ENERGY CONSUMPTION AND ITS REDUCTION POTENTIAL IN LATVIAN INDUSTRY SECTORS

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ABSTRACT

This article, firstly, compares the distribution of energy consumers by industry sectors in Latvia. Next, the manufacturers which have received state support within the Climate Change Finance Instrument (CCFI) programme are examined by their industry sectors (food products, chemical products and metalworking). The energy saving calculated by companies (by NACE sectors) and its distribution by energy efficiency measures are analyzed. The planned savings structure is compared to statistical indicators of OECD countries, European Union and Latvia both by data available in sectors and during operation of industrial buildings. Further, the distribution of planned measures by types of energy efficiency is examined, and savings in megawatt-hours (MWh) and as total company consumption are compared. When comparing the percentage of energy efficiency measures with the EU study, the statistics of the CCFI tender does not depict the indicators specified by the EU: first, crosscutting electric energy and manufacturing processes, then heat savings. The heat energy saving for heating of buildings dominates in CCFI tender measures; the next significant indicator is energy savings in the manufacturing process. This article provides an example of planned and achieved results of two companies based on the monitoring data at the disposal of the authors. Energy efficiency in industries needs more studies, especially in terms of utility solutions and measure payback periods. A more detailed statistics by sectors is required, surveys of companies that have not received state support and ETS companies would provide more information about energy efficiency possibilities.

Keywords: industrial energy audit, energy efficiency, energy savings, industrial energy audit guidelines

INTRODUCTION

The purpose of this article is to analyze energy efficiency measures in industry sectors (excl. constructions) in Latvia, reviewing them in the context of statistics of the European Union and OECD (Organisation for Economic Co-operation and Development). Conclusions and recommendations are given to increase the competitiveness of Latvian industrial companies by reducing energy consumption.

This article is based on Latvian statistical data (Central Statistical Bureau – hereinafter CSB), openly available foreign studies, and the Climate Change Financial Instrument ((hereinafter – CCFI), CM Regulation No.521, 2010) data collected with the support of the Latvian Environmental Investment Fund (hereinafter – LEIF). The choice of the authors to analyze data of the state support programme, CCFI Open Tender "Complex Solutions for Greenhouse Gas Emission Reduction in Manufacturing Buildings" (hereinafter CCFI tender) is explained as follows: although the measures planned in 2010 were performed mainly in 2011, though monitoring data have been summarized in 2013, energy audits and saving calculations of ~40 of companies provide a broad overview of the sector. Therefore, this study will be continued analyzing monitoring data both for the programme implemented in 2010 and the one planned in 2012 – 2013, tracing it until 2015.

The method of the authors includes collection of CSB data and quantitative data of CCFI companies from LEIF documents (Project applications and energy audits), their comparison with statistics of other countries, and an analysis by types of energy efficiency measures and energy saving types. Shortcomings in the CCFI data analysis are caused by different formulations of energy efficiency measures in energy audits; also investments are not split according to activities thus restricting to analyze the payback periods, in some cases contracts were changed. However, these shortcomings do not affect the total result more than by 5%, because the responsibility of funding receivers for quantitative and qualitative indicators in the 5 year monitoring period is legally binding, not allowing less CO_2 savings as calculated, and not more than 5% changes in investment indicators. Limits for the application of foreign statistics is the structure of their data, for example, LR statistics shows a significant woodworking sector, while EU and OECD – manufacture of pulp and paper that have a smaller percentage in LR. Latvian legislation and statistics are analyzed in the article "Development of Industrial Energy Efficiency in Latvia, Legislation and Statistics", authors A. Kursiša, L. Gleizde.

STRUCTURE OF ENERGY CONSUMPTION IN LATVIA AND SECTORAL BREAKDOWN OF COMPANIES RECEIVING CCFI SUPPORT

In the state support programme (CCFI) analyzed in this study, 49 projects were approved, agreements were concluded about the implementation of 41 project. Energy efficiency projects submitted by 39 companies, 57 buildings in total (companies could submit plans of measures for several buildings) were analyzed in this study. All industry sectors are represented at least by few companies, however, manufacturers of food and beverages (4 companies) show higher energy consumption. By the quantity, there are more companies from metalworking (6) and woodworking (5) sectors. 4 industry sectors (descending order) are leading in the energy consumption structure in Latvia:

- manufacture of wood and related products ;
- manufacture of non-metallic mineral products;
- manufacture of food and beverages;
- manufacture of metals.

