RĪGAS EKONOMIKAS AUGSTSKOLA
STOCKHOLM SCHOOL OF ECONOMICS IN RIGA

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PUBLIC PRIVATE PARTNERSHIPS IN THE LITHUANIAN DISTRICT HEATING SECTOR: INNOVATIVENESS, PERFORMANCE, & EFFICIENCY

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Abstract

Public Private Partnerships (PPP) is a fairly new instrument, developed to deal with the inefficiency problems related to provision of public goods by combining the potential of both public and private sectors. However, the various positive effects of this tool are a matter of excessive scholarly and empirical arguments. In response, this study analyses the Lithuanian domestic District Heating industry, aiming to test the performance of the tool in this case. All heating providers that belong to the Lithuanian District Heating Association of varying management types are examined in three aspects widely recognised as crucial: innovation, financial performance, and efficiency. Different techniques are employed throughout the different stages of analysis: interviews and questionnaires, the Economic Value Added^{TM} test, as well as Data Envelopment Analysis and specific parameters' analysis. This three-fold analysis provides the proof of PPP-type companies' supremacy in all aspects, claiming that Lithuanian District Heating PPP examples outperform state-owned operators financially, as well as in respect of innovation and efficiency. Consequently, the results support the proponents' side, encouraging further PPP activity in the country, yet not without a word of caution, requiring serious consideration of several other aspects and preconditions, as well as encouraging more research.

1 Introduction

1.1 PPP Background

The theory of political economics (e.g., Rosen, 1995) suggests that market mechanisms are unlikely to provide public goods (e.g., a country's infrastructure, a critical factor connecting industries, supporting and encouraging trade (Porter, 1998), as well as increasing 'country competitiveness') efficiently. In addition, studies show that the need for significant expenditure on infrastructure in Central and Eastern Europe (CEE) countries remains and will increase as transitional arrangements on EU transport and environmental targets come to an end (Briggs, 2005). Presumably, the best solution has long been to have them provided by the public sector. However, the harsh criticism of the public sector for failing to cope with the duty passed upon them (due to the lack of financial or entrepreneurial resources, pure mismanagement and under-provision) relentlessly fosters the search for a better outcome. Moreover, governments, tightly restricted by the EMU and the Convergence Criteria not to surpass a certain level of budget deficit, cannot afford to increase public spending on public services significantly. Consequently, different types of cooperation are suggested as a possibility. A solution already widely realised in the transportation and environmental sectors in the old EU member states could be *Public Private Partnerships* (PPP) defined as "an *untraditional way of public procurements when a long-term contract between the public and private sectors is made for development or public services provision*" (Lithuanian Public Policy and Management Institute [PPMI], 2005). PPP, an instrument first employed by the UK government 12 years ago, is becoming an increasingly popular option worldwide, since, if utilised properly, it is claimed to be extremely helpful in dealing with the problems concerned. However, despite the ideological definition and the large number of real-life examples worldwide (notably though, still most widely applied in the UK), some considerable opposition against it is present, continuously reinforcing discussion. Furthermore, such authors as Leslie J. C Riggin, Patrick G. Grasso, and Mary L. Westcott propose that claims of PPP success are still largely based on anecdotal evidence only (Public Administration Review, 1992).

1.2 PPP in Lithuania

According to official data sources (Lithuanian PPP department, PPMI, Sorainen Law Offices, or local investment consultancies), PPP in Lithuania is not sufficiently developed yet. Only several projects have the features of the instrument. Projects such

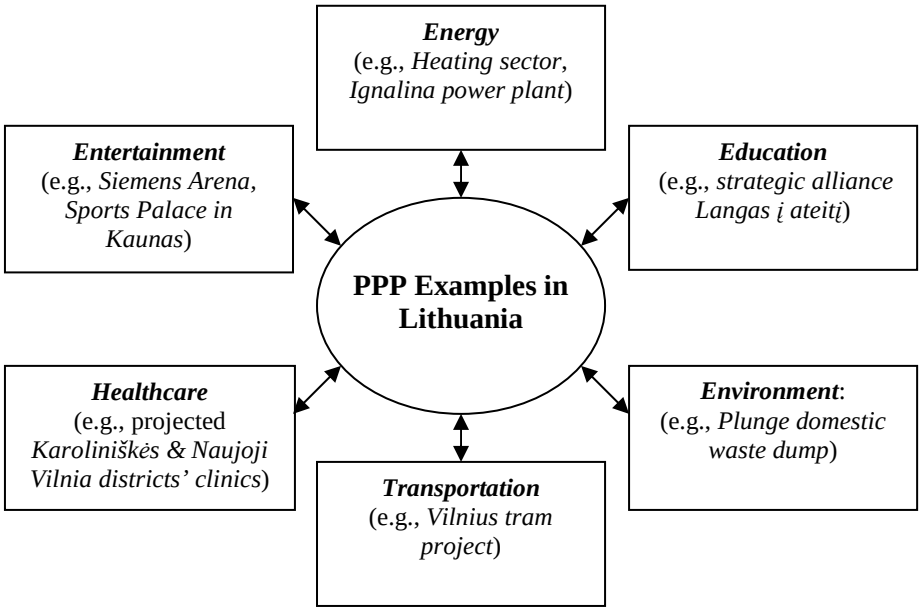
as *Langas į ateitį*, *Siemens Arena* and several other regional ventures (e.g., Plunge domestic waste dump, rented to a private entity) could be called pilot PPP projects. Some examples of contractual rental agreements, which, although without formal status, are nothing more than other categories of PPP, defined as "Operate, Maintain and Manage" (OM&M) by Grimsey, Lewis (2004, 12), can also be found. However, there are many PPP design plans or visions for the future in the healthcare, education, and infrastructure industries in the country. Following more experienced countries' practices, several feasibility studies for PPP project financing and tendering have already been ordered by municipalities[1]. The new *Sports Palace* in Kaunas, Nemunas Island, or concerns about the catastrophic situation of the low quality and desperately fund- and investment-lacking Lithuanian higher education system, could be seen as specific examples of other PPP opportunities. One of the biggest advances, following other countries' experiences, was establishing a special PPP projects management and coordination department at the Ministry of Finance of Lithuania in May 2005. Its main current task is to prepare PPP process development strategy for the country. Yet, it is still rather fresh, inexperienced, and small (employing personnel consiting of three experts), and claims that despite the completed initial legislative base there is still a big need for its compliance with other legislation present in the country, such as the fact that excessive municipal liabilities up to this moment have not been included in State debt. Consequently, economists predict that these uncontrollable liabilities may not only run the municipalities, but also even the State government into bankruptcy. In response, deputies are preparing to reform the concession law to put certain limits on municipal borrowing (Pačkauskaitė, 2006). This action should encourage more careful decision-making processes before taking up long-term liabilities. In short, regardless of serious discussions worldwide, the overall Lithuanian experience with the PPP tool is rather poor. Yet, the first contracts are being made, pilot projects are being implemented and planned further (refer to **Figure 1.** below for a schematic overview of current and potential PPP activity in Lithuania).

In the end, the heating sector has been pointed out by the Lithuanian PPP department as the only example in the country where comparative analyses between the different forms of ownership and management would be feasible (Kalinauskiene,

[1] E.g., Vilnius municipality tenders for Karoliniškės and Naujoji Vilnia district clinic developments are about to announce their results; meanwhile, a remarkable Vilnius tram project is under serious discussion and consideration.

2005). Moreover, the Vilnius city heating network rental agreement is regarded as one of the more successful currently active PPP projects (PPMI, 2005). As a result, as the most evident sector with PPP examples in Lithuania, the heating industry becomes the most researchable and appealing for this study.

Figure 1.: *PPP activity in Lithuania*



Source: developed by authors

1.3 District Heating (DH) Industry

1.3.1 PPP & DH in Europe

At first glance, DH projects seem to form a negligible part in the whole range of various PPP projects across Europe. For instance, the 6th European Global Summit provided the following figures for PPP projects in all European countries: 77% PPP projects connected with *transportation* (roads, tunnels, railways), 9% with the *health* sector, 8% with the *IT* sector, and the remaining 6% associated with *education*, *leisure*, *airports*, and *prisons*; DH projects were not even mentioned (Kalinauskiene, 2006). Looking at the information provided by the European Investment Bank, summarising PPP projects by country and sector (see **Appendix A**), no information about DH could be found either (2004, 14). Indirectly, this all implies that other forms of ownership and management are common among other European Countries.

The District Heating System Ownership Guide (DHSOG) reports that forms of ownership and management have changed significantly during the 1990s in both Western European and CEE countries (2006). DH systems have usually been integrated into state-owned national electricity utilities (mostly in CEE countries), or have been one of the universal municipal multi-utilities provision functions (Western

European Countries). However, when in the last decade of the 20th century the command-control economies collapsed, the more traditional market economies had chosen to liberalise energy trading and open up competition in previously monopolistic electricity and natural gas markets. These changes brought about several new and diverse ownership structures. As a result, currently four different types of DH company ownership exist among European countries: full public control by the state or municipality, full private control, mixed ownership and management between public and private parties, and not-for-profit community-owned cooperatives (DHSOG, 2006).[2]

1.3.2 DH in Lithuania

The first transformation processes in the Lithuanian DH industry started in 1997, when the ownership of central heating supply companies was transferred from AB *Lietuvos energija* to municipalities. During 1997-2000, 44 distinct central heating supply companies were established. After the government established a specific regulatory body, The State Price Regulation Commission of Energy Resources ('The Commission') to regulate different infrastructure activities, and the parliament adopted a new Heating Law, effective as of July 1st, 2003, the "district heating sector started its transition to the new system of legal regulation" (Lithuanian District Heating Association [LDHA], 2005). The functions of the Commission include preparing heat and hot water pricing methodologies and regulating the prices of suppliers realising over 5GWh of heating energy per year. It is also assigned to evaluate the costs of heat production (considering the company facilities owned and costs of input materials) as well as investments to enhance productivity, and ensure that no companies earn higher than pre-specified profits. Lastly, it is handling complaints and assigning licenses to operate in the DH market (LDHA, 2005).

Currently, DH systems account for ~50% of gross heat production in Lithuania (LDHA, 2005). There are around 60 suppliers, which realise over 5GWh of heat per year; therefore they are regulated by the State, i.e., the Commission (Lietuvos Šilumos Tiekėjų Asociacija [LŠTA], 2005).

