scale, industrially functional steel mill. The outcomes will be of great interest to both the bioethanol end-users but also to Europe as a whole through the reduction of the usage of fossil fuel and thus significantly reducing GHG emissions. To assess the sustainability a Life Cycle Assessment (LCA) is used for the environmental assessment, furthermore a social Life Cycle Assessment (s-LCA) is applied, providing scientific indicators for social aspects of this new value chain. To assess the sustainability along the whole value chains, life cycle-based methodologies have been developed over the last years. Life Cycle Assessment (LCA) considers mainly environmental impacts along supply chains, from extraction of raw materials to end-of-life of products. LCA is also a key tool for the steel industry as well as for biorefineries. Based on the integrated process design for TORERO the LCA methodology is adapted to the specific challenges and framework conditions of the project. The different sectors (e.g. steel industry, wood waste chain and the recycling, waste industry) and the circular economy approach are included and linked to each other in the assessment. Within the LCA the environmental effects of the whole value chain of the TORERO process are analyzed. The key environmental effects for the assessment (e.g. GHG emissions, GHG emission reduction potential, primary energy demand) are quantified and compared with LCA of conventional reference products e.g. gasoline, electricity from waste wood. The most relevant systems are identified, for which then the environmental effects are assessed. Alternative uses of waste wood and the actual situation in the steel industry are part of the conventional reference system. Similarly to LCA, social Life Cycle Assessment (s-LCA) integrates traditional life cycle assessment methodological steps while having social impacts as focus). The social Life Cycle Assessment (s-LCA) is a rather novel method that follows in principle the ISO 14040 framework and complements the environmental LCA. It is used to assess the social and sociological aspects of products, their actual and potential positive as well as negative impacts along the life cycle. In 2009, the UNEP/SETAC s-LCA Guidelines were issued, which aims at providing a general guidance on the use of s-LCA, facilitating a more uniform performance of this technique. In TORERO, the s-LCA (Social Life Cycle Assessment) methodology is being adapted and will be done to identify and describe the most relevant social effects (e.g. labour practices and working conditions, regional corporate citizenship, product responsibility). Coupling the assessment of environmental and socio-economic issues may support more comprehensive sustainability assessment of impacts, benefits, and related trade-offs. TORERO demonstrates for the first time a technology concept for creating and using torrefied wood for the production of bioethanol in a steel mill, fully integrated in a large-scale, industrially functional steel mill. The installation of the new process will probably not be completed within the next half year but preliminary results on the set-up of the assessment in this special context will be available at the time of the conference. The demonstrated use of biomass in the steel mill to produce advanced biofuels will also transform steel sector into a biorefinery to become a relevant part in the future bioeconomy.

Acknowledgement: TORERO has received funding from the European Union's Horizon 2020 - Research and Innovation Framework Programme (H2020-EU.3.3.3. - Alternative fuels and mobile energy sources). Project ID: 745810.

Techno-economic modelling of bioeconomy value chains

Christa Dißauer
BEST Bioenergy and Sustainable Technologies GmbH
Gewerbepark Haag 3, 3250 Wieselburg-Land, Austria
christa.dissauer@bioenergy2020.eu

Co-Authors: Christoph Strasser, Monika Enigl, Doris Matschegg

In the context of Austria´s and the EU´s ambitious goals to combat climate change by reducing the demand for fossil fuels in all sectors, many industries plan to increase the share of renewable energy in their production processes. Furthermore greenhouse gases shall be reduced by 36 % until 2030 (compared to 2005), which means another 14 Mio. tons CO_{2eq} will have to be reduced per year in comparison to data from 2016. In doing so, some industries find it sufficient to use green electricity or green gas from the grid, but for some industries the use of biomass is particularly interesting. In particular, the wood-based economy as an essential part of the Austrian bio-based economy is needed to promote the development of sustainable production and sustainable energy generation. Besides the increasing demand for woody biomass, the supply side will also undergo substantial changes since increasing calamities (such as bark beetle infestation and windthrow) caused by climate change will affect the wood supply to a varying extend. Hence, within the **project "BioEcon"** the BIOENERGY 2020+ team together with industry partners analyses the effects of these developments on the wood-based economy and the corresponding supply chains in terms of economic and technological perspectives including econometric models to evaluate woody biomass supply and demand.

Objectives & Approach
The transition toward a bioeconomy relies to a large extent on the advancement in technology of a range of processes, on cost competitiveness, on the achievement of breakthrough in terms of technical performances and depends on the availability of sustainable biomass. The BioEcon project aims to identify and evaluate these challenges and chances for the wood based industries in a future bioeconomy, in particular by

- Evaluating the biomass potentials in Central Europe
- Identifying and categorizing of market risks and opportunities for selected woody biomass sectors
- Assessing the supply chain interactions of woody biomass, wood products and wood fuels in a future Austrian bioeconomy
- Developing scenarios "Wood Demand in the Austrian Bioeconomy" and analyzing price elasticities of selected wood biomass products and fuels
- Furthermore, to provide a basis for taking strategic decisions on whether and how to increase the share of biomass utilization in the participating industries a tool for techno-economic assessments based on pre-defined building blocks is elaborated.

Results

- Market study on risks and opportunities for woody raw materials and products including the analysis of supply and demand behavior of relevant stakeholders
- Econometric models to predict future supply and demand of woody-biomass under pre-defined conditions of a biobased economy in Austria (taking into account import and export quantities)
- Tool for techno-economic assessments incl. reference assessments for selected value chains
- Development of recommendations and guidelines based on techno-economic assessments, econometric models and a cross-sectoral approach

Kreislaufwirtschaft mit Kompost- und Gärrestanwendung

Sandra Uschnig
Kompost & Biogas Verband Österreich
Schwedenplatz 2/20-21, 1010 Vienna, Austria
uschnig@kompost-biogas.info

Co-Author: Bernhard Stürmer

In Österreich werden täglich fast 13 ha Boden verbaut, davon werden 41% dauerhaft versiegelt. Daneben spielt auch Bodenerosion und Degradation der Bodenqualität, unter anderem durch intensive Landwirtschaft, Klimawandel etc., eine Rolle. Fehlen Maßnahmen zur Erosionsminderung kann es zu Bodenverlusten kommen. All dies vor dem Hintergrund einer langfristigen Sicherung der Versorgung mit qualitativ hochwertigen heimischen Lebensmitteln. Der Einsatz von Kompost und Gärresten kann einen wesentlichen Beitrag zur Lösung dieses Problems leisten. Insbesondere die Wasserspeicherfähigkeit ist eine wichtige Eigenschaft von Humus, gerade auch in Hinblick auf Extremwetterereignisse. In der Natur entsteht Humus in einem ständigen, kreislaufförmigen Prozess. Organisches Material wird zu Humus umgewandelt und im Boden angereichert. Durch die Bewirtschaftung der Böden wird der Kreislauf unterbrochen, daher ist es wichtig die, z.B. durch die Ernte entnommene organische Substanz, wieder zurückzuführen. Dies kann durch den Einsatz von Kompost und Gärresten erfolgen. In Kompostanlagen passiert der Ab- und Umbau organischer Substanz zu Humus durch Mikroorganismen wesentlich schneller als in freier Natur. Kompost enthält Nähr- und Dauerhumus. Kompost stellt einen Vollwertdünger dar in dem alle Pflanzennährstoffe enthalten sind. Insbesondere der Gehalt an Stickstoff, Phosphat und Kalium spielt eine wichtige Rolle. Aus 1,25 Mio. t biogenen Abfällen produzieren die derzeit 402 Kompostanlagen in Österreich jährlich 445.000 t Kompost. Die zur Kompostierung zulässigen Inputmaterialien sind in der Kompostverordnung 2001 definiert. Diese legt auch die Häufigkeit der externen Güteüberwachung des Kompostes fest.

In Österreich sind die Qualitätsanforderungen an Ausgangsmaterialien zur Kompostierung, deren Endprodukte Qualitätskompost, Kompost oder Qualitätsklärschlammkompost definiert und geregelt. Hinsichtlich der Kompostierungstechnik wird hauptsächlich in offenen Mieten kompostiert mit dem Ziel, negative Umweltauswirkungen und Emissionen zu minimieren. Um den hohen Standard der Kompostierung in Österreich zu gewährleisten stellt der Kompost & Biogas Verband Österreich ein Zertifizierungssystem bereit. Dieses überprüft die Einhaltung der Vorgaben Kompostverordnung 2001 sowie des Stands der Technik der Kompostierung. Die österreichischen Biogasanlagen produzieren jährlich aus nachwachsenden Rohstoffen, Reststoffen der Landwirtschaft und biogenen Abfällen etwa 1,5 Mio. t Gärreste. Die Hauptnährstoffe im Gärprodukt sind Stickstoff, Phosphor und Kalium. Gärprodukte bewirken eine Verbesserung der organischen Bodensubstanz, da sie nach wie vor über langsam abbaubares organisches Material verfügen. Im Zuge eines Projektes wurden in Zusammenarbeit mit der AGES, Laboranalysen von Gärresten ausgewertet und hinsichtlich den Anforderungen des nationalen Düngemittelrechts und der zukünftigen EU-Düngemittelverordnung untersucht. Düngemittel dürfen in Verkehr gebracht werden, wenn sie bestimmte Mindestanforderung erfüllen und bei sachgerechter Anwendung die Fruchtbarkeit des Bodens, die Gesundheit von Menschen und Tieren und den Naturhaushalt nicht gefährden. Außerdem müssen sie das Wachstum von Pflanzen fördern, die Qualität der gedüngten Pflanzen verbessern und/oder den Ertrag der gedüngten Pflanzen erhöhen. Zusätzlich müssen die Grenzwerte für Schwermetalle eingehalten werden. Zudem muss einer der Mindestgehalte an Makronährstoffen in der Frischmasse erreicht werden. Die Nährstoffkonzentrationen können stark variieren, je nach Eingangsmaterialien und Mischungsverhältnis. Die Analyseergebnisse der untersuchten Gärprodukte zeigen, dass die vorgegebenen Anforderungen eingehalten wurden. Gärprodukte können als organischer Dünger (Typ 8), als Biogasgülle (Typ 9) oder gemäß §9a DMG und DMVO anerkannt werden. Während i.d.R. der Typ 9 bereits aufgrund der eingesetzten Substrate als Düngemittel anerkannt ist, können Biogasanlagen, die biogene Abfälle einsetzen, die rechtliche Produkteigenschaft (Düngemittel) über den Typ 9a bescheidmäßig erwirken. Aufgrund der Eigenschaften von Gärprodukten sollte die Anerkennung als Düngemittel kein Problem darstellen. In Österreich wurden bereits mehrere Bescheide für Abfallbiogasanlagen ausgestellt. Die Grenzwerte für Schwermetalle wurden in 99,64 % der Untersuchungen unterschritten.

Platform chemicals from biogenic residues by hydrothermal processes

Jakob Köchermann
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH
Torgauer Straße 116, 04347 Leipzig, Germany
Jakob.koechermann@dbfz.de

Co-Authors: Christian Klüpfel, Kati Görsch, Marco Klemm

The rising world population and the resulting shortage of agricultural land imply that in future agricultural products must be utilized as effectively as possible. Therefore, biomass-processing industry has to transform from a single to a multi-product business – called biorefinery. From that purpose, the development of bio-based products like chemicals or fuels from agricultural residues, side streams of pulp and paper or forest industry plays an important role. However, most of these biogenic residues have high moisture contents and need to be dried before they are able for conversion. Hydrothermal processes have received a lot of attention in recent years, since they are suitable to convert such wet biogenic residues in platform chemicals. Platform chemicals are appropriate as starting materials for the production of several different valuable derivatives and offer important flexibility and breadth to the biorefinery. [1]

Within the research project HTKkChem, carbohydrate-rich residues (starch, cereal husks, corncobs) will be used as starting material for production of such platform chemicals. The aim in this ongoing project lies on the development of a two-stage hydrothermal process for the provision of the platform chemicals 5-hydroxymethylfurfural (5-HMF), furfural, levulinic acid, and γ-valerolactone (GVL). While in the first stage, carbohydrates are hydrolyzed and dehydrated using homogeneous catalysts, in the second stage an in-situ hydrogenation is carried out with the aid of heterogeneous catalysts.

For this purpose, experiments with starch residues from a wheat starch factory were carried out using different brönsted/lewis acid combinations. Preliminary results indicate that brönsted/lewis acid combinations perform better regarding the target products compared to use only a brönsted or lewis acid. At the conference, the process concept and results from the experimental examination for the first stage should be presented.

Reference:
[1] J.J. Bozell, G.R. Petersen, Technology development for the production of biobased products from biorefinery carbohydrates—the US Department of Energy's "Top 10" revisited, Green Chem. 12 (2010) 539.

13:30–15:00 Uhr

Parallelblock 4

Fortschritte bei der Festbettvergasung und Nutzung von Biokohle

01:30 pm–03:00 pm

Parallel session 4

Advances in fixed bed biomass gasification and in biochar utilization

Integrated tar-free thermochemical air/steam fixed-bed updraft gasification of biochars

Stefan Eder
Fraunhofer UMSICHT
An der Maxhütte 1
92237 Sulzbach-Rosenberg, Germany
stefan.eder@umsicht.fraunhofer.de

Co-Authors: Andreas Hornung, Robert Daschner, Andreas Apfelbacher

For endothermal biomass conversion processes, like pyrolysis, the integrated thermochemical gasification of solid residues, with subsequent combustion of the produced gas, offers a cost-efficient possibility to generate the required process heat and helps to improve the efficiency of the whole process chain. Especially for decentralized solutions with smaller power ranges, an updraft, fixed-bed gasification technology is advantageous due to its simple process control, high heat transfer rates in the fixed bed, high carbon conversion rates, flexibility in terms of upscaling, and low financial investment. Contrary to biomass, the residues from biomass pyrolysis processes (chars) contain only little volatile components as they have been already processed at 700 °C, as this is the case for TCR®. This is advantageous with regard to a tar-free gasification process. On the other hand, TCR® char may be characterized by a high amount of ash and corrosive elements like sulphur and chlorine depending on the feed material for the pyrolysis or TCR® process. Therefore, issues like the gasification temperatures have to be addressed regarding ash melting and sintering. Experiments on fixed-bed updraft gasification with different char feedstock from TCR®-technology suggest that an optimal working point concerning air/steam ratio and superficial velocity exists. This results in moderate gasification temperatures and a high gas quality.

A concept for updraft gasification with subsequent combustion chamber has been designed at Fraunhofer UMSICHT in Sulzbach-Rosenberg. A pilot plant for auto-thermal, atmospheric air/steam gasification with updraft reactor was built up with a rated thermal input of 45 kW, depending on the feedstock.

Balance of energy and mass is calculated for each experiment. This also includes the measurement of the vertical temperature profile in the gasification reactor and the analysis of the product gas composition. In former experiments, the comparison of the DIN CEN/TS 15439 and solid-phase-adsorption (SPA) method showed that SPA is the better method for low boiling tars. Therefore, a sampling point for SPA method, including trace heating in the product gas line has been integrated to measure the fraction of tar in the product gas.

Experiments on the fixed-bed updraft gasifier with various char feedstock suggest the possibility of eliminating the production of tars by using TCR® char as feedstock. Due to the product gas composition, it can be used as combustion gas and improve the overall efficiency of a plant by being used in a CHP unit or downstream combustion chamber to heat the TCR® unit. The gasifier ash is of low carbon content and powder form, as ash melting was avoided. Usage as fertilizer or for phosphorus recovery has been proven.

Advances in biomass conversion based on gasification for overcoming barriers in bioenergy use for bioheat, bioelectricity and biofuels

Andrés Anca-Couce
Technische Universität Graz, Institut für Wärmetechnik
Inffeldgasse 25b, 8010 Graz, Austria
anca-couce@tugraz.at

Co-Authors: Georg Archan, Lukas von Berg, Gernot Pongratz, Stefan Martini, Christoph Hochenauer, Robert Scharler

Biomass has plentiful energy applications. The most common final energy use is bioheat obtained from biomass combustion. The production of bioelectricity from combustion of solid biomass or from biogas and first-generation liquid biofuels obtained from food crops are the other two most relevant final energy uses. Bioenergy is currently the most relevant renewable energy source, representing 19% and 10% of the final energy consumption in Austria and the EU-28 in 2015, respectively. However, bioenergy and other renewable energy sources still need to significantly increase their use in the following years in order to avoid the most disastrous consequences of global warming. Bioenergy has the main advantage that it allows the production of heat, power and transport fuels. In this work, the current barriers to increase the use of bioenergy and recent advances on gasification-based technologies reached at TU Graz together with several partners are discussed. Biomass gasification is a technology that offers high efficiencies for converting solid biomass and the possibility of producing a wide range of products, including bioheat, bioelectricity and biofuels.

- Bioheat production in commercial systems is currently mainly based on combustion of woody biomass. The main drawbacks are the emissions of air pollutants, mainly NO_x and PM, and the limited feedstock flexibility, specially at small scales. Improvements in these respects can be achieved with combustion technologies operated with a low oxygen concentration in the fuel bed. This is obtained with a low primary air ratio and/or flue gas recirculation in the fuel bed, which resembles a fixed-bed gasifier. This should be combined with air staging technologies that promote reducing conditions for minimizing NO_x emissions. The potential in emissions reduction of NO_x and PM as well as the increase in feedstock flexibility with this approach is discussed.
- Bioelectricity production in commercial systems is currently mainly based on Rankine cycles and gas engines, employing solid biomass or biogas. However, the electrical efficiency of biomass to power is limited by the thermodynamic cycles, commonly to values around 30% with gas engines. This electrical efficiency can be significantly increased with the use of Solid Oxide Fuel Cells (SOFC) employing a producer gas from biomass gasification, achieving values over 40%. The power production from solid biomass employing SOFCs is addressed, and the suitability of employing a producer gas from fixed bed or fluidized bed gasification and the required gas cleaning is discussed.
- Biofuels production from lignocellulosic or waste biomass based on gasification is not yet at a commercial stage. However, this technological pathway has a high potential in the future, as the use of first-generation biofuels will be limited in the next years. Current research activities are focused on fluidized bed gasification to produce liquid or gaseous fuels. However, a through gas cleaning is required for these purposes, as well as for the use of SOFCs. Primary and secondary measures that can be employed for reducing the presence of contaminants such as tars in the producer gas from fluidized bed gasification as well as the different options for biofuels production are discussed.

Concluding, this work summarizes the potential of biomass gasification for increasing the use of biomass to produce bioheat, bioelectricity and biofuels, going beyond the common current applications. It addresses the current main constraints that hinder these developments and advances that can support to overcome them.

Char recirculation in fixed bed gasification systems: effects on conversion yields and process efficiency

Francesco Patuzzi
Free University of Bozen-Bolzano
Piazza Universitá 5
39100 Bolzano, Italy
francesco.patuzzi@unibz.it

Co-Authors: Daniele Antolini, Giacomo Bonzi, Stergios Vakalis, Marco Baratieri

Small-scale gasification of woody biomass is a technology that has had a rapid development in the last years, mainly driven by favorable subsidization regimes. This has been particularly true in the South Tyrol region in Italy, where almost 50 small-scale biomass gasification plants for combined heat and power (CHP) production are currently in operation. Biomass gasification process produces a minor fraction of solid carbonaceous by-product, known as char. Even though char presents chemical and physical characteristics that make it a potentially interesting and valuable product in the view of pushing gasification from a co-generative process to a poly-generative platform, economically viable solutions are not available yet and the disposal of char still represents a non-negligible cost in the plant management. As an example, almost 1300 tons of char are produced every year in South Tyrol. These must be disposed of as a waste, with considerably high costs, typically in the order of 150 €/ton. As a consequence, most of the recent developments in the small-scale gasification technology available in the market aim at reducing as much as possible the amount of material to be disposed, integrating into the plant an additional oxidizing section, i.e. afterburner, in order to have an outlet material stream mainly composed by ashes. Nonetheless, this approach can be barely considered as an improvement of the system, and concerns could be risen both from an environmental (combustion emissions) and energy efficiency point of view. The heat generated by char combustion is typically not recovered and the objective of the treatment is only to reduce the quantity of material to be disposed.

The aim of the present work is to investigate an alternative solution for reducing the amount of generated char and at the same time increasing the efficiency of the whole conversion process. The proposed solution, investigated in a small-scale open-top gasifier installed at the Free University of Bolzano, is to recirculate the char inside the gasifier in order to increase the residence time and the conversion yields. The gasifier has been upgraded with the installation of a hopper, a fine separator and a conveyor belt for the automation of the char recirculation. The effect of char recirculation in a fixed bed biomass gasification system is assessed, considering two main case studies. In the first one (case A), the gasifier is operated in order to produce char with a yield of about 10 % when fed with only pellets, while in the second case (case B) the secondary air is tuned up in order to achieve a higher conversion (char yield of about 5 %). In both the cases, the produced char is recirculated into the gasifier and the results are compared with those obtained at the same operative conditions but feeding the reactor only with pellets.

The results show that char recirculation allows a significant reduction of the overall char yield (in the order of 40 - 60 %), without significantly impact the process if this is well tuned up. The producer gas composition and LHV remain almost constant in all the investigated cases, while the GCE tend to decrease. Nonetheless, considering the overall effect, GCE slightly increases in case B, where the process is better tuned up. From the results of this work it is possible to conclude that char recirculation could be a feasible and attractive solution to improve the conversion yields in fixed bed gasifiers, although this is currently not allowed by the legislation. For a complete viability assessment of co-gasification of biomass and char in the existing fixed bed technologies further investigations are required, in particular in relation to three main aspects: the effect of granulometry (char in powder form could negatively impact the process in case of recirculation), the long term effect (reiterating the recirculation for a long time could also negatively impact the process) and the impact on the emissions.

Investigation of the adsorption potential of char residues derived from small-scale biomass gasifiers

Vittoria Benedetti
Free Univeristy of Bozen-Bolzano
39100 Bolzano, Italy
vittoria.benedetti@unibz.it

Co-Authors: Eleonora Cordioli, Filippo Marchelli, Francesco Patuzzi, Marco Baratieri

This study aims at investigating the feasibility of using biomass gasification char as adsorbent for CO_2 and H_2S.

Char is the solid residue obtained after the gasification of biomass, i.e. the thermochemical conversion of biomass in an oxygen-deficient atmosphere (Basu, 2010). Currently, char is treated as an industrial waste with high costs associated for its management and disposal. Considering the Italian Region of South Tyrol as benchmark, 1300 tons of biomass gasification char are produced every year with a related disposal cost that ranges from 140 - 150 €/ton (Basso et al., 2018). However, char possesses remarkable properties, such as a high carbon content and well developed porosity, that make it suitable for several applications and thus, it could be valorised lowering its economic, energetic and environmental impacts (Benedetti et al., 2018).

For example, char could be valorized as cheap precursor for activated carbons (ACs) due to their similarities in terms of physical-chemical properties and mechanism of formation (Benedetti et al., 2018). In particular, this study wants to assess char suitability as substitute/precursor of AC for CO_2 and H_2S adsorption. For this purpose, five chars were taken from five different biomass gasifiers (commercial and pilot) and characterized through elemental analysis, physisorption analysis, particle size distribution, inductively coupled plasma mass spectrometry (ICP-MS), and scanning electron microscopy.

CO_2 adsorption/desorption capacity of chars were investigated through thermogravimetric analysis and their performances were compared with two commercial ACs selected as reference.
The effects of adsorption temperature (T_{ads} = 50 - 75 - 100 °C), CO_2 concentration (CO_2:N_2 = 1:1 - 1:4), chemical activation (with KOH or $ZnCl_2$), and adsorption cycles were investigated.
The highest uptake (3.7 %) was measured for char activated with KOH, at T_{ads} = 50 °C and CO_2:N_2 = 1:1.

In the case of H_2S, adsorption tests were reproduced in lab-scale tubular fixed-bed reactor for chars and two ACs selected as references. The results highlight that all samples could capture hydrogen sulphide, showing different adsorption performances. The materials' specific surface area and metal and oxygen content seem to affect the removal capacity. After these tests, the best-performing char was selected and its adsorption performance tested under different operative conditions, i.e. at different inlet concentrations of H_2S (250-1000 cm^3m^{-3}) and temperatures (T = 25 - 50 - 90 °C). The maximum adsorption capacity that was reached is 6.88 mg of H_2S per gram of char. For the studied range, the maximum adsorption capacity is not influenced by the inlet volume fraction of H_2S. A temperature increase from ambient to 90 °C seems to have a beneficial effect on the adsorption performance

These preliminary results are promising and confirm that recycling gasification char as adsorbent could enhance its overall value, open up innovative horizons for its valorisation and offer an innovative way for its management.

15:30–17:00 Uhr

Parallelblock 5

Grünes Gas

03:30 pm–05:00 pm

Parallel session 5

Green Gas

Optimizing the economics of a hydrogen production by optimization of the CO_2 removal step

Jürgen Loipersböck
BEST Bioenergy and Sustainable Technologies GmbH
Inffeldgasse 21b
8010 Graz, Austria
juergen.loipersboeck@best-research.eu

Co-Authors: Gerald Weber, Markus Luisser, Reinhard Rauch, Hermann Hofbauer

Hydrogen production in 2010 was estimated to 50 Mt/a. 96 % of today's hydrogen is produced by converting fossil fuels in thermochemical processes. As main conversion technology steam reforming of natural gas and naphtha has been established. Hydrogen is mainly used in refineries, for ammonia production and in several chemical production plants. Hydrogen is also seen as a promising alternative energy carrier for the transport sector. Therefor an increasing demand on hydrogen over the next years can be assumed.

To substitute fossil produced hydrogen several renewable hydrogen routes have been established. Beside electrolysis of water also steam reforming of biogas, methane pyrolysis and gasification technologies have been developed. This work will focus on hydrogen production based on dual fluidized bed gasification of biomass.

Dual fluidized bed gasification gives the possibility to establish a renewable hydrogen production route and substitute fossil fuels. A hydrogen production plant consisting of a dual fluidized bed gasifier, a water gas shift stage, a CO_2 removal, a pressure swing adsorption and a steam reformer was erected and operated over 1000 h. The gathered data was validated and a model for up-scaling was developed. A benchmark size of 10 MW fuel input power was used as base for economic estimations. As described in previous work an overall efficiency of 55 % can be achieved, which is comparable to alternative technologies. Compared to other renewable routes, hydrogen production based on dual fluidized bed gasification gives the possibility of a fuel flexible system for continuous hydrogen production.

Hydrogen production derived by DFB gasification of wood is a reliable process, which needs to be optimized due to economic reasons. Special attention has to be paid on the CO_2 removal, to obtain an economic efficient process.

In this study a parameter variation of the CO_2 removal, which consists of absorption and desorption column, was done. Mono-ethanol-amine (MEA) was used as a solvent. One focus of the experimental investigations was the desorption at low temperatures to gain the possibility of using temperature levels which are common in district heat grids. For the experiments real synthesis gas with impurities was used. Over the gas cleaning steps of the hydrogen production plant, impurities were removed and hydrogen content was increased. To increase the efficiency of the CO_2 removal and further the hydrogen production, a parameter study was done. A good correlation between separation efficiency and desorption temperature could be observed.

Economics were calculated comparing natural gas steam reforming, electrolysis and hydrogen production based dual fluidized bed gasification. First results show a high potential for establishing the $BioH_2$ plant as a commercial production plant. An economic plant operation with wood chips can be achieved at plant sizes of 20-30 MW fuel input power. A switch to lower quality biomass can reduce the economic feasible plant size even further.

Decentralized high-purity hydrogen generation and energy storage from biomass and biogas with fixed-bed chemical looping processes

Sebastian Bock
Technical University of Graz
Institute of Chemical Engineering and Environmental Technology
Inffeldgasse 25/C, Graz, Austria
sebastian.bock@tugraz.at

Co-Authors: Robert Zacharias, Richard Schauperl, Gernot Voitic, Viktor Hacker

The regional utilization of locally available, renewable resources is crucial within a sustainable energy system to avoid long-distance transport for both the feedstocks and the energy carrier. The Reformer Steam Iron Cycle (RESC) is capable to upgrade biomass or biogas into hydrogen as superior energy carrier with an efficiencies up to 73% in decentralized systems [1,2]. Through the inherent energy storage capability of the RESC, it enables to uncouple availability and demand considering to a future volatile energy system. Furthermore, through the inherent sequestration of pure carbon dioxide from the carbonaceous feedstock the process is a potential negative emission technology if CO_2 is utilized for CCU with CCS technologies.

Graz University of Technology, AVL List GmbH and Rouge H2 Engineering GmbH investigated the system in the cooperative research project “HyStORM – Hydrogen Storage via Oxidation and Reduction of Metals”. Several crucial challenges for a future implementation were addressed and presented: The currently largest 10 kW fixed-bed chemical looping research system worldwide generates high-purity hydrogen with above 99.999% from biogas [3–5]. In a smaller lab system, the direct pressurized release up to 100 bar with inherent CO_2 sequestration was demonstrated [6].

Acknowledgements

Financial support by the Klima- and Energiefonds through the Energy Research Program 2015 is gratefully acknowledged.

References

[1] V. Hacker, A novel process for stationary hydrogen production: the reformer sponge iron cycle (RESC), J. Power Sources. 118 (2003) 311–314. doi:10.1016/S0378-7753(03)00076-4.
[2] S.D. Fraser, M. Monsberger, V. Hacker, A thermodynamic analysis of the reformer sponge iron cycle, J. Power Sources. 161 (2006) 420–431. doi:10.1016/j.jpowsour.2006.04.082.
[3] S. Nestl, G. Voitic, R. Zacharias, S. Bock, V. Hacker, High-Purity Hydrogen Production with the Reformer Steam Iron Cycle, Energy Technol. 6 (2018) 563–569. doi:10.1002/ente.201700576.
[4] S. Bock, R. Zacharias, V. Hacker, Experimental study on high-purity hydrogen generation from synthetic biogas in a 10 kW fixed-bed chemical looping system, RSC Adv. 9 (2019) 23686–23695. doi:10.1039/c9ra03123e.
[5] S. Bock, R. Zacharias, V. Hacker, High purity hydrogen production with a 10kWth RESC prototype system, Energy Convers. Manag. 172 (2018) 418–427. doi:10.1016/j.enconman.2018.07.020.
[6] R. Zacharias, S. Visentin, S. Bock, V. Hacker, High-pressure hydrogen production with inherent sequestration of a pure carbon dioxide stream via fixed bed chemical looping, Int. J. Hydrogen Energy. 44 (2019) 7943–7957. doi:10.1016/j.ijhydene.2019.01.257.

Combined production of hydrogen and CO_2 from biogas via sorption-enhanced reforming

Julien Meyer
Institute for Energy Technology
Instituttveien 18, 2007 Kjeller, Norway
julien.meyer@ife.no

Co-Authors: Antonio Geraldo de Paula Oliveira

Biogas production in Europe has significantly increased in the last decade. The installed electric capacity and the biomethane production have reached in 2016 9985 MW and 17264 GWh respectively [1]. Biogas is used in combined heat and power applications, and to cover the biogas plant's energy need. It is also upgraded to so-called biomethane to increase its calorific value by removing CO2 and other impurities. Biomethane's primary applications are as transportation fuel, or to a lower extent, as chemical feedstock. However, due to the high methane content of biogas/biomethane, its conversion to green hydrogen via the reforming process is gaining increasing interest, for use as energy carrier in transportation or stationary applications in high efficiency fuel cells, or as a valuable bio-based chemical.

Sorption-Enhanced Reforming (SER) is an emerging alternative reforming process with integrated CO2 separation. In the SER-process, the reforming reaction is carried out at 600-650^{o}C in the presence of a mixture of a reforming catalyst and a selective solid sorbent for CO2, usually a CaO-based material. The integration of heat between the exothermic CO2-sorption (carbonation) and endothermic reforming reaction improves the energy efficiency. The key advantages of adding a solid sorbent in the reforming process are: (1) Process intensification and overall process simplification, (2) no shift reactors and catalysts, (3) higher hydrogen yield (>95 vol%, dry basis) in one single step compared to conventional steam methane reforming. These advantages have the potential to reduce the hydrogen production costs and the energy consumption of the process. Applied to biogas, since SER integrates CO2 separation, it has the potential to avoid the costly biogas upgrading step and to produce both valuable green hydrogen and bio-CO2. The SER process has been successfully demonstrated and validated with methane as feedstock in laboratory scale reactors with natural CaO-based sorbents (dolomite and calcite), both in fixed bed and fluidized bed systems [2]. New synthetic CaO-based sorbent materials with high sorption capacity have also recently been tested successfully in the SER process in fluidized bed conditions where high hydrogen yield and high CO2 capture rate have been obtained [3].

In the present work, a study of the SER process using synthetic biogas as feedstock is presented. Process parameters like CH4/CO2 ratio, steam to CH4 ratio, temperature, type of sorbent, sorbent to catalyst ratio, as well as fluidization velocity have been investigated. The results show that high hydrogen concentration over 95 vol% (dry basis) and high CO2 separation rate over 90% are achievable in one single step for both natural and synthetic sorbents, proving the feasibility of the SER technology for green hydrogen and bio-CO2 production from biogas.

This work has been funded by the Research Council of Norway in the framework of the Bio4Fuels Research Centre (www.nmbu.no/en/services/centers/bio4fuels).

[1] European Biogas Association, Statistical report 2017.

[2] K. Johnsen, H. J. Ryu, J. R. Grace, C. J. Lim. Sorption-enhanced steam reforming of methane in a fluidized bed reactor with dolomite as CO2-acceptor. Chemical Engineering Science, Vol. 61, Issue 4, 2006, 1195-1202.

[3] A. Aranda, M. Aznar, J. Meyer, S. Kazi, R. Murillo, G. Grasa, L. Di Felice. Performance of optimized CO2 solid sorbents for hydrogen production by Sorption-Enhanced Reforming (SER) in fluidised bed reactor. 21st World Hydrogen Energy Conference 2016. Zaragoza, Spain, 2016.

15:30–17:00 Uhr

Parallelblock 6

Upgrading und Charakterisierung von Biomassebrennstoffen II

03:30 pm–05:00 pm

Parallel Session 6

Upgrading and characterization of solid biomass fuels II

Upgraded biomass to BIOCOAL pellets production for small scale heat applications

Pedro Abelha
Energy Research Centre of The Netherlands (ECN part of TNO)
P.O. Box 1
1755 ZG Petten. The Netherlands
pedro.abelha@tno.nl

Co-Authors: Jan Pels, Joris Spaan

This work aims for the successful production and testing of "normal" white pellets versus BIOCOAL pellets, made from several low-value biomass waste streams, in small-scale combustion installations with extensive analysis of combustion performance and emissions. The work explicitly assesses the use of various low-value woody/non woody biomass materials, before and after upgrading by torrefaction and possible washing, when needed. Currently these unused feedstocks are available in significant amounts at (potential) Yilkins Dutch customers like Futerra, Meerlanden, Sortiva and GroeneWaarden (partners in the project). The production of "normal" pellets and upgraded (BIOCOAL) pellets is performed with Multiflex technology by Yilkins (project partner). Combustion tests of low-value biomass pellets and BIOCOAL pellets in different small-scale boilers were carried out by ECN>TNO and DPS (project partner), for the purpose of determining the possible range for this application.

The combustion results of the tests that were carried out by ECN>TNO are reported in this document. Results on gaseous emissions, particulate matter formation, combustion efficiency, ash quality and its potential local application are presented and discussed.

The potential impact for the small scale energy sector involves the use of cheaper and locally available woody biomass for the production of heat. With respect to technological innovations, it has become clear how the boiler operation conditions and combustion chamber should be designed and what the impact is on emissions. From a social point of view, emissions can be reduced, the mineral cycle can be closed locally and todays unused biomass streams can be transformed for heat generation products leading to a more sustainable local energy market.

Acknowledgment*:* Research funded by the Dutch Ministry of Economic Affairs (Tender TKI.BBE – Topsector Tuinbouw&Uitgangsmaterialen project BBE-1710).

Contamination of wood chips with mineral soils – fuel quality and combustion behaviour

Carina Kuchler
Technology and Support Centre in the
Centre of Excellence for Renewable Resources (TFZ)
Schulgasse 18, 94315 Straubing, Germany
carina.kuchler@tfz.bayern.de

Co-Authors: Elisabeth Rist, Daniel Kuptz, Markus Riebler, David Zimmermann, Elke Dietz, Robert Mack, Claudia Schön, Uwe Blum, Herbert Borchert, Hans Hartmann

Purpose
The contamination of woody biomass with mineral soils might have a substantial impact on fuel quality and the combustion behaviour. Due to careless forest operation or muddy conditions during fuel production, e. g. during logging, transportation or storage, high shares of mineral soil could be added to the fuels [1]. Former research projects shows that shares up to 10 w-% mineral soil can occur [2]. This may lead to unwanted effects during combustion such as high gaseous and particulate matter emissions, corrosion or slag formation. The aim of this study was to evaluate the combustion behaviour of contaminated wood chips including the identification and evaluation of potential damage to boilers and of the impact on air quality.

Approach
For the contamination trials of different wood chip assortments, three different mineral soils (A, B and C) were used. The soils were selected in order to represent large forest growing regions of coniferous tress in Bavaria, Germany, with high timber and biomass production. Every soil was air-dried, crushed and screened to 2 mm. This diameter corresponds with the geological fraction-limit between fine soil and coarse soil [3]. For each region, wood chips from stemwood and forest residues (both Norway spruce) were used as raw material. They were acquired locally aligned to the regions of each soil. Fuels were artificially contaminated with 10 w-% mineral soils from the respective region. In addition, wood chips of one region (i. e. “region A”) were contaminated with all three mineral soils (5 and 10 w-%, dry matter) to determine the sole effect of the different soils. Moreover, the mechanical fuel treatments, e. g. washing and screening (8 mm and 16 mm diameter) were investigated. Wood chips with neither contamination nor mechanical treatment were used as reference material. Wood chips were analysed for physical and chemical fuel quality parameters according to international standards for solid biofuels. All fuels were dried to 15 w-% moisture content prior combustion tests in a Guntamatic Powerchip 20/30 boiler (nominal heat output of 30 kW) during 6 hours continuous full load operation trials. Within these trials, measurements of the gaseous and particulate matter emissions were performed. After combustion, the total amount of slag and ash was collected from the boiler and slagging behaviour was evaluated according to the PASSA – method.

Outlook
Combusting trials started recently and will be completed in summer 2019. Thereby, emissions, ash content and slagging behaviour are expected to be higher in the contaminated samples compared to the reference fuels. Final results will be presented at the conference and will include recommendations for fuel quality assurance and a comparison of the emissions values with thresholds of the German Federal Emission Control Act (1. BImSchV) and of the European Ecodesign directive.

[1] KUPTZ, D.; SCHULMEYER, F.; HÜTTL, K.; DIETZ, E.; TUROWSKI, P.; ZORMAIER, F.; BORCHERT, H.; HARTMANN, H. (2015): Optimale Bereitstellungsverfahren für Holzhackschnitzel. Straubing, Freising-Weihenstephan: Technologie- und Förderzentrum im Kompetenzzentrum für Nachwachsende Rohstoffe (TFZ); Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF). Berichte aus dem TFZ, Nr. 40, 316 Seiten, ISSN 1614-1008

[2] DIETZ, E.; KUPTZ, D.; BLUM, U.; SCHULMEYER, F.; BORCHERT, H.; HARTMANN, H. (2016): Qualität von Holzhackschnitzeln in Bayern. Gehalte ausgewählter Elemente, Heizwert und Aschegehalt. Straubing, Freising-Weihenstephan: Technologie- und Förderzentrum im Kompetenzzentrum für Nachwachsende Rohstoffe (TFZ); Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF). Berichte aus dem TFZ, Nr. 46, 141 Seiten, ISBN 1614-1008

[3] SCHEFFER, F.; SCHACHTSCHABEL, P. (1984): Lehrbuch der Bodenkunde. 11. neu bearb. Aufl., 1. durchges. Nachdr. Stuttgart: Ferdinand Enke. S. 19. ISBN: 3-432-84771-8

Reliability of TGA data for characterization of alternative biomass feedstocks

Stefan Retschitzegger
BEST Bioenergy and Sustainable Technologies GmbH
Inffeldgasse 21b, 8010 Graz, Austria
stefan.retschitzegger@best-research.eu)

Co-Authors: Norbert Kienzl, Andrés Anca-Couce, Christos Tsekos, Scott Banks, Tzouliana Kraia, Francesco Zimbardi, Axel Funke, Paula Marques

With fossil fuels continuing to shrink, but the need for energy growing every day, alternative energy sources have continually to be sought. The impact for biomass is that new feedstocks are getting more and more relevant. However, the application of new feedstocks in thermochemical processes is prone to cause problems due to a different conversion behaviour compared to classic woody biomass. For this purpose, different feedstock characterisation methods have been developed. One commonly used method is Thermogravimetric Analysis (TGA), which allows determining relevant chemical reactions and their respective kinetics. Although TGA is widely used, the concordance of results originating from analyses with different TGA systems, often obtained by following individual protocols, is not well studied. Hence, results may differ substantially depending on the institution performing the analyses.

This issue is being studied in the Horizon 2020 project BRISK II, which is dedicated to uniting leading European research infrastructures dealing with biofuels. Within the project a TGA round robin has been started currently involving seven partners across Europe. The aim of the round robin is to evaluate pyrolysis, torrefaction and char oxidation/gasification of new biomass feedstocks and to compare results with more known feedstocks like wood. In order to validate the TGA results against literature and to minimise potential inhomogeneity in biomass feedstocks, also Avicel Cellulose PH-105 as a well-defined reference material has been included in the round robin. In the first stage of the TGA round robin pyrolysis of Avicel Cellulose PH-105 and beech wood (homogenised in an ISO certified lab and distributed to all partners) were investigated. For this purpose, an experimental procedure was formulated, which was followed by each partner.

The evaluation of the first stage of experiments is completed and a main result is presented with the temperature of the maximum reaction rate (peak temperature) at a heating rate of 5 K/min. The mean peak temperature for Avicel Cellulose PH-105 was determined with 325°C, which is in good agreement with literature (327°C - Grønli et al. (1). However, the values of the peak temperature within the round robin were ranging from 314°C – 338°C. A comparable range of the peak temperature was found for the beech experiments (335°C – 364°C). The deviation did only depend on the instrument and not on the material investigated. (e.g. minimum temperature for Avicel Cellulose and beech obtained by the same partner).

These first data show that the instruments used do have an influence on the results. The ongoing evaluation will help with the determination of the characteristics of the instruments and methods employed by each partner, providing a benchmark for the experiments to follow. By identifying the differences between the various instruments and procedures, it will be possible to obtain meaningful final measurement protocols and results. In future tests within the round robin new biomass feedstocks and different atmospheres will be investigated. Furthermore, additional partner from the European Energy Research Alliance (EERA) are planned to be included in the round robin in order to extend the range of TGA systems considered. The final results will allow a thorough evaluation of the comparability of TGA tests and the factors causing differences.

(1)Grønli, M., M.J. Antal, and G. Várhegyi, *A Round-Robin Study of Cellulose Pyrolysis Kinetics by Thermogravimetry.* Industrial & Engineering Chemistry Research, 1999. 38(6): p. 2238-2244.

Introduction of a biodegradable agent for detoxification of hemicellulosic hydrolysates for xylitol production

Fanny Machado Jofre
Engineering School of Lorena
University of São Paulo (EEL/USP)
Rua de Reitoria 374, Brazil

Co-Authors: Júlio César dos Santos, Andrés Felipe Hernández Pérez, Sarah de Souza Queiroz, Henrique Azank dos Santos, Maria das Graças de Almeida Felipe

Lignocellulosic biomasses are rich on C6 and C5 sugars that can be used in several biochemical processes, for example xylose bioconversion into xylitol production, which is an important sweetener and chemical input for food, pharmaceutical, and cosmetic industries. Deconstruction of lignocellulosic biomasses is a crucial step to use these monomeric sugars in fermentative processes. Particularly in the case of hemicellulose, dilute acid hydrolysis is one of the most used methods to break down this heteropolysaccharide fraction into the constituent monosaccharides, mainly xylose.

Besides the solubilization of sugars, this method also releases and form toxic compounds to microorganisms, like acetic acid, furans and predominantly phenolic compounds. Before fermentation step, a detoxification procedure is performed commonly based on adsorption with activated charcoal, in order to reduce the concentration of these toxic compounds. However, activated charcoal is non-biodegradable and expensive to regenerate. To solve this problem, methodologies to detoxify hemicellulosic hydrolysates has been studied to deploy a more economical, sustainable and profitable method. Hence, this work aims to reuse the residual inviable biomass of *Candida guilliermondii* FTI 20037 derived from the xylitol bioproduction as a detoxifying agent of the hemicellulosic hydrolysate of sugarcane bagasse and straw mixture (HHSBS). The yeast *C. guilliermondii* was cultivated on HHSBS and supplemented with nutrients employing a bioreactor of 1L, at 30°C, for xylitol production. After the fermentation process (72h), the residual yeast biomass was separated from the fermented broth by centrifugation, inactivated by autoclaving and oven dried at 75°C until constant mass. Next, it was ground with mortar and pestle and then used as detoxifying agent of HHSBS. The detoxification experiments were carried out from a (2^4) factorial design with triplicate at the central point, in which the independent variables were pH of the HHSBS, ratio between dry biomass and HHSBS, time of contact and temperature. The reference experiment of detoxification was performed using activated charcoal. It was observed that the treatment of the HHSBS with inviable dry biomass of *C. guilliermondii* reduced the content of all toxic compounds evaluated, mainly phenolic compounds, for which it was achieved a maximal removal of 27%.

The HHSBS obtained from this detoxification procedure was used for a fermentability test, using in this case viable cells of *C. guilliermondii,* and compared to the fermentability of the HHSBS detoxified by the reference method, in which a 40% removal of phenolic compounds was observed. After 46 and 70 hours of fermentation, the xylitol yield was higher in the HHSBS treated with inviable dry yeast cells ($Y_{p/s}$= 0.790 and 0.706 g/g, respectively) than in the HHSBS detoxified with the reference method ($Y_{p/s}$= 0.654 and 0.648 g/g, respectively). The results obtained are effective to reduce toxic compounds and promising to establish an alternative method for detoxification of hemicellulosic hydrolysates by using residual microbial biomass.

Donnerstag
23
Jänner

15:30–17:00 Uhr

Parallelblock 7

Thermochemische und thermokatalytische Verfahren

Thursday
23
January

03:30 pm–5:00 pm

Parallel Session 7

Thermochemical and thermocatalytical processes

Conversion of biogenic residues into fuels and green hydrogen by Thermo-Catalytic Reforming TCR®

Johannes Neidel
Fraunhofer UMSICHT
An der Maxhütte 1
92237 Sulzbach-Rosenberg, Germany
Johannes.neidel@umsicht.fraunhofer.de

Co-Authors: Andreas Hornung, Robert Daschner, Andreas Apfelbacher

Biomass has become an important source to meet the current energy requirements and to supply raw materials for chemical processes. The conversion of biogenic substances into fuels or platform chemicals has been an important part of specific research work for several years. Many of these approaches pursue pyrolytic conversion of the plant ingredients hemicellulose, cellulose and lignin. Due to the thermo-chemical decomposition of biological substances such as sewage sludge, paper sludge, residual wood or digestate into the products oil, gas and char, these are available for energetic and material use.

One of these processes is the Thermo-Catalytic Reforming TCR® technology developed and patented at the Fraunhofer UMSICHT. The development of the Thermo-Catalytic Reforming technology at Fraunhofer UMSICHT started with a laboratory-scale plant with a throughput of 2 kg/h as a batch process. The operation parameters like heating rate, temperature and residence time were successfully transferred from the lab-scale plant into a continuous 30 kg/h demonstration plant and 300 kg/h industrial plant scale. The objective is to generate synthetic fuels from residual biogenic materials. Various kinds of feedstocks can be converted into TCR®-oil and green hydrogen by means of the TCR® process. Based on intermediate pyrolysis in combination with integrated catalytic reforming, this process is characterized in particular by the significantly improved quality of the products compared to conventional pyrolysis processes. The potential of this process to generate green fuels according to the European standards EN 228 (gasoline) and EN 590 (diesel) has been proven on a laboratory and pilot scale plant. The used feedstocks for the production of the fossil fuel substitutes include sewage sludge and digestate from biogas plants.

The low viscosity (10 mm²/s), the low total acid number and the lower heating value (LHV) of 32–34 MJ/kg characterizes the high quality of the TCR crude oil. These properties, together with the storability, the miscibility with fossil and biogenic fuels and – as a unique property – the thermal stability, provides best conditions for further upgrading in a petroleum refinery. The syngas produced is rich in hydrogen (up to 45 vol.-%) and has a calorific value of 10 to 15 MJ/kg. Depending on the feedstock, the char can be used as a soil conditioner or could be gasified for energy purpose. Phosphorus recovery from the gasification ash of the char is also a possible field of application that is being investigated in detail. In conclusion, TCR® products can be used for a wide variety of energy and material applications and contribute to a closed material cycle using residual biomass.

Biomass chemical looping gasification (BCLG) using ilmenite as oxygen carrier

Francisco García-Labiano
Instituto de Carboquímica
Consejo Superior de Investigaciones Científicas (ICB-CSIC)
Miguel Luesma Castán, 4
50018 Zaragoza, Spain
glabiano@icb.csic.es

Co-Authors: Iván Samprón, Oscar Condori, Juan Adánez, Luis F. de Diego, María T. Izquierdo

Chemical Looping processes have reached a relevant development during last 20 years, especially for combustion (CLC) due to the low-cost CO_2 capture process inherently obtained. Regarding fuel, the carbon neutrality of biomass can give more carbon credit for this technology since negative emissions can be reached if (CO_2 capture and storage) CCS is finally used.

More recently, Biomass Chemical Looping Gasification (BCLG) rises as an efficient process to produce non-nitrogen diluted syngas by eliminating the need for energy intensive gas separations, as usual in other gasification processes. BCLG shares similar principles with CLC although here biomass is partially oxidized to produce syngas ($CO+H_2$) as opposed to being fully oxidized in CLC where the desired product is heat/electricity.

In BCLG technology, lattice oxygen of oxygen carrier is used to replace pure gaseous oxygen to gasify the fuel. A two interconnected fluidized reactors is the most usual configuration. In the fuel reactor, biomass is converted into gas (pyrolysis gas), liquid (tar) and solid (char) and then the pyrolysis products react with the oxygen carrier. Thus, solid fuel is converted to synthesis gas and the oxygen carrier is reduced in parallel. In the air reactor, the reduced oxygen carrier is regenerated in air atmosphere to begin a new cycle. Because the oxidation reaction is strong exothermic, the required heat of fuel gasification can be provided by the circulating oxygen carrier from the air reactor

This work reports more than 20 hours of continuous operation in a 1.5 kW_{th} Chemical Looping Gasification unit. Pine was used as fuel and ilmenite as oxygen carrier. Different methods to optimize the control of the oxygen transferred from the oxygen carrier to the biomass for syngas production were investigated. The analysis of the BCLG process efficiency as a function of several operating variables such as temperature, H_2O/biomass ratio and oxygen excess (λ) was carried out. In addition, a complete characterization of the oxygen carrier after operation was included. It was concluded that the most relevant variable affecting syngas quality was the oxygen excess (λ), while increasing temperature produced a decrease in tar generation.

Torrefaction of waste biomass - process parameters and quality assesment

Marcin Jewiarz
Agricultural University of Krakow
Department of Mechanical Engineering and Agrophysics
Balicka 120, 30-149 Krakow, Poland
Marcin.jewiarz@urk.edu.pl

Co-Authors: Marek Wrobel, Krzystof Mudryk

Paper presents analysis of the torrefaction parameters (time and temperature) on the characteristics of formed biochar. The calorific value as well as ash content were determined for biochar obtained from three selected types of wood, Populus, Alder and Black Locust, and several byproducts or wastes from agriculture, such as husks, shells, vegetables stems. Wood samples were felled on experimental backyard placed on Department of Production Engineering and Energetics. After harvesting, samples were left under rooftop for several weeks. After that, samples were dried to determine moisture content and prepare it for torrefaction. Pyrolysis was conducted with use of specially designed batch reactor, with several sets of process temperature (200, 250, 300°C) and residence time (30, 60, 90min.). The mass difference of samples after and before pyrolysis were noticed. After the process the calorific value and ash content were determined to obtain basic information about the influence of the time and temperature on the quality of formed biochar. Elemental analysis (CHNS) and trace elements concentration was assessed, do determine different than energy production possible applications of formed biochar. As specific and absolute density was assessed, the particles porosity were determined.

Presented results shows that torrefaction has affected both calorific value and ash content. In the wood samples highest differences in calorific values were obtained for Black Locust samples. Mass difference for all samples were similar for the same conditions. In case of agricultural waste, the most favorable materials were husk. What is important the process affected also parameters like hydrophobicity or susceptibility to grinding. The paper suggests several applications for biochar.

13:30–17:00 Uhr

Workshop

Erdölfreie Land- und Forstwirtschaft

01:30 pm–05:00 pm

Workshop

Petroleum-free agriculture and forestry

Hackgut – ein traditioneller Brennstoff mit Zukunft!? Welche Qualitäten sind in Praxisanlagen zu finden?

Josef Rathbauer
HBLFA Francisco Josephinum – BLT Wieselburg
Rottenhauserstraße 1
3250 Wieselburg, Austria
josef.rathbauer@josephinum.at

Co-Authors: Rudolf Zeller, Lukas Sulzbacher, Kurt Krammer

Vor einigen Jahrzehnten hat der Einzug von Holzhackmaschinen die Zerkleinerung von Holz revolutioniert. Hackgut, ein mit verschiedenen Förderaggregaten förderbarer Energieträger, hat die Entwicklung von automatisch beschickten Feuerungen verschiedener Leistungsgrößen ermöglicht. In der Praxis gibt es Hackgutfeuerungen von wenigen KW Leistung bis in den dreistelligen MW-Bereich in Biomasseheizkraftwerken. Die Logistikkette ist in der Praxis etabliert.

In zahlreichen Forschungsprojekten wurden der Einfluss des Ausgangsrohstoffs, die Auswirkung des Wartungszustands der Hackgeräte, die Lagerbedingungen untersucht. Die Qualität und Zusammensetzung des Brennstoffes hat einen großen Einfluss auf die Effizienz und die Emissionen einer Biomassefeuerung.

Es gibt kaum öffentlich zugängliche Daten über die in der Praxis anzutreffende Hackgutqualität im Brennstofflager. In einem laufenden Projekt werden über mehrere Heizperioden Hackgutproben von einzelbetrieblichen Anlagen ab 30 kW bis zu Biomassenahwärmeanlagen im einstelligen MW-Bereich gezogen und analysiert. Zur Beurteilung der Brennstoffproben werden die Parameter der EN ISO 17225-4 herangezogen, die eine Reihe von physikalischen und chemischen Eigenschaften umfassen.

Statistische Auswertungen der Ergebnisse geben einen Überblick über die derzeit in Praxisanlagen eingesetzten Hackgutqualitäten. Bei der weiteren Analyse der Ergebnisse wird untersucht, ob Korrelationen zwischen Korngrößenverteilung, Anlagengröße, Einzelbetrieb, Gemeinschaftsanlage etc. bestehen.

GHG-migitation potential of using biofuels in agricultural machinery

Daniela Dressler
Technologie- und Förderzentrum Straubing
Schulgasse 18
94315 Straubing, Germany
daniela.dressler@tfz.bayern.de

Co-Authors: Pia Schneider, Edgar Remmele

Climate and resource protection are among the most important social tasks of the 21st century, especially since the Climate Agreement of Paris in 2015. In this context, the reduction of greenhouse gases (GHG) in the non-emission trading system (ETS) sectors such as agriculture is regulated for the first time by national climate protection plans. German agriculture has to reduce GHG emissions by 31 to 34% by 2030 compared to 1990 levels. In Germany, the production and use of decentralized rapeseed oil fuel and rapeseed methyl ester offer a great potential for reducing GHG-emissions and achieving climate targets. Whether biofuels meet sustainability criteria is defined in the Renewable Energy Directive (RED) and determined by default values for example. However, previous studies have shown that location as a factor has a major impact on emissions along the supply chain of bio-based products and bioenergy. Consequently, default values are not suitable to identify site-specific optimization potentials and to derive recommendations for action to reduce GHG-emissions. There is still a knowledge gap in the calculation and mitigation of greenhouse gas emissions for the production and processing of bio-based fuels, which requires further research.

Purpose
The aim of this study is to identify site-specific optimization potentials for reducing greenhouse gas emissions of rapeseed production and subsequent processing to rapeseed oil fuel and rapeseed oil methyl ester, respectively. Based on the optimization potential recommendations for action for farmers and foresters are derived. Additionally, a special attention will be given to the GHG-mitigation potential by using biofuels in agricultural machinery compared to fossil fuel and its role for reaching the national aims of the climate agreement. The calculated level of GHG-mitigation is significantly influenced by the chosen and regulatory system boundaries.

Approach
Within the research projects “Expert Group Resource Management Bioenergy in Bavaria” (ExpRessBio) and “Region-specific GHG-emissions of rapeseed production in Bavaria” (RegioTHGRaps) regional and farm-specific greenhouse gas balances are carried out for the production of rapeseed and rapeseed oil fuel. The assessment is based on specific data of 36 farms located within six different soil-climate-areas of Bavaria, Germany over four years. For the production of rapeseed oil fuel, data of three decentralized oil mills (for a total period of four producing years) is collected and evaluated. For the GHG balances the ExpRessBio-Method is used (a harmonized LCA methodology based on ISO 14040/44 standard).

Results and Conclusions
The LCA results of rapeseed production show a considerable variation of GHG-emissions. The analysis of farm-specific data found that the farm-specific emissions have a larger range than the region-specific emission deviations. Moreover, in addition to mineral N-fertilizers, manure or fermentation residues are often applied excessively. The study identified nitrogen-efficiency and the type of applied N-fertilizer as key parameters influencing the GHG reduction potential in the production of rape seed. In comparison to the default value of the Directive 2009/28/EC, which is related to industrial scale oil production (36 g CO2 MJ-1 rapeseed oil), the GHG-emissions of the whole process chain for specific decentralized rapeseed oil production in Bavaria is slightly lower (approx. 35 g MJ-1 by using heating value allocation). By substituting rapeseed oil fuel for the total amount of fossil diesel in agricultural machinery, greenhouse gas emissions can be reduced by 5.4 million tonnes of CO2 equivalent. This corresponds to 37% of the reduction target for German agriculture. If the feeding value of rapeseed press cake is included in the system boundaries of the assessment, the calculated GHG reduction potentials are significantly higher.

Alternative Antriebe für den land- und forstwirtschaftlichen Maschinenpark

Jürgen Karner
HBLFA Francisco Josephinum – BLT Wieselburg
Rottenhauser Straße 1
3250 Wieselburg, Austria
juergen.karner@josephinum.at

Im Arbeitseinsatz müssen moderne Landmaschinen üblicherweise hohe Antriebsleistungen bereitstellen. Die dafür notwendige Energie kommt vom Traktor. Die Leistungsübertragung vom Traktor auf das gekoppelte Gerät kann mechanisch, zum Beispiel als reine Zugleistung oder mittels Zapfwelle oder hydraulisch erfolgen. Höchste Leistungen lassen sich allerdings nur mechanisch übertragen. Sofern an einem Arbeitselement ein drehzahlvariabler Antrieb gewünscht ist, wird dieser heute üblicherweise hydraulisch ausgeführt. Die Hydraulik lässt sich am Gerät flexibel verzweigen, hat jedoch den Nachteil eines relativ schlechten Wirkungsgrades im Teillastbereich.

Hier können elektrische Antriebe zukünftig eine entscheidende Rolle spielen. In Forschungseinrichtungen und den Konstruktionsabteilungen der Landmaschinenhersteller wird schon seit einiger Zeit intensiv daran gearbeitet. Einige elektrische Antriebskonzepte sind bereits serientauglich. Durch die gute Steuer- und exakte Regelbarkeit gepaart mit hoher Effizienz werden sich neue Möglichkeiten eröffnen. Rein elektrische Systeme scheinen aus heutiger Sicht für mehrstündige Offroad-Anwendungen nicht sinnvoll zu sein. Die für die Arbeitserledigung notwendige Energiemenge ist in einem Speicher mitzuführen. Beim Traktor ist dies der Dieseltank. Durch die hohe Energiedichte von Flüssigkraftstoffen kann genügend Energie gespeichert werden, um lange arbeiten und weit fahren zu können. Ein batterie-elektrischer Speicher würde das Eigengewicht entscheidend erhöhen. Von untergeordneter Bedeutung ist dieser Nachteil eines batterieelektrischen Systems bei kleineren, leistungsschwächeren Maschinen, die nur kurze Zeit eingesetzt werden, wie z.B. Hoflader. Hier bieten bereits einige Hersteller entsprechende Modelle an. Auch hybride Antriebssysteme sind für land- und forstwirtschaftliche Maschinen interessant. Die Grundlast kann von einem Verbrennungsmotor abgedeckt werden, die von einem zweiten System überlagert wird, um z.B. Spitzenlasten abzudecken.

Für eine gute Effizienz werden Drehstrommotoren eingesetzt. Für deren Regelung wird der generierte Wechselstrom zunächst gleichgerichtet und anschließend zur Versorgung des Elektromotors entsprechend geregelt und umgeformt. Das heißt es gibt im elektrischen Antriebsstrang einen Wechselstrom-, einen Gleichstrom- und wieder einen Wechselstromabschnitt. Um Anbaugeräte elektrisch zu betreiben ist eine Schnittstelle zur Leistungsübertragung erforderlich. Somit ist in einem Abschnitt dieses elektrischen Systems ein Stecker vorzusehen, dessen Standardisierung einen zentralen Aspekt darstellt. Dieses Thema sowie jenes der Sicherheitsanforderungen werden in der Branchenorganisation AEF gemeinsam von Traktor- und Geräteherstellern in Zusammenarbeit mit Zulieferern vorangetrieben.

Hybride Antriebssysteme scheinen auch in der Landtechnik zunehmend Bedeutung zu erlangen. Sogenannte Agro-Hybrid-Strukturen können aus dem Automotive Bereich abgeleitet werden. Die zu erzielende Funktion determiniert jedoch die anzuwendende Hybrid-Architektur entscheidend. Auch hier gibt es Beispiele von Herstellern, die zusammen mit den Vor- und Nachteilen präsentiert werden.

New rapeseed oil fueled tractors are ready for practical use - Experiences from a Bavarian long-term field trial

Johannes Ettl,
Technologie- und Förderzentrum
Schulgasse 18
94315 Straubing, Germany
johannes.ettl@tfz.bayern.de

Co-Authors: Klaus Thuneke, Peter Emberger, Edgar Remmele

Pure plant oil fuels, used in compatible agricultural machinery contribute sustainable food supply. Especially rapeseed oil fuel significantly reduces greenhouse gas emissions up to 91 % and thus, lowers the carbon footprint of agricultural products. Additionally, rapeseed oil fuel used for agricultural tractors features benefits such as the increase of regional added value, synergy effects with combined feed production, protection of soil and water and the reduction of import dependency. However, despite major advantages plant oil fuels are barely used in practice, because of technical, economical and sustainability concerns of potential users.

