KA 385

INCREASING THE COMPETITIVENESS OF SMEs THROUGH ENERGY EFFICIENCY

WP1
Comparative analysis on competitiveness

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Executive summary

This report constitutes the first work package of the Project KA 385 for increasing the energy efficiency in small and medium-sized enterprises. As the aim of this project is to increase and implement energy efficiency in SMEs, the boundaries as well as a common background for the overall project is necessary. In this first work package, the work consisted at setting up the boundaries for implementing energy efficiency in small and medium-sized enterprises in the region of Karelia, located in North-West Russia, and the Northern Ostrobothnia region in Finland.

This report investigated the present day situation of the relationship between the SMEs and energy efficiency. It showed that both regions are relatively similar in terms of SMEs with a similar amount of SMEs. Karelia presents a majority of single entrepreneurs representing more than half of the overall SMEs in the region.

The standardisation and legislation framing the energy efficiency action in both regions revealed a heavy process in both cases. The Finnish framework for implementing energy efficiency in SMEs and farms beneficiate of an experience over 15 years of energy audit and energy efficiency agreement experience, which made it efficient over time but may be improved for the audit process. The Russian energy efficiency action plan is rather new and accounts multiple steps and administration bureau that make it challenging for a SME to get involved. Secondly, in Russia the tendering process for being granted the subsidies may turn SMEs to be more reluctant for getting involved in such process. Energy management is described in the international standard while the energy audit processes are described in the European/National standards.

A comparative analysis guideline is given in the end where the choice of the unit for an inter-country comparison is to be carefully chosen especially when economic factors are used.

Disseminating the knowledge and sharing best practices comes by showing the number of audits carried out in Northern Ostrobothnia and the most common energy efficient measures implemented with their respective payback period. A payback period of 2 to 5 years is a common figure that occurred.

Contents

1 Present-day situation

The definition of Small and Medium-sized Enterprise (SME) differs from Finland and Russia, thus Table 1 summarizes the requirements in terms of employees and turnover to achieve in order to verify which firm can be consider as an SME and which cannot. The main difference for small-sized enterprises lay in the number of employees, and for the medium-sized company in the turnover.

Table 1. Definition of SMEs in Finland and Russia.

Company category	Employees AND		Turnover		OR Balance sheet total
	Finland	*Russia*	*Finland*	*Russia*	*Finland*
Medium-sized	< 250	< 250	≤ € 50 m	≤ 1 000 m RBL (≈ € 24.5 m)	≤ € 43 m
Small	< 50	< 100	≤ € 10 m	≤ 400 m RBL (≈ € 9.8 m)	≤ € 10 m
Micro	< 10	< 15	≤ € 2 m	≤ 60 m RBL (≈ € 1.5 m)	≤ € 2 m

1.1 SMEs in Karelia and Northern Ostrobothnia

A quantitative comparison of the segmentation in SMEs has been carried out for Finland and Russia. Regarding Finland, very detailed information is provided by the Eurostat website that highlights the different segments down to three categories. In 2010 the European statistics accounted 229 974 registered SMEs in Finland, representing over 99 % of the entire company park, split into four categories: Industry, Construction, Services, and Trade. However, the Finnish statistics totalised 321 607 SMEs[1] for the whole Finland as broader categories are taken into account such as agricultural activities, educational institution, insurance companies, and health services. The main difference lays in the consideration of the agriculture that adds up over 56 168 SMEs to the European statistics, and education around 3 040. Following the segmentation defined in the Finnish statistics, in 2011 Northern Ostrobothnia accounts around 22 463[2] SMEs thus representing approximately 7 % of the total number of SMEs in Finland (Figure 1 and Figure 2) for a total population of 397 887 inhabitants[3]. Similarly, assuming that the segmentation in Northern Ostrobothnia and in the entire Finland is somewhat similar, the employment rate of SMEs in Northern Ostrobothnia represents 65.8 % of the total employment rate in the region with 61 986 personnel out of the 94 132 employed persons.

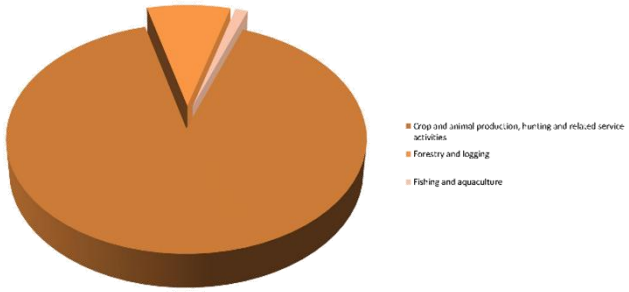


Figure 1. Number of SMEs in the agricultural sector, Northern Ostrobothnia.

[1] Statistics on the number of enterprises and employees for Finland. http://www.webcitation.org/6Gkc7k3vC
[2] Statistics on the number of enterprises per region in Finland. http://www.webcitation.org/6GkcB3r5X
[3] Statistic Finland database for the population in the Northern Ostrobothnia region http://193.166.171.75/database/StatFin/vrm/perh/perh_en.asp

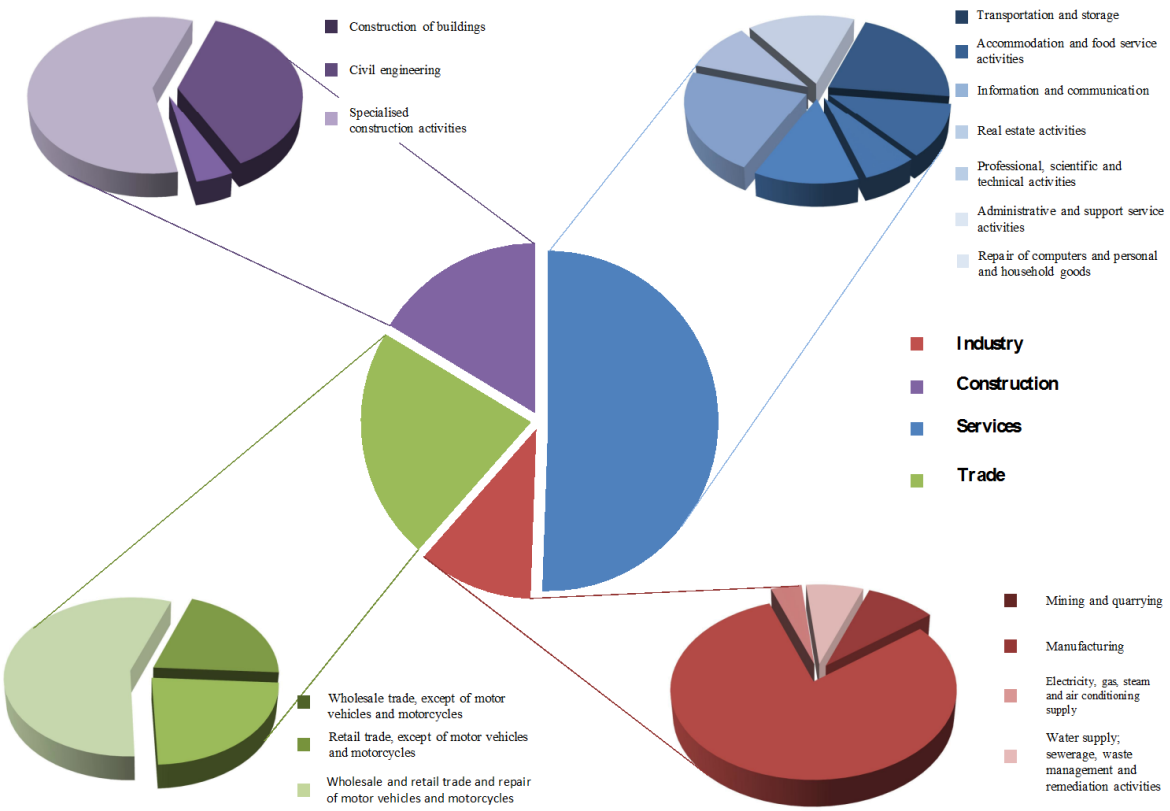


Figure 2. Number of SME per business segment in Northern Ostrobothnia. Agriculture is taken apart the regular SME framework as it is classified in a separate category in the statistics. (Eurostat, 2013)

The Republic of Karelia in Russia accounts 21 061 registered SMEs for a population of approximately 643 548 people in 2012. Over 11 900 out of the total number of SMEs in Karelia are registered as single entrepreneurship. The remaining companies are spread into Industry (4.5 %), Construction (4.5 %), and Agriculture (0.8 %).

Table 2. Sectorial activities for SMEs in Karelia and Northern Ostrobothnia.

Sector	**Number of enterprises**	**Percentage of all**	**Number of enterprises**	**Percentage of all**
	Northern Ostrobothnia		*Karelia (RosStat 2012)*	
Services	7657	34%	1618	7.7%
Industry	1657	7%	955	4.5%
Trade	3358	15%	3381	16.1%
Construction	2476	11%	945	4.5%
Agriculture	4898	22%	176	0.8%
Education	179	1%		
Financial and insurance activities	376	2%		
Arts and recreation	277	1%		
Transportation and Communication			669	3.2%
Individual Entrepreneurs			11900	56.5%
Unknown			1417	6.7%

(*) Data take into account companies registered since 2009.

1.2 Energy Consumption in SMEs

Energy consumption in Finnish SMEs is not presented in this report since no information is freely available. However, it is to be noted that anonymous data results of energy consumption levels of SMEs having done the energy audit and/or joined the energy efficiency agreement system located in Northern Ostrobothnia could be retrieved for statistical purposes. A request has been sent to Motiva Oy that has positively replied but data so far has not arrived.

Regarding the energy consumption of SMEs in Karelia, it seems that data are not available at all and only general sectorial figures for the entire federation is available. However, Karelia Energia and the recent Russian Energy Agency are collecting all the energy passports emitted after the energy audit process.

