CHEMICAL ENGINEERING TRANSACTIONS
VOL. 39, 2014
A publication of AIDIC
The Italian Association of Chemical Engineering
www.aidic.it/cet
Guest Editors: Petar Sabev Varbanov, Jiří Jaromír Klemeš, Peng Yen Liew, Jun Yow Yong

ISBN 978-88-95608-30-3; **ISSN** 2283-9216
DOI: 10.3303/CET1439252

Green Energy Strategy 2050 for Latvia: a Pathway towards a Low Carbon Society

Dagnija Blumberga[a], Ginta Cimdiņa[a], Lelde Timma*[a], Andra Blumberga[a], Marika Rošā[a]

[a]Institute of Energy Systems and Environment, Riga Technical University, Azenes 12/1, Riga, Latvia, LV1048
lelde.timma@rtu.lv

Therefore the main aim of the paper is to develop and present a roadmap for low carbon society with an overall aim to achieve independence from fossil fuels by 2050 in Latvia. The paper also reviews current and the perspective development of energy system in the country.
The results show that it is possible to create energy supply system in Latvia, which is based on renewable energy sources by 2050. A quantitative evaluation of the modelled scenarios is given based on energy demand and apprising energy related greenhouse gas emissions.

1. Introduction

European Commission (EC) strengthened climate and energy targets with following commitments until 2020: to reduce greenhouse gas (GHG) emissions by 20 % compared to 1990 levels, to increase the share of renewable energy sources (RES) in the final energy consumption to 20 %, and to achieve a 20 % improvement in energy efficiency. These commitments are implemented in binding legislation and policy strategies.

The leading EU member states contemplate the transition to RES and implement this idea in its climate policy. 100 % renewable energy systems are analysed at country level for Denmark by Lund and Mathiesen (2009) and, Germany by Henning and Palzer (2014), Macedonia by Ćosić et.al (2012), Protugal by Krajačić et al. (2011) and Ireland by Connolly et.al (2011), at municipality level for Danish cities Aalborg by Østergaard et.al (2010) and Fredrikshavn by Østergaardand Lund (2011) and at European level by Steinke et.al (2013), Spiecker and Weber (2014) and Rasmussen et.al (2012). Common targets in these strategies are; to decarbonise power sector firstly due to its GHG reduction potential; to give the role of the main energy source to biomass; to reduce energy consumption in buildings; to use RES together with smart energy storage, and; to implement cost effective solutions for energy efficiency and RES. Although case studies do not provide a common methodology, they outline a vision of future energy systems, where reduction in fossil fuel consumption is possible.

This paper presents methodology underpinning the development of Latvian Green energy strategy 2050 by IESE (2011). Overall aim of the strategy is to achieve independence from fossil fuels and it was developed on the basis of two research projects by IESE (2008) and (2009). Both studies showed that Latvia can ensure fossil fuel free energy system. In addition, also study by Porubova and Bazbauers (2010) showed that it is possible to create an energy supply system (including transport) in Latvia which is solely based on renewable energy sources even within the limits of the estimated potential.

Please cite this article as: Blumberga D., Cimdiņa G., Timma L., Blumberga A., Rošā M., 2014, Green energy strategy 2050 for latvia: a pathway towards a low carbon society, Chemical Engineering Transactions, 39, 1507-1512 DOI:10.3303/CET1439252

2. Background information on Latvia

Within the EU Latvia is one of five leaders with 35.8 % of RES in total gross final energy consumption (see Figure 1); 44.7 % of electricity, 44.5 % of heating and cooling, and 4.8 % of transport fuel were provided from RES in 2011 (MoE, 2013) and (Eurostat, 2014).

