

STRATEGIC APPLICATION PRINCIPLES OF ENERGY RESOURCES FROM HEAT SUPPLY MERCHANT VIEW POINT

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Abstract. The study was accomplished in 2010. The applied research methods are based on the analysis of the studies by other authors, industry experts, statistic data and the (unpublished) information provided by the Latvian district heating merchant “xxx”. Spearman’s rank correlation coefficient was used for evaluating data regularity.

In 2020 the energy produced from renewable sources (Directive 2009/28/EC) in total energy consumption in Latvia has to reach 40%. Such an objective can be achieved by promoting the use of biomass at cogeneration (CHP) plants, the potential of which is the district heat supply system. Wood as an energy resource in its structure accounts for only 25-30%; therefore, the primary condition is the introduction of modern technology which would provide the possibility to diversify energy resources.

The calculations confirm that the realised amount of thermal energy indirectly affects profit; directly it is affected by the rate of thermal energy, so the structure of use of energy in heat supply enterprises is associated with lowering the cost of (restrictive) factors - the energy cost, specific production technologies, energy efficiency. Currently, the primary condition of heating companies is to find such energy resource(s) to ensure the approved schedule of temperature and thermal load. The next determining factor is the energy price.

In assessing the factors that will affect energy usage in the future, the main strategic principle of energy consumption will be linked to limiting the growth or even reducing heat tariff, by realising optimal efficiency and minimal environmental pollution during energy transmission.

Key words: Energy, district heating, energy resources, the strategic principles.

Introduction

Climate change, a limited amount of resources, an increasing competition and pricing, as well as political conflicts have influenced the increasing importance of energy in the European Union, which takes a leading role in sustainable policy making (Sprūdis et al., 2009).

During the period until 2008, the European energy policy was aimed at certain sectors - support renewable energy, cogeneration, market liberalisation, energy efficiency, etc. In 2009, the Third energy package was developed, in which the current Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC is the first attempt of the European Union at creating a comprehensive legal framework for renewable energy promotion in key energy sectors. This Directive in the European Union in 2020 implies the increase in the share of renewable energy in total energy consumption by 20% by stating its goals to be achieved (The Renewable Energy..., 2009).

In assessing the studies developed by the European Union “European Energy and Transport Trends to 2030-Update 2007”, “Renewable Energy Technology Roadmap 20% by 2020” and Latvian developed research “Evaluation of the Usage Potential of Renewable Energy Sources in Latvia Until 2020”, the authors concluded that in Latvia the emphasis of 2020 on the target - 40% renewable energy in total energy use - is associated with the potential of biomass and wind energy (Capros et al., 2008; Renewable Energy Technology..., 2008; Atjaunojamo energoresursu izmantošanas..., 2008).

The widest possible use of biomass in Latvia is the

district heating, since it accounts for approximately 65% of the total heat load (about 70% of the district heat consumers in the household), while heat production is used for more than 30% of the Latvian annual energy consumption. District heating is associated with a decentralised energy production, local energy supplies and extensive cogeneration opportunities (Latvijas ilgtspējīgas attīstības..., 2009).

However, in order to assess the practical use of renewable energy in district heating plants, the strategic use of energy principles which determine the choice of heat production should be determined.

Hypothesis: Energy conditions for the use in district heating are primarily based on the strategic aspects of the use rather than accessibility.

Research aim: Identify the strategic principles of energy use in district heating in commercial activities.

Research tasks:

1. To evaluate heating in Latvia and energy used in its manufacture.
2. To determine profit-making principles from the heat operator’s point of view, summarise the factors that determine heat production of the energy mix.
3. To create a combination of factors that will determine the strategic use of energy.

