

Energy sector process control system to ensure achievement of energy efficiency targets in Latvia: a case study

Ineta Geipele

Riga Technical University
Institute of Civil Engineering and Real Estate Economics
Riga, Latvia
ineta.geipele@rtu.lv

Gita Actina

Energy Efficiency Center
Institute of Physical Energetics
Riga, Latvia
gita.actina@inbox.lv

Sanda Geipele

Riga Technical University
Institute of Civil Engineering and Real Estate Economics
Riga, Latvia
sanda_geipele@inbox.lv

Namejs Zeltins

Energy Efficiency Center
Institute of Physical Energetics
Riga, Latvia
zeltinsh@edi.lv

Abstract — The basic condition of energy sector development is fundamental complex of flexible and accessible multi-level process control system. Energy-efficient process management system is involved in four hierarchical levels subordinate to each other to ensure the flow of information and contribute to the common and individual objectives. This study is established with the objective to find and determine energy-efficient process management subjects and to define the performance factors, which influence their interaction scheme. Based on studies and analysis of scientific and practical information, authors of this research established and defined interactions of energy-efficient process management system subject groups and their needs, discovered energy-efficient process management system participants and their interaction, offer graphical representation of scheme of institutions involved in energy-efficient process management system in Latvia. To describe and evaluate the energy sector process control system in Latvia statistical, logical, data processing and analysis methods have been used in this research. This research can be applied internationally to improve energy sector development based on development of management system of energy efficient processes.

Keywords — Energy sector sustainable development, energy efficiency management, energy-efficient process management system, energy sector process control system.

I. INTRODUCTION

Demand of energy sector is associated with regional changes: population growth in regions, as well as increasing of urbanization. Statistical data analysis shows that energy industry is also affected by national economic growth: increase in gross of domestic product per capita, it contributes to job creation and the level of decline in poverty in the country. Unfortunately it is associated as well with price growth for energy providers and subsequent increases in tariffs. [1, 2] Main challenge of management system of energy efficient processes to achieve the most efficient results is to find a balance between conflicts of interest and conditions of limited resources.

Average growth rate of world population in 1990 to 2010 was 1.4%, while in the previous 20 years - 1.8%. African and Middle Eastern countries showed the highest population growth rate of 2.4-2.8%. The lowest growth rate was observed in OECD and CIS countries (about 0.2-0.01%). [3, 4, 5] According to statistical projections, the world population number by 2050 will grow up to 9.7 billion, while in Latvia it will shrink to 1.4 million. [1, 2] Despite the increase in GDP, its growth per capita is negligible and the level of energy consumption per capita in 2050 will not rise significantly. [6]

Average 22% of the consumed energy are produced from coal, which is the leading fuel type in power generation in the total energy balance. Hydro Resources Provide 5-6% of global power generation while Utilization of nuclear energy has reached 17-18%. [7, 8]

Sustainable development can be described as national and regional development that supports needs of today and minimize the risks and impacts of needs of future generations. Strict environmental requirements and high economic indicators can provide sustainable development. Economic development must not degrade the environment, as well as decisions of today are to ensure a high quality of life for future generations. [9]

The two main topics of discussions at the conference “Rio + 20” held in June 2012 in Rio de Janeiro were building of “green economy” for sustainable development as well as poverty reduction and improvement of coordination of sustainable development by creating an institutional framework that includes the global, national and regional levels. [10]

National energy policy in Latvia is focused on national economic development based on stability of energy supply. To achieve targets of Latvian national energy policy it is recommended to provide the access to commercial energy resources to energy end-users ensuring reliability and stability of energy supply guarantees. As long as these requirements are not met establishment of regional energy policy is encumbered. The same time attention to environmental issues (climate changes and environmental pollution) must be paid as well.

