# IMPROVING ENERGY EFFICIENCY: THE SUPPLY SIDE APPROACH LESSONS

Dagnija Blumberga and Ivars Veidenbergs, Riga Technical University

## 1. SYNOPSIS

Prospects for energy saving measures in Latvia. Supply side management study.

## 2. ABSTRACT

The objective of this paperis to share the experience acquired from having worked on energy saving issues together with Latvia's thermal energy producers and consumers for the last three years since Latvia regainedindependence. During these years a transition has been made from the former USSR economy to market economy.

In this paper we will try to provide an insight to production, distribution and use of thermal energy by DH plants and industries in Latvia, possibilities to improve energy efficiency, environmental feasibility, and evaluation of project proposals, and energy saving strategies that will most effectively overcome psychological obstacles.

Energy efficiency improvement should begin with implementation of low cost energy saving measures along with supply side management. The analysis of energy and fuel consumption and the impact of energy costs is based on data provided by producers.

On the other hand, capital investments with short payback period show the specific conditions of the present situation in energy economy. Recommendations for the implementation of energy conservation projects and purchase of more efficient equipment are based on energy engineering analysis, as well as environmental and economic evaluation.

## 3. INTRODUCTION

Background

During the last four years a lot of changes came to pass in Latvia's economic structure. Transition from centrally planned economy to market economy is vital for the development of the country and achieving the prerequisite for a politically independent state. Economical reorganisation is impossible without changes in energy sector.

Latvia is one of the few countries in the world which have no natural resources of oil, gas and coal. Until 1990 almost 90% of energy resources had been imported from the former Soviet Union. Therefore Latvia was very strongly hit by the world's third energy crisis. The Government of Latvia believe that this energy crisis (taking into account that it occurred in a transitional period), both from political and economic point of view, is much more critical for Latvia than the former two energy crises were for many Western countries.

Government programmes try to forecastpossible changes in the development of Latvia's energy sector.

Second part of this paper contains results of investigations during implementation ofenergy auditing, monitoring and targetingin DH plants and industries in Latvia. This allows to provide an insight to heat energy generationand distribution side development and opportunitiesin energy saving in current energy economy situation.

## 4. ANALYSIS OF GOVERNMENT PROGRAMMES

In the period of time from 1992 to 1994 the Latvian Government worked out six Energy Programmes andconceptions. The most important of them are the following:

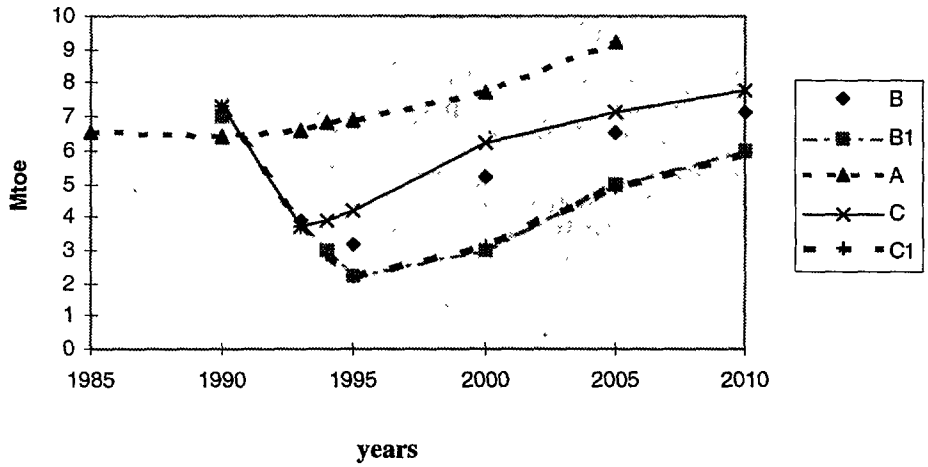
- Energy Restructuring Programmeof Latvia, 1994;
- Energy Masterplan for Latvia, 1994;
- State Energy programme, 1992.