Materials and Methods

Research methods used in the paper: analysis, synthesis and monographic research method in analysing the research of other authors. Spearman’s

$$\text{rank correlation coefficient } r_s = 1 - \frac{6 * \sum_{i=1}^n (X_i - Y_i)^2}{n(n^2 - 1)}$$

was used for evaluating data regularity. A graphical method for statistical display of data and a model design were used. The study was accomplished in 2010. It is based on the analysis of studies by other authors, industry experts, and information published by the Central Statistic Bureau of the Republic of Latvia and the (unpublished) information provided by the Latvian district heating merchant "xxx".

Results and Discussion

1. Heat energy consumption and its production

Latvia is located in the climatic zone, where the heating season lasts more than six months, lasting an average 200 to 210 days, so this steam is one of the major components of Latvian energy (Vīgants, 2010).

The study "Evaluation of the Usage Potential of Renewable Energy Sources in Latvia Until 2020" explains the thermal energy consumption trends. The study concludes that the main factor influencing the consumption is thermal climatic conditions (average temperature). By contrast, factors such as gross domestic product (GDP), population and energy consumption intensity of heat affect it indirectly. The fact above explains the Figure 1. Heat energy consumption changed during the period when the Latvian economy experienced rapid annual GDP growth, but the heat consumption did not increase (Atjaunojamo energoresursu izmantošanas..., 2008).

Based on the Latvian District Heating association collected data (within 95% of the Latvian district heating merchants), the production of thermal energy is very different in several ways:

- In district heating overall proportion, wood compiles ~ 30%, but natural gas ~ 62%;
- In local and individual heating overall proportion, wood compiles ~ 55%, but natural gas ~ 25%;
- In boiler houses and cogeneration (CHP) cycle overall proportion, wood compiles ~ 18%, but natural gas ~ 82% (Siltumapgāde Latvijā, 2009).

Furthermore, the distribution of wood at district heating plants is not the same. Latvian regional averages of the total district heating consumption of wood are used most: 38% in Vidzeme, Kurzeme - 22%, Latgale - 21%, Riga region - 7%, and 7% in Zemgale. Described situation is explained by the natural gas supply system - in areas with no access to natural gas pipeline, wood is primarily used (Vīgants, 2010).

In assessing the share of CHP heat production (see Fig. 1.), it can be concluded that the upward trend is positive (regardless of the energy type, since a reduction in energy consumption compared to, where the heat and electricity produced in isolation, hence the emission reduction), with different authors' study of the potential of CHP cycle is directly related to heating systems. Some of the studies in which it is highlighted:

- "Latvian Sustainable Development Strategy until 2030 Project" concluded that the major energy and cogeneration possibility is the district heating supply (Latvijas ilgtspējīgas attīstības..., 2009).
- "Energy Efficiency Improvement of Heat Supply Business Opportunities" concluded that district heating is the most effective way of heating to justify a decentralised production of energy diversification opportunities and potential cogeneration (Turlajs et al., 2009).
- In 2008, Communication from the Commission to the European Parliament and the Council "Europe can Save More Energy by Combined Heat and Power Generation", has highlighted that the cogeneration technology is very effective and optimal for usage at the district heat supply (Communication Europe can..., 2008).

Assessing the use of wood and cogeneration development potential, it is concluded that the primary condition is advanced technologies for district heating, thereby using more energy range and with varying costs. The statement above is the fact of the Latvian