2 Energy Audit Framework

In one of the first steps for enabling energy efficiency action plans (EEAP) a SME goes through the energy audit system. Energy audits are categorised depending on the degree of details in which the audit is being carried out. The state of the art for energy auditing described in the literature divides it in three parts in which the first step covers economic analysis of the energy consumption, the second looks into an energy analysis for a specific spot of energy consumption, and the third one examines in detail the energy flow for the abovementioned spot. Energy audits result in an EEAP that will trigger the implementation of energy efficiency measures for reducing the energy consumption and/or optimising the energy flow.

Energy audits are defined at different levels – regulation, standards and guidelines – in which definitions and requirements may slightly differ but are coming from a very general view to a more country specific requirements. In this section, the energy audit in the regulation and standards for Europe, Finland and Russia will be highlighted. Secondly, the details of the recommended steps for organising audits are listed including the national guidelines methodology to be used in every-day life.

2.1 Energy audits in the regulation

Increasing the energy efficiency in general requires defining the starting point by which energy efficiency can be performed. Energy audits represent the base for implementing energy efficiency in SMEs as it highlights the current state of energy consumption and allows setting up targets for reducing the energy consumption. There are different ways for implementing such measures, either through the implementation of technical standards used by the industries or through legislation. Considering the structure of the European Union, the following sections will investigate the implementation of energy audits in the European and Finnish legislation. International standards will be investigated, as they are usable in both countries, as well as National standards.

2.1.1 Europe

The European Union enforced energy audit in the regulation in 2006 through the Directive 2006/32/EC for "*Energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC*" in its Article 12. Although the European Directive does not make mandatory the performance of energy audits in SMEs, it clearly states that Members States (MS) must provide high-quality energy audit framework to SMEs. In parallel, MS shall frame the energy audit into an energy efficiency improvement programme, which would promote and encourage SMEs to undertake an energy audit. The directive highlights the different type of energy efficiency measures that can be implemented in the different sectors or residential/tertiary, industrial and transportation sectors. Finally, the Directive set the guidelines for calculation methodology of energy saving due to implementation of energy efficiency measures, considering the variable part that is the occupation, weather, opening-hours, production levels, and relationship to the other units (Directive Annex IV). Also, it introduces two types of calculation, a top-down calculation method that is used for evaluating the overall energy savings at the country level that is split up afterwards by sectors, and a bottom-up calculation that shall evaluate the efficacy of an energy efficiency measure. It stresses the fact of uncertainties in measurement and in calculation that should not be omitted when reporting an energy audit for instance. The Directive 2006/32/EC still applies for national legislation but will be gradually replaced by the new Directive 2012/27/EU.

The Directive 2012/27/EU on "*Energy Efficiency*" is an extended evolution of the Directive 2006/32/EC in which several articles are translated in the new directive. However, the 2012/27/EU Directive has introduced a whole article on implementing energy efficiency in SMEs. First of all, the role of the auditor is clearly defined and shall be qualified and/or accredited. On top of the existing financial support that should promote energy efficiency in SMEs, concrete examples of how energy efficiency measures are implemented and an exchange of best practices between SMEs shall be supported by MS. The new directive encourages each MS to develop their methodology for performing an energy audit and shall be presented by the 5th of December 2013. Finally, the energy audit shall highlight clearly the long-term savings and not only the short-term savings. Although energy auditing is not mandatory for SMEs, it is recommended that the energy auditing shall be performed every four years for non-SMEs.

As European Directives cannot be directly transposed into national legislation but stands for giving away guidelines to MS, every country needs to transpose the Directives into their regulations. Thus, Finland has been involved into the process of adapting the European Directives on energy efficiency into the Finnish legislation.

2.1.2 Finland

In order to promote energy saving Finland compiled separate programs for energy saving and energy efficiency in 1992, 1995, 2000, and 2002. In 2005 the energy saving and energy efficiency measures were integrated as part of the report on climate and energy policy given by the Council of State to the Parliament. The Ministry of Trade and Industry began subsidizing energy audits for service buildings, industrial and power plants in 1992. The actual energy audit program was launched in 1994. Within the program framework, over 7300 energy audits have been carried out since 1992. The practical organization of the auditing program has been Motiva's responsibility already since 1993. Motiva's duties include promoting, developing, and follow-up of auditing operations alongside with training energy auditors and quality assurance of the audits. (The State of Finland 2011)

In Finland Energy Efficiency Agreements (EEAs) are the primary means to implement and fulfil the requirements of the Directive 2006/32/EC in industry and commerce, which include SME's. Excluding energy industry, there is no actual legislation concerning EEAs. In the beginning of 2011 over 50% of Finland's energy end-consumption was in the framework of EEAs.(Pekkarinen 2010; TEM 2013c)

Attendance in an EEA is voluntary for an enterprise. After joining the EEA the enterprise is obliged to continuously improve its energy efficiency and promote renewable energy. Within two years after joining the EEA the enterprise must have defined the energy saving potential and set a timetable and targets for the recognized energy efficiency measures. These measures can be determined for example by conducting an energy audit. Audits are supported with subsidies by the Finnish Government. (Motiva 2010; Pekkarinen 2010)

The Energy Efficiency Directive (2012/27/EC) came into force in December 4th 2012. It replaces Directives 2006/32/EC and 2004/8/EC. The legislation provided by the Directive 2012/27/EC has to be put into force by June 5th 2014 at the latest. In Finland the Ministry of Employment and the Economy (TEM) has appointed a work group to prepare the implementation of the Directive 2012/27/EC. (TEM 2012)

2.1.3 Russia

The Russian Federation has developed a set of legislative documents for implementing energy efficiency in the industry. In 2009, the Russian Federation has developed the *Energy Saving and Energy Efficiency Improvement Plan* that has been applied at the regional level with the *Regional Programme on Energy Savings and Energy Efficiency for the period up to 2020* by the Government of the Republic of Karelia[4]. The regional development plan gives priorities to projects having a fast payback period with significant energy savings. These energy action plans form the base for enhancing energy efficiency in SMEs as they are seen as an important factor for reducing unemployment. Thus, the Republic of Karelia gives recommendations, in their energy programme, to SMEs[5] for increasing their energy efficiency starting with upgrading the pumps used, implementing control systems for an automatized heat control, improving the insulation and to develop the energy recovery systems. A specific part is dedicated to the agricultural sector in which the uses of CHP units are promoted. The regional legislation for improving energy efficiency in SMEs is included in the resource management in general which include the water usage. Specific targets and short description of the auditing process is available. The definition of short and long term investments for SMEs is defined in this regional legislation, long-term investment being defined as having a payback time over 5 years and low cost measure from 1 to 2 years payback period.

Similarly to the European legislation, energy audits are mandatory to public institutions and large industries, whereas SMEs may carry out the audit on a voluntary basis.

The federal legislation, N 261-ФЗ on energy savings and energy efficiency[6], set up the frame implementing the energy efficiency action plan. Apart from the large industries that consume a lot of energy, energy audits are mandatory for public institutions (state or municipal), and production and/or transportation of e.g. water, gas, heat, electricity, oil, coal companies, which might include SMEs involve in this business. For all the other entities, carrying out an energy audit is thus voluntary. However, for each energy audit (mandatory and voluntary), an energy certificate or energy passport is issued.

The national action plan has been renewed in April 2013 that set new target for Russian's energy consumption and CO_2 emissions. The new energy efficiency programme 2013-2020 for SMEs strongly recommends taking the energy audit in which a specific programme will be dedicated for SMEs. The dissemination will be carried out by the business incubators throughout the Russian Federation and by the educational institutions.

The order N 634[7] approved by the President regarding the subsidies covers seven different fields that help to enhance energy efficiency in SMEs: Employees' training up to 0.5 m Руб (≈ 12300 €), Energy audits up to 1.5 m Руб (≈ 37 000 €), energy management system implementation including also the ISO 50001 certification up to 0.5 m Руб, implementing energy efficient measures up to 3 m Руб (≈ 74 000 €), lease or loan repayment to credits

[4] Regional Programme on energy saving and Energy efficiency for the period up to 2020 in Karelia (N 156-P): http://www.gov.karelia.ru/gov/Legislation/lawbase.html?lid=5421

[5] Package to reduce energy costs in small and medium-sized business (Order 219) http://www.gov.karelia.ru/Legislation/lawbase.html?lid=5232

[6] http://base.consultant.ru/cons/cgi/online.cgi?req=doc;base=LAW;n=132068

[7] *Recommendations for the coordination of programs implemented by state support of small and medium business, to promote self-employed unemployed citizens support. Small farms in rural areas and to support innovative business forms.*

organizations for implementing or modernizing energy efficient measures up to 3 m Руб. In average, it is considered that the energy audit is subsidized at 50%.

Finally, the Russian Federation has developed a financial legislation[8] that allows cutting off the taxes of purchased material for improving energy efficiency (N 132- ФЗ).

2.2 Energy audit standardisation

Energy audits has been standardised within the International Standardisation Organisation (ISO) and the European Committee for Standardisation (CEN) bodies. The ISO organisation is recognised in most of the countries across the world, including Russia and Finland. Standardising the energy audit system allows companies to benefit from the best practices spread around the different industries. Due to geographical and economic constraints, more specific standards are being developed in Europe and/or Russia. European Standards are commonly ruled by three organisations that handle different types of standards either separately or in joint working groups. The European Committee for Electrotechnical Standardisation (CENELEC) is focusing its activity into electric and electronic matters e.g. safety, products, transmissions; European Telecommunication Standards Institute (ETSI) has centralised its standards towards telecommunication, and the CEN is handling all other matters. Standards are crucial when uniform methodologies need to be implemented throughout different countries, business structures and so on. Standards are made by companies, for companies to level up the quality of their business. In this section, the International standard (ISO) for energy audit will be highlighted. Then, going from top-to-bottom, the European standards that cover the energy auditing process will be explored. Finally, the Russian standards for energy audit are explained in order to understand the correlations and differences in methodology.