All the above mentioned programmes contain an overview ofthe situation in the energy sector 5 - 10 year ago,nowadays,they also forecast possible Government policies in the future.

### 4.1. Energy Scenarios

Changes in the demand for primary energy resources forecasted in the above mentioned Programmes are illustrated in

*Figure 1.*




In this chapter primary energy resources is expressed in megatons of oil equivalentMtoe.

**Table 1. Versions of scenarios for the development of the demand for primary energy resources.**

| Version | Source of information | Remarks |
|---|---|---|
| A | State Energy Programme, 1992 | |
| B | Energy Reconstruction Programme of Latvia, 1994 | According to the optimistic National Economy development scenarios |
| $B_1$ | Energy Reconstruction Programme of Latvia, 1994 | According to the pessimistic National Economy development scenarios |
| C | Energy Masterplan for Latvia, 1994 | According to the West - oriented scenarios 1 |
| $C_1$ | Energy Masterplan for Latvia, 1994 | According to the CIS - oriented scenarios 2 |

| | | |
|---|---|---|
| $D_A$ | | Version A<br>According to the reference scenario of the US working group on global energy efficiency |
| $D_B$ | | Version B<br>According to the reference scenario of the US working group on global energy efficiency |
| $D_C$ | | Version C<br>According to the reference scenario of the US working group on global energy efficiency |
| $D_E$ | | According to the efficiency scenario of the US working group on global energy efficiency |

In the programmes worked out in 1994 two development scenarios for the determination of economy development perspectives in Latvia are applied, i.e.:

⇨ a more optimistic one;
⇨ a more pessimistic one.

Both of them are further explained in the Energy Master Plan, 1994.

According to the optimistic, West - oriented scenario 1, due to a fast privatisation process and an influx of foreign investments, economy will quickly change for the better andwill have been restored by 1995. The 1990 gross domestic product ( GDP) level is foreseen to be reached about the year 2000, assuming a high annual GDP growth rate of 12%. The decade to follow, 2000 - 2010, development will be of a more moderate character with an annual GDP rate increase of 5%. Thus, the 2010 GDP level will be approx. twice as high as the 1990 one.

According to the pessimistic, the CIS - oriented scenario 2,in 1994 - 1995 there will be a stagnation period due to the lack of investments and severe dependence on the CIS economy, which is in a crisis still. Consequently,GDP will increasewith an annual growth rate of approx. 9% during the following decade, i.e. 1995 - 2005. The 1990 GDP level will have been reached again by 2010.
Figure 1 presents a diversity of results due to differentapproaches. All documents envisage growthin the demand for primary energy after a period of decline. The scenarios differ only in the duration and the level ofthe decline. Whereas the State Energy programme 1992 does not delineate any considerable decline(1985 ... 1990), the two above mentioned programmes, worked out in 1994, in the pessimistic scenarios picture a decrease of energy demand in1990 ... 1995 up to 70 %.

The reason for the decline is easy to find. This is the decline of the Latvia's economy in general, and the collapse ofindustry. The fact that energy prices rose 5 (and more) times has played a significant role in the decrease of energy consumption. The previous argument should be considered under various angles. One of them is slow progress towards energy efficiency and energy conservation; the most important reason being, however, unsatisfied demand.

Recovery of economy has been forecasted for the span of the time within 1993 ... 1995. In the two latter Programmes, calculations of the growth rate were based on the GDP development by sector, the 1990 energy consumption level and the potential energy saving.

The more optimistic scenarios envisage that the level of energy consumption characteristic of 1990 can only have been reached again by approx. 2010. It will only be possible after a change in the infrastructure of the National Economy, a betterment of energy efficiency and having implementedan energy saving strategy. Presumably, in this case, the energy conservation potential in 1995 ... 2015 will change linearly from 10% to 50%.

The energy conservation potential in more pessimistic scenarios is assumed to be moderate, a linear change during 2000 ... 2010 being from 5% to 20%, lacking a rise in a demand for district heating. Due to bad economic conditions, the 1990 energy consumption level will not be reached until 2015.