Participants of CCFI, according to the energy consumption ratio of companies, shows a slightly different trend:

- manufacture of food and beverages – with high prevalence;
- manufacture of chemicals and chemical products;
- manufacture of other fabricated metal products;
- repair of equipment and storage functions.

It should be noted that the companies that have received state support form an incomplete picture, because the total energy consumption per pre-performance of measures makes 1.6 % from the total consumption of the industry sector. 33 companies in the ETS (Emissions trading scheme) system, larger energy consumers and respective creators of emissions making about 40% of energy consumption were excluded from support. Latvian ETS members are operators, who, according to the requirements of the Law "On Pollution" received greenhouse gas emissions permits. The structure of these companies is led by:

- manufacture of non-metallic mineral products;
- manufacture of food products;
- manufacture of wood and of wood and cork products ;
- manufacture of chemicals and pharmaceutical products.

In the European Union (Altmann M, Michalski J, Brenninkmeijer A, Tisserand P. (2010)), companies operating in the ETS system make ~50% from industry's energy consumption, however the impact of ETS trading on energy efficiency is poorly studied.

Therefore, the limits of this study are defined by the analysis of the companies that have received state support and measures (project of 2010, implementation in 2011 – 2012).

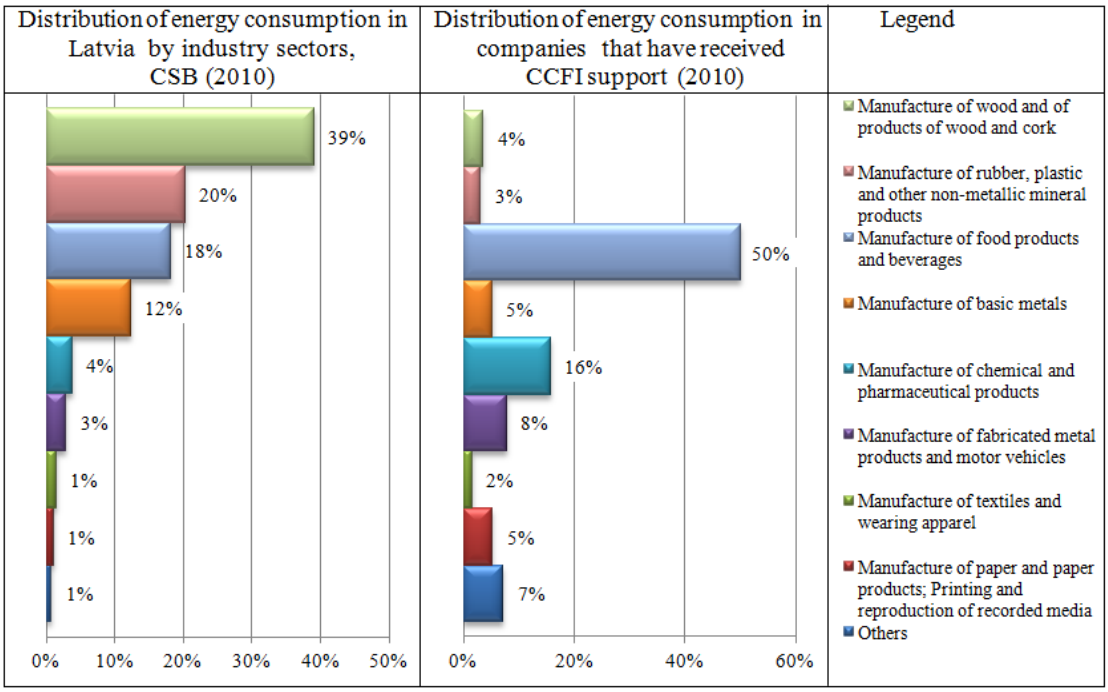

Figure 1. Energy consumption structure in Latvia by industry sectors, CSB and CCFI, 2010. Calculated based on total electric energy and heat energy consumption, MWh

ENERGY SAVING BY TYPES OF ENERGY AND INDUSTRY SECTORS

When reviewing energy supply of companies supported by CCFI, the total distribution of fuel supply for industries includes all type of energy resources available in Latvia: centralized heat supply and electricity; and local boiler houses using natural gas and liquefied gas, biomass (wood), diesel oil, mazut and coal. The saving of energy resources by their type matches the power supply structure of companies.