2.2.1 International standard

Implementing energy efficiency measures has been developed in the International Standard ISO 50001:2011 on Energy Management Systems. The International standard targets the implementation of energy management system within an entity. Thus, one of the first steps for implementing an energy management system is to set up the frame for energy policy within the entity by defining the line that the entity wants to follow. The energy policy set up for the energy management system may set energy consumption targets as well as a personal commitment for reaching the target. Once the foundations are set up, the energy planning process takes the relay for planning the energy policy target set in the energy policy goals of the organization. In this matter, energy planning aims at framing the implementation of energy measures by identifying the weak points in the energy use, and the leading factors that contributes to the energy consumption of the firm. In this process, baseline energy consumption must be set for comparison purposes and implementation measures are carried out. The measures' effectiveness needs to be checked while auditing the firm. The effectiveness is compared with the baseline energy consumption value set in the energy implementation process that represents the checking process. Finally, once the energy audit has given its results, the energy management review highlights the possible changes in the energy policy of the firm to be undertaken or the corrective measures that needs to be implemented in order to keep the target set in the original energy policy plan set by the firm.

[8] Amendment in article 95 of the first, and second part of the tax code the Russian Federation in formation of enabling tax environment for innovation, and article 5 federal law on amendments to the second part tax code of the Russian Federation and separate Acts of the Russian Federation http://base.consultant.ru/cons/cgi/online.cgi?req=doc;base=LAW;n=114836

Although the standards does not explicit the methodology for implementing an energy management system in a firm, it highlights the main steps through which any management system needs to go through in order to have a complete quality system. Energy audit is part of the energy management system and thus needs to be highlighted in a different standard at a national level.

2.2.2 European standards

The European Standard suite of the EN 16247 has been developed jointly by CEN and CENELEC as a response to the European directive 2006/32/EC. The EN 16247 standard is broken down into four parts where each of them addresses energy audit matters for different businesses. The first part (EN 16247-1) is highlighting the general requirements for any types of energy auditing processes, including the different steps to carry out during an energy audit, from the pre-audit to the reporting of the energy inspection. The first part of the standard has been released in mid-2012. The three other parts (EN 16247-2, -3, and -4) shall be published by mid-2014 and will address specifically the energy audit in buildings, processes, and transportation respectively.

The general requirements of this standard build up the framework for implementing energy audit in any industry. Most of the standard is based on the recommendation set up in the international standard ISO 50001:2011, but are specifically drawn for energy audit. The European standard EN 16247-1:2012 explains the main step and the quality system that has to be put in place for carrying out a good energy audit. The main steps can be broken into four different stages: pre-audit process, data collection, energy analysis, and reporting.

The pre-audit process consists on defining the boundary of the energy audit and the purpose of carrying out this energy audit in the context for this industry by considering the human resource management, the size of the company. It will prioritize the data to be collected by considering safety and security issue. The data collection process consists on defining the energy spots for the different energy end use (e.g. heating, lighting, process, and electricity) in the audited area with their corresponding energy consumption, defining the current energy management system, collecting the economic data over a defined period, and evaluating the viability of the measurement systems. After the data have been collected, the energy analysis shall highlight the points where improvements can be done, first by breaking down the energy consumption, by carrying out a financial analysis of possible energy efficiency measures, their cost, payback period, and non-energy gain e.g. time saved in a process. The reporting represents the last step of the energy audit process in which a summary of the actions to be undertaken is listed. It considers different matters such as difficulties met while auditing, calculation and simulation results, financial report, and improvement made on the process or on the building.

2.2.3 Russian Standard

The Russian Federation has developed a consequent number of standards dedicated to the energy audits and has got several standards dedicated to the calibration of instruments, quality controls, measurement procedure (GOST R - 8.563-96). The energy audit standards are not mandatory per se as each Self-Regulatory Organization (SRO) can develop their methodology for auditing that has been approved by the Ministry of Energy, but the Russian standards represent guidelines to follow if necessary. For instance, the GOST R – 51749-2001 is looking at the definitions of the energy consuming equipment in industry with their energy efficiency indicators, while the GOST 51541-99 is focusing only on energy efficiency

indicators and the harmonisation of the different indicators throughout the standards on energy efficiency.

The GOST 51387-99 is highlighting the regulatory and methodological support for energy audits.

On top of the standardization body, the ministries publish guidelines for carrying out energy audits in different energy sectors such as the coal industry (УДК 22:658.26[9]) in which six stages are described and that is specifically dedicated to this industry.

2.3 Audit Methodologies in Finnish SMEs

Audit methodologies in Finland are tailored for different company sizes in terms of employees, building volumes, and annual energy costs. The following chapters describe different elements of which an audit project consists of. Also different types of audit models and their suitability are considered. A more thorough description of an industrial energy audit by Motiva can be found from Annex 1.

2.3.1 Responsible parties in energy auditing

The four centrally involved parties in energy auditing in Finland are Ministry of Employment and the Economy (TEM), Motiva, energy inspectors, and buyers of the audits. The TEM has the main responsibility of the energy auditing activities. TEM also provides main guidelines for energy auditing. Granting the subsidies is responsibility of the regional Centers for Economic Development, Transport, and the Environment (ELY-keskus). (Motiva 2009; TEM 2013a)

Appointed by the TEM, Motiva is in charge of coordinating the energy audit activities. Motiva's duties in auditing activities are monitoring, development, quality verification, training and guiding of inspectors, and advising auditing subsidy claimants. Motiva also provides execution and reporting instructions for energy auditing processes. (TEM 2013a; Motiva 2009)

The energy inspector is responsible for executing the actual energy audit. To each project two Motiva certified energy inspectors (persons in charge of the audit) have to be appointed and they are responsible of the auditing work and following instructions. The inspectors can use the Handbook for Energy Inspectors, which is the third level of guidance after TEM and Motiva. The handbook describes good auditing practices and gives also instructions for conducting the actual auditing. (TEM 2013a)

The buyer of the audit answers for ordering the energy audit, applying the energy subsidy, and being compliance with the instructions and obligations given by the energy department of the TEM. (TEM 2013a)

2.3.2 Financial support

On the legal foundation according to Act (1063/2012) by the Council of State the TEM supports energy audits of service buildings, industrial objects, and subjects in energy industry. The subsidy is targeted at the total cost of the energy audit, which consists of labour expenditure, travel expenses, and rent of measuring devices with certain preconditions. In

[9] On Technique for conducting energy audits in enterprises and organizations of the coal industry http://www.webcitation.org/6Gkbkohes

2013 the maximum subsidy as a rule is 40%. For municipalities, federations of municipalities, and micro, small, and medium-sized enterprises the maximum subsidy, however, is 50% of the supported audit costs. The process of applying for the energy subsidy for the energy audit from SME point of view is described in Figure 3. (TEM 2013b)

After the audit another subsidy can be applied for executing the energy saving measures found in the auditing process. In investment subsidies weight is put in the implementation of new technologies and the subsidy at maximum can be 40%. New technology in this case means such technological or other solutions which have not earlier been implemented in larger commercial scale in Finland. The amount of subsidy is defined separately for each project. In practise the subsidy for new technology is most often between 25-35% and it concerns only the share of the project which includes new technology. The support for low technology share of the project is lower and is subsidized according to subsidy for low technology. (Motiva 2013)

Enterprises or offices that have joined an Energy Efficiency Agreement can receive investment subsidies also for realizing low technology saving measures on grounds of case-specific consideration. This subsidy is 20% at the most (Motiva 2013).

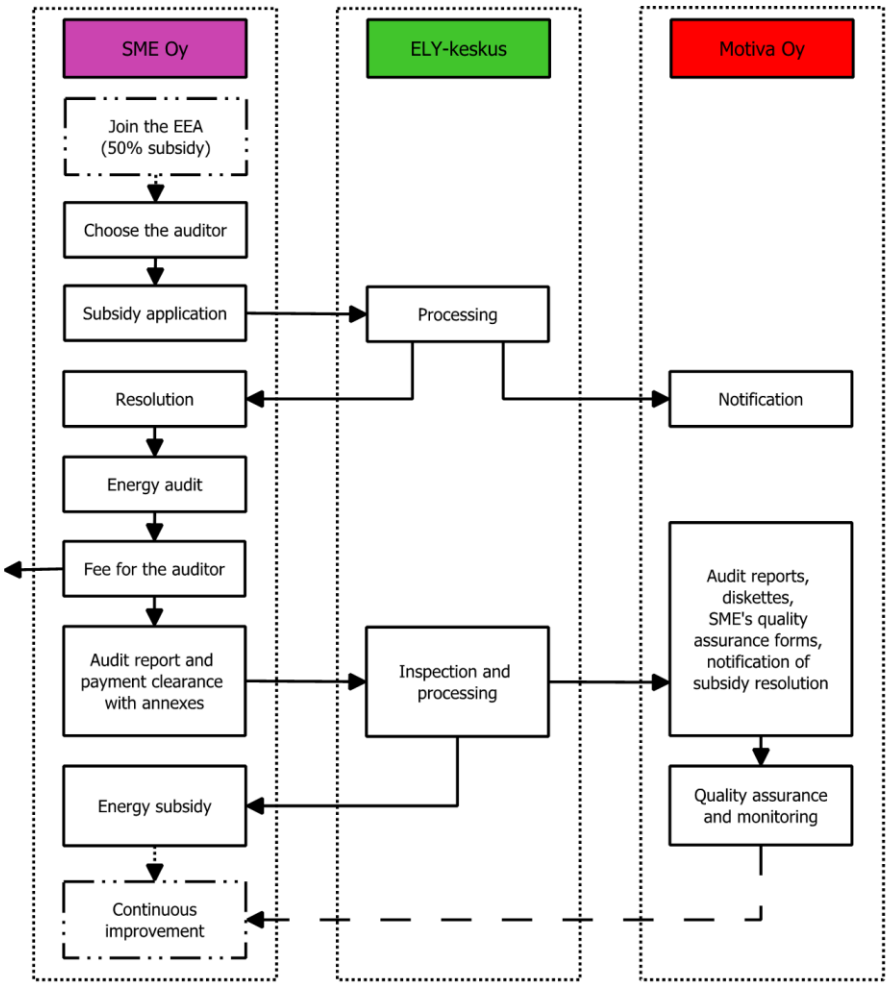


Figure 3. Energy subsidy for energy audit from SME point of view. (TEM 2013b)

2.3.3 Energy audit models in Finland

The chosen audit model is case-specific and is based on building type, volume, and energy costs. For example, audit model for property can be used (e.g. Building Energy Inspection) if the enterprise energy usage is low. Audit models subsidized by the TEM in 2013 are (TEM 2013a):

- Service buildings
    - Building Energy Inspection
    - Building Energy Audit
    - Follow-up Energy Audit
    - Post-acceptance Audit
- Industrial objects
    - Industrial Energy Audit
    - Industrial Energy Analysis
    - Process Industry Energy Analysis
- Energy industry
    - District Heating Energy Audit
    - Power Plant Energy Analysis.