Until 2000 the industry itself was experiencing decreasing production and sales (industrial bankruptcies, disconnections, decreased welfare level, switches to gas heating). However, recent years brought notable stability, enforced further by decreased losses in heating pipeline networks. Yet, the main transmission networks

[2] For more detailed partnership ownership descriptions and examples in Europe, refer to **Appendix B**.

are 30-40 years old, at the edge of expiration, yearning for new investment and renovation. Luckily, these investments are already taking place, thereby improving the overall situation as average costs to the final consumer drop. Moreover, there is proof that DH enterprises are increasingly switching to renewable energy sources, bio-fuel in particular (LŠTA, 2005). Clearly, all these innovations require substantial investment, making PPP a promising and attractive cooperation option, bringing more of the necessary private capital.

1.4 Research Question

As already indicated above, despite the ideological definition (partnership for development or public services provision) and the large number of real-life examples, worldwide opposition against PPP is present. Its adherents claim that private involvement via PPP enables the government to improve national services without increasing the national budget deficit, providing qualitatively better projects by *operating more efficiently*, possessing *market experience* and *innovative creativity* (Ham, Hans van, and Joop Koppenjan, 2001). On the other hand, the scale of PPP projects in the Lithuanian DH market is rather small; with the public facilities of some districts being leased to private entities, a part of the Lithuanian DH industry can be classified as OM&M PPP contracts. In response, PPP opponents usually argue that "procurement costs related to technical, financial, design and legal advice are relatively higher in smaller projects, the transaction and development costs are disproportionately large" (International Financial Services London, 2003, 6). Therefore, a widely spread opinion is that a really successful PPP project could only be a large-scale project. Still, Grimsey and Lewis claim that in emerging markets public utilities leasing remuneration systems stimulate the "private operator to update customer files and implement efficient collection procedures to *improve the collection ratio from customers*, expand the customer base to *service more customers* and *increase the revenue base*, and to *undertake regular maintenance* to increase the reliability of facilities and postpone their renewal" (2004, 225). All these factors suggest that - in spite of comparatively small project scale - company performance should still improve in several aspects. Moreover, in addition to the above, *leasehold partnerships* and *private equity partnerships* exist as another type in the Lithuanian DH market; the private involvement here is through the equity market as majority or

selected minority private equity ownership[3]. Obviously, the latter type of partnership has less private involvement, which should imply fewer characteristics and, thereby, positive effects of PPP projects. Yet, private equity involvement is one of the more usual partnership types in the European DH market. This fact makes it interesting to compare: which type of collaboration leads to better performance.

In short, the serious argumentative discussion about PPP "providing qualitatively better projects by *operating more efficiently*, possessing market experience and *innovative creativity*" (Ham, Hans van, and Joop Koppenjan, 2001), and *performing better financially*[4] continues enthusiastically worldwide. Simultaneously, the Lithuanian DH sector provides a good space for analysis. Therefore, this paper sets out to research ***whether PPP projects are really more innovative and efficient at the same time performing better financially than other forms of ownership and management in the Lithuanian DH sector***. More specifically, three hypotheses are to be tested:

H1: PPP projects have more innovative capabilities than their public counterparts.

H2: Economic Value Added™ (EVA™) analysis would indicate higher real value added by PPP projects than by their public counterparts.

H3: PPP projects produce heat more efficiently than their public counterparts.

1.5 Contribution

Many authors (e.g., Riggin, *et al*, 1992[5]) note that not only is PPP success largely based on anecdotal evidence, but that it is also a particularly difficult task to competently empirically prove something regarding PPP, as data on projects are considerably sensitive or difficult to obtain, resulting in difficult attribution of the full range of effects of a partnership project[6]. Therefore, ultimately, even an attempt at PPP evaluation could "indicate kinds of information to be documented throughout partnership, demonstrating if partnership strategies are more successful in meeting public objectives than non-partnership approaches" (Riggin, *et al*, 1992).

[3] For more detailed partnership ownership descriptions and examples in Europe refer to **Appendix B**.

[4] Due to the same market experience, improved collection ratio from customers, expanded customer base while servicing more customers and increasing the revenue base, as well as regular maintenance undertaken

[5] Please consult the original version of SSE Riga Bachelor Thesis under the same title and authors, **Appendix A.**, **8.1.5** for deeper discussion.

[6] This is why local governments are encouraged to make information disclosure a condition of participation in PPP projects for the parties involved.

This three-fold analysis should provide a notably thorough comparison of the different types of companies. More specifically, quantitative, empirical evidence as to how much better (or worse) a private body performs could be compared to the contracting costs, consequently reasoning new PPP contracts in the heat provision market. Also, they could help in assessing whether central heating provision utilities leasing contracts are worth prolonging, and even provide policy solutions evaluating PPP experience in general.

In brief, this paper should firstly be a great contribution to policy makers as it provides evaluation and comparison of the industry, individual and overall PPP project performance, as well as hints for future decisions (e.g., which contracts to prolong, which issues to cover). Secondly, the economy should also benefit from this thorough coverage of the whole Lithuanian DH industry and PPP project performance. Finally, academia as well as the general public should also gain from the increased base of PPP analysis of yet another country and industry, especially when the topic is still rather fresh and lacking in-depth analysis.

After introducing the topic by providing the general background (on PPP, its Lithuanian experience, and the *DH Industry*) as well as elaborating on the *Research Question* and its *Contribution* to various parties, the study continues with the *Methodology* part comprising a theoretical model, *Data* and empirical methods for the three-fold analysis. The *Results* part, including the three-fold *Analysis* of the *Empirical Findings* presented, follows next. *Discussion of the Results* and *Conclusions* are the final parts.

2 Methodology

The three-fold research question calls for a careful comparative analysis of three aspects in Lithuanian DH industry: innovativeness (1), ability to add value (2), and operating efficiency (3). To do that, firstly, an innovativeness assessment via questionnaires is presented. EVA™ analysis aiming to assess the financial-economic performance aspect follows next. Operating efficiency evaluation employing the DEA method and several individual parameter assessments is the finalising part[7]. To compare PPP and public companies in an objective, statistical, way, the results from all the three parts of the study are at the end examined using SPSS software.

[7] The reasoning for the methodology chosen can be found in the original version of SSE Riga Bachelor Thesis under the same title and authors.

Specifically, as the sample is smaller than 30 entities, the Mann-Whitney test for the 2 group means' comparison is performed.

2.1 Innovative Capacity Comparison

2.1.1 Research Strategy

Although many empirical studies measure innovativeness looking at "the rate of adoption as the number of innovations adopted within a given period" (Damanpour, 1991, 589), pure analysis of this data would not allow understanding why some organisations are more innovative than others. Therefore, in this study a research representing a communication method collecting primary, internal data from company directors and experts helps to examine certain empirically validated characteristics shown to correlate with innovative behaviour in different organisations in addition to straightforward research for the exact ratio of innovations per period. Specifically, some generic organisational characteristics correlating with innovativeness within different types of companies are examined by questionnaires. The administration method of survey chosen was e-mail-based questionnaire research, sent out to pre-selected potential respondents (with ex-ante contact made via telephone). Prior to the main research, extensive field research was carried out to gain sufficient knowledge in the DH sphere, and then get to the most important innovativeness aspects here. A real-life interview as well as e-mail and phone-based consultations were held with the head of the Commission's heat department, Antanas Katinas. We also contacted a doctor of science and professor at Vilnius Gediminas Technology University's Heat Department, Vytautas Martinaitis, as well as several heating companies to check upon unclear issues (e.g., AB "*Kaunas Energija*", UAB "*Vilniaus Energija*"). Much useful information was acquired from the Commission and LDHA webpages. Furthermore, prior to launching the real final questionnaire, several pilot surveys with the actual companies (UAB "*E-energija*" and UAB "*Švenčionių Energija*") were carried out to assure the relevance of the questions. These questionnaires were presented to company representatives and any unclear formulations or questionable issues were discussed to obtain several valuable and useful suggestions for improvements. Two different sizes of company (a small and a big one) were chosen to cover all possible misunderstandings in entities of different size or production scale. Furthermore, to deal with the likely disadvantage of low potential response to the final questionnaire, a pre-contact with each of the company representatives (something of the 'warm-

calling' type) was established. However, while the total number of recipients was 28, the response rate was only 8[8].

2.1.2 Questionnaire

The questionnaire, examining which type of companies in the Lithuanian heating sector demonstrate more innovative behaviour, was designed to look at actual innovations performed and generic characteristics, empirically proved to correlate with innovative behaviour, by building in each relevant aspect. To deal with any possible misunderstandings, a definition of what was meant by innovation had been introduced. Then the respondents were asked to mark different kinds of innovation done by their company within a certain period. To get an idea of each company's expenditure on innovations, the actual and necessary innovation costs as turnover percentages were asked. To handle quantitative research with structured data collection, mostly fixed-alternative questions were posed.

The first generic parameter associated with innovative behaviour in many different companies is *environment*, usually described as competition faced in the market (e.g.: Miller and Friesen, 1982, 11 or Miller 1983, 788). While almost no competition between central heating providers in the Lithuanian DH market exists,[9] some districts face competition with substitute services providers. The main competition here comes from individual and alternative heating source options. Therefore, the perceived competitive threat from these entities was asked for in the questionnaire.

Another generic parameter described by Lumpkin and Dess (1996, 143) as greater reliance on technically trained specialists is *technocratization* (e.g., Miller, 1983, 788; Lumpkin and Dess 1996, 143; Miller and Friesen 1982, 4 or Damanpour 1991, 558). This parameter was assessed by comparing the numbers of various engineers to the total number of employees in the company. Also, the employees' learning possibilities at their daily work tasks, as well as the companies' interest in enhancing employee specialisation by providing various training and other development opportunities were questioned and assessed.

One more organisational parameter found by Damanpour (1991) to significantly correlate with innovative behaviour within many different types of organisations is

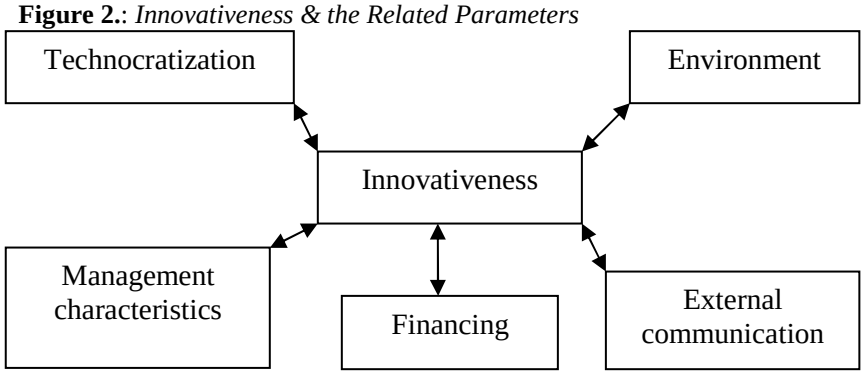
[8] However, one of the responses (coming from "*Dalkia*") holds for two companies ("*Vilniaus energija*" and "*Litesko*"), making the total represented nine DH providers.