Purpose of the work
It is the purpose of this work, to show the reliability and downtimes of pure rapeseed oil compatible tractors in practice. Based upon 10 years of research with actual 22 tractors of different manufacturers and development stages (exhaust gas stage I, II, IIIA, IIIB, IV, V) by field tests and test stand trials, results of operational reliability, engine wear, power output, fuel efficiency and exhaust gas emissions are evaluated and compared with diesel fuel operation.

Approach
The in-field and at the test stand monitored plant oil fuel was cold-pressed rapeseed oil, complying with the national German standard DIN 51605 for rapeseed oil fuel. The operation behaviour was assessed by the evaluation of data from electronic control unit (ECU), handwritten operation logbook, engine oil and fuel analysis as well as driver interviews. Emission testing on the tractor test stand is based on the standard procedure of EU guideline 2016/1628. Differing from type approvals, where engine test stands are used, here the measurement is done at the tractors with mounted engines. The power is measured at the power take-off (PTO) with a dynamometer. As testing cycle the Non-Road-Steady-Cycle (NRSC) and an adapted Non-Road-Transient-Cycle (10sNRTC) are applied.

For real driving emission (RDE) measurements two state-of-the-art tractors are being used. The tractors Fendt 724 S4 and John Deere 6215R meet latest exhaust gas standards and were tested in practice performing various agricultural works. By using a PEMS Semtech Ecostar, which was set up in a box for off-road use, the emission components CO, HC, NOX, are nitrogen oxides (NOX), carbon monoxide (CO), carbon dioxide (CO2), hydrocarbons (HC) and particulate mass (PM) are measured.

Results
Investigation of the monitored 22 tractors for more than 70.000 hours showed no considerable failures or damages. Even exhaust gas after-treatment systems enabled a reliable operation with high emission reduction efficiency. Neither performance nor fuel consumption showed any deterioration during the investigated period. Generally, the limited exhaust gas components (NOX, CO, HC, PM) determined at a tractor test stand by remained at a nearly same level over the operating time. Without exhaust after treatment, the HC and PM emissions with rapeseed oil fuel are mainly lower than with diesel fuel, whereas NOx are little higher. However, with increasing exhaust stages and application of exhaust after-treatment systems differences between fuels become less relevant. Plant oil tractors with exhaust gas stage IV achieve the legal emission limits with rapeseed oil fuel in the NRSC and 10sNRTC.

Results of RDE measurements show that recorded emission values also fulfil related limiting values for both fuels. Conformity factors that relate actual emissions, measured with PEMS, to corresponding test cycle values, measured at the test stand are within approaching legitimacy.

Betriebsverhalten und Real-Driving-Emissions eines forstwirtschaftlichen Harvesters im Betrieb mit Rapsölkraftstoff

Peter Emberger
Technologie- und Förderzentrum Straubing
Schulgasse 18
94315 Straubing, Germany
peter.emberger@tfz.bayern.de

Co-Authors: Klaus Thuneke, Georg Huber, Johannes Ettl, Edgar Remmele

Durch die Verwendung von Rapsölkraftstoff anstelle von Dieselkraftstoff kann die Forstwirtschaft einen wichtigen Beitrag zum Klima- und Ressourcenschutz aber auch - aufgrund der besonderen Betankungssituation im Wald - zum Boden- und Gewässerschutz leisten. Rapsölkraftstoff kann darüber hinaus aufgrund seines hohen Treibhausgasminderungspotenzials gegenüber Dieselkraftstoff den Product-Carbon-Footprint (PCF) von Holzpartien deutlich senken, der zum überwiegenden Teil durch den verwendeten Kraftstoff verursacht wird. Während für Rapsöltraktoren verschiedener Motorengenerationen die Praxistauglichkeit nachgewiesen werden konnte, liegen für moderne forstwirtschaftliche Arbeitsmaschinen kaum Erkenntnisse vor.

Vorgehen
Im Rahmen des Kooperationsprojekts zwischen Bayerischen Staatsforsten, John Deere European Technology Innovation Center, John Deere Forestry, Donauwald Forstmaschinen und TFZ wurde ein John Deere 1470G Vollernter auf den Betrieb mit Rapsölkraftstoff umgerüstet und von Mitte 2017 bis Ende 2018 im realen Einsatz getestet. Der Harvester ist mit einem Motor der Abgasstufe IV mit Oxidationskatalysator, Parti-kelfilter und SCR System ausgestattet.
Während des Feldtestes wurden verschiedene Betriebsdaten aufgezeichnet und Betriebsstoffe untersucht, um Aussagen zu Produktivität, Motoreffizienz und Verschleiß treffen zu können. Darüber hinaus wurde das Emissionsverhalten im realen Betrieb mittels eines portablen Emissionsmesssystems mehrfach untersucht.

Ergebnisse
Die Produktivität und die Motoreffizienz des Harvesters lagen im Betrieb mit Rapsölkraftstoff auf dem gleichen Niveau wie vor der Umrüstung im Betrieb mit Dieselkraftstoff. Ein Kaltstart des Harvesters war auch bei Temperaturen von bis zu -17 °C möglich. Analysen der Motorenölqualität lassen aufgrund des geringen Gehalts an Verschleißmetallen auf eine ordnungsgemäße Funktion der ölgeschmierten Bauteile schließen. Das Motorenölwechselintervall konnte im Betrieb mit Rapsölkraftstoff bei 500 h belassen werden, wie dies auch im Dieselbetrieb üblich ist. Aus den mit dem Harvester gewonnen Erkenntnissen lassen sich weitere mögliche technische Optimierungsmaßnahmen ableiten.

Emissionsmessungen mit einem portablen Emissionsmessystem (PEMS) vor und nach der Umrüstung sowie nach 1850 h Rapsölbetrieb zeigen, dass die Emissionen von Stickoxiden und Kohlenstoffmonoxid keinen statistisch signifikanten Unterschied im Betrieb mit Diesel- und Rapsölkraftstoff aufweisen. Insgesamt bewegen sich alle untersuchten Schadstoffkomponenten auf einem geringen Niveau und die Grenzwerte der Abgasstufe IV werden im realen Betrieb eingehalten.
Während des Feldtests mit Rapsölkraftstoff absolvierte der Harvester 2.100 Betriebsstunden und verbrauchte dabei rund 42.500 l Rapsölkraftstoff. Dadurch konnte der Umschlag von 41.000 l Dieselkraftstoff auf nicht-versiegelten Flächen im Forst und Treibhausgasemissionen in Höhe von rund 120.000 kg CO2-Äquivalente vermieden werden. Aufgrund der positiven Ergebnisse betreiben die Bayerischen Staatsforsten den Harvester auch über das Projektende hinaus mit Rapsölkraftstoff.
Schlussfolgerungen

Die Projektergebnisse zeigen am Beispiel eines Harvesters, dass der Betrieb von forst-wirtschaftlichen Arbeitsmaschinen mit Rapsölkraftstoff technisch möglich ist und somit ein wirksamer Beitrag zum Klima- Boden- und Gewässerschutz geleistet werden kann.

Offene Fragestellungen im Spannungsfeld „Situation in der Gegenwart und zukünftige Anforderungen zur Zielerreichung“

Alexander Bachler
Agricultural Chamber of Austria
Schauflergasse 6
1014 Vienna, Austria
a.bachler@lk-oe.at

Ausgangslage
Vielfältige Zielvorgaben auf europäischer (Pariser Klimaziele, Erneuerbaren-Richtlinie RED II, etc.) und nationaler Ebene (Nationaler Energie- und Klimaplan, Klimaschutzgesetz, Klima- und Energiestrategie, Bioökonomiestrategie) betreffen auch den Sektor „Land- und Forstwirtschaft“. Dabei hat die Land- und Forstwirtschaft jedoch eine Sonderrolle. Auswirkungen der anhaltenden Klimaverschlechterung mit ihren immer häufiger auftretenden Extremwetterereignissen (Hitzeperioden, Dürre, Starkregen) treffen die produzierende Land- und Forstwirtschaft direkt und unvermindert. Gleichzeitig leistet die Land- und Forstwirtschaft durch Produktion von Lebensmitteln, Futtermitteln, Rohstoffen für stoffliche und energetische Nutzungen sowie Nebenprodukt- und Reststoffströmen einen wesentlichen Beitrag zur Abmilderung der Klimaverschlechterung. Dies ist jedoch mit entsprechendem Energieeinsatz und daraus resultierenden Emissionen aber auch mit Investitionskosten und hohen Anlagevermögen verbunden.

Situation in der Gegenwart
Die Land- und Forstwirtschaft verbraucht insgesamt rund 22 PJ Energie pro Jahr, damit werden alle Lebens- und Futtermittel produziert und Erneuerbare Energieträger (Biomasse) im Ausmaß von rund 245 PJ zur Verfügung gestellt. In Teilbereichen wie beispielsweise der Traktion werden dafür jedoch mangels praxistauglicher Alternativen erhebliche Mengen an fossilen Energieträgern eingesetzt. Die Erreichung gesetzter Zielvorgaben stellt auch Anforderungen an die Land- und Forstwirtschaft, die Emissionen an Treibhausgasen weiter zu reduzieren. Der vermehrte Einsatz Erneuerbarer Energieträger, allen voran Biotreibstoffe, kann dazu einen wichtigen Beitrag leisten.

Offene Fragestellungen und mögliche Lösungsansätze
Was braucht es an Maßnahmen und Technologien für die Land- und Forstwirtschaft, um die Zielsetzungen erreichen zu können? Welche Technologieformen sind besonders gefragt? Wie sollen Rahmenbedingungen ausgestaltet werden, um die Zielerreichung der Land- und Forstwirtschaft bestmöglich zu unterstützen? Was erwartet die Land- und Forstwirtschaft von den Maschinenherstellern? Welche Rahmenbedingungen sind für eine rasche Marktdurchdringung förderlich?

Diese und ähnliche Fragestellungen sollen in Zusammenschau mit den Erkenntnissen aus den vorangegangenen Vorträgen des Panels dem Versuch einer Beantwortung sowie der Skizzierung der potentiellen Ausgestaltung dafür notwendiger Rahmenbedingungen zugeführt werden.

15:30–17:00 Uhr

Parallelblock 8

Integrierte Bioraffinerie- und Biogaskonzepte

03:30 pm–05:00 pm

Parallel Session 8

Integrated biorefinery and biogas concepts

Global cooperation on biogas technologies

Dominik Rutz
WIP Renewable Energies
Sylvensteinstr. 2
81369 Munich – Germany
dominik.rutz@wip-munich.de
www.wip-munich.de

Co-Authors: Felix Colmorgen, Rainer Janssen

To meet the growing demand for heating, power and fuel, biogas has already proved its potential as a versatile energy carrier. Thanks to favourable regulation and energy policy, the number of biogas plants in operation in the European Union has increased to over 18,000 to reach an installed capacity of 10 GW as of 2016. Biomethane production has steadily increased to over 17,000 GWh per annum. It is estimated that biogas has the potential to contribute at least 1.5% of the EU's primary energy mix by 2020. Recent advancements have helped to make the technology more cost competitive through efficiency improvements in the anaerobic digestion process and biogas use. Furthermore, biogas upgrading and biomethane production offer new opportunities for the use of biogas to be utilized as a substitute for fossil fuels in the transport sector and injected into the natural gas grid.

Biogas production has seen a significant growth in the last 20 years in Europe, mainly driven by the favourable support schemes and policy in place. The positive policy and financial support schemes that have helped establish the industry are now undergoing significant changes in their structure and scope, posing many challenges for the market. This decreasing support trend can be seen across Europe. For example, the recent change to the Renewable Energy Sources Act (EEG) in Germany introduces a technology specific tendering system with a maximum market premium and up to a maximum capacity depending on the type of technology. This trend is expected to continue in Europe as governments try to support the most cost-effective technologies, as seen by the reducing feed-in tariffs. Economics are the key determine factor affecting the development of biogas production. For European biogas technology providers, it is increasingly important to get also active in non-European markets. This is supported by the EU project DiBiCoo.

The overall objective of the DiBiCoo project is to support the European biogas/biomethane industry by preparing markets for the export of sustainable biogas/biomethane technologies from Europe to developing and emerging countries. This will be achieved by the development and application of innovative digital and non-digital support tools and actions, by knowledge transfer and capacity building as well as by the preparation of demo cases up to the investment stage. This will increase the share of renewable energies, both in Europe and in importing countries.

More specifically, the DiBiCoo proposal aims to support the European biogas industry in diversifying its sales market and therefore increasing the deployment of biogas technologies in emerging markets across Latin America, Africa and south east Asia, helping mitigate GHG emissions and increasing the share of global renewable energy generation. The project aims to synthesise and develop country-specific technologies and solutions in the import markets. The target countries (importing countries) selected for the DiBiCoo proposal are Argentina, Ethiopia, Ghana, Indonesia, and South Africa.

A presentation at the CEBC will provide an overview on the international biogas markets, its challenges, opportunities and its role in future sustainable energy mixes. Furthermore, the key characteristics of the DiBiCoo project will be presented.

Prospective life cycle assessment of a microalgae biorefinery concept integrated in regional biogas plants

Maresa Bussa
HSWT - Hochschule Weihenstephan-Triesdorf - University of Applied Sciences
TUM Campus Straubing for Biotechnology and Sustainability
Petersgasse 18
94315 Straubing, Germany
maresa.bussa@hswt.de

Co-Authors: Hubert Röder

The gap between biomass demand and supply has been identified as the main obstacle for the transition towards a sustainable bioeconomy. Microalgae have been recognised as promising feedstock to tackle the problem of insufficient biomass supply. Currently, their environmental sustainability is constrained by a high energy-demand for cultivation, as well as by the provision of carbon dioxide and nutrients. The hypothesis is that an integrative biorefinery concept coupling microalgae cultivation with biogas plants can overcome the current drawbacks of microalgal biomass and ensure the economic competitiveness of biogas plants after the expiration of existing feed-in tariffs in many European countries.

This work presents a prospective life cycle assessment (LCA) of a novel biorefinery concept, in its early stage of development, for the production of valuable intermediate products from *Chlorella vulgaris*. The target products of the biorefinery concept are lipids, polysaccharides as well as proteins. Lipids are of high interest for the market of food additives as well as for the high-value sector of cosmetics and health care. Protein-rich products are, in addition, attractive for the animal feed sector as well. Polysaccharides can substitute other biopolymers in the chemical industry. Experimental and literature data were used to compile the life cycle inventory for the biorefinery.

In a first step, two integrated process designs were developed. In both systems, the biomass substrate is turned into biogas and digestate by means of anaerobic digestion. The microalgae are fed with the digestate in order to meet their nutrient needs. In the case of excess digestate, the residues can be used as organic fertiliser in agriculture. In the first system, the biogas is purified to bio-methane, which is combusted in a co-generation unit. The so produced electricity and heat are used to run the cultivation process. The separated carbon dioxide is injected into the cultivation pond. In the second system, the biogas is combusted in a co-generation unit without upstream purification. Industrially generated carbon dioxide, mainly produced as by-product of ammonia and hydrogen production, is used as carbon source. The outcomes of the LCA suggest that significant improvements can be achieved by integrated cultivation approaches.

In a second step, four different approaches for the extraction of the target compounds were designed. Monte-Carlo simulation was used to assess the environmental performance of the approaches and to obtain threshold values for energy and material consumption on industrial scale as well as target process yields to ensure environmental competitiveness with substitutable products.

Biorefinery model for use the straw base horse manure in different co-digestion technologies and biofuel production

Sándor Bartha
Reserch-Cercetare Silox LTD
2. Centralei
520068, Sf. Gheorghe, Romania
sbarthacv@yahoo.ro

Co-Authors: Santino di Berardino, Florbela Carvalheiro, Patricia Moniz, Luis C. Duarte

In the last period in Central European region also the horse keeper farms start to grow and the resulted manure growing quantity different problems for farmers and also for the environment. The resulted manure in this farms are stored in concrete open tanks or in concrete platform with collectors for the liquid phases. The use of manure in agriculture presents a biological risks because that contain a variety of pathogenic micro- organisms including Salmonella spp., Campylobacter spp. And E. Coli O157, parasitic protozoa; Cryptosporidium parvum and Giardia Lamblia and viruses and in case of the large farms different types of medicines used in treatment of the animals – in this case that can be entering in the food chain. In general the horse manure resulted in rural area after composting are used local farms as fertilizer, in case of the farms and small scale horse centers sited near the urban area the resulted and collected horse manure is instead often to send to waste to landfill waste deposal or to combustion plants. Base the statistical dates in EU countries the resulted yearly horse manure quantity is more than 100.000tones. That quantity has a big negative impact to the environment in case if it not used in sustainable way.

In this publication is presented one theoretical model built base lab scale experimental dates for developing one sustainable technologies for disposal of the horse manure resulted in special in rural area. The model is developed for two cases one for small scale farms from 2-10 horses and the second for a medium farm with more than 50 horses. In the article, at the first part it will be presented the proximate and ultimate analysis results for the used feedstocks (horse manure, and different organic wastes; like potato pill and expired fruits and vegetables resulted in local food market, or in case of the farms in coastal area seaweeds) in co-digestion technologies. It is indicated the optimal mixture composition for the anaerobic digestion, resulted base the evaluated the C/N ratio, which is in the range; 20-32% for maximal CH_4 yields. The resulted biogas composition is evaluated with preferment gas analyzer and the obtained experimental dates are used in material balance evaluation process for the process and it is presented the optimal structure with unit elements of the technological schemes. In this technological structure is introduce, in case for the small scale unit one microalgae growing part where the resulted organic liquid phase are treated and the CO_2 from biogas is captured – in this way is realized the decarburization of the co-digestion technologies. The resulted microalgae can be valorized on the biofuel market. The presented models can be one model village base biorefiney model in rural area.

New perspectives on soybean molasses utilization in Brazil

Bruna Mello
Institute of Chemistry, UNESP – Sao Paulo State University
brunamello30@gmail.com
Prof. Francisco Degni street 55
14800-900 Araraquara
Brazil

Co-Authors: Mello, Bruna, Rodrigues, Brenda Clara, Costa, Maria Angélica Martins, Arnaldo Sarti

Brazil soybean production generates a great number of by-products without an effective commercial value or sustainable destination. In this context, the main objective of this work was to evaluate the potential use of an anaerobic/aerobic baffled reactor (AABR) with an aerobic chamber (AC) in the biogas generation and treatment of soybean molasses which is a by-product derived from concentrated soybean protein processing industry. The entire bench scale AABR reactor consisted of three anaerobic chambers, one aerobic chamber and one settling tank. The reactor was fed with soybean molasses as substrate (103 days) for several operating conditions (0.43 $kgCOD.m^{-3}.d^{-1}$ at 3.86 $kgCOD.m^{3}.d^{-1}$) in which the substrate concentration was gradually increased (800 to 6,000 $mg\ COD.L^{-1}$) and the hydraulic detention time (TDH) was maintained at 48 h and 36 h. The anaerobic system showed an excellent average efficiency in COD removal (total and filtered) as higher as 91%. The mean concentration of COD_{Total} and $COD_{Filtered}$ in effluent varied between 34.4 mg L^{-1} to 763.8 mg $L^{-1}$and 29.1 mg L^{-1} to 540.3 mg L^{-1}, respectively, after the aerobic chamber (phases 1 to 6).

Considering the entire system (anaerobic + aerobic), the average value of COD removal efficiency was as high as 95.4%. No accumulation of volatile fatty acids (VFA) was found, as the VFA concentration remained between 30.6 and 226.4 $mgHac.L^{-1}$ in the final effluent. The results show that AABR has great potential for a sustainable destination of soybean molasses.

09:00–10:30 Uhr

Parallelblock 9

Sekundärmaßnahmen zur Reduktion der Emissionen aus der Biomasse-Verbrennung und Vergasung

09:00 am–10:30 am

Parallel Session 9

Secondary measures for the reduction of emissions from biomass combustion and gasification

Innovative high efficiency filter for particulate matter from biomass flue gases

Augusto Bianchini
Department of Industrial Engineering (DIN)
University of Bologna
Via Fontanelle 40
47121 Forlì, Italy
augusto.bianchini@unibo.it,

Co-Authors: Marco Pellegrini, Jessica Rossi, Cesare Saccani

Solid biomass is considered a renewable energy source since, during the lifecycle, it determines a neutral CO_2 balance and it is easily and continuously available. Due to its potential benefits, both economic and environmental, solid biomass has been recognized as a realistic alternative to traditional fossil fuels, above all to produce thermal power for domestic heating. Nevertheless, solid biomass combustion produces a great amount of particulate matter (PM), determining a negative impact on air quality, climate and human health. In particular, domestic biomass heating systems are one of the greatest sources of PM emissions. It derives from three main factors that makes residential biomass combustion inefficient: an incorrect operator behavior, improper operating conditions and a scarce quality of biomass.

To address this issue in the short term, an effective solution could be the installation of a filtration device for the collection of PM in the biomass flue gases. This method is widely spread in the industrial sector, which shall comply whit stringent emission limits. In the residential sector, the high investment and maintenance costs and the complex management of a filter have limited its installation on domestic heating systems. However, to limit the impact of domestic biomass combustion, some scientific researches and the regulatory framework are now under development to successfully provide a PM filtration device for small-scale heating systems.

In this paper, a review of the main PM filtration devices for domestic heating systems is conducted. These devices are based on the same technologies used in the industrial sector and they are near to the commercialization or under development. The technical and economic features of these technologies are analyzed to identify their strengths and weaknesses.

An innovative high efficiency filter, developed by the Department of Industrial Engineering of the University of Bologna, is then presented. It was tested on a pilot plant consisting of a 25 kW_{th} biomass boiler for residential use. The paper shows the preliminary experimental results, which demonstrates the promising impact (technical, environmental and economic) of the innovative filter in comparison with the other available technologies for domestic heating systems. The final aim is to demonstrate that the implementation of the innovative filter in residential size heating systems can really increase the sustainability of biomass combustion and further spread its plant marketability.

New filter technology for combined NO_x and dust emission reduction – From laboratory to practice

Julian Walberer
Fraunhofer UMSICHT
An der Maxhütte 1
92237 Sulzbach-Rosenberg, Germany
julian.walberer@umsicht.fraunhofer.de

Co-Authors: Martin Meiller, Robert Daschner, Andreas Hornung

The idea of this innovative filter concept is to combine three individual flue gas technology treatment systems into one product to be more economic and efficient. The development should be capable to meet stricter emissions limits for decentralized applications such as solid fuel combustion which have been set by the European legislation. In Europe, air pollution, especially NO_x and particulate matter, leads to a tightening of the limit values for several combustion processes, including stationary as well as mobile applications. This trend is also affecting several biomass applications. Due to this, Fraunhofer UMSICHT has developed this new filter technology. The core part of the filter is a ceramic filter candle, which is used for common dust separation. The ceramic filter material is activated with modified catalysts to enable selective catalytic reduction (SCR) at low temperatures (150 – 200 °C). In addition to this, the filter material should also have the opportunity to reduce acid components like SO_2 or HCl. This treatment step could be realized with an additional precoat layer on the surface of the filter material. In this speech, we will present the idea of a combined filter, the results and basic research which was done in a previous project and the upscale of the technology into a commercial scale.

Approach:
For the activation of the ceramic material, a new and innovative impregnation process was developed and different catalysts were produced (figure 2). In total, more than 25 different catalyst combinations were developed and tested. For every catalyst ($V_2O_5/WO_2/TiO_2$, MnO_x/TiO_2, MnO_x/TiO_2/Ce, Fe-ZMS, Cu-ZMS), at least five different specifications of the catalyst were taken by changing different charging cycles, charging pressures, calcination atmospheres and calcination temperatures. For the evaluation of then NO_x-conversion an SCR-test rig (figure 3) was designed and manufactured. The results showed that the ceramic filter material could be activated with different catalysts. The development of the catalyst focused on high NO_x-conversions rates at low temperatures. This ability is required for flue gas cleaning of combustion processes in order to prevent efficiency losses by reheating the flue gas, which occur in standard SCR applications. With the modified catalysts, low temperature SCR (150 – 200 °C) with high NO_x-conversion (> 70 %) was achieved. Due to this, the combined filter material can be an option to meet stricter limits.

Upscale:
Based on the promising results a new project, called DAnkEE (Demonstration einer Anlage zur kombinierten Entstaubung und Entstickung) was started in September 2018. The aim of this project is the demonstration of a combined filter for dust and NO_x reduction for biomass furnaces in the range of 0.1 - 5 MW. The first step will be an upscale of a manufacturing process for SCR catalysts in the low-temperature range developed by Fraunhofer UMSICHT. That includes the upscale of the impregnation plant and the calcination process. Further aims are the development and testing of combined filter in the technical area of Fraunhofer UMSICHT under real conditions. For this purpose, a demonstrator will be developed together with an industrial partner, which enables the simultaneous reduction of NO_x and the separation of dust. The evaluation of the developed filter will be done with flue gas from an incineration plant fired with biogenic residues.

Methodik zur kontinuierlichen Überwachung der Funktion von Elektrofilteranlagen bei Biomassefeuerungen durch Erfassung von Betriebsparametern

Bastian Alt
TUM Campus Straubing für Biotechnologie und Nachhaltigkeit
Technische Universität München
Schulgasse 16, 94315 Straubing, Deutschland
bastian.alt@tum.de

Co-Author: Matthias Gaderer

Elektrofilter werden häufig zur Reduzierung von Partikelemissionen von Biomassefeuerungsanlagen eingesetzt, um die von der Regierung vorgeschriebenen gesetzlichen Grenzwerte für Staubemissionen zu erreichen. Die EU Directive 2015/2193 fordert einen Nachweis über den effektiven, kontinuierlichen Betrieb von sekundären Emissionsminderungseinrichtungen von mittleren Verbrennungsanlagen. Diese Vorgabe soll zukünftig in der 44. Bundesimmissionsschutzverordnung (44.BImSchV) in Deutschland umgesetzt werden soll. Darüber hinaus wird dies auch für Kleinanlagen, die in naher Zukunft für häusliche oder isolierte Versorgungsanwendungen genutzt werden, notwendig und vorteilhaft sein. Es mangelt jedoch an Lösungen, wie dieser Nachweis erfolgen soll. Modernste Online-Staubpartikelmesstechnik mit optischen Signalen muss rauen Messbedingungen wie hohen Temperaturen, elektrostatischer Aufladung und korrosiven Partikeln standhalten. Daher sind sie zu teuer, um die Wirtschaftlichkeit von Biomassefeuerungen nicht zu bedrohen. Mit Hilfe der Betriebsparameter Strom und Spannung des Elektrofilters kann der Abscheider selbst jedoch die emittierte Staubkonzentration durch ein mathematisches Verfahren ermitteln. Dadurch entfallen höhere Investitionen und es ist möglich, eine einfache und kontinuierliche Überprüfung der Anlage durchzuführen. Dieser Vortrag beschreibt das Projektvorgehen, die verwendete Methodik und die erzielten Ergebnisse.

Zielsetzung:
Vorrangiges Ziel dieses Projekts ist es, ein Verfahren zu definieren, das die emittierte Staubkonzentration direkt aus den Betriebsparametern des Abscheiders bestimmen kann. Dies führt zu einer zugelassenen Methode für Anlagenbetreiber, um den korrekten Betrieb ohne zusätzliche Messsysteme nachzuweisen. Dies kann sogar die übliche Praxis der periodischen Messungen ersetzen oder zumindest den Zeitraum zwischen den Inspektionen verlängern. Dies wird auch die Betriebs- und Investitionskosten für Biomassefeuerungsanlagen senken und damit die Wirtschaftlichkeit erhöhen.

Das Projekt wird von der Fachagentur Nachwachsende Rohstoffe e.V. (FNR) gefördert und gliedert sich in vier große Arbeitspakete. Zunächst werden die zu untersuchenden Abscheider ausgewählt und vorbereitet. Durch die Installation eines Online-Messgerätes und die Protokollierung der Betriebsparameter wird die charakteristische mathematische Beschreibung der jeweiligen Anlage definiert. Zweitens wird dieser Datenfluss über einen begrenzten Zeitraum aufgezeichnet. Das dritte Arbeitspaket zielt darauf ab, die Daten auszuwerten und Erkenntnisse über das Langzeitverhalten der Anlage zu gewinnen. Schließlich wird die Methode selbst entwickelt und getestet.

Ergebnisse und Diskussion:
Die bisherigen Ergebnisse zeigen, dass mit der vorgestellten Methode der kontinuierliche und effektive Betrieb nachgewiesen werden kann. Es ist möglich den Abscheidegrad aus den Betriebsparametern zu berechnen, wenn eine entsprechende Charakterisierung der Anlage durchgeführt wird. Bei der Gegenüberstellung des berechneten und gemessene Abscheidegrads ergab sich eine Abweichung von 0,316 % (Absolutwert) im stationären Betrieb. Außerdem konnte die Verfügbarkeit des Filters in verschiedenen Szenarien ermittelt werden. Die weiteren Untersuchungen fokussieren sich auf die Ermittlung eines einheitlichen „Feuer ein“-Signals aus dem Rauchgas und der Definition der Grenzen und Schwachstellen der Methodik.

Evaluation of gas cleaning processes for the coupling of biomass gasification with Solid Oxide Fuel Cells (SOFC)

Stefan Martini
BEST Bioenergy and Sustainable Technologies GmbH
Inffeldgasse 21b
8010 Graz, Austria
stefan.martini@best-research.eu

Co-Authors: Jacqueline Lagler, Norbert Kienzl, Timotheos Tsiotsias, Stefan Reschitzegger,

The growing demand for CO_2-neutral on-demand supply of cold, heat and power leads to the aim of developing a biomass-based energy conversion system providing all of them in an efficient and flexible configuration. A promising solution is to combine a biomass gasification system with a Solid Oxide Fuel Cell (SOFC) stack and an absorption chiller including a smart off heat and of gas utilisation. Such a tri-generation system is investigated in an ongoing collaborative European research project, BIO-CCHP. For SOFC as a clean gas application the gas composition including all trace compounds is the most relevant issue for durability and hence economic suitability. Only a detailed knowledge of both product gas quality and SOFC requirements, allow the determination of the most appropriate cleaning processes.

In this work the focus lies on the measurement of compounds which have been identified as crucial for prolonged SOFC operation- hydrogen sulphide (H_2S), carbonyl sulphide (COS), hydrogen cyanide (HCN) organic sulphur compounds like thiophene, mercaptanes, sulphur containing polycyclic aromatic hydrocarbons (PASH), C2- andC3-hydrocarbons, benzene, toluene, xylene (BTX) and polycyclic aromatic hydrocarbons (PAH) as well as particulate matter (PM).

A mobile test facility including a heated fixed bed adsorption column and a comprehensive gas characterization setup allow for evaluating different gas treatment approaches. These approaches are tested under real gas conditions at industrial gasification plants. Due to the diversity of existing biomass gasification technologies the high-temperature gas treatment processes are applied in combination with six different gasifiers in Austria, Poland and Sweden. Up to now test campaigns at a staged air-gasifier, a downdraft air-gasifier and a bubbling fluidized bed steam-gasifier have been conducted. The focus has been on desulphurisation processes employing commercially available ZnO-based sorbents, evaluated from 350°C to 450°C. Reliable and sensitive methods for gas analysis are crucial in order to evaluate gas treatment processes and achieved gas qualities for SOFC-application. The gas characterisation set up includes offline and online analysis methods. Absorptive accumulative sampling for BTX, PAH, organic sulphur compounds as well as H_2S, NH_3, HCN and HCl is combined with subsequent offline analysis by e.g. GC-MS, UV-VIS, ICP-OES. Online analysis includes FTIR, NDIR, TCD gas analysis and micro-GC (semi-online).

This paper will show first results of achieved clean gas qualities, which have been determined in the frame of test campaigns at three different gasification technologies. A detailed validation of the employed gas measurement techniques regarding main gas components and potential harmful impurities as listed above will be presented.

09:00–10:30 Uhr

Parallelblock 10

Dekarbonisierung industrieller Prozesse und der Energieversorgung

09:00 am–10:30 am

Parallel Session 10

Decarbonization of industrial processes and energy supply

Chemical Looping Combustion of biomass for negative CO_2 emissions

Juan Adánez
Instituto de Carboquímica
Consejo Superior de Investigaciones Científicas (ICB-CSIC)
Miguel Luesma Castán, 4, 50018 Zaragoza, Spain
jadanez@icb.csic.es

Co-Authors: Teresa Mendiara, Iñaki Adánez-Rubio, Alberto Abad, Antón Perez-Astray, Luis F. de Diego

Bioenergy with carbon dioxide (CO_2) capture and storage (BECCS) technologies represent an interesting option to reach negative carbon emissions, which implies the removal of CO_2 already emitted to the atmosphere. Chemical looping Combustion is a combustion process with inherent CO_2 separation with low cost and energy penalty that is considered as promising for BECCS technology. In CLC, the oxygen needed for combustion is supplied by a solid oxygen carrier circulating between the fuel and air reactors. In the fuel reactor biomass is pyrolized and both volatiles and char generated react with the oxygen carrier.

Depending on the oxygen carrier, reaction proceeds by different mechanism. In the iG-CLC (in-situ gasification Chemical Looping Combustion) char is gasified by means of steam/CO_2) and the oxygen carrier reacts with pyrolysis gas and gasification products using lattice oxygen. In the CLOU mechanism, using oxygen carriers than can release gaseous oxygen at high temperature, both char and volatile matter react directly with gaseous oxygen. The reduced oxygen carrier is regenerated by air in a separate air reactor. Interconnected fluidized reactors are commonly used to carry out Chemical Looping Combustion.

Process performance parameters as combustion efficiency and CO_2 capture are highly dependent on the type of oxygen carrier and its reactivity. This work analyses results obtained during the biomass combustion in a 1 kW and 50 kW continuous units of interconnected fluidized bed reactors using different oxygen carriers reacting in iG-CLC mode (iron and Mn ores); in CLOU mode (Cu and Cu-Mn mixed oxides) or by in a mixed mode (Fe-Mn mixed oxides). Due to the high volatile content of the biomass, some unconverted gases can appear (CO, H_2, CH_4) at the fuel reactor outlet, decreasing the combustion efficiency, if iron or manganese ores are used as oxygen carriers (iG-CLC). However, if synthetic oxygen carriers (Cu, Cu-Mn mixed oxide) with high reactivity, that operate in CLOU mode are used, any unconverted gas appears at the outlet of the fuel reactor. In this work a comparison between the performance obtained using (Fe and Mn ores, Cu and Cu-Mn oxides) is carried out.

Importance of biomass for the decarbonization of industrial process heat supply

Martin Meiller
Fraunhofer UMSICHT
An der Maxhütte 1
92237 Sulzbach-Rosenberg, Germany
martin.meiller@umsicht.fraunhofer.de

Co-Authors: Lars Komogowski, Robert Daschner, Andreas Hornung

Motivation:
Energy transition in Germany still focuses the electricity sector too much. To reach the CO_2 reduction goals, efforts in the mobility as well as the heating sector have to be intensified. The achievement of national climate goals set up at the Paris Agreement will only succeed, if all sectors participate. In particular, industry is facing a huge challenge, which is especially evident in the provision of process heat. Maintaining and expanding the competitiveness of German and European companies is of fundamental social and economic importance.

The area of process heat in the industry with a final energy requirement of almost 1,700 PJ is of comparable importance as the household sector (space heating and hot water approx. 1,900 PJ) in Germany. Against this background, many questions arise.

- How can decarbonisation be achieved in the industry sector?
- Which technologies are available?
- How much research and development is needed?
- What role will the bioenergy industry play?

Approach:
The presentation will address these issues by discussing the following aspects: At first, it explains how CO_2 saving targets affect the industry. Afterwards technologies available for a renewable process heat supply will be presented. A comparison of different technologies (solar, biomass, power-to-heat, heat pumps) focusing on their advantages, disadvantages and compatibility for specific industrial applications is done. Based on this, we identified areas in which specific needs for R&D-activities exist and how products / product platforms should be optimized in order to meet the future requirements.

Project:
Furthermore, the system integration of bioenergy in an industrial energy system is illustrated using an example from food industry. In this context, also a new energy storage technology, developed by Fraunhofer UMSICHT, is introduced. This latent heat storage technology uses metal alloys as storage media. The storage concepts allows a direct production of superheated steam for several process heat applications in the temperature range between 250 and 550 °C.

Overview and Status of Bioenergy Retrofits in Europe's Industry – First results of the BIOFIT project (HORIZON2020)

Patrick Reumerman
BTG Biomass Technology Group BV
P.O. Box 835
7500 AV Enschede, The Netherlands
reumerman@btgworld.com

Co-Authors: Dominik Rutz, Rainer Janssen, Dina Bacovsky, Arne Gröngröft, Heidi Saastamoinen

The BIOFIT project (www.biofit-h2020.eu) is a HORIZON2020 initiative that aims to facilitate the introduction of bioenergy retrofitting in five specific industries, namely first-generation biofuels, pulp and paper, fossil refineries, fossil firing power and Combined Heat and Power (CHP) plants.
Spurred by innovation, bioenergy technologies are becoming more advanced and diverse, leading to the production of a variety of advanced transport fuels (first- and second-generation bioethanol, biodiesel and bio-kerosene), intermediate bioenergy carriers and high efficiency, low carbon emission production of power, heating and cooling. Besides erecting entirely new bioenergy plants, retrofitting existing facilities, meaning the replacement of part of a plant or installation with state-of-the-art equipment, can be a good alternative solution to replace fossil fuels or to upgrade outdated renewable technology. Retrofitting often results in lower capital expenditure (CAPEX), shorter lead times, faster implementation, lower production time losses and risks.

The core actions in BIOFIT are Mapping of existing bioenergy retrofits, studying both technical and non-technical aspects, developing concrete retrofit proposals in collaboration with industrial partners, engaging and supporting the broader industry through five Industry fora (working groups, and wider Dissemination of project results and findings.

In this paper first results of the mapping exercise will be presented. Part of the mapping exercise is an on-line retrofitting map which shows the major locations in the EU were bioenergy retrofits have taken place, and provides basic characteristics. A select number of bioenergy retrofits has been highlighted further in the form of best practice factsheets, that show succesfull actual retrofits that have taken place in all five target sectors. To determine the motivations, experiences and perceptions of the people that were responsible for implementing retrofits, a survey has taken place. The aim of this survey is to identify especially the sector-specific and in-company barriers towards retrofitting, and to suggest optimal strategies to facilitate further bioenergy retrofitting. To disseminate knowledge on bioenergy retrofitting to relevant stakeholders, a bioenergy retrofitting handbook has been completed. The handbook is meant to facilitate technical understanding of bioenergy retrofits, thereby presenting the information in understandable language and easy-to-understand graphs and illustrations. The legal, institutional and political framework conditions at EU level and at the level of a selected number of EU countries have been identified and summarised in a framework conditions report. In the project separate attention is paid to providing advice for policy makers on national and regional level. The first summary paper for policy makers has recently been produced.

Initial results show that the use of bioenergy is widespread in the EU. Many large-scale industrial bioenergy plants have been implemented, with retrofitting as the dominant mode of implementation. There are large differences between countries that are likely related to biomass availability. Sector-wise there are also large differences: 60% of the energy used in the pulp and paper industry is renewable, while the fossil refineries sector shows comparatively little bioenergy use. Combustion is an often-used technology, obviously in the fossil fired power sector and for CHP but more advanced technologies like gasification and production of intermediate bioenergy carriers are gaining ground. In the first-generation biofuels sector, there is – because of the EU REDII sustainability requirements - a keen interest to switch to second-generation biofuels, thought feedstock availability is considered limiting.

The BIOFIT consortium consists of fourteen partners from eight European countries: Sweden, The Netherlands, Germany, Spain, Finland, Austria, Bosnia-Herzegovina and Greece. The consortium is a well-balanced mix of industrial and academic / research partners.

Experimental investigation of biomass based reducing agents for blast furnace ironmaking

Norbert Kienzl
BEST Bioenergy and Sustainable Technologies GmbH
Inffeldgasse 21b
A-8010 Graz
norbert.kienzl@best-research.eu

Co-Authors: Christoph Strasser, Richard Deutsch

Steel production via blast furnace (BF) utilizes coke and coal to reduce iron oxides which results in high greenhouse gas (GHG) emissions. One possibility to mitigate fossil GHG emissions in iron respectively steel production is to replace fossil reducing agents by biomass-based reducing agents (bioreducers). Charcoal as bioreducer was used in the beginning of steelmaking. Today, most commonly reported biomass utilization in the blast furnace is in the form of charcoal via tuyeres to replace pulverized coal injection (PCI). The injection of charcoal fines is used in small charcoal BFs in Brazil. However, large furnaces have different quality and process requirements (including strong lump coke as well as large supply of biomass). Hence, further work is needed in order to customize the bioreducers.

Objectives & Approach
A previous study showed - based on results from literature - that the appropriate biomass pre-treatment procedure will most probably be between torrefaction and charcoal production. This project also showed that low cost feedstocks will be needed to stay competitive. Therefore, the objectives are to develop an application tailored biomass pre-treatment procedure via pyrolysis to produce a bioreducer which meets the quality needs of the partner from steel industry and to use feedstocks like wood from short rotation forestry and other so far rather underutilized resources for the bioreducer production. The main methodologies in the project are thermogravimetric studies, batch experiments in muffle furnace, continuous experiments in a lab-scale reactor, experiments regarding grindability, miscibility and pneumatic conveying on different scales.
For using biomass in steel production as a bioreducer it has been proposed that PCI could be entirely replaced by charcoal. But charcoal is expensive and global markets for industrial charcoal do not exist. Therefore we aim to develop the whole value chain to produce a bio-based energy carrier respectively bioreducer which meets the quality needs at best economic conditions.

Methods
Pyrolysis was performed in a lab-type muffle furnace (MF) with a capacity of 1.2 kg per batch in a temperature range from 280 °C to 550 °C for different sizes of the input material and different duration of treatment. C, H and N contents as well as the calorific value of the products were determined according to EN 15104 and EN 14918, respectively, and furthermore assessed in respect to the reducing potential of the bioreducer. After fine-grinding the products with varying grinding intensities the flow behaviour of the produced pulverized bioreducer was assessed using the Revolution Powder Analyzer (Rev2015) from Mercury Scientific Inc. A rotating cylinder made of glass and a high-speed camera for data collection different parameters like solid to liquid ratio (SL-Ratio) and the avalanche energy is calculated with this Powder Analyzer. In order to tentatively assess the fluidization behaviour of the bioreducer in a small scale, a test tube with a gas permeable disk was equipped with a control and measurement system for the fluidization gas stream in order to evaluate the minimal fluidization velocity.

Results
The chemical analysis showed that with increased treatment temperature the C content of the produced material is also increased. The C recovery rate, which relates to the amount of carbon which is left from the input material, the char yield, and the amount of volatile matter decline with an increasing temperature. The calorific value increases also with relation to the raising C content. In respect to the flowability and fluidization behaviour of the various powders produced, it could be shown that within certain ranges of treatment time and temperature, the most significant parameter was the particle size distribution of the bioreducer material. Although flowability and fluidization results of the bioreducer material fall short of the results of the fossil reference, the outcomes indicate that a pneumatic conveying of the bioreducer in a PCI equipment is possible.

Acknowledgements:
This work has been funded within the FFG (Austrian Research Promotion Agency) program COMET (Competence Center for Excellent Technologies).

09:00–10:30 Uhr

Parallelblock 11

Die Zukunft grüner Kraftstoffe und grünen Gases

09:00 am–10:30 am

Parallel Session 11

The future of green transportation fuels and of green gas

Lessons learned from Alternative Fuels Experience

Andrea Sonnleitner
BEST Bioenergy and Sustainable Technologies GmbH
Gewerbepark Haag 3,
3250 Wieselburg-Land, Austria
andrea.sonnleitner@bioenergy2020.eu

Co-Author: Dina Bacovsky

Decarbonising the transport sector is one of the key goals of national and international climate change mitigation policies. Rapid and effective market introduction of alternative fuels and vehicles is needed to reduce greenhouse gas emissions from the existing vehicle fleet as soon as possible and as extensively as possible. However, experience with various attempts to introduce alternative fuels and vehicles to the market has shown that this is not always successful. Several participants in the Advanced Motor Fuels Technology Collaboration Program (AMF TCP) have therefore proposed an annex on lessons learned from market launch attempts.

The circumstances of the introduction of advanced motor fuels and the factors influencing their commercialization (resource, transport infrastructure, economic situation, etc.) in each country are different, and it is difficult to universally evaluate an advanced motor fuels policy. For this reason, this annex clarifies the background and objective of the central government and local governments' introduction policy and specific measures on advanced motor fuels in the past, and summarizes the effectiveness, successes, and lessons learned regarding the promotion of advanced motor fuels in each individual case of introduction and commercialization.

The participating countries Austria, Finland, Japan, Sweden and the USA conduct analyses of their own case studies on past market introduction, taking into account specific framework conditions for each country.

The sum of the case studies will be analysed and key drivers of successes and key barriers of failures will be identified. Preliminary results from this work will be discussed in an expert workshop in 2020, and then the final lessons learned and recommendations will be derived. Policy briefs including key messages, best practices, lessons learned, avoided mistakes related to advanced motor fuels covering both fuels and related vehicle technologies will be developed and provided as recommendations for political decision makers.

Volkswirtschaftliche Effekte des Ausbaus von Erzeugungskapazitäten für erneuerbare Gase und deren Einspeisung in das Gasnetz

Martin Höher
Austrian Energy Agency
Mariahilfer Straße 136a
1150 Vienna, Austria
martin.hoeher@energyagency.at

Ziel der vorliegenden Studie ist eine Analyse der volkswirtschaftlichen Effekte einer „Greening the Gas“ Strategie: Ersatz von fossilem Erdgas durch die Einspeisung von Biomethan, Wasserstoff und synthetischem Erdgas aus erneuerbaren Quellen in das bestehende Gasnetz. Das Ausbaupotenzial bis zum Jahr 2050 für erneuerbare Gase wurde entsprechend den Analysen von JKU und Montanuniversität mit mind. 2 Mrd. Nm^3 Gas jährlich angesetzt. Diese Menge entspricht nach heutigen Projektionen in etwa der für 2050 erwarteten Gasnachfrage für die Raumwärmeerzeugung.
Betrachtet wurde einerseits der Aufbau von Produktionskapazitäten für erneuerbare Gase, deren Aufbau mit ersten Biomethanproduktionsanlagen im Jahr 2004 einsetzte, und andererseits der weitere mögliche Ausbau der Produktionskapazitäten auf 2 Mrd. Nm^3 erneuerbare Gase bis zum Jahr 2050. Investitionen, welche nicht in der österreichischen Wirtschaft wirksam werden (Import technischer Anlagen oder Komponenten), wurden in die Analyse nicht einbezogen. Die Abschätzung der durch „Greening the Gas“ entstehenden Wertschöpfung und Beschäftigung erfolgt mittels Input-Output-Analyse auf Basis der in Österreich wirksamen Investitionen und des laufenden Aufwands für den Betrieb der Anlagen.

Der Ausbau der Produktionskapazitäten für erneuerbare Gase löst Gesamtinvestitionen von 14,7 Mrd. Euro aus, davon können 10,8 Mrd. Euro als für die österreichische Wirtschaft wirksam angesetzt werden. Darüber hinaus entstehen im Betrachtungszeitraum 14,0 Mrd. Euro Aufwände durch den Betrieb der Anlagen. Als Wertschöpfung ergibt sich daraus insgesamt ein Betrag von 20,9 Mrd. Euro, wovon 8,2 Mrd. Euro Biomethan und 12,7 Mrd. Euro Wasserstoff und synthetischem Erdgas zugerechnet werden können.

Die Beschäftigungseffekte aus der Investitionstätigkeit für „Greening the Gas“ liegen bei jährlich 2.000 bis 4.000 Vollzeitbeschäftigen, während der Betrieb der Anlagen langfristig bis zu 6.000 Vollzeitbeschäftige schafft und über den betrachteten Investitionszeitraum bis 2050 hinausreicht. Das bis 2050 insgesamt geschaffene Einkommen summiert sich auf rund 9 Mrd. Euro.

Das zukünftige Energiesystem wird zunehmend von volatilen Energieträgern wie PV- oder Windstrom gekennzeichnet sein. Vor diesem Hintergrund ist die saisonale Speicherbarkeit von erneuerbaren Gasen hervorzuheben, welche witterungsunabhängig für die Erzeugung elektrische Energie, Wärme oder mechanischer Energie genutzt werden können. Die dadurch erzielbare Flexibilität im Energiesystem kann die voranschreitende Energiewende unter Nutzung volatiler Erneuerbarer erst möglich machen. Die damit verbunden gesteigerte Wertigkeit sollte bei zukünftigen volkswirtschaftlichen Betrachtungen von erneuerbaren Gasen entsprechend berücksichtigt werden.

Die Aufbereitung und Einspeisung von Biogas in das Erdgasnetz an Stelle des Einsatzes zur Ökostromerzeugung weist zudem förderspezifische Vorteile auf. Mit dem Unterstützungsvolumen für die Ökostromproduktion aus Biogas von 79 Mio. Euro im Jahr 2017 wäre die kostendeckende Einspeisung von 225 Mio. m^3 Biomethan möglich gewesen, dessen Energiegehalt die Ökostromeinspeisung (aus Biogas) um 50% übertrifft. Eine Betrachtung der Ökostromförderung insgesamt zeigt, dass die Ökostromeinspeisung von 10,5 TWh im Jahr 2017 ein Unterstützungsvolumen von 860 Mio. Euro benötigte. Eine der Ökostromeinspeisung energetisch äquivalente Biomethaneinspeisung hingegen würde lediglich ein Fördervolumen von 360 Mio. Euro erfordern.

On the development of biofuel policies in the EU

Amela Ajanovic
Energy Economics Group
Vienna University of Technology
Gusshausstr. 25-27/370-3
1040 Vienna, Austria
ajanovic@eeg.tuwien.ac.at

In the last decades fuels based on biomass have been considered as one of the major alternative to fossil fuels and an important means to cope with increasing greenhouse gas (GHG) emissions from the transport sector. Biofuels have been widely promoted and supported by different policy measures. However, with the increasing use of biofuels some new challenges, such as sustainability of biofuels or competitions with food production have become more evident. This has reduced the enthusiasm for biofuels, and led to changes in policy framework, and finally, resulted in plummeting of investments in biofuels worldwide, especially for first generation biofuels.

The major goal of this work is to document and analyse the development of the biofuels use as well as to investigate development of the supporting policy conditions (e.g. tax reductions, blending mandates, etc.). All relevant EU regulations and directives (e.g. Renewable Energy Directive, Fuel Quality Directive, EU Energy and Climate Change Package, Indirect Land Use Change Directive) will be considered as well as broad portfolio of national biofuel policies implemented in the EU countries. Of special interest is to identify major differences between countries and to identify positive examples and derive lessons learned.

Since the major problems of first generation biofuels are limited potentials and modest ecological performance, interest in advanced biofuels is increasing. The Renewable Energy Directive provides an overall policy framework for the production and promotion of advanced second generation biofuels in the EU.

The future use of biofuels – first as well as second generation - is very dependent on the development of their economic and environmental performances. A major conclusion is that the time of political promotion of biofuels is widely over and even for second generation biofuels no bright prospects are on the horizon.

Freitag
24
Jänner

11:00–12:30 Uhr

Parallelblock 12

Herausforderungen für Multi-Fuel-Feuerungen mit niedrigsten Emissionen

Friday
24
January

11:00 am–12:30 am

Parallel Session 12

Challenges for multi-fuel and lowest emission combustion systems

Eco+ ready boilers – striving towards ultra low emissions

Morten Gottlieb Warming-Jespersen
Danish Technological Institute
Kongsvang Alle 29
8000 Aarhus C, Denmark
mgjn@teknologisk.dk

Co-Authors: Anne Mette Frey, Anders Pødenphant, Thomas Nørgaard Jensen

In 2020 new EcoDesign legislation for combustion in biomass boilers will be implemented. The new yearly efficiency requirement (calculated as an average of 15% nominal load and 85% minimum load) is 77%. For automatic boilers- the emission limits for NO_x is 200 mg/m^3, dust 40 mg/m^3, CO 500 mg/m^3, and OGC 20 mg/m^3 (at 10% O_2). Compared to earlier requirements, where only the nominal load was taken into consideration, the minimum load performance will thus also be included in the yearly performance of the boiler. It is expected that the regulation will be even stricter in the future, wherefore it is important to develop ultra-low emission boilers ready for EcoDesign+ levels.

Aim
The aim of the project is to develop two, novel small scale Ecodesign+ biomass boilers with gasification technology and flue gas recirculation (FGR) to reduce emissions of dust and NO_x while increasing the energy efficiency. The boilers will be optimised for real life use. Based on the insight from the project development work, guidelines will be drawn and offered as a platform to the Danish producers of boilers, hence the industry in general can apply it for their individual future development work. In addition, the project will be the first in the Nordic countries to develop boilers as to such a level that they are Ecodesign+ ready for stricter legislation in the future.

Innovation
To accommodate the above-mentioned issues the project addresses the following main activities:

- Investigation of wood pellet properties impact on combustion
- Investigation of the effect of technological improvement of combustion system with respect to efficiency and emission, more specifically
  - Gasification impact on dust emissions
  - FGR impact on formation of NO_x
- Optimization of the control system for lowest possible real-life emissions and high efficiency
- Development of advanced control algorithms including wood pellet properties

In order to broaden the project scope and make the outcome more applicable to various boiler types, two combustion principles from two different boiler manufactures will be designed and manufactured during the project. The experience with the different boilers and combustion systems optimization will be used to generate general guidelines with improvement advises with the aim of helping manufacturers to develop Eco-design boilers of world class in the future by having led the foundation. The technology that will be applied on the new boiler systems in this project builds on gasification technology and FGR, resulting in reduced dust (goal 50% reduction) and NO_x emissions (goal 30% reduction).
The applicability in real life operations will be ensured by taking various wood pellets in to consideration. This will be researched by investigations of the impact of the wood pellets properties on the combustion, with focus on the most influencing parameters of the pellets e.g. diameter, hard wood vs soft wood and pre-treated vs untreated wood pellets.

Evaluation of ash melting behavior of rice husk and rice straw during thermochemical conversion

Hossein Beidaghy Dizaji
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH
Department Thermo-chemical Conversion
Torgauer Straße 116
04347 Leipzig, Germany
hossein.beidaghy@dbfz.de

Co-Authors: Thomas Zeng, Dirk Enke

Utilization of biomass fuels in energy production plays a major role in reduction of greenhouse gas emissions in order to meet the ambitious targets which has been set by the United Nations Climate Change Conference (Paris agreement) [1]. Since the potential of high quality woody biomass for energy production is limited and rapid increase in wood utilization resulted in high quality woody material shortage in some regions, other biomass such as agricultural residues, agricultural by-products, etc. seem to be a promising alternative, particularly for small- (<100) and medium-scale (0.1 - 1 MW) combustion applications [2]. During the combustion of biomass, inorganic elements can significantly contribute to undesired slag formation in the bottom ash [3]. There are several solutions to control the ash melting tendency of biomass, including adjustment of the combustion conditions and modification in chemical composition of the biomass fuels [4]. In particular, chemical pre-treatment and blending of the biomass are two common methods to modify the chemical composition of the biomass [5 - 7]. The objective of the present work was to evaluate ash-melting behavior of rice husk (RH) and rice straw (RS) using blending, water washing and acid leaching strategies. In this regard, the disintegration method and sieving method were employed to assess ash melting behavior of RH and RS during combustion. Fuels and ashes were characterized based on existing standards for solid biofuels. Remaining ash samples were also evaluated using XRD and SEM.

The results revealed whether the ash melting behavior of RH and RS can be mitigated by blending or washing and leaching strategies. This information is used to assess the applicability of such fuels in small and medium scale combustion appliances.

References

1. *United Nations Framework Convention on Climate Change. Adoption of the Paris Agreement: Proposal by the President. Paris Climate Change Conference - November 2015, COP 21. Paris, France; 2015.*
2. Mola-Yudego, B.; Arevalo, J.; Díaz-Yáñez, O.; Dimitriou, I.; Haapala, A.; Carlos Ferraz Filho, A.; Selkimäki, M.; Valbuena, R. Wood biomass potentials for energy in northern Europe: Forest or plantations? *Biomass and Bioenergy* 2017, *106*, 95–103, doi:10.1016/j.biombioe.2017.08.021.
3. Zeng, T.; Pollex, A.; Weller, N.; Lenz, V.; Nelles, M. Blended biomass pellets as fuel for small scale combustion appliances: Effect of blending on slag formation in the bottom ash and pre-evaluation options. *Fuel* 2018, *212*, 108–116, doi:10.1016/j.fuel.2017.10.036.
4. Fernández, M.J.; Mediavilla, I.; Barro, R.; Borjabad, E.; Ramos, R.; Carrasco, J.E. Sintering reduction of herbaceous biomass when blended with woody biomass: Predictive and combustion tests. *Fuel* 2019, *239*, 1115–1124, doi:10.1016/j.fuel.2018.11.115.
5. Said, N.; Bishara, T.; García-Maraver, A.; Zamorano, M. Effect of water washing on the thermal behavior of rice straw. *Waste Manag.* 2013, *33*, 2250–2256, doi:10.1016/j.wasman.2013.07.019.
6. Chen, P.; Gu, W.; Fang, W.; Ji, X.; Bie, R. Removal of metal impurities in rice husk and characterization of rice husk ash under simplified acid pretreatment process. *Environ. Prog. Sustainable Energy* 2017, *36*, 830–837, doi:10.1002/ep.12513.
7. Schliermann, T.; Hartmann, I.; Beidaghy Dizaji, H.; Zeng, T.; Schneider, D.; Wassersleben, S.; Enke, D.; Jobst, T.; Lange, A.; Roelofs, F.; et al. High quality biogenic silica from combined energetic and material utilization of agricultural residues. In . Proceedings of 7th International Symposium of Energy from Biomass and Waste, Venice, Italy, 15-18 October, 2018, ISBN 978-8-86-265013-7.

Mitigation of particulate matter emissions from the combustion of corn cobs in a small scale multi-fuel boiler

Natasa Dragutinovic
Institute of Environmental Technology and Energy Economics
Technical University of Hamburg
Eißendorferstraße 40
21703 Hamburg, Germany
natasa.dragutinovic@tuhh.de,

Co-Authors: Martin Kaltschmitt

Combustion of low-cost, abundant, local crop residues for energy production could increase sustainable energy independency of agricultural regions and facilitate their transition to renewable energy sources. Due to challenging fuel properties of crop residues such as higher ash, alkali, P, N, S, and Cl contents, their thermochemical utilization results in increased pollutant emissions and is associated with ash-related problems. In addition, the combustion of crop residues in conventional combustion units constructed for solid fuels such as log wood and coal is in most cases inefficient, if not unfeasible. High ash content and specific ash melting behaviour of crop residues require active ash removal systems and / or moving (cooled) grates to avoid ash sintering and combustion air blockages. Moreover, the control system has to be adjusted to crop residue fuel properties such as lower heating value in comparison to woody biomass.

Conditioning of solid biogenic fuels e.g. through pelletizing could mitigate particulate matter emissions as well as improve combustion efficiency. Pelletizing improves mechanical properties (durability, bulk density, fine content) of the fuel, enabling better transport and storage, as well as utilization in automated fuel-feeding units (which enable better process control and continuous stabile operation). Pellets are produced with the goal of meeting the quality requirements according to the ISO 17225-6 (non-woody pellets).

In order to decrease negative environmental impact and increase energy efficiency of the crop residue combustion in small and medium sized units without secondary flue gas treatment, the aim of this research topic is to investigate the effect of pelletizing on the particulate matter emissions and ash melting behaviour during the combustion of corn cobs in a small scale multi-fuel boiler, during full and partial load conditions. The influence of pelletizing on the particulate matter (PM) and carbon-monoxide (CO) emissions from combustion of corn cobs has been experimentally investigated in a multi-fuel 25 kW boiler with a moving grate and automatic de-ashing system. Gaseous emissions have been continuously monitored using a gas analyser, whereas total particulate matter emission has been discontinuously measured according to VDI 2066-1. Results have shown that pelletizing process influences PM emissions.

Experimentelle Analyse und Optimierung der Emissionen eines 30 kW Laborreaktors einer neuen Multi-Fuel-Low-Emission Feuerungstechnologie

Georg Archan
Institut für Wärmetechnik
Technische Universität Graz,
Forschungsgruppe „Sustainable, Clean and Bioenergy Systems“,
Inffeldgasse 25b
8010 Graz, Austria
georg.archan@tugraz.at

Co-Authors: Andrés Anca-Couce, Leonhard Pölzer, Markus Buchmayr, Christoph Hochenauer, Joachim Kelz , Kai Schulze, Johann Gruber, Robert Scharler

Motivation
Um die Emission schädlicher Luftschadstoffe zu senken, werden zunehmend strengere gesetzliche Emissionsgrenzwerte für Verbrennungsanlagen eingeführt. Auch für Biomasse-Kessel besteht in diesem Kontext der Bedarf nach einer Emissionsreduktion, wobei NO_x und Feinstaub hervorzuheben sind, da diese noch nicht so gut beherrscht sind wie die Emissionen aus unvollständiger Verbrennung, wie etwa von CO. Besonders wichtig im Sinne einer Erhöhung der Brennstoffflexibilität und damit einhergehend, einer Vergrößerung des Marktpotentials von Biomasse-Feuerungen, ist dies für Brennstoffe mit erhöhten Stickstoff- und Aschegehalten (z.B. landwirtschaftliche Reststoffe und Energiepflanzen), da dies zu erhöhten Staub- und NO_x-Emissionen führen kann.

Ziel und Vorgehensweise
Diese Arbeit zielt auf die experimentelle Untersuchung der verschiedenen Einflussparameter eines mit unterschiedlichen Brennstoffen betriebenen 30 kW Festbett-Laborreaktors auf die entstehenden Staub-, CO- und NO_x-Emissionen ab, um daraus Primärmaßnahmen zur Emissionsreduktion ableiten zu können. Der Festbett-Laborreaktor weist eine dreifache Luftzufuhr sowie zusätzlich eine Zufuhr von rez. Rauchgas unter und über dem Rost auf. Die Anlage wurde mit niedrigen Sauerstoffkonzentrationen im Brennstoffbett betrieben (niedrige Primärluftverhältnisse und Rauchgasrezirkulation), wodurch die Betttemperaturen und damit die anorganischen Feinstaub-Emissionen gesenkt sowie Verschlackungen verhindert wurden. Die eingesetzte doppelte Luftstufung in der Gasphase, kombiniert mit der Rauchgasrezirkulation über dem Rost, sorgte für entsprechend lange Verweilzeiten unter reduzierten Bedingungen und guter Durchmischung der Reaktionspartner, was schlussendlich eine effektive Reduktion der NO_x-Emissionen ermöglichte. Der vollständige Ausbrand des Rauchgases, wurde in der nachfolgenden Ausbrandzone realisiert. Der Festbett-Laborreaktor wurde mit Fichtenholz-Hackschnitzeln und mit Miscanthus als relevanter Brennstoff für halmgutartige Brennstoffe betrieben. Dabei wurden alle relevanten Schadstoffe im Rauchgas, die Temperaturverteilung im Brennstoffbett sowie Temperaturen und Gaszusammensetzung an verschiedenen Positionen in der Brennkammer gemessen.