For service and industry sectors the suitable audit model can be chosen according to following tables (Table 3 and Table 4):

Table 3. Suitable audit models for service sector. (TEM 2013a)

Building volume (m^3)	Building Energy Inspection	Building Energy Audit
< 5 000	X	
5 000 - 10 000	X	X
> 10 000		X

Table 4. Suitable audit models for industry. (TEM 2013a)

Cost of energy and water excl. VAT (€/a)	Building energy inspection	Industrial energy audit	Industrial energy analysis	Process industry energy analysis
< 15 000	X			
15 000 - 55 000	X	X		
55 000 - 1 400 000		X	X	
1 400 000 - 3 000 000			X	
> 3 000 000			X	X

2.3.4 Industrial energy audit models

2.3.4.1 Industrial Energy Audit

The Industrial Energy Audit is an auditing model for such industrial facilities where the examination of energy usage and efficiency is not considered to be reasonable. Reason for this can be for example recently renewed process with ensured energy efficiency or small process energy costs. In that case the energy consumption of the production processes is examined only in such extent that they can be presented in distribution of total consumption. The target of the Industrial Energy Audit is to examine energy saving possibilities of all process related commodities, building services, and structures. (Motiva 2009)

2.3.4.2 Industrial Energy Analysis

In the Industrial Energy Analysis all the primary and secondary energy flows as well as the energy saving possibilities of the facility are examined. In energy analysis the production

processes are in a central role and thus the participation of facility's own production and maintenance organizations in the auditing is usually necessary. (Motiva 2009)

2.3.4.3 Process Industry Energy Analysis

The Process Industry Energy Analysis for energy-intensive process industry is a two-phase audit model modified from the Industrial Energy Analysis. The focus is in mapping of the energy saving possibilities of the production processes. In addition, the energy saving possibilities in facility service systems and building systems are determined. (Motiva 2009)

2.3.4.4 Tasks in energy auditing process in Finland

In Finland an energy audit project consists of ten steps. (TEM 2013a)

1. Choosing the inspector	- The buyer of the audit chooses the inspector according to the expertise, price, and other factors. - Nomination of two Motiva-certified persons put in charge of the project.
2. Energy subsidy application	- The buyer delivers the application to the ELY-keskus of the region. - Binding agreements are not to be made before the subsidy application has been made in ELY-keskus.
3. Start meeting	- The energy inspectors and the buyer agree on the schedule, details, and emphases.
4. Gathering preliminary information	- Based on the information collected by the buyer or the inspectors and buyer together, the inspectors will have an overview of the facility and its energy economy.
5. Field work and measurements	- The inspectors review heat, fuel, power, and water systems and equipment. - Buyer's representative and technical operators are interviewed. - Focus points of consumption and saving possibilities are found out through observations and measurements.
6. Analysis of saving possibilities	- On the basis of preliminary information and field work the inspectors analyze the level of energy usage and energy saving measures. - Energy saving measures can be for example improved operating techniques or changes that require investments.
7. Reporting	- The inspectors present results in an audit report according to Motiva guidelines. - The report should contain information on saving measures in such extent that the feasibility and profitability are clearly pointed out.
8. Report delivery session	- The inspectors present the auditing results and the action proposals to the buyer. In the session the further actions that are chosen are entered into the report. - The delivery session is also a good chance to educate the personnel. Especially if operating techniques can be improved, the inspectors need to go over them with the operating personnel.
9. Energy subsidy payment clearance	- After completing the audit project the buyer fills in the payment clearance in which the final funding and realized costs are presented. The payment clearance with enclosures is delivered to the ELY-keskus or to the TEM.
10. Realizing of measures and monitoring.	

2.3.4.5 Renewable energy sources in the energy auditing

In addition to energy cost savings the energy audits aim to decrease CO_2 emissions resulting from energy usage. The possibilities and profitability of renewable energy utilization has to be done in facilities where there is electric heating or fossil fuels are used in heat and/or power generation or in a process. If the facility is not consuming fuel and is connected to district heating system, the examination of renewables is usually not necessary. Options for renewable energy examinations are replacing fossil fuel (e.g. oil) with wood-based fuel (e.g. chips) and utilization of heat pumps in parallel or primary heat generation or in heat recovery. The profitability of heat pumps is always studied in facilities that have electric heating. Review on utilization of solar energy, biogas, and other renewables can be included in the energy audit if they are economically viable. (TEM 2013a)

3 Comparative analysis for implementing energy efficiency in SMEs

As the energy audit methodologies vary from country to country, it is a challenging work to compare not only the methodologies but also the recommendations that come out after the entire energy audit has been carried out. Indeed, not only the methodology used to evaluate the energy efficiency of a SME matters but also the results coming from it are highly dependent on the cost of energy within the country. Thus, although the energy efficiency audits measure the same variables, the conclusions may differ depending on the price of e.g. gas, crude oil, electricity, as it is related to the country studied. In order to establish an inter-comparison between the energy audit methodologies carried out in Finland and in Russia, a qualitative comparison has been carried out representing the differences between both methodologies. A quantitative analysis shall be carried out to figure out interconnections between the units and uncertainties used while auditing a facility in both countries.

3.1 A qualitative comparison

The first step of the comparative analysis consists on defining the way that leads to carrying out an energy audit in SMEs in Finland and Russia. Thus, the energy efficiency implementation process needs to be detailed in order to compare the easiness for promoting and make SMEs more energy efficient on the long run. Figure 4 is a graphical representation of the energy efficiency framework in Finland. The Finnish structure optimized the energy efficiency implementation for SMEs by having two interlocutors: one for the energy and one for the economic part.

The Centre for Economic Development, Transport and the Environment (ELY-Keskus) forms the link between the TEM and the SMEs for providing any kind of financial supports for the energy audit process or the implementation of energy efficiency measures. It is to be noted that the access to the subsidies is guaranteed for every participants who is part of the EEA and has already carried out either the audit and/or the energy efficiency measures within the structure. Motiva represents the only and single interlocutor for signing the agreement, then the whole process goes through with the ELY-Keskus that delivers the reports and necessary documents to Motiva. The Policy framework is set by one Act for the subsidies and the EEA.

The Russian process for implementing energy efficiency in SMEs is presented in Figure 5. The policy framework is rather complete and has a complicated structure as several legislative documents frame the energy efficiency action. The number of parties involved in the process of putting in place energy efficiency in SMEs is multiple. The main structure is represented by the regional office of the Ministry of Economic Development Karelia that is the local representative of the Federal Ministry of Economic Development.

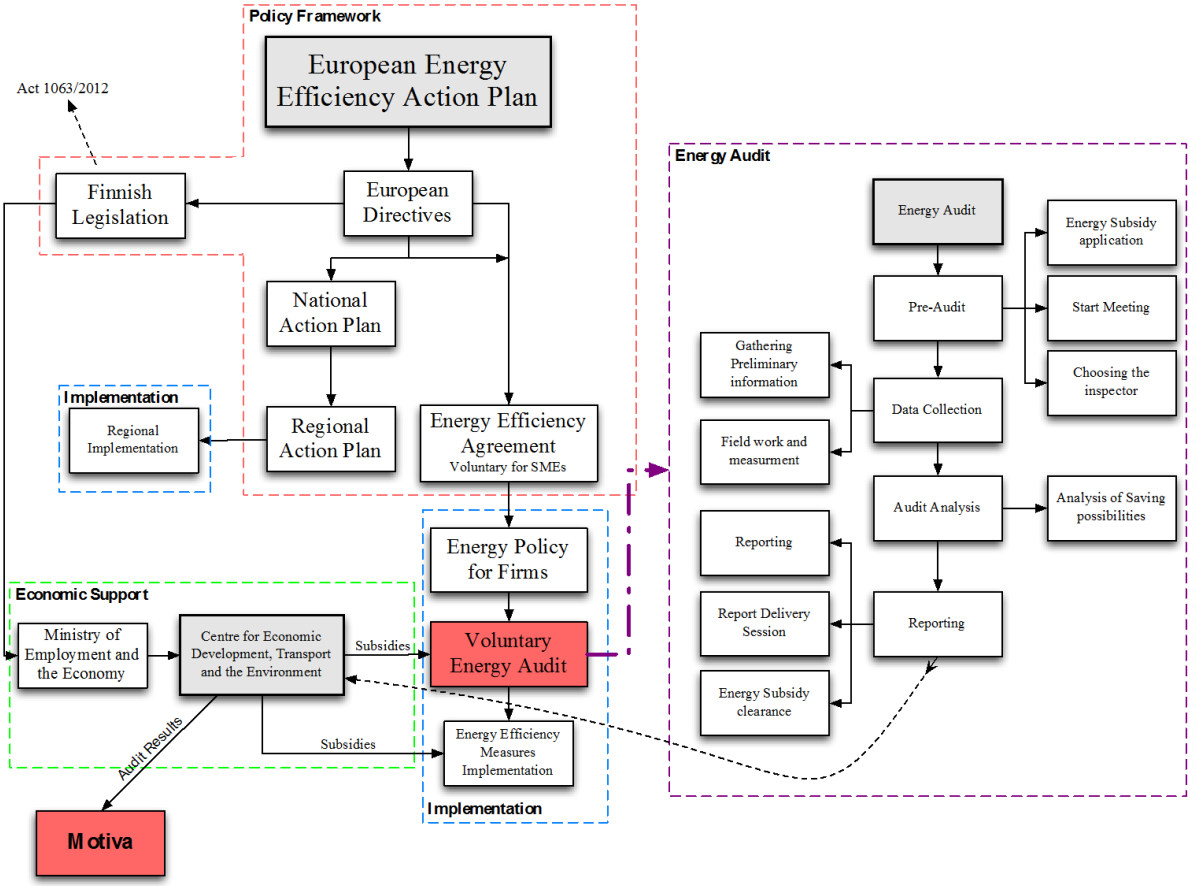


Figure 4. Energy efficiency implementation logic diagram comprising the energy audit process, Finland.