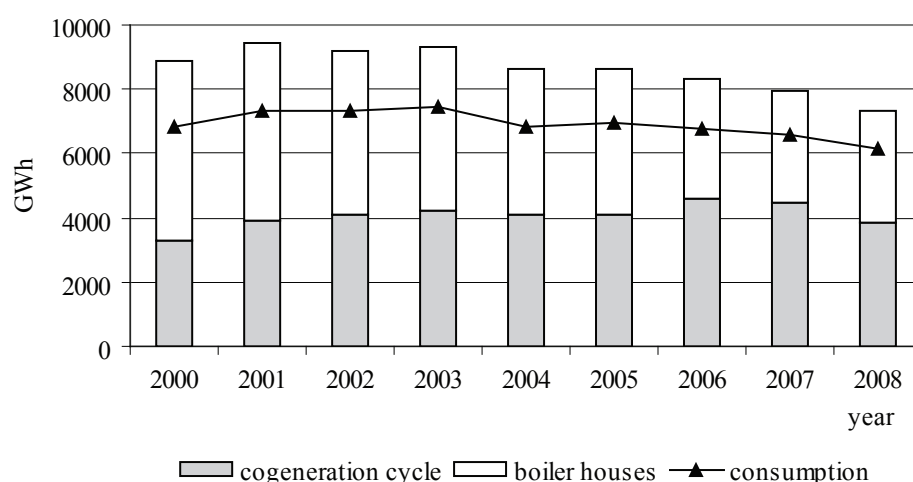


Figure 1. Produced heat in boiler houses in Latvia and cogeneration cycle and heat to the final consumer trend (GWh), 2000-2008.

Source: Created by the authors, based on Elektroenerģijas ražošana, imports ..., 2010

district heating comparison with Finland, where the cost of heat to the final consumer is on average 45.6 EUR MW h⁻¹ (calculated 32 LVL MW h⁻¹). In Latvia such heat rate in 2009 was only in 5% of the companies forming part of Latvian District Heating association (Vīgants, 2010).

On the other hand, the Latvian District Heating association indicates that a large part of the heating companies have already fulfilled all the prerequisites for increasing the energy efficiency requirements (at current energy type). New energy efficiency opportunities from heat business standpoint are possible only by changing the heat sources and switching to the production of the cogeneration cycle which requires substantial investment (Ratniece-Kadeģe, 2009).

2. Effects of realised amount of heat on profit

Both the Latvian District Heating association enterprises and Farmers' parliament in their studies point to the positive usage experience of the Scandinavian fluidised-bed boilers, since their efficiency is even drawn up to 80-85%; moreover, it allows the use of all forms of biomass and its blends (Vīgants, 2010; Atjaunojamie energoresursi Latvijā..., 2008).

Based on the above mentioned, for the mathematical statistical calculation the Latvian heat company is chosen where such a boiler for heat production is used. Table 1 represents data from the chosen Latvian district heating company's economic activity in an eight year period.

As shown by Latvian District Heating association enterprises, additional profit increase can be realised

via the amount of heat only at low temperatures when the heat consumption is increasing (on the condition that the rate of thermal energy covers the cost of production) (Siltumapgāde Latvijā, 2009).

For the proof or rejection of that argument, the mathematical statistical method is used - Spearman's rank correlation coefficient.

The estimated coefficient ($r_s = 0.29$) indicates that there is a weak positive correlation between the amount of heat energy and the profit (see Formula 1.). However, using the SPSS computer program, calculated correlation coefficient of reliability test p-value (0.493) is greater than 0.05; therefore, the probability of P 0.95 shows that the relationship between the realised amount of heat and profit does not exist (maximum likelihood, which can be assumed that such a correlation exists, however is 0.507). Calculations show that the increase in company's operating revenue can not be directly linked with the consumption of heat provided. Therefore, it can be argued that the profit growth, based on heat consumption, can be ensured with temperature lowering.

In assessing the situation in more detail from the district heating company's point of view, it is possible to argue that the correlation between the amount of consumed heat and profit is not only decreasing temperature and increasing heat consumption. Heat volume and profit are the unifying factors for the transmission losses. Rate of thermal energy includes heat transmission losses; however, increasing the amount of heat, decreases the percentage of losses (physical losses do not change) because they are

Table 1

Realised energy and profit of heating enterprise "xxx", 2002 – 2009
(Calculations of Spearman's rang correlation)