Table 1. Breakdown of energy sector according to energy consumption [11]

	TWh	%
Electricity	7.23	14
Transport	13.15	27
District heating	7.31	15
Local and individual heating	21.58	44
Total:	49.26	100

The target of management of energy efficient processes is primary energy savings in the amount of 0.670 Mtoe (28 PJ), which must be achieved by 2020 according to the energy efficiency Directive EU 2012/27/EU. Within the indicative target, the achievement of two sub-targets must also be ensured: [11]

- annual savings 1.5% of energy delivered to the country's energy end-users - total 0.261 Mtoe (10,9 PJ) by 2020 (achievement of the target to be ensured by energy producers);
- 3% of state-owned building areas must be annually renovated, maximum estimate - total 678,460 m², with respective energy savings 0.0044 Mtoe (0.18 PJ) throughout the period 2014-2020.

Final consumption of electricity in Latvia 2013 was 6,576 GWh, but in 2012 – 6,448 GWh. Reduction of heat consumption in 2013 compared to 2012 is 3.2%. In the gross electricity consumption structure, three dominant sectors of consumption prevail: commercial and public services (35.8%), industry and construction (23,9%), and household sector (23.6%). Energy consumption in the energy sector in Latvia is presented in Table 1.

Average energy intensity in EU member states gradually decreases, while in Latvia it is increasing with every year (see Table 2). That leads to conclusions that current energy efficiency management system in Latvia is not efficient and needs to be improved.

Table 2. Primary and final energy intensity in EU-28 and in Latvia [11]

	Primary energy intensity (toe/1,000EUR)						Final energy intensity (toe/1,000EUR)					
	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
EU-28 (average energy intensity index)	0.152	0.151	0.149	0.152	0.144	0.143	0.152	0.151	0.149	0.152	0.144	0.143
Latvia	0.31	0.306	0.357	0.382	0.334	0.329	0.31	0.306	0.357	0.382	0.334	0.329

Greatest potential for achievement of national energy efficiency targets in Latvia is related to improvement of individual heating supply, as well as commercial and public service domain. To reach and influence participants of energy efficiency management system it is necessary to create and develop a model of management of energy efficient processes, initially defining the circle of participants.

The term energy management has been used differently in academic literature, there is no cohesive definition. What many descriptions of energy management have in common is that they mainly focus on implementation of energy efficient technologies and replacing inefficient equipment. However, energy management also includes care and maintenance of technology to preserve an efficient operation. It requires continuous work and improvements. [14]

Economical strategy of a sustainable development imposes certainly to promote efficiency and a rational energy use in buildings as the major energy consumer in all member states of the European Union (EU). [16]

II. SUBJECTS OF ENERGY EFFICIENCY MANAGEMENT SYSTEM

The energy efficiency management system involves four inter-subordinated hierarchical levels. Promotion of individual and cooperative targets and ensuring of the information flow between involved institutions is the key function of energy efficiency management system. Analysis of performed scientific research is base for the graphical scheme of mine subjects involved energy sector development and responsible for successful operation of energy efficiency management system in Latvia (see Fig.1.).

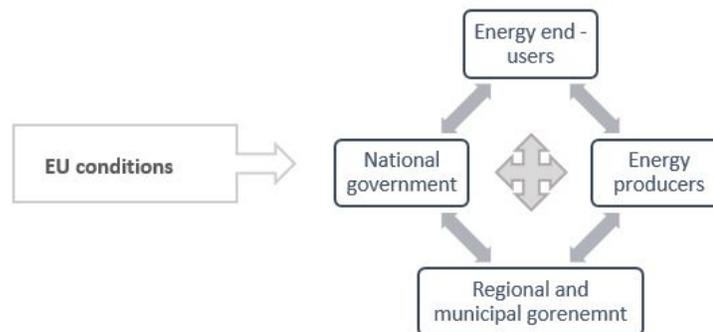


Fig. 1. Scheme of energy efficiency management system involved levels [Figure made by the authors]

Level of energy end-users contains private and municipal commercial entities, households and other municipal institutions. Regional and municipal government includes regional planning institutions (in Latvia those are five regional planning departments – Vidzeme, Kurzeme, Latgale and Riga) well as specialists and experts group responsible for energy sector development at municipal level. At national level responsible for development and setting targets of energy efficiency is Energy Efficiency Division of Ministry of Economics. Ministry of Economics in cooperation with the ministries of Environment and Agriculture are the leading responsible institutions of energy sector development taking into account legislatives of European Union.