Ergebnisse und Schlussfolgerung
Die Analyse der durchgeführten Experimente ergibt, dass die untersuchten Primärmaßnahmen hinsichtlich der NO_x-Emissionen sowohl für Holzhackschnitzel als auch für Miscanthus zufriedenstellend funktionierten. Im optimalen Betriebspunkt hinsichtlich NO_x-Emissionen konnten in den durchgeführten Messkampagnen NO_x-Emissionen <100 mg / Nm^3 bei 13 vol.-% O_2 für Hackschnitzel und <200 mg / Nm^3 bei 13 vol.-% O_2 für Miscanthus erreicht werden. Die systematische Untersuchung der Einflussparameter auf die Feinstaubbildung ergab, dass niedrige Sauerstoffkonzentrationen bzw. Temperaturen im Brennstoffbett essentiell für niedrige Emissionen waren. Für den Brennstoff Miscanthus musste unter dem Rost zusätzlich rez. Rauchgas eingesetzt werden, um Verschlackung zu verhindern und niedrige Feinstaubemissionen zu erzielen. Die durchgeführten Staubmessungen ergaben Feinstaubemissionen (PM_{10}) < 2 mg / Nm^3 bei 13 vol.-% O_2 für Hackschnitzel und Miscanthus. Aktuell werden detaillierte experimentelle Untersuchungen über die Bildungsmechanismen von Feinstaub- (PM_{10}) und NO_x-Emissionen durchgeführt. Insgesamt ist diese Arbeit ein großer Schritt in Richtung eines grundlegenden Verständnisses der Prozesse in der neuen Multi-Fuel-Low-Emission-Technologie, als wichtige Basis für deren Entwicklung, Optimierung und nachfolgende Markteinführung.

Freitag
24
Jänner

11:00–12:30 Uhr

Parallelblock 13

Bioenergie und biobasierte Bioökonomie in Europa

Friday
24
January

11:00 am–12:30 pm

Parallel Session 13

Bioenergy and biobased bioeconomy in Europe

Fostering Bioeconomy in Central, East and South-East Europe. The Experience of the CELEBIO project in the Czech Republic, Slovakia, Hungary, Slovenia, Croatia and Bulgaria

Peter Canciani
Central European Initiative
Executive Secretariat
Via Genova 9
34121 Trieste, Italy
canciani@cei.int

Bio-based value chains offer economic growth that contributes to key European political priorities: climate change mitigation, efficient use of indigenous resources and global competitiveness. Transition to a bio-economy is challenging, requiring alignment and collaboration by policy, R&D and industry players. However, the pace in which bio-based technologies are deployed is not balanced throughout Europe. This is particularly the case in 'moderate/modest innovator' countries according to the European Innovation Scoreboard. This may be the result of insufficient knowledge of the potential for the bio-based industry in these countries. This also applies to the activities and opportunities offered by the Bio-based Industries Joint Undertaking and of the Bio-based Industries Consortium.

The Central Europe LEaders in Bioeconomy (CELEBio) project contributes with fact-based information and networking, which represent a starting point for further expansion of the Bioeconomy in eight countries of Central Europe (Bulgaria, Czech Republic, Croatia, Hungary, Slovak Republic and Slovenia) through the elaboration of evidence-based Action Plans for each of the targeted countries.

In order to set the grounds for further action in support of the uptake of bio-based technologies and facilitate matchmaking between stakeholders in research and industry, the CELEBio project team will assess biomass potentials, map Bioeconomy stakeholders and set-up a network of national info points. In particular, CELEBio activities encompass:

- The assessment and mapping of sustainable biomass potentials in the eight target countries that will also be correlated with current socio-economic trends, addressing demography, rural development and logistics
- The mapping of bio-based industries and major actors with detailed information on existing bio-based industries and major actors, including also industries that could benefit from adding a bio-based perspective in their operations. The mapping will be completed with a SWOT analysis, highlighting the main obstacles that are hindering the deployment of bio-based technologies in the target countries.
- The development of Bioeconomy Action Plans for the eight target countries
- Raising awareness through activities deployed at both national and regional level, with multiple actors involved and with marked attention to long-term sustainability.

CELEBio project is funded by the EC under Grant Agreement n.838087 and is implemented by the following partners: Central European Initiative (IT), Wageningen Research (NL), Imperial College of London (UK), Masarykova Univerzita (CZ), Regional Centre for Information and Scientific Development (HU), Energy Institute Hrvoje Pozar (HR), World Wildlife Fund Bulgaria (BG), Business and Innovation Centre Bratislava (SK), Association of Chemical Industry of Slovenia at Chamber of Commerce and Industry (SI).

Development of the bioenergy as a part of renewable energy in the Nordic Countries: A comparative analysis

Tapio Ranta
Lappeenranta-Lahti University of Technology
School of Energy Systems
Lönnrotinkatu 7
50100 Mikkeli, Finland
tapio.ranta@lut.fi

Co-Authors: Mika Laihanen, Antti Karhunen

In this study, a comparative analysis of the bioenergy and renewable energy situation in the Nordic countries, here Finland, Sweden, Denmark and Norway, was carried out. What are the sources of renewable energy and where renewable energy is used. The development of renewable energy use is described by time series and compared to the overall development of the EU. All of the Nordic countries have a high renewable energy consumption and have already met the target for gross final energy consumption according to the Europe 2020 strategy while at EU level we are lagging behind the 20% target.

In total, 53.2 Mtoe renewable energy was used in the Nordic countries in 2017, which was 51% of the final energy consumption, 104.2 Mtoe. Bioenergy accounts for about half of renewable energy, 25.9 Mtoe, and is expected to continue to grow. Especially in Norway and Sweden the share of renewable energy was high (71% and 55%) compared to Finland and Denmark (41% and 36%). Norway is famous for hydropower (84% share of RES in 2017) and Denmark for wind power production (21%), whereas Finland uses a lot of biomass for co-generation and heating (78%), followed by Denmark (64%) and Sweden (54%) in 2017. The high efficiency of co-generation is anticipated to be one of the most important success factors in district heating.

At EU level, bioenergy plays even a higher role in renewable energy production (57%) in 2017 and is expected to continue to grow in all end-use sectors such as heating and cooling, electricity generation, transport, in the 2020s.

Bioenergy Development Strategy and Investment Plan: A Regional Approach to Accelerate Diffusion of Modern Bioenergy Technologies in East Africa

Michael Kiza
East African Centre of Excellence for Renewable Energy and Efficiency (EACREEE)
P.O. Box 16775
Kampala, Uganda, Africa
m.kiza@eacreee.org
www.eacreee.org

Bioenergy (especially woody biomass) is still the dominant part of the energy mix of East African Community (EAC) Partner States comprising of Burundi, Kenya, Rwanda, South Sudan, Tanzania and Uganda. Around 90% of rural and low-income urban households in the EAC use either firewood or charcoal to cook. While rural households prefer firewood, urban ones favour charcoal. Charcoal provides over 82% of the energy used by urban households. In the long run, demand for biomass-based energy - especially charcoal - is expected to rise.

If sustainably utilized, bioenergy can help keep the greenhouse gases emissions from the EAC Partners States low. However, the current utilization is unsustainable. While the demand for biomass is rising, the supply is decreasing. Currently Burundi faces a biomass energy (wood and charcoal) supply deficit ranging from 56%-155%. On the other hand, Kenya's deficit for wood biomass energy is at 70%, while charcoal has a deficit of 122%. Mainland Tanzania similarly has annual wood demand and supply imbalance and deficit of 19.5 million m3, or 20%. In Zanzibar, assessments indicate a supply deficit of 10% for wood and 178% for charcoal. Uganda and Rwanda similarly face bioenergy deficits estimated at 69% and 29%, respectively. Although a lot of efforts are being made to shift to utilization of alternative fuels for cooking like liquefied petroleum gas (LPG), it is projected that the demand for traditional biomass will increase in absolute terms due to rising population and lack of affordable alternative energy sources. Given that dependency on traditional biomass will remain a challenge into the future, more efficient end-use of traditional biofuels could be a key part of the transition towards sustainable bioenergy supply. This should be coupled with sustainable forest management and efficient bioenergy conversion technologies.

The bioenergy challenge in the EAC region is a trans-boundary problem – requiring common action. However, this trajectory of over dependency on traditional biomass could be altered by accelerating the transition to modern bioenergy systems and rapidly transforming the region's rural economies. Appropriate regional strategies and policy interventions is therefore crucial in order to address this trans-boundary challenge. Hence, it was sought necessary to put in place Bioenergy Strategy and Investment Plan for the East African region.

The Bioenergy Strategy and Investment Plan for the East African region has the ultimate objective of accelerating the diffusion of modern bioenergy technologies in the EAC. The Bioenergy Strategy and Investment Plan is built on the following market enablers: planning and decision making information and awareness, creation of an enabling environment for investors and project developers, harmonization of policies and regulations, getting political commitment and mainstreaming modern bioenergy, availing appropriate finance and risk mitigation, capacity building and skills enhancement, standards setting and enforcement, and identifying champions in each country to achieve the strategy objectives. These market enablers are expected to facilitate the dissemination of both supply and demand side interventions that will realize up scaling improved, efficient and clean bioenergy end use; as well as ensuring sustainable bioenergy supplies.

Bio-based strategies and roadmaps for enhanced rural and regional development in the EU – the BE-Rural project

Felix Colmorgen
WIP Renewable Energies
Sylvensteinstr. 2
81369 Munich, Germany
felix.colmorgen@wip-munich.de
www.wip-munich.de, www.be-rural.eu

Co-Authors: Dominik Rutz, Cosette Khawaja, Rainer Janssen

Limitations of natural resources, climate change, world population growth, and loss of biodiversity are among the main global challenges today. The switch of current economic systems to bioeconomies can maintain the long-term prosperity of modern societies by enabling economic growth in accordance with protecting nature and the environment. The basis of the present European and national bio-based strategies was formed in 2012 through the strategy "Innovating for Sustainable Growth: A Bioeconomy for Europe" of the European Commission. Therein the bioeconomy is defined as "the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy. Its sectors and industries have strong innovation potential due to their use of a wide range of sciences, enabling and industrial technologies, along with local and tacit knowledge." The bioeconomy is currently generating a turnover of € 2.3 trillion why it can already be considered as an important pillar in the EU economy.

One of the major strengths of the bioeconomy concept is the development and support of rural, costal and remote areas by adding values to commodities which are produced by the agricultural, forestry, fishery or waste sectors. This could reduce the rural exodus through job creation and improve the territorial cohesion through social innovation. It could especially support SMEs from different sectors. Therefore, underused or even unused potentials and resources need to be identified, analyzed and valorized. Thereby, the local context must be considered, and concepts developed which can stimulate new businesses at different scales. The overall goal is a more proportionate and fair sharing of the benefits of a competitive and sustainable bioeconomy across regions, countries and whole Europe.

The BE-Rural project, funded by the EU's Horizon2020 programme, supports the establishment of regional and local bio-based economies by involving relevant actors in the development of bioeconomy strategies and roadmaps. The target regions of BE-Rural are in Eastern and Southeastern Europe: Stara Zagora (Bulgaria), Szczecin Lagoon and Vistuala Lagoon (Poland), Strumica (North Macedonia), Covasna (Romania) as well as Vidzeme and Kurzeme (Latvia). The characteristics of the selected regions are analyzed, best practices identified, and business models defined. This analysis will help to assess the 'bioeconomy potential' of each selected region. Based on that, a series of regional Open Innovation Platforms will be implemented to kick-start the co-creation process, bringing together key stakeholders from academia, policy, business and civil society to develop ideas and capitalize on their bioeconomy potential. These activities will include research & innovation capacity building workshops, educational seminars and webinars, summer schools and bio-based Pop-up stores. A knowledge network will be established to share knowledge, lessons learned and best practices from the Open Innovation Platforms at an inter-regional level, to close the information gap on issues related to sustainability and to increase capacities of regional authorities and stakeholders.

11:00–12:30 Uhr

Parallelblock 14

Bioenergie in der Praxis

11:00 am–12:30 pm

Parallel Session 14

Bioenergy in practice

Maisspindeln – die nachhaltige Alternative zu Klimakiller Grillkohle

Alfred Kindler
Energie, Klima und Bioressourcen
Landwirtschaftskammer Steiermark
Hamerlinggasse 3
8010 Graz, Austria
alfred.kindler@lk-stmk.at, http://www.stmk.lko.at

Wenn die Temperaturen wieder über die 20 Grad steigen, kommen Kugelgrill und Co. aus ihrem „Winterschlaf". Grillen zählt in Österreich neben Schifahren zu einer der beliebtesten „Volkssportarten". Was auf den Grill kommt, ist uns sehr wichtig, aber womit wir grillen, wohl eher nicht. In den Kochbuchabteilungen der Bücherläden sieht man, wie vielfältig das Grillen mittlerweile geworden ist.

Die Befeuerung ist aber eher alternativlos und konservativ. Kohle, Gas und Elektrizität ist den selbsternannten „Grillgöttern" egal, Hauptsache es ist günstig und brennt. Man könnte meinen, dass die Holzkohle eine umweltfreundliche Alternative ist - in der jetzigen Form jedoch nicht. In Europa werden jährlich 800.000 Tonnen Holzkohle für das Grillen genutzt. Der Großteil davon kommt aus dem EU-Ausland. Das Problem: In den Säcken steckt oft Kohle aus Tropenholz. In afrikanischen Ländern bildet die Holzkohleproduktion für lokale Bauern in den Trockenzeitperioden einen rettenden Strohhalm, um ihre Familien zu ernähren. Der hohe Holzkohlebedarf hat dazu geführt, dass Nigeria nur noch zu 4 % mit Wald bedeckt ist. Der jährliche Flächenverlust durch Rodung beläuft sich auf etwa 350.000 ha, wobei Nigeria seit 1990 rund 36 % seiner Wälder verloren hat. Auch die Lage in Sambia ist erschreckend. Wird der Waldrodung für die Holzkohlegewinnung nicht Einhalt geboten, so könnte das Land in 20 Jahren ohne Bäume dastehen. Dabei sind weltweit rund 15 % der klimaschädlichen Treibhausgasemissionen auf Waldzerstörung (Brandrodung) und Walddegradation zurückzuführen. Für die Produktion einer Tonne Holzkohle werden bis zu 12 Tonnen Holz benötigt, wobei der Großteil des im Holz gespeicherten Kohlenstoffs ungenutzt entweicht. Holzkohlenomaden ziehen in Familienverbänden durchs Land und verkohlen alle Bäume, die sie fällen können. Neben dem Verlust der Waldfläche bedroht die Holzkohlenproduktion die Lebensgrundlage der Bauern - den fruchtbaren Boden. Durch das Schwelen entstehen Gase, die nicht nur für die Menschen schädlich sind, sondern auch den Boden unfruchtbar macht, das Grundwasser vergiftet und die Biodiversität gefährdet. Doch stoppen will diese Entwicklung in Afrika scheinbar niemand. Zu lukrativ ist das Geschäft. Die Einnahmen aus dem illegalen Kohlehandel sind mit 7,4 Milliarden US-Dollar jährlich fast dreimal so hoch wie die aus dem illegalen Drogenhandel.

Eine umwelt- und ressourcenschonende Alternative zur Holzkohle bieten heimische Maisspindel. Sie fallen als Reststoff in der Körnermaisernte in ganz Europa an und werden durch das einwirkende Sonnenlicht am Feld getrocknet. In Europa werden jährlich 8,4 Mio. Hektar Körnermais angebaut. Durch die Nutzung der Maisspindel werden die Wälder entlastet und bei der Verarbeitung kaum Emissionen ausgestoßen. Mit ihrer minimalen Rauchentwicklung und dem wegfallenden Importbedarf von Grillkohle, zeichnet sich die Verwendung von Maisspindeln im Vergleich zur Holzkohle durch Nutzerfreundlichkeit und Nachhaltigkeit besonders aus. Was das persönliche Grillerlebnis betrifft, brennt Grillkohle aus Mais schnell und ist binnen 15 Minuten grillfertig. Zudem erreicht sie Temperaturen von bis zu 800°C, während normale Kohle lediglich bis zu 600°C heiß wird. Ein weiterer Vorteil ist, dass weder der Grillmeister noch die verarbeitenden Parteien sich ihre Hände schmutzig machen müssen. Außerdem eignet sich die anfallende Asche hervorragend als Dünger, wodurch der Upcycling-Kreis vollständig und nachhaltig geschlossen wird. Die Fläche von Körnermais in der EU – mit den anfallenden Maisspindeln – könnte den Holzkohleverbrauch für das Grillen um das mehr als 10-fache substituieren. Würde die Hälfte der Grillkohle in Europa durch Maisspindeln ersetzt, könnte man jährlich rund 8 Millionen Tonnen CO_2 einsparen. Vergleich: Österreich emittiert jährlich rund 80 Miilionen Tonnen CO_2.

Biomasseanlage und Abwärmeauskopplung aus einer Papierfabrik samt Pufferspeicheroptimierung

Leo Riebenbauer
Büro für Erneuerbare Energiea
Ing. Leo Riebenbauer GmbH
Hauptplatz 13
8243 Pinggau, Austria
office@riebenbauer.at

Schon seit vielen Jahren setzt man in der steirischen Stadt Bruck a. d. Mur auf umwelt-freundliche Energieversorgung. Dazu leistet die Brucker BIO Fernwärme GmbH einen wesentlichen Beitrag. Der erste Schritt zu einer CO^2-neutralen Wärmebereitstellung wurde in Bruck bereits im Jahr 2008 durch die Errichtung eines Biomasseheizwerkes mit einer thermischen Leistung von 8 MW gesetzt. Seither wird das, mittlerweile 21 km lange Fernwärmenetz kontinuierlich weiter ausgebaut, um alle öffentlichen Gebäude, sämtliche Schulen wie die österreichweit einzige Höhere Bundeslehranstalt für Forstwirtschaft - Bruck, das Landeskrankenhaus und eine Vielzahl an Betrieben und Haushalten mit erneuerbarer Wärme aus der Region zu versorgen.

Ressourceneffizienz durch Wärmerückgewinnung
Im Hinblick auf den ressourcenschonenden Umgang mit Energie wurde schon beim Bau des Heizwerkes eine Rauchgaskondensationsanlage installiert, die den Wärmegehalt des Rauch-gases nutzt. Dadurch wird der Brennstoffeinsatz reduziert und der Gesamtwirkungsgrad der Anlage wesentlich erhöht. Darüber hinaus trägt der Einsatz modernster Abgasreinigungs-technik dazu bei, dass alle vorgegebenen Grenzwerte bei weitem unterschritten und die gesetzlichen Luftreinhaltungskriterien erfüllt werden können.

Nachhaltige CO^2-Einsparung durch industrielle Abwärmenutzung
Parallel zum Netzausbau in der Stadt Bruck an der Mur erfolgte ab 2012 die Auskopplung von industrieller Abwärme aus dem ortsansässigen, Papier erzeugenden Unternehmen Norske Skog. Mittlerweile ist schon die zweite Ausbaustufe der Wärmeauskopplung in Betrieb und so kann durch die kluge Einbindung von 16,6 MW industrieller Abwärme in das Brucker Fernwärmenetz der Ressourcenverbrauch an Waldhackgut auf ein Minimum reduziert werden. Wärmebereitstellung aus Biomasse dient mittlerweile ausschließlich der Spitzenlast-abdeckung. Aktuell werden aufgrund der ganzheitlich angelegten Energiebereitstellung jährlich rund 9.300 Tonnen CO^2 eingespart!

Optimierung der Wärmeversorgung
Um die Versorgungssicherheit mit CO^2-neutraler Wärme noch zu optimieren und weiterhin hundertprozentig zu gewährleisten, wird das Wärmeversorgungssystem derzeit durch drei große Pufferspeicher mit je 200.000 Liter Speichervolumen erweitert. So kann mittels Kombination der drei Säulen der Fernwärme-Bereitstellung: Biomasseheizwerk, Industrielle Abwärmenutzung und Groß-Pufferspeicherlösung in der Stadt Bruck an der Mur ein Höchst-maß an Versorgungssicherheit, Energie- und Ressourceneffizienz und CO2-Einsparung erzielt werden.

Ökologischen Fußabdruck von Heizsystemen nach dem Sustainable Process Index (SPI)

Dieter Preiß
Amt der Steiermärkischen Landesregierung
A 15 - Fachabteilung Energie und Wohnbau
Referat Energietechnik und Klimaschutz
Landhausgasse 7, 2. Stock
8010 Graz, Austria
dieter.preiss@stmk.gv.at

Co-Authors: Michael Eder, Barbara Truger, Alexander Passer

Ökologischer Fußabdruck nach dem Sustainable Process Index
Die Idee des Ökologischen Fußabdrucks ist eine Art der Bewertung der ökologischen Nachhaltigkeit. Er ist ein Maß dafür, wie stark menschliches Handeln die Natur verändert und belastet. Bei der Methode des Sustainable Process Index (SPI) werden alle Stoff- und Energieflüsse, die im Lebenszyklus zur Herstellung eines Produkts oder der Bereitstellung einer Dienstleistung zwischen dem vom Menschen geschaffenen Lebensraum (Anthroposphäre) und der Natur (Luft, Wasser, Boden) ausgetauscht werden, berücksichtigt und in einen Flächenverbrauch umgerechnet. Der SPI berücksichtigt dabei neben dem Verbrauch an Rohstoffen auch entstehende Emissionen und Abfälle.

Was wurde untersucht?
Untersucht wurde eine Reihe von Heizsystemen für durchschnittliche Einfamilien- und Mehrparteienhäuser, jeweils im Bestand, (hochwertig) saniert und im Neubau. Der Fokus lag dabei auf dem Wärmebereistellungssystem. Infrastruktur und Betrieb der einzelnen Heizsysteme wurden in der Bewertung berücksichtigt. Die berechneten Fußabdruckswerte wurden anschließend zur besseren Vergleichbarkeit auf eine kWh Wärmebedarf bezogen.

Einfamilienhaus mit geringer thermischer Qualität der Gebäudehülle im Vergleich.
Am Beispiel eines bestehenden Einfamilienhauses gemessen, stellen Elektro-Direktheizungen (mit AT-Strommix[1]) bzw. bestehende Ölkessel stellen die schlechtesten der untersuchten Varianten aus Umweltsicht dar. Wärme aus Gas, die über einen konventionellen Gaskessel bereitgestellt wird, weist einen etwas geringeren Ökologischen Fußabdruck auf. Gasbrennwertkessel mit kombinierter solarer Warmwassergenerierung und Außenluft-Wärmepumpen sind zwar geringfügig besser, haben einen ähnlichen Ökologischen Fußabdruck der sich aber immer noch auf einem hohen Niveau befindet. Die Wärmeversorgung mit einer Grundwasser- bzw. Erdreichwärmepumpe liegt auf dem Niveau der Fernwärme mit 50 % erneuerbaren Energiequellen (50 % Hackschnitzel, 50 % Gas). Am besten schneidet die Wärmeversorgung mit Stückholzvergaser kombiniert mit einer Solartechnologie ab. Ihr Fußabdruck beträgt nur noch rund ein Fünftel der Wärmeversorgung mit Öl.

[1] Berechnung basierend auf Daten der IEA (Statistics, Electricity and heat for 2015). Österreich nutzt nur Strom aus den Nettoimporten (Berechnungsmethode des Umweltbundesamts).

Freitag
24
Jänner

13:30–15:30 Uhr

Parallelblock 15

Fortschrittliche Methoden und traditionelle Technologien

Friday
24
January

01:30 pm-03:00 pm

Parallel Session 15

Advanced methods meet traditional technologies

Der Kachelofen – ein durch die Jahrhunderte bewährtes Produkt in der CFD Simulation

Johannes Mantler
Österreichischer Kachelofenverband
Forschungs- und Versuchsanstalt der Hafner Österreichs
Dassanowskyweg 8
1220 Vienna, Austria
mantler@kachelofenverband.at

Co-Authors: Thomas Schiffert, Rudolf Haselböck, Florian Schüssler, Stefan Riebenbauer

Der Kachelofen ist ein seit Jahrhunderten bewährtes Produkt, das durch technologische und stilistische Innovationen auch heute als Heizsystem sehr beliebt ist. Die physikalischen Zusammenhänge beim auf den ersten Blick „einfachen“ Produkt Kachelofen sind hochkomplex. Die zyklische Beheizung führt zu komplexen, instationären Zuständen, welche hohe Anforderungen an ein Simulationsmodell stellen. Das Ziel des FFG geförderten Projektes „Numerische Simulation von Kachelöfen“ ist, eine gekoppelte thermische und numerische Strömungsanalyse zu erstellen Die Validierung erfolgt mittels von Versuchen an drei realen Kachelöfen.

Als Randbedingungen werden der Energieeintrag im Brennraum, der Abgasvolumenstrom, der Wärmetransport vom Abgas an den Festkörper, die Wärmeabgabe an der Oberfläche des Ofens sowie die Umgebungsbedingungen herangezogen. Der Brennraum wurde als thermisches Ersatzmodell ohne Berücksichtigung der chemischen Verbrennungsreaktionen dargestellt. Dazu wurde der Energieinput auf Holzscheit-ähnliche Volumina mit Flammen aufgebracht. Beim Volumenstrom wurde auf die Verbrennungsrechnung sowie aus Messungen zur Wärmeleistung zurückgegriffen. Die Wärmeübergangs-koeffizienten an den Oberflächen wurden in eigenen Submodellen ermittelt.

Bei der Validierung an realen Kachelöfen im Versuchslabor wurden die Temperaturen im Abgas, im Schamotte-Festkörper, an der Oberfläche sowie im Raum mit Thermoelementen und teilweise einer Thermographiekamera erfasst (Bild 3: Messungen). Außerdem wurden der Unterdruck im Kachelofen aufgrund des Auftriebes, die Luftgeschwindigkeit in der Zuluft und die Emissionen erfasst. Die Daten zur Validierung wurden an Kachelöfen mit verschiedenen Bauweisen in mehrwöchigen Messungen aufgezeichnet.

Die Ergebnisse der Simulationsmodelle zeigen hohe Übereinstimmungen mit den Messdaten aus Validierungsprozess (Bild 4: Oberflächentemperaturen im Simulationsmodell). Außerdem zeigt sich für unterschiedliche Bauformen und Umgebungsbedingungen eine gute Reproduzierbarkeit. Mit diesen Modellen kann der Kachelofen unter Berücksichtigung der Behaglichkeit zukünftig bei der Planung und Berechnung von Gebäuden forciert werden. Außerdem kann die Planung für weitere Forschungsfragen deutlich gezielter erfolgen, wenn eine vorherige Simulation des Versuchsaufbaus durchgeführt wird, um auf spezifische Fragenstellungen detaillierter einzugehen.

Advanced Test Methods for Pellet Stoves and Consequences on Real Life Performance

Gabriel Reichert
BEST Bioenergy and Sustainable Technologies GmbH
Gewerbepark Haag 3
3250 Wieselburg-Land, Austria
Gabriel.reichert@best-research.eu

Co-Author: Christoph Schmidl

Third party testing of direct heating appliances fueled with pellets has been established in many countries worldwide. The main goals are ensuring operation safety and a minimum level of performance of the products prior to market implementation. This kind of approval procedure for new products requires testing standards, certified testing bodies and a legal framework defining minimum requirements for specified performance parameters which are assessed in the respective standards.
While the overall targets are quite similar for all countries having set-up such procedures, the practical implementation of these targets in the national/international testing standards is remarkably different. This applies to both, the way of operating the appliance during the testing and the measurements performed during the testing. Furthermore, several industries were requested recently to modify their product standards towards more realistic operating conditions. The most famous example is car industry, but this request may also apply to biomass heating systems. Therefore this study aimed at: (1) In-depth comparison of existing testing standards worldwide for direct heating systems fueled with pellets (2) Review of newly developed lab testing methods for pellet stoves better reflecting real-life performance (3) Comparison of testing results based on existing standards and advanced testing methods with real-life performance in terms of emissions (emission factors) and efficiency

In an extensive literature review existing testing standards worldwide as well as novel testing methods better reflecting real life performance were analysed in a comparative assessment. The main focus was put on: (1) Fuel characteristics (quality parameters – normative and/ or informative), (2) Operating conditions (chimney draught conditions, room temperature…), (3) Testing procedure (number of testes phases, start, stop, nominal and part load, load changes and cleaning intervals…), (4) Measurement methods evaluating emissions and efficiency. In total, 6 national or international testing standards as well as lab testing methods were analysed. In a second step lab testing results were compared with results of field measurement campaigns to show the range of emissions factors and efficiency between lab testing according to standards and real life performance in the field for the same products. Testing standards and the related legal framework conditions are powerful tools to influence the market. By defining the testing conditions and measured parameters the technology development can be directed. When testing at best-case conditions, development will focus on this operation regime; when testing under difficult or even worst-case conditions, manufacturers will concentrate their efforts to improve the performance under these difficult conditions. This study highlights differences between existing testing standards, advanced methods and real life performance of direct pellet heating appliances. Based on this the resulting effects on the development of technology are analysed and conclusions for the development of future standards can be drawn.

In harmonized European standards (EN standards) comparability of testing results is the leading requirement in the development of new standards. Therefore highly reproducible testing conditions are selected which in some cases do not reflect real-life operation as closely as desired. As a result products have been developed that perform extremely well under the defined testing conditions, but usually perform significantly worse in real-life. Completely different to this, other standards test the appliances at very difficult or even worst-case scenarios. The main argument is, to force manufacturers to ensure a minimum level of performance of their products even under these unfavourable conditions. Consequently several manufacturers being present on international markets change their products when bringing them on such markets. Most of these technical changes improve the performance under unfavourable testing conditions, but at the same time worsen the performance under good/optimal testing conditions, so that the full potential of the technology cannot be used anymore. This study identifies possibilities to combine the advantages and overcome some of the drawbacks of each concept.
This study was done within the program of IEA Bioenergy - Task 32.

“EN-PME” - a new European method for particle matter (PM) measurement for local space heaters and boilers burning solid fuel

Frank Kienle
HKI Industrieverband Heiz- und Küchentechnik
Lyoner Straße 9
60528 Frankfurt, Germany
kienle@hki-online.de

Co-Author: Eric Smit

In 2016, a consortium of European research institutes (EN-PME-TEST) published a report regarding a new method for PM measurement, called EN-PME. This method could possibly replace the current PM measurement methods in use around Europe. On basis of the report of the EN-PME-TEST consortium, it was decided by the members of CEN/TC 295 during its plenary meeting of November 18, 2016, that WG5 of CEN/TC 295 will work further on developing the EN-PME method1 as the single European method for PM measurement for those appliances covered by prEN 16510, with the ultimate goal to include it in aforementioned – by then - harmonized European standard. Also WG1 of CEN/TC 57 – WG1 (solid fuel boilers) has expressed their full support for the further development of the EN-PME method, with the aim to include this method in standard EN 303-5 in due time. It is to be expected that a measurement with the EN-PME method will give results that cannot be referenced to existing emission limit values, due to differences in measurement conditions (when compared with existing methods). Before the EN-PME method can be included in a harmonized standard, it is necessary to determine emission limit values related to this method. Also the method has to be validated for other fuels (e.g. mineral fuel) and other appliances, not covered by the EN-PME-TEST project. This project will be finalized or at least have serious results by the end of 2019. In order to inform the branch and related research institutions it is forseen to present these results together with some detailed information about the test method itself

Ecodesign and particulate matter
As of January 1, 2022, the European regulation on ecodesign requirements for solid fuel local space heaters will enter into force in all member states of the EU. From then on these appliances must comply with minimum requirements for efficiency and for the emission of CO, NOx, hydrocarbons (OGC) and particulate matter (PM). The ecodesign regulation states three possible methods for the measurement of particulate matter. These methods are based on the current national methods as used in e.g. Germany, Austria, Norway, Denmark, UK, Belgium, Italy and France. The limit values for the PM emission as given for each method in the ecodesign regulation are not comparable with each other and to make matters more complicated, the description of the methods differs on critical details from the national methods.
So there is the need for a uniform European measurement method: EN-PME!

What is the EN-PME method?
The EN-PME method is a method to measure the emission of particulate matter (dust) in the flue gases coming from residential appliances fired by solid fuel such as wood or pellets. It is based on sampling and measurement of particulate matter and hydrocarbons at the same temperature (180 °C).
In 2015, after 3 years of research, the method was presented by a consortium of 18 European research and test institutes.

The EN-PME method will be tested by notified test laboratories on approximately 150 different appliances covering all types of solid fuel local space heaters. These tests will run simultaneously with the ‘normal’ particulate matter measurement as part of the initial type test of the appliance.
The goals of this project are varied:
1. To prove the validity of the method on all types of solid fuel local space heaters, i.e. is the method able to collect a representative sample of particulate matter under type test conditions.
2. To prove that the EN-PME method can replace the current three methods.
3. To create a database with EN-PME emission results from which a possible emission limit under ecodesign can be proposed.

Freitag
24
Jänner

13:30–15:30 Uhr

Parallelblock 16

Nachhaltigkeit von Bioenergie- und Bioökonomiewertschöpfungsketten I

Friday
24
January

01:30 pm-03:00 pm

Parallel Session 16

Sustainability of bioenergy and bioeconomy value chains I

Bioenergy from boreal forests – the Swedish approach to sustainable wood use

Kjell Andersson
Svebio – Swedish Bioenergy Association
Holländargatan 17
111 60 Stockholm, Sweden
kjell.andersson@svebio.se

Applying science-based managed forestry practices it is possible to both increase forest stocks and at the same time increase mean growth and harvests. Thus at the same time increase yearly up-take of carbon and constantly increase the positive substitution effects, both thru material substitution and energy substitution. This has been proven in Swedish forestry during the last decades in real life and practice. Boreal forests managed in a sustainable way can offer a large source for bioenergy and renewable material supply. The successful Swedish model can be applied in all boreal forest regions. The untapped resources are particularly large in Russia and Canada. But also in Europe there are large potentials to increase the supply of biomass from forests and at the same time increase carbon up-take.

This model has recently been described in a new report from IRENA, International Renewable Energy Agency, written by Kjell Andersson from Svebio, Swedish Bioenergy Association, and Jeffrey Skeer, IRENA:
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Mar/IRENA_Swedish_forest_bioenergy_2019.pdf

The purpose of a presentation at the Central European Biomass Conference would be to present the main results of this study. Among other features of the study, we can present a detailed picture (flow-chart) of the flows of biomass in the Swedish combined forestry-bioenergy system that supplies 37 percent of the energy use in Sweden. The report also gives strong arguments for the carbon neutrality of forest biomass.

Measuring, governing and gaining support for sustainable bioenergy supply chains – main findings and recommendations of an IEA Bioenergy collaborative project

Luc Pelkmans
IEA Bioenergy
9 rue de la Fédération
75739 Paris Cedex 15, France
luc.pelkmans@caprea.be

Co-Authors: Martin Junginger, Göran Berndes, Annette Cowie, Uwe Fritsche, Inge Stupak, Tat Smith

Several systems to define and monitor performance and progress towards sustainability of bioenergy have been developed for implementation at different scales, including operations, landscapes or jurisdictions. Even if much has been achieved, there are still challenges associated with understanding, defining, measuring, governing and communicating sustainability of bioenergy. This is due to very different perceptions of sustainability of bioenergy in society and how it can be implemented. This has led to a pronounced lack of trust in potential benefit of bioenergy within some groups.
In light of these challenges, the IEA Bioenergy inter-Task project on "Measuring, governing and gaining support for sustainable bioenergy supply chains" was formed to synthesise works of a number of IEA Bioenergy Tasks.

The project aimed at addressing the following questions:

- Objective 1: How to measure and quantify progress towards more sustainable practices?
- Objective 2: How to improve the input, output and throughput legitimacy of existing and proposed governance systems?
- Objective 3: How to engage more successfully with the broad range of stakeholders so that policies and sustainability governance are perceived as legitimate and helpful for build-up of social capital, trust, and support among all stakeholders?

The project was started in 2016 and completed early 2019. A multitude of studies were initiated focusing largely on the agricultural and forestry sectors, and on biogas systems. The project has created a wealth of findings, which led to recommendations for policy makers and others involved with measuring, governing and communicating sustainability of bioenergy. The findings also raised questions that need further work, which is picked up by a dedicated new IEA Bioenergy Task on 'Climate and sustainability effects of bioenergy within the broader bioeconomy'.

This paper will summarize the main findings and recommendations from the work carried out in the Inter-Task project.

BB-CLEAN: Strategic tools towards a sustainable use of biomass for low carbon domestic heating

Giacomo Gerosa
Università Cattolica del Sacro Cuore
Department of Mathematics and Physics
Via Musei, 41
25128 BRESCIA, Italy
giacomo.gerosa@unicatt.it

Co-Authors: Maria Chiesa, Rossella Urgnani, Gianluca Antonacci, Julie Cozic, Giordano Pession, Darko Ferčey, Christoph Sumereder, Nejc Jurko, Marc Tobias, Anais Devouassoux

Biomass is a widely used fuel for domestic heating appliances in the Alpine Region (AR). Its combustion avoids fossil CO2 emissions, but it is one of the principal sources of particulate matter (PM). Starting from the state of the art of emissions due to biomass burning in the Alpine Region, the BB-CLEAN project (approved in the framework of the Alpine Space III call, project period: April 2018-April 2021) aims at investigating PN, PM and black carbon (BC) concentrations due to biomass burning (BB) using aethalometers, optical devices and a low pressure cascade impactor as well as PM dispersion and deposition depending on meteorological and atmospheric stability conditions. Monitoring campaigns performed in different Alpine Regions will study PM and BC concentrations, as well as PM and PN fluxes at ground level.

Vertical profiles of meteorological parameters (temperature, relative humidity) and PN and PM concentrations will integrate the monitoring campaigns through the use of drones and a tethered balloon. A modelling-chain will be developed in order to foresee PM concentrations on a 3-days resolution and experimental campaigns will provide the data to calibrate and validate the models. Studying emissions, dispersion and deposition of PM due to BB it will be possible to define the most suitable periods to burn biomass with the least environmental impact. Since the environmental burden of BB is usually unknown or underestimated by citizens and policymakers, awareness raising campaigns are foreseen and a free mobile app will be developed, based on the results given by the integrated model, so that population will be able to use biomass in a more sustainable way. Citizens will be directly involved in the project through personal exposure measurements as well as joining in a crowdsourcing platform used to open discussions on technological, policy or, more simply, awareness aspects linked to biomass burning use for domestic heating. Final aim of the project is the development of innovative technological, economical and regulative tools in order to develop homogenized policies to mitigate the impact of biomass burning in the Alpine Region.

Acknowledgements:
This project is co-funded by EU funds (ERDF) in the framework of the Alpine Space Programme 2014-2020.

Waldrestholznutzung – Vermeidung übermäßiger Nährstoffentzüge mit Hilfe von Nährstoffbilanzkarten

Stephan Rimmele
Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF)
Hans-Carl-von-Carlowitz-Platz 1
85354 Freising, Germanya
Stephan.Rimmele@lwf.bayern.de

Co-Authors: Elke Dietz, Markus Riebler, Matthias Jantsch, Hans-Joachim Klemmt, Desirée Köhler

Im Zuge der Energiewende in Deutschland leistet die Energie aus Biomasse einen wichtigen Beitrag. Das zunehmende Wachstum dieser Energiebranche führt zu einem ansteigenden Bedarf an verwertbarer Biomasse als Ausgangsstoff der Energieerzeugung. Um diesen Bedarf zu bedienen, sind in der Forstwirtschaft Entwicklungen im Gange, die zu einer verstärkten Nutzung von Holzsortimenten zur Energieerzeugung führen, deren Verwendung in der Vergangenheit wirtschaftlich unrentabel war. Insbesondere die Nährstoffversorgung von Waldökosystemen darf bei einer intensivierten Biomassenutzung nicht außer Acht gelassen werden, um dem Nachhaltigkeitsanspruch der Forstwirtschaft gerecht zu werden und optimale Zuwächse auch in Zukunft zu gewährleisten. An der Bayerischen Landesanstalt für Wald und Forstwirtschaft (LWF) wird in diesem Zuge ein digitales Informationssystem entwickelt, welches für die gesamten bayerischen Waldflächen auf Basis von Nährstoffbilanzierungen die optimale nährstoffnachhaltige Nutzung berechnet. Die praktische Anwendbarkeit von Nährstoffbilanzierungen auf Waldökosysteme wurde bereits durch mehrere Studien für einzelne Waldstandorte überprüft und belegt. Im Gegensatz zu den bereits abgeschlossenen Projekten ist es unser Ziel, Nährstoffbilanzierungen für die gesamte bayerische Waldfläche durchzuführen und Ergebnisse mit einer minimalen Auflösung von 50x50 Metern zur Verfügung zu stellen, die eine relativ kleinräumige Einschätzung von Flächen ermöglicht. Bei den durchgeführten Nährstoffbilanzierungen werden alle für ein Waldökosystem relevanten Nährstoffquellen und Nährstoffsenken berücksichtigt. Bei den Nährstoffquellen handelt es sich um Depositionseinträge und die Nährstoffnachlieferung durch die Verwitterung des Ausgangsgesteins und bei den Nährstoffsenken um Nährstoffverluste über das Sickerwasser und die Nutzung von Biomasse. Die Depositionseinträge werden von uns über Depositionsdaten aus einem deutschlandweiten Netz von Messstationen berücksichtigt, wobei wir deren geringe Auflösung mithilfe von besser aufgelösten Niederschlagsdaten für die benötigten kleinräumigen Berechnungen erhöhen konnten. Da insbesondere die Trockendeposition eine schwer zu erfassende Größe darstellt und die verfügbaren Daten die Ansprüche an die Qualität nicht erfüllt haben, wurde die Trockendeposition über den Trockendepositionsindex (DDF) aus der Nassdeposition von Natrium abgeleitet. In diesem Zuge wurde ein flächiges Bestandeshöhenmodel (BHM) aus einem digitalen Oberflächenmodel (DOM) und digitalen Geländemodel (DGM) abgeleitet, welches einerseits als Eingangsparameter für die Berechnung der Trockendeposition dient und gleichzeitig zur Ableitung weiterer Eingangsparameter verwendet wird. Die Verwitterung des Ausgangsgesteins und die daraus resultierende Bereitstellung neuer Nährstoffe im Boden wird von uns mithilfe des Programms PROFILE berechnet, welches auf Grundlage von Bodendaten, Depositionseinträgen und Nährstoffentzügen die Verwitterungsrate vorhersagen kann. Gleichzeitig lassen sich mit PROFILE die Nährstoffverluste über das Sickerwasser bei Vorliegen von entsprechenden Niederschlagsdaten berechnen. Die Nährstoffentzüge über Biomassenutzungen sind abhängig von der Art der Waldbewirtschaftung und damit Waldbesitzart und werden von uns über verschiedene mit dem Waldwachstumssimulator SILVA simulierte Nutzungsszenarien mit unterschiedlicher Nutzungsintensität berücksichtigt. Über die Simulationsergebnisse können mit Hilfe von Biomassefunktionen die in der Biomasse gespeicherten Nährstoffmengen berechnet werden. Die abschließenden Bilanzierungen unter Einbezug aller zuvor berechneten Bilanzglieder erlauben dann Aussagen zur Nährstoffsituation der einzelnen Waldstandorte und bieten eine Grundlage für Empfehlungen zur Nutzungsintensität im Bezug auf Nährstoffnachhaltigkeit. Ein solches einfach verständliches Informationssystem für staatliche, kommunale und private Nutzung kann ein wichtiges Werkzeug sein, um die nährstoffnachhaltige Waldbewirtschaftung zu adressieren und damit die Wuchskraft der bayerischen Wälder für die Zukunft zu erhalten.

15:30–17:00 Uhr

Parallelblock 18

Technologien für dezentrale Biomasse-KWKs

03:30 pm-05:00 pm

Parallel Session 18

Technologies for decentral bioelectricity production

Small Scale CHP from biomass – results from a demonstration project in Sweden

Daniella Johansson
Energy Agency for Southeast Sweden
Valhallavägen 1
371 41 Karlskrona, Sweden
daniella.johansson@energikontorsydost.se

Combined Heat and Power (CHP) technologies based on biomass combustion have great potential to reduce CO2 emissions since they use renewable energy sources, such as wood fuels or sawdust. Typical fields of application for biomass CHP plants are wood processing industries, sawmills, district heating systems and industries with a high process heating and cooling demand. In order for CHP plants to operate in a way that is economically and ecologically beneficial, both the electricity and the heat produced must be utilized.

CHP technology is already available on both Swedish and European markets. Due to the high installation costs, and a lack of information about its efficiency, the technology is currently not widely used in small-scale implementations (less than 10 MWthermal). Extensive research has been undertaken to illustrate the vast environmental potential of CHP technology but a larger initiative that looks at increasing market application is still needed.

Therefore, to meet the gap between commercialization and research, three different techniques for small-scale electricity production of biomass-based cogeneration have been built and demonstrated in southeast Sweden as part of the project Small Scale CHP LIFE +. Partners of the project, where the demonstration plants are built, are Emå Dairy in Hultsfred and Ronneby Miljö & Teknik AB and Ronneby Miljöteknik Energi AB in Ronneby.

The aim is to pave the way for a broader application of biomass-based CHP and thereby increase the production of local, renewable electricity. Three different techniques are being demonstrated at three different sites, namely a micro-scale gasifier (50kWe) at a dairy, and two turbine solutions in district heating facilities using wet steam (500kWe) and Organic Rankine Cycle, so called ORC, (50kWe) techniques respectively.

This paper will give a brief introduction to the implemented techniques but will mainly focus on experiences from the installations; all the way from planning, purchasing and installation to continuous operation. Covered areas include, but are not limited to, feedstock market, challenges regarding connecting the installations to existing, and running, industries and district heating facilities, operational issues and profitability as well as a brief outlook for future possibilities.

In recent years, with an increased price of electricity and higher focus on power capacity, the interest for small scale CHP has increased in Sweden. Today, there are 15 small scale CHP units operating in Sweden. Nine of these are a direct result of the demonstration project Small Scale CHP LIFE+. The most disseminated technology is the ORC unit, which is being installed at small district heating plants (<10 MWthermal) in southern Sweden. The results show that the ORC technology is reliably and could have a payback time between 6 to 10 years, depending on energy prices and local specifications.

Main contents and messages of the presentation:
• Potential for small scale CHP in Sweden
• Development for small scale CHP in Sweden and in EU
• Experience (technical and economic) from demonstration of three technologies for small scale CHP in Sweden
• Challenges and possibilities for small scale CHP based on biomass

Development of a demand-based controller for small biomass fired CHP systems

Daniel Büchner
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH
Torgauer Straße 116
04347 Leipzig, Germany
daniel.buechner@dbfz.de
www.dbfz.de

Co-Author: Christian Schraube

In 2018, DBFZ, EIFER and ÖkoFEN have started a common research project, with the goal to develop and to demonstrate an optimized controller for biomass-based small-scale combined heat and power units (CHP) installed in multivalent central heating systems. Within the project, an innovative controlling strategy for flexible generation of heat and electricity will be developed and demonstrated. The basic goal is to identify various strategies that offer the biggest advantage for different fields of application and use cases. The strategies are developed for two main expectations:

1. maximum benefit for the operator in terms of power generation for self-consumption or grid feed-in
2. plant operation with the highest grid supporting coefficient

The control strategy shall also be capable to work on local properties without any communication of personal or consumption data across property boundaries. At the beginning of the project, the different fields of application were set. Fourteen different standard load profiles were defined for the heat consumption and ten for the power consumption. In addition, historical data from the demonstration site was considered. Photovoltaics, solar heat, biomass-based CHP and biomass boilers are taken into account on the generation side. Water storages and batteries are considered to decouple the generation from the consumption side. To determine grid supporting key performance indicators (KPI), the residential load for Germany was used.As a first step, the benefits of different controlling strategies are examined on simulation level. The whole simulation is done with Simulink using newly developed controller algorithms and physical models. The CHP unit is tested on test stand level in parallel to identify technical limitations in terms of part-load behavior and efficiency as well as operational flexibility. Finally, the control approach is implemented in a robust software application, which will run on a computer at the demonstration site.

Based on the different results the improvement of performance will be assessed by using several KPI's, like heat and power production costs, grid support coefficient, self-generation, self-consumption, total annual costs, annuity total costs and flexibility factors. Also device-based KPI's were used, like fuel efficiency, heat storage efficiency, system efficiency, number of boiler starts, full load hours of the boiler, average boiler operation time per start, average boiler load and fuel consumption.

The KPI's are determined for four operating concepts:

1. full-load operation of the CHP unit
2. modulating operation of the CHP unit
3. increase of runtime by using bigger heat storages
4. operation of the CHP unit with the highest grid supporting level

The initial results are showing, that the full-load operation of the CHP unit leads to the lowest overall costs, the shortest average runtimes, the lowest grid supporting coefficient and the biggest self-consumption factor.
In contrast, operating the CHP unit with the highest grid supporting level leads to the highest overall costs together with the longest average runtime, the least starts and the least self-consumption factor. Further investigation will be done to identify the impact of storage sizes, demand side management and the building's thermal inertia on the KPI's.In autumn 2019 a prototype controller will be implemented at the demonstration site, in order to identify the potential benefits and the restrictions in a real-life environment. The controller unit will acquire locally available data from the central heating system components and the building. They will be used as input parameters for the control algorithm, which is optimizing the heat and power generators operation intervals.

Mit Holzgas in die Energieautarkie - Smarte Lösungen zur Eigenversorgung

Manuel Moser
GLOCK Technology GmbH
Gaston-Glock-Park 1
9170 Ferlach, Austria
manuel.moser@glock.at

Die GLOCK Ökoenergie GmbH beschäftigt sich seit mehreren Jahren intensiv mit der Thematik der erneuerbaren Energien. Aus den zahlreichen Forschungsthemen hat sich die Biomasse Kraft-Wärme-Kopplung (KWK) als sinnvollste Lösung herauskristallisiert. Für die Entwicklung war es immer wichtig, aus der heimischen Ressource Biomasse neben Wärme auch Strom erzeugen zu können. Um beides zu generieren, wurde ein Holzgas-Blockheizkraftwerk bis zur Serienreife entwickelt. Das Ziel war, aus den Rohstoffen Hackgut oder Pellets ökologische Wärme und Strom zu produzieren. Ein großer Vorteil der Gaston Glock Vergaser-Blockheizkraftwerke (GGV) besteht darin, dass Standardhackgut inklusive Feinanteil mit einer maximalen Holzfeuchte von 30 % verwenden kann. Die automatische Hackgutzuführung mit Eisenabscheidung sowie die integrierte Aschelogistik sorgen für einen reibungslosen Betrieb.

Einfache Umsetzung durch praktische Lösungen
Ein Praxisbetrieb in Ueckermünde, die Hotel- und Ferienanlage Haffhus, nutzt die nachhaltig produzierte Energie eines Blockheizkraftwerkes der GLOCK Ökoenergie, um sich selbst mit Strom und Wärme zu versorgen. In Verbindung mit einem Stromspeicher wird die Versorgung eigenständig und komplett netzunabhängig realisiert. Der Hotelbetrieb Haffhus hat sich vom öffentlichen Netz getrennt und die Energieautarkie in die Praxis umgesetzt. Eine Photovoltaik-Anlage war der Beginn des nachhaltigen Hotels. Bei sonnigem Wetter kann die Anlage Strom für einen ganzen Tag produzieren. Nachdem Dirk Klein, der Manager der Haffhus GmbH, das Hotel vollkommen autark betreiben wollte, erkundigte er sich weiter um nachhaltige Alternativen für die Eigenproduktion an Strom und Wärme. Die Entscheidung fiel auf die GGV 1.7 (18 kW_{el}, 44 kW_{th}) der GLOCK Ökoenergie. „Das Ziel war, den erzeugten Strom selbst zu verbrauchen und nicht ins öffentliche Netz per Ökostromtarif einzuspeisen“, sagt Klein, der ein Einsparpotenzial von jährlich 10.000 Euro erkannte. Wird nicht der gesamte Strom verbraucht, so wird der Reststrom in einem Batteriespeicher gepuffert. Die Kapazität des Speichers reicht dazu aus, um 76 Zimmer einen ganzen Tag lang mit Strom zu versorgen. Die Abwärme der GGV 1.7 wird in Ueckermünde zur Beheizung der Hotelzimmer sowie für den Spa- und Wellnessbereich verwendet. Um effizient Energie für den gesamten Hotelbetrieb bereitzustellen, wird eine komplette Visualisierung und Steuerung aller Energieflüsse eingesetzt. Damit werden Engpässe vermieden und es wird eine konstante Erzeugung sowie eine effiziente Verteilung der Energie erzielt. Ferner nehmen die Hotelbelegschaft und die Gäste Einfluss auf das Energiemanagement des Hotels.

Für Erweiterungen im Zimmer- und Spa-Bereich plant der Hotelbetrieb in Zukunft einen Ausbau der PV-Anlagen und des Stromspeichers, sowie die Installation eines zweiten Blockheizkraftwerkes der Firma GLOCK Ökoenergie.

Power from hidden fuels in the wood processing industry, up to 1 MWel

Sebastian Kießling
Professor Dr. Berg & Kießling GmbH (B+K)
Burger Chaussee 25
03044 Cottbus, Germany
service@bergundkiessling.com

Co-Author: Peter Eisenkolb (CP i-Invest GmbH)

Eine dezentrale Wandlung von holzartigen Festbrennstoffen in Wärme/Kälte und parallel in Strom wird bisher kaum umgesetzt, obwohl sie erhebliche Potenziale für gewerbliche/industrielle Anwender, für den Erfolg der Energiewende und für die Umwelt mit sich bringt. Der innovative Technologieansatz eines extern befeuerten Mikrogasturbinen-Systems wird erläutert und die technische Funktionsweise eines dezentralen KWK-Systems zur Verwertung heterogener Festbrennstoffe im Leistungsbereich <1 MWel vorgestellt. Erste Betriebserfahrungen bestätigen die Potenziale dieses dezentralen Systems in Hinblick auf Energieeffizienz, Wirtschaftlichkeit, Versorgungssicherheit, Grundlastbereitstellung und Klimafreundlichkeit. Im Detail werden die Einbindung der extern befeuerten Gasturbine in bestehende Anlagen, die Konkretisierung der verwertbaren Brennstoffe (Waldpflegematerialien und holzartige Produktionsreststoffe) anhand von Anwendungsbeispielen und Referenzen aufgezeigt. Die hohen Verbrennungstemperaturen und -verweilzeiten führen zu niedrigsten Emissionen. Fazit: Ein hohes ökologische Potenzial und ein hoher wirtschaftlicher Nutzen durch die Erschließung von holzartigen produktionsbegleitenden Abfallprodukten als Wert- und Brennstoffe für die Strom- und Wärmeerzeugung.

Das Unternehmen:
Die Professor Dr. Berg & Kießling GmbH (B+K) wurde im Jahr 2012 gegründet und ist Spezialist für die Entwicklung und Konstruktion innovativer und umweltfreundlicher energietechnischer Anlagen auf Basis von Mikrogasturbinen für die unterschiedlichsten Bereiche. Das Unternehmen wurde 2017 mit dem Innovationspreis Berlin-Brandenburg in der Kategorie Energietechnik ausgezeichnet. Eine Referenzanlage läuft seit 2017 mit über 10.000 Betriebsstunden.

Die Anlage:
ClinX ist das dezentrale Kraft-Wärme-Kopplungs-System der B+K mit extern befeuerter Gasturbine. Die Anlage wandelt heterogene, holzige Reststoffe von Gewerbe- und Industrieanwendern vor Ort in Wärme und Strom. ClinX ist eine kompakte, containerbasierte Anlage mit vorgefertigten Anschlüssen zur einfachen Anlageninstallation. In der Brennkammer verbrennen die Wertstoffe bei Temperaturen von bis zu 1200 °C. Die dabei entstehende Wärme wird in einen einzigartigen Hochtemperaturwärmetauscher geleitet. Kernstück der Anlage ist die extern befeuerte, luftgelagerte Turbine. Sie verdichtet ausschließlich saubere Luft und benötigt keine Schmierstoffe oder Kühlmittel. Somit ergeben sich besonders lange Wartungs- und Serviceintervalle. Die verbleibende Wärmeenergie im Rauchgas und der Abluft kann beispielsweise für ein bestehendes Heizungs-und Trocknungssystem genutzt werden. Hochwertige Materialien und die robuste Bauweise der Anlage sind für eine lange Betriebszeit ausgelegt.

Anwendungsbereiche der Technologie:
ClinX kann selbst sehr durchmischte holzige Stoffströme wie Industrierestholz, Landschaftspflegeholz und Waldpflegeholz in saubere Energie wandeln. Die Anlage ist für die Verwertung von naturbelassenen, störstoffbelasteten Stoffströmen konzipiert, z.B. Verschnittholz mit hohem Ast- oder Rindenanteil und hohem Feuchtigkeitsgehalt. Für Gewerbe- und Industriekunden lassen sich somit kostengünstige Brennstoffe erschließen, die direkt im Betrieb anfallen. Diese durchmischten Stoffströme sind für die meisten marktüblichen Systeme nicht nutzbar. Eine dezentrale Wandlung dieser störstoffbelasteten Brennstoffe in Wärme und Strom bei gleichzeitig hoher Umweltverträglichkeit wird im Leistungsbereich < 1MWel mit ClinX möglich.

Freitag
24
Jänner

15:30–17:00 Uhr

Parallelblock 19

Nachhaltigkeit von Bioenergie- und Bioökonomiewertschöpfungsketten II

Friday
24
January

03:30 pm-05:00 pm

Parallel Session 19

Sustainability of bioenergy and bioeconomy value chains II

Recycling von Holzabfällen in Europa – Ausgewählte Aspekte

Martin Wellacher
Montanuniversität Leoben
Franz-Josef-Straße 18
8700 Leoben, Austria
martin.wellacher@unileoben.ac.at

Im Beitrag wird die kaskadische Nutzung von Holz entsprechend der Faserlänge ausgewählter Leitprodukte in der Kaskade als neues Konzept einer nachhaltigen Nutzung vorgeschlagen. Um die Nachhaltigkeit der Verwendung von Holz zu gewährleisten, muss die Nutzungsdauer maximiert werden. Je länger Holz im stofflichen Kreislauf erhalten wird, desto größer ist der Nutzen für das Klima und desto geringer ist der Ressourcenverbrauch. Dieses Nachhaltigkeitskonzept geht über die derzeitige Nachhaltigkeitsvorstellung hinaus, die v.a. von Zertifikaten, z.B. FSC, dominiert wird.

Anhand der Stoffströme von Holzabfällen in Österreich und ihren Verbindungen zueinander wird dargestellt, dass es Lücken in der kaskadischen Nutzung gibt, die zurzeit mit Importen geschlossen werden. Auch auf die Anteile von Holzabfall in gemischten Gewerbeabfällen und Restabfall wird eingegangen, da diese nur mehr einer thermischen Nutzung zugeführt werden.

Aufgabenstellung
Aufgabenstellung des Beitrages ist es, für Holzabfälle einen Überblick über einschlägige Gesetze in ausgewählten europäischen Ländern zu geben, (gute) Beispiele zur kaskadischen Nutzung zu nennen und die noch wenig genutzten Potentiale zu beschreiben.

Methode
Als Methode dient eine Literatur- und Experten-Recherche.

Ergebnisse
Folgende Gesetze werden erläutert: EU-Verpackungsverordnung, DE-Altholzverordnung, AT-Recyclingholzverordnung sowie Gesetze zu Holzabfällen in IT, FR, GB und PL. Als (gute) Beispiele werden die Spanplattenindustrie, das Altpapierrecycling und die zunehmenden Re-Use-Aktivitäten genannt.

Potentiale werden für die Mitgliedsländer gesehen, die derzeit Holzabfälle zu großen Anteilen deponieren. Hinsichtlich der Wirtschaftssektoren liegen die Potentiale in den Sägewerken, der Bauwirtschaft und der Plattenindustrie. Bei der Spanplattenproduktion wird schon rezykliert, aber es sind noch Verbesserungen möglich, z.B. durch eine Feinanteilreduktion bei der Holzabfallaufbereitung, die zu mehr stofflicher anstatt thermischer Nutzung führen würde. In der OSB- und MDF-Plattenindustrie werden noch gar keine Holzabfälle eingesetzt. In der Faserindustrie fehlt der Reyclinggedanke komplett. Als Methoden zu einem verstärkten Recycling werden vorgeschlagen: bessere Quellensortierung, schonende Logistik und Zwischenlager für alle Branchen, z.B. in lokalen Tischlereien, Re-Use-Gebote und Ökodesign for Re-Use, z.B. von Möbeln. Mit einem Ausblick auf die zu erwartende Marktentwicklung wird geschlossen.

Promotion of European underutilised lands for sustainable bioenergy production using Web-GIS Tools

Manuela Hirschmugl
Joanneum Research Forschungsgesellschaft mbH
Steyrergasse 17
8010 Graz, Austria
manuela.hirschmugl@joanneum.at

Co-Authors: Carina Sobe, Guido Bonati, Marie-Alice Budniok, Marc Buiting, Alfonso Calera, Lindsey Chubb, David Cifuentes, Marco Colangeli, Stefano Fabiani, Peter Gyuris, Nicoleta Ion, Rainer Janssen, Cosette Khawaja, Dirk Knoche, Raul Köhler, Giuseppe Pulighe, Mathias Schardt, Rainer Schlepphorst, Alejandro Simon, Asta Soininen, Lorenzo Traverso, Oleksandra Tryboi, Attila Uderszky

The overall objective of BIOPLAT-EU, a Horizon2020 project, is to promote the market uptake of sustainable bioenergy in Europe using marginal, underutilised, and contaminated lands for non-food biomass production through the provision of a web-based platform that serves as a decision support tool. The Renewable Energy Directive (REDII) identifies six core areas of action among which key action number 5 is concerned with the strengthening of sustainability of bioenergy production and use in the EU. Marginal, underutilised, and contaminated lands (MUC) cannot be used for food/feed production or for recreational and conservation purposes, but in some cases, they still retain the potential to produce non-food biomass for bioenergy purposes. The results of previous EU-funded projects demonstrated the viability of using these lands in selected case study regions in the EU for sustainable bioenergy production. In order to expand the geographical outreach of the concept to all European and selected neighbouring countries, the project BIOPLAT-EU produces a tool and a database that will be instrumental in assessing environmental, social as well as techno-economic sustainability on MUC lands through a web-based platform. The first step is the generation of a database of maps on MUC lands in Europe. These maps are produced based on high resolution satellite and other remote sensing data (Copernicus information layers, time series data from Sentinels and other satellites) and their attributes. Additional geographic data are used either for inclusion (e.g. marginal lands or contaminated soil maps) or for exclusion (protected areas, areas used for different purposes). There will be one pan-European map of lower resolution and more detailed maps for some areas with large potential MUC lands, e.g. in Ukraine, Spain, Hungary and Italy.