Year	Realised heat, MWh (X)	Profit, LVL (Y)	R _x	R _y	(R _x – R _y) ²
2002	56110	-132368	6	6	0
2003	56065	+93884	7	2	25
2004	55865	-127841	8	5	9
2005	57995	-62349	4	4	0
2006	59593	+87207	2	3	1
2007	57785	-227966	5	8	9
2008	58611	-181300	3	7	16
2009	59664	+168177	1	1	0
Total					60

Source: Calculations by the authors, based on data from the Latvian district heating enterprise "xxx"

Calculations:

$$r_s = 1 - \frac{6 \cdot 60}{8(8^2 - 1)} = 0.285714 \quad (1)$$

Where:

r_s - Spearman's rank correlation coefficient x - sign of factorial
n - number of observations y - tangible sign of

Source: (Paura and Arhipova, 2002)

calculated as the difference between sold and produced heat. The transmission losses are directly dependent on the heat supply temperature and indirectly dependent on the heat flow - the higher feed temperature, the greater the losses - this can be explained by the loss of heat absorbed by the mines, land etc (Sabiedrisko pakalpojumu tarifu..., 2001).

Based on the fact that the amount of realised heat indirectly affects the profit, but directly affects the heating rate, which has borne the cost of production, the company used structure of primary energy may be correlated with heat production cost restrictive (reducing) factors. The relevant factors are used in energy cost, production technology specific characteristics depending on the required heat load and energy efficiency measures which reduce heat transfer losses. This factor is the variation of the limiting factor of the investment that the company can afford to invest in heat sources and heat systems.

The specific unit of heat consumption (see Fig. 2.) in the company is the approved temperature schedule and the load of heating main (flow) which determines heat supply temperature depending on the environmental temperature and the heat load of building.

In contrast, the temperature schedule assurance is a key energy resource (see Fig. 2.), whose processing heat sources are capable of providing the required heat supply temperature. If the required temperature schedule can be achieved by both natural gas and wood chippings, the next determining factor is the energy

price, whichever is of a lower production costs.

Heating and hot water supply to the technological conditions require that the supplied heat at the same time provides the building with heat and hot water. During heating season, the company needs to provide heat, which is sufficient for both hot water heating and heating systems to ensure temperatures. In contrast, during the summer season, providing hot-water heating requires significantly less heat load, which creates the company's need for multiple heat sources with different production capacity.

3. Strategic use of energy principles (future situation)

Due to environmental improvement and primary fossil fuels (natural gas) reserves limitations, heating companies in the future will need to restructure the production of thermal energy, replacing natural gas entirely with renewable energy sources. The strategic setting of energy conversion will be carried out with optimal efficiency and minimal environmental pollution.

Significant is the fact that the substitution of fossil fuel in heating plants (despite the financial opportunities) has to be associated with both the available energy resources and consumer's needs. To specify the future factor cluster of heating enterprise that will influence the strategic use of energy, the cluster has to be divided into three categories (see Fig. 3.) and each category has to be examined separately, according to the processes in the energy sector and the economic situation in the country.