Figure 2 shows the subjects of management system of energy efficient processes and characterize the impact of interaction between factors affecting the achievement of energy efficiency targets at different hierarchic levels.

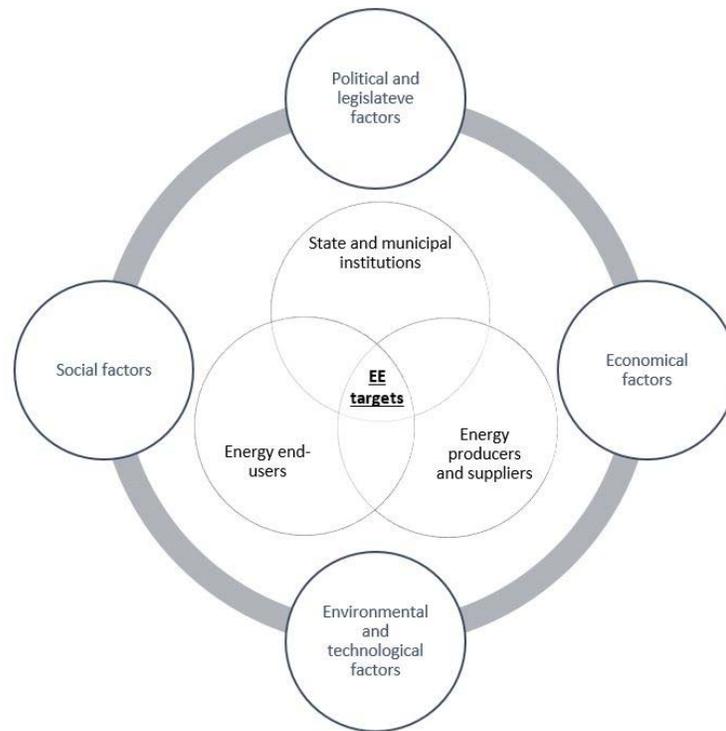


Fig. 2. Scheme of energy efficiency management system involved levels [Figure made by the authors]

The basis for achievement of energy efficiency targets by 2020 according to the EU Directive 2012/27/EU is mutual coordination between the state and local government institutions, energy producers and suppliers, as well as energy end-users.

Currently not sufficient extent involved in the energy efficiency management system are interests and needs of households and merchants, which do not relate directly to the energy sector. This cause the unsustainability of created energy sector development plans based on theoretical and statistical approximate calculation data.

Table 3 shows a complex of functions and tasks of energy efficiency management system in the micro- and macro-environment in order to coordinate and facilitate the needs and objectives of all stakeholders.

Table 3. Functions and tasks of management system of energy efficient processes in Latvia [11]

Micro-environment – internal environment				Macro-environment - external environment			
No.	Functions	No.	Tasks	No.	Functions	No.	Tasks
1.	Administrative - develop and update the concept of development of heat supply and the action plan of development of sustainable energy, organize and supervise their implementation, prepare the annual progress report on the implementation process.	1.	Establish and maintain a register of building heating and air conditioning equipment in Riga.	4.	Link (the State-local governments) - participate in development of draft legislative enactments, policy planning and regulatory documents Within competence: collaborate with the State and local government institutions, non-governmental organizations and other legal and natural persons within the competence.	12.	Prepare the energy demand and supply forecasts as a basis for making decisions on energy development.
		2.	Provide evaluation of energy, ecological and economic consequences of the measures.			13.	Prepare visuals and hand-outs on the issues and solutions for energy efficiency and renewable energy resources.
		3.	Establish and maintain local renewable energy equipment register in the administrative area, as well as annually renew the registry database on the amount of energy consumed from this equipment.			14.	Provide evaluation of energy, ecological and economic consequences of the measures.
						15.	Prepare the energy demand and supply forecasts as a basis for making decisions on the development of energy