### 4.2. Primary Energy Use, Forecast for 2025

Another approach for the primary energy use forecast is proposed by American specialists (Energy Efficiency, 1991). Practical experience in exercising energy saving options in developing countries and Eastern Europe allow to present a convincing evaluation of prospective GDP and energy efficiency levels.

Presumable GDP growth rates for a number of regions are presented in the forecasts up to 2010, worked out for the US Department of Energy (International Energy Outlook, 1990). To usethe method for Latvia, it is worthwhile to apply the following data:

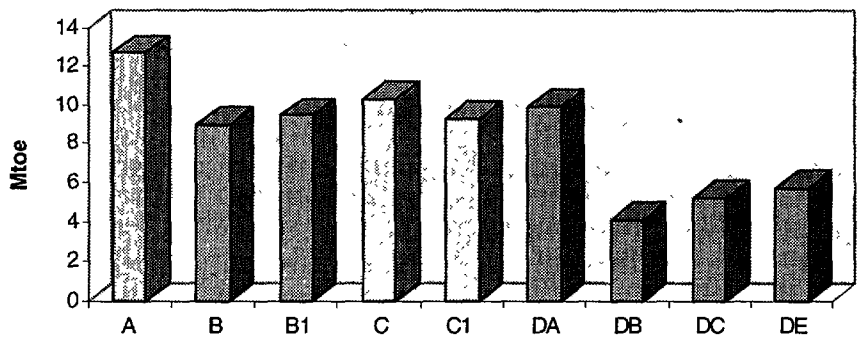
- 2,9%/annum - growth rate for the CIS;
- ·2,7%/annum - growth rate for Eastern Europe.

Two scenarios of energy demand form in the year 2025 for nine world regions are worked out in Energy Efficiency, 1991: the Reference Scenario and the Efficiency Scenario.

The reference scenario assumes a number of structural changes in the end-use sectors, envisions technical evolution, with a significant improvement of energy efficiency as economies develop and capital flow(for energy purposes) changes; it also anticipates some other efforts to increase energy efficiency.

The efficiency scenario assumes that substantial further efforts aremade - with a large scale assistance- to improve the efficiency of energy consumption and supply. It does not envision any significant changes in consumers' behaviour or industrial development that could contribute to a lower rate of energy consumption, yet, it does assumegovernments' heavily investingin public transportation to reduce energy consumption and abate air pollution.

Forecasts for primary energy consumption in Latvia in 2025 are calculated for all the proposed versions (see Table 1) andare shown in Figure 2.




The method proposed in (Energy Efficiency, 1991) is used for the evaluation of results in version D (see Table 1). Efforts to improve efficiency of energy supply and consumption for Eastern European countries will yield an annual decrease of primary energy use of 0,2% per year during the period of 1985 ... 2025, given the application of the Efficiency Scenario (see column DE in Figure 2 and Table 1).

In the reference scenario the annual growth of primary energy consumption in Eastern Europe is stated to be 1,3%/annum. That assumption is applied for calculating primary energy use in the following:

- the year 1985 for version A;
- the year 1994 for version B;
- the year 1993 for version C.

### 4.3.Discussion

Forecasts of primary energy consumption shown in Figure 2 could be divided into three groups.

- The first group represents version A.Such a high rate of primary energy consumption (12,7 Mtoe) can be explained by industrial sector development and a low rate of energy saving.
- The second group comprises versions B, B1, C, C1, DA. The level of primary energy consumption is 9 ... 10 Mtoe. In fact, primary energy consumption grows slower than GDP. The major reason for that will be energy conservation on both generation and consumption sides.
- The third group consists of versionsDB, DC, DE. Such a low level of primary energy consumption (4 ... 6 Mtoe) is based on introduction of state-of-the-art Western technologies, as well as a consistent energy saving strategy and Government's commitment in conducting the policy. It seems to be more effective and optimistic from the global environmental and energy efficiency viewpoint.