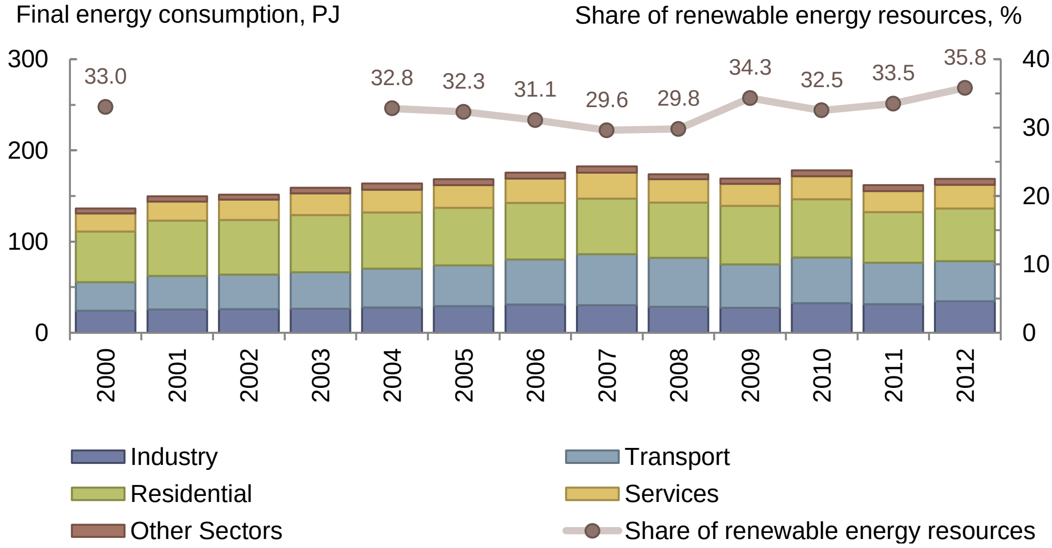

Figure 1: Historical final energy demand and the share of renewable energy resources in Latvia (MoE, 2013) and (Eurostat, 2014)

Final energy consumption has grown by 20 % in 2011 in comparison to the year 2000; reaching the highest point in 2007. A short-term decrease in energy demand was observed during 2008-2009 as a result of economy downturn; nevertheless in overall energy demand raises (Figure 2).

Based on the type wood fuel was dominated in final energy consumption with the share of 24.0 %, followed by hydropower, biofuels, biogas, straw and other biomass and wind power; still roughly two thirds of energy needs are provided by natural gas and oil products (MoE, 2013).

The total GHG emissions peaked in 2007 and again in 2010 rising just above the threshold of 12 Mt CO_2 eq.; where 27 % of all emissions arise from transport sector and 20 % from agriculture in 2012 (Eurostat, 2014). Latvia's target is to limit the total national GHG emissions to 12.19 Mt CO_2 eq. until 2020.

The ETS sectors accounts for around one fifth of total emissions – the remaining is produced in non-ETS sectors (small-scale energy production, small industry, transport, agriculture, households and waste sector), therefore the reductions achieved in non-ETS sectors are important (Roos, 2012). The targets for emissions in ETS and non-ETS sectors are given in the Section 2.1.

3. Methodology

Based on the analysis on current situation, the energy demand (including losses in transmission and distribution) was estimated; this estimate forms an input ("Input data" in Figure 2) and it is the variable, which is used to determine the potential of energy generation and consumption.

Authors determine energy balance by: energy consumption, which accounts for energy demand; energy generation, which comprises energy supply; legislation, which includes conditions stated by law; assumptions, database I, which potential amounts of RES; database II, which shapes technological solutions; database III, which merits the potential of innovative technologies; support mechanisms (economical), which affect required investments.

The methodology includes both identification of demand side and estimates of energy supply side development. Authors covered four energy demand sectors: households, industry, services (including construction) and transport. Two scenarios were developed to forecast energy demand – baseline (B) scenario and energy efficiency (EE) scenario. Significant role plays assumptions which are summarized in Table 1.