In parallel, a public user-friendly Web-GIS tool, the STEN tool, is developed to assess the environmental, social and techno-economic sustainability aspects of scenarios and value chains with respect to specific economic and non-economic conditions for bioenergy production on MUC lands. The tool is based on existing recognised and tested methodologies developed in the context of the FORBIO project and in particular it will use the set of sustainability indicators produced in the context of this precursor H2020 project. The starting point for the production of said set of sustainability indicators has been the most broadly accepted tool for bioenergy sustainability analyses available worldwide: the Global Bioenergy Partnership (GBEP) Sustainability Indicators for Bioenergy. Furthermore, in BIOPLAT's methodologies and sustainability indicators the novel concept of the target area developed in the context of the FORBIO project is applied in order to geographically define the specific surface of land (borders) fundamentals to allocate impacts correctly in their context. A specific target area could be 1) the area of the watershed(s) that contain the MUC lands; and/or 2) the area of the municipalities touched upon/interested by the bioenergy production operation; and/or 3) the area as defined by cultural heritage (e.g. regions or zones) that is touched upon/interested by the bioenergy production operation. The STEN tool enables stakeholders to search for MUC lands in Europe at a sub-national level. It further gives the user specifications about these lands such as agronomic and climatic conditions and consequently what type of biomass can be planted on these lands (e.g. giant reed, Miscanthus, switchgrass, etc.). The tool will be able to assess 7 environmental (GHG emissions, air pollutants emissions (non-GHG), soil quality, water quality, water availability, biodiversity, land use change), 4 social (land tenure, income generation, jobs in the bioenergy sector, and access to modern energy services), and 5 techno-economic indicators (productivity, net energy balance, gross value added, infrastructures and logistics, capacity of use of bioenergy) based on a few user-defined inputs. By demonstrating the use of the tool on specific case studies, the BIOPLAT-EU project will have solid and practical material to be shared with the stakeholders during working groups and workshops to mobilise and encourage them to start their own projects. Communication with local and regional authorities is an important activity within the project as it will help to remove legal or political market uptake barriers. Finally, the BIOPLAT-EU project will provide technical support to stakeholders on aspects linked to biomass production and processing, market access, management, access to finance, etc. It will also link biomass producers and processors with investors and guide them on how to make their projects bankable. In the presentation we show the first results of MUC land mapping and a preliminary version of the decision support tool.

The PARIS-Lifestyle – The Role of Biomass for Climate Friendly Lifestyles in the Bioeconomy Fulfilling Climate Targets in 2050

Gerfried Jungmeier
Science Tower
Waagner-Bior-Strasse 100
8020 Graz, Austria
gerfried.jungmeier@joanneum.at

Co-Authors: Gudrun Lettmayer, Neil Bird, Stefan Schwarzinger

A key to reaching the 1.5° C target in the year 2100, as set out in the Paris Agreement, is to alter our lifestyles significantly. Growing consumer-groups have become increasingly aware of the climate impact connected to their choices over the past years and new climate oriented lifestyles are developing. We study the spread and development of this emerging "Low Carbon Orientation" in consumption which stimulates growing demand for low carbon products and services, for which sustainable integrated biomass use for food, feed, material, chemical and energy plays a crucial role. "Low-Carbon Lifestyles" are characterised by having significantly (> 80%) lower greenhouse gas emissions than most of the current lifestyles in industrialized countries and are analysed by four questions to satisfy a consumer's needs: (1) How much? – Quantifying the amount of services and products consumed; (2) Of what? – Specifying the type of products and services with associated GHG emissions; (3) Why? – Analysing the behaviour and reasons for consumption and (4)Who? Which people are we addressing? The evidence that the choice of lifestyles is one of the most relevant influence on an increased sustainable biomass use and future GHG emission underlines the necessity to analyse and assess different current and future innovative low carbon lifestyles on a scientific level. An analytic framework is established by combining consumption behaviour and their associated life cycle based environmental impacts to provide relevant and accurate facts and figure for future innovation and societal challenges to meet the climate targets of the Paris agreement, e.g. integrated biomass use, lifestyle transformation issues. A model - „LIFESTYLE 1.0" – is developed to calculate the consumption based greenhouse gas emissions (2000 – 2016) of the 8 Mio Austrian inhabitants in comparison to the national GHG inventory. Based on the statistics the consumption and demand of annual products and services with a detailed focus on biomass use for the following needs are quantified: Food, Housing (incl. buildings, heat and power), Mobility, Clothing, Goods consumption, Recreation (incl. holidays, sports) and Public services. Based on life cycle assessment (LCA) the GHG emissions (CO_2, CH_4, N_2O) and area demand (agriculture and forest) in Austria and abroad for these products and services are calculated. The consumption based GHG emissions and area demand are compared to other countries (e.g. EU 27, world) and 4 typical lifestyles were modelled ("cheerful consumer environmental oriented", "cheerful consumer fun oriented", "thrifty consumer" and "sustainability oriented consumer – Paris Lifestyle". With the results main characteristics of future sustainable lifestyles are identified ("lifestyle typology") with a special focus on using biomass for food, materials and energy, to analyse future consumption choices and a lifestyle transformation strategies in combination with behaviour changes. The results demonstrate that the consumption based GHG emissions in Austria are significantly higher (45 -55%) than the national inventory show (Fig 1). The GHG emissions abroad for electricity, food and consumption are higher than the GHG emissions in Austria. The GHG emissions and area demand in agriculture and forestry of the 4 different lifestyles are strongly determined by the sustainable and integrated use of biomass. The results confirm that future sustainable, modern and comfortable lifestyles with very low GHG emissions („low carbon lifestyles") are possible. A first set of main influences on the GHG emissions of different lifestyles are identified and its consequences on the future sustainable use of biomass, e.g. vegetarian diet, innovative mobility, annual income.The results confirm that in a global economy the real GHG emissions and the sustainable biomass use can only be calculated and assessed on the bases of consumed products and services of different lifestyles using the cumulated life cycle based environmental impacts, mainly GHG and area demand. The national inventories become more and more obsolete to reflect the real GHG emissions per capita. The GHG emissions of lifestyles are mainly determined by the amount and type of energy carriers and the mobility choices, e.g. biofuels, whereas the area demand is determined by the eating habits, e.g. meat consumption and the clothes. The following conclusions are made:

- The research on low carbon lifestyles focuses on three questions: „How much?", "Of What?", "Why?" and "Who?"
- In most of the analysed cases the question „How much?" is more relevant for the life cycle based GHG emissions than the question "Of what?"
- Low GHG emissions for heat and electricity can be realised much quicker, easier and cheaper than for mobility, consumption and food.
- The GHG emissions can be reduced by energy efficiency and renewable energy technically relatively easy compared to the land demand in agriculture and forestry.
- Biomass as renewable material and energy source in innovative sustainable value chains plays a crucial role to provide a broad range of services and products in the Low Carbon Bioeconomy.
- A future comfortable, innovative and sustainable lifestyle is possible e.g. „Climate Friendly Lifestyle".
- Already today there are many excellent and tracked examples and approaches that might become megatrends for "Low Carbon Lifestyles" to reduce GHG emission significantly.
- This sustainable Climate Friendly Lifestyle is called „Paris Lifestyle©", which is characterised by very low GHG emissions and which contributes to the climate targets of the Paris agreement to limit global warming (< 2°C) by 2100.

15:30–17:00 Uhr

Parallelblock 20

Bereitstellung, Speicherung und Verteilung von Biowärme

03:30 pm-05:00 pm

Parallel Session 20

Supply, storage and distribution of bioheat

Evaluation of Austrian Biomass District Heating Plants

Sabrina Metz
AEE – Institute for Sustainable Technologies
Feldgasse 19
8200 Gleisdorf, Austria
s.metz@aee.at

Co-Author: Harald Schrammel

In Österreich gibt es über 2.000 Biomasseheizwerke, die über Nahwärmenetze Kunden mit erneuerbarer Wärme versorgen und so einen wichtigen Beitrag zur nachhaltigen Energieversorgung und regionalen Entwicklung in Österreich leisten. Von diesen Heizwerken sind mehr als 800 Anlagen mit ihren Daten in der qm heizwerke Datenbank, da sie bei Planung, Bau und Errichtung durch ein Qualitätsmanagementsystem für Biomassenahwärmeanlagen (qm heizwerke) begleitet wurden. Diese breite Datenbasis ermöglicht einen guten Überblick über den österreichischen Heizwerkspark und erlaubt es die Effizienz und Ausführungsqualität der österreichischen Biomasseheizwerke zu ermitteln. AEE INTEC als Programmleiter von klimaaktiv qm heizwerke hat zu diesem Zweck die Heizwerke evaluiert.

Methodik
Hierfür wurden Auswertungen der Benchmarkingergebnisse einer Vielzahl von Heizwerken durchgeführt und diese, wo sinnvoll, auch Planungsdaten aus der qm heizwerke Projektdatenbank sowie Daten von weiteren Heizwerkserhebungen gegenübergestellt. Die Benchmarkingergebnisse wurden durch eine automatische Auswertung der Betriebsdaten aus der qm heizwerke Datenbank generiert. Zu diesem Zweck werden Kennzahlen der Anlage, zum Bespiel Wärmeverluste, ermittelt und mit Zielwerten und Kennzahlen vergleichbarer Anlagen verglichen.

Zusammenfassung der Ergebnisse
Die Evaluierungen zeigen, dass durch die Anwendung von qm heizwerke die Effizienz der Anlagen steigt und sich beispielsweise die Netzverluste durch die Anwendung von qm heizwerke verringern. Dennoch gibt es für viele der Heizwerke Optimierungspotentiale, etwa bei der Integration von Rauchgaskondensationsanlagen, denn der Wärmerückgewinnungsanteil weist bei vielen Anlagen ein Verbesserungspotential auf, oder bei der Reduktion der Rücklauftemperatur des Fernwärmenetzes.

Um den Erfolg und die Effizienz österreichischer Biomasseheizwerke zu sichern, ist es notwendig alle eventuellen Optimierungspotentiale zu kennen aber auch die Nachhaltigkeit und die Effizienz der Anlagen darzustellen und zu kommunizieren.

Integration and smart management of energy storages at historical urban sites

Michael Heidenreich
Innovationszentrum Weiz
Franz-Pichler-Straße 30
8160 Weiz, Austria
mheidenreich@gmx.at

Up to 80% of total energy consumption in the EU is attributed to urban areas, mostly with historical urban centres. At the same time, low carbon energy supplies in the style of energy storages, especially in historical urban centres, is a rarity in central Europe. This is mainly because of strict architectural protection constraints, higher implementation costs and often also conflicts with town planning policies.

The STORE4HUC project aims to improve territorially based low-carbon energy planning strategies. It will enrich policies that support climate change mitigation in historical city centres by focusing on improved urban and spatial planning for integrating energy storage systems to enhance the public institutional and utility capabilities. It is challenging to provide a low carbon energy supply in cities in a style of energy storages. Especially in historical urban centres it is very difficult to achieve these results, because interventions in this specific area meet strict architectural protection constraints, involve higher implementation costs and often come in conflict with town planning policies. Therefore, the main objective is to improve and enrich energy and spatial planning strategies targeting historical city centres by focusing on integration of energy storage systems to enhance the public institutional and utility capabilities.The pilot actions implemented in specific sites will demonstrate the various energy storages that can be adapted and transferred to other local or regional environments.

The storages will provide good show cases to the local authorities which can benefit in sense of improved energy efficiency and increase usage of renewable energy sources and lower costs for energy. The transnational strategy will provide the recommendations for improving the energy and spatial planning. The energy management tool will enable to monitor all features that proof the effectiveness of the pilot installations. Additionally, the autarky rate tool will indicate the economic and reasonable utilisation of storages. By establishing the stakeholder deployment desk Store4HUC will reach the relevant players to share the knowledge and also transfer it to other additional audience. It will enable to gain wider consensus of the pilot instalment and further tool usage, especially with the signed memorandums of the future tool utilisation. The project approach foresees also peer review actions, mutual learning within project consortium and exchange of experiences and knowledge with target groups what can enhance the transnational added value. Innovative energy storage installation and storing of renewable energy sources determines the innovative aspect of Store4HUC.

The partners will develop policy recommendations and identify suitable integrated technological solutions to overcome low carbon development barriers in historic centres. They will also facilitate the development of open energy and load management systems for energy efficiency and use of renewables. With its concepts and pilot systems, STORE4HUC will provide smart city test beds, where technicalities will be reconciled with historical and architectural values.

System integration and dimensioning of heat storage tanks in heating plants with automated wood furnaces

Felix Schumacher
Lucerne University of Applied Sciences and Arts (HSLU)
Technikumstrasse 21
6048 Horw, Switzerland
felix.schumacher@hslu.ch

Co-Authors: Thomas Nussbaumer, Jürgen Good

- Nowadays, wood energy covers about 5.8 % of the European Union's energy consumption (EU-28, 2016) whereas the shares of wood energy in national energy mixes reach up to 20 % (Eurostat, 2018). During the last three decades an obvious growth of the European wood energy capacity was observed (Eurostat, 2019) and further expansion is expected in the future. Beside this increase a technology shift from manually operated logwood appliances to automated wood furnaces occurred. In Switzerland a quadruplicating of automated wood furnaces was observed between 1990 and 2017 (Stettler & Betbèze, 2017). During the implementation, two constraints have to be considered:
- Wood furnaces emit a notable amount of particulate matter and organic pollutants (Müller, 2016). The main reasons are rapid variation of the furnace output and start-up / shut-down phases that lead to incomplete combustion.
- It is common to combine wood furnaces with a natural gas or oil boiler (bivalent system) to deal with the pronounced changes of the heat demand over the year. The fossil fuel boilers are used in winter to cover peaks of heat demand and in summer, when the heat demand is lower than the minimal heat output of the automated wood furnace at part-load. The fraction of the annual heat demand, covered by fossil fuels varies between 10 % and more than 20 %. The use of fossil fuel leads to CO_2 emissions and needs to be minimised.
- The integration of a heat storage tank into a heating system enables decoupling the boiler output from the heat demand and therefore creates the possibility to control the thermal power of the wood furnace with the objectives of pollutant reduction and efficiency increase. Furthermore, the stored heat can be used during low demand or peak demand periods, replacing fossil heat in bivalent systems. It was observed that the control concept has a big impact on the fossil fuel share in bivalent wood heating systems with heat storage tanks (Good, Jenni, & Nussbaumer, 2005). However, in-depth experiences on ideal dimensioning and system control approaches regarding costs, pollution and CO_2 emissions are missing.
- The goal of this project is to develop the theoretical basis for the implementation of automated wood furnaces with integrated heat storage tanks that obtain minimised fossil energy share for bivalent systems or even enable monovalent systems with a 100% wood energy share as well as minimized emissions of particulate matter and organic pollutants. Based on the results of this project, guidelines and postulations regarding the implementation of heat storage tanks and the corresponding system controlling are formulated and published by the quality management system QM Holzheizwerke® (Good, 2008), which is applied in Switzerland, in Austria and in the southern part of Germany.
- The approach consists of a thermodynamic simulation of an automated wood furnace-based heating system with an integrated heat storage tank and a heat demand sequence. The heat demand is covered by the furnace output and additional heat from the storage tank. Various control concepts are implemented that compute the manipulate variable of the furnace output from the storage level. A set of demand sequences, representing typical days of the year, are defined by analysing the measured heat demand of two district heating systems. To relate the furnace behaviour with the pollution, long-term pollution measurements are analysed statistically. The simulation is validated and optimized by measurements of a 150 kW wood heating system with an integrated 3000 L stratified heat storage tank. An optimisation procedure regarding ecological and economical aspects is applied on the simulation, delivering ideal dimensioning of the heat storage tank and the corresponding parameter settings of the control unit. Therefore, quality criteria are introduced to quantify the performance of a system such as furnace output continuity, start-up / shut-down frequency and the need of additional fossil fuel. The following list summarises the first results of this simulation:
- A storage tank with a storage capacity of 1 hour rated furnace output highly increases the usability of wood furnaces over the year and therefore reduces the usage of fossil fuel.
- A storage tank with a storage capacity of 1 hour rated furnace output highly improves the furnace output continuity in sequences with rapid consumption variations and therefore reduces the pollution.
- The start-up / shut-down frequencies of low demand periods are reduced by the implementation of storage tanks, resulting in a reduction of the pollution. The optimal choice of control parameters depends on the storage dimensions and on the heat consumption profile (Summer / Winter).

Effiziente Gebäudetechnik und Biomasse-Nahwärme – Integriertes Energie-Contracting am Beispiel Mautern, Steiermark

Daniel Schinnerl
Siemens AG Österreich, Smart Infrastructure
Strassganger Straße 315
8054, Graz-Straßgang, Austria

Co-Authors: Jan W. Bleyl, Willibald Ehrenhöfer

Die Auftraggeber des Projektes Integriertes Energie Contracting Mautern in Steiermark verfolgten einerseits das Ziel der Umsetzung von Einsparmaßnahmen in den Gebäuden, um Wärme-, Strom- und Wasserverbrauch zu reduzieren, und andererseits die Energieversorgungsanlagen zu modernisieren und auf emissionsarme, nachhaltige und regionale Energieträger umzustellen. Weiters sollen vor allem auch Komfortsteigerungen und geringere Verbrauchs- und Instandsetzungskosten resultieren. Die Finanzierung aller Maßnahmen soll aufgrund von Budgetengpässen durch den Auftragnehmer erfolgen [Amt d. Stmk. Landesregierung, A16 2015]. Alle Gebäude wurden bisher mit Erdgaskessel wärmeversorgt und es sind keine erneuerbaren Energien integriert. Die Qualität der Gebäudetechnik der bestehenden Gebäude war „mittelmäßig" und war teilweise Instandsetzungsbedürftig. Die Planung des neu errichteten LPZs war nach Stand der Technik, jedoch ohne innovativen bzw. effizienten Ansatz.

Methodik
Bei diesem Projekt wird das Integrierte Energie Contracting Modell angewendet [Bleyl 2011], welches sowohl die Einsparpotentiale der Gebäude und als auch deren Versorgungssysteme einbezieht. Der Leistungsumfang dieses Modells kombiniert zwei Ziele:

1. Reduktion des Nutzenergiebedarfs durch Umsetzung von verbrauchsseitigen Energieeffizienzmaßnahmen im Gebäude (Leistungsgruppe 2) und
2. Effiziente Lieferung des verbleibenden Energiebedarfs (Leistungsgruppe 1).

Ergebnisse
Die verbrauchsseitigen Einsparmaßnahmen und die Modernisierungsmaßnahmen wurden von der Siemens AG Österreich, Building Technologies, umgesetzt, erreichen ca. 18% Wärmeeinsparung, nennenswerte Stromeinsparungen und erlauben einen intermittierenden Sommerbetrieb des Heizwerkes. Das Biomasse Heizwerk mit 1 x 400 kW Kessel und 800 kW Gas-Kessel als Reserve wurde von Franz Mayr-Melnhof-Saurau Forstmanagement und Entwicklungs GmbH umgesetzt und versorgt über ein Stahl-Doppelrohrsystem ganzjährig die vier Gebäude mit erneuerbarer Wärme. [Mayr-Melnhof-Saurau Forstmanagement 2015]
Kloster, Baujahr 17. Jhdt., Sanierung 1997, Gemeinde Mautern; Maßnahmen: Dämmung oberste Geschossdecke, Mess-, Steuer-, Regelungstechnik, Hocheffizienzpumpen, dezentrale thermische Solaranlage, Pufferspeicher und Warmwasserbereitung sowie Beleuchtungs- und Leuchtmitteltausch mit LED.
Neue Mittelschule inkl. Turnhalle, Baujahr 1992, Gemeinde Mautern; Maßnahmen: Instandsetzung und Modernisierung der Wärmeverteilung, Mess-, Steuer-, Regelungstechnik, Hocheffizienzpumpen, bedarfsgerechte Regelung der Lüftungsanlage, sowie Beleuchtungs- und Leuchtmitteltausch mit LED.
Landespflegezentrum (LPZ), Fertigstellung 2017, Land Stmk. Referat 16; Maßnahmen: Natriumhypochlorit Anlage sowie dezentrale thermische Solaranlage.
Seniorenwohnheim, Baujahr 2004, Gemeinnützige Wohn- u. Siedlungsgenossenschaft Ennstal reg. GesmbH; Maßnahmen: Wärmeübergabestation und Umstellung auf erneuerbare Wärmelieferung.

Schlussfolgerungen
Durch die Umsetzung von verbrauchsseitigen Einspar- und Instandsetzungsmaßnahmen konnten die Größe der Biomasse-Nahwärmeanlage optimiert werden, die Energieeffizienz in den Gebäuden und der Versorgungsanlage gesteigert werden, erneuerbare Energien integriert werden und die Kosten langfristig gesenkt werden.

Industrial exhibition

Industrial exhibition

Eschlböck: Hacker- und Fahrzeugbau aus einer Hand!

Der spezialisierte Holzhackmaschinenhersteller Eschlböck wurde mit der Entwicklung der Biber Powertrucks VICAN, VICTOR und MAROX zunehmend auch zum Spezialisten im Fahrzeugbau. Eschlböck treibt den Hacker über ein einstufiges neu entwickeltes Getriebe zwischen Motor und Fahrantrieb an. Die neue Kraftübertragung der Biber Powertruck-Reihe ermöglicht eine hohe Leistungsübertragung bei gleichzeitig geringstem Kraftstoffverbrauch und senkt damit die CO2 Bilanz in der Hackgut-Herstellungskette.

2019 wurden zwei neue Biber Powertrucks MAROX und VICAN 110 vorgestellt. Die Baureihe Biber 110 wurde mit einem 110 cm Durchmesser großen neuen Hackrotor ausgestattet.

Der große verstellbare Messervorgriff des neuen Z-Rotors und der große Freiraum vor und hinter dem Messer ermöglichen einen ungehinderten Materialdurchgang und damit wenig Feinanteil und ein stückiges, grobes Hackgut. Sämtliche Verbindungen des innovativen Rotors sind geschraubt und damit exakt verarbeitet und ermöglichen eine lange Lebensdauer und eine servicefreundliche und zeitgemäße perfekte Austauschbarkeit bei Verschleiß und Fremdkörperschäden. Wie beim bewährten Kombirotor kann sowohl mit dem ganzen als auch dem halben Messersatz gearbeitet und damit Kraft gespart werden.

Der neue MAROX, ist auf MAN-Basis mit 510 PS und der neuesten Motorengeneration EURO 6d. 2600 Nm Drehmoment lassen auf höchste Leistungswerte im Hackbetrieb schließen. Der neue MAROX besticht durch seine Geländetauglichkeit mit der 6 x 6 Achskonfiguration, dem 12-Gang Automatikgetriebe und dem Fahren und Hacken vom Bedienplatz aus.

Neu auf den Markt gebracht wurde 2019 außerdem die neue Einsteigermaschine Biber 60 sowie der komplett überarbeitete und seit 1992 bewährte Biber7.

Nähere Informationen unter www.eschlboeck.at

Fototext: Vorstellung des neuen Biber Powertrucks VICAN 110 im September am Biberfest 2019

GREEN CARBON

Reducing CO2 emissions is the greatest challenge in the international efforts for climate protection. With our state-of-the-art and fully automated production we are able to store 3 kg of CO2 in just 1 kg of biochar.

So far, the conventional production of vegetable carbon posed two major problems: During carbonization, waste gases which don't meet the European environmental standards occur and the energy loss amounts to up to two thirds of the used raw material.

Both problems can be solved with the modern plant technology developed by POLYTECHNIK. It makes it possible to once more bring the state-of-the-art production of vegetable carbon, which in large parts had been ousted in Europe, closer to this huge sales market and to utilize suitable raw materials close to their point of production.

The most important areas of application are the production of vegetable carbon for soil improvement (Terra preta), the production of high-quality carbon products for the industrial sector, as well as the production of charcoal for the consumer.

Our production plants for vegetable carbon are designed to manufacture products with an especially high carbon content and a low amount of tarry pollutants. The pyrolysis process (transformation of biomass under heat and in absence of air) is achieved by means of a batch process within a retort system.

The waste gases and pollutants which occur during the carbonization process are thermally recycled within a closed cycle. The excess energy which develops during the process can be utilised for heat or energy production. This offers the possibility to meet all relevant environmental standards and to achieve an especially high energy yield from the used raw materials during the carbonization at the same time.

The complete production process, from the supply of the raw materials to the provision of the vegetable carbon, is automated in large parts and performed in shifts, 24 hours per day, 7 days a week.

POLY H.E.L.D. ® Low-emission combustion with extreme air staging

POLY H.E.L.D.® is the combustion technology of the future. The combustion system with extreme air staging, designed as fixed-bed type with counter-current, allows for a low-emission and efficient combustion of various fuels. Dust emissions for wood-based biomass remain lower than 20 mg/Nm3 at 11% O2. A value of below 10 mg/Nm3 can be reached with quality wood chips. Additionally, the POLY H.E.L.D. combustion technology is able to exploit high-ash fuels with relatively low ash melting points at low emissions. The system accomplishes these low emission values with primary measures and without an additional flue gas purification, which makes it a highly economical solution. As a unique design, this system achieved a 20-30% lower NOx emission (compared to conventional combustion plants) without secondary measures like SNCR or SCR.

Fuel is supplied via a screw stoker (or other feed systems). Fuel height is controlled by a redundant measuring system. The plant is started automatically by a hot-air blower.

The grate is a conical grate, specifically developed for this technology by POLYTECHNIK. The new grate is mounted below the fixed bed and is cleaned from ashes simultaneously to the left and the right. In this process, the ash is discarded onto two screws on both ends of the grate and from there it is transported to another ash screw which transfers all of the ashes to a container. The grate frame is water-cooled.

The producer gas is combusted in a newly developed, multi-stage lean gas burner at low emissions with a slight air surplus and high efficiency. Subsequently, the flue gas flows through the heat exchanger and the energy can be used for various purposes: hot air, warm water, hot water, steam and/or thermal oil can be used as heat media.

AUSTROFLEX Rohr-Isoliersysteme GmbH
Finkensteiner Strasse 7
A-9585 Gödersdorf-Villach, Austria.
www.austroflex.com

AUSTROFLEX - the expert for thermal energy networks

Founded in 1985, Carinthia-based company **Austroflex** has been active for 35 years in technical insulation and the development and production of systems and solutions for the insulation of heating & cooling pipes – made in Austria.

Today, we are recognised within the industry as an expert supplier of flexible **Pre-insulated Pipe Systems**, a comprehensive range of thermal **Solar Pipe Systems** and an assortment of **Technical Insulation** solutions.

Typical Applications

- District Heating and Cooling networks
- Domestic heating and hot sanitary water
- Biomass/Biogas - CHP installations, Wood and Pellet boilers
- Heat pumps
- Solar thermal systems
- Potable water
- Specific industrial process piping

The `Reverse Power Plant'

SYNCRAFT® wood power plants are climate-positive to support climate protection

Zero emissions are no longer sufficient to counteract climate change. The CO_2 that has already been released must be removed from the atmosphere again, according to the Paris Climate Protection Agreement. To do this, more greenhouse gases must be bound than are released. The climate-positive power plants of SYNCRAFT® are already working with this process: the carbon dioxide remains within the production cycle and is thereby used positively instead of further polluting our environment. The term 'reverse power plant' has been adopted, to highlight the sequestering of CO_2 which is already in our atmosphere.

More than just a wood power plant

The first SYNCRAFT® wood power plant was originally intended to focus primarily on the provision of electricity and heat. The valuable third product, charcoal, was only discovered later and the true potential of it was proven by a 2017 scientific study. As a result, product development was intensified in the Tyrolean town of Schwaz in order to further expand the production of charcoal. By arrangement with the MCI Management Center Innsbruck, a collaboration project was started with the government of Tyrol, also involving Bioenergy 2020+ as a scientific partner. SYNCRAFT® currently offers four different wood power plant models, each of which is adapted to individual customer needs. To ensure that the system is properly installed, SYNCRAFT®'s engineering team takes care of the overall planning, construction and ongoing maintenance of the plant.

Charcoal as a high-yield CO_2 storage medium

The fossil fuels oil and gas are not renewable and release a lot of carbon dioxide during combustion. Wood as a renewable raw material is therefore a good alternative. Although wood contains CO_2 derived from air, part of it remains stored in the charcoal generated at the SYNCRAFT® wood power plant and is therefore no longer released. This creates a profitable and environmentally friendly cycle, because this coal can be used positively: for example, as a feed additive for animal health, similar to coal tablets, or it can bring additional fertility to the soil. This generates additional yield and reduces the use of fertilizers, which in turn counteracts pollution of the environment by overfertilization.

Coal-fired power plants need to pump carbon dioxide into the ground to achieve a negative emissions balance. This not only requires additional energy, but also has no added value and is furthermore unsafe. This is not the case with wood power plants, however, they do generate ash, which is a waste product. A SYNCRAFT® wood power plant on the other hand produces high-quality charcoal instead of ash. Since this provides an additional source of income, this indirectly reduces energy costs and thus enables electricity and heat from forest wood chips to be supplied well below the limits of competitors.

The production of charcoal happens alongside, so to speak, and does not reduce the supply of electricity and heat. The power plants still have a year-round efficiency of 92 %.

The simultaneous provision of sustainable, renewable energy and the storage of CO_2 through the sensible utilisation of the high-quality charcoal is what makes SYNCRAFT®'s wood power plants special. They close the circle without releasing climate-damaging gases into the environment. A good 36 grams of CO_2 are stored per kilowatt hour of energy provided (source: FH Vorarlberg). The CW700-200+ power plant in Dornbirn stored nearly 600 tons of carbon dioxide in 2018. This shows that even a single wood power plant from SYNCRAFT® can make a huge contribution.

Froling: The big name for heat and electricity made from wood and pellets
Innovative solutions with a capacity range from 7 to 3,000 kW

Froling is the big name in automated biomass boilers fuelled by pellets, wood chips or log wood. The family-owned manufacturer offers high-efficiency heating systems (ranging from 7 to 3,000 kW) as well as solutions for fuel storage, tanks, heat exchangers and control systems. It exports to more than 35 countries worldwide and has large-scale manufacturing plants in Austria and Germany. With the experience of over 50 years in heating technology Froling developed the new wood power plant Type CHP, which produces heat and electricity from wood. The CHP50 has received the "Energy Genie" in 2015, which is an Innovation Award of the Ministry of Environment for new products according to the criteria of innovation, energy saving und novelty.

The Froling fixed-bed gasifier CHP 50 is available with an electrical output of 46/50/56 kW and a thermal output of 110 – 115 kW and achieves a total efficiency of more than 85%. The CHP can be installed ready for operation in a container (wood gasification system including safety technology, exhaust gas line and automatic gas flare) and is already put into operation and tested at the production plant of Froling. The other possibility is the indoor-variant where eg. up to 20 units can be installed as a cascade at one location. The first systems are successfully in operation since 2013. The customers are very enthusiastic about the fully automatic betrieb and the high efficiency. The worldwide acting Froling service team can ensure a appropriate on-site support of the CHP system.

Customer care from planning to servicing

The broad range of services provided by Froling is greatly valued by heating engineers, builders, planners, architects and other engineers. No matter what your need, Froling offers a full advice, planning, implementation and after-care service. Experts from around the world take part in training sessions at our training offices. Froling also offers a highly extensive customer service network.

Facts and figures:
Factories: Grieskirchen (AUT), Stritzing (AUT), Marzahna (GER)
Sales/training/competence centres: Grieskirchen (AUT), Munich (GER), Strasbourg (FRA), Bolzano (ITA)
Staff: around 600
Export ratio: over 80 percent
Markets: Europe (our main market); USA; other distributors around the world

Contact details:
Froling Heizkessel- und Behälterbau GmbH
Industriestrasse 12, A-4710 Grieskirchen
Austria tel. +43 (0) 7248 6060
Germany tel. +49 (0) 89 927 926 0
info@froeling.com; www.froeling.com

Feuer und Flamme!
Hargassner ihr Biomasse Spezialist

Hargassner – Ein Familienunternehmen mit Tradition und Herz! Seit über 30 Jahren am Markt und mit mehr als 86.000 zufriedenen Kunden, hat sich die Firma am nationalen und internationalen Biomasse-Markt etabliert.

Firmengeschichte

Vor 30 Jahren überzeugte Anton Hargassner seine Frau, bei dem neu gebauten Familienhaus auf eine selbstgebaute Heizung zu setzen. Als Sohn eines landwirtschaftlichen Betriebs kam kein anderer Brennstoff als Holz in Frage. Da damals die Holzheiztechnik praktisch nicht existierte, entwickelte Hargassner die Hackschnitzelheizung für das eigene Haus damals selbst. Seine Frau überzeugte er damit, dass die selbstgebaute Heizung automatisch mit Brenngut beschickt wurde. Für diese und ähnliche Entwicklungen erwarb Hargassner in den folgenden Jahren Patente und gründete 1984 die Firma Hargassner GesmbH im oberösterreichischen Weng.
Seit 30 Jahren produziert die Firma Hargassner nun schon Hackgutanlagen und seit über zehn Jahren auch Pelletsanlagen. Im Angebot sind Anlagen im Leistungsbereich von 9 bis 200 kW mittels Kaskadenlösung bis 800 kW. Seit 2010 werden auch Stückholzkessel von 20 - 60 kW hergestellt. Neu im Sortiment befinden sich die Stückholz/Pellets Kombikessel. Die Firma verfügt über eine Produktionskapazität von 10.000 Kessel/Jahr. Das Unternehmen beschäftigt mittlerweile über 220 Mitarbeiter. Seit 2013 beträgt die Gesamtfläche der Firma 30.000 m2. In der Produktion sind modernste CNC-gesteuerte Blechbearbeitungsmaschinen, Schweißroboter und eine vollautomatische Pulverbeschichtungsanlage im Einsatz.

Innovation

Ein Hauptaugenmerk im Unternehmenskonzept wird auf die eigene Forschungs- und Entwicklungsabteilung gelegt. Die Produktentwicklung findet innerhalb der Firma Hargassner statt gemäß dem Motto „Vorsprung durch Qualität und Technologie“. Seit 2012 ist das neue Forschungs- und Entwicklungszentrum eröffnet – Größe: weitere 3.600 m2. Das neue Forschungs- und Entwicklungszentrum stellt quasi eine Firma in der Firma dar. Ohne die eigentliche Serienproduktion zu stören, können hier Prototypen gebaut werden. Mit 20 neuen Versuchsständen ist nun auch eine kontinuierliche Forschung möglich. Auf dem Prüfstand stehen nicht nur Heizungen, sondern vielmehr auch neue Brennstoffe und Bedienelemente.

Neuheiten 2017

Hargassner bietet neu Hackgutheizungen im Leistungsbereich bis 330 kW an. Diese sind mittels Kaskadenlösung bis zu 2 MW kombinierbar und vereinen die gewohnte Eco-HK Qualität und Leistungsfähigkeit.

Auch brandneu ist die Erzeugung von Wärme und Strom aus Holz. Mit der neuen KWK Heizung können 60 kW Wärme und 20 kW Strom erzeugt werden. Speziell geeignet ist diese umweltfreundliche Energieversorgung für Gewerbebetriebe, öffentliche Bauten und Nahwärmenetzbetreiber. Zum Einen überzeugt sie durch eine kompakte Bauweise mit sehr wenig Platzbedarf, zum Anderen durch den vollautomatischen Betrieb durch das durchdachte Regelungskonzept – die ideale Lösung für alle, die einen konstanten Energiebedarf haben, wie z.B.: Gastronomie & Hotellerie oder Industriebetriebe, Micronetze etc.

Autor: Marketing Abteilung Firma Hargassner
Firma: Hargassner GmbH, Anton Hargassner Straße 1, 4952 Weng
E-mail: office@hargassner.at
Homepage: www.hargassner.at

BÜRO FÜR ERNEUERBARE ENERGIE
Ing. Leo Riebenbauer GmbH

In Verantwortung für Klima- und Umweltschutz widmet sich die Ing. Leo Riebenbauer GmbH bereits seit Beginn der 1990er Jahre der Planung und dem Engineering von Erneuerbarer Energie. Erklärtes Unternehmensziel ist es, durch die Projektierung und Errichtung von Energieerzeugungsanlagen auf Basis vorhandener regionaler Ressourcen größtmögliche Versorgungssicherheit für Haushalte, Industrie, Gemeinden und ganze Regionen zu schaffen.

Die Tätigkeitsbereiche des Ingenieurbüros liegen in der Entwicklung, Planung und Umsetzung nachhaltiger Energiesysteme für Wärme und Strom aus regenerativen Energiequellen. So sorgt das Unternehmen ***Büro für Erneuerbare Energie - Ing. Leo Riebenbauer GmbH*** in den Bereichen Biomasse-Nah- und Fernwärme, Strom aus Holz und Biogas, Photovoltaik, Solarthermie, industrielle Abwärmenutzung, Energiespeicherung und energieeffiziente Gebäudetechnik national und international für innovative, ganzheitliche Lösungen in der Energieplanung. Darüber hinaus ist das Ingenieurteam der Ing. Leo Riebenbauer GmbH Ansprechpartner für alle Fragen der technischen Optimierung und Effizienzsteigerung bereits bestehender Anlagen.

Energiesysteme aus dem ***Büro für Erneuerbare Energie – Ing. Leo Riebenbauer GmbH*** zählen mittlerweile nicht nur national, sondern auch international zu den Vorzeige- und Referenzprojekten hinsichtlich Erneuerbare Energie und Klimaschutz.

BÜRO FÜR ERNEUERBARE ENERGIE
Ing. Leo Riebenbauer GmbH
Hauptplatz 13
A - 8243 Pinggau
T: +43 3339 25113
M: +43 664 344 87 20 | +43 664 423 10 71
office@riebenbauer.at | www.riebenbauer.at

Komptech GmbH

Kunter, Andreas, Dipl.-Ing.
Komptech GmbH
8130, Frohnleiten
Kühau 37
a.kunter@komptech.com
www.komptech.com

The Komptech company
Komptech is a leading international manufacturer of machines and systems for the mechanical and mechanical-biological treatment of solid waste and biomass, and the processing of woody biomass for use as a renewable fuel. The product range comprises over 30 different types of machines, which cover the key steps in waste handling and biomass processing. Modular construction with different power classes simplifies combining machines into complete systems. The focus is always on innovative technology and solutions that bring maximum user benefit.

Biomass processing
Energy generation from renewable sources is the order of the day, to counteract negative environmental effects like the greenhouse effect and resulting climate change. Komptech supplies machines for processing wood in all of its many forms, from logs to forestry residue and municipal cuttings to old wood, all of which can be processed to provide energy or raw materials. The company's products range from machines for shredding and chipping to screening and separation to clean out contraries.
For example, high-speed chippers or low-speed shredders can turn woody green cuttings into a coarsely structured fuel. Subsequent separation by a stone separator or drum screener brings a considerable quality improvement - fines go to composting and contraries are removed by stone separation, magnetic separation or wind sifting. The customers for the fuels are biomass heating and cogeneration plants, who need a low-cost fuel with a specific calorific value and grain size.

In keeping with our slogan "Technology for a better environment" we see it as our function to develop the right concepts and the most economical machines to meet these challenges. Because in processing woody biomass into fuel, the goal is always to get maximum fuel output for minimum energy input.

Company facts and figures
2016 group revenue: approx. € 105 million
60% revenue in Europe (of which 10% in Eastern Europe), the rest in the US, Japan and Australia.
4 companies at 3 locations in 3 countries - Austria, Germany, Slovenia
Employees: approx. 560

bioenergie

Your plus in heat.

„Efficient use of energy“ –
an ambitious guiding principle successfully implemented

The corporate group “Bioenergie” is a Styrian family business with focus on environmental-friendly district heating generation out of waste heat and biomass. The enterprise is among the largest providers of sustainable and efficient heat in Austria. For more than 20 years, Bioenergie has been a pioneer in the fields of waste heat utilization, district heating technology and biomass heating plants.

The family-owned enterprise consists of several companies. At the moment, it supplies thousands of satisfied customers in Austria at 22 sites of district heating. About 500.000 MWh heat is delivered currently per year. Thereby, around 180.000 tons of climate-damaging CO_2 is saved.

- ✓ Planning, manufacturing and operation from one provider
- ✓ Quality assurance and cost controlling
- ✓ Outstanding und longtime technical know-how

3 core areas

- Biomass power plant
- District heating supply
- Waste heat utilization

Facts

- 22 sites of district heating in Austria
- 3 biomass plants with power-heat coupling
- 5 wind power plants
- 3 hydroelectric power plants
- 4 waste heat generations
- 2.500 satisfied customers

Contact

Bioenergie Wärmeservice GmbH
Alte Hauptstraße 9, A-8580 Köflach
☎ +43 (0) 3144 71 207-21
✉ office@bioenergie.at

KLAGENFURT
Biomass Capital of Europe!

„The city with a **carbon-free** future"

- Two strong partners – Stadtwerke Klagenfurt AG and Bioenergie Kärnten.
- Stadtwerke Klagenfurt AG is one of Carinthia's most important infrastructure companies in the areas of electricity, heat, gas and water.
- Bioenergie Kärnten supplies 27,000 households with CO2-free district heating at its locations in the east, south and north of Klagenfurt.
- 40,000 households are supplied with green electricity from biomass.
- 50% reduction in CO2 in Klagenfurt due to green electricity and district heating from biomass.
- The common goal is to further improve the quality of life and the air quality in Klagenfurt and to make Klagenfurt a model city in bioenergy production through the use of cutting-edge technology.

Our energy is supplied by nature

STW Stadtwerke Klagenfurt

BIO ENERGIE KÄRNTEN

DI Erwin Smole
STW Vorstand

Mag. Harald Tschurnig
STW Vorstand

DI(FH) Markus Poppe
GF Bioenergie Kärnten

Ing. Johann Moser
GF Bioenergie Kärnten

KWB: Über 25 Jahre Heizkomfort

KWB steht für Kraft und Wärme aus Biomasse und ist das Synonym für innovative Heizlösungen. Seit mehr als 25 Jahren setzt der österreichische Hersteller Maßstäbe am Biomassemarkt. Rund 80.000 Kundinnen und Kunden vertrauen weltweit auf die Premium-Heizsysteme aus St. Margarethen/Raab (AT).

Einfach und sauber heizen

Die KWB GmbH wurde 1994 in der Steiermark (AT) gegründet und vertreibt ihre innovativen Heizlösungen weltweit. Innovationskraft steckt in den Genen der KWB, mit seinen Lösungen war das Unternehmen seiner Zeit immer ein Stück voraus: KWB erfand die vollautomatische Reinigung für Holzheizungen sowie den 3-fach geteilten Scheitholzkessel und revolutionierte die Heizungssteuerung mit einer intuitiven Regelungseinheit. KWB war aber auch Vorreiter in der technologischen Entwicklung von Pelletheizungen und setzte mit dem KWB Raupenbrenner neue Standards bei Hackgutheizungen. Mit dem einzigartigen KWB Teilbar-Tragbar-System wurde die Arbeit des Heizungsbauers enorm erleichtert – ein weiterer Meilenstein am Erfolgsweg der KWB. Zum Produktportfolio gehören heute aber auch Solaranlagen, Kaminsysteme, Wärmepumpen und Speichertechnik. Heizlösungen von KWB leisten seit über 25 Jahren einen maßgeblichen Beitrag dazu, dass sich Biomasse am Markt als zukunftsfähige Energieform etabliert hat. Dazu Helmut Matschig, KWB Geschäftsführer: *„25 Jahre KWB: 80.000 zufriedene Kundinnen und Kunden mit verschiedensten Bedürfnissen. Auch in den folgenden Jahren halten wir unsere vier Trümpfe für das Heizen mit Holz fest in der Hand: Komfort, Umweltfreundlichkeit, Kostenersparnis und Heimat."*

Über KWB

KWB ist Lösungsanbieter für Erneuerbare Heizungssysteme. Als Spezialist für Holzheizungen bietet KWB Pellet-, Stückholz- und Hackgutheizungen von 2,4 – 300 kW. KWB erfand die vollautomatische Reinigung für Holzheizungen, den dreifach geteilten Scheitholzkessel, den robusten Raupenbrenner und revolutionierte das Unterschub-Brennsystem für Pelletkessel. Zum Produktportfolio gehören aber auch Solaranlagen, Kaminsysteme, Wärmepumpen und Speichertechnik. Die KWB GmbH wurde 1994 in der Steiermark gegründet und bietet ihre Produkte weltweit an. In Österreich, Deutschland, Frankreich und Italien unterhält KWB ein eigenes Vertriebs- und Service-Netz. In vielen weiteren Ländern kooperiert KWB mit lokalen Vertriebspartnern. Derzeit beschäftigt das Unternehmen konzernweit knapp 300 Mitarbeiterinnen und Mitarbeiter.

Postersession

Poster session

Microgrid Lab – R&D project for decentralized energy supply with biomass and other Distributed Energy Resources (DER)

Stefan Aigenbauer
BEST GmbH
Gewerbepark Haag 3, A 3250 Wieselburg-Land
stefan.aigenbauer@best-research.eu

Co-Authors: Michael Stadler, Michael Zellinger, Christine Mair, Pascal Liedtke, Armin Cosic, Muhammad Mansoor

Microgrids are local energy grids that (partly) cover their own energy demand. Due to decentralized renewable energy sources, energy costs and CO_2 emissions of microgrids are reduced. Various storage systems and strategies, like load shift, are employed to balance the volatile energy flows. Intelligent controllers improve the energy management of the micro and smart grids.

The presented project “Microgrid Lab 100%” enables a real application for the developments of the following two ongoing basic research projects: “OptEnGrid” (FFG 858815) and “Grundlagenforschung Smart- und Microgrid“ (K3-F-755/001-2017) research projects, which are based on the leading microgrid optimization tool DER-CAM+ (Distributed Energy Resources – Customer Adoption Model) from Lawrence Berkeley National Laboratory at the University of California. These two BEST GmbH basic research projects form the basis for new innovative microgrid controller concepts, which will be implemented and tested in the presented Microgrid Research Lab in Wieselburg. The Microgrid Research Lab will include the Technology- und Reseach Centre (tfz) Wieselburg-Land and the new firefighting department next to the tfz.

Objective and Introduction:
The major objective of the Microgrid Research Lab at Wieselburg is to combine the existing technologies as biomass boilers, absorption and compression cooling and heat storages at tfz with the newly installed technologies: Photovoltaics (PV), electric vehicle (EV) charging stations and a battery, within one testbed for microgrid developments. This concept is used for analyzing the interactions of all these technologies to increase the system efficiency. For example: The installed wood chip boiler has enough capacity to supply the new firefighting station completely with heat. In return, a new installed PV and battery system at the firefighting station can be used for the testbed and most of the produced electricity can used at the tfz. The final Microgrid Lab will support the development of new microgrid controller strategies.

Results:
Within the project Microgrid Lab 100%, a mathematical analysis of the future microgrid has been performed. In comparison to the reference case, the microgrid solution shows a cost reduction of 12% and a decrease of CO_2 emissions of 18%. These values will be achieved by installing additional technologies and implementing a microgrid controller.
There will be two major outcomes of this project:

- a tested and verified methodology for energy planers and architects to design and develop integrated distributed energy systems and the
- Microgrid Lab testbed itself, to test the control-, communication- and integration processes in real-time. The Microgrid Research Lab will act as testbed for technology providers, technology manufactures, as well as different utilities and new emerging sectors.

Acknowledgment:
The project Microgrid Lab 100% (Nr. K3-F-760/003-2018) was funded as FTI leader-project by the government of Lower Austria, WST3 - department for economy, tourism and technology.

Residential wood combustion impact on air quality in Lombardy (North Italy)

Elisabetta Angelino
Air Dispersion Modeling and Emission Inventory Unit Chief
Environmental Monitoring Sector
Environmental Protection Agency of Lombardy Region
Via Rosellini 17
20124 Milano, Italy
e.angelino@arpalombardia.it

Co-Authors: Elena Brevetti, Guido Lanzani, Alessandro Marongiu

As reported by national and local atmospheric emission inventories, residential wood combustion is a relevant source of PM10. In Lombardy region, in the Northern Italy, during 2014 the residential heating has determined 39% of primary PM10 total emissions and this amount was due for more than 98% to the combustion of solid ligno-cellulosic biomass.

In order to improve the regional emission inventory (www.inemar.eu) preliminary analysis on new emission standard, real appliances behavior and emission factors has been performed selecting the more appropriate set of values for the regional context. During the last years, results from telephonic surveys have been collected for monitoring the time varying consumption of biomass for domestic use and identifying the displacement of the main categories of small combustion installations. These data are discontinuous and a specific methodology for completing and integrating time series has been developed allowing also to estimate the overall age of the installed appliances to put into relation with the emission factor calculation on news standards.

Traditional stoves and closed fireplaces have been resulted the main relevant sources accounting for 63% of the emission of PM10 from domestic wood burners.

Source apportionment studies have confirmed the importance of biomass burning also in urban areas as a source of PM10: measurements of levoglucosan, as a tracer, have allowed to estimate the contribution of wood combustion on PM air concentration and measurements of BaP in different Lombardia Region areas to relate biomass burning not only to PM concentration but also to PAH levels, too.

Sustainable through resource efficiency? An impact assessment case study on lignin use in plastics

Raphael Asada
Universität Graz
Institute of Systems Sciences
Innovation and Sustainability Research
Merangasse 18/1
8010 Graz, Austria
raphael.asada@uni-graz.at

Co-Authors: Julia Wenger, Claudia Mair, Tobias Stern

Resource efficiency plays a central role in the sustainability discourse and is reflected as an objective in national action plans related to natural resources [1, 2]. An important element here is cascading utilization, i.e., the value-adding material use of biobased resources, by-products and waste prior to energy recovery [3]. Technical lignin, a by-product from the pulp and paper industry that is currently used to recover process chemicals as well as to generate heat and power, has been extensively researched for decades to enable its use in material applications. For example, lignin may partly substitute petrochemical phenolic compounds in plastics [4]. Exploring this particular case by means of scenario technique, the present study discovers some environmental and socioeconomic implications of improved resource efficiency through intensified cascading.

Scenario
Both, lignin and precursors for phenolic compounds are by-products generated by joint production processes – e.g. kraft pulping, steam cracking, or catalytic reforming. The global diffusion towards lignin use in plastics increases the demand for lignin, while demand for phenolic compounds decreases, which leads to altered profitability of the joint production activities. The theory of diminishing returns (e.g. Cobb-Douglas production function with partial factor variation) [5] implies an increase in production volume when prices rise and a reduction in volume when prices fall, taking into account production capacities. In this way, biobased and petrochemical industries are assumed to adjust their production activities and, in doing so, induce positive and negative effects on environmental and socioeconomic sustainability.

Research objective
A semi-empirical model for selected and simplified pulp mill and steam cracking or catalytic reforming operations is established, using production and price statistics, life cycle inventories, and cost estimations derived from public sectoral data and literature. The past supply behavior is examined to project volume adjustments under various price assumptions, which allows for the quantification of associated changes in climate change, ecosystem quality, resource depletion, value creation, jobs, and health. The study presents advantages and limitations of the approach and provides a contribution to the discussion of sustainability arguments related to resource efficiency.

[1] Schaffartzik, Anke; Eisenmenger, Nina; Krausmann, Fridolin (2015): Ressourcennutzung in Österreich – Bericht 2015. Wien: BMLFUWG. Online: https://www.bmnt.gv.at/dam/jcr:5f7d5688-9efa-4e99-ab33-48ec5f567da7/renu15_DE_web_abgabe2.pdf [24.5.2019].
[2] Strimitzer, Lorenz; Höher, Martin; Kalt, Gerald; Bruckner, Andrea; Schmidl, Johannes (2015): Aktionsplan zur Stofflichen Nutzung nachwachsender Rohstoffe. Wien: BMLFUW. Online: https://www.klimaaktiv.at/dam/jcr:05178a2e-dcaa-4d0c-bc9a-e439babb208b/Aktionsplan_Nawaro_J%C3%A4nner_2015_Final.pdf [24.5.2019].
[3] Vis, Martijn; Mantau, Udo; Allen, Ben (2016): CASCADES: Study on the optimized cascading use of wood. *No 394/PP/ENT/RCH/14/7689, final report*. Brussels, Belgium: European Commission. Online: https://publications.europa.eu/en/publication-detail/-/publication/04c3a181-4e3d-11e6-89bd-01aa75ed71a1 [24.5.2019].
[4] Stewart, Derek (2008): Lignin as a base material for materials applications: Chemistry, application and economics. In: *Industrial Crops and Products*, 27(2), 202-207. DOI:10.1016/j.indcrop.2007.07.008.
[5] Perman, Roger; Ma, Yue; Common, Michael S.; Maddison, David; McGilvray, James (2011): Natural resource and environmental economics. Fourth edition. Harlow et al.: Addison Wesley (Pearson).

The contribution of advanced renewable transport fuels to transport decarbonisation in 2030 and beyond

Dina Bacovsky
BEST Bioenergy and Sustainable Technologies GmbH
Standort Wieselburg
Gewerbepark Haag 3
3250 Wieselburg-Land, Austria
Dina.bacovsky@best-research.eu

Co-Authors: Adam Brown, Ilkka Hannula, Juhani Laurikko, Alicia Lindauer, Magnus Lindgren, Kyriakos Maniatis, Shahana McKenzie, Franziska Müller-Langer, Nils-Olof Nylund, Jack Saddler, Andrea Sonnleitner, Yutaka Takada, Lars Waldheim, Yu We

In the light of climate change, there is an urgent need to decarbonize our societies. The transport sector is specifically challenging, as transport demand is still growing, and so are the sector´s GHG emissions. Several countries have set ambitious national targets for GHG reduction in the transport sector. These are often backed with policy measures for implementation of both advanced renewable transport fuels and electrification. The current EU legislation (RED-II) specifically promotes advanced biofuels with dedicated multipliers and strong sustainability criteria, setting up a framework for their promotion and deployment. Germany has a national target of reducing transport CO2 emissions by 40% by the year 2030, Finland by 50%, and Sweden by 70%. Major economies, such as the USA,Brazil, China, and India have set up dedicated programs for the implementation of biofuels and/or electric vehicles at large scale. Will this implementation occur fast enough to meet national targets for a clean and climate-friendly transport sector? In a project set up jointly by two Technology Collaboration Programmes of the International Energy Agency, namely the IEA Bioenergy TCP and the Advanced Motor Fuels TCP, the contribution that advanced renewable transport fuels should make to the decarbonisation of the transport sector is assessed by means of countryspecific assessments.

First the key strategies for transport decarbonisation and the introduction of alternative fuels in the European Union, Germany, Finland, Sweden, USA, Brazil, China, India, Japan and Australia are described. Based on these strategies, on the current status of the vehicle fleet and fuels in use, and on projections on the uptake of electric vehicles, probable compositions of the national vehicle fleets in 2030 are calculated for five of these countries. Linking the GHG emissions of these fleets to the national targets, renewable fuel volumes needed to reach the national targets are estimated. Conventional and advanced biofuels as well as electrofuels are being considered. The analysis provides scenarios for advanced renewable transport fuels market shares in 2030, and reveals country-specific barriers to the implementation of advanced renewable transport fuels. The assessment is backed up by a description of the technology status of biofuel and electrofuel pathways, feedstock availability, current fuel production costs, future feedstock costs, future fuels carbon intensity and the compatibility of fuels with existing engines. Also, the results of the country-specific assessments regarding advanced renewable fuel volumes required to meet national GHG reduction targets are compared to global supply and demand expectations. IEA data and other published data are used to evaluate how the country assessments match with existing projections for their regions and globally. The project concludes by identifying policy gaps and providing recommendations to policy makers how to overcome these gaps and prepare the path for the successful market introduction of both advanced renewable transport fuels and electric vehicles.

Fabric Filter for small biomass boilers with a novel regeneration method

Björn Baumgarten
University of Applied Sciences Rottenburg
Schadenweilerhof 1
72108 Rottenburg, Germany
baumgarten@hs-rottenburg.de

Co-Authors: Harald Thorwarth

Climate change caused by greenhouse gas emission is one of the most pressing and most discussed challenges for society. In media, most focus is on reducing CO_2 emissions of transportation and electricity generation. However, one of the most energy consuming sectors is heating. Here, the usage of readily available biomass boilers can reduce CO_2 emissions.

Current designs of biomass boilers already reduce emissions of unburnt hydrocarbons, CO, NO_x and other pollutants to a minimum by ensuring optimal burnout of the used fuel. However, particulate matter emissions are still a challenge and the current emission limits are hardly meet. In order to reduce emissions, electrostatic precipators can offer a limited reduction of particulate emissions during stable operation of around 80%. As alternative, fabric filters can reduce particle load more drastically with an collection efficiency of up to 99,9%. Classic fabric filters made of textile are inflammable, thus are not suited for biomass combustion. Fabric filters made of a stainless steel mesh are non-inflammable, but regeneration proved to be problematic in previous works. Traditional jet-pulse cleaning and mechanical cleaning did not yield convincing results. Instead, a novel regeneration method was used.

For testing, a prototype of a filter with a surface of 1,2 m² and a maximum load of 80 m³/h was build and operated using a KWB Multifire as flue gas generator. The experiments were performed batch wise, after cleaning the filter the boiler was preheated until stable operation was ensured followed by filter testing until a pressure drop of 2000 Pa was reached. For cleaning, a novel method was used.
Wood pellets were burned to represent a best-case scenario with high quality combustion for the ultrasonic cleaning tests. PM emissions were very low before the filter (4-8 mg/m³, 13% O_2), and a collection efficiency of up to 97±2 % was measured. Cleaning was successful, even after tar formation after inducing a boiler malfunction.

In search of a continuous process, a simplified process was tested in a next step using low quality wood chips from residual forest wood. PM emissions were much higher and exceeded the legal limit in Germany with 30-70 mg/m³. According to the manufacturer, the wood chips chosen are not suitable for the boiler but were used on purpose to stimulate bad combustion. CO emissions were extremely high with up to 4000 ppm and VOC emissions up to 300 mg/m³. Collection efficiency increased to 99±1 % and regeneration was reliable. In addition to testing the regeneration, the performance of the filter was assessed. Data about the pressure drop depending on the amount of dust collected by the filter and the gas velocity was collected. While the relationship between gas velocity and pressure drop is linear, the relationship between pressure drop and dust collected is nonlinear and depends on the burned material.

In total, the results are very promising. Design of a bigger, continuous filter system using the results of the prototype filter is underway and operational tests with an 180 kW boiler are planned for the heating period of 2019/2020.

* A patent application is filed, details will be released as soon as possible

Vorstellung Projekt „Waldschutz – Klimaschutz – Moderne Holzenergie“

Martin Bentele
DEPV Deutscher Energieholz- und Pellet-Verband e.V.
Neustädtische Kirchstraße 8
10117 Berlin, Germany
bentele@depi.de

Der klimabedingte zunehmende Schadholzanfall in den deutschen Wäldern wird in den kommenden Jahren zu einem erhöhten Aufkommen von Waldresthölzern führen, die nur bedingt stofflich nutzbar sind.

In einem gemeinsamen Projekt in Bayern wollen der Deutsche Energieholz- und Pelletverband (DEPV), die Bayerischen Staatsforsten (BaySF), der Bayerische Waldbesitzerverband und der Bayerische Forstunternehmerverband für diese Hölzer einen Markt suchen und die Wärme- und KWK-Erzeugung von Holzhackschnitzeln und Pellets bei potenziellen Nutzern erhöhen.

Projektziele sind:

• Schutz der Waldlandschaften durch Waldschutzmaßnahmen (Reduzierung borkenkäfertauglichen Materials).
• Klimaschutz durch die Steigerung von Attraktivität und Nachfrage nach modernen Holzfeuerungen (Bewerbung u. Beratung bei Nutzern wie Kommunen, Dienstleistung, Gewerbe und Industrie) und dadurch Erhöhung des Einsatzes von Hackschnitzeln und Pellets.
• Qualitäts- und Professionalisierungsoffensive bei der Bereitstellung von Hackschniteln, als Voraussetzung zur Steigerung des Angebots hochwertigen Brennstoffs (Voraussetzung zur Erreichung von Ziel Nr. 2).
• Schaffung von Branchenbewusstsein und Netzwerken für Hackschnitzel.
• Erhöhung regionale Wertschöpfung durch Zubau an Feuerungen und verstärkte Nutzung der Energieholzsortimente Hackschnitzel und Pellets.

Die i.R. des Projektes geplanten Maßnahmen sind im Zuge der Diskussionen um die Intensivierung der Klimaschutzpolitik, z.B. durch CO2-Bepreisung wichtig, um Waldbesitzer und Energieholzanbieter und auch moderne Energieträger aus Holz konkurrenzfähig zu machen.
Aufgrund seines modellhaften Charakters hat dieses Projekt gute Chancen durch die Fachagentur Nachwachsende Rohstoffe (FNR) gefördert zu werden.
Gez. Martin Bentele, DEPV

Der Deutsche Energieholz- und Pellet-Verband e.V. vertritt seit 2001 die Interessen der deutschen Pellet- und Holzenergiebranche. Kessel- und Ofenhersteller, Produzenten von Pellets und weiterer Energieholzsortimente, Komponentenhersteller sowie Vertriebspartner haben sich in diesem Bundesverband organisiert.

Locally produced solid biofuels for individual space heating – CO_2 emissions and competitiveness with brown coal and heat pumps

Jiří Beranovský
CTU in Prague, FEE
Technická 2
Praha 6
16627 Czech Republic
jiri.beranovsky@fel.cvut.cz

Co-Authors: Jaroslav Knápek, Tomáš Králík, Kamila Vávrová

The paper deals with the results of research focused on the complex aspects of the use of intentionally grown biomass on agricultural land for the production of solid biofuels as an alternative for individual household heating. The study primarily deals with the analysis of CO2 emissions of the logistics cycle of biomass for the production of energy pellets. Growing, harvesting, transport and storage are evaluated in the pellet production cycle. The aim is also to take into account the consumption profile during the year in terms of heating of common family houses, which are typical end-market segment for these fuels. It is assumed that in family houses, bio-pellets are able to substitute typical fossil fuels, such as brown coal and old wood burning heating devices and also electric boilers. One of the competing technology with the pellets are heat pumps. The results show the CO2 emissions related with considered fuels and technologies for their utilization. Comparative analysis is aimed biopellets from intentionally grown biomass, brown coal, natural gas and electricity used in electric boilers and heat pumps. Analysis combines CO2 emissions related with individual fuels utilization with costs of these fuels utilization. Cost of biopellets from intetionally grown biomass is derived from the economic models of individual energy crop plantations. At the same time, the restrictions imposed by EU legislation on Ecodesign's fuel and combustion equipment requirements and NOx emissions are discussed. Preliminary results of analyzes show that to achieve the competitiveness of pellets produced from specifically grown biomass, it would be necessary to either significantly ecological tax on coal (from about 0.3 to 3-3.5 EUR / GJ), or to multiply the agricultural subsidy per area. In addition to the Czech Republic, the results are also relevant for other countries, such as Bulgaria and Poland, which also have a high proportion of solid fuels for household heating.