If the most used power fuel resources are: **central heating, natural gas, wood (biomass) and electricity;** then the most highly ranked savings are provided by: **central heating, natural gas, electricity, wood (biomass).** In total, 27% of the forecasted savings is formed by electricity reduction, the other part consists of heat energy. We view energy saving by sectors in the context of the total consumption of companies, where the most significant consumption is in the "Manufacture of food products and beverages", that is followed by "Manufacture of chemical and pharmaceutical products".

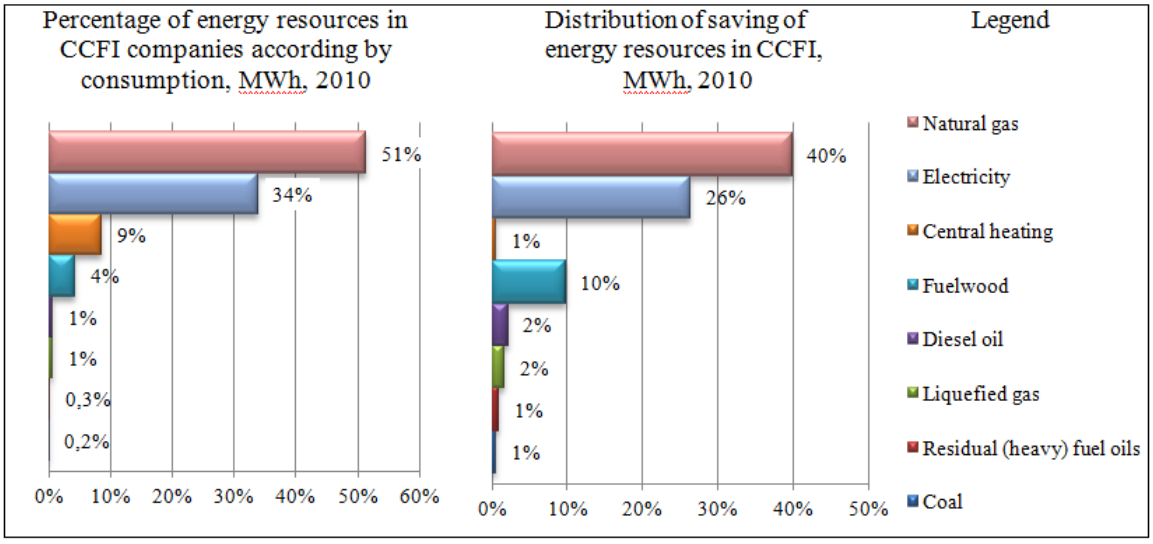

Figure 2. Distribution of percentage saving of energy resources in CCFI projects

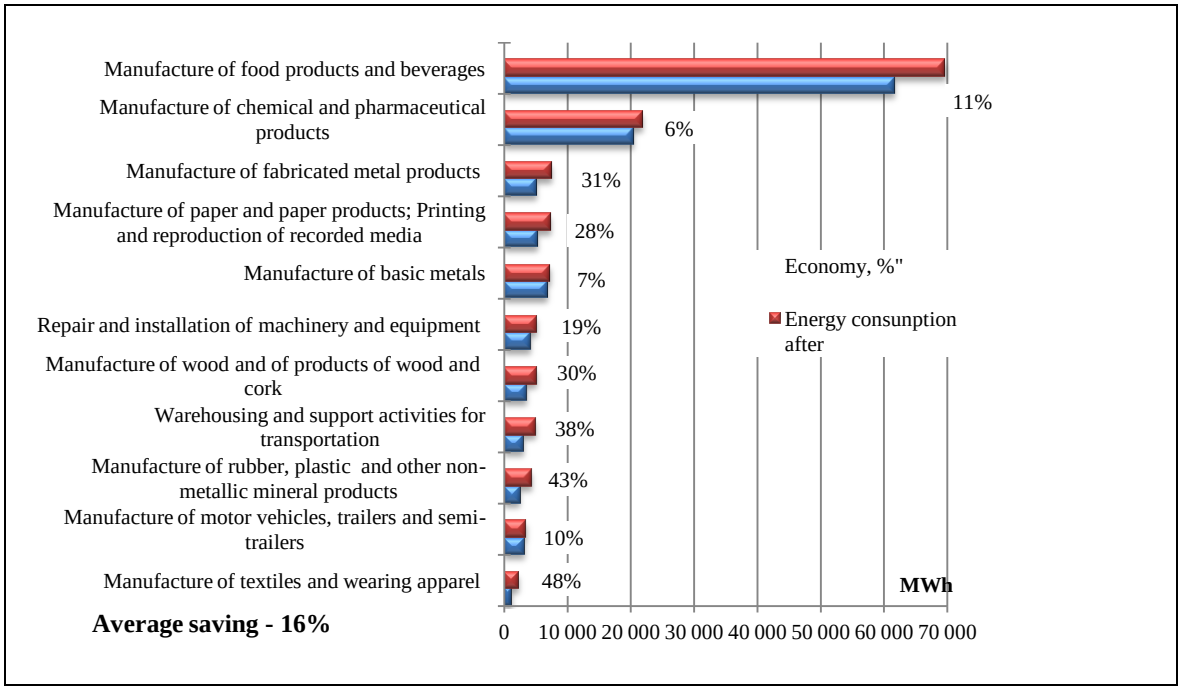

Figure 3. Distribution of saving in CCFI projects by sectors of operation

COMPARISON WITH EU AND OECD STATISTICS; INDUSTRIAL BUILDING AGE FACTOR

Comparison with EU and OECD statistics

When reviewing savings in the most significant sectors, EU benchmarks cannot be applied due to the lack of sector data, however, we may compare estimates of EU and OECD countries for energy cost ratio in companies and the savings forecast for the sector in general or on average in the company.
Considering that the European and OECD study had no data collected on the woodworking sector, which is specific to Latvia due to its high energy consumption, this sector is not included in the table.

Table 1
Comparison of industry sectors' data

Sector	Data source	Energy cost ratio (%) in company	Potential energy saving (%)
Manufacture of basic metals	OECD[1]	10-30	10
	EU[2]	n/d	6-7
	CCFI[3]	**1-4**	**3-45**
Manufacture of food products and beverages	OECD	1-10	25
	EU	10	11-13
	CCFI	**2-7**	**3-37**
Manufacture of chemical and pharmaceutical products	OECD	50-85	9-25
	EU	n/d	17
	CCFI	**1-5**	**1-13**
Manufacture of non-metallic mineral products	OECD	25-50	20-35
	EU	n/d	**n/d**
	CCFI	**1-4**	**6-79**
Manufacture of textiles and wearing apparel	OECD	5-25	10
	EU	n/d	**n/d**
	CCFI	**1-7**	**33-63**

1- Saygin D., Patel M.K., Gielen D. (2010);