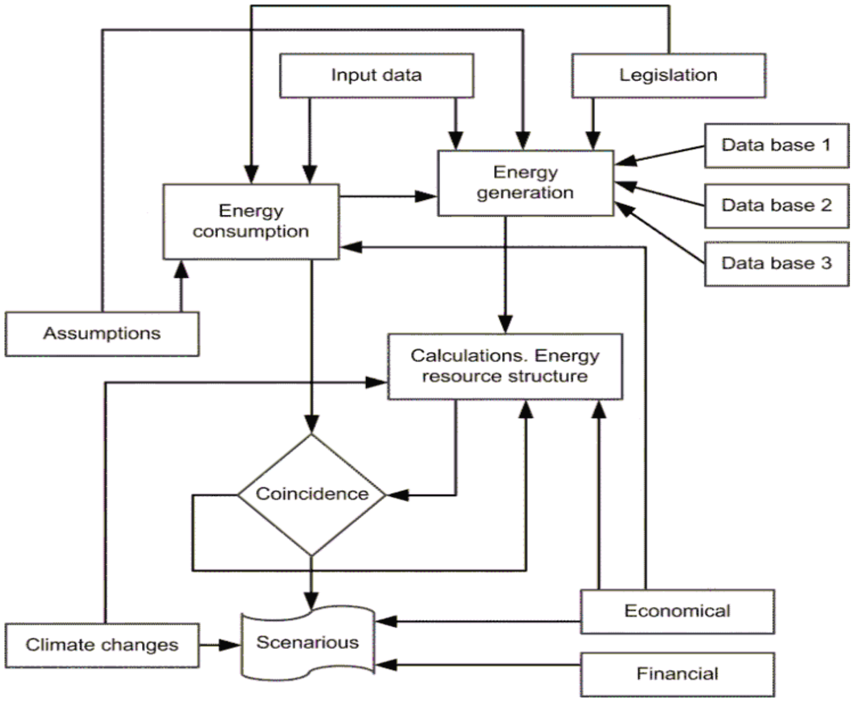

Figure 2: Algorithm of the methodology

Table 1: Assumptions made for energy demand side estimates

Sector	Scenarios	Assumption	Reference
General	B, EE	Annual population growth rates (−0.60…−0.75) by 2020	(CB, 2007)
	B, EE	Annual GDP growth rates (−0.34…+5.68)by 2020	(WB, 2014)
	B, EE	Added value in GDP for industry 11 %, for services 72%.	(ODYSSEE, 2007) and (ADEME, 2007)
Households	EE	Electricity consumption increases from 1995 kWh/year in 2007 to 2700 kWh/year (EU-15 average in 2007) by 2015	
	EE	Dwelling area per household increases from 67 m^2 in 2007 to 91 m^2 (EU-15 average in 2007) by 2020.	
	EE	Heat consumption decreases from 250 kWh/m^2/year in 2008 to 195 kWh/m^2/year by 2016 and 150 kWh/m^2/year by 2020.	(MoE, 2008) and (MoE, 2006)
	B, EE	2.49 persons per household	(CSB, 2013)
Services	B, EE	190000 employees	(CSB, 2013)
	EE	Power consumption per employee increases from 3000 kWh/year to 5200 kWh/year by 2015	(ODYSSEE, 2007) and (ADEME, 2007)
	B, EE	Heat consumption by 20% larger than heat consumption in households due to increased ventilation needs.	
Industry	B, EE	Heat intensityand power intensity remains at 2007 level)	
	B, EE	14.5% decrease in the number of employees by 2020	(MoE, 2007)

In the B scenario end-use energy efficiency is determined in accordance (MoE, 2008). The EE scenario assumes the convergence towards average energy intensity in EU-15 (in 2004) in Latvia until 2020. Data on energy efficiency indicators among various sectors are gained from researches (ODYSSEE, 2007).

Energy supply includes several options which depend from availability of renewable energy resources, technology development and prices of biomass as well as technologies. The structure of energy resources can vary. Therefore, if a scenario is obtained in which the energy demand is fully satisfied then this scenario can be considered for use and further analysis. There may be several such scenarios. Some of those may fail to equilibrate demand and supply, and it is necessary to return to the main calculation unit – "Energy resources structure". When scenarios are selected, the analysis continues with economic and climate evaluation of those and selection of the best financial solutions.