Maßnahmen zur Senkung sekundärseitiger Rücklauftemperaturen: Erkennen und Heben von Optimierungspotenzialen

Jakob Binder
AEE – Institut für Nachhaltige Technologien
Feldgasse 19
8200 Gleisdorf, Austria
j.binder@aee.at

Co-Authors: Harald Schrammel, Marnoch Hamilton-Jones

Eines der Hauptziele von Fern- und Nahwärmenetzen der 4. Generation ist es, die Integration von erneuerbaren Niedertemperatur-Wärmequellen zu ermöglichen. Um dieses Ziel zu erreichen, spielt die Reduktion der erforderlichen Vorlauf- und Rücklauftemperaturen in Wärmenetzen eine essentielle Rolle und hat darüber hinaus noch weitere Vorteile wie die Senkung der Netzverluste oder des Pumpstrombedarfs. Das österreichische FFG-Projekt „T2LowEx“ untersucht die technischen und wirtschaftlichen Potenziale von Umsetzungsmaßnahmen zur Senkung der kundenseitigen Rücklauftemperatur und deren Auswirkung auf Gesamtnetz.

Methodik
Gemeinsam mit vier Wärmenetzbetreibern wurden die häufigsten Fehler und Optimierungspotenziale erhoben. Diverse Methoden zur Erkennung von optimierungsbedürftigen Kunden wurden angewendet und evaluiert. Darauf basierend wurde ein Katalog von potenziellen Umsetzungsmaßnahmen erstellt (z.B. Austausch oder Spülung von Wärmetauschern, Optimierung der Regelungsstrategien, Sanierung des Heizungs- bzw. Warmwassersystems, Anpassung oder Austausch von Regelungsventilen), die bei 20 Objekten durchgeführt, messtechnisch erfasst und evaluiert wurden. Die gemessenen Effekte der Einzelmaßnahmen wurden für eine Potenzialabschätzung einer Optimierung der im Projekt vertretenen Wärmenetze herangezogen. Aus dieser gingen abschließend eine Bewertung der wirtschaftlichen Potenziale von sekundärseitigen, rücklaufsenkenden Maßnahmen für Wärmenetzbetreiber und Empfehlungen für entsprechende neue Businessmodelle hervor.

Zusammenfassung der Ergebnisse
Es wurde eine einfache Methode zur Erkennung und Bewertung von optimierungsbedürftigen Kunden definiert, die bereits mit Wärmemesszählerdaten (Energie, Volumen) auf Jahresbasis auskommt. Weiters wurde eine von Sven Werner und Henrik Gadd entwickelte Methode evaluiert, die Wärmemesszählerdaten in höherer Auflösung erfordert. Die umgesetzten Optimierungsmaßnahmen und Fehlerbehebungen ergaben eine Senkung der Rücklauftemperaturen und eine damit verbundene Erhöhung der Spreizung um 5 bis 25 °C, wobei die Höhe der Kosten für die Umsetzung nicht direkt mit der Größe des Effekts in Zusammenhang stand.

Die Ergebnisse der Potenzialabschätzung für die Gesamtnetze und die Erarbeitung von Businessmodellen auf Basis der erreichbaren Kosteneinsparung aufgrund der rücklauftemperatursenkenden Maßnahmen ist aktuell noch in Bearbeitung und sollten bis Ende 2019 vorliegen.

Laccase production and delignification from white-rot fungi in co-culture

Carla S. Cárdenas-Bustos
Product and Processes Design Group
Chemical Engineering Department
Universidad de los Andes
Bogotá, Colombia
cs.cardenas208@uniandes.edu.co

Co-Authors: Catalina Villarreal, Julián E. Prieto-Vivas, Santiago Delgado, Rocio Sierra, Juan S. Chiriví-Salomón

Laccases are enzymes capable of oxidizing phenolic compounds and play an important role in delignification processes. White-rot fungi are the main producers of these enzymes, and lignocellulosic materials can induce their expression. Hence, strategies to increase laccase production and delignification are desired. The aim of this study was to assess the laccase production and lignin degradation by co-culture of *Pleurotus ostreatus*, *Pleurotus eryngii*, *Trametes pubescens*, *Ganoderma lucidum*, and *Lentinula edodes*. We made semi-solid state cultures using lignocellulosic substrates: rice husk and sugar cane bagasse. Both laccase activity and glucose concentration from the aqueous phase were measured over 28 days. Lignin and carbohydrates content were also determined from lignocellulosic substrates. As a result, glucose profiles differ as a function of substrate, with higher concentrations in sugarcane bagasse. For both mono and co-cultures, higher activities were found in rice husk, with the exception of *P. eryngii-G. lucidum* and *P. eryngii-T. pubescens* co-cultures. The highest laccase activity was achieved by *P. ostreatus* in rice husk with a value of 21,317 U/L. On the other hand, *L. edodes* produced the lowest laccase activity in both substrates. In conclusion, rice husk demonstrated suitability as a substrate to obtain higher laccase activity than sugarcane bagasse. Finally, we expect a higher delignification in cultures that produced laccases with greater activities.

Study on the catalytic effect of gasification char for the removal of toluene in a tar cracking reactor

Eleonora Cordioli
Faculty of Science and Technology
Free University of Bolzano
Piazza Università 5
39100 Bolzano, Italy
ecordioli@unibz.it

Co-Authors: Francesco Patuzzi , Marco J. Castaldi , Marco Baratieri

Tar formation is one of the major causes hindering the development of biomass gasification technologies; tar causes corrosion, fouling, and clogging, thus damaging the gasifier downstream equipment. The use of char as a filter for removing tar has been recently investigated, because its large specific surface area, pores distribution, and surface reactivity make it a good candidate not only for adsorption applications, but also for catalytic cracking of heavy hydrocarbons. The removal of tar by means of catalytic cracking is considered to be the most efficient solution, because the energy contained in the tar is recovered and the gaseous yield of the gasification process is enhanced. Char itself is an undesired product of gasification processes; it indeed represents a significant cost for gasification plants owners who have to dispose of it, and, if not managed properly, it can represent an environmental threat as well.

The present work proposes to repurpose char collected from a local commercial gasification plant, by assessing its feasibility for tar cracking applications. The use of a by-product for enhancing the gasification process itself, would avoid the purchase and use of expensive catalysts, and would reduce the waste from the plant. This could represent both an economic and an environmental benefit, in accordance with the principles of circular economy. For inspecting its potential for tar cracking, within this study gasification char was tested for the removal of toluene, which was chosen as representative tar compound. Tests were run in a fixed-bed reactor, using as carrier gas either nitrogen or a gaseous mixture resembling producer gas (CO, H_2, CO_2, and CH_4) to observe the change in performance under different atmospheres, and the effect of temperature was also investigated by varying the furnace temperature in the range 800-950 °C. In order to evaluate the tar removal efficiency of the char, the gases yields at the reactor outlet were monitored during the tests, and the condensable products were collected and analyzed through gas chromatography techniques, in order to identify the products (e.g. benzene) of the tar cracking and quantify them. Comparison of the results with empty-reactor tests, allowed also for discerning the thermal cracking effect, due exclusively to the high temperatures involved, and the catalytic effect of the char.

An extensive characterization of the char (in terms of elemental composition, minerals and functional groups contents, specific surface area) before and after each test allowed also for a better understanding of the catalytic process and of the properties enhancing the catalytic activity of the material.

Preliminary results, showed high efficiency values and a high reactivity of char for catalytic cracking of toluene, confirming that gasification char has high potential for being re-cycled and effectively applied in operating gasification plants.

Die Rolle der Biomasse als Technologie in der zukünftigen netzgebundenen Wärmeversorgung

Stefano Coss
AEE – Institut für Nachhaltige Technologien
Thermische Energietechnologien und hybride Systeme
Feldgasse 19
8200 Gleisdorf, Austria
s.coss@aee.at

Biomasse als Brennstoff und Technologie gilt seit jeher als nachhaltiger, nachwachsender Brennstoff im heimischen Energiesystem. Die Vorteile dieser nachwachsenden Ressource gepaart mit den technologischen Fortschritten in der Verbrennungstechnik werden in Österreich sowohl in kleinen Hausanlagen als auch im mittleren und großen Maßstab zur Versorgung von mehr als 2400 kleiner und mittlerer Wärmenetze eingesetzt. Diese Wärmenetze sind eine wertvolle Infrastruktur, um bislang ungenutzte regionale erneuerbare Wärmequellen nutzbar zu machen und die Wärmewende voranzutreiben.

Dies verlangt von den Biomasse-Nahwärmeanlagen ein immer höheres Maß an Flexibilität, um unterschiedlichste regionale Wärmequellen (Solarthermie, Abwärme, Wärmepumpen) bestmöglich zentral oder dezentral einzubinden und Energiesysteme unterschiedlicher Domänen (Strom, Wärme, Gas) zu koppeln. Die Herausforderung liegt dabei im sinnvollen Zusammenspiel der einzelnen Erzeugungseinheiten und deren spezifischen Charakteristika wie etwa Temperatur- und Lastprofil. Dies geschieht meist durch den Einsatz von Wärmespeichern, Wärmepumpen sowie der Implementierung von intelligenten Regelkonzepten. Ziel ist die Optimierung der Energiegestehungskosten, die Minimierung des Fossilenergieeinsatzes und die bestmögliche Nutzung aller regional verfügbaren Wärmequellen.

ThermaFLEX ist ein Leitprojekt der Vorzeigeregion Energie, Sub-Projekt des Green Energy Labs, und hat sich u.a. zum Ziel gesetzt die Flexibilität der netzgebundene Wärmeversorgung in Österreich signifikant zu erhöhen, die Systemtemperaturen zu reduzieren und die Dekarbonisierung der großen urbanen Fernwärmesysteme nach dem Vorbild der Biomasse-Nahwärme voranzutreiben. Dies geschieht einerseits durch die Entwicklung von neuen Technologieansätzen und Systemlösungen für die dargestellten Herausforderungen aber auch durch die begleitende Implementierung und Demonstration der entwickelten Maßnahmen im großindustriellen Maßstab. Dazu sind im Projekt ThermaFLEX unter anderem zwei Biomassenahwärmenetze als Demonstratoren integriert. Zu den geplanten Umsetzungsmaßnahmen zählen der Zusammenschluss von zwei Nahwärmenetzen zur wechselweisen und bedarfsorientierten Einspeisung von Wärme aus Biomasse und Abwärme sowie zur Möglichkeit der Abschaltung eben dieser im Sommerbetrieb, der Optimierung und Integration einer Abwasserreinigungsanlage als zusätzlichen Wärmequelle, der Umsetzung kaskadischer Wärmenutzungen und Niedertemperatursystemen, der Implementierung intelligenter Regelungen und von Großwärmespeichern.

ThermaFLEX startete im November 2018 mit 4 Jahren Projektlaufzeit. Erste Konkrete Konzepte liegen bereits vor, bis Ende 2019 laufend weiterentwickelt und werden die zukünftige Rolle der Biomasse in Nahwärmenetzen sichtbar machen.

Investigation of combustion characteristics of maize stalk, rice husk, bamboo pellets and bamboo-biochars

Tobias Cremer
Hochschule für Nachhaltige Entwicklung Eberswalde
Alfred-Möller-Str. 1
16225 Eberswalde, Germany
Tobias.Cremer@hnee.de

Co-Authors: Martin Amoah, Sebastian Paczkowski

The potential of bamboo as biomass resource has motivated Ghana to establish bamboo plantations across the country. Currently, there are approximately 300,000 hectares of bamboo resources occupying 5% of the country's total forest area. Still, the properties of Ghanaian bamboo have not yet been researched and there is only little knowledge on the combustion properties of that raw material. As well, at present, there is no economic use of the stalk of the maize and the husk and the straw of the rice in Ghana and these materials are only burned in the open.

To being able to use the biomasses as effectively as possible, in this study the chemical composition, combustion characteristics and ash melting behavior of biomass samples (maize stalk, rice husk, bamboo pellets as well as two bamboo- based biochars) were analyzed.

In general, compared to bamboo pellets, bamboo charcoal and bamboo charcoal briquettes exhibited increases in energy density, lower moisture and volatile matter contents and higher thermal stability. The lowest energy density of rice husk could be attributed to its high proportion of non-combustible parts such as ash and volatile matter contents as well as low proportion of fixed carbon and lignin contents. The melting temperatures of especially rice husk and bamboo charcoal briquettes were within the range of the range of 1,300-1,400 ℃, a temperature range that is reported to be non-critical for most applications of woody biomass. Ash melting temperature of maize stalk and bamboo pellets was between 1,200-1,250 °C. The deformation and melting temperatures of all biomasses were found to relate to high concentration levels of Ca, Mg, Si, as well as Si/K and Ca/K ratios.

Higher proportions of cellulose and hemicelluloses of the biomass samples resulted in greater losses in weight whereas a higher proportion of lignin resulted in lower losses in weight. Ignitability of the studied biomass samples increased with increase in volatile matter and decrease in moisture content. FT-IR spectra showed that with the application of heat, the amounts of the functional groups such as OH, -C-H, C=O, -C=C- in the carbonized samples were found to decrease significantly.

Based on the results, it generally can be said that the production of charcoal from bamboo and other environmentally-friendly biomass sources such as maize stalk and rice husk should be considered more intensively as an attractive option for replacing conventional charcoal, especially in household use.

Advanced Fischer-Tropsch biofuels production from syngas derived from Chemical Looping Gasification: A preliminary process simulation study

Nikolaos Detsios
Centre for Research & Technology Hellas /Chemical Process and Energy Resources Institute
6th km. Charilaou-Thermis,
GR 57001 Thermi, Greece
detsios@certh.gr

Co-Authors: Konstantinos Atsonios, Panagiotis Grammelis, Paul Dieringer Christian Heinze, Jochen Ströhle

In recent decades, there has been a considerable increase in the production of greenhouse gases (GHG) worldwide with negative effects related to the climate change and its consequences. EU targets to a 20% reduction of the GHG emissions by 2020 and 40% by 2030. Taking into consideration that the transport sector contributes almost 30% of total EU greenhouse gas emissions, a major challenge to reach these goals is to increase the share of renewable energy in the nowadays highly petroleum-dependent transport sector. Biofuels have been identified as an effective strategy to reduce CO_2 emissions in transport sector. Lignocellulosic biomass conversion into liquid biofuels through thermochemical routes has been considered as a promising option that offers several advantages. The main challenge for those pathways is to develop advanced technologies with reduced energy consumption. The main advantages of chemical looping gasification (CLG) compared to the most common gasification technologies is the avoidance of an expensive and energy-consuming Air Separation Unit (ASU), the wide feedstock flexibility and the light biomass handling before gasification. This study presents the conceptual process design for the production of Fischer-Tropsch (FT) liquids from syngas derived from Chemical Looping Gasification. A process simulation analysis is performed of the overall system that consists of the CLG Gasification Unit, the Gas cleaning & Conditioning Unit the Fischer-Tropsch Synthesis & Upgrading section, as well as a combined heat and power unit. The main objective is to perform the necessary energy and mass balance calculations, to determine the appropriate process configuration of the integrated scheme and to compare with the corresponding thermochemical route based on oxygen blown CFB gasifier. The model development and the process simulations were performed with Aspen Plus™.

Acknowledgements
This work has been carried out in the framework of the European Union's Horizon 2020 research and innovation programme under grant agreement No 817841 (Chemical Looping Gasification for sustainable production of biofuels - CLARA).

Quantification of wood chip components using image recognition - a rapid and low-cost method

Dr. Elke Dietz
Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF)
Abt. 4 Forsttechnik, Betriebswirtschaft, Holz
Hans-Carl-von-Carlowitz-Platz 1
D-84345 Freising, Germany
Elke.Dietz@lwf.bayern.de

Co-authors:
Markus Riebler, David Zimmermann, Johannes Hillenbrand, Herbert Borchert

Purpose
The quality and heat value of solid biofuels like wood chips depend on their spe-cific composition of components. If wood chips contain a lot of bark or needles, combustion can be difficult or higher emission may occur. Critical elements, such as potassium (K), nu-cleus for fine dust, or chlorine (Cl) and sulfur (S) lead to corrosive damage in the heating system. They are enriched in green plant parts as needles. Heavy metals like zinc (Zn), copper (Cu) and lead (Pb) are often enriched in bark. For ash levels exceeding 1.5 w-%, according to DIN EN ISO 17225-4, element contents of wood chips are relevant for quality and combustion. At present, the quantification of wood chip components, such as bark, wood and needles is technically intensive, time-consuming and insufficient. Hence, a rapid determination method using image recognition was developed.

Approach
Three case studies were carried out using wood chips from energy round wood and forest residues. Under defined conditions, pictures were taken from the wood chip samples. To detect the variation of the sample, repeatability was tested photographing each sample five times. Perspective distortion must be excluded, therefore each picture was checked. After that, image recognition was performed using GIS-applications (Arc View 10) such as image processing and raster classification by training areas. Following up to the image classification, the quantification of components was performed by zonal statistics for each image. In a second step, image recognition was optimized lowering shadow ef-fects. Furthermore, the entire process was also performed with dried wood chips of energy round wood.

Results
The quantification of wood chip components from both assortments, energy round wood and frost residues, show good reproducibility of the results. The determination of components as wood, bark and needles is nearly entire, even little wood or bark splitters can be detected. Each of the five pictures was processed and the results of the amounts were averaged. As a result, fresh wood chips from energy round wood contain 77.1 ± 1.3 vol-% wood particles and 22.9 ± 1.3 vol-% bark particles. Wood chips from forest residues showed 51.0 ±1.1 vol-% wood, 37.5 ± 1.5 vol-% bark particles and 11.0 ± 0.8 vol-% nee-dles. The third sample, dried energy round wood, showed 88.1 ± 0.9 vol-% wood and 11.9 ± 0.1 vol-% bark particles.

Conclusions and Outlook
First results suggest that image recognition of wood chips is a promising approach for rapid and even low-cost determination and quantification of wood chip components. To verify the results separating the components manually and determin-ing their masses is intended.

Biomass feedstock flows in the Danube region

DI Dr. Christa Dißauer
BIOENERGY 2020+ GmbH
Gewerbepark Haag 3
3250 Wieselburg-Land, Austria
Christa.dissauer@best-research.eu

Co-Author: Christoph Strasser

Background
A large amount of biomass is available along the Danube with the potential to improve energy security and foster sustainable energy production. Due to its fertile soil and vast forests, the Danube region is one of Europe's major areas for biomass production and still has untapped potential for bioenergy generation. Additionally, with the bioeconomy gaining momentum all over Europe, another growth market opens up for both the Danube region's biomass value and supply chains as well as for Danube logistics. Currently, biomass is mainly processed locally due to a lack of secure, efficient and environmentally-friendly logistic solutions. The project ENERGY BARGE (1) of the Danube Transnational Programme built up synergies between the bioenergy industry and the Danube logistics sector. For this purpose ENERGY BARGE analysed requirements regarding transport, handling and storage of the biomass feedstock, identified promising biomass products for inland waterway transports, initiated concrete transports via Danube through B2B events and implemented pilot actions in selected Danube ports. In addition, the ENERGY BARGE modal shift platform supports key actors and stakeholders from the bioenergy industry in the Danube region: https://energy-barge.eu

Biomass trade in the Danube region
Internationally traded solid biomass volumes are growing rapidly. However, the refined solid and liquid biofuel markets still have a long way to go before they reach the level of agricultural biomass used for feed and food as well as fossil fuels. In Bulgaria, Croatia, Germany, Hungary and Romania mainly agricultural biomass commodities such as crops (wheat, meslin, maize) are traded. In contrast, woody biomass is the main share of traded biomass in Austria and Slovakia. In the respective countries, most of the total agricultural biomass supply is used for feed and food production, only a very small part is used for bioenergy production. About the half of the total woody biomass supply is used for the production of bio-materials, the other half is used for bioenergy production. Austria, Germany and Croatia also import as well as export relevant amounts of biodiesel and mixtures thereof. While Austria and Germany are the two countries most relying on import, Bulgaria and Slovakia are classic exporting countries. Interestingly, although the export numbers include all types of biomass, these two countries are also the ones with the lowest application rate in per cent of biomass for bioenergy.

Transport on the Danube – a logistics option for the bioenergy and bioeconomy sector
Biomass trade flows barely include residue material, mainly due to a limited transport worthiness in terms of physical and economic characteristics. Hence, especially the first process step from residue material to a bioenergy carrier product, e.g. pellet, should be taking place decentral, only the intermediary or final products are suitable for long distance transports, which also increases value creation in rural areas.

Since inland waterway transport offers the best transport capacity per unit transported, it is a highly suitable transport mode for bio-based products. Additionally, the capacity to transport large volumes of goods on long distances (bulk freight capacity) results in comparatively low transport costs especially for bulk cargo. Another advantage stems from the overall positive environmental performance of inland navigation. With regard to specific energy use, it can be described as the most effective and most environmentally friendly mode of transport, since an inland vessel is able to transport one ton of cargo around four times further than a truck using the same amount of energy. Moreover, external costs, i.e. costs caused by pollution or noise emissions are lowest for inland navigation when compared to road, air and rail transport. Especially regarding CO_2 emissions, inland waterway transport outperforms the other transport modes.

(1)Programme co-funded by European Union funds (ERDF, IPA, ENI)

Nachhaltigkeit – Die gute fachliche Praxis jetzt auch zertifiziert – Die Umsetzung der Nachhaltigkeitsanforderungen der RED II in nationales Recht

Florens H. Dittrich
Bundesverband Bioenergie e.V.
Invalidenstraße 91
10115 Berlin, Germany
dittrich@bioenergie.de

Sachverhalt
Mit der Annahme der Richtlinie (EU) 2018/2001 (Erneuerbare Energien Richtlinie - RED II), wurde die Notwendigkeit der Nachhaltigkeitszertifizierung von Biokraftstoffen auf sämtliche Bioenergieträger ausgeweitet. Somit werden ab 2021 nicht nur alle Biokraftstoffhersteller die Nachhaltigkeit und Treibhausgasminderungspotentiale ihrer Produkte gewährleisten und nachweisen müssen, sondern auch alle Anlagenbetreiber, die feste Biomassebrennstoffe in einer Anlage mit einer Gesamtfeuerungswärmeleistung von über 20MW verfeuern sowie gasförmige Biobrennstoffe in Biomasseanlagen mit einer Gesamtfeuerungswärmeleistung von mehr als 2MW.

Stellungnahme
Die Entwicklung und Umsetzung der Zertifizierung erweist sich als Herausforderung, da die Vorgaben der Richtlinie sehr allgemein gehalten sind und konkrete Vorgaben erst im Laufe dieses Jahres von der Kommission veröffentlicht werden sollen. Zudem sind die Absatzwege der Bioenergieprodukte divers und nicht zentral über Ordnungsrecht reglementiert. Weiterhin lassen Stichtagsregelungen, unterschiedliche forstliche und landwirtschaftliche Praktiken und Definitionen von Biodiversität und Schutzflächen der Richtlinie einen weiten Interpretationsspielraum zu. Ziel der Branche ist es ein System zu entwickeln, das zum einen Richtlinienkonform die tatsächlich erbrachte nachhaltige und klimaschützende Biomassenutzung dokumentiert, auf der anderen Seite der bewährten Wertschöpfungskette durch überm..ige bürokratische Anforderungen keine Steine in den Weg rollt.

Vorschlag
In dem Vortrag werden die Herausforderungen der Vorgaben sowie der Prozess der Umsetzung der RED II in nationales Recht (deutsches Recht – mit Überblick in andere Mitgliedsstaaten zum Stand der dortigen Umsetzung) dargelegt. Der Vortrag bietet ein umfassendes Prozessbild sowie eine Darstellung praktischer Ansätze und Lösungsoptionen für alle Anlagenbetreiber von Bioenergieanlagen sowie deren Lieferanten und Urproduktion aus Forst und Landwirtschaft.

Der Bundesverband Bioenergie e.V. (BBE) ist der Dachverband des bundesdeutschen Bioenergiemarktes. Im BBE sind die Marktakteure entlang der gesamten Wertschöpfungskette des biogenen Strom-, Wärme- und Kraftstoffmarktes organisiert: vom Biomasseanbau und ihrer Bereitstellung über den Maschinen- und Anlagenbau, bis hin zu der Planung und dem Betrieb von Bioenergieanlagen in den unterschiedlichen Sektoren.

Possibilities for production and utilization of corn cob pellets as a fuel for rural residential heating

Djordje Djatkov
University of Novi Sad
Faculty of Technical Sciences-Department of Environmental Engineering
Novi Sad, Serbia
djordjedjatkov@uns.ac.rs;

Co-Authors: Miodrag Viskovic, Milan Martinov

Currently, wood is commonly used as a raw material for fuel pellets. However, there are regions where wood is scarce or with insufficient quantities to cover the existing market for pellets. This is true for rural areas with intensive agriculture, where agricultural by-products, *i.e.* herbaceous biomass or crop residues, are used due to high availability and partially lower costs in comparison to wood and fossil fuels. Corn is one of the most widely grown field crops worldwide, so corn harvest residues have significant potential for energy generation. By applying diverse harvesting procedures, beside corn stover that subsumes the aboveground residual biomass, solely corn cobs could be collected. Traditionally, whole corn cobs have been used as a fuel for residential heating in rural areas, which is unfortunately followed by low efficiencies and high airborne emissions, due to combustion in simple heat appliances. Corn cobs in the form of pellets could have potentially multiple advantages comparing with the whole corn cobs. Fuel composition is homogeneous, moisture content is reduced (increased heating value), blending with other biomasses or admixing with additives (pressing aids and slagging inhibitors) is possible to improve pellet properties. Next, automation of stoking is enabled, leading to increased comfort for the user, higher conversion efficiencies and lower airborne emissions. All these aspects were background and motivation for the conducted investigation.

In this investigation, it was determined how and to what extent various parameters influence the key mechanical-physical properties of fuel pellets made from corn cobs. The parameters varied included particle size and the moisture content of raw material, the shares of wood and additives, and pressing intensity. The investigated key pellet properties were bulk density and mechanical durability.

The obtained results are the following. Corn cob pellets had bulk densities of 547.7 - 719.5 kg/m^3, a mechanical durability of 88.0 - 98.8 %, and pellet yields of 98.2 - 100.0 %. Particle size and pressing intensity showed a very strong significance ($p < 0.001$). Thresholds values defined in standard ISO 17225-6 were achieved by either raising the extrusion ratio to 4 or reducing the particle size using sieve mesh size larger than the pellet press die openings. Corn cobs show good abilities as a raw material for pelletizing. In order to obtain quality pellets, effective measures are variation of particle size and pressing intensity.

Profitability assessment of investment in heating facilities that use corn cobs as a fuel, will be conducted by application of the calculator and decision-making tool named *BiomasaPro*. *BiomasaPro*, developed within previous research activities at the Faculty of Technical Sciences Novi Sad, is intended for planning and construction of biomass combustion appliances. For the assessment, all data about potential costs and savings achieved through usage of corn cob pellets as a fuel will be considered. The profitability will be assessed based on: Net Present Value (*NPV*), Internal Rate of Return (*IRR*) and Payback Period (*PBP*).

Mitigation of particulate matter emissions from the combustion of corn cobs in a small scale multi-fuel boiler

Natasa Dragutinovic
Institute of Environmental Technology and Energy Economics
Technical University of Hamburg
Eißendorferstraße 40
Hamburg, Germany
natasa.dragutinovic@tuhh.de

Co-Author: Martin Kaltschmitt

Combustion of low-cost, abundant, local crop residues for energy production could increase sustainable energy independency of agricultural regions and facilitate their transition to renewable energy sources. Due to challenging fuel properties of crop residues such as higher ash, alkali, P, N, S, and Cl contents, their thermochemical utilization results in increased pollutant emissions and is associated with ash-related problems. In addition, the combustion of crop residues in conventional combustion units constructed for solid fuels such as log wood and coal is in most cases inefficient, if not unfeasible. High ash content and specific ash melting behaviour of crop residues require active ash removal systems and / or moving (cooled) grates to avoid ash sintering and combustion air blockages. Moreover, the control system has to be adjusted to crop residue fuel properties such as lower heating value in comparison to woody biomass.

Conditioning of solid biogenic fuels e.g. through pelletizing could mitigate particulate matter emissions as well as improve combustion efficiency. Pelletizing improves mechanical properties (durability, bulk density, fine content) of the fuel, enabling better transport and storage, as well as utilization in automated fuel-feeding units (which enable better process control and continuous stabile operation). Pellets are produced with the goal of meeting the quality requirements according to the ISO 17225-6 (non-woody pellets).

In order to decrease negative environmental impact and increase energy efficiency of the crop residue combustion in small and medium sized units without secondary flue gas treatment, the aim of this research topic is to investigate the effect of pelletizing on the particulate matter emissions and ash melting behaviour during the combustion of corn cobs in a small scale multi-fuel boiler, during full and partial load conditions. The influence of pelletizing on the particulate matter (PM) and carbon-monoxide (CO) emissions from combustion of corn cobs has been experimentally investigated in a multi-fuel 25 kW boiler with a moving grate and automatic de-ashing system. Gaseous emissions have been continuously monitored using a gas analyser, whereas total particulate matter emission has been discontinuously measured according to VDI 2066-1. Results have shown that pelletizing process influences PM emissions.

The influence of alkaline additives on the microbial degradation of woodchips – a preliminary study

Sabrina Dumfort
Management Center Innsbruck
Maximilianstrasse 2
6020 Innsbruck, Austria
sabrina.dumfort@mci.edu

Co-Authors: Ljubica Begovic, Judith Ascher-Jenull, Heribert Insam

Storage of woodchips for energy production is a necessary step in the biomass supply chain. However, difficulties such as self-heating as well as dry matter losses occur due to wood degrading microorganism. Even though this is not a new concern further studies are necessary to fully understand underlying processes, quantify dry matter losses as well as finding possible counteractions. According to the state of the art, during the storage of woodchips temperatures of up to 80 °C and dry matter losses of 10 to 40 % can be reached leading to health risks and economic losses for district heating plants. Primary factors influencing the degradation rate are the temperature, moisture content and oxygen availability. Also, pH and nutrient availability are the main microbial growth factors either promoting or inhibiting their growth. At present, drying the biomass to a moisture content of below 30 % (wet weight basis) is the only established counteraction inhibiting fungal growth but is a very energy and therefore cost-intensive method.

This study focuses on the inhibition of wood-decaying microorganism by increasing wood pH from an acidic to an alkaline environment. Calciumcarbonate ($CaCO_3$) as well as calciumhydroxide ($Ca(OH)_2$) were investigated as potential additives for this purpose. Besides their potential to inhibit bacterial and fungal growth, these additives are of great interest in the field of biomass gasification since they could support tar conversion as well as avoiding ash melting.

For this purpose fresh spruce and poplar woodchips were mixed with 1, 2 and 4 %-m additive (on a dry weight basis) and the microbial activity was measured with a multi-sample soil respiration system (ADC BioScienific Ltd.). Respiratory tests are used to record the metabolic activity of microorganism by quantifying produced carbon dioxide (CO_2) during the degradation of various substrates that are in the present case hemicellulose, cellulose and lignin of the woody biomass. Experiments were conducted for 21 days under aerobic and mesophilic (21 °C) conditions. Since the chemical composition of heartwood, bark and needles/leaves varies greatly and influences the microbial activity to a significant amount, these components were investigated separately for spruce woodchips.

Measuring the pH of all wood fractions revealed an acidic environment with a pH of 6.3 to 6.5. The addition of $CaCO_3$ enhanced pH of up to 8.3 (1 %-m), 8.6 (2 %-m) and 8.6 (4 %-m). Even though pH could be enhanced significantly, different microorganisms are still able to cope with this environment showing a high CO_2 production rate thus a high metabolic activity. Only the bark and needle fractions of spruce woodchips showed a significant reduction with the addition of $CaCO_3$ however to a rather small degree. The addition of $Ca(OH)_2$ led to an increase of pH of up to 11.1 (1 %-m), 11.6 (2 %-m) and 12.1 (4 %-m). This strong alkaline environment inhibits the growth of different microorganism leading to a lower metabolic activity. These findings illustrate the potential of alkaline additives as a possible counteraction against dry matter losses of forest residues and might also help in reducing health risks due to fungal spores that are produced during the storage process. However, this is a preliminary study investigating the potential of alkaline additives under laboratory conditions. Further experiments have to be conducted under more realistic test conditions especially regarding the woodchip amount and test temperature. During storage temperatures of up to 60 °C are reached within the woodchip piles thus different microbial processes take place and higher dry matter losses are reached. Additionally, storage tests in industrial scale (250 m3) will be conducted.

Furfural production using sugarcane biomass hemicellulosic hydrolysate: Process Simulation

Kelly Johana Dussán
Department of Biochemistry and Chemical Technology
Institute of Chemistry, Sao Paulo State University-UNESP
Araraquara 14801309, Brazil
kelly.medina@unesp.br

Co-Authors: Giuliano Formaggio de Mello, Thais Kuriki Kovacs, Miquéias Gomes dos Santos, Débora Danielle Virgínio da Silva, Maria Angélica Martins Costa

Furfural is a furanic aldehyde obtained from the acid treatment of pentoses found in lignocellulosic material. It has excellent physical and chemical properties that allow its application in the generation of fertilizers, antacids, plastics, paints, fungicides, among many others, besides having important derivatives for the chemical industry, such as furfuryl alcohol and tetrahydrofuran. The production potential of this compound in Brazil is enormous, since the country is the world's largest producer of sugarcane and the surplus bagasse of this activity is a source of lignocellulosic biomass. However, the low yield observed in the existing methods to obtain furfural and the high energy requirement in the process do not allow it to be supplied at a competitive market price. Therefore, the need to optimize the process to improve the conditions that affect the final product price is undeniable. One of the most used tools in the optimization of chemical processes is the simulation. The objective of this study was to simulate the production of furfural from sugarcane biomass in Aspen Plus® under two conditions: in the first, pre-treatment and reaction occur separately (case 1); in the second, both occur in the same equipment (case 2). An initial flow of 166,67 ton/h of biomass was used, leading to the yield of 15,43 ton/h of furfural in case 1, with an energy requirement of around 65 MJ per kg of pure product obtained, and 22,25 ton/h of furfural in case 2, with a requirement of around 400 MJ per kg of product. The results lead to the conclusion that the production in two stages is more energetically viable, but both routes present an exaggerated energy consumption, which can make the processes unfeasible. Thus, the energy integration of the process streams was made using the Aspen Energy Analyzer tool, obtaining a thermal exchange network for each case, with energy savings of approximately 85% in case 1 and 67% in case 2. Furthermore, the integration of furfural production to the second-generation ethanol production chain could give sustainability to the process, favoring the full use of biomass, with the generation of higher value-added bioproduct.

Analysis of The Digestate Biomass Combustion Process

Krzysztof Dziedzic
BESKID ŻYWIEC Sp. z o.o.
Research and Development Department
Kabaty 2
34-300 Żywiec, Poland
dziedzickrzysiek@poczta.fm

Co-Author: Bogusława Łapczyńska-Kordon

The paper presents an experimental and numerical (based on the mathematical model) analysis of the mechanism and kinetics of waste biomass combustion. The research material comprised four types of digestates from biogas production, obtained by methane fermentation of a mixture of apple pomace and corn silage with different percentages of individual components. The physical and chemical properties of the material under investigation were determined. The thermal decomposition of the test material was analyzed using standard thermogravimetric (TG) and Differential Scanning Calorimetry (DSC) techniques. In addition, a new method of thermal analysis was proposed be using computerized thermal analysis.

The research has made it possible to formulate the kinetics model of particle combustion in two stages in the solid phase: first - drying particles and the second - degassing and char combustion. The structure of the model was derived from the laws of heat and mass exchange and process thermodynamics and described by differential equations along with corresponding boundary conditions (condition of the first kind - for mass diffusion equation, condition of second kind - equation describing temperature distribution in particle). The method of elemental volume was used to solve the model, simulations were performed in the Excel environment by the km3r method. The model was verified with regard to the logical course of changes in temperature and weight in relation to the laws of science and validated by the experiments of particle combustion in the laboratory.

GrateAdvance - Advanced adjustable grate solutions for future fuel flexible biomass combustion technologies

Sabine Feldmeier
BEST Bioenergy and Sustainable Technologies GmbH
Gewerbepark Haag 3
3250 Wieselburg, Austria
Sabine.Feldmeier@best-research.eu

Co-Authors: Elisabeth Wopienka, Markus Schwarz; Ramin Mehrabian, Andrés Anca-Couce, Thomas Nussbaumer, Gabriel Barroso, Marcus Öhman, Christoffer Boman

The GrateAdvance project deals with the development of future combustion appliances that can be operated with different types and qualities of biomass fuels, and ensure low emissions and high operational security regarding slag handling at the same time. The further development of a particular combustion technology – the Screw Burner – was the next step. Key project work and main results of the project were:

- Single pellet tests were conducted with poplar, wheat straw, grass and grain mill residues, to investigate the effect of different combustion conditions (different process temperatures, oxidizing and reducing atmospheres) on ash release and ash transformation and combustion tests were conducted for validation utilizing the same fuels.
- Combustion tests in a 20 kW underfed residential burner were performed with these fuels, to validate the combustion behavior with special regards to ash transformations, slag formation and emissions of gases and particulate matter.
- Reaction schemes were developed to describe the release of tars, NOx precursors (NH3 and HCN) and ash-forming elements (e.g. potassium) during conversion of different biomass fuels. These reactor schemes were incorporated into a single particle model and validated with experimental results. They were finally employed to describe the bed release in the novel screw burner technology.
- Simulation tools were applied to study several details of the screw burner technology. It was feasible to predict the particle movement by applying the Discrete Element Model and by modelling the gas-solid multiphase flows (Euler-Granular based on kinetic theory). Simulation results regarding as grate geometry, effect of air routing on temperature range and formation of CO and NOx emissions contributed to the design and construction process of the 35 kW prototype.
- A wide range of test fuels (e.g. miscanthus, willow, bamboo, grain mill residues, corn husks, olive stone groats, maize) was utilized in the 35 kW prototype. The ash content of the fuels varied between 0.4 and 7.9 wt.%. Despite the poor quality of some of the fuels, stable combustion conditions were achieved with CO emissions below the limit value of 500 mg/MJ for standardized fuels. Only fuels with a very high content of nitrogen (> 1 wt.%) resulted in NOx emissions exceeding the emission limit value of 300 mg/MJ. Further, most of the test fuels caused PM emissions higher than the limit value of 35 mg/MJ.
- The basic concept for future fuel-flexible operation was developed and parameter settings for different fuel types were identified during the practical tests. We implemented the control concept in the 150 kW prototype.
- We developed a methodology to derive the scale-up concept for the large Screw Burner prototype (150 kW) based on the small one (35 kW). The scale-up methodology was validated by CFD simulations to investigate the predicted pollutant emissions and the pressure loss. Combustion tests with the 150 kW prototype will be finalized by end of 2019.
- In addition, the dimensioning for the integration of an electrostatic precipitator (ESP) in the 150 kW prototype was performed to reduce PM emissions and meet the emission limit value.

The combination of scientific and technical experiences within the project enabled a valuable exchange of knowledge and methods. In addition, by sharing cross-national results – i.e. lab-scale analytics on ash transformation, advanced CFD simulation tools, specific solid fuel conversion models, a laser laboratory for Particle Image Velocimetry – we ensured a good data quality. Furthermore, combustion tests were conducted in all countries for validation.
The research has received funding from the Austrian Research Promotion Agency (FFG) within the 9th ERA-NET Bioenergy Joint Call: Bioenergy Concepts, the Swiss Federal Office for Energy (SFOE), and the Swedish Energy Agency (SEA).

Co-location of industries in Biomass Power Plants. Towards a Circular Economy. Project presentation

Lucía Roca Fernández-Vizarra
Chief Operation Officer in Gestamp Biomass
CEO in Gestamp Biomass
c/ Ombú, 6 10th floor
28045 Madrid, Spain
lucia.roca@gestampren.com

Co-Author: Emilio López Carmona

Aim and approach used
The aim of the study and initiatives carried out by Gestamp Biomass was to achieve a more efficient use of the resources and favor feasibility of Biomass Power Plants (4 to 75 MWe) in difficult economic environments (with low feed in tariffs or expensive fuels or O&M costs).

Scientific innovation and relevance
Developing and integrated industrial approach is the key to achieve a successful model. Only through an innovative approach that combines technical and economical knowledge it is possible to align the interests of different stakeholders to materialize a circular economy concept. Our business model has achieved a win-win solution for all involved participants after an intense work of research and interest alignment.

Innovation is not on the processes by themselves, widely known, but on the business approach linking them into a single multi-stakeholder cycle. Innovation can also be found in the potential eco-labelling (new to the market) of products produced through this approach.

This approach is of the outmost relevance as it sets a the path for the future, implementing for the first time theoretical approaches into an existing Biomass Power Plant and may lead to change Policies and the Best Practices in the Sector.

Results or preliminary results and conclusions
An innovative integrated approach focused on Circular Economy was carried out with the result of the integration of four of the above different industries by linking their industrial processes: Greenhouse, CO_2 capture and cleaning plant, a Fertilizer Plant and the Biomass Power Plant (15 MWe).

The overall result is a win-win situation for all involved parties who can not only reduce their supply costs but also benefit of significant synergies in terms of operational costs, efficient use of resources and infrastructures. In addition there is a positive net reduction of CO_2 emissions to the atmosphere and an increase of overall efficiency. Raising awareness of the multiple positive contributions and opportunities still to be developed around biomass power plants is one of the missions of this contribution.

This project is, as per May 2019, pending on a LIFE grant approval.

Gegenüberstellung der Energieeffizienz von Biomasseanlagen mit Abgaskondensator bei verschiedenen Betriebsbedingungen

Morteza Fesharaki
Herz Energietechnik GmbH
Herzstraße 1
7423 Pinkafeld, Austria
Office-energie@herz.eu

Da die Verwendung von Abgaskondensatoren zur Brennwertnutzung, im Vergleich zu Heizwert-Abgaswärmetauschern, sowie Generell der Einsatz von Brennwerttechnik bei Hackgutanlagen im Vergleich zu Pelletanlagen sehr selten ist hat die Fa. HERZ Energietechnik GmbH beschlossen einen serienreifen Abgaswärmetauscher zu entwickeln, welcher individuell an Anlagen von 100-500kW angeschlossen werden kann. Dieser nachgeschaltene Abgaskondensator soll das Rauchgas vom Hackgutkesseln bis unter den Kondensationspunkt abkühlen und es zusätzlich ermöglichen mind. 50% der noch bestehenden latenten Wärme nutzen zu können. Das Konzept basiert auf den bewährten Systemen der Herz Wärmetauscher von Industrieanlagen. Durch die Nutzung der Kombination von Turbulenter Strömung und Spaltströmung ist es gelungen die Wärmetauscherfläche um 20% im Vergleich zu herkömmlichen Wärmetauschern zu reduzieren. Nach Umfangreichen Materialuntersuchungen mit verschiedenen Abgaszusammensetzungen wurde der entsprechend passende Edelstahl ausgewählt. Das Ergebnis der Entwicklungsarbeit zeigte, dass es gelungen ist bei einer System-Rücklauftemperatur von 60°C die Abgastemperatur konstant auf 65°C zu halten.

Da es gelungen ist die Anlage sowohl im Voll als auch im Teillastbetrieb kondensierend zu betreiben, arbeitet der Wärmetauscher gleichzeitig auch ähnlich eines Rauchgaswäschers. Um die Reisezeit zu erhöhen, wurde zusätzlich eine Wasser-Einspritzung im Warmzustand des Abgases eingebaut. Dadurch ist es nicht erforderlich einen Abgasbypass zu installieren. Vom Prinzip her eine ähnliche Reinigung-Technologie wie es auch bei Müllverbrennungsanlagen angewendet wird. Durch diese Anwendung kann die Staubbelastung im Abgas um bis zu 90% reduziert werden. Die Firma Herz Energietechnik hat bereits 15 Anlagen am Feld wodurch ausgesuchte Ergebnisse vorgestellt werden können. Messungen haben ergeben, dass der thermische Wirkungsgrad bis zu 20% höher ist, bzw. der Materialverbrauch um 20% gesunken ist.

Methodological framework for evaluating environmental and socio-economic impacts of short rotation coppice-based value chains.

Daniela Fürtner
Wood K plus – Kompetenzzentrum Holz GmbH
Team Market Analysis and Innovation Research
Altenbergerstraße 69
4040 Linz, Austria
d.fuertner@wood-kplus.at

Co-Authors: Enrique Alejandro Perdomo, Lea Maria Ranacher, Peter Schwarzbauer, Franziska Hesser

The increasing importance of bio-based materials has surged as an option to counter the negative impacts of using non-renewable resources. Nonetheless, the production of bio-based material has also lead to several issues regarding land use and land use change such as the food vs. fuel debate. Using underutilized, marginal land to plant fast growing poplars for short-rotation-coppice (SRC) is a promising approach for the sustainable production of biomass for bio-based products. The establishment of these new, sustainable value chains aims for economic and social benefits as well as the lowest possible environmental impact. Therefore environmental and socio-economic impact assessment makes it possible to identify and optimize such consequences, thus providing valuable information for stakeholders and policy makers. Within the EU Horizon 2020 BBI-JU project „Dendromass 4 Europe“ (D4EU - https://www.dendromass4europe.eu) four new value chains from poplar wood and bark, from short rotation plantations in Slovakia, are developed. The aim of this study is to establish an environmental system analysis, following the approach of Life Cycle Assessment (ISO 14040 series, ILCD Handbook), and a socio-economic assessment of the impacts of this four new bio-based materials in parallel to value chain creation and R&D advancements. In a first step, the value chain is mapped in order to obtain a detailed overview of the running processes. This information about single steps in the production processes allow to identify stakeholders involved and relevant, influencing indicators can get assigned. Consequently, in order to address the equal relevance of environmental and socio-economic impacts, the concept of eco-efficiency as a benchmark is considered. Eco-efficiency provides remarks on the price competitiveness of a product, the satisfaction of human needs and ecological impact, to scope system improvement.

Every activity along the value chain causes interlinked socio-economic and environmental impacts. Nevertheless, there is no established integrative approach to evaluate the production value chain in connection with short-rotation biomass production. This study will critically review methodologies and applied practices, in order to select a suitable methodological framework for analyzing and integrating both matters. In order to find a suitable solution, it is important to take a detailed view of the value chain („from cradle to grave“) and its processes, in this way it is possible to develop a base to obtain comparable propositions. The overall process, from field growth, bio-based material production, use phase and end-of-life phase, is considered; the environmental analysis contemplates mainly the Life Cycle Analysis methodology. By studying comparable socio-economic and environmental indicators, competent guidance to relevant stakeholders is possible. Moreover, as the work is carried out in the course of R&D activities, a modifiable approach can be created with the help of sensitivity analysis. As a preliminary result, it is possible to present a suitable socio-economic and environmental assessment framework for analyzing SRP. The framework serves as a scientifically-based guide to the further develop each in-depth analysis, considering their interlinkages and thus investigating the sustainability of SRC-based bio-materials.

This study received funding from the Bio Based Industries Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 745874 Biobased Solutions.

Options for an efficient usage of solid biofuels in decarbonized heating grids

Heike Gebhardt
Deutsches Biomasseforschungszentrum (DBFZ)
Department Thermo-chemical Conversion
Torgauer Straße 116
04347 Leipzig, Germany
heike.gebhardt@dbfz.de

The current energy system, still dominated by fossil fuels, has to be transformed to renewable technologies until 2030/2050 in order to reduce their environmental impacts and create sustainable overall energy systems. District heating grids provide several options to integrate fluctuating renewable energy sources as well as surplus heat from sewage and industrial processes. However, the transformation of existing heating grids into renewable based grids brings both options and challenges. Since every district heating system is unique, there is no general concept for the transformation.

In September 2019 a collaborative research project with DBFZ, TU Dresden and Biomass Institute Ansbach will start. The project aims to develop an optimization software associated with pre- and post-processing that supports district heating network operators in their planning of the decarbonization process. The optimization software will be a further development of "FreeOpt", which had been released by the TU Dresden. During the pre-processing, the operator analyses the current district heating network, demand, supply technologies and the potential for the integration of renewable heat sources. The result of the pre-processing is an individual set of several different combinations of usable heat sources, storages and operating options, which can be implemented in the optimization tool. Depending on the preferences of the user, the software optimizes the variants regarding heat generation costs, operating cost, primary energy demand or greenhouse gas emissions. In addition, fuzzy boundary conditions, such as demographic transition and state of renovation are taken into account.

Furthermore, a district heating network model will be set up with the SimulationX-software to determine the technical limitations of implementation of the drawn up variants. To verify the performance of the developed optimizer, the results will be compared to those of other available software. Additionally the technical feasibility of the recommended dimensions and combinations will be controlled within the SimulationX model. The advising group of operators will also assess the evaluation of the handling and operability as well as the way of presentation and evaluation of the results, the software.

At the beginning of the project, an extensive research of the current technologies in terms of need of space, environmental impacts, valid laws, investment costs, technical specifications and the overall potential will be done. In order to focus on significant technologies and cover the real-life expectations, a group of district heating network operators was already consulted. Based on the research results, the method of the pre-processing will be developed and presentable until the end of 2019. The method contains the determination of the boundary conditions of the optimization tool and all needed operating numbers from the district heating network as well as an approach to create the set of transformation variants.

Additivierung als brennstoffseitige Maßnahmen zur Minderung von Feinstaubemissionen für Holzhackschnitzelfeuerungen im unteren Leistungsbereich

Christian Gollmer
Technische Universität Hamburg
Institut für Umwelttechnik und Energiewirtschaft
Eissendorfer Strasse 40
21073 Hamburg, Germany
christian.gollmer@tuhh.de

Co-Author: Martin Kaltschmitt

Die vollständige thermochemische Umwandlung von biogenen Festbrennstoffen (z. B. Holzhackschnitzel/-gut) bedingt die unumgängliche Freisetzung von (anorganischen) Feinstaubemissionen insbesondere bei der Nutzung von Feuerungsanlagen im niedrigen bis mittleren Leistungsbereich. Infolgedessen kann es gerade in urbanen bzw. dichtbesiedelten Regionen in Abhängigkeit der Anlagendichte bzw. des Nutzungsverhaltens der Anwender zu deutlichen Überschreitungen der zulässigen Grenzwerte für Feinstaubemissionen in der Umgebungsluft kommen. In diesem Kontext zeigt der Einsatz sogenannter Additive ein vielversprechendes, brennstoffseitiges Lösungskonzept auf, welches zu einer temperaturstabilen Einbindung der feinstaubbildenden Elemente in der Asche führt. Auf diese Weise lässt sich eine merkliche Reduktion der messbaren Feinstaubemissionen während der Verbrennung von bspw. Holzhackschnitzeln/-gut erzielen. Herausforderungen sind hierbei u. a. die Auswahl und Dosierung geeigneter Additive infolge ggf. variierender Brennstoffe bzw. Brennstoffqualitäten, die technische bzw. konstruktive Umsetzung der Additivzuführung sowie die derzeitigen gesetzlichen bzw. rechtlichen Rahmenbedingungen.

Ausgehend von der zuvor skizzierten Problemstellung soll eine labortechnische Routine vorgestellt werden, welche die Charakterisierung bzw. Auswahl verschiedener, potentiell geeigneter Additive für den Einsatz zur Minderung der Feinstaubemissionen in einer realen Kleinfeuerungsanlage (bspw. Holzhackschnitzel/-gut) erlaubt. Anhand unterschiedlicher Beurteilungskriterien lässt sich mittels dieser Routine eine Bewertung der analysierten Additive vornehmen; d. h. unter den untersuchten Additiven lassen sich ein bzw. ggf. mehrere Additive identifizieren, welche vielversprechende Eigenschaften hinsichtlich ihrer Minderungswirkung auf die Feinstaubemissionen bei der Verbrennung von Holzhackschnitzel/-gut aufweisen.

Neben der Identifizierung potentiell geeigneter Additive gilt es darüber hinaus die Zuführung bzw. Einbringung der Additive in bestehende und/oder neue Anlagenkonzepte zu realisieren. Die hierbei verfolgten Lösungsansätze setzen eine ausreichende Mischbarkeit von Additiv und Brennstoff (z. B. Holzhackschnitzel/-gut) bzw. ein akzeptables Anhaftungsverhalten der Additive auf der Oberfläche des Brennstoffes voraus. Zu diesem Zweck werden verschiedene Untersuchungsergebnisse in Abhängigkeit der Additiv- sowie Brennstoffeigenschaften vorgestellt. Die dargestellten Ergebnisse weisen dabei auf gute Voraussetzungen hinsichtlich der Additivierbarkeit von Holzhackschnitzeln/-gut hin, wodurch sich ein hohes Potenzial bzgl. der möglichen Umsetzbarkeit ergibt. Des Weiteren wird eine technische bzw. konstruktive Option zur Additivzuführung vorgestellt, welche sich sowohl für die modulare Ergänzung bzw. Erweiterung gängiger Bestandanlangen als auch für die integrierte Implantation in Neuanlagen eignen dürfte.

Abschließend sollen erste Ergebnisse für die erreichbare Reduktion der Feinstaubemissionen während der Verbrennung von additivierten Holzhackschnitzeln/-gut in einer Kleinfeuerungsanlage dargestellt werden; d. h. die Übertragbarkeit der labortechnischen Voruntersuchungsergebnisse auf den realen Anwendungsfall soll für die entsprechenden Additive verifiziert werden. Dazu wird u. a. auch die Variation verschiedener Anlagen- bzw. Betriebsparameter betrachtet. Dabei zeigt sich, dass sich neben den Feinstaubemissionen ebenfalls auch weitere Schadstoffemissionen durch die Verwendung von geeigneten Additiven reduzieren lassen.

Hocheffiziente Biomassevergasung in Japan

Erwin Greiler
OeCompany
Attemsgasse 23
8020 Graz, Austria
e.greiler@oecompany.eu

Motivation und zentrale Fragestellung
Durch die thermochemische Biomassevergasung (kurz: *Biomassevergasung*) wird feste Biomasse CO_2-neutral in ein brennbares Gas umgewandelt. Mit Hilfe der Kraft-Wärme-Kopplung werden über die Verbrennung des sog. *Holzgases* in speziell adaptierten Motoren sehr hohe Gesamtwirkungsgrade erreicht. Deshalb ist die Biomassevergasung heute eine Schlüsseltechnologie für die sinnvolle, dezentrale Energieerzeugung. Bereits ab 1867 war diese Technologie unseres Netzwerkpartners ein Grundstein für die weltweite industrielle Entwicklung. Sie stellt einen wichtigen Baustein jeder Energiewende dar – gestern, heute und auch in Zukunft.

Aufgrund der katastrophalen Umweltzerstörung in der Prefäktur Fukushima im März 2011 – ausgelöst durch einen Tsunami mit schwersten Folgeumweltkatastrophen – hat sich in den Zeiten des infrastrukturellen Wiederaufbaues in der Region eine Gruppe von Menschen an uns gewandt mit der Bitte, eine umweltschonende Biomassevergasungsanlage in der Stadt Kesennuma-shi zu planen und in der Folge auch zu realisieren.

Methodische Vorgangsweise
Das innovative Biomasseprojekt *Hocheffiziente Holzbiomassevergasung in Kesennuma-shi* besteht im Wesentlichen aus einer komplett neu entwickelten Biomassevergasungsanlage inklusive intelligenter Abwärmenutzung aus den beiden BHKW. Diese Anlage produziert u. a. Warmwasser mit 95 Grad Celsius Vorlauftemperatur für ein großes ortsnahes kommunales Fernwärmenetz. Aktuell geplant wird eine Abgaswärmenutzung zur erweiterten umweltschonenden Stromerzeugung, wodurch eine äußerst innovative und flexible, umweltschonende und auch wirtschaftlich noch attraktiver Anlage entsteht.

Ergebnisse und Schlussfolgerungen
Diese Anlage stellt erneut die Machbarkeit und auch die wirtschaftliche Tragfähigkeit des Konzeptes „Holzvergasung kleiner Leistung“ unter Beweis. Mit Laufzeiten über 8.400 Stunden im Jahr überzeugt diese Technologie unseren Kunden in Japan. Das hat zur Folge, dass wir gemeinsam mit unserem japanischen Kunden schon intensiv an weiteren Projekten in ganz Japan arbeiten.

Das Projekt *Kesennuma-shi/Japan* in Zahlen

Gesamtinvestition	**> 6.000.000 €**
Output - elektrisch	**2 x 400 kW**
Output – thermisch	**2 x 450 kW**
Volllaststunden	**8.400 h/a**
Stromproduktion	**7.728.000 kWh/a**
Wärmeproduktion	**7.560.000 kWh/a**
Hackschnitzelbedarf	**< 650 kg/h**
Thermische Nachverstromung	**120 kWel**
Stromspeicherkapazität	**2 x 1.150 kWh**

Bush Encroachment in Namibia / Southern Africa

Frank Gschwender
Bush Control and Biomass Utilisation Project
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Wielinger Str. 52
82340 Feldafing, Germany
frank.gschwender@

Bush encroachment on pasture land is causing massive economic and ecological damage in Namibia. This affects more than 30 million hectares, which is more than 30 per cent of Namibia's land area. The most significant consequences of bush encroachment are reduced carrying capacity of affected rangeland as well as reduced groundwater recharge. However, bush encroachment also provides a great opportunity for economic development in Namibia. The accumulated biomass resulting from bush thinning piles up to an estimated amount of 300 million tons with an annual increase of 3.5%. This can be gainfully used, making it an economically viable resource for business. Sustainable financing could be well motivated for by the macro-economic benefits of bush thinning which include rangeland restoration, rural employment generation, domestic value addition, groundwater recharge and renewable energy supply.

The bilateral project 'Bush Control and Biomass Utilisation' is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry of Economic Cooperation and Development (BMZ) and aims at the economic utilisation of biomass from controlled bush thinning of pasture land. The focus is on wood chip production for energy generation purposes, the production of (emergency) animal feed as well as sustainable charcoal production for export. Additional options are manifold, incl. biochar, active carbon, wood plastic compounds, bio plastic. The project operates country-wide with a particular focus on two selected regions in the central north of Namibia, namely Otjozondjupa and Oshikoto. The project works with key stakeholders, including the Namibian Ministry of Agriculture Water and Forestry and other line ministries - such as Ministry of Environment and Tourism, Ministry of Industrialisation, Trade and SME Development and Ministry of Mines and Energy - and involves private sector organisations, farmers associations and businesses to promote public private partnerships.

The entire bush encroached land sustainably produces 8 – 10 million ton p.a. which should be taken off the system – only to maintain the current bush encroachment level. The exploitation of this enormous resource requires international cooperation both on R&D and technology as well as on off-take. The establishment of biomass development and technology partnership is pursued from the GIZ Regional Office in Feldafing/ Munich.

Life Cycle Assessment of electricity and heat generation of biomass gasification plants including the district heating network

Babette Hebenstreit
FH Vorarlberg
Hochschulstraße 1
6850 Dornbirn, Austria
babette.hebenstreit@fhv.at

Co-Authors: Elena Käppler, Tobias Ilg

All energy generation leads to greenhouse gas (GHG) emissions. Investigating the whole life cycle, even renewable energy generation has a positive GHG emission food print from e.g. materials used during construction of the plant and transport processes during maintenance. Especially, GHG emissions calculated for energy from biomass vary widely. Thus, biomass is a renewable under discussion. However, biomass stores carbon in its chemical structure. If this carbon is bound long term, biomass can also lead to negative greenhouse gas emissions.

Although, many studies on GHG emissions for biomass exist, life cycle assessments for small scale biomass gasification plants (<500 kWel) are still rare. We contribute with the analysis of a biomass gasification plant in Dornbirn, Austria. The plant is a floating fixed-bed gasifier with extra pyrolysis step and a gas engine for heat and electricity production. The main goal is to calculate the GHG emissions associated with the generation of one kWh of electricity or heat. In contrast to most of the published life cycle assessments of cogeneration plants, the construction and operation of the local heating network is included in the system boundaries as well as the entire supply chain of the wood chip production. The life cycle assessment is done according to the ISO standard 14040/44, the software SimaPro with EcoInvent database is used. Wherever possible, we gathered local data for the life cycle inventory. Especially, the gasification plant is modelled in detail. Also, the construction of the district heating grid and the biomass supply chain are adapted to the local site, with datasets from EcoInvent in the background. Therefore, the results are reliable for floating fixed-bed gasifier applications in mountain rich areas, which is so far not analysed in the literature.

The floating fixed-bed gasifier produces biochar, as a byproduct to heat and electricity. First, we calculate a base case, excluding the carbon bound in the biochar. For the base case, the plant emits 28.1 g of CO_2 per kWh. A share of 47 % of the GHG emissions is caused by the operation phase including the fuel supply. The energy-intensive turnover of wood chips is the main driver and holds a share of 27 % of the total emissions. Therefore, a change of the machines (wheel loader etc), e.g. to electric drives, would have the strongest impact to reduce the GHG emissions. Second, if we take into account the additional biochar produced during the gasification process, the plant has a negative carbon footprint of -36.8 g CO_2 eq per kWh. Thus, our analysis shows, that biomass gasification is a possible CO_2 sink. This assumes that the biochar will not be burnt and therefore acts as a long-term CO_2 sink.
We show the energy and material balance as the starting point of our calculations, the GHG emissions associated with the different processes, as well as a sensitivity analysis of different parameters. Furthermore, we plan a life cycle assessment of different biochar usages (e.g. as as fertilizer for soil treatment) and their associated GHG emissions, an outlook will be given.

Environmental and socio-economic aspects of new plant breeding technologies applied in root chicory for inulin and terpene production

Maria Hingsamer
JOANNEUM RESEARCH Forschungsgesellschaft mbH
Waagner-Biro-Straße 100
8020 Graz, Austria
Maria.hingsamer@joanneum.at

Co-Authors: Michael Kernitzkyi, Veronika Kulmer

Chicory varieties, such as the Belgian endive and the Italian radicchio, have been used as food in salads for a long time. They are appreciated for their characteristic bitter taste. The crop that is called root chicory is cultivated for food fibre inulin.

Inulin is a prebiotic; it boosts the growth of beneficial gut bacteria and stimulates our immune system. The inulin fibre is included in food such as yoghurts and cereal bars as low-calorie sweetener, fat replacer and to enhance gut health. In Europe, root chicory is mainly cultivated in the Netherlands, Belgium and the Northern part of France.

In addition to inulin, chicory roots store different terpenes. Terpenes are organic compounds naturally occurring in many plants. The terpenes give chicory varieties their typical bitter taste. Some terpenes can also inhibit the growth of fungi or bacteria, as antibiotics, or are reported in scientific publications to prevent cancer cells from growing. Therefore, the terpenes from chicory could be processed to generate new medicinal drugs.