The Regional Ministry is in charge for distributing the subsidies at each level of the process as each step in the implementation of energy efficiency can be subsidised. One of the main differences that can be a brake for the implementation of energy efficiency measures in SMEs lays in the allocation of subsidies as they are given away only to the best applications, selected by the Regional office of the Ministry of Economic Development Karelia. Otherwise, the audit report is going through a set of institutions that collect the information from the audit (the Russian Energy Agency and Energy Karelia). Energy Karelia fulfils a similar role as Motiva in Finland as they are a public institution awarding the right for SROs' belonging companies to audit. Overall, there is one SRO in Karelia that comprises 37 energy inspectors (Ministry of Energy 2013). However, instead of having the report sent directly to the ministry for being granted the subsidies, the energy audit results (energy passport) needs to travel through the two institutions mentioned above, whereas Motiva does not interfere in the subsidy allocation process.

The Russian Federation has implemented a tax credit system that could contribute greatly to the implementation. However, it appears that each of the incentives requires an application that makes the overall process heavy for a SME with low amount of human resources.

The differences between both systems reveal a heavy system for implementing energy efficiency in SMEs, in which the Russian system shows a multi-step system that may slow down the overall process as well as the motivation for SMEs to integrate such system. The tendering system may not contribute positively either as there are no guarantees for subsidies being granted for implementing the energy efficiency measures.

3.1.1 Energy audit Comparison

A fundamental difference between both legislation lays in the definition of what is energy efficiency and what does it represent in Finland and in Russia. When Europe and by consequent Finland define energy efficiency as either a ratio of energy or a ratio of energy

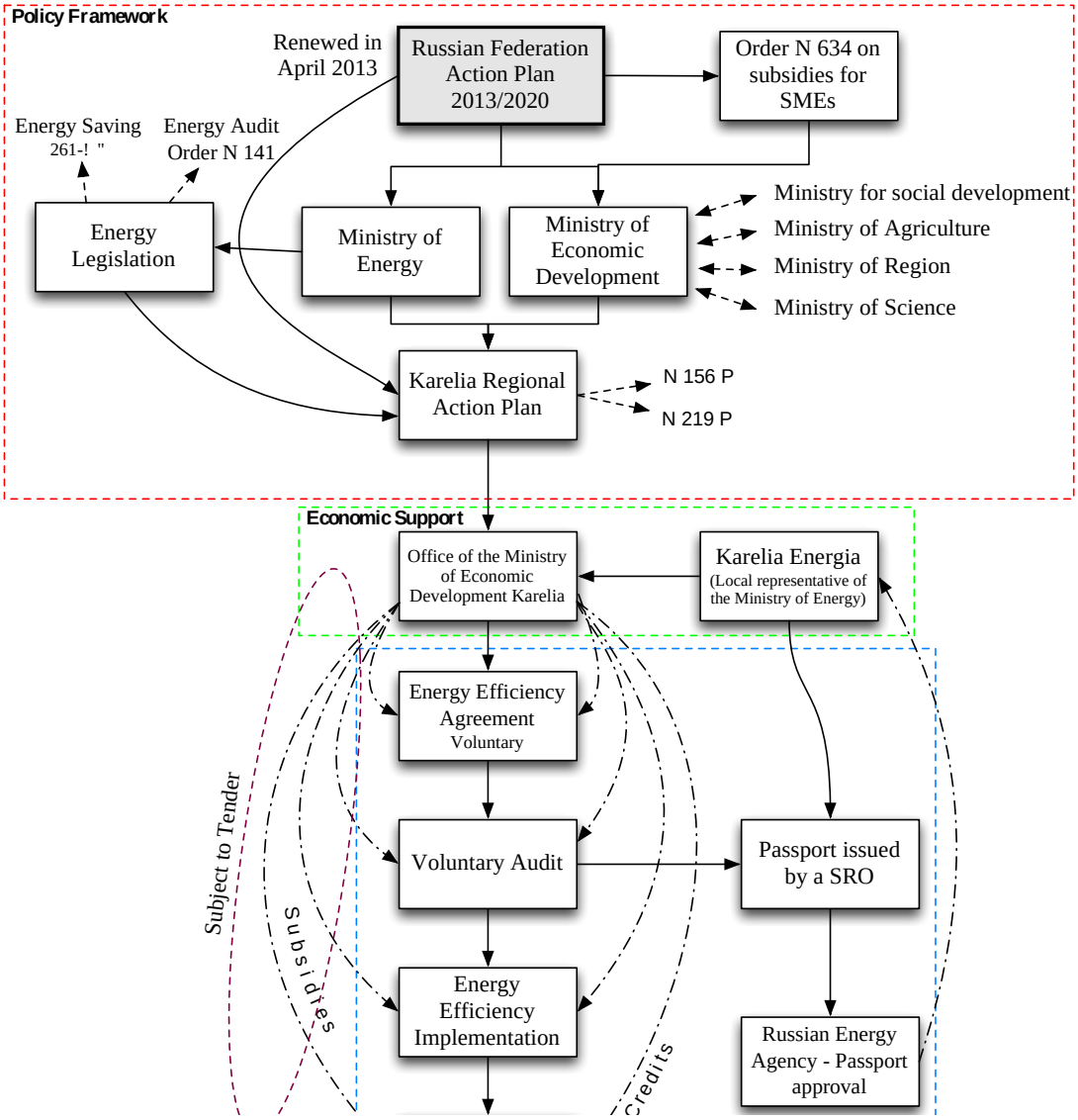
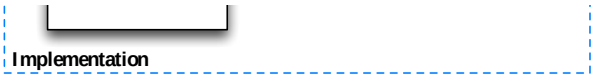


Figure 5. Energy efficiency implementation logic diagram, Russia.



with an action produced, the Russian Federation defines energy efficiency as an economic optimization of the energy chain. This difference of definition for energy efficiency affects directly the end result of implementing energy efficiency in SMEs as the target on one side is to reduce the energy consumption and on the other side to reduce the bill, which might be the same but not necessarily. Table 5 and Table 6 put in perspective the differences in the

legislation and the standardization for each country. The difference in the definition for energy efficiency can be noticed in the plan for implementing energy efficiency measures. The European Union considers long term payback period depending on the impact that such measure could have on the energy consumption. However, long term payback is not as well defined as opposed to the Russian Federal Law which sets the long term payback period at 5 years.

The auditing process is not detailed in the European legislation and neither in the Finnish legislation as the methodology is part of the EEA (Energy Efficiency Agreement) system that is used for transposing the Energy Service Directive in Finland. Thus, only general guidelines for the audit process can be found in the legislation. The Russian Federation has a very precise part of the legislation dedicated to the energy audit. The energy audit is not described in the Federal legislation but in the regional legislation.

Each of the standards and national methodology for energy audits are composed by four steps. However, the national methodology tends to be more detailed as they have to be addressed to expert auditors. The methodology steps are rather similar and offer a complete overview of the energy flow within a facility.

Table 5. Comparative analysis for energy audits applied to SMEs in the European and Russian legislation.

	Directive 2006/32/EC	Directive 2012/27/EU	Federal Russian Regulation
Definitions	**Energy Efficiency -** Ratio between an output of performance, service, goods or energy, to input of energy; **Energy Audit -** a systematic procedure to obtain adequate knowledge of the existing energy consumption profile of a building or group of buildings, of an industrial operation and/or installation or of a private or public service, identify and quantify cost-effective energy savings opportunities, and report the findings	**Energy Efficiency -** Ratio of output of performance, service, goods or energy, to input of energy; **Energy Audit -** a systematic procedure with the purpose of obtaining adequate knowledge of the existing energy consumption profile of a building or group of buildings, an industrial or commercial operation or installation or a private or public service, identifying and quantifying cost-effective energy savings opportunities, and reporting the findings	**Energy efficiency -** characteristics reflecting the ratio of the useful effect of the use of energy resources to the cost of energy produced in order to achieve this effect, with respect to products, processes, entity, individual entrepreneur; **Energy audit -** the collection and processing of information on the use of energy resources in order to obtain reliable information on the amount of used energy resources, energy efficiency indicators, identify opportunities for energy conservation and energy efficiency with the reflection of the results in the energy passport;
Auditor	Energy audit should be carried out by an independent body (Art. 12)	In-house auditor or external auditor (must be qualified and/or accredited expert) and must be independent authorities (Art. 8)	Art. 15 of the 216 FZ Members of the public institution in the field of energy audit
Audit for SMEs	Energy audit should be financially promoted by the energy efficiency programme (Art. 11)	(Art. 8) - Encouraging SMEs to carry out energy audit in SMEs - Financial Support for energy audits in SMEs - Concrete examples should be given to SMEs on how energy management can help their business -> exchanging best practices. - Energy audit may be stand alone or be part of a LCA assessment	(Art. 15) Energy audit Determine the energy efficiency levels and the potential for energy saving, energy audit are done on a voluntary basis unless stated. The energy audit should automatically lead to the issue of an energy passport that allows applying for subsidies. (Art 16.) Financing for SMEs **<u>Republic of Karelia Energy Action Plan N 156 P</u>**: Preparatory phase: Defines the SMEs' profile; Primary energy audit: Energy consumption data collection, technical; characteristics of the SME (machineries, age, process architecture, etc…), mapping the primary energy consumption flow diagram; Full energy audit: Additional data collection specific to a process, checking the measuring instruments; Monitoring: Organization for the monitoring of energy consumption for the next audit.; Definition of the long term, and low term cost measures for improving energy efficiency; Defines the different financial source for SMEs (for implementing the energy efficiency measures); Promote the education of the workers for energy saving → allowing education
	Annexes		
Energy Savings	- Describes the Top-Bottom and Bottom-up approach calculations to be used for evaluating the energy savings - Guidelines for measurement uncertainties	- Each country develop their methodology and a detailed methodology should be presented by **December 2013, 5th** by the MS (Annex V part 4) - Uncertainty is not managed anymore (Mention of the methodology in Annex XIV part 2.2.b 2nd paragraph)	
Energy Audit	Not Applicable	- up-to-date, measured, traceable operational data on energy consumption (for electricity) load profile - Detailed review of energy consumption - Long terms savings → LCCA (Life cycle cost assessment) and not SPP (Simple Payback Period) - Data shall be stored	

Table 6. Comparative analysis of the standards and methodology employed for carrying out the energy audits in Finland and Russia.