[9] Due to the practice of using sole transmission networks in an area, each provider (who has either direct ownership or leasehold of these networks) faces a situation similar to a natural monopoly.

external communication. To assess this, the companies' degree of cooperation with different market players was examined. The specific question about the presence of a customer service desk was meant to evaluate collaboration with customers more objectively. In addition, companies were asked if they felt they were receiving enough external support for implementing innovations.

Personal Characteristics, certain attitudes company managers have towards change in particular, represent one more parameter (e.g., Ellis, Webster, 1998, 2; Miller, 1983, 778). The specific questions to see differences between managers' personal characteristics in response to innovativeness in organisation were consulted from a study of Myung Jae Moon, called 'The Pursuit of Managerial Entrepreneurship: Does Organisation Matter'. Management's opinion on red-tape (cross-checked by looking at the number of administration workers relative to the total employee number) and formalisation levels was questioned. Also, having split the employees to engineers, pure technical workers, support staff, and administration, their empowerment level as well as encouragement to participate in innovation development processes and company mission and goal awareness were examined.

Figure 2.: *Innovativeness & the Related Parameters*



Source: developed by authors

Finally, an additional parameter not so widely discussed in literature investigating whether PPP and public companies face different constraints for innovation *financing* was included. Questions on financial constraints and to access different funds were posted.

The resulting schematic depiction of this part of the study can be seen in **Figure 2.** above[10].

[10] The complete version of the questionnaire (in English) can be found in the original version of SSE Riga Bachelor Thesis under the same title and authors, **Appendix D**.

2.2 EVA™ Analysis

To examine any differences arising in PPP and public companies' financial-economic performance, the widely-used EVA™ analysis was chosen as the most appropriate; since, firstly, it is able to assess the real value added by companies, and, in addition, it is empirically proven to have the highest statistical correlation with shareholders' value creation in comparison to common accounting ratios (qtd. in Garvey, Milbourn, 2000, 211). As a result, this analysis not only assesses the return in each company after considering all the costs involved, but also does it in a more reliable and significant way than other common financial analysis tools. Finally, this analysis suits the DH industry very well as "it relies on invested capital, it is more suitable for analyzing asset-intensive firms <…> that exhibit somewhat predictable growth trends. The best use of economic profit tends to be in traditional and mature industries." (Harper, 2006, 6) On the other hand, it could be argued that this method, although widely-used, still has several weaknesses. One usual difficulty is the method's inability to assess companies in a single time period (e.g., huge one-period investments may distort conclusions). However, that is not so relevant to this research, as more than one period is analysed. Moreover, all the leasehold agreements were started a few years prior to the chosen analysis period, and the heaviest investments were made at the very beginning. Finally, as the Commission allows companies to increase the heating price to recover all the necessary investments, the companies' performance in this aspect should not differ greatly. Another persistent problem is that unless all cash adjustments are made, the economic profit will be subject to accrual distortions. However, David Harper argues that three major adjustments together with consistency maintained are enough to attain reasonable economic profit calculation (2006, 6). The method is explained next.

EVA™ "is often defined as the value of an activity that is left over after subtracting from it the cost of executing that activity and the cost of having lost the opportunity of investing consumed resources in an alternative activity" (Wikipedia, 2005). The formula to calculate it is as follows:

Economic profit = NOPAT – [WACC × Invested Capital]
NOPAT: Net Operating Profit after Taxes
WACC: Weighted Average Cost of Capital

Source: Harper, 2006, 6

The potential list of necessary adjustments to income statement and balance sheet to calculate NOPAT and Invested Capital is provided in **Table 4.** below.

Table 4.: *Adaptations for Accounting Data*

EBIT → NOPAT	**Book Capital → Invested Capital**
Add: increase in LIFO reserve	Add: LIFO reserve
Add: increase in allowance for bad debt	Add: bad–debt reserve
Add: implied interest on operating leases	Add: present value of future operating-lease obligations
Add: minority interest provision (if not already included)	Add: minority interest
Add: increase in deferred income tax reserve	Add: deferred tax liability

Source: Harper, 2006, 6

The common WACC formula is: $$WACC = \frac{E}{V} * \mathrm{Re} + \frac{D}{V} * Rd * (1 - Tc)$$

where:

Re = cost of equity
Rd = cost of debt
E = market value of the firm's equity
D = market value of the firm's debt
V = E + D
E/V = percentage of financing that is equity
D/V = percentage of financing that is debt
Tc = corporate tax rate

(WACC, 2006)

2.3 Operating Efficiency Comparison

In their study 'Economic and Environmental Efficiency of District Heating Plants' Agrell and Bogetoft (2001) describe the heating industry as that of natural monopolies with high asset specificity. Moreover, the managed Lithuanian heating industry can be regarded as operating under regulatory economics. Furthermore, the technology here is inherently multidimensional, turning primary energy sources into several heat products (gas, water, etc.). All this goes as substantial argumentation for the appropriateness of using the DEA method for efficiency valuation[11]. In addition, from an operational viewpoint, there is no use in benchmarking against average performance, given the diversity of the operators' size in the industry, as it would render the large-scale actors suboptimal informational rents. Consequently, similarly to Agrell and Bogetoft (2001), we deduce that the DH industry is well-suited to efficiency analysis by DEA.

Further following the similar study by Agrell and Bogetoft (2001), the output of *heat* is assumed to be exogenously given (as the demand for heat is so specific and rather inelastic, especially in the short term). The "inputs for the activity are the *asset base*, the *capital*, the *primary energy input*, *labour* and *other expenses*" (2001).

[11] Pure technical efficiency is the most relevant when the output level is given (determined); relative efficiency is more important in regulated economies; multiple production inputs have to be considered; all features the DEA method is able to deal with. More elaborated argumentation on efficiency and productivity measurement choice can be found in Bauer *et al* (1998), Berger and Mester (1997), Berger and Humphrey (1997), Hollingsworth *et al* (1998, 163) or Weill (2002), and the original version of SSE Riga Bachelor Thesis under the same title and authors.

However, there are two reasons against using capital in the model: 1) valuation of capital available in the accounting data is based on historic and possibly distorted costs, and there is evidence that depreciation practices in public and regulated utilities in no way mimic the true replacement cost, nor any plausible cost of capital; 2) in the short-run operation perspective, the capital base must be considered as a sunk specific investment (from the myopic viewpoint irrelevant to ongoing operations) (ibid, 2001). Furthermore, bearing in mind the particular features of our research, consideration of the asset base would also lead to unrealistic results, since they are not in the Balance Sheets of the renting operators. To measure pure technical efficiency, a universal input list for all the companies has to be chosen. This prevents considering 'other expenses', as they might differ substantially across the entities. Finally, the primary energy inputs are divided into *energy* and *fuel in oil equivalent*, leading to the list of inputs being as follows: *energy*, *fuel in oil equivalent,* and *labour*.

The selected input and output data collected from the online LDHA annual reports is then processed with specific non-commercial software *EMS* (*Efficiency Measurement System*) developed for non-parametric efficiency measurement, the DEA method measuring the *technical efficiency* of the 2 groups of companies (PPP & public)[12]. Furthermore, as simple DEA methodology requires, convexity of the production function and constant returns to scale are assumed to obtain *technical efficiency* scores, which is not wrong in this case, since the scale of operation is determined exogenously and pure technical efficiency assumes it. The *superefficiency* option is used to discriminate more evidently among different results in case the efficiency scores obtained are relatively close.

To strengthen operating efficiency performance analysis, in addition to DEA, several individual parameters, whose importance is highlighted in PPP literature, are investigated. Firstly, PPP are argued to have a great negative impact on employment (cutting down on labour); secondly, they are claimed to collect payments from customers better; thirdly, the cost to the final consumer should be lower. These factors are particularly interesting to look at, as, e.g., even though the heating price-ceiling is regulated, the "*Vilniaus Energija*" price is set notably below it. In addition, a direct technological parameter representing improvements in technology (the technical loss in the heat transmission process) can be investigated to see how well the companies

[12] *Allocative efficiency* is rather irrelevant in regulated industry.

manage and improve their transmission networks. All these parameters as percentage changes and in absolute terms (except for the employment impact) are compared between PPP and publicly-owned companies.

2.4 Data

2.4.1 The Sample

To maintain the analyses' compatibility and consistency, and to leave the possibility of aggregating them at the end, all three parts were performed with the same companies' sample, namely, the LDHA members. The sample[13] is sufficiently representative, as: (1) the companies collectively produced and supplied 90.8-99.0% of total heat provided to the Lithuanian heating network throughout 2001-2004; (2) all the privately owned companies are members of this association; (3) the members can be considered as the more competitive ones, as LDHA membership status provides the possibility to participate in various legislative and educational processes[14]. Furthermore, while there are several private heat producers, according to Lithuanian legislation, the transmission networks cannot be privatised, and private entities can only operate them under lease agreements with municipalities (Katinas, 2005). Therefore it should be emphasised here that the scope of this analysis comprises companies both producing and transmitting heat to the customer. In this way, the operations can be performed either by public or private bodies (under special lease agreements), or by companies where both private and public parties are equity owners. According to Commission member, Deputy Head of the Heat Department, Juozas Mockevičius, there are five PPP companies in the Lithuanian DH market (2006). Three of them are operated under a lease agreement: UAB "*E-Energija*", UAB "*Litesko*", and UAB "*Vilniaus Energija*". While the first is a Lithuanian company, the other two are daughter companies of the French concern "*Dalkia*". In addition, there are two more partnerships with private equity ownership: AB "*Kaunas Energija*" and UAB "*Fortum Heat Lietuva*". In addition, it is interesting to note that prior to becoming partnerships, the economic and technical indicators of the acquired companies were not satisfactory, in some cases resulting in very poor performance. In all cases, private participation has positively influenced them. The most successful example in this case is the *Dalkia* leasing agreement, when, according to international auditors' conclusions, before leasing the infrastructure UAB "*Vilniaus Energija*" had

[13] A full list of the sample companies is provided in **Appendix C**.
[14] Consequently, the remaining public companies appear to be inadequate comparison being the more extreme cases.

been suffering heavy losses (in 1998 – LTL 22.8mn, 1999 – LTL 10.5mn and 2000 – LTL 24mn) while after entry of the private operator the service quality improved notably, the non-payment rate has stabilised at only 1-2%, disconnections have stopped, consequently raising overall performance (Kalinauskiene, 2005; International Energy Agency, 2004).