CHIC, a H2020 project, aims to improve the quality of chicory with clear consumer benefits by the development of new chicory plants that on the one hand produces more and putative healthier inulin and on the other hand produces sufficient amounts of medicinal terpenes. Whereas it can take easily between one and two decades to develop a new plant variety by conventional plant breeding, the use of new plant breeding techniques (NPBTs) in CHIC allows to develop new chicory varieties in a much shorter time. Some of the traits CHIC wants to improve are almost impossible to achieve by conventional plant breeding only. Therefore, the ambition of CHIC is to develop and implement different NPBTs to convert chicory into a robust multipurpose crop that will produce products with human benefits. The CHIC consortium will evaluate the efficiency of a certain new plant breeding technique known as genome editing, as well as the safety, environmental, regulatory, socio-economic and broader societal issues. By involving stakeholders and by raising public awareness at all phases of the project CHIC strives to ensure responsible and desired innovations.

The aim of this abstract is to provide information on the environmental and socio-economic aspects of the NPBTs and the whole value chain of the new chicory varieties and products. All relevant stages of NPBT are screened: the R&D phase of NPBTs of new chicory, the large scale cultivation of new chicory as well as the processing and utilization of chicory products. For the environmental assessment the methodology of Life Cycle Assessment (LCA) will be used. Based on the integrated process design the LCA methodology is adapted to the specific challenges and framework conditions of the project (e.g. key environmental aspects). The different process steps of the whole value chain (e.g. cultivation, processing) will be included in the assessment. Within the socio-economic assessment the impact of different NPBTs on economic and social indicators will be quantified such as GDP, production volume, growth, competitiveness, and employment as well as the distribution of wealth and income between different sectors and regions within the EU and the global economy. In particular, focus will be laid on how NPBTs, the large scale cultivation and processed products impact the global value chain of agriculture, food and food processing and pharmaceutical chemical industry and hence how these effects unfold in the global economy. Thereby the inter-linkages between large-scale deployment of NPBTs and intra-EU and international trade will be explored. With these assessments information on environmental and socio-economic will be gained; the results will be used to lead the development within the project in a sustainable direction.

Acknowledgement: CHIC has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 760891.
The project is coordinated by Wageningen University and Research. Thanks to all project partners: Wageningen University & Research, Université des Science et Technologies de Lille, Leibniz - Institut für Pflanzenbiochemie, The New Zealand Institute for Plant and Food Research Limited, Fondazione Edmund Mach, VTT Technical Research Centre of Finland Ltd., Institu za biološka istraživanja Siniša Stanković, Julius Kühn-Institut Bundesforschungsinstitut für Kulturpflanzen, Graz University of Technology, Art & Science Synergy Foundation, European Plant Science Organization E.P.S.O., Sensus b.v., Instituto de Biologia Experimental e Tecnológica, KeyGene nv, IDConsortium.

Fernwärme Demonstrator Leibnitz setzt neue Standards für die urbane Wärmewende in „small smart cities“

Wolfgang Horn
Grazer Gasse 4
8430 Leibnitz, Austria
wolfgang_horn@drei.at

Es ist evident: die Maßnahmensetzungen für eine Bewältigung des Klimawandels und der Energiewende auf (inter-)nationaler Ebene zeigen per Mitte 2019 wenig Durchschlagskraft, zu viel Kompromissbereitschaft und viele unerwünschte Rebound-Effekte. Daher haben Städte eine besondere Rolle in dieser weitreichenden Herausforderung für beispielhafte Realisierungen, insbesondere bei der Wärmewende.

Wesentliche Indikatoren für das Gelingen der urbanen Wärmewende bis 2030 sind klare strategische Ziele, konsequente Kombinatorik aller Maßnahmen in einer verbindlichen Roadmap und starke Investments in eine flächendeckende neue post-carbon Infrastruktur.

Der österreichische Klima- und Energiefonds (KLIEN) fokussiert Lösungen in „small smart cities“ und „Vorzeigeregionen Energie“ zB mit dem Leitprojekt „Thermaflex“.

In diesem Rahmen setzt Leibnitz für ca. 25.000 Einwohner auf 100% carbon free und 100% erneuerbare Fernwärme aus industrieller Abwärme und Biomasse (ca. 60 GWh/a). Dank einer starken Allianz von Privatwirtschaft, KLIEN, Wissenschaft und Politik wird es hier möglich, Visionen für 2030 schon jetzt speditiv und vorzeigbar zu realisieren.

Der strategische Impuls ist der signifikante Ausbau des im urbanen Bereich flächendeckenden Fernwärmesystems und damit Versorgung von mehr als 60% aller Nutzer, um dort fossile (und importierte) Energieträger für die Raumwärme vollständig zu ersetzen. Das System mit bi-direktionalem Netz zeigt technische Raffinessen (Speicher, Niedertemperatur-Zonen, Kühlung, end-to-end data communication, Industrie 4.0 Regelungsprozesse, Open Data Platform etc.), die wissenschaftlich mit „Thermaflex“ begleitet, neue Standards nicht nur für technische Faktoren definieren. Auch die Energieraumplanung wird in diesem Kontext ihre neue Rolle einnehmen.

Ein besonderer Erkenntnisaspekt wird ergänzend aufgezeigt: Der Transformationsprozess in Leibnitz ist mit echtem Missionsgeist privater Unternehmen einerseits, einer Bürgerbeteiligung bei der Visionsfindung für „Leibnitz - Vorzeigestadt 2030“ andererseits befeuert worden. So erfolgte eine Initialzündung, die Identität für die eigene Handlungsmacht der Stadt, der Betreiber und der Nutzerinnen schaffte. Dieses Empowerment hat sich als essentiell erwiesen.

Anhand der konkreten Ergebnisse des „Prototyps System Leibnitz“ und deren Dokumentation aus mehreren Forschungsarbeiten, die komprimiert vorgestellt werden, wird der Rollout für andere Städte dieser Größenordnung fassbar, strategisch verbindlich formulierbar, kalkulierbar und somit leichter politisch umsetzbar.

Compact biomass pyrolysis equipment for processing a large range of biogenic raw materials

Iuliean Hornet
EcoHornet Ltd.
Romania
president@ecohornet.ro

Co-Author: Eden Mamut

EcoHornet is a Romanian company specialized on the manufacturing of highly efficient biomass burning and processing equipment covering a range of 5 lines of equipment in 70 types of models. The paper is presenting the latest achievements of the company in manufacturing a compact, highly efficient and versatile pyrolysis equipment.

The system has been developed based on cooperation with University research groups and is integrating cutting-edge concepts, materials and engineering tools.

The system is taking the advantage of an in-house original patent of pellet burner that is operated at high temperature and has unique performances in terms of efficiency and low environmental impact.

The pyrolysis processing reactor is versatile, covering a range of temperatures between 150 and 900^{o}C that allows the use a large variety of biogenic raw materials.

A performant process monitoring and automation system has been specially conceived for this equipment that allows the continuous adaptation of the process parameters to the specific composition of the raw material and to the requirements of the operation. In such a way, the pyrolysis installation is autonomous and starts the operation only when the reactor is fed at nominal capacity and the operation is running in optimal processing conditions.

The requirements for the quality of the feedstock consists only in the shredding size of less than 10 mm and humidity less than 10 %. The correction of the humidity is done using waste heat from the processing line. The operation of the processing installation may be adjusted for maximizing the biochar, bio-oils or pyrolysis gas fractions according to the requirements and the composition of the raw materials.

Was wäre wenn Strom aus Holz 2 EURO Cent / kWh kostet und dabei hochwertige Holzkohle herstellt?

Benjamin Hupfauf
MCI Die unternehmerische Hochschule
Department für Umwelt-, Verfahrens- & Energietechnik
6020 Innsbruck, Austria
benjamin.hupfauf@mci.edu

Co-Authors: Angela Hofmann, Thomas Hämmerle, Marcel Huber

Unter den erneuerbaren Energiequellen zur Stromerzeugung spielt die Verbrennung oder Vergasung von Biomasse in Zukunft eine äußerst wichtige Rolle. Ein wesentlicher Grund für deren Bedeutung ist die Unabhängigkeit zwischen dem Zeitpunkt der Verfügbarkeit der Energiequelle und der Stromerzeugung. Um ihre Bedeutung langfristig zu erhalten, sind jedoch entsprechend niedrige Stromgestehungskosten (SGK) erforderlich, ferner muss die eingesetzte Technologie auch ohne subventionierte Einspeisetarife für erneuerbare Energien rentabel arbeiten können.

Ziel dieser Arbeit ist es, die SGK von Biomasseheizkraftwerken mit einem Vergasungsreaktor - insbesondere Holzvergasungsanlagen – durch die Nutzung oder Valorisierung des Vergasungsrückstands und eines günstigen Einsatzmaterials zu reduzieren. Im Wesentlichen wird der Vergasungsrückstand zu einem Produkt höherer Qualität verarbeitet, so dass die Holzkohle die Eigenschaften einer Aktivkohle (AC) aufweist. Darüber hinaus sollte Altholz (unbehandelte Paletten und Verpackungsholz) so behandelt werden, dass die anfallenden Fraktionen in einem vorhandenen Schwebebettreaktor verarbeitet werden können. Dazu sollen eine "Funktionalisierungs-einheit" (Green Carbon Unit (GCU)) in einem Schwebebett Holzvergasungsprozess (SBVP) und Aufbereitungsverfahren für Altholz entwickelt werden.
Neben der Möglichkeit, Altholz in einem SBVP ökologisch und ökonomisch zu verarbeiten, bietet die GCU die Möglichkeit, Menge und Produktqualität der hergestellten Holzkohle an den gegebenen Marktanforderungen anzupassen. Dies ermöglicht beispielsweise einen Teillastbetrieb mit erhöhter und einen Volllastbetrieb mit geringerer Holzkohleproduktion, um den regionalen Bedürfnissen und geforderten Lastprofilen gerecht zu werden.
Wie aus Tabelle 1 ersichtlich, wirken sich die Brennstoffkosten mehr als 50 % auf die SGK aus, somit kann der Einsatz von Altholz-Hackschnitzeln die Produktionskosten um ca. 50 % reduzieren. Zusätzlich kann durch die Veredelung der Holzkohle zu AC eine weitere Reduktion von ca. 50 % (AC ca. € 1 kg^{-1}) erreicht werden.
Rahmenbedingungen zur Berechnung der SGK:

- Die Berechnungen basieren auf einer 500 kW_{el} Anlage.
- Alle Kosten und Einnahmen werden auf Cent / kWh_{el} berechnet.
- Die Fernwärme oder das Nahwärmenetz sind nicht in den Investitionen enthalten.
- „Nur“ die Hochtemperatur-Wärme (HTW) wird als Einnahmen berechnet.
- Niedertemperaturwärme wird als Trocknungswärme verwendet.
- Das Verhältnis von kW_{el} / kW_{HTW} ist 40 / 60.
- Für die Wärmeeinnahmen werden 4 € Cent / kWh_{HTW} berechnet, was 6 € Cent / kWh_{el} entspricht
- Die Holzkohleeinnahmen werden mit 200 € / T_{TS} (Tabelle 1) und 1000 € / T_{TS} (Tabelle 2) berechnet.
- Die Brennstoffkosten werden auf 85 € / T_{TS} (Tabelle 1) und 25 € / T_{TS} (Tabelle 2) festgesetzt.

Table 1: SGK vom Standard SBVP

Investition	+ 5 € cent/kWh
Finanzierung	+ 1 € cent/kWh
Betrieb und Wartung	+ 3 € cent/kWh
Brennstoff	+ 7 € cent/kWh
Wärmeerlös	- 6 € cent/kWh
Holzkohleerlös	- 1 € cent/kWh
Stromgestehungskosten	+ 9 € cent/kWh

Table 2: SGK vom SBVP mit Altholz und GCU

Investition	+ 5 € cent/kWh
Finanzierung	+ 1 € cent/kWh
Betrieb und Wartung	+ 3 € cent/kWh
Brennstoff	**+ 2 € cent/kWh**
Wärmeerlös	- 6 € cent/kWh
Holzkohleerlös	**- 4 € cent/kWh**
Stromgestehungskosten	+ 2 € cent/kWh

Die Vorbehandlung von Altholz und die Nachbehandlung der Holzkohle reduzieren die SGK von Vergasungsanlagen - insbesondere einer SBVP-Anlage - von derzeit 0,09 € kWh^{-1} um ca. 75 % (hier handelsübliche AC als Nebenprodukt) auf € 0,02 kWh^{-1} (Berechnung siehe Tabelle 2). Nach dem gegenwärtigen Stand der Technik ist die Verwendung und Valorisierung von Vergasungsrückständen ein wenig erforschtes Gebiet. Insbesondere sind bisher keine Systeme bekannt, die eine "Inline / In-Situ" –dezentrale Aktivierung des Vergasungsrückstands durchführen und als Einsatzstoff Altholz verwenden.

Detailed investigations of high terpene concentrations in biogas laboratory trials

Lukas Knoll
BEST Bioenergy and Sustainable Technologies GmbH
Konrad-Lorenz-Straße 20
3430 Tulln, Austria
Lukas.knoll@best-research.eu

Co-Authors: Marion Sumetzberger-Hasinger, Magdalena Nussbaumer, Dennis Dalnodar, Andreas Paul Loibner, Bernhard Drosg

Biogas is a highly important pillar in the European renewable energy strategy as it can be produced from a wide variety of organic feedstocks including food waste, sewage sludge and manure. Besides the main compounds in biogas – methane and CO_2 – several impurities may be present depending on the type of substrate used in the process. Consequently, kind and quantity of impurities may vary strongly. The presence of trace compounds in biogas such as terpenes might cause odour and operational problems. Terpenes are known as antimicrobial agents which can affect biogas production. In particular limonene is in the focus of current research as it is the major component of citrus essential oils. Yet, terpenes are also present in various substrates such as clover and carrots.

The aim of this study was to investigate the effect of terpenes on the anaerobic digestion process. For this reason, batch tests with increasing amounts of limonene added to the substrate (0, 500, 1000, 2000 mg/kg) were performed under mesophilic conditions in 1L glass reactors. The biogas potential was hardly influenced at limonene concentrations of 500 and 1000 mg/kg whereas the kinetics slowed down at 1000 mg/kg. At a concentration of 2000 mg/kg, an inhibition of the biogas potential of more than 50% was observed. Despite a very high limonene concentration in the liquid phase, this contaminant could not be detected in the gas phase, which suggests that gas sampling is a critical point.

To investigate the impact of terpene containing substrates on anaerobic digestion, semi-continuous experiments with orange peels as substrate were performed. Therefore, 2L glass reactors were operated under mesophilic conditions with an OLR of 0.5 - 2.5 gVS/(L·d). With the increase of the OLR the limonene concentration in the produced gas rose from 1,88 µg/L to 12,30 µg/L. A pure orange peel feed proved to be problematic by causing instabilities in the anaerobic digestion process (VFA up to 4500 mg/L).

Regulation strategy of power driven solid biomass CHP plants in flexible district heating

Katharina Koch
Professur für Regenerative Energiesysteme
TUM Campus Straubing für Biotechnologie und Nachhaltigkeit
Technische Universität München
Schulgasse 16
94315 Straubing, Germany
katharina.jh.koch@tum.de

The main work task is the simulation and optimization of an existing district heating system with a solid biomass CHP plant, by the intelligent integration of a power-to-heat component and a seasonal heat storage. For an efficient energy system, the flexible operation mode of the solid biomass CHP plant in order to be able to contribute in the energy is essential. In the focus of the simulation model is the optimized dimensioning and regulation of the different components in the energy system, in order to rise the resource efficiency (ecology, economy, efficiency) of the model. Concepts for a flexible heat supply with a high share of renewable energies will be developed and analyzed in different scenario simulations.

Purpose of the work
The goal of the work is to enlarge the simulation model of an existing district heating system with a seasonal heat storage and a power to heat component, in order to drive the CHP plant according to the prices of the energy markets. An optimized dimensioning and controlling of the different components in the mode, should lead to a resource efficient combined heat and power system.

Approach
The simulation model is generated with MATLAB. The input data for the validation of the model is removed from a metering system of the simulated district heating (district heating Grassau, Biomassehof Achental, Germany).

Scientific innovation and relevance
With power-to-heat components and the seasonal heat storage it is possible to cut the overload in the power grid and to use this energy (power-to-heat) for the heat supply in district heating systems. The sector coupling reduces frequency and voltage fluctuations and ensure therefore the security of supply. This leads to lower costs for the TSO (Transition system operators) and reduces the costs for the end costumers. The scientific relevance lies in the complex connection and controlling of different equipment components in order to obtain a resource optimized energy system.

Results and Conclusion
First, a control concept was developed in the simulation tool, which allows the biomass CHP plant to participate in the EPEX electricity exchange. The operating mode was first adapted to the marginal costs and the EPEX price in a price-optimized way. The participation in the control energy market is another significant control component. The focus here lies on the tertiary control power, as this simplifies planning and availability issues. The calculation of the offer price for the control energy market was based on the variable costs of the solid biomass CHP plant. In addition, a methodology was developed which serves as a decision criterion for determining the positive as well as the negative control energy. The first scenario simulations differ between the heat- and power-controlled operation of the CHP plant. In the result plots, the running time of the CHP plant and the peak load boiler as well as the losses and the charging behaviour of the long-term storage in the heating system were compared.

Platform chemicals from biogenic residues by hydrothermal processes

Jakob Köchermann
DBFZ Deutsches Biomasseforschungszentrum
und gemeinnützige GmbH
Torgauer Straße 116
04347 Leipzig, Germany
jakob.koechermann@dbfz.de

Co-Authors: Christian Klüpfel, Kati Görsch, Marco Klemm

The rising world population and the resulting shortage of agricultural land imply that in future agricultural products must be utilized as effectively as possible. Therefore, biomass-processing industry has to transform from a single to a multi-product business – called biorefinery. From that purpose, the development of bio-based products like chemicals or fuels from agricultural residues, side streams of pulp and paper or forest industry plays an important role. However, most of these biogenic residues have high moisture contents and need to be dried before they are able for conversion. Hydrothermal processes have received a lot of attention in recent years, since they are suitable to convert such wet biogenic residues in platform chemicals. Platform chemicals are appropriate as starting materials for the production of several different valuable derivatives and offer important flexibility and breadth to the biorefinery. [1]

Within the research project HTKkChem, carbohydrate-rich residues (starch, cereal husks, corncobs) will be used as starting material for production of such platform chemicals. The aim in this ongoing project lies on the development of a two-stage hydrothermal process for the provision of the platform chemicals 5-hydroxymethylfurfural (5-HMF), furfural, levulinic acid, and γ-valerolactone (GVL). While in the first stage, carbohydrates are hydrolyzed and dehydrated using homogeneous catalysts, in the second stage an in-situ hydrogenation is carried out with the aid of heterogeneous catalysts.

For this purpose, experiments with starch residues from a wheat starch factory were carried out using different brönsted/lewis acid combinations. Preliminary results indicate that brönsted/lewis acid combinations perform better regarding the target products compared to use only a brönsted or lewis acid. At the conference, the process concept and results from the experimental examination for the first stage should be presented.

Reference

[1] J.J. Bozell, G.R. Petersen, Technology development for the production of biobased products from biorefinery carbohydrates—the US Department of Energy's "Top 10" revisited, Green Chem. 12 (2010) 539.

Monitoring the quality of wood pellets at Slovenian market – An important information for the consumers

Nike Krajnc
Slovenian forestry institute
Večna pot 2
1000 Ljubljana, Slovenia
nike.krajnc@gozdis.si

Co-Authors: Darja Stare, Peter Prislan

Based on the facts that pellet market in Slovenia is growing fast, Slovenian forestry institute decided to make an (independent) analysis of wood pellet quality on domestic market. First study was done in January 2013, when pellets from 16 different producers were bought in different shops. The 15 kg sacks, which is the most common marketed form, were collected and tested. First results showed that only 3 from 16 analysed samples meet the criteria for the highest quality class A1 (according to at that time existing international standard EN ISO 17225-2) and what was more alarming 6 of them even fail the criteria for class B. The results were published in several Slovenian newspapers but in this first analysis pellet producer's names were not revealed. After high respond from pellet consumers we decided to perform analysis of wood pellet quality on Slovenian market together with Slovene Consumers' Association (known as ZPS in Slovenia), which is an independent, non-profit and non-governmental organization and has been protecting and representing consumer interests since 1990. The main idea for the cooperation was that Slovenian forestry institute collect samples (15 kg pellet sacks) and prepare analysis of selected parameters while Slovene Consumers' Association takes over the presentation of results to the public. The idea was to use the methodology for ranking of products that is commonly used by Slovene Consumers' Association when quality tests results of different products are presented. For this second analyse 15 samples of wood pellets were collected in 8 different shops all around Slovenia. Since 2013 we published already 5 independent analysis of pellet quality and the results are getting better from year to year.

For each sample following analysis according to EU standards were done: Bulk density (EN 17828:2016), Water content (EN 18134-1:2015), Mechanical durability (EN 17831-1:2016), Ash content (EN 18122:2016), Particle content <3,15 mm (EN 18846:2016) and Net caloric value (EN 18125:2017). According to measured parameters all samples were classified in quality classes A1, A2 and B (according to EN 17225-2:2014). Beside mentioned analysis also the data available at declaration on the bags were analysis and weigh of all bags was checked.

The share of samples classified in quality class A1 is increasing year by year and on the other hand the number of samples that are not classified in any of the quality classes due to poor quality is reduced. However, the problem is even bigger, since the quality class of pellets recorded on the bags and also confirmed by certificates doesn't match the quality of pellets determine in the laboratory. With our analysis and in close cooperation with Slovene Consumers' Association we are aiming to improve the situation at the market, we are trying to rise the awareness of consumers and promote high quality pellets at Slovenian market.

Environmental impact assessment of steam explosion pretreatment in biogas production chains in Austria

Iris Kral
Institute of Agricultural Engineering
University of Natural Resources and Life Sciences Vienna
Peter Jordan Str. 82
1190 Vienna, Austria
Iris.kral@boku.ac.at

Co-Authors: Gerhard Piringer, Molly K. Saylor, Javier Lizasoain, Susanne Frühauf, Andreas Gronauer, Alexander Bauer

Agriculture has the task of providing the four F's food, feed, fibers, and fuels, which can lead to land competition. Efficient energy production from agricultural residues would counteract this trend. Hence, the purpose of the work summarized in this thesis was to assess the environmental impacts and efficiency of different biogas production chains and to compare them to established technologies and energy mixes using the method of life cycle assessment (LCA). LCA estimates the potential environmental impacts of products and services throughout their life cycles.

Steam explosion (SE) pretreatment technology enables biogas production from lignified biomass, such as maize straw or hay. This helps to save fossil fuels by adding a renewable heat and electricity source. The study assesses 2 common substrates mixtures in 2 different scenarios each: 1a. Maize silage scenario (SIL) – traditional Austrian biogas production; 1b. Maize stover scenario (STO) – biogas production using maize stover after SE pretreatment; 2a. Local biogas scenario (LB) - a hypothetical local biogas scenario based on hay from previously unused grassland, including SE pretreatment, and 2b. Status quo scenario (SQ) - reference scenario representing the status quo in a given region with heating oil, wood chips, and grid electricity as municipal energy sources. Besides the biogas plant, the system for all biogas chains includes substrate production, a combined heat-and-power (CHP) unit, digestate management, and transportation. SIL and STO were modelled using attributional LCA while the comparison for of LB and SQ is based on a more prospective system expansion approach, leading to broader system boundaries and therefore more complex process chains. The functional unit for all scenarios is one kWh of electricity at the regional grid. Biogas off-heat as a co-product in the LB and SQ scenarios, and missing biogas energy from unused hay in the SQ scenario were addressed through system expansion.

Of the two maize scenarios, the STO scenario results in lower total climate change impacts than those of the typical biogas system (239 g CO_2-eq kWh_{el}^{-1} vs. 287 g CO_2-eq kWh_{el}^{-1}), and this holds also for the other impact categories (e.g., cumulative energy demand, acidification, eutrophication). Methane slip emissions from the CHP exhaust account for the largest global warming potential (GWP) share in both scenarios. Other large GWP contributions are from substrate production and grid electricity for plant operations. SE pretreatment of substrates contributes only slightly (0.5 g CO_2-eq kWh_{el}^{-1}) to the total emissions of a biogas plant, if the heat demand can be covered by waste heat from the CHP unit. Hence the use of agricultural residues as biogas substrates after pretreatment can be a suitable alternative to the use of energy crops.

In three of the assessed impact categories of the regional scenarios, the LB scenario has lower impacts than the SQ scenario, including climate change (367 g CO_2-eq kWh_{el}^{-1} versus 501 g CO_2-eq kWh_{el}^{-1}). Dominant contributions to climate change in the SQ scenario are from heating oil combustion and grid electricity; in the LB scenario dominant contributions are unburned methane in the CHP exhaust, as well as machinery CO_2 during hay production. However, ammonia emissions from biogas digestate cause a substantial LB scenario disadvantage in acidification and particulates formation. If more than 58% of the LB scenario's marketable off-heat replaced heat from wood chips rather than from heating oil, LB would lose its climate change advantage. Advantages of integrating a local biogas plant in municipal energy and waste systems depend strongly on the extant municipal energy system characteristics.

Biochar's reaction kinetics under gasification conditions by experimental tests with TGA

Jacqueline Lagler
BEST Bioenergy and Sustainable Technologies GmbH
Inffeldgasse 21/B
8010 Graz, Austria
jacqueline.lagler@bioenergy2020.eu

Co-Authors: Stefan Martini, Norbert Kienzl, Astrid Loder

During the last years biomass evolved into one of the most important energy sources in Central Europe. Depending on the atmosphere, different types of thermochemical processes can be differentiated: pyrolysis, gasification and combustion, whereas pyrolysis operates without any oxygen in the atmosphere, combustion with the highest ratio of oxygen. Depending on the conversion technology and conversion conditions, different products can be generated: heat, cooling power and electrical power, liquid, gaseous and solid products, such as hydrogen, FT-fuels and biochar. This work focuses on the valorisation of solid side products of gasification based biomass CHP-systems to increase ecologic and economic benefit. Depending on the conversion process of biomass into producer gas this solid residue consists mainly of ash or of so called biochar with high carbon content. Increasing the amount of biochar leads to a decrease of producer gas, but, with the high market potential of biochar, the economic benefits increase. According to its characteristics (e.g. purity, surface structure) different applications can be addressed and therefore different prices can be achieved. Therefore, extended research on biochar treatment processes and related reaction kinetics of biochar is from crucial importance for the development and optimisation of downstream upgrading processes in order to reach the desired quality of the biochar. In the past, such considerations of utilising side products, like biochar, have not been in the centre of attention during the design phase of gasification reactors. Therefore, the establishment of a finishing-treatment of biochar extracted from a gasification process is under investigation. The focus of this paper lies on the reaction kinetics of biochar activation itself and not the primary material (biomass).In order to derivate correlations between reaction kinetics and atmosphere compositions as well as temperature, experimental test runs are conducted with a Thermogravimetric Analyser (TGA) including a steam furnace, which enables studies of mass and energy changes under defined absolute humidity. To produce applicable and reliable data, the limitations of the TGA-test-setup are evaluated with examinations on variations of sample mass, bulk density, particle size distribution and the gas flow. On this basis the test design is defined with certain specifications on the sample preparation and a constant flow velocity. The investigated biochar taken out the gasification process is dried, milled and sieved for the TGA-tests. The main part is devoted to conduct a detailed investigation changing the content of moisture (H_2O) and carbon dioxide (CO_2) as well as the temperature. The tests are operated at a temperature range between 700 and 1000°C, H_2O-concentrations from 0 to 80 vol% and CO_2-concentrations also in the range of 0 to 80 vol%. These systematic experimental variations provide the basis for a model of the reaction kinetics of biochar under different boundary conditions. The data is to be evaluated via the generic model including temperature and the partial pressures of CO_2 and H_2O. Afterwards it will be matched with conventional models (e.g. Arrhenius plot, linear regression models) to determine their suitability. One of those models was used in the paper of Ollero et al, where the influence of CO_2 on the reaction kinetics of olive residue was investigated. (1) First results show that the reaction rate of biochar is much lower than the one of olive residue.
Effects of treatment conditions on the surface properties are investigated by taking out the treated samples after a defined treatment period at a defined mass loss and subsequent surface analysis (BET, pore size/volume distribution) of the samples. In first BET surface analysis, the treatments of biochar with vapour lead to a surface of approximately 1000m²/g whereas the original sample has a BET surface lower than 150m²/g. This finding leads to the question how the reaction kinetics of a treatment process influences the surface change. The obtained data is taken as basis for developing an upgrading process for biochar to a high value product of the gasification process. In order to prove the suitability of TGA-tests for identifying optimised treatment conditions, further research shall demonstrate the correlation of the lab-scale TGA-results with experiences of pilot scale tests.

(1)Ollero, Serrera, Arjona, & Alcantarilla. (2003). The CO2 gasification kinetics of olive residue. *Biomass and Bioenergy*, 151-161.

Influence of user behaviour on emissions from firewood stoves

Robert Mack
Technology and Support Centre in the
Centre of Excellence for Renewable Resources (TFZ)
Schulgasse 18
94315 Straubing, Germany
robert.mack@tfz.bayern.de

Co-Authors: Claudia Schön, Hans Hartmann

Firewood stoves are widely used in Europe and they may cause high particle matter (PM) and gaseous emissions. Previous research projects highlighted that the user behaviour is an important parameter that influences the emissions of manually operated firewood stoves. To meet strict emission thresholds not only on a test stand but also in real-life operation it is therefore necessary to identify the main operating errors made by users leading to higher emissions. From the obtained results recommendations for correct stove operation can then be given.

A modern state of the art manually operated firewood stove with a nominal heat output of 7 kW was selected to investigate the influence of user behaviour on emissions. Overall, 5 stove ignition and 9 stove refilling methods were tested. The ignition mode differed in the position of the chosen igniters as well in the orientation and the choice of wood sizes used; this included the “top down” and “bottom up” ignition modes. The refilling modes comprised the refilling according to the stove user manual *(a)*, different primary air settings *(b)*, an overload of fuel *(c)*, different moisture content between 7 and 30 w-% *(d)*, too long logs which were leaning at the side walls of the combustion chamber *(e)*, a delayed refilling *(f)* and a "quasi-continuous" refilling by single logs *(g)*. PM emissions were measured after closing the door of the stove until complete flame extinguishing. The gaseous emissions were measured continuously throughout operation. To achieve close to real life operation, the stove was operated at natural draught conditions and the ignition batch was always started from a cold combustion chamber. The results for the “top down” and “bottom up” ignition modes were also measured at regulated draught at 12 Pa, this was to assess if there was any influence of the draught condition. Additionally, a test according to the European type testing routine (EN 13240) was carried for general evaluation of the emission results. The ignition from the bottom caused lower emissions compared to the ignition from the top. This was achieved when using small wood sticks and an igniter at natural and constant draught conditions. But the highest emissions within the ignition studies were caused in the mode when using crumped newspaper as igniter from the bottom. The firewood stove performed very well at nominal load at natural draught conditions when it is operated according to the user manual. Then German national emission requirements (max. CO: 1687 mg/Nm3; OGC: 212 mg/Nm3; PM: 22 mg/Nm3) were easily met. Compared to this proper stove operation, the highest emissions were released when the primary air was not closed after the ignition batch (CO 9379 mg/Nm3; OGC 1283 mg/Nm3; PM 142 mg/Nm3). Such maloperation could be avoided if the stove was equipped by a relatively simple automatic combustion air control. Moreover, high emissions occurred when the stove was refilled after the flames were already extinguished or the fuel was too wet. By throttling the combustion air flow, only the CO emissions were increased by the factor 1.7 compared to the proper stove operation. Similar, an overfilling of the combustion chamber only increased the gaseous emissions. The use of too long wood logs, too dry wood or the continuous refilling with single logs led to similar or slightly lower gaseous and particle emissions compared to the proper stove operation according to the user manual.

The results confirm that the user has a big influence on the emissions of firewood stoves. Therefore, manufacturers should develop precise manuals that describe the best ignition mode as well as the optimal way of refilling including the proper amount of fuel and the optimal fuel condition. These instructions should be specifically adjusted to each stove. This should best be done by creating a quick-user-guide provided by the stove manufacturer, based on experimental evaluation performed by the manufacturer. Additional improvement potential is given by introducing automatic combustion air control units which can prevent severe maloperational hazards. This technology not only corrects air flow (e. g. when the primary air flow is left open by the user) but could also help to indicate other unfavourable user behaviour like too late refilling of wood or stove overloading. The potential of automatically controlled stoves in comparison to a manual operated stove including realistic user behaviour should be addressed in future studies.

Control strategies for multivariant biomass systems

Johnse Mathew
Thermo-chemical Conversion Department
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH
Torgauer Straße 116
04347 Leipzig, Germany
Johnse.Mathew@dbfz.de

Co-Author: Daniel Büchner

In the present scenario, every manufacturer has their own individual legacy standards and control platform for biomass appliances, which makes it challenging for networking with numerous subsystems. Therefore, an integration between different vendors, a common platform is necessary that works without interrupting their own hardware and software. This research introduces a single gateway interactive central wireless control platform for biomass systems by meeting the demands of users.

The prototype for plug and run wireless gateway is developed with Raspberry Pi, because of its simplicity and adaptability. It functions as a wireless pre-programmed plug and runs controller, of which the prerequisite includes, predefined register sets and manufactures permission to read and write data in their own standard protocol. A functional program block is loaded as a software script package in the controller and is programmed with respect to the system output communication protocol and inbuilt selected register sets to build a two-way replicated data and visualization gateway. The replicated layer is a wireless-enabled transceiver and is independent of the inbuilt primary control. This data are used for local visualization, further analysis, management, and control. The data transmission is formulated with a wireless local area network because of its high-speed and long-range communication option. This method is adopted as the controller is intended to perform plug and run operation without interrupting the normal working of the biomass system and to avoid internal hardware deployment.

In the first prototype model, simple plug and run installation are established with reading and write functions on various systems with different protocols. The control is centralized with a local wireless graphical user interface. It is also formulated with three different architectures named, Wireless switching; Planetary and Parallel strand depends on the complexity and user preferences. Even though the prototype does not explicitly address the central control platform concept, the output received suggests that the underlying objectives of this concept could be best achieved by enhancing the different elements of this model. This gateway operates in plug and runs only if the exact set of memory registers and communication protocol is pre-defined. This model also has difficulty in handling all the measurement and control values in complicated operations. Single window with multi-level real-time data logging, networked historical database, alarm, are also needed to improve the model.

The field of application includes all biomass boiler systems, cogeneration, heating circuits, smart home systems, etc. This gives the manufacturers the benefit of cheap distributed control operation, extended wireless secured interface and compatibility with any other vendor equipment. The users will have a customized selection system from multiple manufacturers, the lesser need of technological knowledge, common software and single end- visualization. This model could be developed further with the data sharing from the photovoltaic system, weather station, and energy storage equipment thus making it an intelligent feed-forward predictive model. Thus, increasing energy efficiency and maximizing the utilization of renewable energy sources. The performance needs to be improved in close partnership with manufacturers and users.

Experiences from carbon taxation

Gustav Melin
Swedish Bioenergy Association (SVEBIO)
Kammakargatan 22
111 40 Stockholm, Sweden
gustav.melin@svebio.se

Co-Authors: Kjell Andersson

Sweden has implemented carbon taxation since 1991. The tax was introduced on a relatively low level around 30 €/tonne CO2 for households and the service sector, and lower for industry. During the period 2000 - 2005 Sweden made a ”green tax shift” and increased the carbon tax drastically to the highest level globally. At the same time other taxes, on income and employment, were reduced. During the last years the carbon tax has been increased to the same high level also for industry outside EU-ETS. The carbon tax level is today around 120 €/tonne CO2.

Despite the high carbon tax, the Swedish economy is doing well, with growth rate not lower than other countries in EU.

The high carbon tax level has promoted energy efficiency, savings of fossil fuels, and conversion to renewable energy. The bioenergy sector has benefitted particularly, as biomass fuels have been needed for boilers and heat plants as well as in industry to substitute fossil fuels that have prohibitively expensive to use in most cases.

The paper gives insights into the Swedish experience of carbon taxation and the effects for the bioenergy business community.

Negative carbon dioxide emissions from pulp mill

Mendoza Martinez Clara
Universidade Federal de Minas Gerais (UFMG)
Departamento de Engenharia Quimica,
Av. Antônio Carlos 6627
CEP 31270-901 Belo Horizonte
Minas Gerais, Brazil
clara.mendoza.martinez@gmail.com

Co-Authors: Kuparinen Katja, Goulart Faria Débora, Saari Jussi, Vakkilainen Esa, Cardoso Marcelo

Global greenhouse gas emission reductions are unlikely to be sufficient t*o reach* the goal of keeping the warming below 2°C. Carbon dioxide must also be removed from the atmosphere (NET). Kraft pulp mills produce CO_2 in combustion processes. The recovery boiler, the biomass boiler, and the lime kiln are the largest sources of CO_2. As these CO_2 emissions originate almost entirely from burning biomass (bioenergy), the pulp mill can be considered nearly carbon-neutral as long as the wood feedstock is obtained from sustainable sources. Using carbon capture and storage with bioenergy (BECCS) or beneficial use (BECCU) permanently removes some of the carbon from circulation. Pulp mills can therefore provide a part of the negative emissions needed for climate change mitigation.

An alternative way of creating negative emissions in a pulp mill is converting process residues that are currently disposed of by landfilling or incineration to materials that can serve as a stable permanent carbon storage. Ideally the residues could be converted to additional products resulting in additional revenue for the plant. Existing processes utilizing CO_2 in pulp mill include tall oil manufacturing, lignin extraction, and production of precipitated calcium carbonate (PCC). CO_2 can be captured from a stream of flue gases by e.g. absorption in an aqueous solvent. Chemical absorption by alkanolamines (amine scrubbing) appears to offer an attractive and commercial alternative for CO_2 separation from combustion flue gases at pulp mills.

In addition carbon can also be removed from circulation permanently by applying conversion technologies other than combustion on some of the biomass streams containing carbon. In case of lignin extraction; removing lignin from the black liquor before combustion in the recovery boiler, some of the CO_2 emission can also be avoided altogether. Hydrothermal carbonization of the bio-sludge generated during primary (chemical) and secondary (biological) wastewater treatment processes is another possibility of removing carbon in a pulp mill. The produced hydrochar is an inert substance and resistant to biological degradation. It has potential use for example as adsorbents for environmental applications. When mixed in soil, it can improve its carbon organic matter, reduce N_2O emissions, as well as forming a permanent carbon storage. In this paper the potential of the aforementioned technologies – post-combustion amine scrubbing for BECCU, and hydrothermal carbonization of bio-sludge – are evaluated.

A modified concept of the mechanical durability test for small batches of pellets

Krzysztof Mudryk
Department of Mechanical Engineering and Agrophysics
Agricultural University in Krakow
Balicka 120
30-149 Kraków, Poland
Krzysztof.mudryk@urk.edu.pl

Co-Authors: Marcin Jewiarz, Marek Wróbel

Increase in consumption of biomass pellets leads manufacturers use other than raw wood materials, like energy crops and grasses, as feedstock to pellet production. This requires research and optimization connected to dye type, channel geometry, agglomeration pressure and other process parameters. Often the nature of laboratory work related to the production of the pellets, involves the production of a several granules, for example on hydraulic presses, which are subjected to numerous qualitative tests. One of the most important quality properties is the mechanical durability of pellets determined in accordance with standard ISO 17831-1:2015. This parameter informs about the ability of densified biofuels to remain intact during handle and transportation processes.. For very small laboratory batches(approx. 50g), it is impossible to use durability test according to the ISO 17831-1:2015 standard, mainly due to fact that one batch mass should be equal to approx. 500g.

The aim of this study was to modify the method used to determine the mechanical durability of the pellet to be appropriate for small smaller batches. During this investigation it was assumed that it is possible determine the mechanical durability of several granules (small sample) of biomass pellets mixed with plastic granules (to fulfil the standard requirements). In this case, five types of plastic granulates were used for verification of the made assumptions. The specific density of this materials was from 1.02 to 1.42 g/cm3. A number of verification tests were carried out using various pellets with known mechanical durability ranged from 0.87% to 0.98%.. The obtained results showed that it is possible to determine the mechanical strength of pellets in accordance with the guidelines of ISO 17831-1:2015 for a sample of approximately 20-40g. with reasonable accuracy.

Techno-economic analysis of biomass gasification for off-grid rural electrification

Palyomwene Mutilifa
Namibia University of Science and Technology
Private Bag
13388 Windhoek, Namibia.
pmutilifa@nust.na

Co-Author: Evert Strydom

In Namibia, there's an old phenomenon that has been triggering severe economic losses for the past decades to date. This phenomenon is known as bush encroachment and is defined as the invasion and/or thickening of aggressive undesired woody species. About 40% of Namibia's land is affected by this phenomenon and nearly 75% of these areas are without electricity. Biomass Gasification (BG) technology can be the perfect solution to rural electrification; because not only will it provide electricity but it will also help control bush encroachment in Namibia. For these reasons, a feasibility study is required.

Methods. Literature reviews; Quantitative data collection and data analysis from an existing gasification plant; Simulation of three scenarios with different power installing capacity against three biomass feedstocks (Wood chip, charcoal and wood pellets).

Findings. (1) From the literature reviews, biomass gasification was found to hold great promises in rural electrification because it is a matured technology, it can accommodate different scale capacities and it is feasible in areas with viable biomass. Plant management and technical training to locals were found to be crucial factors that lead to a successful plant. (2) The investigations and analysis made at the existing BG plant indicated that some existing BG technologies were manufactured locally. From the data analysis, it was found that the producer gas substitutes 77% of the diesel and that the input cost of the plant when the gasifier is running is half the price of the plant when it's running only on diesel. The drawbacks from the existing plant include lack of instrumentation, lack of technical experts and poor gas cleaning units. (3) The simulations of the three scenarios have proved that, although both feedstocks resulted in feasible projects, the best alternative feedstock for gasification is the wood pellets, because its production cost can keep the consumers paying for electricity throughout the project's lifetime.

Social Implication. Apart from controlling the unending phenomenon, the biomass is readily available which makes it the cheapest renewable energy sources for small scale power generation. Rural electrification unlocks the development potential of rural areas; provisions of biomass to the gasification plants, local farmers can generate extra income. Also, the plant operation brings about job opportunities to the local people.

Limitations. Due to the unavailability of gas monitoring devices in the country, the existing plant's emissions could not be analyzed. Also, due to confidentiality policies within different organisations, comparisons of solar energy and the grid extension against BG in terms of financial feasibility were not derived.

Renewables-based drying technology for cost-effective valorisation of waste from the food processing industry – DRALOD

Özge (Çepelioğullar) Mutlu
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH
Torgauer Straße 116
04347 Leipzig, Germany
oezge.cepeliogullar.mutlu@dbfz.de

Co-Authors: Daniel Büchner, Thomas Zeng

The EU27 annually generates 90 million tonnes of food waste, which stands as an important environmental problem, not only in terms of resource efficiency, but also because each tonne of food waste corresponds to two tonnes of CO_2 emission, in average. Therefore, food-processing industry needs sustainable solutions for waste valorization and re-use. In addition, it is already known that increasing the share of the renewable energy sources in long-term energy projections has become an important task for the countries. Although renewable sources have many promising application areas individually, hybrid systems in which more than one of these technologies combined have drawn significant attention lately for compensating their drawbacks along with their flexibility in operation[2]. From this perspective, DRALOD project aims to combine solar and biomass energy technologies. The project is performed in close co-operation with the partners from different European countries including PERNIA (Spain), RISE (Sweden), DBFZ (Germany) and Ökotherm (Germany) within the framework of EU Horizon 2020 under the grant agreement 820554.

The main aim of the DRALOD project is to create an alternative solution in drying process, using solar energy as the primary source with a back-up biomass heating plant to dry especially food processing residues with high moisture content up to 80%. A pilot plant will be developed to operate with capacity to dry 35,000 ton materials per year with a ~2,500 m^2 installation for solar air drying, an air ducting system for ~150,000 m^3/h, a biomass system of 1MW, a drying tunnel and auxiliary systems. To create a more sustainable and cost-effective overall plant, different biomass residues based on their local availability will be used as fuel in the boiler.

The main focus of the presentation will be the development of such a plant, which includes different sub-systems as well as many operational parameters, that bears some challenges, especially in terms of the control strategy. In this regard, a detailed process development has to be carried out in order to fully understand the thermodynamically interactions of each sub-system such as solar walls, dryer, and the biomass boiler. Therefore, Aspen Plus, as one of the most common process simulators, was chosen to model the pilot plant. Afterwards, a sensitivity analysis was performed to gain insight about the influence of operational parameters such as air temperature, airflow rate, moisture content of the feedstock etc. on the thermodynamic efficiency of the overall system. The obtained simulation results were further validated with the plant operational data. In addition, the cost-optimization of solar and biomass systems was investigated to dry continuously at low drying temperatures. Based on this, a smart control strategy enabling for a cost-optimal plant operation based on the solar-biomass energy mix were derived using Matlab/Simulink.

In the light of these tasks, the important parameters for realizing a control strategy for an efficient operation of the drying plant based on the solar-biomass energy mix while preserving the critical quality parameters of the drying material (e.g. uniformity, elimination of pathogens, preservation of nutrients and organoleptic qualities) were studied in detail.

Potential and limitations of the single-pellet-press concept for biomass assessment and process design

Wilfried Pichler
Holzforschung Austria
Franz Grill Straße 7
1030 Vienna, Austria
w.pichler@holzforschung.at,

Co-Authors: Martin Weigl, Richard Götzl

Whereas the single-pellet-press (SPP) concept was first invented within the 1980´s, nowadays scientific and practical interest is much higher due to the enormous potential. A single-pellet-press basically consists of one single die and a piston. The system used within this work was designed and crafted by the authors. It is installed within a 250 kN universal testing device, and the die is tempered. Two independent setups enable the separate testing of the compression behaviour and the flow process of the pellet within the die. Hence, the system is predestinated for biomass assessments with higher numbers of categories as well as for the engineering process of dies.

Within this work, spruce wood particles originating from different comminution processes were used. These raw material fractions got characterised by dynamic image analysis applying a QICPIC/RODOS system (Sympatec GmbH). For this study a screening design was applied, covering each two stages of water content (ten or 13 %), starch content (0,5 or 2 %), hammer mill sieve size (five or ten mm), portion of chips within the milling mixture (25 or 75 %), hammer mill rotary speed (80 or 100 % of maximum) as well as application of a bypass while milling (none or 3,15 mm), summing up to 16 trials. Results from the SPP-trials were compared with pilot scale trials of the same material performed at the pilot plant.

Results showed in general a good agreement between the SPP characterisation process and the biomass pilot plant trials, whereas none can replace the other. The SPP gives the opportunity to perform tests under very controlled conditions, however it is a discontinuous process. For the first time it has been shown, that SPP-trials allow predictions for process energy and for product quality.

Gasification-derived char applied to tar removal and gas upgrading in straw gasification

Giulia Ravenni
Technical University of Denmark (DTU)
Department of Chemical and Biochemical Engineering
Frederiksborgvej 39
4000 Roskilde, Denmark
grav@kt.dtu.dk

Co-Authors: Z. Sárossy, J. Ahrenfeldt, U.B. Henriksen

Gasification-derived char is considered as an inevitable waste stream generated by gasification plants, and it often implicates disposal costs that burden particularly small scale plants [1]. Reforming of tar contained in producer gas is a promising application for biomass char: several authors reported a catalytic effect of carbonaceous materials with different origins for tar cracking and reforming [2–8], also in comparison with commercial catalysts [9]. The advantages of using gasification-derived char for this purpose are to avoid costs associated with expensive metal-based catalysts while making use of a renewable and inexpensive waste material. In this work, char has been used in a gas treatment unit for the upgrading of producer gas generated by the $100kW_{th}$ Low Temperature-Circulating Fluidized Bed (LT-CFB) gasifier at DTU, Risø Campus. The LT-CFB gasifier operates with two separated stages for pyrolysis and gasification, at a maximum process temperature of 750°C. It is designed to convert cereal straw and other ash-rich feedstocks. The drawback of this technology is the severe tar load in the producer gas. The quality of the LT-CFB producer gas has been significantly improved by using residual gasification char. The char used in this study is produced in a TwoStage fixed bed gasifier (also known as "Viking" gasifier) from gasification of spruce wood chips. The residual char has a particle size suitable for fixed bed operation (with particles up to 1-2 cm), and has a specific surface area of 1253 m^2/g [10]. Gasification char from the Viking gasifier was used as bed material in a test reactor, also coupled with partial oxidation of volatiles in the zone above the bed. The producer gas was sampled before and after the passage through the reactor, with Solid Phase Adsorption (SPA) tubes and a Petersen column for the quantification and analysis of tar by GC-MS (Agilent, Denmark). The gas composition (N_2, H_2, CO, CO_2, CH_4) at the outlet of the reactor was monitored with an online gas analyzer (ABB, Denmark). In addition, characterization tests were performed on the Viking char before and after using it for gas treatment, to estimate the structural modifications caused by the experiments and investigate the mechanism of deactivation in presence or absence of air injection for partial oxidation. The elemental composition (CHN) was evaluated by an Elemental Analyzer EuroEA (Eurovector, Italy). The specific surface area was quantified by Brunauer-Emmett-Teller (BET) analysis through N_2 adsorption at 77 K (Nova 2200, Quantachrome Instruments, USA). Scanning Electron Microscopy (SEM) (ThermoFisher, USA) was used to visualize the changes in the surface structure before and after the tar reforming experiments.
Extensive tar removal up to 98% was achieved, accompanied by an improved gas composition especially in regard to the H_2 content. Char consumption and the stability of the clean gas quality were evaluated in order to define the feasibility of this gas treatment solution and envisage the possibility for upscaling.

[1] Patuzzi F, Prando D, Vakalis S, Rizzo AM, Chiaramonti D, Tirler W, et al. Small-scale biomass gasification CHP systems: Comparative performance assessment and monitoring experiences in South Tyrol (Italy). Energy 2016;112:285–93. doi:10.1016/j.energy.2016.06.077.
[2] Griffiths DML, Mainhood JSR. The cracking of tar vapour and aromatic compounds on activated carbon. Fuel 1967:167–76.
[3] Boroson ML, Howard JB, Longwell JP, Peters WA. Heterogeneous cracking of wood pyrolysis tars over fresh wood char surfaces. Energy & Fuels 1989;3:735–40. doi:10.1021/ef00018a014.
[4] Al-Rahbi AS, Onwudili JA, Williams PT. Thermal decomposition and gasification of biomass pyrolysis gases using a hot bed of waste derived pyrolysis char. Bioresour Technol 2016;204:71–9. doi:10.1016/j.biortech.2015.12.016.
[5] Park J, Lee Y, Ryu C. Reduction of primary tar vapor from biomass by hot char particles in fixed bed gasification. Biomass and Bioenergy 2016;90:114–21. doi:10.1016/j.biombioe.2016.04.001.
[6] Sun Q, Yu S, Wang F, Wang J. Decomposition and gasification of pyrolysis volatiles from pine wood through a bed of hot char. Fuel 2011;90:1041–8. doi:10.1016/j.fuel.2010.12.015.
[7] Dabai F, Paterson N, Millan M, Fennell P, Kandiyoti R. Tar formation and destruction in a fixed-bed reactor simulating downdraft gasification: Equipment development and characterization of tar-cracking products. Energy & Fuels 2010;24:4560–70. doi:10.1021/ef100681u.
[8] Phuphuakrat T, Namioka T, Yoshikawa K. Tar removal from biomass pyrolysis gas in two-step function of decomposition and adsorption. Appl Energy 2010;87:2203–11. doi:10.1016/j.apenergy.2009.12.002.
[9] Abu El-Rub Z, Bramer EA, Brem G. Experimental comparison of biomass chars with other catalysts for tar reduction. Fuel 2008;87:2243–52. doi:10.1016/j.fuel.2008.01.004.
[10] Ravenni G, Elhami OH, Ahrenfeldt J, Henriksen UB, Neubauer Y. Adsorption and decomposition of tar model compounds over the surface of gasification char and active carbon within the temperature range 250–800 °C. Appl Energy 2019;241:139–51. doi:10.1016/j.apenergy.2019.03.032.

WEBio: the web platform to identify bioresources on your territory

Charlotte Richard
ENGIE (www.engie.com)
361 avenue du Président Wilson
93210 Saint-Denis, France
charlotte.richard@engie.com

Co-Authors: Gwenael Postec, Silvia Silvestri, Luca Tomas, Elodie Le Cadre, Geoffrey Karakachian, Gian Antonio Battistel , Didier Bouniol

WEBio aims to be the first European platform to provide data access with all biomass resources georeferenced and updated each year at a local level. Improving access to these biomass data (quantity, location and characterization) will allow a new sustainable approach for bioeconomy and the principle of circular economy will be applied more easily. WEBio represents a climate smart agriculture/forestry solution through digitalization of data collection for biomasses such as by-products or waste.

A dedicated database containing information about energetical, chemical, agronomical and environmental parameters referred to four classes of biomasses has been created. It is then linked with georeferenced and quantitative data. The innovation of the project is mainly based on the management of big data from aerial, spatial captors and geographical information coupled with data at local level. The first version of the tool includes four typologies of biomasses deriving from forestry, agriculture, livestock farming and sludges from wastewater treatment plants. By digitizing the bioresource information, WEBio allows to better manage the bioresources for the development of climate positive projects and to optimize the use of biomass by minimizing the environmental impacts. In addition, WEBio allows the potential users to build up their projects in the best environmental and economic conditions. First of all, they can select the best location according to their requests to overcome one of the main difficulties today represented by the location of any industrial initiative. WEBio can target the areas where adequate biomass is potentially available for its need thanks to the geolocalisation service. Again, the tool permits to optimize the logistic costs (short chains) to limit the transport distance and secure the feedstock; this is crucial to reduce the climate impact. Moreover, it permits to estimate the climate impact of the projects in the planning phase.

Two demonstration areas were identified to test the tool. The first one is Loiret (French department) with urban and rural areas. The second one is an area of 20 km radius around the city of Trento, called “Trentino” area. The WEBio project plans to build a prototype for the Loiret area. This prototype will be tested by 3 beta testers in order to improve our tool and to reach the next step, i.e. the pilot version of WEBio. Moreover, the specifications for a pilot in Trentino area pilot will be defined during the project.

WEBio is a project supported by the EIT Climate KIC Call 2018 "Late Demonstrator Stage", which follows the first Ideator phase (2016) and the subsequent Accelerator phase (2017). It will end in December 2019.

Lagerstabilität von Holzhackschnitzeln – Bestimmung der Sauerstoffzehrung in Behältern gelagerter Holzhackschnitzel zur Ableitung des vollständig lagerstabilen Wassergehalts

Markus Riebler
Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF)
Abt. 4 Forsttechnik, Betriebswirtschaft, Holz
Hans-Carl-von-Carlowitz-Platz 1
84345 Freising, Germany
Markus.Riebler@lwf.bayern.de

Co-Autoren: Nicolas Hofmann, Frank Burger, Herbert Borchert

Holzhackschnitzel sind eine bedeutende Quelle erneuerbarer Energien, da mit ihnen auch bei ausbleibendem Sonnenschein und Wind zuverlässig Wärme und Strom produziert werden können. Die Lagerung von Holzhackschnitzeln ist ein wichtiger Schritt innerhalb der Hackschnitzelbereitstellungskette aus Waldhölzern, um den zeitlichen Versatz zwischen Produktion und Verbrauch auszugleichen. Trockenmasse- und damit Energieverluste aufgrund von mikrobiellen Abbauprozessen spielen gerade bei der Lagerung waldfrischer Hackschnitzel eine bedeutende Rolle. Diese Verluste können jedoch durch eine vorgeschaltete technische Trocknung, die in der Praxis häufig mit Abwärme von Biogasanlagen be-trieben wird, deutlich reduziert werden. Dabei kann der Wassergehalt der Hackschnitzel rasch in einen Bereich gebracht werden, der einerseits den Einsatz in Kleinfeuerungsanlagen ermöglicht, andererseits zugleich die mikrobiologische Aktivität und damit Trockenmasseverluste reduziert. In der Praxis werden Hackschnitzel häufig zu lange getrocknet, was zu Wassergehaltswerten im einstelligen Prozentbereich führt. Dies kann negative Auswirkungen auf die Verbrennung haben, indem z. B. aufgrund der zu hohen Temperaturen im Kesselraum die Rückbrandgefahr steigt oder die Schamottierung des Ofens Schaden nehmen kann. Darüber hinaus ist eine Übertrocknung aus energetischer, ökonomischer und auch ökologischer Sicht ineffizient. Für die Lagerfähigkeit der Hackschnitzel ergibt sich durch die Übertrocknung auch kein zusätzlich positiver Effekt. Der Wassergehaltswert, bei welchem Holzhackschnitzel lagerstabil sind, wurde bisher nicht tiefergehend untersucht, sodass sich in der Literatur Werte zwischen 15 w-% und 30 w-% finden. Ziel des im Mai 2019 abgeschlossenen Forschungsprojekts „Effiziente Lagerungs- und Aufbereitungsverfahren für Holzhackschnitzel“, welches die Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF) und das Technologie- und Förderzentrum Straubing (TFZ) in enger Kooperation durchgeführt haben, war es, den lagerstabilen Wassergehaltswert für die beiden Ausgangssortimente „Waldrestholz“ und „Energierundholz“ so genau wie möglich zu bestimmen. Eine geeignete Methode, um die Lagerstabilität hinreichend genau beurteilen zu können ist die Messung des Restsauerstoffs in abgeschlossenen Behältern innerhalb eines definierten Zeitraums, da jegliche Sauerstoffabnahme in den Eimern -im Vergleich zu den in der Atemluft enthaltenen 20,9 Vol-% Sauerstoff- auf mikrobielle Aktivität und damit auf Abbauprozesse schließen lässt. Hierfür wurden im Freiland gelagerte Fichtenhackschnitzel im Trockenschrank bei 60 °C auf Wassergehaltswerte zwischen 3 und 32 w-% konditioniert und danach in luftdicht verschlossenen 10 l-Eimern für 48 Stunden bei 21 °C und 34 °C gelagert. Am Ende der Lagerzeit wurde der in den Eimern verbliebene Restsauerstoff über ein Ventil mit Hilfe einer Ballonpumpe abgesaugt, zur Trocknung über eine Kieselgelkartusche geleitet, um die Qualität der Messung zu erhöhen, und mit Hilfe eines zuvor kalibrierten Luftsauerstoffmessgeräts (GOX 100) bestimmt. Der Trockenmasseverlust wurde stöchiometrisch errechnet. Insgesamt wurden mit dieser Methode innerhalb von drei Monaten 96 Proben untersucht.

Die Ergebnisse zeigen, dass Wassergehaltswert und Restsauerstoffkonzentration in den Eimern so-wohl für das Sortiment Waldrestholz, wie auch für Energierundholz statistisch signifikant korrelieren: Bei höherem Wassergehalt sinkt die Restsauerstoffkonzentration. Der Sauerstoffverbrauch wächst exponentiell mit dem Wassergehalt. Eine erhöhte Lagertemperatur führt zudem zu einem höheren Sauer-stoffverbrauch. Auch die Lagerdauer in der Miete bis zur Durchführung des Experiments beeinflusste die Sauerstoffzehrung. Ein mit Hilfe einer multiplen Regression erstelltes statistisches Modell kann etwa 90 % der Streuung beim Sauerstoffverbrauch erklären. Aus dem Sauerstoffverbrauch wurde rechnerisch der Trockenmasseabbau abgeleitet. Es gibt beim Wassergehalt keinen Schwellenwert, unterhalb dessen kein Abbau mehr stattfindet. Auch bei sehr trockenen Hackschnitzeln wird Sauerstoff verbraucht, wenngleich dies vermutlich keine mikrobielle Ursache hat. Der Betreiber eines Hackschnitzellagers muss sich deshalb überlegen, welchen Trockenmasseverlust er in Kauf nehmen möchte. Aus einer Tabelle kann dann der Zielwassergehalt entnommen werden, auf den die Hackschnitzel getrocknet werden müssen, um den veranschlagten Trockenmasseverlust nicht zur überschreiten.

Bio-Hub Ecosystems: Profitability through Circularity for Sustainable Forestry, Energy, Agriculture and Aquaculture

Kimberly Samaha
Chief Executive Officer
Born Global LLC
254 Commercial Street
Portland ME 04101, USA
ksamaha@born-global-inc.com

The Bio-Hub Ecosystem model was developed to address a critical area of concern within the global energy market regarding biomass as a feedstock for power plants. Yet the lack of an economically-viable business model for bioenergy facilities has resulted in the continuation of idled and decommissioned plants.

This study analyzed data and submittals to the Born Global Maine Innovation Challenge. The Innovation Challenge was a global innovation challenge to identify process innovations that could address a 'whole-tree' approach of maximizing the products, byproducts, energy value and process slip-streams into a circular zero-waste design. Participating companies were at various stages of developing bioproducts and included biofuels, lignin-based products, carbon capture platforms and biochar used as both a filtration medium and as a soil amendment product.

This case study shows the QCA (Qualitative Comparative Analysis) methodology of the prequalification process and the resulting techno-economic model that was developed for the maximizing profitability of the Bio-Hub Ecosystem through continuous expansion of system waste streams into valuable process inputs for co-hosts. A full site plan for the integration of co-hosts (biorefinery, land-based shrimp and salmon aquaculture farms, and tomato green-house and a hops farm) at an operating forestry-based biomass to energy plant in West Enfield, Maine USA.

This model and process for evaluating the profitability not only proposes models for integration of forestry, aquaculture and agriculture in cradle- to-cradle linkages of what have typically been linear systems, but the proposal also allows for the early measurement of the circularity and impact of resource use and investment risk mitigation, for these systems.

In this particular study, profitability is assessed at two levels CAPEX (Capital Expenditures) and in OPEX (Operating Expenditures). Given that these projects start with repurposing facilities where the industrial level infrastructure is already built, permitted and interconnected to the grid, the addition of co-hosts first realizes a dramatic reduction in permitting, development times and costs.

In addition, using the biomass energy plant's waste streams such as heat, hot water, CO2 and fly ash as valuable inputs to their operations and a significant decrease in the OPEX costs, increasing overall profitability to each of the co-hosts bottom line.

Economically viable Bio-Hubs with favorable environmental and community impacts may prove critical in garnering local and federal government support for pilot programs and more wide-scale adoption, especially for those living in severely economically depressed rural areas where aging industrial sites have been shuttered and local economies devastated.