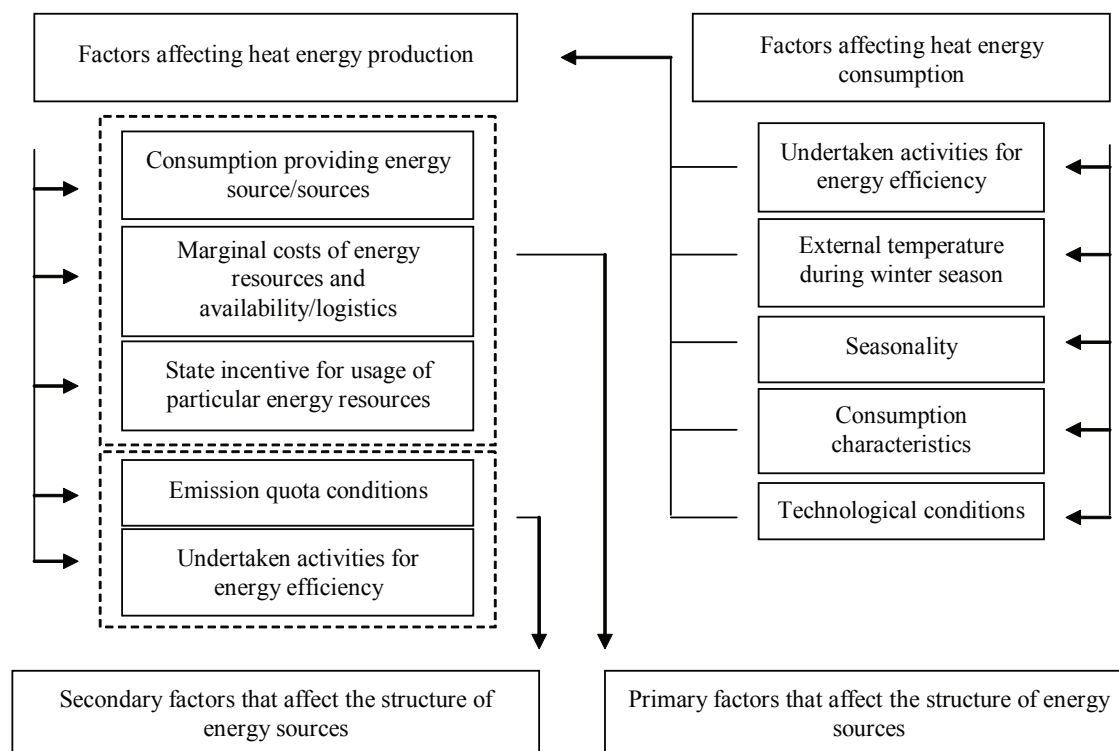


Figure 2. The factors affecting heating enterprises "xxx" structure of used energy.

Source: Created by the authors

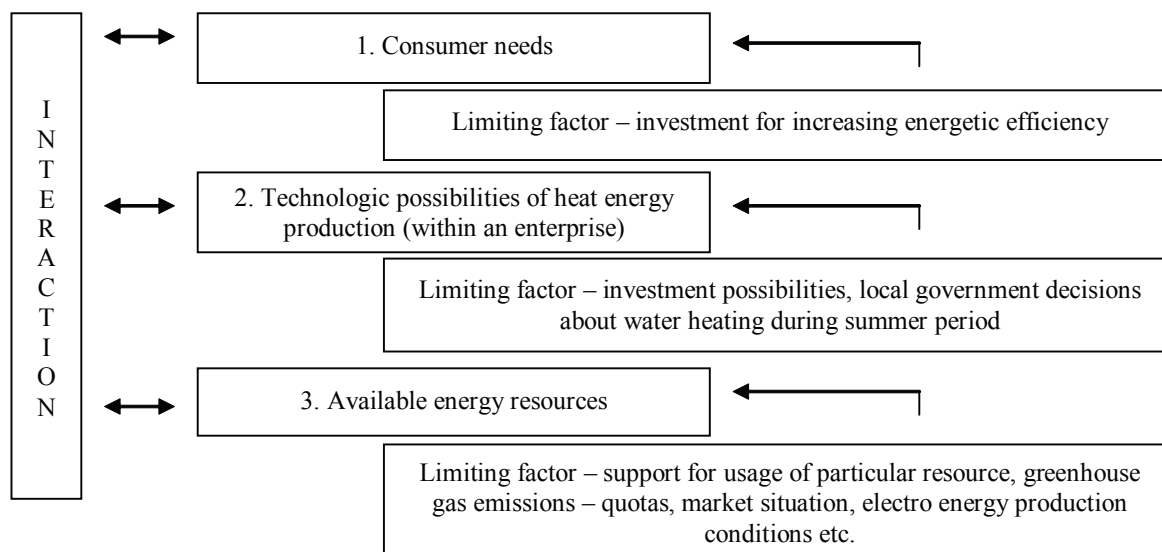


Figure 3. Aggregate factors that will impact the strategic usage of energy resources in heat supply enterprises in future.