2.4.2 Financial Data

The necessary financial data on individual companies for 2003 and 2004 (the two years after the regulatory body in the industry was established) were collected from the publicly available database of the Lithuanian *State Enterprise Centre of Registers* (www.kada.lt). According to Lithuanian legislation, companies are obliged to annually present their Income Statements, Balance Sheets, and Cash Flow data. As all the entities must report, and the information from the financial statements must be audited, the data set is not only sufficiently consistent, but also plausibly reliable.

2.4.3 Technological & Operational Data

Technological data for efficiency analysis were collected from LDHA webpage statistics. The association provides statistics for different technological and operational parameters. Statistical data are available since 2001. That year (or the end of 2000) is the date when most municipalities started leasing or sold shares of DH facilities to private equity holders. However, since "*Vilniaus Energija*" was leased in February 2002, it had been adjusted to the sample with the companies leased in 2001/2000 for a more thorough analysis of the major changes in companies after they became privately managed. For "*Vilniaus Energija*" the data of 2002 were treated in the one sample with the data for other companies of 2001.

2.4.4 Data Adjustments for EVA™ Analysis

For the sake of sustaining research uniformity, only the main accounting data adjustments, suggested by Harper (2006, 6), were carried out. Since some of the financial data were provided without final notes, two assumptions had to be made to sustain consistency of the data set throughout the analyses. Firstly, Earnings before Financial and Investing activities were used instead of EBIT, as interest expenses amounted to the major part of the former. Second, reported taxes were used in the analysis instead of cash taxes. According to David Harper, "truth be told, we could use reported taxes and we would still have a viable economic profit number" (2006, 3).

Finally, WACC was calculated using the information employed by the Commission. The risk-free interest rate was obtained following commission normative descriptions; the annual interest rate calculated as the average yield of a three-year Government Bond issued a year before the period analysed in the primary market, with Lithuanian litas as the issue currency (Valstybinė Kainų ir energetikos Kontrolės Komisija, 2003). The necessary information was obtained from the Lithuanian Central Bank webpage. For 2003, the risk-free interest rate was 5.210% and for 2004 – 4.277% (Lietuvos Bankas, 2006). Following the recommendations of the Commission, Business risk premium was calculated by taking into account three operational aspects. Firstly, the pressure to the heat transmission networks was analysed, dividing all the heat produced for a certain year by the kilometre length of the transmission networks. If 3500-5000MWh of realised heat could be assigned to 1 km of transmission networks for a certain year, then 1% should be added to the business risk premium. Accordingly, for 2500-3490MWh, 2%; while for 2490MWh and less, 3% should be added to the business risk premium. Secondly, the factual renovation of transmission networks (during the duration of the pre-set heat price) is to be investigated. If 10% or more of the transmission networks had been renovated, then 2% should be added to the business risk premium. Accordingly, if 5-10% had been renovated, then 1% is to be added; and for less than 5%, 0.5% is to be added to the business risk premium. Thirdly, decreases in heat production costs were assessed. If costs decreased by more than 10%, then 1% was added to the business risk premium; if 5-10% – 0.5%. Finally, the components were added with the maximum sum capped at 3% points[15] (Valstybinė Kainų ir energetikos Kontrolės Komisija, 2005). The business risk premium was added to the risk-free interest rate to obtain WACC.

Table 5.: *Business Risk Premium*

	Percentage points to be added to the business risk premium			
	add 0,5%	add 1%	add 2%	add 3%
1. Realised heat pressure to 1 km of heat transmission networks		3500-5000 MWh	2500-3490 MWh	≤2490 MWh
2. Factual renovation of heat transmission networks		5-10%	≥10%	
3. Realised decreases in heat production costs	5-10%	>10%		

Source: developed by the authors

[15] For a constructive summary, see **Table 5.**

3 Results

3.1 Innovative Capacity Comparison

Firstly, it is important to note that due to the extremely small response sample, it is truly difficult to make any generalisations or draw significant conclusions, distinguishing which group has performed the best. More specifically, from eight responses three were PPP (which were split into two leases and one private equity involvement company for deeper analysis) and five public entities. Moreover, the *Dalkia* group response holds for two, UAB "*Litesko*" and UAB "*Vilniaus Energija*", the group's subsidiaries (maintaining the same cultural behaviour). Yet, due to this small observation rate, the analysis more resembles a case study format.

Looking at the most straightforward aspect, investments in innovations, first, it is important to note, from the beginning, that although "*Dalkia*" did not present the figure for its actual investments as a percentage of turnover, the investments in innovations for its both subsidiaries, UAB "*Vilniaus Energija*" and UAB "*Litesko*", are known and substantial: LTL 300mn in DH facilities in 2002-2006 for the former (Vilniaus Energija, 2006), and LTL 150mn for various innovations till the end of 2005 for the latter (Litesko, 2006). Data on actual investments in innovation implementation during the past five years provided by other companies (see **Table 6.**) clearly indicate a visible difference among PPP and public entities; PPP companies have invested much more. However, no clear trend emerges when the investments are evaluated as being sufficient for the maintenance of the facilities. Only UAB "*Švenčionių energija*" (private equity) claims to be surpassing the necessary amount of investments. Moreover, analysing innovations in operations, interestingly three public companies stated they do not innovate at all in operations in transmission networks, although this field is particularly lacking in investment.

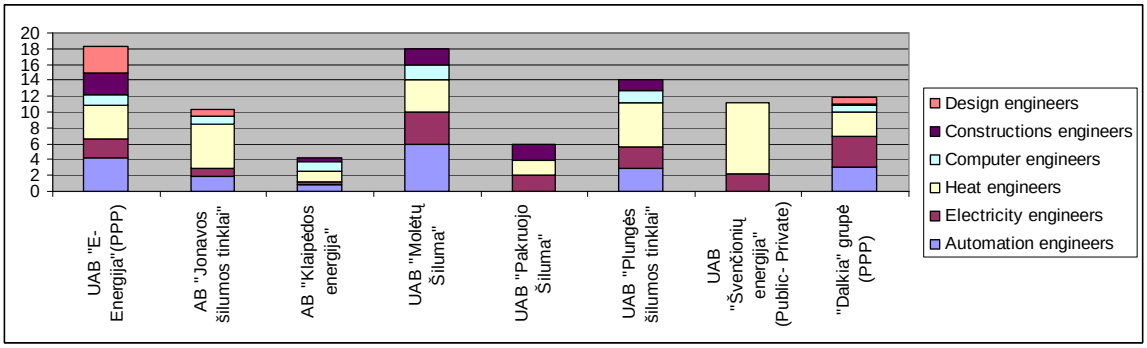
Table 6.: *Companies' Investments in Innovations*

Company Name	innovations investment as % of turnover during the past 5 years	sufficient investment as % of turnover for maintenance
UAB "E-Energija"(PPP)	45%	50%
AB "Jonavos šilumos tinklai"	~0.9%	~2%
AB "Klaipėdos energija"	10%	20%
UAB "Molėtų Šiluma"	15%	30-40%
UAB "Pakruojo Šiluma"	1%	10%
UAB "Plungės šilumos tinklai"	10%	20%
UAB "Švenčionių energija" (Private equity)	50%	10%

Source: developed by authors

Turning to analysis of company characteristics that encourage innovations, the operational *environment*, and the perceived threat of competition, in particular, is looked at next. The average group means (in the scale of 0 to 2) in responses are 0.4 for public entities and 0.8 for the two partnerships. Though no significance tests for the difference for such a small sample can be performed, public companies seem to perceive competition in the market as less threatening.

Figure 3.: *Number of Engineers as a Percentage of Total Employees*



Source: developed by authors

Going further, illustration of the number of different engineers (expressed as a percentage of the total number of employees) in each company is presented in **Figure 3.** The greater the degree of specialisation and different training in an organisation, the greater is the *technocratization* level. While no clear trend is observable from the data at hand again, a PPP company, "*E-Energija*", has the biggest variety of engineer specialisations. However, it is likely that a greater variety of specialists may lead to marginal costs exceeding the marginal benefits achieved. As for general and additional employee development (refer to **Table 7.**), PPP employ the biggest variety of methods. Moreover, public companies are mostly lacking such activities as collaboration between different groups or task rotation; thus, they fail to adopt

Table 7.: *Employee Development*

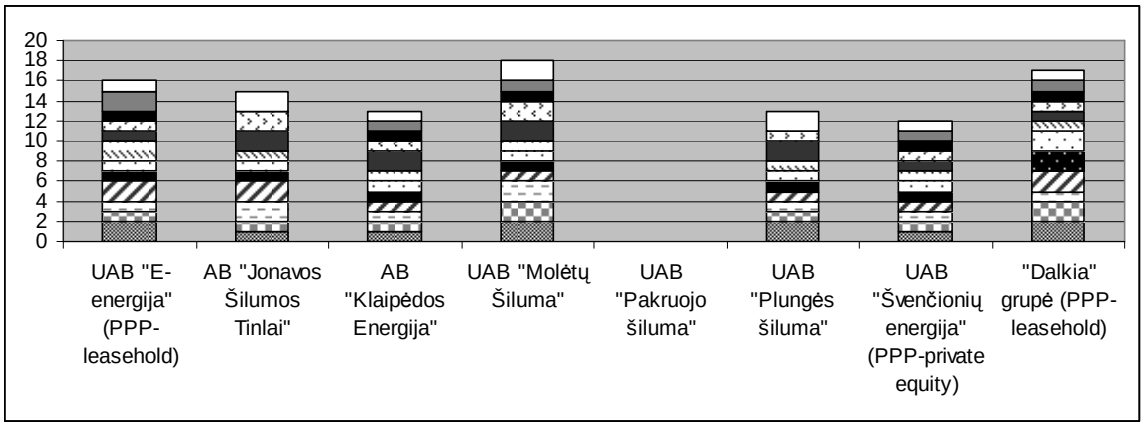
	employee development				additional employee development		
	solving work problems	workgroups collaboration	team-work	task rotation	functional training	specific training	various seminars
UAB "E-Energija"(PPP)	V	V	V		V		V
AB "Jonavos šilumos tinklai"	V	V			V		V
AB "Klaipėdos energija"	V	V	V		V	V	V
UAB "Molėtų Šiluma"	V			V		V	
UAB "Pakruojo Šiluma"	V	V			V	V	V
UAB "Plungės Šilumos tinklai"	V		V		V	V	
UAB "Švenčionių energija" (Private equity)	V	V	V	V	V	V	V
"Dalkia" grupė (PPP)	V	V	V	V	V	V	V

Source: self-developed

measures that are supposed to spread the knowledge base within the organisation and stimulate innovations.