		4.	Collect and update information on energy efficiency and renewable energy resources, to create information databases.			16.	supply. Data analysis and information collection.
2.	Control - provide energy inspector services to achieve increased energy efficiency in residential and public sectors.	5.	Selectively test the operational mode of power supply equipment for public buildings (schools, pre-school educational establishments, administrative buildings, etc.) and provide advice on optimum temperature regime.	5.	International communication - cooperate with foreign and international bodies and organizations, in matters within their competence.	17.	Encourage the use of economically viable and ecologically clean energy-efficient technologies.
		6.	Perform supervision of energy certification according to the requirements of the regulatory enactments.			18.	Encourage investment attraction in increasing the energy efficiency and use of renewable energy resources.
		7.	Establish and maintain a register of renovated multi-family houses and public buildings, through monitoring of energy consumption in buildings for 5 years after the renovation of buildings.	6.	Informative (at national and international level) - publish informational materials and provide information to media about issues within competence of the Agency, organize energy days.	19.	Participate in organizing exhibitions about energy efficiency and renewable energy resources.
		8.	Randomly perform on-site inspections of energy efficient facilities and renewable energy equipment, and provide advice on improving the equipment operation.			20.	Maintain and update the Energy Agency website
3.	Informative (regional level)- to establish and maintain the Agency's structural unit – Information Centre for Energy Efficiency, which provides access to information for citizens.	9.	Provide advice in the field of energy supply, energy efficiency and renewable energy resources.			21.	Encourage economically viable and ecologically clean energy-efficient technologies.
		10.	Arrange and update exhibitions at the Information Centre for Energy Efficiency dedicated to energy efficiency and renewable energy.			22.	Encourage implementation of public and private partnerships.
		11.	Arrange seminars, conferences and activities of the Expert Discussion Club on issues of energy efficiency and use of renewable energy and solutions.			23.	Provide advice in the field of energy supply, energy efficiency and renewable energy resources.
		24.	Arrange seminars, conferences and activities of the Expert Discussion Club on issues of energy efficiency and the use of renewable energy and solutions.				

Table 3 shows the breakdown of functions and tasks of management methods affecting the energy efficient processes according to belonging of issues to be solved to either the micro-environment or macro-environment. Contents of table 3 indicate the proportion between practical action and scientific activity of the management system of energy efficient processes.

III. ENERGY SECTOR DEVELOPMENT PROCESS CONTROL METHODS

Of life quality of residents in aspects of natural opportunities of the region's ecosystem and a competitive business development can be improved within the management system of energy efficient processes. The management system of energy efficient processes in energy sector development mean an interaction of elements of the energy sector, planning process of long-term development of those elements and continued control of implementations of those plans. [12]

The functions of energy sector process control system include evaluation of current situation in specific region and the development of measures system, which has to be taken in to account by local governments by development and execution of energy sector projects.

Development and improvement of the evaluation system of energy efficient processes have a direct impact on sustainable development of energy sector in regions and state in total. Development, evaluation, implementation and control of short-term energy plans of efficient measures taken by local governments encourage further economic development of the region in total. The tasks of the energy sector process control system at national level are presented in Table 4.

Formulation of development of main guidelines for local and regional energy policy development and project implementation process control in accordance with the national energy development and respective directives of the European Union is the first phase to reach energy efficiency and sustainable development targets.

Energy sector development process is firstly connected with implementation of national priorities at local government level:

- encouraging the use of renewable energy resources for heat and electricity production;
- planning and implementing measures for the security of energy supply;
- encouraging the demand of energy-efficient solutions in the interests of commercial companies, industries, service sector and households;
- creating a policy of conservation of climate in the country and regional ecosystems.