Optimierung der thermischen Biomassenutzung durch Autoklavierung

Marvin Scherzinger
Technische Universität Hamburg (TUHH)
Eißendorfer Str. 40
21073 Hamburg, Germany
marvin.scherzinger@tuhh.de

Co-Author: Martin Kaltschmitt

Gegenwärtig können einige biogene Abfallstoffe wie z.B. Grünschnitt und Laub im Stoffstrommanagement einiger städtischer Entsorgungsunternehmen entweder nicht oder nur ineffizient genutzt werden. Auch in bereits bestehenden Verfahren wie z.B. der anaeroben Vergärung können diese Stoffströme nicht weiter verwertet werden. Im Sinne einer ganzheitlichen Nutzung von Reststoffströmen wird daher untersucht, ob mit Hilfe des Verfahrens der Autoklavierung eine Aufbereitung dieser Stoffströme realisiert werden kann. Ziel ist es, dadurch entwässerte und lagerfähige biogene Festbrennstoffe zu erzeugen. Diese könnten gegebenenfalls als Substitut für fossile Brennstoffe genutzt werden und damit einen Beitrag zur Minderung der Treibhausgasemissionen leisten.

Das Verfahren wird derzeit im Technikumsmaßstab in einem elektrisch beheizten Rollautoklav getestet. Die noch feuchte Biomasse wird darin unter ständiger Durchmischung auf Temperaturen zwischen 120 °C und 180 °C aufgeheizt. Durch das Verdampfen von Teilen des Wassers aus der Biomasse stellt sich dabei ein erhöhter Druck im Reaktor ein. Anschließend an die Behandlung werden hauptsächlich die Änderungen der Stoffströme im Bereich des Brennwerts, des Wassergehalts, der Mahlbarkeit sowie der Hydrophobizität untersucht. Anfallende Nebenstoffströme wie z.B. der kondensierbare Anteil des Dampfes werden zusätzlich in Anlehnung an die VDI-Richtlinie 4630 auf ihr Biogasbildungspotential untersucht. Erste Ergebnisse deuten darauf hin, dass Teile der eingesetzten Edukte durch das Verfahren der Autoklavierung zersetzt werden und die genannten Ziele erreicht werden können.

Sophena – Open-Source-Software zur Planung von Heiz(kraft)werken und Nahwärmenetzen

Wolfram Schöberl
C.A.R.M.E.N. e.V.
Schulgasse 18
94315 Straubing, Germany
ws@carmen-ev.de

Die Open-Source-Software "Sophena" bietet die Möglichkeit, die technische und ökonomische Planung eines Wärmeversorgungsprojekts schnell und fundiert durchzuführen. Herzstück von Sophena ist eine Kessel- und Pufferspeichersimulation, aus der Jahresdauerlinien und energetische Kennzahlen ermittelt werden. Dabei können auch KWK-Anlagen und Wärmepumpen berücksichtigt werden. Aufbauend auf diesen Berechnungen wird eine Wirtschaftlichkeitsbetrachtung durchgeführt. Weitere Ergebnisse sind unter anderem eine Treibhausgasbilanz und Effizienzkennzahlen des Projekts.

Mit Sophena wird eine Produktdatenbank zur Verfügung gestellt, in der Heizkessel, KWK-Anlagen, Wärmepumpen, Pufferspeicher, Rauchgasreinigungstechnologie, Wärmerückgewinnungsanlagen, Wärmeleitungen und Hausübergabestationen enthalten sind. Partnerfirmen sind hier Bosch, Buderus, Enerpipe, Guntamatic, Hargassner, Reflex-Winkelmann, Rehau, Schräder, Spanner Re_2, Viessmann und Yados.

Durch die Weiterentwicklungen der Version 2.0, die im April 2019 veröffentlicht wurde, ist Sophena noch flexibler einsetzbar. So können nun z.B. durch die Integration einer Schnittstelle zu Erzeugerlastgängen auch Solarthermieanlagen oder industrielle Abwärme betrachtet werden.
Sophena kann nach einer Registrierung kostenlos von der Website von C.A.R.M.E.N. e.V. heruntergeladen werden. Seit der Veröffentlichung im Juli 2016 haben sich bereits 1.500 Nutzer registriert.

Nach einer kurzen Einführung wird im Hauptteil des Vortrags die Software anhand eines Beispielprojekts live vorgeführt. Abschließend wird auf die geplante Weiterentwicklung (u.a. Mehrsprachigkeit) eingegangen.

Longterm monitoring of NO_X emissions depending on wood chip quality in a medium sized combustion plant

Claudia Schön
Technology and Support Centre in the
Centre of Excellence for Renewable Resources (TFZ)
Schulgasse 18
94315 Straubing, Germany
Claudia.schoen@tfz.bayern.de

Co-Authors: Paul Roßmann, Hans Hartmann, Gerhard Schmoeckel

Purpose
The medium combustion plant directive (MCPD) is now being transferred into German law for combustion plants with a thermal heat output between 1 and 50 MW. Within this regulation, flue gas emissions (CO, NO_X and PM) will be limited to certain values depending on the thermal heat output of the plant. Especially for combustion plants with a heat output from 1 to 5 MW there is a lack of knowledge concerning the variability in the formation of NO_X emissions as caused by the usual variation of fuel properties during a complete heating season. The major fuel parameter in focus is the nitrogen content in the fuel itself. But other important parameters are also monitored, such as moisture content, ash content, bulk density, particle size distribution and element content from elementary analysis.

Approach
Within this investigation a 1.3 MW biomass combustion plant at the Technology and Support Centre in Straubing was monitored for gaseous emissions almost over the entire heating period starting from October 2018 until April 2019. This combustion plant is operated with wood chips mainly from forest residues from local wood chip producers. During each fuel delivery fuel samples were sys-tematically taken and analysed regarding their physical and chemical properties. Based on the fuel properties with main focus on the nitrogen content in the fuel, some correlations were postulated between the nitrogen content in the fuel and the NO_X emissions in the exhaust as well as on the boiler load. The fuel assortment comprised wood chips made from stem wood, various forest residues, short rotation coppice or landscape maintenance; this is to cover a wide range of nitrogen contents in the fuel.

Results and Conclusion
During the monitoring time about 630 tones of wood chips (39 deliveries) were combusted in the TFZ combustion plant. The nitrogen content of the wood chips ranged between 0.05 to 0.44 w-%. Also other fuel parameters were recorded such as the moisture content ranging between 19 and 51 w-%.. A clear influence of the fuel nitrogen on the NO_X emission was detected. Moreover, the boiler load also influenced the NO_X emissions. For all stem wood assortments the future NO_X limiting value was not exceeded. For wood chip assortments having a nitrogen content above 0.4 w-% the NO_X emission were always above 370 mg/Nm³ (6 % O_2).

Life Cycle Assessment and economic perspectives of microbial biosurfactants' production with substrates from sugar industry

Andreas Schonhoff
Forschungszentrum Jülich GmbH
Institute of Energy and Climate Research
Wilhelm-Johnen-Straße
52425 Jülich, Germany

Co-Authors: Petra Zapp, Andrea Schreiber

Increasing interest and necessity of resource-saving and environmental sustainability of products and their production processes require the substitution of fossil and land-intensive commodities. Instruments such as Life Cycle Assessment (LCA) in line with ISO 14040/14044 and established guidelines for economic evaluation procedures can be used to assess the usefulness and sustainability of such process chains.

With production quantities in an eight-digit tonnage range and revenues from 25 to 30 billion €/a the large market of surfactants is the starting point of the Bio²-project which deals with the microbial and technical requirements for the production of next generation biosurfactants like Rhamnolipids (RL) and Mannosylerythritol lipids (MEL D). In the sense of a production that is assumed to be sustainable, by-products of the sugar industry (sugar beet pulp, molasses) are foreseen as substrates for the surfactants production by suitable developed microbial strains based on *Pseudomonas Putida* (RL-production) and *Ustilago maydis* (MEL production). With the aim of a well performing, reliable and efficient product-specific developed process chain, different chains for RL and MEL are investigated.

In order to be able to classify the developed biosurfactants in the sense of a holistic approach, investigations of environmental and economic impacts are necessary. The required data for an evaluation are determined in laboratory and pilot plant trials (up to 150 L fermenter volume) or derived from these data for different analyses on the industrial scale.

A closer view on the results of the LCA allows the tracking of potential improvement options during the development process (e.g. recycling options) and possible environmental impacts. Furthermore, energy or material intensive process stages and modules are identified by the included inventory analysis. By the comparison of different processing routes for the different products and substrates, it is possible to answer the question, which option is the most favorable.

A detection of the costs offers the possibility to identify price driving cost items and saving potentials. Both investment cost and operation costs are the starting point for further analysis with the help of a determination of economic indicators. In addition, the inclusion of today's market conditions and possible future developments enables the development of scenarios by the identification of worthwhile market segments and the estimation of possible sales volumes.

This contribution gives an overview of the environmental impacts of developed process options caused by the production of defined microbial biosurfactants. Embedded in the (bio-) surfactant market context the presented results classify the economic and environmental competitiveness of different developed processing options and examine future perspectives.

Technological Assessment of Hemicellulosic Ethanol Production from Sugarcane Bagasse

Débora Danielle Virgínio da Silva
Department of Biochemistry and Chemical Technology
Institute of Chemistry
Sao Paulo State University-UNESP
Araraquara 14801309, Brazil
debora.virginio@unesp.br

Co-Authors: Sâmila Gabriella Coelho de Almeida, Maria das Graças de Almeida Felipe, Silvio Silverio da Silva, Kelly Johana Dussán

In this study, technological assessment of hemicellulosic ethanol production from sugarcane bagasse was accomplished using Aspen Plus software. The simulation was feed with experimental data of chemical characterization of sugarcane bagasse and operational condition of pre-treatment, detoxification and fermentation stages. The conditions for separation and purification stages was considered by the literature data. A simulation procedure was used for calculated mass and energy balances that allowed obtaining energy consumption of the all units used in the global process of hemicellulosic ethanol production. The results showed that the separation and purification stages consume more energy. The process was analysed utilizing the energy consumption needed to produce 1kg of anhydrous ethanol. The hemicellulosic ethanol production process required 256 kW per kg of product. It is necessary include energy improvement using the concept of energy integration, which allows taking advantage of the cold and hot utilities. The energy savings could result in less environmental impact as well as lower hemicellulosic ethanol production cost, boosting the incorporation of hemicellulosic fraction of sugarcane in biorefineries.

High efficient heat extraction from biomass heating plants by an innovative integration of heat pumps in flue gas condensation

Philipp Standl
Professur für Regenerative Energiesysteme
Schulgasse 16
94315 Straubing, Germany
Philipp.standl@tum.de

In many European countries, the number of biomass heating plants has increased significantly in the early 90s. In Germany, around 1,200 biomass heating plants have been built with a thermal power of > 500 kW each. Along with the development of biomass heating plants, many local heating networks have been implemented. Heating networks provide an emission-free heat supply for surrounding houses and/or other facilities in the local area. Heating networks usually operate for many decades with up to 50 years possible. In general, refinancing heating networks in urban areas takes about 15-30 years. However, biomass heating plants are designed for around 20 years. Thus, operators of many biomass heating plants from 1995 to 2005 will have to make new investments into system components, like firing installation, boiler, and pumps. With new investments, operators have the chance to undertake efficiency-enhancing measures additionally.

Back in the early 90s, biomass heating plants have been designed poorly regarding the conversion efficiency of biomass to heat due to the cheap prices of biomass feedstock. For that reason, old biomass heating plants and local heating networks often operate with high losses. The efficiency of such biomass heating plant can be described by the annual efficiency. The average annual efficiency is around 70% for biomass heating plants. Following optimizations of biomass heating plants are expected to enhance the efficiency (increase of annual efficiency in percent of the overall system):

Reducing flue gas losses by flue gas condensation (10-20%)

- Reducing flue gas losses by integration of an economizer (3-6%)
- Reducing the storage time of the biomass feedstock (2-5%)
- Optimizing the temperature of the local heating network (1-5%)
- Optimizing the local heating network pumps (1-2%)

An integration of a flue gas condensation shows the highest potential for increasing the annual efficiency of a biomass heating plant. For that reason, the focus of this research project will be specifically on this measure.

A biomass heating plant in combination with a local heating network is a complex system that interacts with each other. Consequently, the returning temperature of the local heating network flow has to be taken into consideration when trying to enhance the annual efficiency of a biomass heating plant by integration of a flue gas condensation system. Especially in Germany, the temperature of returning flows are higher than 55°C. However, to condensate flue gas a temperature lower than 55°C is needed. The innovative idea is to close the gap by integrating a heat pump which takes heat of temperatures lower than 55°C and electric energy to provide heat of temperatures higher than 55°C.

For the reason of rising prices of biomass feedstock, low costs for fossil energy, and new technologies for heating facilities, researching within the topic of high-efficient biomass heating plants is more important than ever. More than 20% CO2 emissions can be saved by implementing mentioned efficiency-enhancing measures.

Nachhaltige Klärschlammverwertung in Regionen mit geringer Bevölkerungsdichte

Julia Straub
Technologiezentrum Energie
Wiesenweg 1
94099 Ruhstorf a. d. Rott, Germany
Julia.straub@haw-landshut.de

Co-Authors: Diana Hehenberger-Risse, Josef Hofmann

In den vergangen Jahren wurden die gesetzlichen Anforderungen an die Verwertung von Klärschlamm in der EU und in Deutschland verschärft. Die Umsetzung dieser Anforderungen führt zu einer Steigerung der Kosten für die Klärschlammentsorgung und damit zu einer Steigerung der Abwasserbehandlungskosten. Diese Kosten werden auf die Abwassergebührenzahler umgelegt, wodurch bevölkerungsarme Regionen besonders stark betroffen sind. Weiterhin sind die Reinigung von Abwasser und die Behandlung des dabei anfallenden Klärschlammes mit zahlreichen Umweltauswirkungen verbunden. Die Behandlung des Abwassers auf Kläranlagen ist insbesondere durch die Sauerstoffversorgung der biologischen Reinigungsstufe äußerst energieintensiv. Mit dem gereinigten Abwasser gelangen Stoffe, wie beispielsweise Phosphor oder Stickstoff in den Vorfluter, was zu Eutrophierung von Gewässern führen kann. Der Klärschlamm, der bei der Reinigung von Abwasser entsteht, bedarf einer weitergehenden Behandlung.

Nahezu 30 % des in Deutschland anfallenden Klärschlammes werden derzeit noch landbaulich oder landwirtschaftlich verwertet [1]. Hierdurch gelangen, neben den im Klärschlamm enthaltenen Nährstoffen, auch Krankheitserreger, Medikamentenrückstände, Mikroplastik und Schwermetalle über den Boden in die Umwelt. Durch eine thermische Behandlung, zum Beispiel durch Verbrennung, kann der Klärschlamm hygienisiert werden. Um eine selbstgängige Verbrennung sicherzustellen, muss der Schlamm jedoch zuerst, unter Einsatz elektrischer und thermischer Energie, entwässert und getrocknet werden. Da bisher nur eine geringe Anzahl an geeigneten Anlagen zur thermischen Behandlung von Klärschlamm existiert, sind die Transportwege häufig sehr weit. Die thermische Verwertung umfasst auch die Mitverbrennung des Klärschlammes beispielsweise in einem Kohlekraftwerk. In diesem Fall bleiben die enthaltenen Nährstoffe zwar größtenteils erhalten, werden aber so stark verdünnt, dass eine gezielte Rückführung in den natürlichen Nährstoffkreislauf nicht mehr möglich ist.

Im Jahr 2017 wurden durch die Novellierung der Klärschlamm- und der Düngemittelverordnung die Anforderungen an die bodenbezogene Verwertung von Klärschlamm verschärft und eine Pflicht zur Rückgewinnung von Phosphor wird sukzessive eingeführt. Eine Anpassung der derzeitigen Abwasserbehandlung und Klärschlammverwertung ist also nicht nur aus ökologischer Sicht notwendig, sondern wird auch auf gesetzlicher Ebene gefordert. Die Anpassung der Entsorgungsstruktur muss dabei, neben den gesetzlichen und ökologischen Anforderungen, unbedingt die wirtschaftlichen und sozialen Interessen der Region berücksichtigen, um nachhaltig bestehen zu können. Zu diesem Zweck wird ein System entwickelt, das die Nachhaltigkeit der Abwasser- und Klärschlammbehandlung in einem ganzheitlichen Ansatz bewertet. Das Ziel dieser Studie ist die Entwicklung eines Ansatzes zur Bewertung der ökologischen, ökonomischen und sozialen Nachhaltigkeit der Abwasserbehandlung und des Klärschlammbewertungspfades in Regionen mit einer geringen Bevölkerungsdichte. Die deutsch-tschechische Grenzregion um die Landkreise Tirschenreuth und Cheb dient hierbei als Modellregion, an deren Beispiel die Bewertung durchgeführt wird. Diese erfolgt durch Indikatoren zur Beurteilung ökologischer, ökonomischer und sozialer Aspekte. Somit wird eine Entscheidungsgrundlage geschaffen, die für die Konzeption des gesamten Behandlungs- und Verwertungspfades, inklusive der Transportlogistik, einer Region verwendet werden kann.

Ziel ist die Entwicklung einer ökologisch, technisch und wirtschaftlich optimalen Verfahrenskette für die Behandlung von Abwasser und Klärschlamm im Sinne der Kreislaufwirtschaft, sodass bei einem stabilen Abwasserpreis negative Umweltauswirkungen reduziert werden.

[1] Statistisches Bundesamt. Entsorgung von Klärschlamm in Deutschland nach Entsorgungswegen im Jahr 2017. Zugriff am 22. Mai 2019. Verfügbar unter https://www-genesis.destatis.de/genesis/online

Feinstaubmessung mittels Black Carbon Monitor im alpinen Raum

Christof Sumereder
FH Joanneum – Institut Energie-, Verkehrs- und Umweltmanagement
Werk-VI-Straße 46
8605 Kapfenberg, Austria
christof.sumereder@fh-joanneum.at

Co-Authors: Ulrike Zankel-Pichler, Josef Bärnthaler, Markus Dornhofer, Melanie Horn, Jeannine Schieder, Matthias Theissing

Steiermark ist ein Hotspot in Sachen Feinstaub, nicht zuletzt gilt Graz als die Feinstaubhochburg in Österreich mit den meisten Messwertüberschreitungen. Die Entstehung, Emission und Ausbreitung von Feinstaub ist noch nicht restlos geklärt. Durch die kürzlich publizierten Studien der WHO und anderer medizinischen Forschungsinstitutionen hinsichtlich der gesundheitsschädigenden Auswirkungen und der erhöhten Mortalitätsrate in der Europäischen Union hat das Thema Feinstaub immens an Bedeutung gewonnen.

Im Rahmen des Projekts BB-Clean hat das Institut EVU an der FH Joanneum einen neuen Feinstaubmonitor installiert, der es ermöglicht die Quellen der Emission zu unterscheiden. Durch eine spektrale Transmissionsmessung können in diesem Aethalometer unterschiedliche Wellenlängen am schwarzen Feinstaub (Black Carbon) detektiert und zwischen der unvollständigen Biomasseverbrennung und jener aus fossilen Brennstoffen unterschieden werden. Das Resultat lässt einen Schluss auf die Feinstaubemission durch Biomasseheizungen (Holz, Pellets) oder durch fossile Brennstoffe (Verrennungskraftmaschinen, Straßenverkehr) zu.

Das neue Messverfahren wird derzeit in der Gemeinde Thörl über eine gesamte Heizperiode angewendet. In diesem Beitrag wird das neuartige Messverfahren beschrieben und erste Messergebnisse vorgestellt.

@Interreg Alpine Space
BB-Clean

Removal of H_2S and siloxanes by low-cost activated material

Esther M. Takaluoma
University of Applied Science Kajaani
Kuntokatu 1, Tieto 2
Fi-87100 Kajaani, Finland
Esther.Takaluoma@kamk.fi

Co-Authors: Antti Rimpiläinen, Jani Heikkinen, Kai Tiihonen

Siloxanes and H_2S are undesirable contaminants in biogas and require careful removal before combustion or injection into the grid. Especially the existence of siloxanes from the digestion of wastewater sludge and landfills are a concern when used in combustion engines. While several cyclic and linear siloxanes can be found in biogas, the most prevalent siloxanes are hexamethyldisiloxane, L2, and decamethylcyclopentasiloxane, D5.

In this study, we report the removal of L2 and D5 by amorphous, alkaline activated aluminosilicate, geopolymer) on a lab-scale experiments. The raw aluminosilicate source, metakaolinite, was treated with 8 M NaOH in a ratio of 1 to 0.3 and granulated using laboratory scale mixer. Fractions of 0.25 mm to 1 mm were sieved and used for siloxane removal experiments. The effect of addition of aluminium oxide, analcime, and zinc oxide to the aluminosilicate source has been studied, as well as the effect of pH.

The siloxane concentration was measured online with commercial FT-IR spectrometer calibrated to detect siloxanes in small concentration (Qualvista QBM-100). In laboratory scale, the adsorbents showed a capacity of 1.5 – 6 mg/kg for siloxanes. A lower pH is beneficial for siloxane removal. The material was tested at a commercial biogas plant at a flow of 1-3 m^3/h and 300 mbar pressure. The initial siloxane concentration fluctuated between 14 and 25 mg/m^3. The tests confirmed the previously determined adsorption capacity. Additionally, the geopolymers have shown high capacity for H_2S removal.

In this paper, the results of laboratory work, the upscale of adsorbents, and piloting is discussed together with an economic outlook of the production of geopolymers versus activated carbon for siloxane and H_2S removal.

Trace Element Behavior in Wood fueled Heat and Power Stations in Terms of an Urban Mining Perspective

Julian Tejada
University of Applied Forest Sciences Rottenburg
Schadenweilerhof
72108 Rottenburg am Neckar, Germany

Co-Authors: Jürgen Wiedenmann, Bernd Gall, Bernd Kaiser, Oliver Greißl, Sven Unterberger, Andreas Kappler, Harald Thorwarth

Trace elements occur in a broad variety in natural wood fuel as well as in industrial waste wood fuels in considerable concentrations. Those trace elements can be toxic but they can also be valuable. When wood fuels are combusted in heat and power plants, the trace elements end up in the ash fractions of these installations e.g. (bottom ash, and fine- respectively fly ash). Those ash fractions differ significantly in terms of trace element concentrations, and are therefore of variable quality. On the one hand side they can be a matter of cost intensive disposal.

On the other hand they are a resource of valuable elements demanded by future technologies in an urban mining perspective. Understanding the single pathways of the different elements and their behavior during combustion as well as in the potentially available flue gas cleaning facilities in heat- and power plants, it is possible to predict element concentrations in single ash fractions. The results of this work show the differences of trace element concentrations in wood fuels fired in four different heat- and power plants as well as in the different ash fractions precipitated between the combustion chamber and the chimney. The results of the mass balances of 23 analyzed elements, calculated for four different plants, show that the element behavior in wood fired stations is comparable to the behavior in coal fired stations. The individual element concentrations in the different ashes are determined by a number of different properties.

Those are, the element concentration in the fuel, the volatility of the single elements, the availability and operation of different flue gas cleaning facilities. The concentration of trace elements in bottom and especially in fly ashes of wood fired heat- and power stations are in comparable concentrations as found in economic important ores such as magnetite. The ashes from industrial wood combustion systems can therefore be considered as a valuable resource instead of a hazardous substance.

Production of biogenous liquid and solid energy carriers via the bioCRACK process and subsequent product upgrading

Klara Treusch
BDI-BioEnergy International GmbH
Parkring 18
8074 Raaba-Grambach, Germany
klara.treusch@bdi-bioenergy.com

Co-Authors: Nikolaus Schwaiger, Peter Pucher, Edgar Ahn, Matthäus Siebenhofer

The bioCRACK process

Science is racing against time to stop global warming sooner rather than later, keeping the status quo of living standard. This includes a change from fossil to sustainable biogenous resources for energy provision. Direct biomass liquefaction via the bioCRACK process[1,2] and subsequent liquid and solid product upgrading[3] is one possibility for advanced biofuel production. Therefore, lignocellulosic biomass is pyrolysed in a liquid heat carrier oil, preferably a high boiling side stream of petroleum refineries. Thus, a synergic effect unfolds: biomass benefits from a high heat transfer through the oil contact and the heavy oil fraction is cracked even more intensively by the reactive biomass. Afterwards, non-polar biomass fragments and cracked heavy oil build up a lower boiling product, the so-called bioCRACK oil, which can be upgraded to fuels via hydrogenation in existing refinery units. Polar biomass fragments on the other hand assemble in the pyrolysis oil fraction, also called liquid phase pyrolysis (LPP) oil. The residual heavy oil fraction contains the produced biochar.

Product upgrading

In order to increase the bio-carbon yield, a high recovery of all streams is aspired. Therefore, hydrodeoxygenation (HDO) of LPP oil[4] and the application of the residual oil containing biochar in a coking unit, as a completely new approach, has been investigated in lab scale.

HDO was performed at high liquid hourly space velocities of 0.5 to 3 h^{-1}, 350 to 400°C and 80 to 120 bar as a stand-alone process and as co-processing with petroleum refineries. HDO of LPP oil alone was performed in one step, resulting in products of gasoline-, kerosene-, and diesel quality with 100 wt% biogeneous carbon. For co-processing, LPP oil was hydrodeoxygenated at milder conditions of 300°C in order to enable mixing with heavy gas oil. The second step may then be performed in standard refinery hydrotreating utilities without quality losses, with varying carbon content depending on the amount of admixed pre-treated LPP oil.

Coking of the residual products was performed at 3 barg under nitrogen atmosphere at 500°C. Thus the oil yield was further increased and a high carbon coke (92wt.%) was formed. The resulting oil contained 3.3 wt.% of biogeneous carbon. In the biocoker, a coke with about 15 wt.% biocarbon was produced.

1 J. Ritzberger, P. Pucher, N. Schwaiger and M. Siebenhofer, *Chem. Eng. Trans.*, 2014, 39, 1189–1194.
2 K. Treusch, J. Ritzberger, N. Schwaiger, P. Pucher and M. Siebenhofer, *R.Soc.open sci.*, 2017, 4.
3 N. Schwaiger, R. Feiner, H. Pucher, L. Ellmaier, J. Ritzberger, K. Treusch, P. Pucher and M. Siebenhofer, *Chemie-Ingenieur-Technik*, 2015, 87, 803–809.
4 K. Treusch, N. Schwaiger, K. Schlackl, R. Nagl, A. Rollett, M. Schadler, B. Hammerschlag, J. Ausserleitner, A. Huber, P. Pucher and M. Siebenhofer, *React. Chem. Eng.*, 2018, 3, 258–266.

Building regional policies for a sustainable woody biomass exploitation for energy production in the Alpine region: an example from the Province of Trento

Sara Verones
Agenzia provinciale per le risorse idriche e l'energia
Provincia autonoma di Trento
Piazza Fiera 3
Trento, Italy,
sara.verones@provincia.tn.it

Co-Authors: Lavinia Laiti, Valter Francescato, Andrea Bello, Selene Cattani, Paolo Baggio

The territory of the Autonomous Province of Trento (Italy), in the Southern Alps, is essentially mountainous and about 60% of its surface is covered by forests. Here the use of wood for domestic heating represents a peculiar long-lasting tradition, due to the abundance of this precious renewable resource and to the local climate, characterized by long and cold winters. On the other hand, despite the significant role in reducing greenhouse gas emissions, this source is responsible for around 80% of PM10 and 99% of benzo(a)pyren local emissions respectively, leading to locally critical pollution conditions in winter, especially in the inner valleys. An additional challenge that needs to be addressed is the management of the extra residual biomass resulting from the devastating effects of Vaia storm, that broke down 5 millions of cubic meters of wood in October 2018.

A robust assessment of woody biomass resource exploitation for domestic heating use is essential in building regional energy policies, such as the new Trentino Energy and Environmental Provincial Plan 2021-2030, that will provide a special focus on sustainable biomass energy in synergy with other provincial planning instruments, like the Air Quality Plan approved in 2018.

The integration between provincial planning strategies, stakeholders consultation and external resources, such as those provided by the European environmental project LIFE PREPAIR, represents an attempt at a holistic approach to sustainable biomass energy in the Province of Trento, with attention not only to resource and energy efficiency and the climate, but also to environmental protection and air quality in particular, as well as to human health and safety.

Thanks to the additional support of the LIFE PREPAIR project, whose objective is the reduction of air pollution levels in Northern Italy, Trentino developed a comprehensive methodology for the evaluation of the use of wood fuel in small-scale heating systems, mainly devoted to housing sector.

The contribution presents the results of a survey on biomass-fuelled domestic heating system types and their evolution based on market data, with a special focus on pellet consumption. These are validated by a procedure for the analysis of the energy demand for domestic heating on data provided in the Energy Performance Certificates database and natural gas real consumptions; it allows to estimate the share of biomass over the other energy vectors. In addition, the results integrated and updated the picture provided by the provincial inventory of heating plants (S.I.R.E.) and by previous surveys on wood domestic consumption, enabling a more realistic estimate of the technological turnover rate and of the associated reduction in pollutant emissions, as well as useful insights on the actual spread of wood as integrative energy supply vector.

GHG emission saving evaluation of electricity generated from biogas produced from corn stover

Miodrag Viskovic
University of Novi Sad
Faculty of Technical Sciences-Department of Environmental Engineering
Novi Sad, Serbia
miodragviskovic@uns.ac.rs

Co-Authors: Djordje Djatko, Milan Martinov

According to Renewable Energy Directive (RED), greenhouse gas (GHG) emission saving is a sustainability criteria, which will be applicable from 2021 for electricity generation in biogas plants. Only biogas plant with more than 70 % GHG emission saving in comparison to fossil fuel comparator (183 gCO_{2eq}/MJ), will be suitable for incentive measures and electricity generation will be countable for national targets for renewable energy. It will be applicable for biogas plants that have 2 MW or more installed capacity. Default GHG emission savings for agricultural substrates, manure and corn silage, are in wide range since they depend on applied technological options, *e.g.* on digestate reservoir covering as a most important influence. According to the Directive, GHG emission savings for manure are between 85 – 240 % and for corn silage between 10 and 53 %. Manure is a sustainable substrate due to application of bonus emissions as a result of improved agricultural management, while corn silage can be sustainable only by co-digestion with manure.

In this research is investigated whether corn stover could be more sustainable substrate, comparing to corn silage, in terms of GHG emission savings. This was expected, since in the Directive available method for determination of GHG emission savings introduced measure that only emissions starting from stover collection should be accounted for balance.

Starting point of investigation was determination of biogas yield and composition, done by batch experiment in accordance to VDI 4630. Continuous anaerobic digestion procedure is applied to determine degradation characteristics of corn stover and confirm the expected yields obtained in batch procedure. Results were used to assess the entire life cycle of biogas production and utilization, following the method from RED. Life cycle incorporated collection of corn stover, transport, biogas production, digestate management and electricity generation. Additionally were investigated cases if system boundaries include emissions originating from application of mineral fertilizers used for compensation of lost nutrients or if allocation of emissions is applied between biogas and digestate due to digestate application to fields other than those used for corn stover collection.

Default GHG emission savings for electricity were between 37 and 66 %. The higher saving value is a result of applied digestate reservoir cover. GHG emission savings are generally higher in comparison to corn silage, but still under the sustainability limit of 70 %. When emissions are allocated, savings reach 73 %, but this result is unrealistic since there are deficiencies of the official method in the case of emission allocation. When system boundaries included nutrients compensation, savings are significantly lower, 25 – 44 %, similar as for corn silage.

Corn stover is more sustainable substrate than corn silage, from the aspect of GHG emission saving. Still, the savings are not sufficient to fulfill sustainability criteria. Only in co-digestion with manure, utilization of this substrate can be sustainable.

Agricultural diversification of industrial crop cultivation on marginal land in Europe and the challenge of resilience conservation

Moritz von Cossel
University of Hohenheim
Institute of Crop Science
Biobased Products and Energy Crops
Fruwirthstr. 23
70599 Stuttgart, Germany
moritz.cossel@uni-hohenheim.de

Over the past decade, sustainable biomass production has become more and more associated with agricultural systems which are serving not only economic but also social-ecological demands. This implies social-ecological services such as the protection of both soil and groundwater, improved biodiversity conservation, carbon storage, soil fertility, farm flexibility, rural development, and landscape beauty. Most of the ecological services were proven to support the conservation of the agro-ecosystem resilience. Consequently, they become increasingly important for more holistic evaluation approaches of biomass production systems and their underlying bio-based value chains. In many cases, the crop selection and both the temporal and spatial crop species diversity seem to play an important role. However, it is still far from clear how this applies in case of industrial crop cultivation on marginal agricultural land, especially under aspects of both the numerous types of marginal agricultural land the projected severe climate change effects on the biophysical growth conditions on both favorable and marginal agricultural land across Europe.

Many studies have investigated the potential performances and environmental impacts of various individually defined agricultural research fields. These include comprehensive studies on the monetization of ecosystem services within agricultural systems and thorough investigations on the long-term environmental benefits of perennial industrial crops on marginal agricultural land. However, there is still a huge knowledge gap on how to connect all this information in case of marginal agricultural land utilization with industrial crops. Therefore, the present study aims at the development of marginal agricultural land low-input systems (MALLIS) for industrial crop cultivation which are sustainable from both a bottom-up and top-down perspective. This study builds upon both literature and own investigations.

Preliminary results indicate, that numerous industrial crop species are suitable for marginal agricultural land utilization across Europe. Therefore, the development of highly diverse and thus resilience conserving MALLIS seems realistic. However, the climate change-forced shifts in annual precipitation will be challenging for the cultivation of annual industrial crops. Thus, there might be a shift towards perennial industrial crops on marginal agricultural lands across southern Europe in the future to enable a long-term sustainable provision of biomass for a steadily growing bioeconomy.

Improving energy efficiency in biogas-powered CHPs by implementation of solid oxide fuel cell systems and bidirectional operation

Jeremias Weinrich
Technical University of Munich
Campus Straubing for Biotechnology and Sustainability
Schulgasse 16
94315 Straubing, Germany
jeremas.weinrich@tum.de

Co-Authors: Stephan Herrmann, Felix Fischer, Maximilian Hauck, Hartmut Spliethoff, Matthias Gaderer

Electricity generation from biomass is, in contrast to wind and solar energy, one of few renewable energy sources that can supply base load power and therefore plays a key role in decarbonizing our energy system. In Germany, the biggest share of biomass to electricity is by thermal conversion of biogas in gas engine. Unfortunately, these internal combustion engines (ICEs) exhibit rather poor efficiencies between 28 – 47 %. Solid oxide fuel cells (SOFC), on the contrary, have already demonstrated exergy efficiencies exceeding 90 % and can therefore possibly double the net conversion efficiency by replacing an ICE-CHP with an SOFC-based CHP. However, these fuel cells are still too expensive to compete with gas engines economically.

Within the project BioCORE (Biogas Conversion with Reversible Electrolysis), we aim to overcome this downside by taking advantage of all of the SOFCs possibilities. Our approach is to combine high efficiency with flexibility provided by the possibility of reversible operation.

The use of solid oxide fuel cells that have already shown exergy efficiencies exceeding 90% allows for a highly efficient energy conversion of biogas to electricity. In addition, a novel system setup allows for up to 100 % fuel utilization and high-exergy for the remaining but small share of waste heat. This potentially leads to electrical net conversion efficiencies of around 80 %.

The second pillar of our approach is to operate the solid oxide fuel cell (SOFC) as a solid oxide electrolysis cell (SOEC). By reversing the operation mode, we generate hydrogen by water electrolysis that we convert to methane afterwards. This operation mode draws electricity from the electrical grid while it feeds methane into the gas grid as synthetic natural gas (SNG).

The possibility to switch operation modes allows for a beneficial operation with regard to the electrical grid. In times of high demand, a BioCORE plant generates electricity with a very high electric efficiency. In times of in times of surplus electricity, the plant draws electrical energy and converts it to SNG. This sector-coupling power-to-gas mode stabilizes the electrical grid and is a means of electrical energy storage, as the SNG can be reconverted to electricity (e.g. in modern CCGT plants).

To prove the high expectations we have put in this technology, we will study the system performance within a validation project funded for 3 years by the German Federal Ministry of Education and Research. Therefore, we design and construct of a fully functional demonstration plant with 10 kW_{el} rated electric capacity for an extensive field test at a standard biogas plant with raw biogas. The goal is to validate the stable operation and high conversion efficiencies by a 3-month field test with continuous and alternating reversible operation modes.

The influence of the raw material drying temperature on the biomass agglomeration process

Marek Wróbel
Department of Mechanical Engineering and Agrophysics
Agricultural University in Krakow
Balicka 120
30-149 Kraków, Poland
marek.wrobel@urk.edu.pl

Co-Authors: Marcin Jewiarz, Krzysztof Mudryk,

The studies on biomass agglomeration still not covers all aspects of this process. The main goal of the agglomeration is to get granulate with the desired qualitative features with as low as possible energy used. Usual research takes into account various factors affecting this process. This are: biomass type, moisture content, degree of fragmentation, binders, time, temperature and compaction pressure. The impact of these factors is known - there are difficult (eg. straw, miscanthus) and easy (softwood) materials for agglomeration. Increase in time, pressure and temperature, improves the process as well as the degree of fragmentation increase. Raw material moisture content should fluctuate in the range of 10-15%. But there is lack in literature how drying process (especially the temperature level) affects compaction? Biomass as a lignocellulosic material consists of: cellulose, hemicellulose and lignin. Besides to them there are also sugars, proteins, starch, tannins, oils, organic acids, resins and waxes. Depending on the drying temperature, except water, different substances may evaporates from the material. The temperature rise may also cause the decomposition of different biomass components (eg. lignin which is the main binder). Raw material may change their physical properties (eg. elasticity, plasticity, brittleness), what will affect the quality of obtained granulates.

This paper presents complex research on drying temperature on compaction process. To omit the raw material moisture factor, the samples were dried over a wide temperature range until the moisture was completely removed. Compaction, at selected pressure levels, was conducted on dry material at about 20°C, as quality parameters were considered: granulate specific density, relaxation and durability. As the research material was selected biomass of: miscanthus, pine, beech and cup plant. For each drying temperature of the raw material, the course of changes in quality parameters, depending on the compression pressure was determined

Gezielte Einstellung des Pelletdurchmessers und der Pelletlänge zur Emissionsminderung beim Betrieb von Pelletöfen mit Holzpellets

Thomas Zeng
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH
Torgauer Straße 116
04347 Leipzig, Germany
thomas.zeng@dbfz.de

Co-Authors: Roman Adam, Jan Khalsa, Christian Thiel, Volker Lenz

Vor dem Hintergrund einer zunehmenden Gebäudedämmung und steigender Energiestandards für Neubauten wird der Bedarf an angepassten Kleinfeuerungsanlagen im unteren Leistungsbereich deutlich zunehmen. Ein Teil dieser automatisch beschickten Pelletöfen und Pelletkessel erreicht im Teillastbetrieb Lastzustände im unteren einstelligen Leistungsbereich (< 3 kW). Dementsprechend niedrig ist die zugeführte Brennstoffmenge, die sich auf wenige hundert Gramm pro Stunde belaufen kann. Damit verbunden ist jedoch ein potentiell höheres Emissionsniveau an CO, organischen Verbindungen und Feinstaub, da Teillastzustände nicht die optimalen Bedingungen für einen sauberen Abbrand bieten und die Empfindlichkeit der Feuerstätten gegenüber Störungen des Verbrennungsvorgangs tendenziell mit abnehmender Nennleistung bei gleichbleibender Brennstoffstückigkeit zunimmt (z. B. Emissionsspitzen infolge des Brennstoffeinschubs oder -abwurfs). Insbesondere bei niedrigen Lastzuständen treten zwischen der Zuführung der Pellets lange Intervalle auf, so dass der Abbrand eher einem Chargenabbrand als einer kontinuierlichen Verbrennung gleicht, die durch ein suboptimales Brennstoff-/Luftverhältnis gekennzeichnet ist. Daher kann eine gezielte Reduzierung der Pelletabmessungen (d.h. Durchmesser und Länge) bei niedrigen Verbrennungsleistungen zu einer verbesserten Brennstoffdosierung, Fließeigenschaften in kleinen Förderschnecken und gleichmäßigeren Brennstoffzufuhr führen. Ziel dieser Studie ist es, zu prüfen, in wie weit die Emissionen bei Pelletfeuerungen in einem systematischen Zusammenhang mit den Pelletabmessungen stehen.

Um die Erreichung des formulierten Gesamtziels sicherzustellen, wurden Holzpellets mit einem Durchmesser von 6 mm und unterschiedlichen Pelletlängen (d.h. 4, 6, 9, 12, 18, 24, 30 und 36 mm) sowie einem Durchmesser von 4 mm mit einer Länge von jeweils 4, 6, 8, 9 und 12 mm hergestellt. Die Pelletqualität wurde hinsichtlich Schüttdichte, Abriebfestigkeit, Längenverteilung, Aschegehalt und Gehalt an Feinstaubbildnern im Brennstoff analysiert. In einem weiteren Schritt wurde die Veränderung der physikalischen Pelletqualität durch die mechanische Beanspruchung während des Brennstofftransports in einer Steigschnecke eines Pelletofens mit Abwurffeuerung untersucht. Darauf aufbauend wurde das Abbrand- und Emissionsverhalten (v.a. CO und Gesamtstaub) der dreizehn unterschiedlichen Pelletqualitäten in einem kommerziell verfügbaren Pelletofen mit einer nominellen Leistung von 6 kW im Voll- und Teillastbetrieb untersucht.

Die Ergebnisse zeigen, dass es durch die Brennstoffförderung in den Feuerraum zu einer leichten Verschiebung der Längenklasse hin zu kleineren Korngrößen kommt. Zudem kann anhand der gewonnenen Daten gezeigt werden, dass eine Anpassung des Pelletdurchmessers erfolgversprechender ist als eine gezielte Eingrenzung der Pelletlänge.

Kommt es zur Stickstofffreisetzung bei der technischen Hackschnitzeltrocknung?

David Zimmermann
Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF)
Abt. 4 Forsttechnik, Betriebswirtschaft, Holz
Hans-Carl-von-Carlowitz-Platz 1
84345 Freising, Germany
david.zimmermann@lfw.bayern.de

Co-authors: Elke Dietz, Markus Riebler, Herbert Borchert, Cristian Babut, Daniel Kuptz, Carina Kuchler, Hans Hartmann

In Biomasse gebundener Stickstoff ist temperaturempfindlich, daher kann es bei höheren Trocknungstemperaturen zu Stickstoffverlusten kommen. Das Handbuch für forstliche Analytik (HFA) [1] empfiehlt daher für die Stickstoffbestimmung Trocknungstemperaturen unter 60 °C. Im Projekt „Qualitätssicherungsmaßnahmen zur Verringerung der mineralischen Verschmutzung und zur Verbesserung der Verbrennung von Holzbrennstoffen (Quasi-Holz)“ soll bei Verbrennungsversuchen unter anderem NO_x bestimmt werden. Daher wurde, um Elementverluste v.a. beim Stickstoff zu vermeiden, eine schonende technische Trocknung bei Temperaturen zwischen 40 und 45 °C eingesetzt. Bei einer Probe war es auf Grund der großen Probenmenge jedoch notwendig, die Hackschnitzel bei einem Unternehmer technisch zu trocknen (Heißlufttrocknung im Container). Hierbei können je nach Anlagenführung Temperaturen zwischen 60 und 85 °C erreicht werden [2]. Dies ist insbesondere dann der Fall, wenn für die Trocknung die Abwärme von Biogasanlagen genutzt wird. Da die gemessenen NO_x-Emissionswerte aller im Projekt untersuchten Proben vergleichbar sein sollten, sind eventuelle N-Verluste in Anhängigkeit von der Trocknungstemperatur zu quantifizieren.

Von drei Hackschnitzelsortimenten wurden Trocknungsversuche mit anschließender N- und C-Bestimmung mittels Elementaranalyse durchgeführt. Beim ersten Sortiment handelt sich um eine KUP-Probe (Mischprobe aus Pappel-Klonen) eines 5-jährigen Bestands einer Versuchsfläche bei Wöllershof in Bayern. Die anderen beiden Sortimente sind Energierundholz- und Waldrestholzproben aus Markt Wald in Bayern. Repräsentative Teilproben (Homogenisierung der jeweiligen Hackschnitzelprobe in einem 120 L PE-Fass) der verschiedenen Sortimente wurden bei 105 °C, 80 °C, 60 °C, 50 °C und 40 °C in einem belüfteten Trockenschrank sowie bei Raumtemperatur (ca. 23 °C) in einem Laborabzug getrocknet. Dabei war es wichtig, die Trocknungsbedingungen im Container wie Luftströmung (Ventilator Trockenschrank bzw. Abzug) zu simulieren und immer gleiche Volumina (4 L) mit gleicher Füllhöhe (11 cm) zu verwenden sowie die Hackschnitzel nicht zu wenden, da dies bei herkömmlichen Containertrocknungen ebenfalls nicht der Fall ist. Die Trocknungen im Trockenschrank wurden beendet, sobald die Gewichtsabnahme über 24 h weniger als 2 % bezogen auf das Feuchtgewicht beim Start der Trocknung betrug. Bei den „luftgetrockneten“ Proben im Abzug wurde die Trocknung bei einer Abnahme unter 0,5 % beendet bzw. bis zur Gewichtskonstanz getrocknet, da der Trocknungsprozess deutlich langsamer als bei den höheren Temperaturen verlief. Die Proben wurden anschließend jeweils auf < 4 mm in einer Schneidmühle zerkleinert und nach DIN EN ISO 18135 [3] durch „Kegeln und Vierteln“ in zwei gleiche Hälften geteilt. Ein Teil wurde für eine Glühverlustbestimmung verwendet, der andere Teil wurde in einer Zentrifugalmühle auf < 0,2 mm weiter zerkleinert und anschließend der Wassergehalt sowie der Gehalt an N und C mittels Elementaranalyse bestimmt.

Ergebnisse

Die detaillierten Ergebnisse der Elementaranalyse stehen in kürze zur Verfügung. Untersuchungen zur Änderung des N-Gehaltes aus einem Vorgängerprojekt ergaben für die Trocknung bei 105 °C bei Silberweide einen N-Verlust von 12 m-% bzw. 31 m-% bei Pappel (Max-Klone) gegenüber einer Trocknung bei 40 °C.

Referenzen

[1] GUTACHTERAUSSCHUSS FORSTLICHE ANALYTIK (2014): Handbuch forstliche Analytik (HFA) – Eine Loseblatt-Sammlung der Analysemethoden im Forstbereich, Teil B: Pflanzenuntersuchungen – B1.2.1: Trocknung von Pflanzenproben (BZE). Göttingen: Nordwestdeutsche Forstliche Versuchsanstalt, 678 Seiten.

[2] HARTMANN, H.; RESSEL, J. B. (2016): Transport, Trocknung biogener Festbrennstoffe. In: KALTSCHMITT, HARTMANN, HOFBAUER Hrsg. (2016): Energie aus Biomasse. Grundlagen, Techniken und Verfahren. 3. Aufl. Dordrecht, Heidelberg, London, New York: Springer-Verlag, Seiten. 505–533, ISBN 978-3-662-47437-2.

[3] DEUTSCHES INSTITUT FÜR NORMUNG E. V. (DIN) (2017): DIN EN ISO 18134-2. Biogene Festbrennstoffe - Probenahme. August 2017. Berlin: Beuth-Verlag.

Programm Teil 2

Workshops

Parallelblöcke 1-20

Programme Part 2

Workshops

Parallel sessions 1-20

Workshop: Saubere Luft und effiziente Heizwerke, Saal 1, 13:30 – 17:00

Powered by Keep Warm and Clean Air II Project

Donnerstag 23 Jänner

„Durch die verstärkte Einbindung von erneuerbaren Energieträgern und Abwärme sowie durch stetige Optimierungsmaßnahmen tragen Europas Heizwerke wesentlich zum Klimaschutz und zur Reduktion von Emissionen bei."

Chairman: Klaus Engelmann, *Landwirtschaftskammer Steiermark, Österreich*

„Die Biomasseverbrennung ist nachhaltig, trägt aber dennoch deutlich zur Feinstaubbelastung bei. Dieser Workshop zeigt Ihnen Maßnahmen und Wege der Umsetzung zur Reduktion von Luftschadstoffen, sowie deren Einfluss auf die Luftqualität."

Chairman: Rita Sturmlechner, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

13:30 **Beginn**

Der Workshop zeigt Lösungen auf, wie eine saubere Verbrennung in Biomassekesseln und Öfen gewährleistet und wie der Betrieb von Biomasse-Heizwerken effizient gestaltet wird. Im ersten Teil des Workshops wird demonstriert, wie Heizwerke modernisiert, optimiert und dabei die Emissionen gesenkt werden. Zur Veranschaulichung dienen praktische Beispiele und deren Umsetzung. Der zweite Teil des Workshops befasst sich mit Maßnahmen zur Verbesserung der Luftqualität mit Biomassefeuerungen. Dafür werden technische und nicht-technische Maßnahmen in nationalen und internationalen Projekten und deren Ergebnisse präsentiert.

- Optimierung von Biomasse-Heizwerken
- Reduktion der Rücklauftemperatur
- Emissionsreduktion in Biomasse-Feuerungen
- Einsatz von Biomasse in städtischer Fernwärme
- Biomassequalität als Erfolgsfaktor für saubere Verbrennung
- Emissionsreduktion durch richtiges NutzerInnenverhalten
- Verbesserung der Luftqualität mit Biomassefeuerungen
- Technischer Fortschritt im internationalen Kontext bei Biomassefeuerungen

Im Anschluss bietet sich die Möglichkeit, den „Clean Air II Trailer" zu besichtigen. Dieser Anhänger mit drei installierten Öfen, inklusive umfangreicher Messtechnik, wird im Projekt Clean Air II zur NutzerInnenschulung verwendet. Ein Video zeigt, wie der Trailer zum Einsatz kommt. NutzerInnen können dabei ihr Heizverhalten testen, erfahren ihre Emissionswerte und werden geschult, um einen emissionsarmen und effizienten Betrieb zu gewährleisten.

Simultanübersetzung

17:00 **Ende**

© Nahwärme Fernitz

Workshop: Clean Air and efficient district heating plants, Room 1, 13:30 – 17:00

Powered by Keep Warm and Clean Air II Project

Thursday 23 January

„The increased involvement of renewable energy sources and waste heat, as well as steady optimization measures contribute significantly to climate protection and to reducing emissions."

Chairman: Klaus Engelmann, *Agricultural Chamber of Styria, Austria*

„Although biomass combustion is sustainable, it still contributes to the fine dust load. This workshop will show you measures and ways of implementation for the reduction of air pollutants and thus, present their impact on air quality."

Chairman: Rita Sturmlechner, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

13:30 **Opening**

The workshop will highlight solutions such as ensuring clean combustion boilers and stoves and how to operate biomass district heating plants more efficiently. Part one of the workshop shows how district heating plants can be modernized, optimized and how emissions can be reduced. Practical examples and their implementations will be presented. The second part of the workshop deals with measures of improving air quality with biomass heatings. For this purpose, national and international projects and their results as well as technical and non-technical measures are presented.

The following topics await you:

- Optimization of biomass district heating plants
- Reduction of the return flow temperatures
- Emission reduction in biomass firings
- Use of biomass in urban district heating systems
- Biomass quality as a success factor for clean combustion
- Emission reduction due to correct usage behavior
- Improving air quality with biomass heatings
- Technological progress in the international context in biomass combustion

Afterwards, participants have the possibility to visit the interesting „Clean Air II Trailer". This trailer with 3 ovens installed including extensive measuring technology is used in the project Clean Air II for user training. A video shows how the trailer is used. Users can test their personal heating behavior, learn their emission levels and are trained to ensure low-emission and efficient operation.

17:00 **End**

Simultaneous translation

© Nahwärme Fernitz

Workshop: Erdölfreie Land- und Forstwirtschaft

Saal 3, 13:30 – 17:10

Vortragssprache **Deutsch**

Donnerstag 23 Jänner

„Die Land-und Forstwirtschaft ist Garant für die Lebensmittelversorgung und den Erhalt der Kulturlandschaft in Österreich. "

Chairman: Josef Rathbauer, *HBLFA Francisco Josephinum, BLT Wieselburg, Österreich*

Der Produktionsfortschritt der letzten Jahrzehnte ist wesentlich im zunehmenden Einsatz von Landtechniklösungen begründet. Die Antriebsgrundlagen dazu beruhen jedoch ausschließlich auf fossilen Energieträgern. Um die gesetzten Klimaschutzziele für 2030 bzw. 2050 zu erreichen, ist es notwendig, dass auch in diesem Segment erneuerbare Energieträger die fossilen Treibstoffe ablösen. Landtechnikinvestitionen, die heute getätigt werden, haben meistens eine sehr lange Lebensdauer und werden teilweise 2050 noch im praktischen Einsatz stehen. Es ist daher an der Zeit, dass für diese Art der Mobilität erneuerbare Antriebslösungen am Markt kaufbar sind und die Landwirtschaft diese auch anwendet. Neben dem Beitrag zur Verbesserung der Klimasituation wird damit meistens auch ein wesentlicher Beitrag zur Absicherung der Nahrungsmittelproduktion in Krisenzeiten erzielt, da die erneuerbaren Rohstoffe für die Treibstoffherstellung aus der Region kommen können.

In dieser Session sollen der Entwicklungsstand und bereits erprobte Lösungen aufgezeigt werden. Die BesucherInnen können sich einen aktuellen Überblick verschaffen, um so abgesicherte Grundlagen für ihre nächsten Kaufentscheidungen zu besitzen.

13:30 Eröffnung durch **Josef Rathbauer**

13:40 **Treibhausgas-Minderungspotential bei Biokraftstoffen in landwirtschaftlichen Maschinen**
Daniela Dressler, *Technologie- und Förderzentrum Straubing, Deutschland*

14:00 **Anforderungen an den künftigen land- und forstwirtschaftlichen Maschinenpark,** Andreas Gronauer & Karl Stampfer, *Universität für Bodenkultur, Österreich*

14:20 **Alternative Antriebe für den land- und forstwirtschaftlichen Maschinenpark,** Jürgen Karner, *HBLFA Francisco Josephinum, Österreich*

14:40 **Neue Rapsöl-Traktoren sind praxisreif – Erfahrungen aus einem bayrischen Langzeit-Feldversuch,** Johannes Ettl, *TFZ Straubing, Deutschland*

15:00 **Kaffeepause**

15:30 **Stoffströme für erneuerbare Energien in der Land- und Forstwirtschaft,** Franz Sinabell, *WIFO Wien, Österreich*

15:50 **Betriebsverhalten und Emissionen eines forstwirtschaftlichen Harvesters im Betrieb mit Rapsölkraftstoff**
Peter Emberger, *Technologie- und Förderzentrum Straubing, Deutschland*

16:10 **Planzenöl und Energiewende – Potential der Landtechnik durch Pflanzenöl-Kraftstoff,** Andreas Schröder, *John Deere, Deutschland*

16:30 **Der Gastraktor – eine Alternative**
Klaus Senghaas, *CNH Industrial, Deutschland*

16:50 **Offene Fragestellungen im Spannungsfeld „Situation in der Gegenwart und zukünftige Anforderungen zur Zielerreichung"**
Alexander Bachler, *Landwirtschaftskammer Österreich, Österreich*

HBLFA Francisco Josephinum Wieselburg · Pflanzenöl Austria · AGRAR Plus · Landwirtschaftskammer Österreich

Workshop: Petroleum-free agriculture and forestry

Room 3, 13:30 – 17:10

Language **German**

Thursday 23 January

„Agriculture and forestry guarantee the food supply and the preservation of the cultural landscape in Austria."

Chairman: Josef Rathbauer, *HBLFA Francisco Josephinum, BLT Wieselburg, Austria*

The production progress of the last decades also relies heavily on the increasing use of agricultural engineering solutions. The driving processes for this, however, are still exclusively based on fossil fuels. In order to meet the climate protection targets for 2030 and 2050, the replacement of fossil fuels by renewable energy is a necessary choice for the future of our planet.

Investments in agricultural engineering made today usually stand for a long durability and thus, can partially still be used in 2050. Therefore, it is time to promote renewable solutions for this form of mobility that are purchaseable at the market and then, actively used in the agriculture. Along with the contribution to the improvement of the climate situation, this practice secures the food production in times of crisis, as the renewable raw materials for the fuel production do stem from the region.

This workshop aims at displaying the current state of development and showing approved solutions. Visitors are invited to perceive an up-to-date overview of the current situation, in order to be prepared for future buying decisions.

13:30 Opening by **Josef Rathbauer**

13:40 **Greenhouse gas reduction potential in biofuels in agricultural machinery**
Daniela Dressler, *Technologie- und Förderzentrum Straubing, Germany*

14:00 **Requirements for the future agricultural and forestry machinery,** Andreas Gronauer & Karl Stampfer, *University of Natural Resources and Life Sciences, Austria*

14:20 **Alternative drives for the agricultural and forestry machinery park,** Jürgen Karner, *HBLFA Francisco Josephinum, Austria*

14:40 **New rapeseed oil tractors are ready for use – experience from a Bavarian long-term field trial** Johannes Ettl, *TFZ Straubing, Germany*

15:00 **Coffee break**

15:30 **Material flows for renewable energies in agriculture and forestry,** Franz Sinabell, *WIFO Vienna, Austria*

15:50 **Operating behavior and emissions of a forestry harvester in operation with rapeseed oil fuel**
Peter Emberger, *Technologie- und Förderzentrum Straubing, Germany*

16:10 **Plant oil and energy transition – potential of agricultural technology with plant oil fuel,** Andreas Schröder, *John Deere, Germany*

16:30 **The Gastraktor – an alternative**
Klaus Senghaas, *CNH Industrial, Germany*

16:50 **Unanswered questions in the area of conflict „Current situation and future requirements for achieving the climate goals"**
Alexander Bachler, *Agricultural Chamber of Austria, Germany*

HBLFA Francisco Josephinum Wieselburg · Pflanzenöl Austria · AGRAR Plus · Landwirtschaftskammer Österreich

IEA-Workshop: TASK 32, Saal 7, 13:30 - 17:00

Vortragssprache Englisch

Donnerstag 23 Jänner

Häusliche Holzheizungen

„Der technologische Fortschritt hat Heizen mit Holz zur führenden erneuerbaren Energieform in Europa gemacht. Es ist wichtig, diese Entwicklung konsequent fortzusetzen, um diese Position halten zu können."

Chairman: Christoph Schmidl, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Dieser von IEA Bioenergy Task 32 organisierte Workshop behandelt wichtige Themen für die Verbrennung von Holz in Wohngebäuden: Ofen- und Zentralheizungs-Technologien sowie Betriebserfahrungen und Zertifizierungsmethoden für qualitativ hochwertige Produkte. Darüber hinaus erläutern die eingeladenen ExpertInnen die jüngsten Entwicklungen und zukünftigen Perspektiven fortschrittlicher Regelungskonzepte und Technologien zur Sekundäremissionsminderung.

13:30: Begrüßung

- Morten Tony Hansen, *Ea Energy Analyses, Dänemark (Task Leader)*
- Christoph Schmidl, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Einführung in die Verbrennung von Biomasse und die Reduzierung von Schadstoffen in Öfen und Kesseln
Thomas Nussbaumer, *Verenum, Schweiz*

Technische Richtlinien für die Entwicklung emissionsarmer Öfen
Morten Warming-Jespersen, *Dänisches Technologieinstitut, Dänemark*

Einfluss des NutzerInnenverhaltens auf die Emissionen von Brennholzöfen
Robert Mack, *Technologie- und Förderzentrum Straubing, Deutschland*

Die neue Zertifizierungsmethode für Holzöfen für das Umweltzeichen Blauer Engel
Ingo Hartmann, *Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Deutschland*

15:00 **Kaffeepause**

GrateAdvance – Fortschrittliche adaptierbare Röstlösungen für zukünftige brennstoffflexible Biomasseverbrennungstechnologien
Elisabeth Wopienka, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Brennstoff-Verbesserung durch Kaolin als Zusatzstoff in Pellets & Hackgut in häuslichen Heizkesseln
Hans Hartmann, Technologie- und Förderzentrum Straubing, Deutschland

Elektrostatische Abscheider für häusliche Feuerungen – Stand der Technik und Zukunftsperspektiven
Daniel Jud, *ÖkoSolve AG, Schweiz*

Fortschrittliche Regelungskonzepte für Biomasse-Heizsysteme in Wohngebäuden
Markus Gölles, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

17:00 **Ende**

IEA Bioenergy

IEA-Workshop: TASK 32, Room 7, 13:30 - 17:00

Language English

Thursday 23 January

Residential wood combustion

„Technological progress has established residential wood combustion as the leading form of renewable energy in Europe. It is essential to continue this development consequently to maintain this position."

Chairman: Christoph Schmidl, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

This workshop organized by IEA Bioenergy Task 32 covers highly relevant topics for residential wood combustion: direct-heating and central-heating technologies as well as operational performance and certification methods for high quality products. Additionally, the invited experts are highlighting recent developments and future perspectives of advanced control concepts and secondary emission abatement technologies.