Source: Created by the authors

Specifying the group of future factors (see Fig. 3), it is possible to calculate a future outcome.

1. Consumer needs: rate of thermal energy in recent years has risen faster than personal income levels. On average, the population spends 20 - 30% of their income (the poor more) on the heating payments in winter. The situation requires the buildings to reduce energy consumption from an average of 200 to 250 KWh m⁻² to 150 KWh m⁻²; thus, thermal energy consumption could be reduced by 20 - 25%, followed by the final heat of charge reduction (the reduction in consumption at the expense of) (Latvijas Republikas Pirmās..., 2008).

On the basis of current discussions on the energy efficiency factor of the importance and economic situation in Latvia, one can conclude that the population with such funds is not present. Consequently, it can be predicted that consumer heat demand needs will not change significantly in the coming years (3 to 5 year period). The total energy in the context of district heating companies will be the key to ensuring that the difference between the thermal energy available to the consumer price and the price of electricity is greater than 15 - 20%. If the electricity becomes cheaper than heat, mass-residents might start using electricity for hot water heating and heat provision (Akermanis, 2008).

Latvia will not be able to provide internally-based power capacity, import of electricity or basic power generation (including cogeneration promotion) in high electricity price (support for electricity produced from renewable sources).

2. Technologic possibilities: online heat tariff components can be comprehensively divided into three groups: heat production, distribution and marketing expenses. Fuel costs for heating tariff accounts for 60

- 70% depending on the energy resource used. In case if a rate of thermal energy does not cover the cost of heating and heating company has no spare cash, it is possible to vary only the remaining 30% of the factors affecting heat tariff (staff salaries, repair costs and electricity costs) to cover energy costs (Akermanis, 2008).

Moreover, at least four months are required to approve a new tariff of heat (if it has not been confirmed in tabular form) (Par sabiedrisko pakalpojumu..., 2001).

Therefore, from a technological point of view, the primary requirement is to reduce energy costs in the overall heat tariff. The condition is also important from the standpoint of debtors, because not in all cases the payment for the heat is settled by building management. Heat distribution cost reduction can be achieved by increasing the energy efficiency in heat transfer tracks. Heating companies attracting outside funds and investing in heat transmission run in the reconstruction, reduce heat tariff (tariff would be included in interest payments on borrowed capital, and reduced heat transfer loss of interest) and accounts receivable. By contrast, funds would be re-earned on average in 20 to 25 year period, so now the company is more efficient to operate the existing transmission heat loss (in any case it will be 10 - 12%) and accounts receivable, rather than get in debt with raising capital for 20 years.

3. Available energy resources: most experts consider that the oil peak will be reached within the next 10 years. The biggest unknown will be linked to the fair determination of the extent of oil reserves. About 10 years after reaching the peak of oil production it is expected to culminate in the extraction of natural gas (Strautiņš, 2008).

In assessing the wood chippings as a renewable energy opportunities for Latvian energy, its production potential is very large (virtually unlimited), and the government's guidelines do not provide additional wood chippings for other energy purposes. Heating traders can plan that the wood chippings cost increases will continue to be gradual (Siltumapgāde Latvijā, 2009).

Conclusions

1. District heating not only has a potential opportunity for the usage of extensive biomass and cogeneration, but also needs new technology which will enable to vary the energy sources.

2. Realised amount of thermal heat indirectly affects the operator's profit, but directly affects the rate of thermal energy, since the structure of primary energy use should be associated with heat production cost restrictive factors.

3. Hypothesis is proven, because:

- key factor in the energy mix is the temperature schedule and the thermal load-providing resources (larger role of technological, not economic factors);
- the main strategic principle in the future – district heating enterprises will have to use energy resources with optimal efficiency and minimal environmental pollution.

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