4. Results

4.1 Projected energy demand

In the baseline scenario increase in heat energy consumption continues until 2050, while in the energy efficiency scenario increase is marginal and after 2016 reduction follows (Figure 3). We explain the decrease in heat energy consumption with energy efficiency measures in all sectors, especially in households and services.

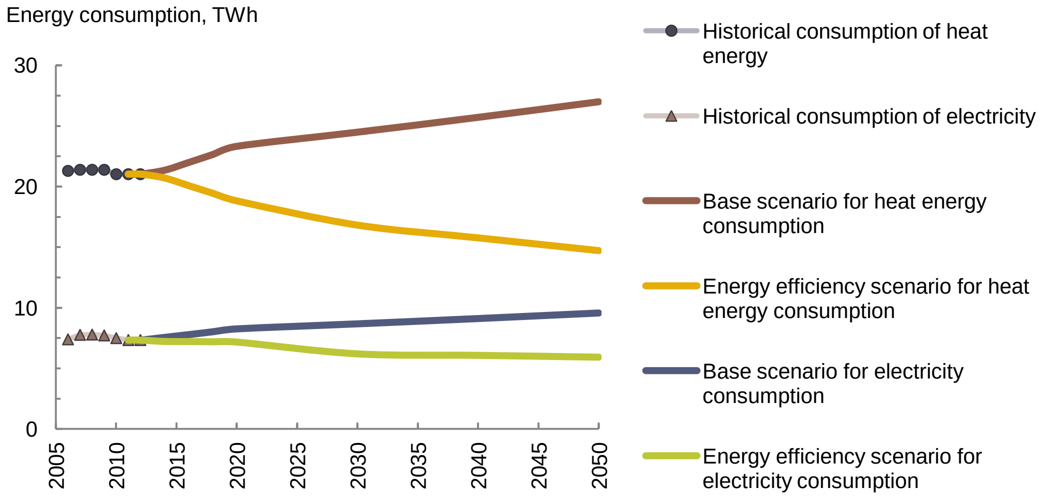

Figure 3: Total final consumption of electrical and heat energy for baseline and energy efficiency scenarios

The final consumption of electricity grows in both scenarios. A growth rate slows down in the energy efficiency scenario by 2015 because the average consumption level of the EU-15 in 2004 is reached in households and services. Electricity consumption in industry is projected to increase gradually by 2020.

4.2 Projected greenhouse gas emissions

GHG emission projections by 2050 are illustrated in Figure 4. Lower GHG in 2020 and 2050 are explained by the transition of the energy sector to energy-efficient end-use and use of renewable energy resources. In the period 2013 – 2020 as well as up to 2050, the gradual decrease in use of the fossil fuel will allow reaching the 20 % GHG level in the energy sector in comparison with 1990.