13:30: Opening

- Morten Tony Hansen, *Ea Energy Analyses, Denmark (Task Leader)*
- Christoph Schmidl, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Introduction to biomass combustion and pollutant reduction in wood stoves and boilers
Thomas Nussbaumer, *Verenum, Switzerland*

Technical guidelines for design of low emission stoves
Morten Warming-Jespersen, *Danish Institute of Technology, Denmark*

Influence of user behavior on emissions from firewood stoves
Robert Mack, *Technologie- und Förderzentrum Straubing, Germany*

The new Blue Angel ecolabel certification method for firewood stoves
Ingo Hartmann, *Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Germany*

15:00 **Coffee break**

GrateAdvance – Advanced adjustable grate solutions for future fuel flexible biomass combustion technologies
Elisabeth Wopienka, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Fuel improvement through kaolin as an additive in pellets & wood chips in domestic boilers
Hans Hartmann, Technologie- und Förderzentrum Straubing, Germany

Electrostatic precipitators for residential combustion technology – State of the art and future perspectives
Daniel Jud, *ÖkoSolve AG, Switzerland*

Advanced control concepts for wood heating in residential buildings
Markus Gölles, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

17:00 **End**

IEA Bioenergy

Parallelblock 1

Polygeneration und Grüne Treibstoffe
Saal 5, 13:30 – 15:00

Chairman: Reinhard Haas, *Technische Universität Wien, Österreich*

13:30 **Beginn**

Thermodynamische Modellierung und Analyse einer Polygenerations-anlage zur Herstellung von Bioöl, Strom, Wärme und Düngemittel
René Kofler, *Technische Universität Dänemark, Dänemark*

Syn-Fuels: Demonstration fortschrittlicher Biotreibstoffe aus nachhaltiger Biomasse
Nils Jäger, *Fraunhofer Umsicht, Deutschland*

EN-Kraftstoffe aus fester Restbiomasse durch katalytische Hydrierung von Bioöl aus dem TCR Prozess
Jan Grunwald, *Fraunhofer Umsicht, Deutschland*

Chemical Looping Vergasung – Ein neuartiger Prozess zur nachhaltigen Herstellung von Biokraftstoffen
Paul Dieringer, *Technische Universität Darmstadt, Deutschland*

15:00 **Kaffeepause**

Vortragssprache **Englisch**

Parallelblock 2

Upgrading und Charakterisierung von Biomassebrennstoffen I
Saal 6, 13:30 – 15:00

Donnerstag 23 Jänner

Chairman: Tapio Ranta, *Technologische Universität Lahti, Finnland*

13:30 **Beginn**

Torrefikation/Karbonisierung – was sind die heutigen Angebote an die Märkte?
Michael Wild, *Wild & Partner KG, Österreich*

Mobile Pelletproduktion – Innovationsgetriebene Revolution der Prozesskette
Martin Weigl, *Holzforschung Austria, Österreich*

Herstellung fester Brennstoffe aus forstlichen Nebenprodukten mittels Pyrolyse
Marta Martins, *Universität Lissabon, Portugal*

Simulation der Vakuumtrocknungstechnik für Hackschnitzel
Vaclav Marek, *Universität Westböhmen, Tschechien*

15:00 **Kaffeepause**

Vortragssprache **Englisch**

Parallel Session 1

Polygeneration und Green fuels
Room 5, 13:30 – 15:00

Chairman: Reinhard Haas, *Technical University of Vienna, Austria*

13:30 **Opening**

Thermodynamic modelling and analysis of a biomass based polygeneration plant producing bio-oil, electricity, heat and fertilizer
René Kofler, *Technical University of Denmark, Denmark*

To-Syn-Fuels: The demonstration of advanced fuels from sustainable biomass
Nils Jäger, *Fraunhofer Umsicht, Germany*

EN-Fuels from solid waste biomass by catalytic hydrogenation of bio-oil produced by thermo-catalytic reforming TCR®
Jan Grunwald, *Fraunhofer Umsicht, Germany*

Chemical Looping Gasification – A novel process for the sustainable production of biofuels
Paul Dieringer, *Technical University of Darmstadt, Germany*

15:00 **Coffee break**

Language **English**

Parallel Session 2

Upgrading and characterization of solid biomass fuels I
Room 6, 13:30 – 15:00

Thursday 23 January

Chairman: Tapio Ranta, *Technological University Lahti, Finland*

13:30 **Opening**

Torrefaction/Carbonization, what are todays offers to the markets
Michael Wild, *Wild & Partner KG, Austria*

Mobile pellet production – innovation-driven revolution of the biomass process chain
Martin Weigl, *Holzforschung Austria, Austria*

Valorization of forestry residues as solid fuels using slow pyrolysis
Marta Martins, *University Lisboa, Portugal*

Process simulations of vacuum drying technologies for woodchips
Vaclav Marek, *University of West Bohemia, Czech Republic*

15:00 **Coffee break**

Language **English**

Parallelblock 3

Konzepte und Wertschöpfungsketten einer biobasierten Bioökonomie

Saal 8, 13:30 - 15:00

Chairman: Gerfried Jungmeier, *Joanneum Research, Österreich*

13:30 **Beginn**

Fortschrittliche Brennstoffe aus Altholz als Energieträger für die Stahlindustrie
Maria Hingsamer, *Joanneum Research, Österreich*

Techno-ökonomische Modellierung von Bioökonomie-Wertschöpfungsketten
Christa Dißauer, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Kreislaufwirtschaft durch Kompost und Gärrestanwendung
Sandra Uschnig & Bernard Stürmer, *Kompost & Biogas Verband Österreich, Österreich*

Hydrothermale Prozesse für die Herstellung von Plattform-Chemikalien aus biogenen Reststoffen
Jakob Köchermann, *DBFZ Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Deutschland*

15:00 **Kaffeepause**

Vortragssprache **Englisch**

Parallelblock 4

Fortschritte bei der Festbettvergasung und Nutzung von Biokohle

Saal 9, 13:30 - 15:00

Donnerstag 23 Jänner

Chairman: Juan Adanez, *Instituto de Carboquimica, Spanien*

13:30 **Beginn**

Festbett-Gegenstromvergasung von TCR® Biokoks - ein einfacher Weg zur Erzeugung teerfreier Synthesegase
Stefan Eder, *Fraunhofer Umsicht, Deutschland*

Überwindung von Barrieren für die Nutzung von Bioenergie durch Fortschritte bei der Biomassevergasung
Andres Anca-Couce, *Technische Universität Graz, Österreich*

Koks-Rezirkulation in Festbettvergasern: Effekte auf Ausbeuten und Effizienz
Francesco Patuzzi, *Freie Universität Bozen, Italien*

Untersuchung des Adsorptionspotentials von Biokohle aus Biomasse-Vergasungsanlagen kleiner Leistung
Vittoria Benedetti, *Freie Universität Bozen, Italien*

15:00 **Kaffeepause**

Vortragssprache **Englisch**

Parallel Session 3

Concepts and value chains of a biobased bioeconomy

Room 8, 13:30 - 15:00

Chairman: Gerfried Jungmeier, *Joanneum Research, Austria*

13:30 **Opening**

Advanced biofuel from waste wood integrated in the steel industry
Maria Hingsamer, *Joanneum Research, Austria*

Techno-economic modelling of bioeconomy value chains
Christa Dißauer, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Circular economy by compost & digestate application
Sandra Uschnig & Bernhard Stürmer, *Kompost & Biogas Verband Österreich, Austria*

Platform chemicals from biogenic residues by hydrothermal processes
Jakob Köchermann, *DBFZ Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Germany*

15:00 **Coffee break**

Language **English**

Parallel Session 4

Advances in fixed bed biomass gasification and in biochar utilization

Room 9, 1 3:30 - 15:00

Thursday 23 January

Chairman: Juan Adanez, *Instituto de Carboquimica, Spain*

13:30 **Opening**

Updraft gasification of TCR® biochar – a smart way to generate tar-free synthesis gas
Stefan Eder, *Fraunhofer Umsicht, Germany*

Advances in biomass conversion based on gasification for overcoming barriers in bioenergy use for bioheat, bioelectricity and biofuels
Andres Anca-Couce, *Technical University of Graz, Austria*

Char recirculation in fixed bed gasification systems: effects on conversion yields and process efficiency
Francesco Patuzzi, *Free University of Bolzano, Italy*

Investigation of the adsorption potential of char residues derived from small-scale biomass gasifiers
Vittoria Benedetti, *Free University of Bolzano, Italy*

15:00 **Coffee break**

Language **English**

Parallelblock 5

Grünes Gas

powered by Energienetze Steiermark

Saal 5, 15:30 – 17:00

Chairman: Christoph Strasser*, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

15:30 **Beginn**

Erneuerbare Gase aus Wasserstoff und Biomethan als wesentlicher Beitrag zur Energiewende in Österreich
Manfred Pachernegg, *Geschäftsführer der Energienetze Steiermark GmbH, Österreich*

Optimierung der Herstellung von Wasserstoff durch Optimierung der CO_2-Abtrennung
Jürgen Loipersböck, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Dezentrale Wasserstoffherstellung und Energiespeicherung aus Biomasse und Biogas mit Festbett Chemical Looping Prozessen
Sebastian Bock, *Technische Universität Graz, Österreich*

Kombinierte Herstellung von Wasserstoff und CO_2 aus Biogas durch sorptions-unterstützte Reformierung
Antonio Oliveira, *IFE Institut für Energietechnologie, Norwegen*

Möglichkeiten und Herausforderungen von Biomethan
Franz Kirchmeyr, *Kompost & Biogas Verband, Österreich*

17:00 **Ende**

Vortragssprache **Englisch**

Parallelblock 6

Upgrading und Charakterisierung von Biomassebrennstoffen II

Saal 6, 15:30 – 17:00

Donnerstag 23 Jänner

Chairman: Martin Weigl, *Holzforschung Austria, Österreich*

15:30 **Beginn**

Herstellung von BIOCOAL Pellets aus Biomasse zur Nutzung in Biowärmeanwendungen kleiner Leistung
Pedro Abelha, *ECN Teil von TNO, Niederlande*

Verunreinigte Hackschnitzeln durch Mineralbodeneintrag – Auswirkungen auf die Brennstoffqualität und die Verbrennungseigenschaften
Carina Kuchler, *Technologie- und Förderzentrum Straubing, Deutschland*

Zuverlässigkeit von TGA Daten zur Charakterisierung alternativer Biomassen
Stefan Retschitzegger, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Einführung eines biologisch abbaubaren Mittels zur Entgiftung von Hemicellulose-Hydrolysaten für die Xylitol-Produktion
Fanny Machado Jofre, *Universität Sao Paolo, Brasilien*

17:00 **Ende**

Vortragssprache **Englisch**

Parallel Session 5

Green Gas

powered by Energienetze Steiermark

Room 5, 15:30 – 17:00

Chairman: Christoph Strasser*, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

15:30 **Opening**

Renewable gases from hydrogen and biomethane as a major contribution to the energy transition in Austria
Manfred Pachernegg, *CEO of the Energienetze Steiermark GmbH, Austria*

Optimizing of a hydrogen production plant by optimization of the CO_2 removal step
Jürgen Loipersböck, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Decentralized high-purity hydrogen generation and energy storage from biomass and biogas with fixed-bed chemical looping processes
Sebastian Bock, *Technical University of Graz, Austria*

Combined production of hydrogen and CO_2 from biogas via sorption-enhanced reforming (SER)
Antonio Oliveira, *IFE Institue for Energy Technology, Norway*

Opportunities and Challenges for Biomethane
Franz Kirchmeyr, *Kompost & Biogas Verband, Austria*

17:00 **End**

Language **English**

Parallel Session 6

Upgrading and characterization of solid biomass fuels II

Room 6, 15:30 – 17:00

Thursday 23 Jänner

Chairman: Martin Weigl, *Holzforschung Austria, Austria*

15:30 **Opening**

Upgraded biomass to BIOCOAL pellets production for small scale heat applications
Pedro Abelha, *ECN part of TNO, The Netherlands*

Contamination of wood chips with mineral soils – effects on fuel quality and combustion behavior
Carina Kuchler, *Technologie- und Förderzentrum Straubing, Germany*

Reliability of TGA data for characterization of alternative biomass feedstocks
Stefan Retschitzegger, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Introduction of a biodegradable agent for detoxification of hemicellulosic hydrolysates for xylitol production
Fanny Machado Jofre, *University Sao Paolo, Brazil*

17:00 **End**

Language **English**

Parallelblock 7

Thermochemische und thermokatalytische Verfahren
Saal 9, 15:30 - 17:00

Chairman: Marco Baratieri, *Freie Universität Bozen, Italien*

15:30 **Beginn**

Umwandlung biogener Rest- und Abfallstoffe in Kraftstoffe sowie grünen Wasserstoff mittels Thermo-Katalytischem Reforming TCR®
Johannes Neidel, *Fraunhofer Umsicht, Deutschland*

Chemical Looping Vergasung von Biomasse unter Verwendung von Ilmenit als Sauerstoffträger
Francisco García-Libiano, *Instituto de Carboquimica, Spanien*

Zwei-Bett-Wirbelschicht-Dampfvergasung von Biomasse - Basistechnologie für eine Vielzahl von Produkten
Matthias Kuba, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Torrefikation von Biomasse - Der Einfluss von Prozessparametern auf ausgewählte Qualitätsparameter von Biokohle
Marcin Jewiarz, *Landwirtschaftliche Universität Krakau, Polen*

17:00 **Ende**

Vortragssprache **Englisch**

Parallelblock 8

Integrierte Bioraffinerie- und Biogaskonzepte
Saal 8, 15:30 - 17:00

Donnerstag 23 Jänner

Chairman: Arthur Wellinger, *Triple E&M, Schweiz*

15:30 **Beginn**

Globale Zusammenarbeit bei Biogas-Technologien
Dominik Rutz et al., *WIP Renewable Energies, Deutschland*

Zukünftige Ökobilanz eines in regionale Biogasanlagen integrierten Mikroalgen-Bioraffinerie-Konzeptes
Maresa Bussa*, *TUM Campus Straubing, Deutschland*

Bioraffineriemodell für die Verwendung von Pferdemist auf Strohbasis in verschiedenen Co-Digestion-Technologien und der Herstellung von Biokraftstoffen
Sandor Bartha et al.*, *Research-Cercetare Silox LTD, Rumänien*

Neue Perspektiven für die Verwendung von Sojabohnenmelasse in Brasilien
Bruna Mello et al.*, *Universität Sao Paolo, Brasilien*

17:00 **Ende**

**angefragt*

Vortragssprache **Englisch**

Parallel Session 7

Thermochemical and thermocatalytical processes
Room 9, 15:30 - 17:00

Chairman: Marco Baratieri, *Free University of Bolzano, Italy*

15:30 **Opening**

Conversion of biogenic residues into fuels and green hydrogen by Thermo-Catalytic Reforming TCR®
Johannes Neidel, *Fraunhofer Umsicht, Germany*

Biomass chemical looping gasification (BCLG) using ilmenite as oxygen carrier
Francisco García-Libiano, *Instituto de Carboquimica, Spain*

Dual fluidized bed steam gasification of biomass – the basic technology for a broad product portfolio
Matthias Kuba, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Torrefaction of waste biomass - process parameters and quality assesment
Marcin Jewiarz, *Agricultural University of Krakow, Poland*

17:00 **End**

Language **English**

Parallel Session 8

Integrated biorefinery and biogas concepts
Room 8, 15:30 - 17:00

Thursday 23 January

Chairman: Arthur Wellinger, *Triple E&M, Switzerland*

15:30 **Opening**

Global cooperation on biogas technologies
Dominik Rutz et al., *WIP Renewable Energies, Germany*

Prospective life cycle assessment of a microalgae biorefinery concept integrated in regional biogas plants
Maresa Bussa*, *TUM Campus Straubing, Germany*

Biorefinery model for the use of the straw base horse manure in different co-digestion technologies and biofuel production
Sandor Bartha et al.*, *Research-Cercetare Silox LTD, Romania*

New perspectives on soybean molasses utilization in Brazil
Bruna Mello et al.*, *University of Sao Paolo, Brazil*

17:00 **End**

**requested*

Language **English**

Austroflex®
Rohr-Isoliersysteme

AustroPUR district heating systems
The intelligent solution

Minimal heat loss, maximum flexibility

Energy efficiency - we don´t just talk about it, we do something about it.

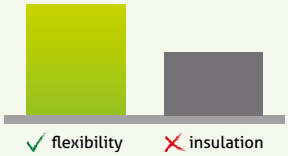
AustroPUR
with flexible outer casing

up to **2x** better flexibility

up to **50%** lower heat loss

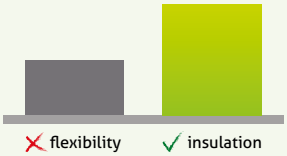
PE
PE insulated district heating systems

up to **50%** higher heat loss



PUR
PUR insulated district heating systems with flat outer casing

up to **50%** lower flexibility



Technology for Nature *Made in Austria*

T: +43 4257 3345-0 | E: office@austroflex.com
www.austroflex.com

KWB

SIMPLE & CLEAN HEATING

PELLET, WOOD CHIP & LOG WOOD HEATING SYSTEMS

2.4 – 300 KW

T +43 3115 / 6116

WWW.KWB.NET

IEA-Workshop: TASK 44, Saal 9, 09:00 – 13:30

Vortragssprache Englisch

Friday 24 January

Flexible Bioenergie und Systemintegration

„Der Anteil von Wind und Sonne im Energiesystem nimmt rasant zu. Um diesen wachsenden Mengen an variabler Energieerzeugung gerecht zu werden, muss das Energiesystem flexibler werden."

Illka Hannula, *VTT Technical Research Center, Finnland*

Chairs:

- **Ernst Höftberger**, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*
- **Daniela Thrän**, *DBFZ Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Deutschland*

Task 44 "Flexible bioenergy and system integration" ist ein neues Betätigungsfeld der IEA Bioenergy. Darin wird das Ziel verfolgt, auf Biomasse basierende Lösungen zu entwickeln und zu analysieren, die flexible Ressourcen für ein kohlenstoffarmes Energiesystem bieten können. Die Arbeiten in Task 44 werden von nationalen VertreterInnen aus Finnland, Deutschland, Australien, Irland, den Niederlanden, Österreich, Schweden, der Schweiz und den USA unterstützt.

09:00 Vorstellung des Task 44 durch **Ilkka Hannula**, *VTT Technical Research Center Finland, Finnland*

Integration großer Anteile variabler erneuerbarer Energien in das Energiesystem – Bedarf an Flexibilität
Niina Helistö, *VTT Technical Research Center Finland, Finnland*

Auf thermischer Vergasung basierende Hybridsysteme – Power to Gas und Power to Liquids
Jitka Hrbek, *Universität für Bodenkultur, Österreich*

Flexible Bioenergie via Pyrolyse
Bert van de Beld, *Biomass Technology Group, Niederlande*

Die zukünftige Rolle der thermischen Biomasse in erneuerbaren Energiesystemen
Morten Hansen, *Ea Energy Analyses, Dänemark*

Flexible Biogassysteme
N.N., *Universität College Cork, Irland*

Podiumsdiskussion mit Vortragenden

12:30 **Mittagspause & Posterpräsentation**

IEA-Workshop: TASK 44, Room 9, 09:00 – 13:30

Language English

Friday 24 January

Flexible bioenergy and system integration

„The share of wind and solar is increasing rapidly in the energy system. To accommodate these growing amounts of variable energy generation, the energy system needs to become more flexible."

Illka Hannula, *VTT Technical Research Center, Finland*

Chairs:

- **Ernst Höftberger**, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*
- **Daniela Thrän**, *DBFZ Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Germany*

09:00: Opening

Bioenergy is a storable and versatile source of renewable energy that could be an important part of the solution in the energy transition. Task 44 "Flexible bioenergy and system integration" is a new activity within IEA Bioenergy. It pursues to develop and analyse biomass-based solutions that can provide flexible resources for a low-carbon energy system. Task 44 is supported by national team leaders from Austria, Australia, Finland, Germany, the Netherlands, Ireland, Sweden, Switzerland, and the US.

09:00 Task 44 introduced by **Ilkka Hannula**, *VTT Technical Research Center Finland, Finland*

IIntegrating large shares of variable renewables into the energy system – needs for flexibility
Niina Helistö, *VTT Technical Research Center Finland, Finland*

Thermal gasification based hybrid systems – Power to Gas & Power to Liquids
Jitka Hrbek, *University of Natural Resources and Life Sciences, Austria*

Flexible bioenergy via pyrolysis
Bert van de Beld, *Biomass Technology Group, The Netherlands*

The future role of thermal biomass power in renewable energy systems
Morten Hansen, *Ea Energy Analyses, Denmark*

Flexible biogas systems
N.N., *University College Cork, Irland*

Podium discussion with presenters

12:30 **Lunch break & Poster presentation**

Workshop: Biokohle, Saal 4, 13:30 - 17:30

Vortragssprache Englisch

Freitag 24 Jänner

Potentiale und Risiken

„Die richtige Nutzung von Biokohle liefert einen wesentlichen Beitrag zur Erreichung von Klimazielen und kann gleichzeitig ökonomisch sinnvoll sein."

Chairman: Stefan Martini, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Die Diversität der Biokohlen ist aufgrund der Ausgangsmaterialien und Herstellverfahren, aber auch der unterschiedlichen Qualitätsanforderungen, welche sich aus den Anwendungen ergeben (von Bodenverbesserung, Futterzusatz und Grillkohle bis hin zu industriellen Anwendungen und Pharmazeutika) immens groß, die Potentiale einer sinnvollen Nutzung auch. Eine falsche Anwendung kann allerdings dem öffentlichen Image der Biokohle und somit der Biomasse nachhaltig schaden und muss vermieden werden.

Der Workshop schafft die Möglichkeit, die aktuelle Situation um das Thema Biokohle aufzuzeigen und mit ExpertInnen sowohl der Hersteller- als auch der Anwenderseite die Potentiale der Biokohle, die notwendigen Schritte zu deren Erschließung, aber auch Fehlentwicklungen zu diskutieren.

13:30 **Beginn**

Session 1: Herstellungsverfahren

14:00 **Wärme und Biokohle Produktion mit einem brennstoffflexiblem Biomasse-Heizkessel**
Thomas Reiterer, *Schmid Energy Solutions, Schweiz*

14:15 **Strom, Wärme und Biokohle Produktion durch Biomasse-Vergasung**
Marcel Huber, *SynCraft, Österreich*

14:30 **Biokohle Produktion aus Getreidespelzen - 8 Jahre Erfahrung**
Gerald Dunst, *Sonnenerde, Österreich*

14:45 **Der Einfluss der Biokohle auf den ökologischen Fußabdruck einer Biomasse-KWK-Anlage**
Babette Hebenstreit, *FH Vorarlberg, Österreich*

15:00 **Kaffeepause**

Session 2: Anwendungen

15:30 **Die Boden-Ausbringung von Biokohle als bereits heute verfügbare Carbon-Capture-Strategie: Potentiale, Risiken, Möglichkeiten**
Rebecca Hood-Nowotny, *Universität für Bodenkultur, Österreich*

15:45 **Rechtliche Aspekte bei der landwirtschaftlichen Nutzung von Biokohle**
Erwin Pfundtner, *AGES Austrian Agency for Health and Food Safety, AT*

16:00 **Industrielle Anwendungen der Biokohle und Holzkohle**
Benjamin Hupfauf, *MCI Management Center Innsbruck, Österreich*

16:15 **Die Modifikation von biogenen, kohlenstoffreichen Feststoffen eröffnet neue Möglichkeiten**
Stefan Martini, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

16:30 - 17:30 **Diskussion**

Workshop: Biochar, Room 4, 13:30 - 17:30

Language English

Friday 24 January

Potentials & Risks

„For achieving the climate targets, the proper utilisation of biochar contributes significantly and can be economically feasible."

Chairman: Stefan Martini, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Due to variable feedstock and production processes, the diversity of biomass-derived carbon rich solids is tremendous, and so is the potential of a worthwhile utilisation. But also on the costumer side, a huge spectrum of quality needs can be observed which is required by different application: from soil conditioning, animal food additives and barbecue charcoal to industrial and pharmaceutical applications. An incorrect utilisation can cause a sustainable damage to public biochar's image, which has to be avoided in any case.

The workshop is designed to create a clear overview of the current biochar situation. Ecological and economical potentials are to be discussed with experts from the production and application side. In conclusion, further steps to use the full potential of biogenic carbon-rich solids as well as aberrations are to be identified.

13:30 **Opening**

Session 1: Production

14:00 **Heat and biochar from a fuel-flexibel biomass boiler**
Thomas Reiterer, *Schmid Energy Solutions, Switzerland*

14:15 **Power, heat and biochar production based an biomass gasification**
Marcel Huber, *SynCraft, Austria*

14:30 **Biochar production from grain husks - 8 years of experience**
Gerald Dunst, *Sonnenerde, Austria*

14:45 **The influence of biochar on the GHG-footprint for heat and electricity production in a biomass gasification plant**
Babette Hebenstreit, *FH Vorarlberg, Austria*

15:00 **Coffee break**

Session 2: Applications

15:30 **Biochar addition to soil as a readily available carbon capture strategy: potential, risks and opportunities**
Rebecca Hood-Nowotny, *University of Natural Resources and Life Sciences, Austria*

15:45 **Legal aspects in the agricultural application of biochar**
Erwin Pfundtner, *AGES Austrian Agency for Health and Food Safety, Austria*

16:00 **Industrial application of biochar and charcoal**
Benjamin Hupfauf, *MCI Management Center Innsbruck, Austria*

16:15 **The modification of biogenic carbon-rich solids opens new possibilities**
Stefan Martini, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

16:30 - 17:30 **Discussion**

Parallelblock 9

Sekundärmaßnahmen zur Reduktion der Emissionen aus der Biomasse-Verbrennung und Vergasung
Saal 6, 09:00 – 10:30

Chairman: Morten Warming-Jespersen, *Dänisches Technologieinstitut, Dänemark*

09:00 **Beginn**

Innovativer, hocheffizienter Staubfilter für Biomassefeuerungen
Augusto Bianchini, *Universität Bologna, Italien*

Innovative Filtertechnik für die kombinierte Entstaubung und Entstickung – Upscale vom Labor – im Demonstrationsmaßstab
Julian Walberer, *Fraunhofer Umsicht, Deutschland*

Online Überwachung von elektrostatischen Abscheidern an Biomasseheizwerken
Bastian Alt, *TUM Campus Straubing, Deutschland*

Evaluierung von Gasreinigungsprozessen für die Kopplung von Biomasse-Vergasung mit Festoxidbrennstoffzellen (SOFC)
Stefan Martini, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

10:30 **Kaffeepause**

Vortragssprache **Englisch**

Parallelblock 10

Freitag 24 Jänner

Dekarbonisierung industrieller Prozesse und der Energieversorgung
Saal 7, 09:00 – 10:30

Chairman: Matthias Kuba, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

09:00 **Beginn**

Chemical Looping Verbrennung von Biomasse für CO_2-negative Emissionen
Juan Adanez, *Instituto de Carboquimica, Spanien*

Bedeutung von Biomasse bei der Dekarbonisierung von industrieller Prozesswärme
Martin Meiller, *Fraunhofer Umsicht, Deutschland*

Überblick und Status von Bioenergie-Nachrüstungen in Europas Industrie – erste Ergebnisse des BIOFIT-Projektes (Horizon 2020)
Patrick Reumerman, *BTG Biomass Technology Group BV, Niederlande*

Experimentielle Untersuchung von biomasse-basierten Reduktionsmitteln für den Hochofenprozess
Norbert Kienzl, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

10:30 **Kaffeepause**

Vortragssprache **Englisch**

Parallel Session 9

Secondary measures for the reduction of emissions from biomass combustion and gasification
Room 6, 09:00 – 10:30

Chairman: Morten Warming-Jespersen, *Danish Institute of Technology, Denmark*

09:00 **Opening**

Innovative high efficiency filter for particulate matter from biomass flue gases
Augusto Bianchini, *University of Bologna, Italy*

New filter technology for combined NO_x and dust emission reduction – from laboratory to practice
Julian Walberer, *Fraunhofer Umsicht, Germany*

Online monitoring of electrostatic precipitators at biomass heating plants
Bastian Alt, *TUM Campus Straubing, Germany*

Evaluation of gas cleaning processes for the coupling of biomass gasification with Solid Oxide Fuel Cells (SOFC)
Stefan Martini, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

10:30 **Coffee break**

Language **English**

Parallel Session 10

Friday 24 January

Decarbonization of industrial processes and energy supply
Room 7, 09:00 – 10:30

Chairman: Matthias Kuba, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

09:00 **Opening**

Chemical looping combustion of biomass for negative CO_2 emissions
Juan Adanez, *Instituto de Carboquimica, Spain*

Importance of biomass for the decarbonization of industrial process heat supply
Martin Meiller, *Fraunhofer Umsicht, Germany*

Overview and Status of Bioenergy Retrofits in Europe's Industry – First results of the BIOFIT project (HORIZON2020)
Patrick Reumerman, *BTG Biomass Technology Group BV, The Netherlands*

Experimental investigation of biomass based reducing agents for blast furnace ironmaking
Norbert Kienzl, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

10:30 **Coffee break**

Language **English**

Parallelblock 11

Die Zukunft grüner Kraftstoffe und grünen Gases
Saal 8, 09:00 – 10:30

Chairman: Josef Rathbauer, *HBLFA Francisco Josephinum, Österreich*

09:00 **Beginn**

Die Wirtschaftlichkeit von grünem Gas
Reinhard Haas, *Technische Universität Wien, Österreich*

Erfahrungen mit der Markteinführung alternativer Treibstoffe
Andrea Sonnleitner, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Volkswirtschaftliche Effekte des Ausbaus von Erzeugungskapazitäten für erneuerbare Gase und deren Einspeisung in das Gasnetz
Martin Höher, *Österreichische Energieagentur, Österreich*

Über die zukünftige Rolle der Biotreibstoffpolitik in der EU
Amela Ajanovic, *Technische Universität Wien, Österreich*

10:30 **Kaffeepause**

Vortragssprache **Englisch**

Workshop: Zur Folgenabschätzung der Verwendung von Lignin in Kunststoffen
Saal 4, 09:00 – 12:30

Freitag 24 Jänner

Chairmen: Tobias Stern, *Universität Graz, Österreich*
Raphael Asada, *Universität Graz, Österreich*

Ressourceneffizienz spielt eine zentrale Rolle im Nachhaltigkeitsdiskurs und findet sich als Ziel in einer Reihe nationaler, ressourcenorientierter Aktionspläne. Ein wichtiges Element ist die wertschöpfende, stoffliche Nutzung von biobasierten Ressourcen, Nebenprodukten und Abfällen. Die stoffliche Verwendung von technischem Lignin, einem Nebenprodukt der Zellstoff- und Papierindustrie, wird seit Jahrzehnten intensiv beforscht. So könnte Lignin etwa petrochemische phenolische Verbindungen in Kunststoffen zum Teil ersetzen.

20 Studierende der Umweltsystemwissenschaften (Universität Graz, TU Graz) widmeten sich ein Semester lang der Frage, wie eine solche Substitution prospektiv modelliert werden könnte, um deren Wirkung auf Aspekte der ökologischen und sozioökonomischen Nachhaltigkeit abzuschätzen. Im Workshop werden die Möglichkeiten und Grenzen des skizzierten interdisziplinären Modellierungsvorhabens von der Studierendengruppe vorgestellt.

Vortragssprache **Deutsch**

Parallel Session 11

The future of green transportation fuels and of green gas
Room 8, 09:00 – 10:30

Chairman: Josef Rathbauer, *HBLFA Francisco Josephinum, Austria*

09:00 **Opening**

The economics of greening gases
Reinhard Haas, *Technical University of Vienna, Austria*

Lessons learned from alternative fuels experience
Andrea Sonnleitner, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Economics of the extension of production capacities of renewable gases and their feed-in to the gas grid
Martin Höher, *Austrian Energy Agency, Austria*

On the development of biofuel policies in the EU
Amela Ajanovic, *Technical University of Vienna, Austria*

10:30 **Coffee break**

Language **English**

Workshop: Impact assessment of the use of Lignin in plastics
Room 4, 09:00 – 12:30

Friday 24 January

Chairmen: Tobias Stern, *University of Graz, Austria*
Raphael Asada, *University of Graz, Austria*

Resource efficiency plays a central role in the debate of sustainability and is a main objective in a number of national resource-oriented action plans. An important element is the value-adding material use of bio-based resources, by-products and waste. The material use of technical lignin, a by-product of the pulp and paper industry, has been intensively researched for decades. Lignin could, for example, partially replace petrochemical phenolic compounds in plastics.

20 students of environmental systems sciences* (University of Technology, Graz) spent a semester on researching, how such a substitution could be modeled prospectively in order to assess their impact on aspects of environmental and socioeconomic sustainability. In the workshop, the possibilities and limits of the interdisciplinary modeling project outlined are presented by the student group.

Language **German**

Workshop: Highlights der Bioenergieforschung 2020, Saal 1, 09:00 - 15:00

Nationale und internationale Ergebnisse aus den IEA Bioenergy Tasks sowie dem ERA-NET Bioenergy

Simultanübersetzung

Freitag 24 Jänner

09:00 **Beginn**

Die Veranstaltungsreihe „Highlights der Bioenergieforschung" wurde vom Bundesministerium für Verkehr, Innovation und Technologie (BMVIT) mit dem Ziel ins Leben gerufen, eine Plattform für alle ExpertInnen und StakeholderInnen in diesem Bereich zu schaffen.

Österreich beteiligt sich im Rahmen der IEA Forschungskooperation intensiv an verschiedenen Tasks des TCP (Technology Collaboration Programme) Bioenergy. Ziele sind unter anderem die Entwicklung und Vermarktung von umweltfreundlichen, effizienten und kostengünstigen Bioenergietechnologien.

Das ERA-NET Bioenergy ist ein Netzwerk von nationalen Förderstellen, welche die Entwicklung von Bioenergietechnologien forcieren. Der Klima- und Energiefonds und das Bundesministerium für Verkehr, Innovation und Technologie (BMVIT) unterstützen mit ihrer Teilnahme die koordinierte Förderung transnationaler Forschungs- und Entwicklungsprojekte zur nachhaltigen Nutzung von Bioenergie.

Bei der „Highlights der Bioenergieforschung" werden aktuelle Entwicklungen und Ergebnisse aus den IEA Bioenergy Tasks sowie transnationale Forschungs- und Entwicklungsprojekte zur nachhaltigen Nutzung von Bioenergie aus dem ERA-NET Bioenergy vorgestellt. Es erwarten Sie spannende Vorträge zu Themen wie Vergasung von Biomasse und Abfall, Energie aus Biogas, Bioraffinerien und vieles mehr.

Neben richtungsweisenden Forschungs- und Entwicklungsergebnissen bietet die Veranstaltung genügend Raum für den Austausch und die Vernetzung im Bereich der Bioenergieforschung.

Die Highlightsveranstaltung findet wie auch vor drei Jahren im Rahmen der **6. Mitteleuropäischen Biomassekonferenz CEBC 2020** (22. bis 24. Jänner 2020 in Graz) statt.

Das laufend aktualisierte Programm finden Sie unter:
https://nachhaltigwirtschaften.at/de/iea/veranstaltungen/2020/20200124-highlights-bioenergieforschung.php

15:00 **Ende**

Bundesministerium Verkehr, Innovation und Technologie

klima energie fonds

Workshop: Highlights of bioenergy research 2020, Room 1, 09:00 - 15:00

National and international results from the IEA Bioenergy Tasks and the ERA-NET Bioenergy

Simultaneous translation

Friday 24 January

09:00 **Opening**

The series of events "Bioenergy Research Highlights" was launched by the Federal Ministry of Transport, Innovation and Technology (BMVIT) with the aim of creating a platform for all experts and stakeholders.

Austria is participating intensively in the TCP (Technology Collaboration Programme) Bioenergy within the framework of the IEA Research Cooperation. The IEA Bioenergy aims to accelerate the production and use of sustainable and cost-competitive technologies for bioenergy.

In the ERA-NET Bioenergy, national ministries and agencies that own or manage bioenergy research programmes – in Austria, the Climate and Energy Fund as well as the Federal Ministry for Transport, Innovation and Technology – work together in order to improve cost-effectiveness and ensure the maximum research impacts for bioenergy.

The event "Highlights of Bioenergy Research 2020" presents current developments and results from the IEA Bioenergy tasks as well as transnational research and development projects for the sustainable use of bioenergy from the ERA-NET Bioenergy. Exciting lectures on topics such as gasification of biomass and waste, energy from biogas, biorefineries and much more are awaiting you.

In addition to directional research and development results, the event provides enough space for exchange and networking in the field of bioenergy research.

The event "Highlights of Bioenergy Research" 2020 will be a part of the **6th Central European Biomass Conference CEBC 2020** which will take place from the 22nd to 24th of January 2020 in Graz.

You will find the continuously updated programme online at
https://nachhaltigwirtschaften.at/en/iea/events/2020/20200124-highlights-bioenergy-research.php

15:00 **End**

Bundesministerium Verkehr, Innovation und Technologie

klima energie fonds

Parallelblock 12

Herausforderungen für Multi-Fuel-Feuerungen mit niedrigsten Emissionen
Saal 6, 11:00 – 12:30

Chairman: Anne-Mette Frey, *Dänisches Technologieinstitut, Dänemark*

11:00 **Beginn**

Eco+ fitte Biomassekessel – das Bemühen um niedrigste Emissionen
Rene Lyngso Hvidberg, *Dänisches Technologieinstitut, Dänemark*

Evaluierung des Ascheschmelzverhaltens von Reisschalen und Reisstroh bei der thermochemischen Konversion
Hossein Beidaghy Dizaji, *DBFZ Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Deutschland*

Reduktion der Staubemissionen aus der Verbrennung von Maiskolben in einer Multi-Fuel-Feuerung
Natasa Dragutinovic, *Technische Universität Hamburg, Deutschland*

Experimentielle Analyse und Optimierung der Emissionen eines 30 kW Laborreaktors einer neuen Multi-Fuel-Low-Emission Feuerungstechnologie
Georg Archan, *Technische Universität Graz, Österreich*

12:30 **Mittagspause & Posterpräsentation**

Vortragssprache **Englisch**

Parallelblock 13

Bioenergie und biobasierte Ökonomie in Europa
Saal 8, 11:00 – 12:30

Freitag 24 Jänner

Chairman: Amela Ajanovic, *Technische Universität Wien, Österreich*

11:00 **Beginn**

Unterstützung für die Bioökonomie in Mittel-, Ost- und Süd-Ost-Europa – Erfahrungen aus dem CELEBIO Projekt in Tschechien, Slowakei, Ungarn, Slowenien, Kroatien und Bulgarien
Peter Canciani, *CEI Central European Initiative, Italien*

Entwicklung der Bioenergie als Teil der Erneuerbaren in den Ländern Nordeuropas – eine vergleichende Analyse
Tapio Ranta, *Technologische Universität Lahti, Finnland*

Bioenergieentwicklungsstrategie und Investitionsplan: Ein regionaler Zugang zur Beschleunigung der Diffusion moderner Bioenergietechnologie
Michael Kiza, *EACREEE East African Centre of Excellence for Renewable Energy and Efficiency, Uganda*

Strategien zur Förderung von regionalen Bioökonomien – Das Be-Rural-Projekt
Felix Colmorgen, *WIP Renewable Energies, Deutschland*

12:30 **Mittagspause & Posterpräsentation**

Vortragssprache **Englisch**

Parallel Session 12

Challenges for multi-fuel and lowest emissions combustion systems
Room 6, 11:00 – 12:30

Chairman: Anne-Mette Frey, *Danish Institute of Technology, Denmark*

11:00 **Opening**

Eco+ ready boilers – striving towards ultralow emissions
Rene Lyngso Hvidberg, *Danish Institute of Technology, Denmark*

Evaluation of ash melting behavior of rice husk and rice straw during thermochemical conversion
Hossein Beidaghy Dizaji, *DBFZ Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Germany*

Mitigation of particulate matter emissions from the combustion of corn cobs in a small scale multi-fuel boiler
Natasa Dragutinovic, *Technical University of Hamburg, Germany*

Experimental analysis and optimization of a 30 kW lab reactor of a multi-fuel-low-emission furnace
Georg Archan, *Technical University of Graz, Austria*

12:30 **Lunch break & Poster presentation**

Language **English**

Parallel Session 13

Bioenergy and biobased bioeconomy in Europe
Room 8, 11:00 – 12:30

Friday 24 January

Chairman: Amela Ajanovic, *Technical University of Vienna, Austria*

11:00 **Opening**

Fostering bioeconomy in Central, East and Southeast Europe – The experience of CELEBIO project in the Czech Republic, Slovakia, Hungary, Slovenia, Croatia and Bulgaria
Peter Canciani, *CEI Central European Initiative, Italy*

Development of the bioenergy as a part of renewable energy in the Nordic Countries – a comparative analysis
Tapio Ranta, *Technological University of Lahti, Finland*

Bioenergy Development Strategy and Investment Plan: A regional approach to accelerate diffusion of modern bioenergy technologies in East Africa
Michael Kiza, *EACREEE East African Centre of Excellence for Renewable Energy and Efficiency, Uganda*

Strategies for the development of regional bioeconomies – the Be-Rural project
Felix Colmorgen, *WIP Renewable Energies, Germany*

12:30 **Lunch break & Poster presentation**

Language **English**

Parallelblock 14

Bioenergie in der Praxis
Saal 7, 15:30 - 17:00

Freitag 24 Jänner

Chairman: Christian Metschina, *Landwirtschaftskammer Steiermark, Österreich*

11:00 **Beginn**

Maisspindeln – die nachhaltige Alternative zum Klimakiller Grillkohle
Alfred Kindler, *Landwirtschaftskammer Steiermark, Österreich*

Energieeffizienz im Heizkraftwerk Klagenfurt
Markus Poppe, *Bioenergie Kärnten, Österreich*

Biomasseanlage und Abwärmeauskopplung aus einer Papierfabrik samt Pufferspeicheroptimierung
Leo Riebenbauer, *Büro für Erneuerbare Energie Ing. Leo Riebenbauer GmbH, Österreich*

Ökologischer Fußabdruck von Heizsystemen nach dem Sustainable Process Index (SPI)
Dieter Preiß, *Amt der Steiermärkischen Landesregierung, Österreich*

12:30 **Mittagspause & Posterpräsentation**

Vortragssprache **Deutsch**

Matchmaking im „Bioenergie-Heurigen"

Saal 14, Mittwoch, 22. bis Freitag, 24. Jänner 10:00 - 17.00

Während der gesamten **6. Mitteleuropäischen Biomassekonferenz (CEBC 2020)** haben Sie die Möglichkeit, bei Speis und Trank gemeinsame Geschäftsmöglichkeiten und Synergien im **CEBC-Bioenergie-Heurigen** zu besprechen. Im gemütlichen Ambiente können Sie potenzielle InvestorInnen und GeschäftspartnerInnen aus aller Welt kennenlernen. Das einmalige Matchmaking-Event kann im Anschluss an spannende, wissenschaftliche Vorträge und Workshops besucht werden oder Ihnen als kleine Stärkung zwischendurch dienen. Ergreifen Sie die Gelegenheit und profitieren Sie von der internationalen Ausrichtung der Konferenz. *Prost!*

Parallel Session 14

Bioenergie in practice
Room 7, 15:30 - 17:00

Friday 24 January

Chairman: Christian Metschina, *Agricultural Chamber of Styria, Austria*

11:00 **Opening**

Corn spindles - the sustainable alternative to climate damager charcoal
Alfred Kindler, *Agricultural Chamber of Styria, Austria*

Energy efficiency in the HKW Klagenfurt
Markus Poppe, *Bioenergie Kärnten, Austria*

Biomass plant and waste heat extraction from a paper mill with buffer storage optimization
Leo Riebenbauer, *Büro für Erneuerbare Energie Ing. Leo Riebenbauer GmbH, Austria*

Ecological footprint of CHP-plants according to the Sustainable Process Index (SPI)
Dieter Preiß, *Amt der Steiermärkischen Landesregierung, Austria*

12:30 **Lunch break & Poster presentation**

Language **German**

Matchmaking in the „Bioenergy-Heurigen"

Room 14, Wednesday, 22nd to Friday, 24th, 10:00 - 17:00

Throughout the **6th Central European Biomass Conference (CEBC 2020),** visitors have the opportunity to discover common business opportunities and build synergies, while enjoying a glass of wine or beer next to a traditional bite of Austrian cuisine. In a welcoming environment you can meet business partners and investors from all over the world. The unique matchmaking event can be used before or after interesting scientific lectures and workshops and thus, serves as an ideal snack in-between. Take this opportunity and benefit from the international range of the conference. *Prost!*

Parallelblock 15

Fortschrittliche Methoden und traditionelle Technologien
Saal 6, 13:30 – 15:00

Chairman: Christoph Schmidl, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

13:30 **Beginn**

Der Kachelofen – ein durch die Jahrhundertwende bewährtes Produkt in der CFD-Simulation
Johannes Mantler, *Österreichischer Kachelofenverband, Österreich*

Prüfmethoden für Pelletöfen – Überblick und aktuelle Entwicklungen
Gabriel Reichert, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

EN-PME – eine neue Methode zur Bestimmung der Staubemmissionen von Öfen und Kesseln
Frank Kienle, *HKI Industrieverband Haus-, Heiz- und Küchentechnik, Deutschland*

N.N.

15:00 **Kaffeepause & Posterpräsentation**

Vortragssprache **Englisch**

Parallelblock 16

Nachhaltigkeit von Bioenergie- und Bioökonomiewertschöpfungsketten I
Saal 8, 13:30 – 15:00

Freitag 24 Jänner

Chairman: Martin Wellacher, *Montanuniversität Leoben, Österreich*

13:30 **Beginn**

Bioenergie aus Nadelwäldern – der schwedische Zugang zur nachhaltigen Holznutzung
Kjell Andersson, *SVEBIO Swedish Bioenergy Association, Schweden*

Messen, Steuern und Fördern nachhaltiger Bioenergie-Wertschöpfungsketten
Luc Pelkmans, *IEA Bioenergy, Belgien*

BB-CLEAN: Strategische Werkzeuge für die nachhaltige Nutzung von Biomasse für die Raumwärmebereitstellung
Giacomo Gerosa, *Katholische Universität vom Heiligen Herzen, Italien*

Waldrestholznutzung – Vermeidung übermäßiger Nährstoffentzüge mit Hilfe von Nährstoffbilanzen
Stephan Rimmele, *LWF Bayrische Landesanstalt für Wald- und Forstwirtschaft, Deutschland*

15:00 **Kaffeepause & Posterpräsentation**

Vortragssprache **Englisch**

Parallel Session 15

Advanced methods meet traditional technologies
Room 6, 13:30 – 15:00

Chairman: Christoph Schmidl, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

13:30 **Opening**

The tiled stove – a product proven over centuries modelled and simulated by CFD
Johannes Mantler, *Österreichischer Kachelofenverband, Austria*

Advanced test methods for pellet stoves and consequences on real life performance
Gabriel Reichert, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

"EN-PME" – a new European method for particle matter (PM) measurement for local space heaters and boilers burning solid fuel
Frank Kienle, *HKI Industrieverband Haus-, Heiz- und Küchentechnik, Germany*

N.N.

15:00 **Coffee break & Poster presentation**

Language **English**

Parallel Session 16

Sustainability of bioenergy and bioeconomy value chains I
Room 8, 13:30 – 15:00

Friday 24 January

Chairman: Martin Wellacher, *Montanuniversität Leoben, Austria*

13:30 **Opening**

Bioenergy from boreal forests – the Swedish approach to sustainable wood use
Kjell Andersson, *SVEBIO Swedish Bioenergy Association, Sweden*

Measuring, governing and gaining support for sustainable bioenergy supply chains
Luc Pelkmans, *IEA Bioenergy, Belgium*

BB-CLEAN: Strategic tools towards a sustainable use of biomass for low carbon domestic heating
Giacomo Gerosa, *Catholic University of the Sacred Heart, Italy*

Forest residues – Avoiding excessive nutrient removal using nutrient balancing
Stephan Rimmele, *LWF Bayrische Landesanstalt für Wald- und Forstwirtschaft, Germany*

15:00 **Coffee break & Poster presentation**

Language **English**

Parallelblock 17

Vortragssprache **Deutsch**

Logistik
Saal 7, 13:30 – 15:00

Freitag 24 Jänner

Chairman: Karl Stampfer, *Universität für Bodenkultur, Österreich*

Für die Bioenergie ist die Logistik ein entscheidender Kostenfaktor. Durch die klimawandelbedingten Schadereignisse mit punktuell großen Biomasseanfall gewinnt der überregionale Ausgleich zunehmend an Bedeutung. Der Workshop überprüft bestehende Logistikketten, von der Gewinnung über die Aufbereitung bis hin zum Transport der Biomasse mittels LKWs, Bahn, Schiff und Hochseetransport.

Regionale Logistikketten und ihre ökonomischen Grenzen
Karl Stampfer, *Universität für Bodenkultur, Österreich*

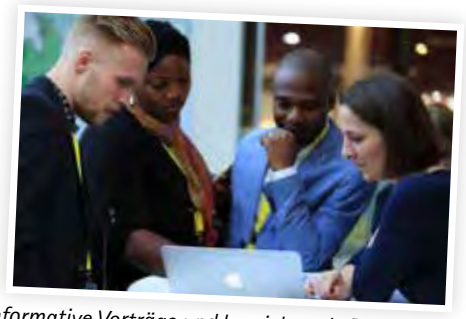
Agrarlogistik auf Schiene – was ist möglich?
Leo Leichtfried, *Österreichische Bundesbahnen, Österreich*

Die Donau – eine Chance für die Bioenergiebranche?
Christa Dißauer, *BEST Bioenergy and Sustainable Technologies GmbH, Österreich*

Hochseehäfen als Option für die österreichische Bioökonomie
N.N.

Hacken, trocknen, transportieren – Erfahrungen und Kennzahlen aus der regionalen Brennstofflogistik
Martin Gaber, *Landforst Holzenergiezentrum, Österreich*

15:00 **Kaffeepause & Posterpräsentation**



Informative Vorträge und bereichernde Diskussionen...

...treffen auf ein interessiertes Fachpublikum.

Parallel Session 17

Language **German**

Logistics
Room 7, 13:30 – 15:00

Friday 24 January

Chairman: Karl Stampfer, *University of Natural Resources and Life Sciences, Austria*

13:30 **Opening**

For bioenergy, logistics is a decisive cost factor. Because of the negative impacts of the climate change, the cross-regional compensation is becoming increasingly important. The workshop provides an overview of existing logistic chains, dealing with the extraction, process and preparation of the biomass and also deals with its transport via agricultural motor tractors, trucks, trains, inland vessels and high-sea transport.

Regional logistics chains and their regional boundaries
Karl Stampfer, *University of Natural Resources and Life Sciences, Austria*

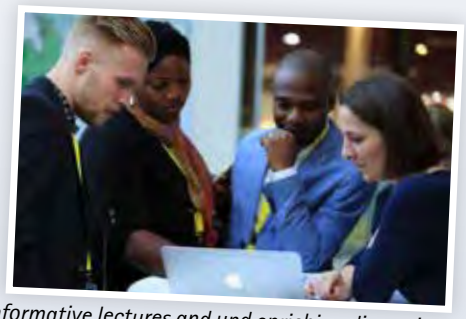
Agricultural logistics by rail – what is possible?
Leo Leichtfried, *ÖBB Österreichische Bundesbahnen, Austria*

The Danube – a chance for the bioenergy sector?
Christa Dißauer, *BEST Bioenergy and Sustainable Technologies GmbH, Austria*

Seaports as an option for the Austrian bioeconomy
N.N.

Chopping, drying, transportation – experience and key figures from regional fuel logistics
Martin Gaber, *Landforst Holzenergiezentrum, Österreich*

15:00 **Coffee break & Poster presentation**



Informative lectures and und enriching discussions.....

...meet a .professional audience

Parallelblock 18

Technologien für dezentrale Biomasse-KWKs
Saal 6, 15:30 – 17:00

Chairman: Francesco Patuzzi, *Freie Universität Bozen, Italien*

15:30 **Beginn**

Biomasse-Kraft-Wärme-Kopplungsanlagen kleiner Leistung – Ergebnisse eines Demonstrationsprojekts in Schweden
Daniella Johannson, *Energy Agency for Southeast Sweden, Schweden*

Entwicklung eines bedarfsgeführten Reglers für kleine, biomassebefeuerte BHKWs
Daniel Büchner, *DBFZ Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Deutschland*

Mit Holzgas in die Energieautarkie – Smarte Lösungen zur Eigenversorgung
Manuel Moser, *Glock Ökoenergie, Österreich*

Potenziale dezentraler KWK-Anlagen – Gewerbliche Verwertung von heterogenen, festen Reststoffen aus Forstwirtschaft und Industrie im Leistungsbereich < 1 MW
Sebastian Kießling, *B+K Berg & Kießling GmbH, Österreich*

17:00 **Ende**

Vortragssprache **Englisch**

Parallelblock 19

Freitag 24 Jänner

Nachhaltigkeit von Bioenergie- und Bioökonomiewertschöpfungsketten II
Saal 8, 15:30 – 17:00

Chairman: Luc Pelkmans, *IEA Bioenergy, Belgien*

15:30 **Beginn**

Recycling von Holzabfällen in Europa – Ausgewählte Aspekte
Martin Wellacher, *Montanuniversität Leoben, Österreich*

Die Förderung von ungenutzten Flächen für die nachhaltige Bereitstellung von Bioenergie mit Hilfe von webbasierten geografischen Informationssystemen
Manuela Hirschmugl, *Joanneum Research, Österreich*

Der Paris-Lebensstil – Die Rolle der Biomasse für einen klimafreundlichen Lebensstil in der Bioökonomie zur Erfüllung der Klimaschutzziele 2050
Gerfried Jungmeier, *Joanneum Research, Österreich*

N.N.

17:00 **Ende**

Vortragssprache **Englisch**

Parallel Session 18

Technologies for decentral bioelectricity production
Room 6, 15:30 – 17:00

Chairman: Francesco Patuzzi, *Free University of Bolzano, Italy*

15:30 **Opening**

Small Scale CHP from biomass – results from a demonstration project in Sweden
Daniella Johannson, *Energy Agency for Southeast Sweden, Sweden*

Development of a demand-based controller for small biomass fired CHP systems
Daniel Büchner, *DBFZ Deutsches Biomasseforschungszentrum und gemeinnützige GmbH, Germany*

Energy self-sufficiency with wood gas CHP – Smart solutions for self-sufficiency
Manuel Moser, *Glock Ökoenergie, Austria*

Power from hidden fuels in the wood processing industry, up to 1 MWe
Sebastian Kießling, *B+K Berg & Kießling GmbH , Austria*

17:00 **End**

Language **English**

Parallel Session 19

Friday 24 January

Sustainability of bioenergy and bioeconomy value chains II
Room 8, 15:30 – 17:00

Chairman: Luc Pelkmans, *IEA Bioenergy, Belgium*

15:30 **Opening**

Waste wood recycling in Europe – selected issues
Martin Wellacher, *Montanuniversität Leoben, Austria*

Promotion of European underutilised lands for sustainable bioenergy production using Web-GIS tools
Manuela Hirschmugl, *Joanneum Research, Austria*

The PARIS-Lifestyle – The role of biomass for a climate-friendly lifestyles in the bioeconomy fulfilling climate targets in 2050
Gerfried Jungmeier, *Joanneum Research, Austria*

N.N.

17:00 **End**

Language **English**

Parallelblock 20

Freitag 24 Jänner

Bereitstellung, Speicherung und Verteilung von Biowärme
Saal 7, 11:00 - 12:30

Chairman: Richard Zweiler, *GET Güssing Energy Technologies, Österreich*

15:30 **Beginn**

Evaluierung der österreichischen Biomasse-Fernwärme
Sabrina Metz, *AEE Intec Institut für Nachhaltige Technologien, Österreich*

Integration und Management von Energiespeichern in historischen Städten
Michael Heidenreich, *Innovationszentrum Weiz, Österreich*

Systemintegration und Dimensionierung von Pufferspeichern für Heizungssysteme mit automatischen Holzfeuerungen
Felix Schumacher, *Universität Luzern, Schweiz*

Effiziente Gebäudetechnik und Biomasse-Nahwärme - Integriertes Energie-Contracting am Beispiel Mautern, Steiermark
Daniel Schinnerl, *Siemens AG, Österreich*

17:00 **Ende**

Vortragssprache **Englisch**

Industrial Exhibition
Informationen unter www.cebc.at > Sponsoren

Als PartnerIn der CEBC können Sie

- ein länderübergreifendes Fachpublikum gezielt ansprechen
- Kontakt zu politischen EntscheidungsträgerInnen aus ganz Europa herstellen
- maximale Werbeeffekte erzielen
- Ihre Profile weltweit bewerben!

Parallel Session 20

Friday 24 January

Supply, storage and distribution of bioheat
Room 7, 11:00 - 12:30

Chairman: Richard Zweiler, *GET Güssing Energy Technologies, Austria*

15:30 **Opening**

Evaluation of Austrian biomass district heating
Sabrina Metz, *AEE Intec Institut für Nachhaltige Technologien, Austria*

Integration and smart management of energy storages at historical urban sites
Michael Heidenreich, *Innovationszentrum Weiz, Austria*

System integration and dimensioning of heat storage tanks in heating plants with automated wood furnaces
Felix Schumacher, *University of Lucerne, Switzerland*

Efficient building technology and energy contracting with integrated biomass district heating on the example of Mautern, Styria
Daniel Schinnerl, *Siemens AG, Austria*

17:00 **End**

Language **English**

Industrial Exhibition
More information: www.cebc.at > sponsors

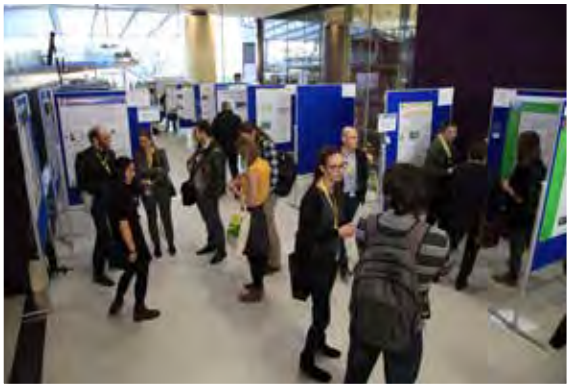
As a partner of the CEBC you can

- target a cross-national professional audience
- establish contact with policy-makers from all over Europe
- benefit from maximal advertising gains
- push your profiles worldwide!

Posterpräsentationen, *Foyer*

Im Rahmen der Posterpräsentation werden ausgewählte Konferenzbeiträge und Projekte zu folgenden Themenbereichen vorgestellt:

- **Bioökonomie**
- **Biogas**
- **Brennstoffcharakterisierung**
- **Wärme aus Biomasse und Verbrennungstechnologien**
- **Biomassepotenziale und Märkte**
- **Logistik und Lagerung**
- **Strom aus fester Biomasse**
- **Energiepflanzen und Reststoffe**
- **Brennstoff- und Substrataufbereitung**
- **Pellets**
- **Nachhaltigkeit**
- **Neue Absatzmärkte für Technologien**



Die Posterausstellung findet im **Foyer** zu den Tagungsräumen statt und ist während der beiden Vortragstage (23. und 24. Jänner 2020) zugänglich.

Darüber hinaus werden in den Konferenzpausen eigene **Postersessions** durchgeführt, in denen Ihnen die AutorInnen für Auskünfte zur Verfügung stehen.

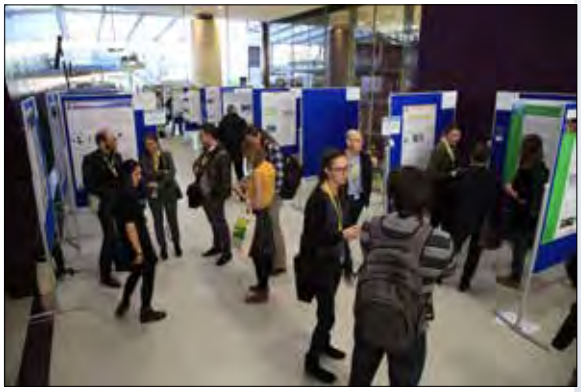
Donnerstag 23 Jänner
10:00–10:30 Uhr
12:30–13:30 Uhr
15:00–15:30 Uhr

Freitag 24 Jänner
10:00–10:30 Uhr
12:30–13:30 Uhr
15:00–15:30 Uhr

Poster Presentations, *Foyer*

Selected conference contributions and projects will be presented within the scope of a poster presentation. The following topics will be presented in detail:

- **Bioeconomy**
- **Biogas**
- **Fuel characterization**
- **Biomass heat and combustion technologies**
- **Biomass potentials and markets**
- **Logistics and storage**
- **Electricity from solid biomass**
- **Energy crops and residues**
- **Fuel and substrate preparation**
- **Pellets**
- **Sustainability**
- **New markets**



The poster exhibition takes place in the foyer of the Messe Congress Graz and is accessible throughout the conference days (23rd and 24th of January, 2020).

Furthermore, there will be guided poster sessions during the conference breaks, which enables the visitors of the conference to ask their questions to the scientists directly.

Thursday 23 January
10:00–10:30 Uhr
12:30–13:30 Uhr
15:00–15:30 Uhr

Friday 24 January
10:00–10:30 Uhr
12:30–13:30 Uhr
15:00–15:30 Uhr

Gallery Walk: Bioökonomie hautnah erleben – ein interaktiver Gallery Walk, *Foyer*

Eine Herkulesaufgabe unserer Zeit ist die Reduktion der Abhängigkeit von fossilen Rohstoffen und Energieträgern. Wie eine Transformation hin zu einer biomassebasierten Wirtschaft funktionieren kann, zeigt die österreichische Wirtschaft. Von Baustoffen aus nachwachsenden Rohstoffen bis zu enzymgewaschenen Vintagejeans: Die Produktpalette aus dem Innovationsbaukasten der Bioökonomie reicht weiter als das Auge sieht. In diesem Sinne stellt der Gallery Walk zahlreiche österreichische Vorzeigeprodukte vor und bietet zudem die Möglichkeit, mit führenden ExpertInnen in einem interaktiven Format zu diskutieren.

- **Bioökonomie**
- **Biogas**
- **Brennstoffcharakterisierung**
- **Wärme aus Biomasse und Verbrennungstechnologien**
- **Biomassepotenziale und Märkte**

Der Gallery Walk wird vom Ökosozialen Forum Österreich & Europa organisiert und findet im Rahmen des EU Horizon 2020 Projekts BLOOM statt, an dem das Ökosoziale Forum und elf andere Organisationen aus acht europäischen Ländern beteiligt sind. BLOOM bringt PraktikerInnen aus Wirtschaft, Forschung und Verwaltung sowie interessierte BürgerInnen aus verschiedenen europäischen Ländern an einen Tisch, um über die Potenziale der Bioökonomie zu diskutieren.

Donnerstag 23 Jänner
13:00–14:00 Uhr
15:00–16:00 Uhr

Freitag 24 Jänner
11:00–11:45 Uhr
14:00–14:45 Uhr

© Fotolia/way4arer

Gallery Walk: Bioeconomy – get in touch – the interactive Gallery Walk, *Foyer*

Reducing the dependence on fossil-based production: The herculean task of our time. However, many examples exist which show that an Austrian economy can move towards a more renewable base of production. The aim of the gallery walk is to offer a vivid opportunity to get in touch with real examples of bioeconomic action. In an interactive format, participants will get in touch with real showcases – provided by Austria's pioneers of bioeconomy – followed by a discussion with leading experts of the field.

- **Bioeconomy**
- **Biogas**
- **Fuel characterization**
- **Heat from biomass and combustion technologies**
- **Potentials and markets for biomass**

The gallery walk is conducted by the Eco Social Forum Austria & Europe as part of the EU Horizon 2020 project BLOOM, which aims at bringing together partners from all across Europe to debate on the potentials of bioeconomy and engagement of the civil society.

Thursday 23 January
13:00–14:00
15:00–16:00

Friday 24 January
11:00–11:45
14:00–14:45

© Fotolia/way4arer

Our media partners:

Our educational partners:

Our trade fair partners:

Our association partners:

An event by:

Österreichischer Biomasse-Verband

Landwirtschaftskammer Steiermark

BEST Bioenergy and Sustainable Technologies

klima+ energie fonds

Supported by:

Das Land Steiermark

Stadt Graz

klimaaktiv

Mit Unterstützung vom Bundesministerium Nachhaltigkeit und Tourismus

Energie Steiermark

Eschlböck Biber Holzhackmaschinen eschlboeck.at

JENZ

GLOCK ÖKOENERGIE

POLYTECHNIK Biomass Energy

fröling besser heizen

SYNCRAFT Das Holzkraftwerk.

STW Stadtwerke Klagenfurt

BIO ENERGIE KÄRNTEN

EGGER PowAir CLEANING

KWB

KOMPTECH

ENERGIE NETZE STEIERMARK

HARGASSNER HEIZTECHNIK DER ZUKUNFT

ERNEUERBARE ENERGIE ING. LEO RIEBENBAUER

bioenergie.at Ihr Plus in Wärme.

Austroflex Rohr-Isoliersysteme