Table 4. Tasks of energy sector process control system and energy sector development at national level
[made by the authors]

National energy development strategy	
Improvement of national legislation and unification of regional energy policy	Institutional structures, intersectoral cooperation
	Assessment and forecast of the need of energy resource
	Implementation of national energy-saving programs
	Reinforcement of conservation measures
	Use of renewable energy sources
	Strengthening of fuel complex scientific and technical potential
	Public awareness of energy issues
	State tracking system of the use of energy
	Development of organizational and technical base auditing and monitoring
	Technical safety guarantees
Safe and efficient operation	
Reducing of the negative environmental impact of energy complex	
Conservation of energy sources and its quality maintenance	
Assessment of energy waste adverse effects on human health	
Involvement of residents and institutions in energy policy	

The structure of regional energy sector processes (see table 5.) is part of national energy policy and determine quality of sustainable development strategy. It is composed of four task groups.

Table 5. Structure of regional energy sector processes [made by the authors]

Regional Sustainable Energy Policy				
Municipality energy efficient action plan	Energy supply in the municipality	Electricity	Electricity production	
			Electricity distribution and supply	
		Thermal energy		Thermal energy generation
				Hot water supply
	Availability of energy resources in the municipality	Renewable energy sources		Hydropower
				Biofuel
				Solar energy
				Wind energy
				Geothermal energy
			Use of wastes	
		Fossil energy resources		Natural gas and its availability
				Oil products
				Coal
				Shale
			Peat	
	Energy efficient projects in the municipality	Thermal insulation projects		Residential buildings
				Public buildings
				Industrial buildings
		Construction and reconstruction		Heating systems
				Electric power transmission
Cogeneration- and others station construction and reconstruction				
Public street lighting				
Fuel consumption in the transport sector			Reducing of CO2	
		Air quality changes		
		Alternative fuel options		
Awareness campaigns in the municipality	Seminars and trainings for raising the competence level			
	Energy efficiency demand stimulation		Household interests	
			Interests of entrepreneurs	

The target of development of energy sector process control methods is to support and encourage positive economic development. Increasing of energy supply safety and implementing the energy efficiency projects in local governments will support regional development and reduce the negative demographic change as well as improve achievement of national energy efficiency targets by 2020.

IV. CONCLUSIONS

National Energy efficiency targets set in accordance with EU directive 2012/27EU is possible to achieve through development and improvement of management methods used in purpose to develop national energy sector and implementation of energy efficiency solution projects in regions of Latvia. Cooperation between all subjects energy sector (state institutions, regional and municipal governments, energy producers and suppliers, as well as energy end-users) have to ensure the mutual interests of all stakeholders by taking into account social, economic, political, legal, and environmental factors influencing the process of decision making and project implementation. Within the framework of the energy process management system an effective communication between all hierarchical levels in this systems have be ensured to achieve the energy efficiency targets.

Functions and tasks of energy process control system to develop Latvian energy sector is closely linked to associations and professional organizations to involve specialist of energy sector in creation and development of national energy policy and management of energy efficient processes. The porpoise of those institutions is to secure consultancy and research on significant sector affecting issues.

Analysis of existing management methods used to secure development of energy sector and achievement of energy efficiency targets by 2020 showed that the information flow between the hierarchical levels of the management energy sector system, mainly between governmental and energy end-user level does not function properly to ensure mutual harmonization

of interests. The break in the information flow has to be observed in the direction from energy end-users to the governmental institutions. Planning of energy sector development mainly support projects of improvement of energy efficiency in energy-producing and supplying companies and in properties owned by local governments.

Differences in economic development and growth rate levels of local governments have to be reduced to encourage national, regional and local development of energy sector. Equal living, working and environmental conditions as well as supportive business environment can promote a balanced and economically justified change in the dynamics of energy consumption as well as sustainable development of energy sector in total. When energy efficiency is compared over time or between different installations, it is particularly important to define suitable system boundaries to ensure that all energy users are considered equally [13]. In order to provide changes in Latvia, efficient solution can be national tax strategy that impact the creation of a productive business environment and its development, implementation of innovations, attracting investors and investment efficiency.