No significant differences for the *degree of collaboration* with other market players can be observed (from **Figure 4.**) too. All companies (except one, UAB "*Pakruojo Šiluma*") collaborate with the various market players (represented by different textures in the figure) to a seemingly similar degree. In addition, the customer service centre is not present only in two small public companies. Therefore, PPP companies seem to have no noteworthy advantage regarding the ability to communicate with external entities or customer responsiveness.

Figure 4.: *Collaboration with Other Market Players*



Source: self-developed

The determinants of *personal characteristics* of the managers, however, seem to contradict the *a priori* expectations (see **Table 8.**). Task formalisation level is slightly higher and employee empowerment levels are lower for PPP companies, which would indicate an additional restriction to on-job creativity. Moreover, awareness of company goals is only slightly higher there.

Table 8.: *Managers' Personal Characteristics*

	bureaucracy level (0, 1, 2)	task formalisation level (0, 1, 2)	technical workers' empowerment (1, 2, 3)	engineers' empowerment level (1, 2, 3)	employee awareness (5-1)
UAB "E-Energija"(PPP)	1	1	1	2	4
AB "Jonavos šilumos tinklai"	1	2	2	2	5
AB "Klaipėdos energija"	1	2	2	2	4
UAB "Molėtų Šiluma"	1	2	1	3	5
UAB "Pakruojo Šiluma"	0	0	2	3	3
UAB "Plungės šilumos tinklai"	2	1	2	2	5
UAB "Švenčionių energija" (Private equity)	0	1	1	2	4
"Dalkia" grupė (PPP)	1	2	1	2	5
Average for Public companies	**1**	**1,4**	**1,8**	**2,4**	**4,4**
Average for PPP companies	**1**	**1,5**	**1**	**2**	**4,5**

Source: developed by authors

No clear trend emerges looking at the ways companies are encouraging innovative activities by their employees again (see **Table 9.**). Both monetary and non monetary means to stimulate employees are used in both public and private companies.

On the other hand, *financing* resources indeed seem to be more available to PPP companies. While all companies indicated the same possibilities to use local financing sources, only PPP companies operated under lease agreement indicated possibilities to use World Bank or resources of Group Entities for necessary investments. Therefore this seems to be the real benefit of infrastructure leasing to a private party. However, all companies, except the "*Dalkia*" group (the mother company of two PPP companies), noted that the major reason they do not use full innovative capability is lack of financing.

Table 9.: *Employee Participation in Innovation Processes Encouragement*

	Bonuses	Social benefits	Career opportunities	Annual assessment	Acknowledge-ments
UAB "E-Energija"(PPP)	V			V	
AB "Jonavos šilumos tinklai"		V			
AB "Klaipėdos energija"					V
UAB "Molėtų Šiluma"		V	V		
UAB "Pakruojo Šiluma"					V
UAB "Plungės šilumos tinklai"	V	V		V	
UAB "Švenčionių energija" (Private equity)	V				V
"Dalkia" grupė (PPP)	V	V	V	V	V

Source: developed by authors

To sum up, PPP companies seem to innovate more and to provide more favourable ground for innovations. However, differently from our expectations, this seems to come not from greater managerial capability or greater collaboration with the external environment (though this does not mean that PPP companies underperform in this way, just that public companies are performing similarly well, too). The better innovative capabilities of PPP companies in the Lithuanian DH market come from greater employee technocratization and, possibly most importantly, better access to different financing (the best access lying with PPP companies under the lease agreement). Moreover, as public companies seem to perceive competition in the market as less threatening, this attitude may be explained by lack of necessary skills or myopic behaviour in this case. Consequently, H1 can be accepted.

3.2 EVA™ Analysis

To begin with, the Mann-Whitney test shows that PPP companies have created significantly (15% for 2003 and 20% for 2004) higher EVA™ than public ones (see the mean values for all ownership groups in **Table 10.**). Moreover, for both years of analysis, private equity companies demonstrate ambiguous results, while PPP companies under lease agreements have been clearly adding value.

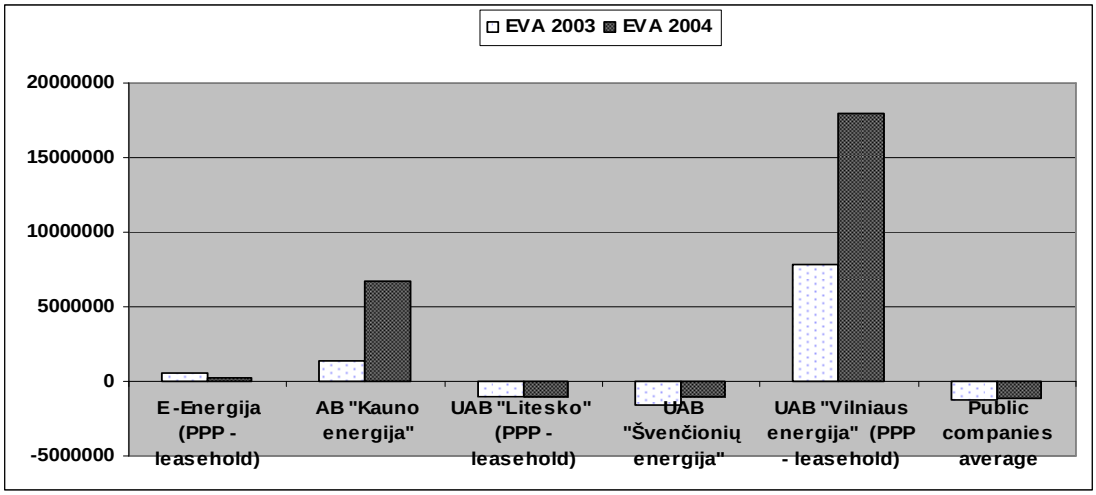
Table 10.: *EVA™ in Different Groups*

		EVA™ 2003	EVA™ 2004
Public companies	Mean	**-1220912,1644**	**-1128033,2513**
	Std. Deviation	1916801,27250	1587032,72241
Private equity	Mean	**-155400,0980**	**2853224,4840**
	Std. Deviation	2105753	5456036,91500
PPP (leasehold)	Mean	**2464900,9229**	**5758310,8807**
	Std. Deviation	2610200,25573	4534804,55583

Source: developed by authors

Still, bearing in mind the small number of entities for the analysis, it is reasonable to analyse each company on a case-by-case basis. Looking at **Figure 5.**, illustrating EVA for each PPP company and average EVA for public companies, it should firstly be noted that while "*E-Energija*", operating DH facilities in three towns, creates value added, "*Litesko*", having an even more diverse range of operations (operating in 10 different cities), is destroying value only slightly less than the publicly-operated companies on average (also see **Table 12.**). The biggest value adders are UAB "*Vilniaus Energija*" and AB "*Kauno Energija*". However, as the two companies serve the two biggest Lithuanian cities, such performance can be explained by possible scale economies.

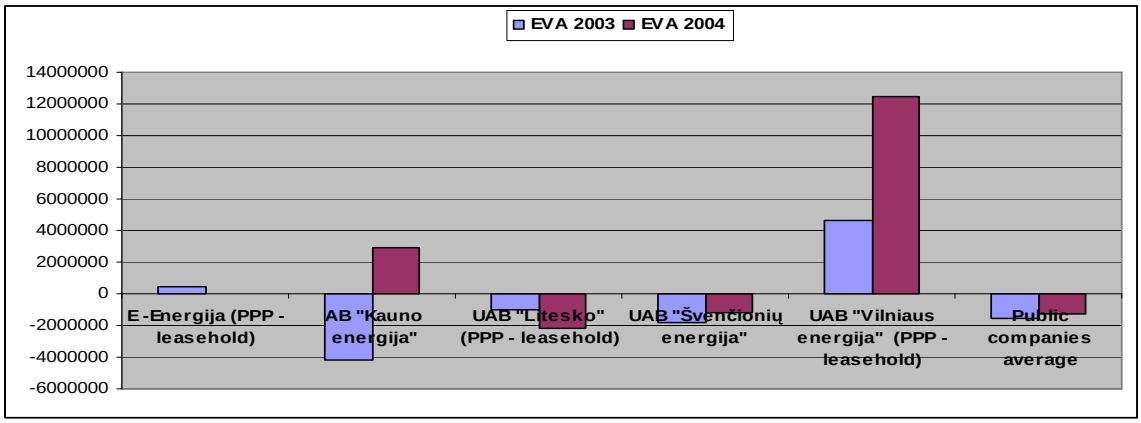
Figure 5.: *EVA™*



Source: developed by authors

Further, it is interesting to look somewhat deeper at the business risk premiums of different companies. Operating in the two biggest cities with high resident density, UAB "*Vilniaus Energija*" and AB "*Kauno Energija*" have the lowest business risk (due to the large amount of heat transferred relative to the length of transmission networks). Therefore, the data was adjusted for all companies to have the same business risk at maximum cap of 3% to see if there is any difference in the results

Figure 6.: *EVA™ After Simulation*



Source: developed by authors

(presented in **Figure 6.**). However, the only apparent difference with this simulation is destroyed value for AB "*Kauno energija*" in 2003. Yet, as it was the year of the company's reorganisation, even these results could not provide evidence against private management.

So far, it might have appeared that EVA™ depends on the scale of company operations. However, looking at EVA™ for the public companies in the other three big Lithuanian cities (**Table 11.**), negative EVA™ can be observed in each case. Therefore, the individual parameters in the functions of EVA™ were looked at (**Table 12.**). The numbers are presented in the ratios format, as percentages of sales, to make comparative analysis feasible. It appears that proportionally higher capital together with lower (or even negative) NOPAT or/and high business risk rate lead to negative EVA™. However, no clear trends from a sample of our size can be revealed. Interestingly, UAB "*Švenčionių energija*" seems to destroy value both by having extremely large relative capital and suffering from negative NOPAT. On the other hand, although UAB "*Litesko*" demonstrates negative EVA™, it has both proportionally lower relative capital and higher relative NOPAT

Table 11.: *Three Big Cities Public Companies' EVA™*

	EVA™ 2003	**EVA™ 2004**
AB "Klaipėdos energija"	-1628,42	-794,141
AB "Panevėžio energija"	-1636354	-6708834
AB "Šiaulių energija"	-1853970	-2817112

Source: developed by authors

in comparison to the average of public companies. This may be an indicator of the ongoing improvements.