### 4.4. Lessons Learned

The lessons learned are as follows:

- A well-designed energy conservation programme can be more effective.
- Government's commitment is consequential for successful implementation of energy efficiency programmes.
- Energy users shall understand that energy efficiency is a priority for national developmentand that words are to be followed by actions and accomplishments.
  ·Investments in energy sector in Latvia should be one of the significant solution in the energy conservation programme.
  ·Energy conservation programme must include aspects on the donor sidetoo.

## 5. CURRENTENERGY SITUATIONFEATURES INLATVIA

Energyefficiency improvement should begin with implementation of low cost energy saving measures along with supply side management.The analysis of energy and fuel consumption and the impact of energy costs is based on data provided by producers.

Regular investigations of generation, distribution and use of thermal energy by DH plants and industries in Latvia allow to provide features obtained during carrying out analysis of the equipment and system operation.

### 5.1. Some energy audit activities

A team of engineers and students fromRiga Technical University and private consulting companyB.V.EKODOMA, Ltd, Riga carried outsite activities at industrial plants and district heating companies of Latvian cities municipalities.Objective ofthis job was to work with representatives and staff of enterprisesto identify and analyze improvements to the plants energy efficiency.

Based on initial investigationwith Riga Technical University's portable energy auditinstruments, the audit team focused efforts of some specialists in enterprises in the short time available on improvements to the boiler house, district heating networkand technology equipment energy efficiency.

In all casesenergy auditing, monitoring and targetingwere finishedwith presentationof recommendations to the plants management andtechnical personnel at the final review meeting. It is important to look on that seminar like first stage energy efficiency training

B.V.EKODOMA, Ltd, Rigaare always recommending that enterprises shall set up enterprisesa computerized energy management program as a first step in energy consumption and costs controlling.

### 5.2. Energy consumption analysis

A graphical presentation prepared byB.V. EKODOMA, Ltd, Rigaof basic data received from differentplants on fuel consumptionand heat energy productionfor the heating seasons are illustrated in Figure3, 4 and 5.

In the former Soviet Union monitoring of fuel was expressed in conventional fuel tonswhich equals 1 ton of coal.That experience is used in graphical presentation of data in Figure 3., 4. and 5.

The primary energy useanalysis is based ondata calculated for following three enterprises:

- -fortwo district heating plants:

  *theKauguriDHplant for 1992 / 1993 and 1993 /1994 heating seasons;
  *theDubulti DHplant for 1992 / 1993 and 1993 /1994 heating seasons;

- -for the Daugavpils Fibreplant for 1990 / 1991 and 1991/ 1992 heating seasons.

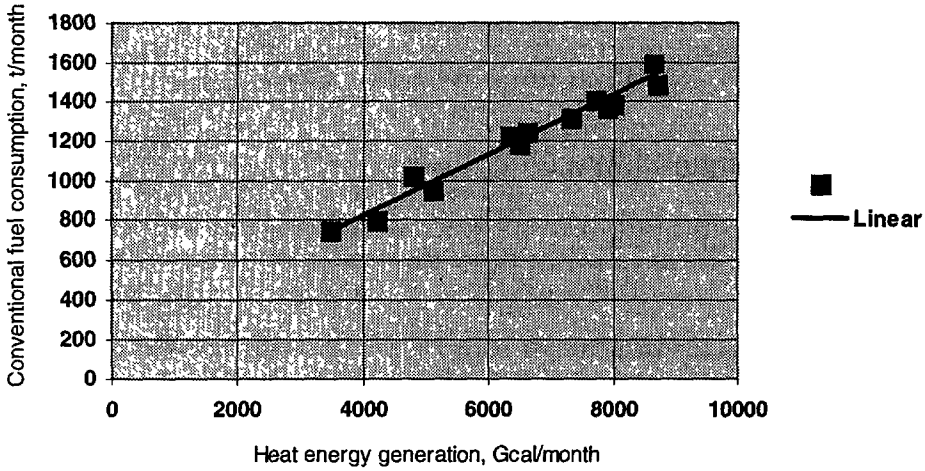



*Figure 3. Monthly fuel consumption / heat energy generation relationships inDubulti DH plant*