To improve achievement of existing energy efficiency targets and energy sector development as well as to prevent obstacles identified in the present research, authors proposes to develop even more precise long-term and short-term plans for the implementation of energy efficient solutions. These plans have to include detailed economic justification.

Adaption of energy sector process control methods of other Member States of the European Union, which have similar issues in energy sector development and achievement of energy efficient targets by 2020 can be an important contribution to encouraging a sustainable development of the energy sector in Latvia.

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BIOGRAPHY

Ineta Geipele, is the Professor at the Faculty of Engineering Economics and Management, the Director of the Institute of the Civil Engineering and Real Estate Economics, the Head of the Chair of the Civil Construction and Real Estate Economics and Management of the Riga Technical University (RTU), Latvia. She has earned Doctor's degree of Economics and Master's degree of Economics in Engineering Sciences at the RTU. Her professional skills are improved in Austria, Germany, Denmark and England. She is an author and co-author of more than 180 scientific publications. Her current research interests are focused on Sustainability Development Problems of Real Estate Market, Construction Industry, including Land Use Management and Institutional Economics. She is an expert on Management

Science of the Latvian Council of Science, a board member: of the FIABCI-Baltic Multinational Chapter; of the Cunftē of the Facility Management of Latvian Housing, a Member of the Latvian Union of Civil Engineers etc.

Gita Actina, Dr. oec, is Head of Latvian energy efficiency network in the Institute of Physical Energetics of Latvian Academy of Sciences since 2003, starting with 2005 also is a research assistant in the field of heat power industry and participated in international and state-funded research projects on planning of sustainable development of regional power sector. Since two years, she holds the position of Secretary General of Latvian Branch of International Association for Energy Economists. In 2000, she acquired a degree of Bachelor of Social Science in management science within the Program of foreign economic relations at the University of Latvia, and in 2002, a degree of Master of Social Science in management science was acquired within the Program of marketing research. Within over 10 years of professional experience, she is participating in solution of energy economics problems at Latvian National Committee of the World Energy Council. The findings of her studies are reflected in 32 publications, which were presented at 19 international conferences.

Sanda Geipele, Dr.oec, Assist. Prof., Researcher, Riga Technical University, Latvia. Within over 5 years she worked as a Chief Economist in Riga City Council's Municipal Revenue Department and her work was related with real estate tax administration. Research interests: Sustainability Development Problems of Real Estate Market, Construction Industry, including Land Use Management and Institutional Economics. She is an author and co-author of 32 scientific publications. Since 2010 she has participated in more than 16 scientific conferences and 5 international scientific and practical projects. Sanda Geipele is an expert on Management and Economics Sciences of the Latvian Council of Science.

Namejs Zeltins is the Head of the Energy Efficiency Centre at Institute of Physical Energetics and a Professor at Riga Technical University. His educational background: M. sc. of theoretical physics, University of Latvia (Faculty of Physics and Mathematics), 1966; Postgraduate, Institute of Physical Energetics, Latvian Academy of Sciences, 1972-1979; Dr.sc.ing., (Candidate of Science in former USSR - Ph.D. in Western countries), Georgian Institute of Energetics and Hydrotechnical Buildings, 1984; Dr.habil.sc.ing., Institute of Physical Energetics, 1993. He is Chair of the Latvian Member Committee of the World Energy Council since 2001. He is also a Member of the European WEC Group, a Member of the Board of the National Energy Confederation. He is a Learned Secretary of the Nuclear Energy Competence Centre of LAS and a Member of the Advisory Editorial Board of Polish Academy of Science "Energy Policy Journal". His academic interests include fuel and energy complex planning, heat and gas supply systems, the energy market and energy utilization.