	ISO 50001	EN 16247-1	Finnish Methodology - Motiva	Russian Methodology - *EtsConsult* Company (ETS 2013)
Definition	Energy Audit is not defined per se as it the ISO 50001 set the ground for energy management. However, an audit is defined as a *systematic, independent and documented process for obtaining evidence and evaluating it objectively in order to determine the extent to which requirements are fulfilled* and where an Energy Review *is* the *determination of the organization's energy performance based on data and other information, leading to identification of opportunities for improvement*	*systematic inspection and analysis of energy use and energy consumption of a site, building, system or organisation with the objective of identifying energy flows and the potential for energy efficiency improvements and reporting them*	Each agreement should define the meaning of energy efficiency and energy audit in their documents. For instance, the oil transport EEA defines energy efficiency as an *implementation of measures that will reduce the amount of fuel used as liquid heating and transport fuel. Energy-efficiency measures may be of technical nature or may be connected with the use of energy-using equipment, approaches and the operating environment, such as buildings, vehicles and the behaviour and habits of end users*	
Auditor(s)	Auditors should be selected for guaranteeing impartiality and objectivity for the audit (§ 4.6.3). Also, the auditor may come from inside the organization or be an external auditor working for the company. The auditor should be competent, impartial and objective.	- Highlight the role of the auditor (may be a sub-contractor) - As an auditor may come from outside the company, all the information must remain confidential - Report any conflict of interests in case the auditor is involve in another business	Selected from any Motiva certified auditor that has completed the training and passed the exam.	Selected from any certified auditor belonging to a SRO certified by Karelia Energia (Local representative for the Ministry of Energy)
Process	**Step 1 Energy Policy**	***Step 1 Before the Audit***	***Step 1 Before the Audit***	***Step 1 Preliminary Survey***
	- Set the target and represent the policy of the company regarding its relationship with energy consumption, - The energy policy frames the purchase or the implementation of energy efficiency measures to be undertaken - The energy policy is an iterative process in which the review process of the document is carried out regularly.	- Set the boundaries, objectives, details and needs for the Audit - Evaluate the human resource management (from the company, including safety and security recommendations) - Establish the priory data before the 1st visit	**1. Choosing the inspector** - The buyer of the audit chooses the inspector according to the expertise, price, and other factors. - Nomination of two Motiva certified persons that are in charge of the project. **2. Energy subsidy application** - The buyer delivers the application to the ELY-keskus of the region. - Binding agreements are not to be made before the subsidy application has been made in ELY-keskus. **3. Start meeting** - The energy inspectors and the buyer agree on the schedule, details, and emphases.	**1. Collection of baseline data** – This stage consists on determining the current energy consumption of the audited firm **2. Identification of priority sites and areas of investigation** – Identify the specifics spots to be audited in depth **3. Evaluation of the technical condition of the equipment and pipelines** – Pre-analysis step for the overall company
	Step 2 Energy planning & Implementation	***Step 2 Data collection***	***Step 2 Data collection***	***Step 2 Data collection (GOST 8.563-96)***
	- Identify the energy consuming spot and their corresponding energy consumption levels - Identify the leading factors contributing for energy consumption and the potential measures to be undertaken	- List of the energy consuming spots (from heating/DHW, lighting, manufacture processes, electric and thermal equipment) - Historical Data of the energy consumption for the SME and for the	**4. Gathering preliminary information** - Based on the information collected by the buyer or the inspectors and buyer together, the inspectors will have an overview of the facility and its energy economy. **5. Field work and measurements** - The inspectors review facility's heat, fuel, power, and water systems and	**4. On site measurement** – get the data from each measuring point. The date come from the sites located from the preliminary survey. Identify the reasons for energy wastes for each sector. Sectors: The power supply system. Production and auxiliary power

	- Set the energy baseline - Implement Energy Performance Indicators to compare with the baseline energy consumption - Ensure the qualification of the employee working in implementing the energy policy of the firm - Periodic audit	selected spot of energy consumption that has been decided to focus on (Also includes previous energy auditing and energy efficiency measures) - Current energy management system - Economic data - In Situ inspection e.g. reliability of the measurement, how does it work, technical drawings	equipment. - Buyer's representative and technical operators are interviewed. - Focus points of consumption and saving possibilities are found out through observations and measurements.	consumption – Electric drives (Actuators, ED). Asynchronous and synchronous motors – Pump Units – Refrigeration equipment – Compressed air and compressors – Heat supply system – Heat exchange equipment – Diagnosis of power plants using thermal imaging survey – Building and structures – Motor fuel – Water supply and sewage disposal – Ventilation System –
	Step 3 Checking	***Step 3 Audit Analysis***	***Step 3 Audit Analysis***	***Step 3 Analytical stage***
	- Energy Audit organisation (at predetermined intervals) - Energy audit aims at determining the degree of compliance of the actual state with the energy policy and its development - Aims at defining the modification action plan in order to stick with the original energy management policy drawn in the first place - Review of the corrective measures effectiveness	- Energy Analysis (Breakdown of the energy consumption, energy flow description, energy consumption profile(s), adjustment with the weather, occupation and other factors - Financial Analysis (Investment evaluation for implementing energy efficiency measures, Expected savings + payback period, Evaluation of the non-energy gains e.g. time saved for a process) - Post-processing (Reliability, uncertainty, necessity to repeat the measures, calculation methods)	**6. Analysis of saving possibilities** - On the basis of preliminary information and field work the inspectors analyse the level of energy usage and energy saving measures. - Energy saving measures can be for example improved operating techniques or changes that require investments.	**5. Analysis of energy expenditures, energy balance** – Final report on the energy balance **6. Enterprise energy efficiency evaluation** – Conclude on the energy efficiency actions to undertake by considering the previous steps and the current consumption. **7. Development of measures and recommendations** – Offer technical recommendations for improving the energy efficiency **8. Analysis of contractual relations for the supply of fuel and energy resources** – **9. Evaluation of specific energy consumption for production**
	Step 4 Management Review	***Step 4 Reporting***	***Step 4 Reporting***	***Step 4 Final Phase***
	- Highlights the actions' effectiveness and review the energy policy of the firm if necessary. The hypothetical new energy policy will serve the new round of energy management process - Under the form of a report, it ranks how well the firm has succeeded in meeting its energy target - Highlights the audit results - Gives figures about the projection of energy consumption in the future for the firm	- The report shall summarize the actions to be undertaken by the company - Report the difficulties met during the energy audit - Simulation, calculation and estimated results must be cleared out in the final report - Summarise the financial analysis and weight the cost of every actions - Report the improvement on the labelling scale after the improvements - The core of the report shall contain the background information, the energy audit process and its results, and the energy efficiency action plan	**7. Reporting** - The inspectors present results in an audit report according to Motiva guidelines. - The report should contain information on saving measures in such extent that the feasibility and profitability are clearly pointed out. **8. Report delivery session** - The inspectors present the auditing results and the action proposals to the buyer. In the session the further actions that are chosen are entered into the report. - The delivery session is also a good chance to educate the personnel. Especially if operating techniques can be improved, the inspectors need to go over them with the operating personnel. **9. Energy subsidy payment clearance** - After completing the audit project the buyer fills in the payment clearance in which the final funding and realized costs are presented. The payment clearance with enclosures is delivered to the ELY-keskus or to the TEM. **10. Realizing of measures and monitoring.**	At the final stage of conducting energy audits performed documenting the EO materials are developed, agreed and approved the reporting documents. The customer has the right to demand from energy auditors to specify certain conclusions to pay greater attention to details and materials on specific topics and areas of investigation. The auditor has the duty to transmit the data to the SRO that will provide the energy passport but also to the Russian Energy Agency for examination.