2 - Altmann M, Michalski J, Brenninkmeijer A, Tisserand P.(2010),; 3- LEIF, CCFI

In total, the companies analysed have a smaller energy cost ratio (it is still explained by comparatively low prices of energy resources in Latvia); however, the potential energy saving in companies significantly exceeds the average of EU and OECD sectors. As a result, the impact of energy efficiency measures on financial indicators of companies is a significant factor.

Industrial building age factor and impact of industry restructuring

In Latvia, according to the most successful energy saving estimates of CCFI projects, saving may reach up to 79%, showing an average saving of 43% in the manufacture of non-metallic mineral products and 48% saving in the manufacture of textiles and clothing.
Along with the general knowledge that insulation of building may provide about 50% saving of heat energy, we also study the OECD explanation about the impact of the life cycle of industrial buildings to the energy saving forecast. In the study (Saygin D., Patel M.K., Gielen D. (2010)), it was concluded that older factories are smaller by size, have lower energy efficiency, and lower efficiency of production technologies. In its turn, the turnover of the companies is frequently not sufficient to transfer manufacturing to a technologically modern building; that is especially characteristic for Russia and former USSR. This aspect forces to continue manufacturing in non-effective buildings. However, it is also specified there that the growth of energy consumption in developing countries is expected from new, effective plants.
In accordance with the data collected by the European Union (Altmann M, Michalski J, Brenninkmeijer A, Tisserand P. (2010)), about 30% of the total energy efficiency reduction is caused by structural changes in industry sectors, innovation of technologies or transfer of energy-intensive manufacturing plants.

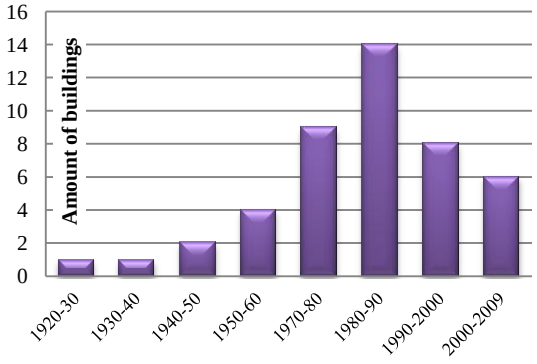

Figure 4. Distribution by the year of construction of buildings, supported by CCFI. Source: LEIF, CCFI