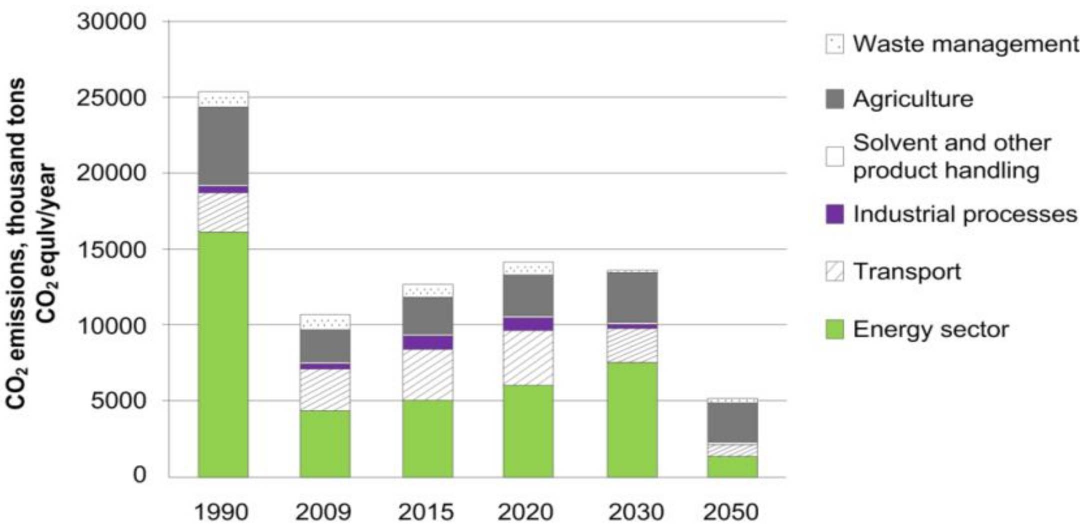

Figure4: Historical GHG emission pattern and GHG emission forecast (including transport)

5. Discussion

It is possible to achieve independence from fossil fuels only by implementing a set of measures and a systematic approach to provide high energy efficiency within the overall energy consumption. This means that if demand for energy services (lighting, heating, technologies for industrial use, etc.) grows, Latvia should be able to meet such demand by offering renewable energy resources.

The government will have to provide a strong and economically sound transition to green energy development. Based on the current knowledge and experience, the key focus should be placed on the following elements:

Based on the current knowledge and experience, the key focus should be placed on the following elements: (1) increase in energy efficiency at all stages of energy supply systems (energy production sources, energy transmission and on the energy end-use side); (2) reduction of peaks of electrical load in the system; (3) efficient use of biomass resources (including biogas) in co-generation systems and partly in transport sector; (4) increase in the share of renewable energy resources in district heating and individual heat supply; (5) broader use of wind energy and other renewable sources of energy; (6) changes in the possibilities of use of the existing renewable energy resources, such as water resources; increase in energy conversion and creation of smart power grids; (7) entry of large energy users (volume wise) into the economy; (8) construction of large biomass extraction plants to convert biomass-to-biofuel.

All of this emphasizes the need for a flexible strategy, which considers also a technological development. Problems that are related to energy supply safety and impact on climate change can also be resolved in a different way. The directions towards green growth depends from development of all energy efficiency and RES criteria which are analyzed above.

6. Conclusions

1. Two energy consumption forecast scenarios are discussed in the study – Base scenario and Energy efficiency scenario. Projections of the first scenario are based on energy intensity indicators of Latvia in 2007. Energy efficiency scenario is created taking into account commitments relevant to the energy and climate package 2020.
2. Heat energy consumption in the Base scenario is expected to increase, while Energy efficiency scenario projects an insignificant increase by 2016 followed by a decrease afterwards. That is explained by the implementation of energy efficiency measures in all sectors, especially in household and services sector. The final consumption of electricity will grow in both scenarios, while its growth rate will largely slow down around 2016 in the Energy efficiency scenario because the average consumption of the EU 2004 level will be reached by then in the service and household sectors.
3. The hypothesis for long term changes of energy demand is based on assumptions of energy intensity indicators, substantial reduction of heat energy consumption (up to 50 %) and partial changes in electricity consumption by changes of structure of electricity end users. Total energy demand will depend from increase of GDP.
4. Lower GHG in 2020 and 2050 are explained by the transition of the energy sector to energy-efficient end-use and us of renewable energy resources. In the period 2013 – 2020 as well as up to 2050, the gradual decrease in use of the fossil fuel will allow reaching the 20% GHG level in the energy sector in comparison with 1990.

References

ADEME, 2007, Evaluation and Monitoring of Energy Efficiency in the New EU Member Countries and the EU-25, ADEME/IEEA, ADEME Editions, Paris

CB, 2007, Census Bureau of the U.S. Department of Commerce Historical and Projected Population and Growth Rates in Population for Baseline Countries/Regions 2000-2020, Census Bureau of the U.S. Department of Commerce.

Connolly D., Lund H., Mathiesen B.V., Leahy M., 2011, The first step towards a 100% renewable energy-system for Ireland, Applied Energy, 88, 502–507.

Ćosić B., Krajačić G., Duić, N., 2012, A 100% renewable energy system in the year 2050: The case of Macedonia, Energy, 48, 80-87.

Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community.