Table 12.: *EVA™ Individual Parameters*

	Business risk premium 2003	Business risk premium 2004	NOPAT/ Sales 2003	NOPAT/ Sales 2004	Capital/ Sales 2003	Capital/ Sales 2004	eva2003	eva2004
E -Energija (PPP - leasehold)	2,00%	0,00%	0,09811	0,05308	0,73046	0,73107	533583	258865,08
AB "Kauno energija" (Private equity)	0,00%	1,00%	0,04979	0,09894	0,83855	1,12867	1333592	6711225,2
UAB "Litesko" (PPP - leasehold)	3,00%	2,00%	0,07866	0,06170	1,07607	1,12319	-993280	-970641
UAB "Švenčionių energija"(Private equity)	2,00%	2,00%	-0,04145	0,02738	3,62715	3,50831	-1644392	-1004776
UAB "Vilniaus energija" (PPP - leasehold)	1,00%	0,00%	0,04828	0,07046	0,43382	0,50221	7854400	17986709
Public companies average	2,06%	2,32%	0,02725	0,03409	1,90214	1,95869	-2422159	-1963982
AB "Klaipėdos energija"	0,00%	1,00%	0,00002	0,00007	0,00138	0,00141	-5450,69	-479,3623
AB "Panevėžio energija"	2,00%	3,00%	0,08001	0,04105	1,34827	1,59689	-1636354	-6708834
AB "Šiaulių energija"	1,00%	2,00%	0,08554	0,07278	1,86636	1,92249	-1853970	-2817112

Source: developed by authors

To sum up, PPP companies seem to add value; however, this conclusion is not unchallengeable. Therefore, if PPP companies were to be monitored, one of the important aspects should be to see if they are really adding economic value. H2 is partly accepted.

3.3 Efficiency Comparison

3.3.1 DEA Analysis

The annual *pure technical efficiency* scores for each individual company as well as the means for the two groups for the period 2001-2005 after DEA analysis with *EMS* software can be seen in **Appendix D**. However, since the more important task here was to compare the mean efficiencies of the two groups (partnerships and public), not to analyse each individual company's efficiency, further analysis was performed using the Mann-Whitney test (to see the means difference significance) and Case Summaries in *SPSS* software. The results are summarised and presented in **Tables 13.** and **14.** below.

Table 13.: *Test Statistics*

	Efficiency 2001	**Efficiency 2002**	**Efficiency 2003**	**Efficiency 2004**	**Efficiency 2005**
Mann-Whitney U	14,000	15,000	23,000	19,000	13,000
Wilcoxon W	167,000	186,000	213,000	209,000	203,000
Z	-,399	-1,788	-1,742	-2,026	-2,452
Asymp. Sig. (2-tailed)	,690	,074	,082	,043	,014
Exact Sig. [2*(1-tailed Sig.)]	,749	,081	,088	,044	,012

a Not corrected for ties.

b Grouping Variable: Public or PPP in 2001-2005

Source: developed by authors

Table 14.: *Case Summaries: Efficiency 2001-2005*

Public or PPP	**N**	**Mean 2001**	**N**	**Mean2002**	**N**	**Mean2003**	**N**	**Mean2004**	**N**	**Mean2005**
Public	17	95.77000	18	94,86167	19	91,11474	19	91,74053	19	88,63053
PPP	2	97.30500	4	105,93000	5	108,25600	5	108,28200	5	104,96400
Total	19	95.93158	22	96,87409	24	94,68583	24	95,18667	24	92,03333

Source: developed by authors

Firstly it is important to note that all differences between the two ownership types' efficiency means, except for 2001 (possibly due to the extremely small 'sample' of partnership companies), are significant (less than 10% level of significance). Secondly, and most importantly, it can be seen that not only the mean efficiency of partnerships is significantly greater than that of public, but it always (except in 2001) reaches the efficiency frontier benchmark and even surpasses it; meanwhile, the public companies' mean efficiency is not only significantly smaller, but also falls behind the benchmark. Furthermore, the mean efficiency of public companies seems to be decreasing every year, which further increases the gap between the two. Another interesting aspect is that looking at AB "*Kauno energija*" and UAB "*Švenčionių Energija*", the two considerably different partnerships separately, it can be noted that their efficiency scores are lower than those of the group, therefore making them downward-biasing factors. This may come about due to the possibly influenced decision-making (if not ruled, as in Kaunas' case with ~86% of ownership) by the public side. Consequently, it is possible to conclude that, on average, in the Lithuanian DH sector public companies operate significantly less efficiently than partnerships.

3.3.2 Other Important Parameter Assessments

Continuing operating performance analysis with assessment of other important parameters, it can firstly be noted that the *average tariff* of PPP companies operated under leasehold agreement was significantly (5%) lower than that of public companies in 2005 (see **Table 15.**) Comparing the average tariff of PPP companies operated under an agreement and those with only private equity involvement, the former is again much lower. Even though the results for 2003 and 2004 are not significant, the average $PPP_{leasehold}$ tariff was also lower than both public and $PPP_{Private\ Equity}$ throughout these years. However, it is interesting to observe that the mean average tariff in 2001 (much before the establishment of the regulatory body) was almost the same for $PPP_{leasehold}$ and public companies. This goes in line with PPP theory, that under direct supervision PPP projects bring much greater value to the final customer.

Table 15.: *Average Tariff & Employment Change*

Ownership		Average Tariff (2001)	Average Tariff (2003)	Average Tariff (2004)	Average Tariff (2005)	Employee Change Since 2001 (%)	Employee Change Since 2003 (%)
Public	Mean	130,4976	131,5289	130,8300	130,3175	-4,57	-5,7809
	N	17	19	20	20	17	19
	Std. Deviation	19,40004	15,62773	17,39710	15,57389	24,732	10,19978
$PPP_{Private\ Equity}$	Mean	140,0000	129,8500	129,5000	128,7600	-14,93	-8,0135

	N	1	2	2	2	1	2
	Std. Deviation	,	18,17264	17,81909	17,30997	,	4,13523
$PPP_{leasehold}$	Mean	131,0533	125,4000	123,0400	107,8533	-10,58	50,9513
	N	3	3	3	3	3	3
	Std. Deviation	29,17031	19,87134	18,96243	11,97531	19,034	98,87106

Table 16.: *Debtors*

Ownership		**Debtors (2002)**	**Debtors (2003)**	**Debtors (2004)**	**Debtors (2005)**	**Debtors Change Since 2001 (%)**	**Employees Change Since 2003 (%)**
Public	Mean	27,1667	25,5556	21,1342	21,4515	-14,7644	-5,7809
	N	18	18	20	19	18	19
	Std.Deviation	12,42507	12,11330	10,00388	9,97075	39,84982	10,19978
$PPP_{Private\ Equity}$	Mean	32,0000	29,0000	28,6215	18,8145	-60,4923	-8,0135
	N	1	2	2	2	1	2
	Std.Deviation	,	9,89949	11,16913	8,72864	,	4,13523
$PPP_{leasehold}$	Mean	29,0000	26,0000	24,9050	27,3013	1,2494	50,9513
	N	3	3	3	3	3	3
	Std.Deviation	8,54400	2,64575	6,59761	4,97070	37,45130	98,87106
Total	Mean	27,6364	25,9130	22,1857	21,9630	-14,6593	1,1246
	N	22	23	25	24	22	24
	Std.Deviation	11,54513	10,92916	9,66182	9,38403	39,43739	36,09279

Source: developed by authors

Total	Mean	131,0295	130,6229	129,7888	127,4972	-5,92	1,1246
	N	21	24	25	25	21	24
	Std. Deviation	19,75966	15,62423	17,01186	16,47566	23,117	36,09279

Source: developed by authors

Considering *debtors' percentages*, the results contradict theoretical expectations. Analysing **Table 16.,** it can be deduced that $PPP_{leasehold}$ performs the worst in collecting payments. First of all, it is recently performing worst in payment collection, demonstrating the biggest debtor percentage figure. Secondly, it is the only group whose total change in debtors since 2001 is positive. Looking at the matter more closely, it appeared that the problem comes from UAB "*Litesko*" and UAB "*E-Energija*", where the payment collection rate had substantially worsened, though it was significantly improved by UAB "*Vilnius Energija*".

Further, no significant differences in percentage *employment changes* since 2001 can be observed, as average employee numbers decreased in all ownership and management groups. This finding also contradicts the theory that PPP has a significantly negative impact on employment. Another theory contradicting fact is the more than 50% employment increase in $PPP_{leasehold}$ companies.

Finally, *improvements in technology* can be assessed looking at the figures of technical losses in transmission processes. As can be clearly seen in **Table 17.**, the technological situation in $PPP_{leasehold}$ in 2001 was no better than that in other companies. However, the subsequent decrease in heat transmission losses was much bigger here. This resulted in statistically significant differences between $PPP_{leasehold}$

and public companies (in 2003 it is significant at 15% level of significance, whereas in 2004 and 2005 at 10%). Moreover, $PPP_{Private\ Equity}$ companies also seem to have performed better in this aspect than the publicly-owned companies. Subsequently, improvements in technology with private involvement in ownership and/or management can be claimed to exist, complying with the theory.

Table 17.: *Technological Loss*

Ownership		Loss (2001)	Loss (2003)	Loss (2004)	Loss (2005)	Change from 2001	Change from 2003
Public	Mean	21,7824	21,6053	21,1400	17,9250	-21,2492	-17,5638
	N	17	19	20	20	17	19
	Std. Deviation	4,41294	4,76940	4,97429	4,42337	13,91031	11,87368
$PPP_{Private\ Equity}$	Mean	25,9000	20,9000	20,6000	16,9000	-34,3629	-19,2161
	N	1	2	2	2	1	2
	Std. Deviation	,	,14142	,56569	,14142	,	,02068
$PPP_{leasehold}$	Mean	23,1333	16,5500	14,8000	13,0333	-41,6847	-24,7720
	N	3	2	3	3	3	3
	Std. Deviation	3,37095	1,90919	4,52990	3,98037	22,61369	28,33953
Total	Mean	22,1714	21,1043	20,3360	17,2560	-24,7930	-18,6025
	N	21	23	25	25	21	24
	Std. Deviation	4,20454	4,56991	5,06827	4,40720	16,24772	13,64044

Source: developed by authors

In the end, the additional parameter analysis leads to conclusions favouring PPP arrangements. Firstly, PPP companies do not have relatively more negative impact on employment than do public companies. On the contrary, employment in PPP companies even seems to increase. Moreover, PPP companies offer lower tariffs to the final consumer, as well as significantly improved heat transmission processes. Even more, $PPP_{leasehold}$ visibly outperform the other two groups in these aspects. After all, no criticising conclusions on PPP could be drawn due to the small sample size and hugely different results among entities concerning payment collection rates.