3.2 Comparative Analysis guidelines

3.2.1 Energy level Comparison

Energy Efficiency can be described from four different angles depending on what input and output factors are taken into account (Patterson 1996). Thermodynamic energy efficiency is most probably the most used as it uses energy values as input and output. The physical-thermodynamic energy efficiency measures would allow evaluating the raise in performance in terms of energy where either the input energy reduces while the useful output remains at the same level or the useful output increases for the same amount of input energy in the process. This first definition of energy efficiency may be the base for evaluating and comparing the energy levels for two SMEs located in two different countries. In this framework, a comparative energy analysis could be to develop an index that would use the primary energy per production units (e.g. $tonne_{Man./}kWh_{pe}$, Passenger/MJ) and thus would allow a fair inter-comparison of SMEs' energy intensity. The primary energy coefficient is a key element in the comparison as it allows measuring the gross amount of energy that is used by sectors.

$$\text{Energy Efficiency} = \frac{\text{Output}}{\sum_1^n E_n \times C_{pe\text{-}n}}$$

In this matter, differences in business sectors make the output format varying. Thus, output format shall be defined for each sector that is represented by SMEs (Industry, Construction, Trade, Services, and Agriculture). Literature suggests (Tuomaala et al. 2012; de la Rue du Can et al. 2010) units to be used for the different sectors although new indexes could be developed for specific areas. For instance, the service sector, and putting on the side the transportation part, could be expressed in terms of surface areas per energy consumed [m^2/kWh_{pe}] in which the energy use can be broken down by energy segments. The transportation sector is usually treated on the side as it requires deeper analysis on the type of goods or passenger, and types of transportation mean that is used in order to evaluate the energy efficiency. In this particular case, the energy efficiency index is expressed in terms of [good or passenger.km/J]. The agricultural sector represents a high energy consumption segment in which the total energy used must take into account the different energy sectors such as the space heating, water pumping, process, lighting, and transportation e.g. boat, tractors. This different energy use must be defined separately as they use different output units. Finally, for the other business segments that cover mostly process work, the unit used for inter-country comparison would privilege the process energy efficiency where the output is expressed in terms of quantity of product production per energy required for processing the above-mentioned product.

Although rating energy efficiency seems to be a delicate task to complete, the retrieved format of the energy efficiency information should be carefully designed in order to separate and make sure that different units are mixed up altogether. Nevertheless, energy indexing represents an important indicator for policy makers or for macro economy sectors but does not give any added value to the SME that would implement such energy efficiency measures. Thus, another index shall be considering the economic impact of energy efficiency measures implementation in SMEs.

3.2.2 Economic Energy Efficiency index

Economic-thermodynamic energy efficiency is another tool that could be employed for evaluating the process efficiency in a SME. In this context, energy efficiency is represented as

the ratio between an output expressed in terms of market price with the input energy that it required to perform this task. In this matter, the input energy must be taken in terms of final energy consumption as it represents the effective part of what a company is taking for carrying out a process. However, the monetary value of the output is a delicate issue in which multiple factor must take into account. First of all, not only the price of a performed task must be taken into account, but also the value of the task in the studied country. Secondly, the countries' wealth, as the gross domestic product (GDP) or any other measure that would represents the monetary value of a service, must be integrated into the equation for considering the variable of the price of goods and services on the market studied.

The primary target would simply compare the production costs with the amount of energy input in the process. However, it is very difficult to interpret this value for inter-country comparison as the price of energy differs from country-to-country. Thus, although this ratio has a meaning for the firms, it is challenging to use it as a reference value for comparing economic-energy efficiency

$$\text{Energy Efficiency} = \frac{\text{Production Cost [€ or Руб]}}{\text{Final Energy input}}$$

An alternative to the above-mentioned method for evaluating the economic-energy efficiency would be to use a ratio of economic value for each country.

3.2.3 Gauging the impact of energy efficiency measures

Finally, for evaluating measures' impact on the energy consumption and their efficacy, the use of the cumulative sum (CUSUM) method responds to this particular need (Beggs 2009). The CUSUM method is a powerful tool able to compare the energy consumption with any adjustment factor such as the replacement of machinery or appliance. In the case where energy audit results would be available from both the Russian and Finnish sides, it would be statistically possible to evaluate the efficacy of the measures implemented. However, the CUSUM method shows some limitations as it works only if a baseline period can be drawn in order have a reference period to which a comparison can be done. Moreover, the CUSUM method allows for evaluating the energy consumption depending on a single variable. As the weather variation represents an important factor in energy consumption, degree-days variation is often used as a reference value. However, any variable could be considered if for instance the energy consumption is not dependent from the weather but on the number of employee or any other variable. The idea remains the same whatever the chosen variable, comparing the energy consumption with an external factor.

The CUSUM method is primarily a graphical representation of the change of energy consumption in a defined space. Nevertheless, by calculating the slope of the linear equation represented by the two consecutive CUSUMs calculated, and pondered the results by the actual amount of energy consumed for the same point, it is possible to calculate the statistical change of energy consumption in terms of percentage.

4 Drivers for SME's participation to the EEAs in Finland

Main reasons and drivers for SMEs to participate the EEAs are savings in energy costs and subsidies for energy audits and energy efficiency investments. Also the improved public image can be valuable. Important by-products are increased energy efficiency, reduced environmental impacts and ultimately increased competitiveness of the enterprise (Pakarinen 2012).

During years 2008-2010 industries, municipal sector, and property and building sector saved 2.6 TWh in heating energy and fuels, 1.3 TWh in electricity, and 130 M€ in energy costs. Carbon dioxide emissions were curtailed by 1.3 Mtons. The total savings equal almost 1% of total energy consumption in Finland (Pakarinen 2012).

4.1 Subsidies awarded

The Northern Ostrobothnia Centre for Economic Development, Transport and the Environment provides data of different granted subsidies for enterprises and other company forms. In 2010 26 energy subsidies for both energy audits and investments were granted to 25 different SMEs in Northern Ostrobothnia (data from January is missing). The SMEs divided into sectors are presented in Figure 6. Figure 7 illustrates how the subsidies spread over different sectors money-wise. (Ely-keskus 2012)

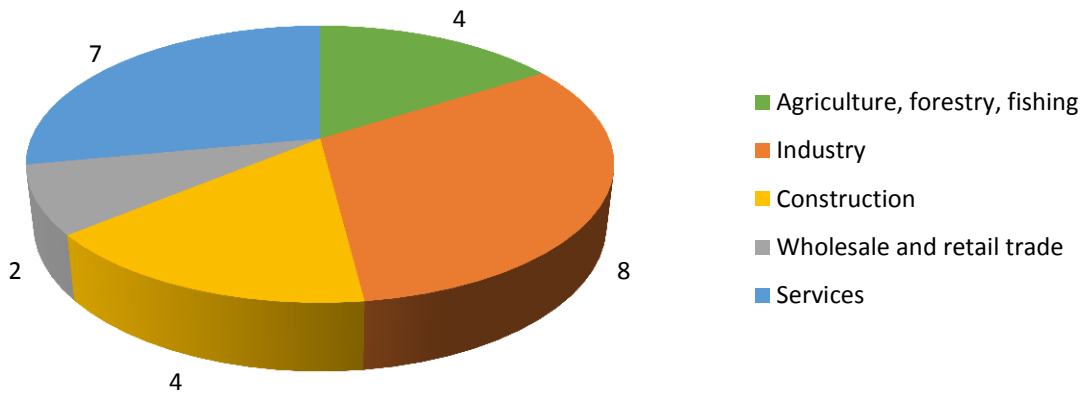


Figure 6. Quantity of granted energy subsidies by sector in Northern Ostrobothnia in 2010 (excl. January). (Ely-keskus 2012)

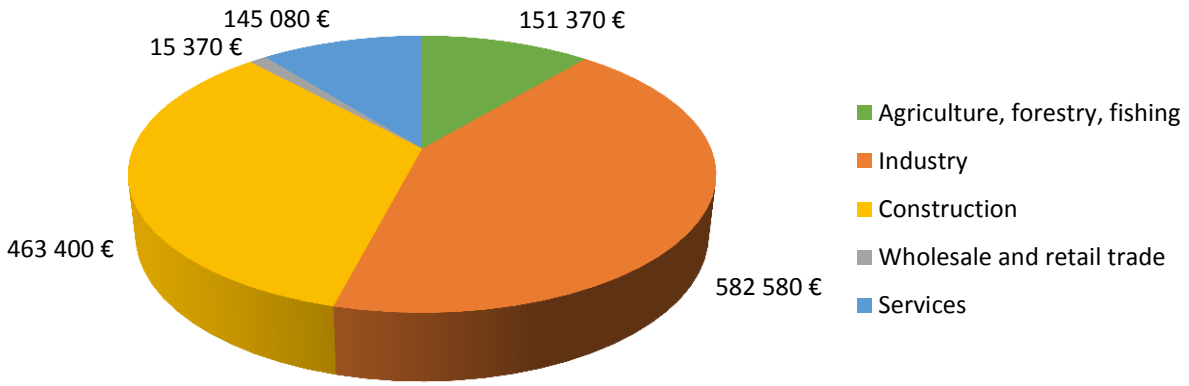


Figure 7. Amounts of granted energy subsidies by sector in Northern Ostrobothnia in 2010 (excl. January). (Ely-keskus 2012)

4.2 Knowledge dissemination

One of the main duty of Motiva and the public institution in Finland is to disseminate the knowledge publicly to everyone who would be interested in implementing energy efficiency. Thus, Motiva has recorded a number of energy efficiency measures that have been implemented with their average payback time period (see Table 7).