In the CCFI program, 47% of investments go into the building and building envelope, both by saving structure (mainly heat energy) and by investments.
The companies that wished to transfer their manufacturing to modern buildings before the economic crisis (for example, AS "Staburadze", AS "VG Kvadra Pak") decided to improve energy efficiency of the existing buildings and the manufacturing process.
Moreover, the buildings that were built before 2000 do not meet Latvian heat insulation standards, the buildings have large losses of energy in heating and also ventilation, that is especially significant in manufacturing plants with high air exchange intensity.
According to the structure of CCFI projects, the trend to renovate the existing buildings and to improve technologies will be maintained, however, in the future, in case of positive economic growth, the development of new manufacturing plants is expected to improve Latvian energy efficiency balance (Kursiša A., Gleizde L. 2013)

CCFI ENERGY SAVING ANALYSIS: PERCENTAGE AND MEASURES

First of all, we must consider that for analysis of savings statistics, a larger number of companies is required, because several sectors are represented by just a few companies (1-3) that do not show a trend, but rather provide only an example of the sector.
Measures for building envelope – insulation, replacement of windows, doors and gates – dominate in energy efficiency by MWh savings; they are followed by measures for energy efficiency in production technologies, and the reconstruction of the heating system. It should be noted that even using energy audit methods, heating efficiency measures in calculations are rarely precisely separable from savings caused by the improvement of the building envelope. Only some companies did not use the opportunity to insulate their building and to replace windows and doors, yet - exactly these few companies achieved the biggest saving with their measures for energy efficiency of equipment and heat recovery. The most frequently used activities, by quantity, are: insulation, replacement of windows, and doors in combination with reconstruction of heating and/or lighting. Activities in manufacturing are less frequent; however, they take an equivalent position in the investments section along with reconstruction of buildings or renovation measures, including both building envelope and utilities. The popularity of insulation may be explained by the long life cycle of buildings and non-compliance with Latvian heat engineering standards that cause large heat losses.

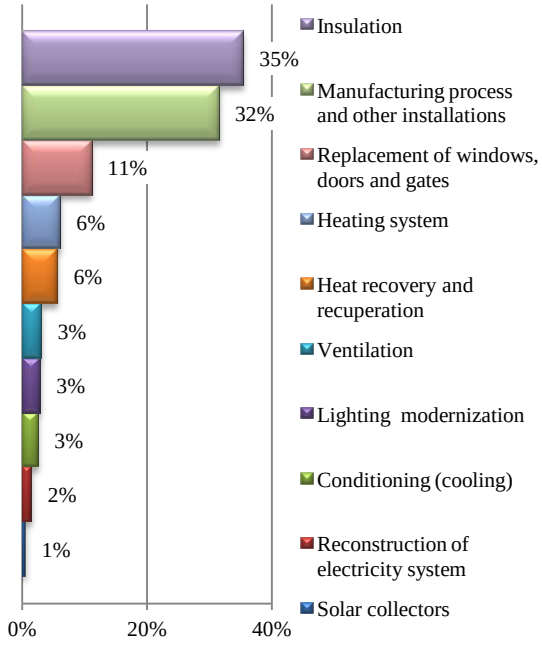

Figure 5. Distribution of saving by types of measures, MWh

The authors of the article analyzed whether the number of energy efficiency measures in the company correlates with the saving ratio (%) in the total consumption, and in megawatt-hours. If we split energy efficiency activities by types according to the saving chart, no mutual relationship is stated, i.e. – large energy saving ratio may be forecast only when insulating buildings, while the largest economy in megawatt-hours could be achieved with individual measures in manufacturing equipment and heat recovery. It is characteristic that insulation may provide a significant saving in up to 79% of buildings that have no significant manufacturing energy consumption. In its turn, if industrial consumption is several times higher that the energy consumption caused by building heating losses, it is possible to achieve a much higher quantitative saving in megawatt-hours (MWh). See the structure of energy efficiency measures to forecast results in Figure 7. The EC document (Altmann M, Michalski J, Brenninkmeijer A, Tisserand P., 2010) tells about the ratios of saving: "Roughly speaking, the energy savings potential in the industry is equally distributed between the three categories of electricity consumption by process specific energy consumption, space heating and crosscutting technologies including lighting, electric motors, pumps, ventilation, cold supply and compressed air." In the same document, p. 15, it is noted that electricity consumption by crosscutting technologies provides for the largest economic savings potential, process specific consumption has medium potentials, and space heating has the lowest potential.
Paying attention to the section with the largest potential, EC, p.16, indicates that "On average over all sectors and over all EU Member States, crosscutting electricity consumption in industry represents some 70% of total industry electricity consumption [ISI, 2009]. This demonstrates the importance of improving these seven crosscutting groups of technologies."