As a result, both parts of the performance analysis lead to acceptance of H3. Moreover, both parts of the analysis show $PPP_{leasehold}$ to be the best performing group.

4 Discussion of Results

4.1 Overall Lithuanian DH Sector PPP Projects' Evaluation

After all parts of the analysis were carried out, the verdicts on the three hypotheses can be discussed more explicitly and the implications, including suggestions for DH PPP development while combining both Lithuanian and European PPP experience, can be made.

Firstly, PPP companies were found to innovate more and provide more favourable grounds for innovations. However, surprisingly, innovativeness cannot be tracked to greater managerial capability: public managers appeared to be equally good as those

in PPP. Therefore, in this respect the findings go against one of the most important PPP proponents arguments (e.g., Ham, Hans van, and Joop Koppenjan, 2001) that partnerships are a good tool for improving managerial performance in public infrastructure provision. Yet, to reach the innovative capability level of PPP, public companies should increase their technocratization, by, e.g., employing more different engineers and increasing their knowledge base in this way. Also, as the importance of good knowledge management is growing, public companies should learn from PPP the methods of knowledge distribution and sharing inside the company. As, according to theory, innovative capacity can be increased by increasing competition in the market, this factor cannot be forgotten as well, while the public managers appeared not to notice any competition in their environment at all. Finally, PPP companies demonstrated the advantage of having a comparatively better borrowing ability, also providing better grounds for innovations.

The second hypotheses, that PPP add more economic value through their operations, could not be universally accepted because of the too controversial results for individual PPP companies and the insufficient number of observations to determine any trends. However, it is important to note that even apparently profitable companies can be destroying economic value. Therefore, EVA could be instrumental in both, determining the best financial performers and controlling the actions of all companies in the industry.

Both parts of the efficiency analysis enable acceptance of the third hypothesis. Firstly, according to DEA results, on average in the Lithuanian DH sector, public companies operate significantly less efficiently than partnerships. Moreover, as the two private equity partnerships (limited private party involvement in management issues) were the worst performers among all partnerships, a connection between operating efficiency (input consumption to production output) and decision-making was hypothesised. Furthermore, efficiency in operations can also be supported by the higher quality of transmission networks discovered. Consequently, this may be the reason for lower average PPP tariffs, detected in the analysis as well. However, although the results of payment collection and employee change contradict theoretical expectations, (e.g., Grimsey and Lewis [2004, 225], predict superior collection rate for PPP companies, while the opponents of PPP warn of significantly decreased employee numbers after private involvement) they should not be heavily relied on due to the extremely varying results among individual companies. Consequently, the

efficient results of private management seem to result in benefiting both the organisation and customers.

Going into more specific generalisations, all parts of the analysis have interestingly demonstrated poorer $PPP_{Private\ Equity}$ performance in comparison to $PPP_{leasehold.}$ As already noted, the reason may be that a private party does not enjoy the full freedom of decision-making by only owning some shares in a company. Yet, the exiguous results of the questionnaires object to such deductions, indicating that the superior private actors' performance does not lie in the managers' personal characteristics. However, the small sample size of the questionnaires requires more information to make any deeper and stronger inferences on this point.

Further, the significantly better results for "*Vilniaus Energija*", the biggest PPP project, go in line well with statements that the greatest benefits from partnerships are achieved in large-scale projects. Moreover, this greatest and the most important partnership project has obviously benefited from the biggest efforts in developing the lease contract. Such results allow the deduction that large project scale, well developed and proper contracts, as well as other preconditions, lead to greatest outcomes. Likewise, many scholars refer to strict governmental control as a means of avoiding all partnership characteristics criticised by opponents of PPP. However, "if public authorities unilaterally define projects, this limits the scope for the creation of partnerships" (Ham, Koppenjan, 2001). Market experience and the creativity of private parties are hard to mobilise then and all the expected gains (from innovative and non-standard solutions assuming institutional renewal) are lost. Consequently, according to Domberger and Jensen, an appropriate contract becomes the core and the degree to which opportunities for partnership are seized. A superior contract depends on the creative capacity of parties to imagine a joint project and strategic and communicative skills in realising it. In parallel, one of the most important success preconditions is the choice of a proper partner. Dhcan Project Team suggests considering several aspects when choosing an ownership scheme for DH systems. Firstly, when a municipality fully or partly owns and manages a DH entity, it is important to ensure that business decisions are separated from policy decisions. Secondly, it is important to ensure that all possible environmental benefits are achieved under control of the private sector. Thirdly, the private sector must focus on the long term perspective. However, public ownership does not guarantee the long term perspective *per se* either, since different interests may prevail. Fourthly, private

partners' financial credibility must be assessed. Finally, the national institutional framework must be appropriate for effective DH (good pricing, effective competition between different energy suppliers, and quality of heat regulation). In short, public ownership can be very useful if the business focus is on customer demand, local specificities are well considered, and business decisions are well separated from policy decisions. Private ownership can also be a good choice if the private owner focuses on customers, has long term orientation, and good field knowledge (DHSOG, 2006). To sum up, all the preconditions must hold to attain successful partnership:

> "Public private partnerships, involving the municipality and a chosen private partner, can be very effective if conditions regarding the guaranteed level of service provision to consumers, sharing benefits with the community and investment in the system are written into a common agreement. In this case the concrete terms of the contract are of key importance, including the conditions for an exit strategy from the contract" (ibid, 2006, 21).

Therefore, a well developed contract is clearly of superior importance.

In the end, the study findings propose that PPP companies do perform better. However, to benefit from all future partnerships the important aspects must be realised and included in contracts. EVA^{TM} benchmarks and encouragement to share experience on knowledge management could be some of the points. The borrowing ability of PPP companies, which was confirmed to be particularly instrumental in the current Lithuanian economic situation, should also be noted and considered when developing agreements.

5 Conclusions

The threefold analysis carried out to see if PPP projects in the Lithuanian DH sector really perform better financially, and are more efficient and innovative than purely public companies, fully accepts two (and one partly) out of three preset hypotheses; implying that PPP projects are more innovative, more efficient, and usually add higher economic value. More specifically, greater innovation capacities of PPP companies seem to lie in superior employee technocratization and better access to different funds. However, only several PPP companies have positive EVA^{TM}, while the others destroy value for shareholders. Therefore, in response, regulatory bodies should consider this parameter in contracts, and monitor whether companies are fulfilling their obligations. In addition, private managers should be guaranteed a

sufficient amount of freedom in operating, since, as most clearly indicated by the analysis of operations (highlighting the inferior performance of $PPP_{Private\ Equity}$), private managers appear to do better here. What is more, the case of the lease of Vilnius Municipality DH facilities, UAB "*Vilniaus Energija*" (the daughter company of the French concern "*Dalkia*"), confirmed theory predictions of the greatest gains from the biggest PPP projects, encouraging not to be afraid of bigger deals. Overall, the results promote further implementation of partnerships in the Lithuanian DH market, yet warning that the major preconditions for successful partnerships have to be followed consistently and foreign countries' experience should be analysed to see the variety of possible options, and, perhaps, even better solutions, as in this way well-prepared partnership projects could become highly instrumental in other sectors as well.

After all, it would be valuable to repeat the study in several years' time, and especially to analyse companies at the end of the lease periods, since this could shed light on the performance of Lithuanian PPP projects during the entire period. Separate parts or the exact combination of this analysis could well be adapted to other future research (other sectors and countries as well). Surely, more and further research to find out any other existing strengths and weaknesses of PPP projects is necessary. The theoretical and research base of the concept should be expanded, as explicit *ex ante* knowledge would help in setting up proper contracts, maintaining the good aspects and improving the flaws, and assisting the overall decision-making.

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6 Appendices

6.1 Appendix A: PPP Projects by Country & Sector

	Roads & Bridges	Light Railway	Heavy Railway	Schools	Health & Hospitals	Central Accommodation	Airports	Housing	Ports	Prisons	Water & Wastewater (incl solid waste)
	Principal sectors of PPP activity					Subsidiary sectors of PPP activity					
Member States											
Austria	▲		▲	○	▲	○	○			○	○
Belgium	▲	○	○	○			▲	▲			▲
Cyprus	▲						▲▲		▲		▲
Czech Republic	▲	○	○	○	○		○	○			▲▲
Denmark	▲		▲	▲		○			▲	○	
Estonia	○			○	○						
Finland	▲	○	○	▲	○	○					○
France	▲▲ ▲▲	▲▲ ▲▲	▲	○	▲	▲	▲		▲	▲	▲▲ ▲▲
Germany	▲▲	▲▲	▲▲	▲▲	○	▲	○			▲	▲▲▲
Greece	▲▲					○	▲▲ ▲▲				
Hungary	▲▲	○		▲▲	▲			○		▲	▲▲
Ireland	▲▲ ▲	▲		▲▲	▲	○		▲			▲▲▲
Italy	▲▲ ▲	▲▲			▲▲	○	▲	○	▲	○	▲
Latvia	○							○			
Lithuania		○									
Luxembourg							○				
Malta					▲			○			
Netherlands	▲▲		▲▲	▲	○	○		○	○	○	▲▲
Poland	▲	○	○			○	○	○	▲		▲
Portugal	▲▲ ▲▲	▲▲	○	○	▲		○	○	○	○	▲▲
Slovakia	○						○				○
Slovenia											▲▲
Spain	▲▲ ▲▲	▲▲	○	○	▲	○	○		▲▲ ▲▲		▲▲
Sweden	○	○	○		○						
UK	▲▲ ▲▲	▲▲ ▲▲		▲▲ ▲▲	▲▲ ▲▲	▲▲ ▲▲	▲▲ ▲▲	▲▲ ▲▲		▲▲ ▲▲	▲▲ ▲▲
Applicant Countries / EFTA											
Bulgaria	○						○				▲▲
Romania	▲▲				▲			○			▲▲
Turkey	○	○	○				▲▲				▲▲
Norway	▲▲		○	▲	▲	○				○	