Table 7. Set of different energy efficiency measures implemented in Finland with their average payback period – 2006/2011 (Motiva 2012)

Measure	Number of actions	Potential saving (k€)	Investment (k€)	Payback period (a)
Heating system	103	4182	26227	4.8
Heat Output	193	1076	1500	0.7
Internal Temperature Reduction	244	519	115	0.4
Improving Control	207	319	1136	3.7
Improving air tightness level	24	35	141	3.7
Insulation - piping	49	298	443	3.1
Total for Heating measures	**820**	**6429**	**29562**	**4.6**
Ventilation	161	2125	12639	5.3
Ventilation running time	1153	4473	1328	0.4
Halving the intake or outtake air ventilation rate	206	778	569	1
Ventilation of services areas stratification	17	32	108	3.3
Control System depending on heating	313	574	480	0.6
Heat recovery system	606	9194	38682	3.8
Night cooling	20	50	123	1.6
Total	**2476**	**17225**	**53928**	**3.1**
Hot Water System	42	324	353	2.4
Limiting water flow rate	494	560	534	2
Water furniture convertible	26	65	206	3.5
Hot water temperature reduction	33	32	30	1.1
Pipe applications in technical areas	2	4	20	5.6
Toilet flush reduction	28	13	107	8
Total	**625**	**997**	**1251**	**1.3**
Electricity	3	9	106	7.8
Tariff and the voltage level of the scan and reactive power compensation	212	678	1546	1.8
Timing depending on the load levelling and peak consumption	4	23	1	0
Lighting	1182	2419	6873	2.7
Electric heating systems	255	358	558	1.5
HVAC Equipment	51	120	518	2
Other Electrical equipment	227	1863	7239	1.8
Change in usage	21	36	2	0.5
Total	**1955**	**5506**	**16842**	**3.1**
Cooling	99	892	5032	2.1
Water consumption	9	105	52	0.7
Condensation heat recovery	42	773	2550	3.1
Total	**150**	**1770**	**7634**	**4.3**
Infrastructures	13	28	159	4.1
Windows and Doors	66	265	1710	6.1
Outer casing	10	30	217	6.7
Roofing	4	20	233	10
Total	**93**	**344**	**2319**	**6.7**
Compressed air	79	367	811	2.8
Compressed air system leak repair	74	419	197	0.6
Total	**153**	**786**	**1008**	**1.3**
Other energy saving potential	**380**	**13529**	**50709**	**3.7**
Total for all the measures	**6652**	**46585**	**163253**	**3.5**

5 References

Beggs, C., 2009. Energy Analysis Techniques. In *Energy: Management, Supply and Conservation*. Elsevier, pp. 101–121.

Ely-keskus, 2012. Työmarkkinoiden, työvoimatarpeen ja talouden kehitys. Available at: http://www.ely-keskus.fi/fi/ELYkeskukset/pohjoispohjanmaanely/Ajankohtaista/Julkaisut/katsaukset_ja_tilastot/Sivut/Tyomarkkinoiden,_tyovoimatarpeen_ja_talouden_kehitys.aspx [Accessed May 15, 2013].

ETS, 2013. Energy Audit Methodology. Available at: http://www.etsconsult.ru/servis.html.

De la Rue du Can, S. et al., 2010. *Energy Efficiency Indicators Methodology Booklet*, ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY.

Ministry of Energy, 2013. Register of self-regulatory organizations in the field of energy audits. Available at: http://minenergo.gov.ru/activity/energoeffektivnost/audit/sro/.

Motiva, 2013. Energiakatselmuksille ja energiatehokkuusinvestoinneille tukea. *Motiva Oy*, pp.1–2. Available at: http://www.motiva.fi/files/6953/Energiatuki_2013_energiatehokkuus_130313.pdf.

Motiva, 2010. Energy audits and analyses. , pp.1–4. Available at: http://www.motiva.fi/files/4369/Energy_audits_and_analyses.pdf.

Motiva, 2012. Review of items measures. Available at: http://www.motiva.fi/files/6832/Katselmuskohteiden_toimenpiteet_2006-2011.xls.

Motiva, 2009. Teollisuussektorin energiakatselmusten ohjeistus. , pp.1–11. Available at: http://www.motiva.fi/files/2728/Teollisuus_KATohjeet_ja_mallisisallysluettelot_2009.pdf.

Pakarinen, J., 2012. Energy Efficiency Agreements and Auditing in Finland. *Motiva Services Ltd.*, pp.1–55.

Patterson, M.G., 1996. What is energy efficiency? Concepts, indicators and methodological issues. *Energy Policy*, 24, pp.377–390.

Pekkarinen, L., 2010. *Energiapalveludirektiivin 2006/32/EY Toimeenpano Ja Vaikutukset*. Lappeenranta: Lappeenranta University of Technology.

RosStat, 2012. SMEs Statistics in Russia. Available at: http://www.gks.ru/bgd/regl/b12_47/Main.htm.

TEM, 2013a. Energiakatelmustoiminnan Yleisohjeet. , pp.1–38. Available at: http://www.motiva.fi/files/6952/Energiakatselmustoiminnan_yleisohje_2013.pdf.

TEM, 2013b. Energiakatelmustoiminnan Yleisohjeet. , pp.1–38. Available at: http://www.motiva.fi/files/6952/Energiakatselmustoiminnan_yleisohje_2013.pdf.

TEM, 2013c. Energiatehokkuussopimukset ja katselmukset. Available at: http://www.tem.fi/index.phtml?s=2588.

TEM, 2012. Energiatehokuusdirektiivin Toimeenpano. Available at: http://www.tem.fi/index.phtml?s=5183.

The State of Finland, 2011. Finland's Second National Energy Efficiency Action Plan (NEEAP-2). , pp.1–183.

Tuomaala, M. et al., 2012. Energy efficiency metrics and improvement potentials. *Aalto University*, pp.1–340. Available at: http://lib.tkk.fi/TIEDE_TEKNOLOGIA/2012/isbn9789526045047.pdf.

Appendix A Content example of an energy audit

(Industrial Energy Audit or Analysis)

Based on Pakarinen (2012)

1 SUMMARY OF ENERGY ECONOMY IN AUDITING FACILITIES AND RECOMMENDATIONS FOR ENERGY SAVING ACTIONS

1.1 Auditing object

Introduction to auditing object including written description of key information (production etc.)

1.2 Energy economy and saving potential

Description of consumption levels, saving potential, saving opportunities, and recommendations for actions. Subtitles can be divided into heat, electricity and water, or other suitable energy consumption distribution

Table 1. Summary of energy consumption and energy saving potential
Table 2. Summary of energy saving actions

2 BASIC INFORMATION ABOUT THE AUDITING OBJECT

2.1 Object

- Name
- Address
- Buildings and facilities
    - Construction year(s)
    - Renovation or enlargement year(s)
    - Type of constructions / functions
    - Building volumes
    - Building surface areas
    - Operating times

2.2 Field of industry, production rates and personnel

- Field of industry for auditing object and written description of operations: production, production rate, personnel etc. Operation of production unit and main processes are described in graphical presentations (flow charts: raw materials -> processes -> end products)
- Incoming raw materials for production
- Main processes in order
- Essential energy-consuming processes and process equipment
- Schematic functional description of process
- End products and production rate

2.3 Connections to municipal technology

Description of heat, electricity and water purchase or production.

2.4 Use, service and maintenance

Description of service and maintenance organizations, consumption monitoring and

reporting system and service contracts in auditing object. Existing energy consumption monitoring and reporting system is evaluated in the report and possible recommendations for developing the consumption monitoring and reporting are presented.

3 ENERGY AND WATER CONSUMPTION AND COSTS

Total consumptions, cost distributions, specific consumption and consumption and cost development during the last few years are given. It is recommended that effects of changes in production structure and volume and in number of personnel on consumption changes are presented in the report.

3.1 Purchase of energy and water

Detailed written description of purchase and production of different energy forms.

3.2 Total consumptions, total costs and specific consumptions

Numerical and graphical presentation, information from several years, if available. Specific consumption is calculated per produced product unit in production building.
It is clearly brought out in this point, if electric heating or fossil fuels are used. It is informed in which point of the report detailed analysis considering these items are given.

3.2.1 Heat and fuels
3.2.2 Electricity
3.2.3 Water
3.2.4 Other total consumptions and costs

3.3 Energy distributions (AUDIT)

Energy distributions are numerically presented so that systems and equipment groups with consumption of at least 5 % from total consumption are allocated

OR Energy balances (ANALYSIS)

Energy balances from primary and secondary energy flows are presented both numerically and graphically so that energy flows which are at least 5% of total consumption are allocated.
Following energy flow allocation is used:

- Buildings (building services and structures)
- Mill service systems (allocated)
- Production processes
- Main processes (production lines)
- Sub-processes (main equipment of production line)
- Main process equipment

3.3.1 Heat and fuels
3.3.2 Electricity
3.3.3 Water
3.3.4 Other allocations and balances

4 A BASIC SCAN OF BUILDING SERVICES AND ENERGY CONSUMPTION

Description of main components of building services, possibilities to use renewable energy forms, operational criteria and status

4.1 **District heating systems**

4.2 **HVAC-systems**

4.3 **Electricity systems**

4.4 **Building automation system**

4.5 **Cooling service systems**

4.6 **Other building service systems**

4.7 **Buildings and structures**

5 **A BASIC SCAN OF MILL SERVICE SYSTEMS AND ENERGY CONSUMPTION**

Description of main components of mill service systems, possibilities to use renewable energy forms, operational criteria and status

5.1 **Water-circulated heating systems**

5.2 **Steam systems**

5.3 **Hot oil systems**

5.4 **Gas distribution systems**

5.5 **Compressed-air systems**

5.6 **Process ventilation systems**

5.7 **Process cooling systems**

5.8 **Process electricity systems**

5.9 **Process water and sewerage systems**

5.10 **Other service systems**

6 **A BASIC SCAN OF PROCESS EQUIPMENT AND ENERGY CONSUMPTION (ANALYSIS)**

When performing Industrial Energy Audit, process description can be given as in section 2.2. Instead, production sub-processes and equipment and energy balances are presented in energy analysis of industry sector. In the case of challenging auditing objects, energy balances are given for each sub-process and equipment. Detected deficiencies and incorrect functions of processes or equipment, which may affect energy consumption, are given. In addition to technical information of processes and equipment possible energy savings have to be reported. Possibilities to use renewable energy forms are reported, too.

6.1 **Sub-Process / process equipment A**

6.1.1 Functional description

6.1.2 Energy balance

6.2..n **Sub-Process / process equipment B…n**

7 **ENERGY SAVING AND PROFITABILITY OF RECOMMENDED ACTIONS**

Description of all recommended energy saving actions and possibilities to use renewable energy forms. Arguments for saving and investment calculations are presented in tabular form. Actions with calculations and arguments, which are not recommended to be implemented in the report, can be presented in chapter 7.

7.1 **Building services and structures**

7.2 **Mill service systems**

7.3 **Process equipment (ANALYSIS)**

7.4 **Other findings and recommendations**