These graphs are provided for useenterprises in identifying variations in energy efficiency.Such kind of analysis was a tool to point the wayfor more detailed investigations.These more detailedstudies were beyond the scope of agreements. Main points arising from the analysiswhich were used todevelop specific recommendations are asfollows:

The analysis of the variation of fuel consumptionwith weather data( outside air temperature,wind,precipitation ) provided a good indication of the operation of thedistrict heating plants. Ambient air temperature had by far the greatest effect of the weather parameters, and the analysis was always limited to that factor.

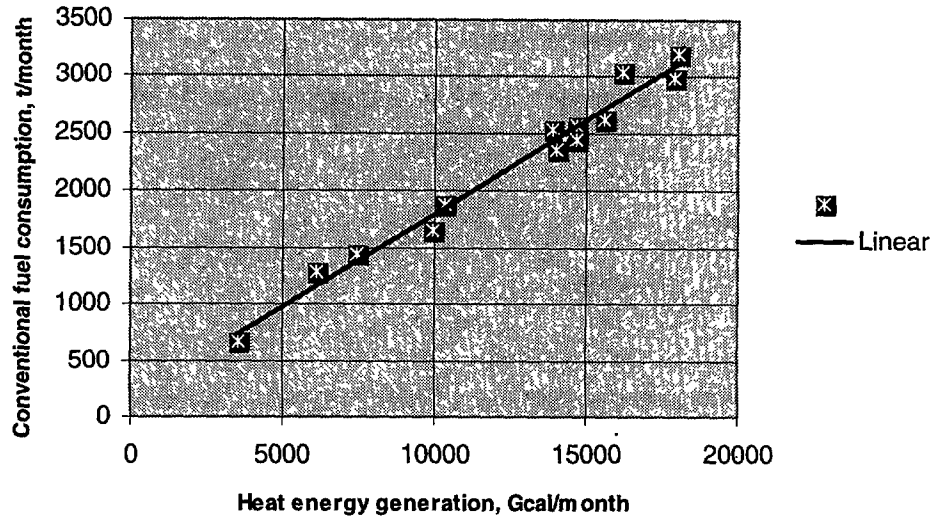



*Figure 4. Monthly fuel consumption / heat energy generation relationships in Kauguri DH plant*

Non-weatherfactors wereessentially not existent, since there is no local control on the heating ( although windows can be opened and closed ), and since sanitary domestic hot water consumption( which would be expected to vary during the day and from weekday to weekend ) is relatively small portion of the total.

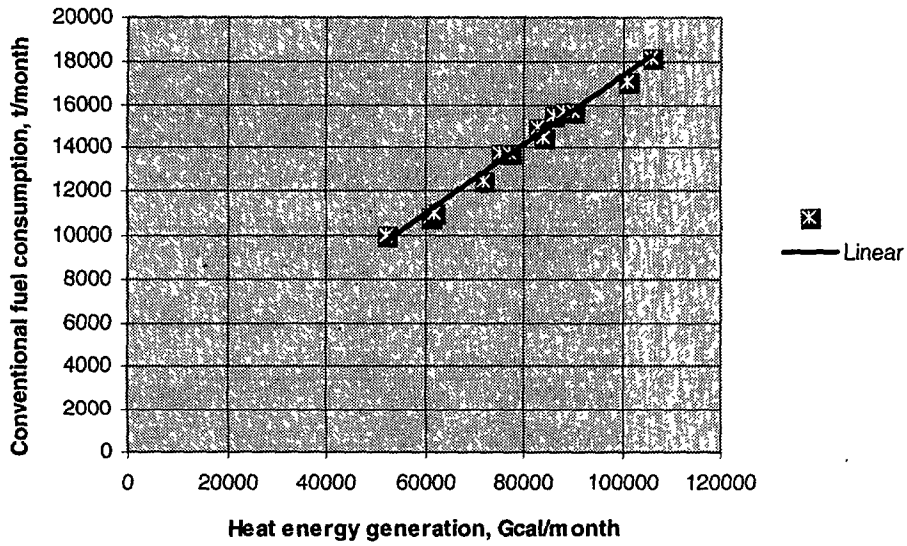



*Figure 5. Monthly fuel consumption / heat energy generation relationships in Daugavpils Fibre plant*