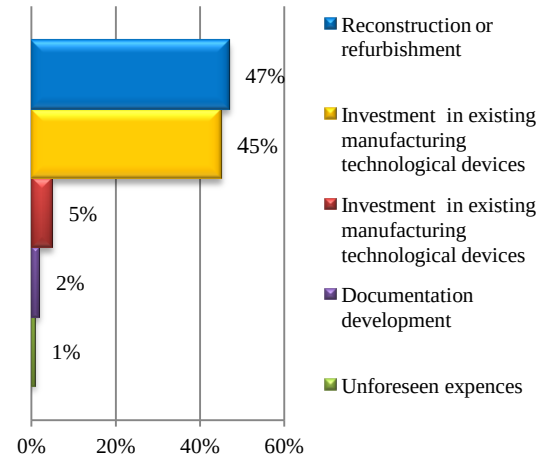

Figure 6. Distribution of investments, Ls

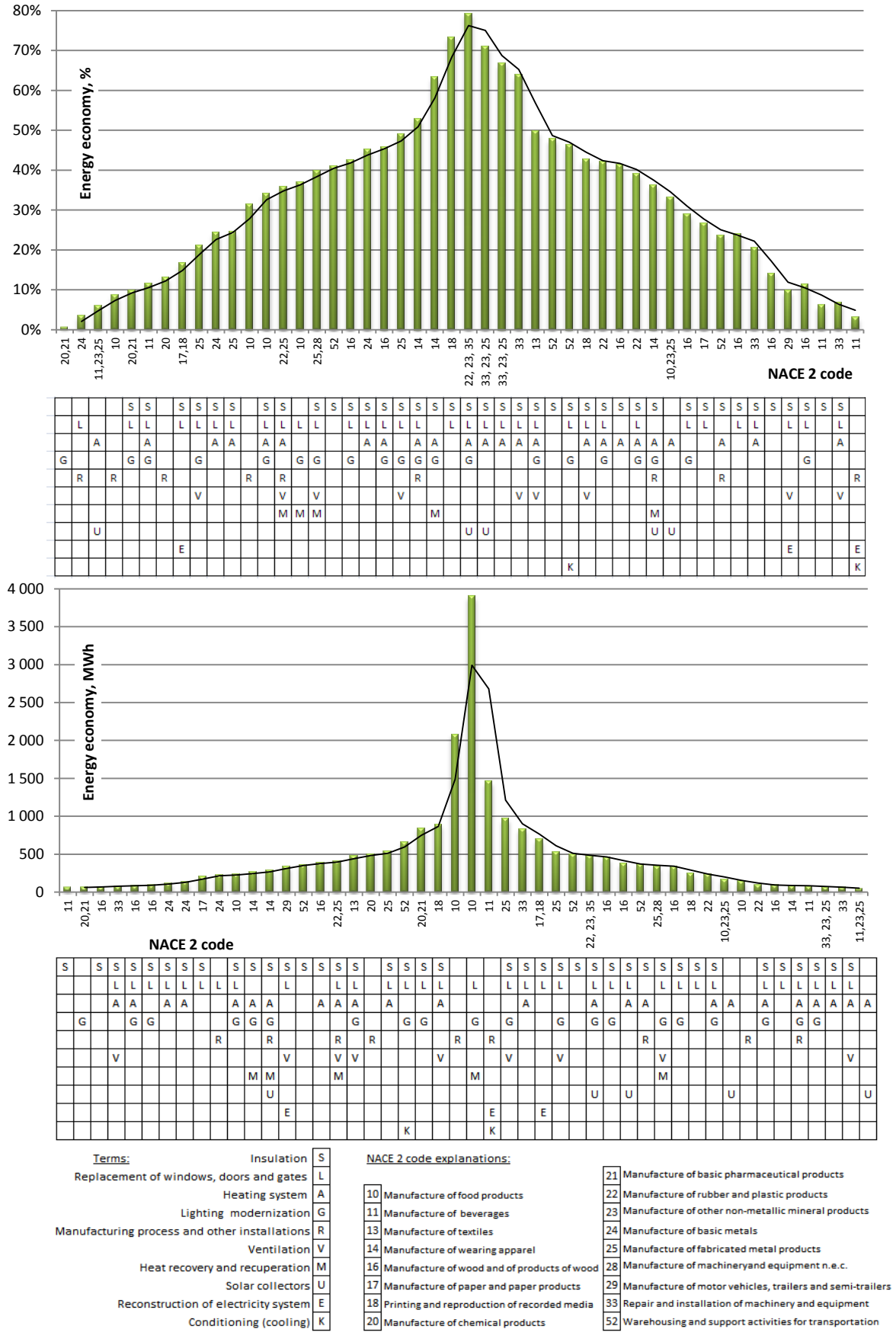

Figure 7. Saving in % and MWh by industrial buildings of sector's companies, with NACE 2 codes

When studying the resulting ratio of savings per activities; and comparing it to the EU study, it must be concluded that the statistics of the CCFI tender does not reflect the indicators that are specified in the EU. The heat energy saving for heating of buildings dominates in the measures, the next significant indicator is energy savings in manufacturing processes. The authors may explain it by auditors' insufficient knowledge of crosscutting technologies, especially in ventilation, cooling and electric systems. The method of calculations for building envelope is known to auditors due to their experience in the sector of buildings, manufacturing processes and saving opportunities are frequently recommended by technologists of companies, however, the remaining savings from processes asks for the interrelation of specific knowledge in several engineering sectors beyond the competence of one professional.

EXAMPLES

SIA "Valmiera-Andren"

SIA "Valmiera-Andren" manufactures large-sized glass fibre containers, including custom design containers. Within the framework of the CCFI project, dismantling of the unused story, insulation of external walls and the roof, replacement of windows, doors and gates, reduction of the area of windows, installing of recuperation-based