EP, 2009, Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

Eurostat, 2014, Statistics.< epp.eurostat.ec.europa.eu> accessed on 10.02.2014.

Henning H.M., Palzer A., 2014, A comprehensive model for the German electricity and heat sector in a future energy system with a dominant contribution from renewable energy Technologies — PartI: Methodology, Renewable and Sustainable Energy Reviews, 30, 1019-1034.

IESE (Institute of Energy Systems and Environment), 2008, Report Renewable Energy Resources in Latvia in 2020 / By order of the Ministry of Environment, Riga

IESE (Institute of Energy Systems and Environment), 2009, Renewable Energy Resources and Energy Efficiency Action Plan in 2020, Report order by the Ministry of Environment, Riga

IESE (Institute of Energy Systems and Environment), 2011, Green Energy Strategy of Latvia 2050.

Krajačić G., Duić N., da Graça Carvalho M., 2011, How to achieve a 100% RES electricity supply for Portugal?, Applied Energy, 88, 508–517.

Krajačić G., Duić N., Zmijarević Z., Mathiesen B.V., Vučinić A.A., da Graça Carvalho M., 2011, Planning for a 100% independent energy system based on smart energy storage for integration of renewables and CO2 emissions reduction, Applied Thermal Engineering, 31, 2073-2083.

Kwon P.S., Østergaard P.A., 2012, Comparison of future energy scenarios for Denmark: IDA 2050, CEESA (Coherent Energy and Environmental System Analysis), and Climate Commission 2050, Energy, 46, 275-282.

Lund H., Mathiesen B.V., 2009, Energy system analysis of 100% renewable energy systems — The case of Denmark in years 2030 and 2050, Energy, 34, 524– 531.

MoE (Ministry of Economy Republic of Latvia), 2006, Energy Development Guidelines for the period 2007-2016, Latvijas Vēstnesis, 122 (3490), Riga.

MoE (Ministry of Economy, Republic of Latvia), 2007, The manufacturing sector outlook and the predicted sectorial restructuring until 2020, Final Report, Latvijas Vēstnesis, 9 (65), Riga.

MoE (Ministry of Economics of the Republic of Latvia), 2008, The First National Energy Efficiency Action Plan.

MoE (Ministry of Economics of the Republic of Latvia), 2012, Latvian energy long term strategy 2030 – Competitive energy for society.

MoE (Ministry of Economics of the Republic of Latvia), 2013, Latvian energy in figures, 43 p.

ODYSSEE, 2007, Evaluation of Energy Efficiency in the EU-15: indicators and policies.

Porubova J., Bazbauers G., 2010, Analysis of long-term plan for energy supply system for Latvia that is 100% based on the use of local energy resources, Scientific Journal of RTU Environmental and Climate Technologies, 4, 82-90.

Rasmussen M.G., Andresen G.B., Greiner M.,2012, Storage and balancing synergies in a fully or highly renewable pan-European power system, Energy Policy, 51, 642–651.

Roos I., Soosaar S., Volkova A., Streimikene D., 2012, Greenhouse gas emission reduction perspectives in the Baltic States in frames of EU energy and climate policy, Renewable and Sustainable Energy Reviews, 4, 2133-2146.

Spiecker S., Weber Ch.,2014, The future of the European electricity system and the impact of fluctuating renewable energy – A scenario analysis, Energy Policy, 65, 185–197.

Steinke F., Wolfrum P., Hoffmann C., 2013, Grid vs. storage in a 100% renewable Europe, Renewable Energy, 50, 826-832.

Østergaard P.A., Mathiesen B.V., Möllera B., Lund H., 2010, A renewable energy scenario for Aalborg Municipality based on low-temperature geothermal heat, wind power and biomass, Energy, 35, 4892-4901.

Østergaard P.A., Lund H., 2011, A renewable energy system in Frederikshavn using low-temperature geothermal energy for district heating, Applied Energy, 88, 479–487.

WB (World Bank), Data, Indicators, <data.worldbank.org/indicator> assessed on 09.02.2014.