Legend

○ Discussions ongoing

▲ Projects in procurement

▲▲ Many procured projects, some projects closed

▲▲▲ Substantial number of closed projects

▲▲▲▲ Substantial number of closed projects, majority of them in operation

(Pricewaterhouse Coopers & EIB, 2004, 14)

6.2 Appendix B: DH Ownership & Management Types in Europe

Ownership Type:		**Features:**	**Examples:**
Full Public Ownership		The current public ownership mostly remains from the historical trend in DH ownership.	• Hungary: 1) the municipality of Budapest fully owns DH distribution networks. 2)the municipality of Debrecen have managed to transform their DH system from the old one, with extremely bad image, to a new and customer-oriented one. • Germany: Munchen; • Sweden: Göteborg, Västerås, Linköping, Eskilstuna, & Växjö; • Austria: Wien • Finland: Helsinki.
Full Private Ownership			• Czech Republic: DH facilities in many municipalities are owned both by local and foreign investors. • Sweden: 1)the DH system in Uppsala has been acquired by Vattenfall. 2)in Malmö Sydkraft (foreign investors company) owns DH systems. 3)Örebro, Norrköping, and in some other smaller municipalities. • Germany: The DH systems in two largest cities are also owned by Vattenfall Europe.
PPP	Operation & Management Contracts	Such cooperation requires no private capital involvement and at the same time there is no ownership change. Operations and management are outsourced from a private entity, which gets paid for services performed; however, the public sector (which maintains ownership) remains responsible for the necessary investments.	• Sweden: Borås, where the municipality is responsible for management and maintains the ownership of the DH system and, at the same time, Fortum Service, following a prewritten contract, provides services for system maintenance and operations.
	Leasing	The type of partnership, present in Lithuania. "In a leasing agreement, an operator rents the DH assets from the owner for a specified, usually long-term period. Operation, maintenance, investments, and company cash flow will be in the hands of the private lessee/operator, who pays a specified amount of rent to the public (municipal) owner/lessor or invests a specified amount of capital into the infrastructure (or a combination of both)." (DHSOG) The ownership stays with the municipality, which at the end of the period will retrieve the assets.	A good example is one of the European Leaders in Energy services, Dalkia Group. E.g., the DH utilities in • Estonia: Tallin, were leased for the private company Tallin Küte, which is 100% owned by Dalkia International. • Lithuania: Litesko & Vilniaus Energija (daughter companies of Dalkia) have leased DH facilities in 11 Lithuanian cities.

	Concession	The difference between concession and leasehold agreement is that under a concession agreement a private entity also becomes the actual owner of the DH facilities for a certain period. In this case, the municipality has no control over DH facilities, so that all important aspects must be pre-specified in the contract. The contract also includes what possibilities the private entity has to prolong the concession at the end of the partnership period.	• France: Paris DH System is operated by the CPCU under a concession, which was obtained for the first time in 1927. The remuneration to the city of Paris amounts to 1.85% from annual CPCU turnover. Still, the municipality of Paris achieved 1/3 ownership of the company.
	Privatization of Heat Generation Only	The structure of this type of ownership depends both on site-specific features and historically set division of DH facilities. For instance, in CEE countries heat has been produced in a Combined Heat Production (CHP) plant organized by the national ministry for power generation. At the same time, heat distribution used to be under municipal responsibility. Therefore, during the liberalization process this separation usually stays in the country. There are several private heat producers in Lithuania as well; however, ownership of distribution networks must stay with the municipalities.	• Poland: Warsaw, where the Swedish company Vattenfall owns the CHP Company, while distribution is the responsibility of the municipality. • Sweden: Alingsås municipality only distributes heat, which is produced by the private company (Sydkraft) from a large biomass boiler. • Latvia: the situation is absolutely different. The municipality owns the CHP plant, while the private entity (Rigas Siltums) takes care of heat distribution.
	Selected Private Minority Equity Partnership	In this type of ownership, a public company selects a private partner and offers them a minority of shares in the DH company. This brings specific new ownership and management skills. However, the public company does not lose control over DH facilities.	• Germany: Düsseldorf, where a private company (SWB – Stadtwerke Bremen) bought a 49.9% share in the DH company owned by the municipality • Austria: the municipal company EVN AG, serving Lower Austria province, has sold 48.5% to private investors, out of which 19% is free float.
	Minority Private Equity Invited Through the Stock Market	The shares are sold via an Initial Public Offering (IPO) and later traded on the stock market. The difference between this model and the previous one is the possibility for a private party to choose the best public partner. In addition, under this kind of partnership the legal and brokerage costs must be taken into consideration.	• Germany: the first company which went private (in 1999) was MVV Energie AG, belonging to Mannheim municipality. The company sold 25% of its shares to private investors. • Italy: ASM Brescia, the Italian multi-utility company, trades 30% of its shares on the stock exchange. • Bulgaria: according to Bulgarian legislation, not more than 50% of the shares of the DH Company can be sold to a private entity.

	Majority Private Equity Ownership	Some municipalities sell a majority of the shares to private entities and in this way have no everyday management responsibilities. However, municipalities still retain some control and influence in the DH companies.	• Czech Republic: in the three largest cities (Prague, Brno, and Ostrava) major ownership stakes in the DH companies belong to private entities. • Germany: Bremen DH facilities are controlled by Essent (a Dutch public utility) while the municipality keeps only a 13.6% interest in the utility. • Macedonia: in Skopje 70% of the company is owned by the employees, 20% belongs to the state, and only 10% to Skopje municipality.
	Full Private Ownership with Municipal Support	Under this arrangement the DH system is fully privatized; however, government still provides some kind of pre-agreed support. The reason for this may, for example, be governmental aims to expand the DH system using local resources in an environmentally friendly way. In such case governmental support is crucial, as a private entity may face substantial financial risks.	UK: Southampton District, where the French company Utilicom owns and operates a geothermal heating company. The municipality works in collaboration with Utillicom to promote environmental and economical benefits of the DH they provide.

(DHSOG, 2006)

6.3 Appendix C: Company Sample

	Company name	**Ownership Type**
1	UAB "Anykščių šiluma"	Public
2	UAB "Birštono šiluma"	Public
3	UAB “E-Energija”	**PPP**
4	UAB "Ignalinos šilumos tinklai"	Public
5	AB "Jonavos šilumos tinklai"	Public
6	UAB "Joniškio energija"	**Public-Private**[*]
7	UAB "Kaišiadorių šiluma"	Public
8	AB "Kauno energija"	**Public- Private**[†]
9	AB "Klaipėdos energija"	Public
10	UAB "Lazdijų šiluma"	Public
11	UAB "Litesko"	**PPP**
12	UAB "Mažeikių šilumos tinklai"	Public
13	UAB “Molėtų šiluma“	Public
14	UAB “Pakruojo šiluma”	Public
15	AB "Panevėžio energija"	Public
16	UAB "Plungės šilumos tinklai"	Public
17	UAB "Radviliškio šiluma"	Public
18	UAB "Raseinių šilumos tinklai"	Public
19	UAB "Šakių šilumos tinklai"	Public
20	AB "Šiaulių energija"	Public
21	UAB "Šilalės šilumos tinklai"	Public
22	UAB "Šilutės šilumos tinklai"	Public
23	UAB "Širvintų šiluma"	Public
24	UAB "Švenčionių energija"	**Public- Private**[‡]
25	UAB "Tauragės šilumos tinklai"	Public
26	UAB "Utenos šilumos tinklai"	Public
27	UAB "Vilniaus energija"	**PPP**
28	UAB "Vilniaus rajono šilumos tinklai"	Public

[*] 66% majority equity owned by UAB “*Fortum Heat Lietuva*”, which is owned by foreign investors (90% *Fortum* and 10% *NEFCO*) (Fortum, 2006).
[†] 85.99% owned by Kaunas municipality; the remaining minority – by private entities (Kauno Energija, 2006).
[‡] 50% majority equity owned by UAB “*Fortum Heat Lietuva*”.

6.4 Appendix D: Efficiency Scores

Year	2001		2002		2003		2004	2005
Company Name	Ownership	Efficiency	Ownership	Efficiency	Ownership	Efficiency	Efficiency	Efficiency
Vilniaus Energija	0	110,9	1	128,6	1	156,75	140,11	135,88
Kauno Energija	0	99,33	0	97,22	1	99,60	94,77	89,07
Klaipedos Energija	0	97,93	0	95,1	0	95,44	95,72	86,57
Litesko	1	103,68	1	101,74	1	97,06	97,89	92,13
Panevezio Silumos Tinklai	0	94,06	0	92,09	0	92,67	93,40	87,27
Siauliu Energija	0	98,64	0	100,94	0	103,71	100,09	93,41
E energija			1	101,74	1	95,53	114,74	116,14
Mazeikiu silumos tinklai	0	91,1	0	88,61	0	88,42	83,50	85,58
Jonavos silumos tinklai	0	101,37	0	101,21	0	98,40	91,62	88,95
Utenos silumos tinklai	0	133,37	0	127,9	0	106,30	108,67	107,49
Silutes silumos tinklai	0	87,92	0	84,94	0	82,91	80,25	76,73
Taurages silumos tinklai	0	91,18	0	90,23	0	90,93	90,37	83,97
Plunges silumos tinklai	0	83,53	0	87,02	0	85,46	81,48	80,60
Radviliskio siluma	0	105,18	0	104,68	0	105,86	115,31	121,05
Raseiniu silumos tinklai	0	79,93	0	83,54	0	87,33	95,32	86,40
Anyksciu siluma			0	99,21	0	101,67	98,19	88,89
Kaisiadoriu siluma	0	90,64	0	93,27	0	92,75	92,12	80,82
Svencioniu energija	1	90,93	1	91,64	1	92,34	93,90	91,60
Ignalinos silumos tinklai	0	91,35	0	87,14	0	77,26	86,84	82,13
Sirvintu siluma					0	84,09	95,06	95,79
Silales silumos tinklai					0	79,54	82,05	87,54
Sakiu silumos tinklai			0	92,3	0	85,54	80,21	76,33
Lazdiju Silumos Tinklai	0	80,97	0	88,5	0	93,00	93,15	86,83
Vilniaus rajono silumos tinklai	0	90,69	0	93,61	0	79,90	79,72	87,63