ventilation, and transfer of the fuel of hot water system from electricity to gas were performed in 2011. The heat energy saving calculated during the CCFI audit was ~40%. Actual heat energy savings according to first heating period monitoring data reach almost 60% saving, see Figure 8.

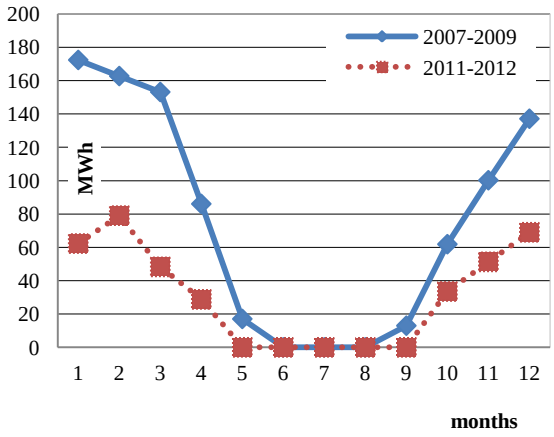

Figure 8. Changes in heat energy consumption in SIA "Valmiera-Andren"

AS "Dinex Latvia"

Metalworking company AS "Dinex Latvia" manufactures exhaust systems and filters for trucks. Within the framework of the CCFI project, insulation of external walls and the roof, replacement of windows, doors and gates, reduction of the area of windows, reconstruction of the ventilation system with air recirculation and improvements of the electrical network were performed in 2011. The heat energy saving calculated during the CCFI audit was ~40%. Actual heat energy savings according to first heating period monitoring data are doubled and reach almost 90% saving, see Figure 9.

CALCULATION OF THE IMPACT OF SAVING AND INVESTMENTS ON HEAT AND ELECTRICITY CONSUMPTION OF INDUSTRY SECTORS AND LATVIA

The companies studied in the CCFI program make 1.6% from the total industry consumption before the implementation of measures, and the planned calculated saving is 0.24%. A higher saving percentage (0.37%) is planned for electricity, it also provides other positive forecasts: larger reduction of CO2 emissions and shorter payback periods due to electricity tariffs.