Annual technological production in lot ofLatvian industrial plants was less than in the previous year ( decrease startedin 1989...1990 year ). Fuel consumptionwas dominated by the demand for heating as much as by production inthe Daugavpils Fibre Plants during heating season

Monthly fuel consumption / heat energy generation relationships were analyzed in above mentioned period. They are presented in Figure 3., 4. and 5. Regression analysis was usedto indicate the fixed energy consumption( constant amount per month ) and the variable energy consumption( additional amount which is related to production ).

Fuel consumption should be well correlated withheat energy generation, as indicated by the results of regression analysis. The amount offuel consumptionin monthly period(dependent variable ) should be correlated to the heat energy productionachieved during the same period( independent variable ).

That analysis led to the development ofplants energy performance model linear equations, of the following form:

$$y = ax + b,$$

wherey - conventional fuel consumption per month,
x - heat energy generation per month,
a - variable fuel consumption per heat energy,
b - fixed fuel consumption per month.

Graphical presentation ofequations demonstrates obtained straight linesinFigure 3., 4. and 5. The lines in the figures show regression analysis of two years data in three enterprises. The main feature in all casesis thatprevious year data deviate under regression line and next year data diverge above this line.

5.3. Results

Results of regression analysis are presented inTable 2.

*Table 2 Regression analyses of boiler houses operation data*

| No | Boiler house | Heating seasons | Equation |
|---|---|---|---|
| 1 | Kauguri DH Plant | 1992/1993 | y = 111,5 + 0,161x |
| 2 | Kauguri DH Plant | 1993/1994 | y = 300 + 0,159x |
| 3 | Kauguri DH Plant | 1992/1993 and 1993/1994 | y = 161 + 0,163x |
| 4 | Dubulti DH Plant | 1992/1993 | y = 163,9 + 0,156x |
| 5 | Dubulti DH Plant | 1993/1994 | y = 279,1 + 0,148x |
| 6 | Dubulti DH Plant | 1992/1993 and 1993/1994 | y = 225 + 0,151x |
| 7 | Daugavpils DH Plant | 1990/1991 | y = 973 + 0,162x |
| 8 | Daugavpils DH Plant | 1991/1992 | y = 1703 + 0,153x |
| 9 | Daugavpils DH Plant | 1990/1991 and 1991/1992 | y = 1337 + 0,158x |

**5.4. Discussions**

Regression analyses data are showing following :

- Growth of primary energy use in is always higher in last heating season than in previous heating season.
- Increasing of fixed fuel use is obtained too. High fixed energy consumption indicates high energy losses in the plant.

- Reason of specific fuel consumption growth could be explained with use severalcommon features in Latvian energy sector. The main of them is reduction ofconsumers number or their heat load ( part of consumers became disconnected, another users reduced heat energy consumption, but some of users closed their technological production ).Equipment stay older and only reconstruction of thosecould help to improve energy efficiency.

### 5.5. Lessons Learned

The lessons learned are as follows:

- Information of energy savings opportunities ( technical solutions and costs ) shall be available for the heads of municipalities and industries.
- Engineering, economical and environmental training of staff is one of themost important way to improvement of energy efficiency.
- Energyauditing, monitoring and targeting is only the first step ofimprovement energy efficiency and for justification of energy saving proposals and projects.
- Investments in energy saving programme in enterprise shall be with specific aim and concrete proposal ( EBRD "Latvia Energy Emergency Investment Programme " andSwedish GovernmentProgramme"An Environmentally Adapted Energysystem in the Baltic States and Eastern Europe".

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