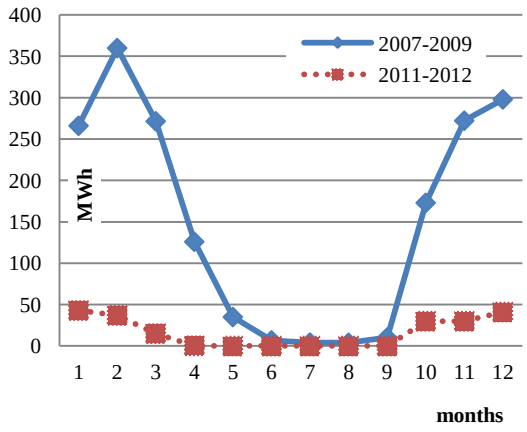

Figure 9. Changes in heat energy consumption in SIA "Dinex Latvia"

Table 2

Calculation of saving

Total saving	Saving in MWh	Average tariff (excl. VAT) in 2011, Ls/kWh	Cost saving, Ls
Electricity, 27% from CCFI's total	6 184	0.073	451 420
Heat energy, 73% from CCFI's total	16 585	0.035	580 490
Total CCFI saving, 100%	22 769		1 031 910
Total investments, Ls		10 675 025	
Total payback period without state support, years		10.3	
Payback period with state support (on average >50%), years		4.3	

Table 3

Calculation of investments

	Consumption in industries LR 2011	Saving in CCFI	% from LR
Electricity, MWh	1 674 720	6 184	0.37%
Heat energy, MWH	7 943 290	16 585	0.21%
Total	9 618 010	22 769	0.24%

CONCLUSIONS AND RECOMMENDATIONS

The companies that have received CCFI support do not fully reflect all sectors, because their total energy consumption before the measures makes 1.6% of the total consumption of the industry, while, for example, companies of the ETS system together make 40% of the total consumption. However, the structure of CCFI sectors sufficiently illustrates the companies representing the leading industry sectors of LR in food, chemical products and metalworking sectors.

The saving of energy resources by types corresponds to the power supply structure of companies; the most highly ranked savings are provided by: **central heating, natural gas, electricity, wood (biomass).** 27% of the forecast saving are formed by electricity reduction, the other part consists of heat energy.

If we compare the ratio of energy costs of companies and the saving potential with available EU and OECD data, a lower percentage of energy costs is stated in companies, however, the potential energy saving significantly exceeds the average value of EU and OECD sectors. As a result, the impact of energy efficiency measures on financial indicators of companies is evaluated as a significant factor. When comparing the resulting ratios of energy efficiency measures with the EU study, the statistics of the CCFI tender does not depict the indicators specified by the EU: first, crosscutting electric energy and manufacturing processes, then heat savings. The heat energy saving for heating of buildings dominates in CCFI measures, the next significant indicator are energy savings in manufacturing processes. The authors may explain it by auditors' insufficient knowledge of crosscutting technologies, especially in ventilation, cooling and electric systems. The method of calculations for building envelope is known to auditors due to their experience in the sector of buildings; manufacturing processes and saving opportunities are frequently recommended by technologists of companies, however, the remaining savings from processes asks for the interrelation of specific knowledge in several engineering sectors beyond the competence of one professional.

Therefore, recommendations for crosscutting technologies and payback periods in manufacturing sectors require more analysis. It is not simple to analyze due to data confidentiality issues, as well as because accurate information is required on energy efficiency technologies, energy saving and tariffs; up to now, Latvia has paid much greater attention to heat energy audits and economy, but methods of electricity savings, that are very important for manufacturers, require a more detailed study in the future.

When analyzing whether the number of energy efficiency measures in the company correlates with the saving ratio (%) in total consumption and in megawatt-hours, no mutual relation is stated, i.e. – large energy savings in the percentage may be forecast only when only insulating buildings, while the largest economy in megawatt-hours may be achieved with individual measures in manufacturing equipment and heat recovery.

Although the analysis performed in this article is based on calculations and forecasts, examples with monitoring data of two companies provide evidence that the forecasts may be achieved and significantly exceeded.

The companies studied in the CCFI program make 1.6% from the total industry consumption before the implementation of measures, and the planned calculated saving is 0.24%. A higher saving ratio is planned for electricity, it also provides other

positive forecasts: larger reduction of CO_2 emissions and shorter payback periods due to electricity tariffs. Energy efficiency in industries needs more studies, especially in terms of utility solutions and investment payback periods. A more detailed statistics by sectors is required; surveys of companies that have not received state support and ETS companies would provide more information about energy efficiency possibilities.

Due to the fact that the companies that have received CCFI support submit monitoring data on the first year of operation till 31 January 2013, the analysis of actual savings must be performed within the framework of another study.

Research limits. The companies implementing energy efficiency measures without state support and the companies operating in the ETS (European Union Emissions trading scheme) system are not included; market influence, energy price increase dynamics, energy efficiency incentives and disincentives, availability of funding, benchmarks, CO_2 saving and other factors included in other studies and report are not analyzed.

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Statistical classification of economic activities in the European Community (*NACE* rev.2)) codes.