LITHUANIA

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VITAL STATISTICS

EU member state

Population
3,286,820 (Department of Statistics of the Government of the Republic of Lithuania, 2010)

Territory
65,300 km²

Capital
Vilnius

GDP/capita
28,793 LTL or 8,339 EUR
Average Annual GDP Growth
1.3% (2010)

Primary Energy Structure

Production
8,507.6 million toe (year 2009)

Demand/Consumption

Gross Consumption
11,457 GWh (year 2009)

Electricity

Production

Imports
1,681.0 GWh (2008)

Exports
2,638.4 GWh (2008)

Total Demand / Consumption
Gross Consumption
12,426 GWh (2009)

INTRODUCTION AND BACKGROUND

MACROECONOMIC SITUATION

The structure of the Lithuanian national economy inherited from its Soviet past was inappropriate in terms of size and access to raw materials and primary energy. Lithuania's transition to a free market economy occurred in two phases. From 1990 to 1995, new political and economic institutions were developed, simultaneously transforming the centrally planned economic system into a market economy. Despite many difficulties during transition period, steady progress in strengthening the performance of market supporting institutions and undertaking the necessary reforms has enabled the possibility of a strong and comparatively long term economic recovery. After the striking decline of the Lithuanian economy in 1990–1994, when GDP dropped 56.1% compared with its level in 1990, the period of 1995–2008 was characterized by stable economic expansion.

Since 1995, the country's economy has been recovering very fast – on average by 6.3% per annum. One important factor stimulating the country's economic development during the period of 2000–2008 was economic support from the EU structural funds and various programs. Successful use of the EU membership and new opportunities are playing very positive roles in reducing social and economic differences between Lithuania and the developed EU countries, as Lithuania gradually approaches average indicators in the EU-27. Owing to such fast economic development, GDP per capita in Purchasing Power Standards (compared with the average of the EU-27) increased in Lithuania from 39% in 2000 to 62% in 2008.

UPDATE ON MEMBER'S ENERGY FRAMEWORK

ALTERATIONS IN PRIMARY ENERGY BALANCE

The development of the total primary energy consumption in million tons of oil equivalents is shown in Fig. 2. Oil and oil products were, over several decades, the most important fuels in Lithuania. However, since 1990 their share in the primary energy balance has been fluctuating in a comparatively large range – from 44.2% in 1991 to 25.6% in 2003, with a clear tendency to a reduced role of heavy oil products due to decreasing consumption of heavy fuel oil for production of electricity and district heat. During the period of 2003–2008, the contribution of oil products to the primary energy balance was increasing due to growth in consumption of motor fuel, and in 2008 it was equal to 31.7%. However, in 2009, due to significant reduction of motor fuel consumption, share of oil products decreased to 29.3%.

At present, natural gas is one of the most important fuels in the Lithuanian primary energy balance. The share of natural gas, the most attractive fuel in a long-term perspective, was about 25% over the period 1990–2008. During the last two years total consumption of natural gas was decreasing, mostly owing to reduction of its non-energy use – in 2009 consumption of gas for production of mineral fertilizers was by 1.6 times less than in

2008 and by 1.9 times less than in 2007. This caused a reduction of natural gas share in the balance of primary energy from 30.8% in 2007 to 27.9% in 2008 and to 25.6% in 2009.

The role of coal was decreasing – from 4.8% in 1990 to 1.0% in 2001. During the period 2002–2007 share of coal in the primary energy balance was increasing and reached 2.7% in 2007, but in 2009 its contribution decreased again to 1.8%.

During the period 1990-2009 the share of nuclear – the cheapest imported fuel – was very high and fluctuated about 30% with the lowest value of 19.7% in 1991 and the highest value of 37.0% in 2003. The role of nuclear fuel was very important because, being comparatively cheap, nuclear fuel helped to relieve certain burden of balance of payments and therefore softened social problems. Nuclear fuel helped to increase the security of the primary energy supply, especially in the power sector. The share of nuclear energy in the primary energy balance in the year 2009 (year of final closure of Ignalina NPP) was 30.3%.

Primary energy resources in Lithuania are rather scarce. Local oil, peat, wood, geothermal and hydro energy, as well as energy from chemical processes could be used to meet consumer energy requirements. In 2009, their share in the country's primary energy balance was 14.3%. Their contribution was increasing very fast during the period 1990–2001 owing to steady growth of local oil extraction – from 12 thousand tonnes in 1990 to the maximal amount of 471 thousand tonnes in 2001. But during the last 8 years, extraction of local oil decreased more than 4 times to 115 thousand tonnes in 2009. Certain contribution into balance of indigenous resources is originated from energy of chemical processes. This energy corresponds to the content of the thermal energy gained in the chemical processes (production of fertilizers), which is transferred into hot water and steam. The share of heat utilized at factories producing mineral fertilizers in the balance of indigenous resources was fluctuating with the highest value of 19.6% in 1990 and the lowest value of 5.8% in 1994. In 2009, their share was equal to 17.7%.

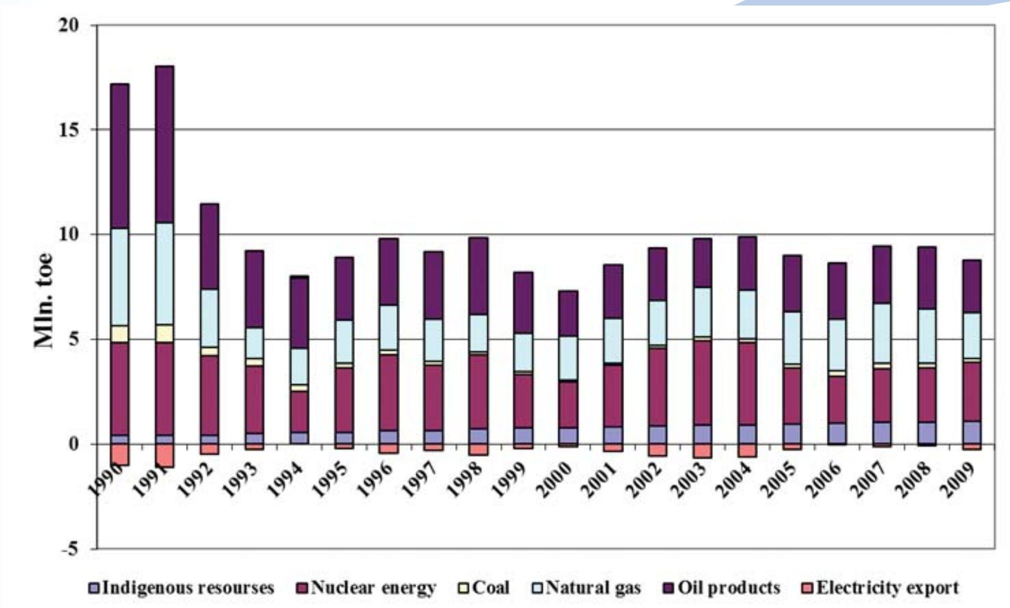

Figure 1: Primary energy supply, million toe

Since 2001, renewable energy sources are playing more and more important role. In 2009, their share in the balance of indigenous energy resources increased to 71.9%. Currently the main renewable energy resource is biomass (including wood waste, boughs, wood chips, pellets, sawdust and waste from agriculture). The contribution of hydro energy in absolute value is fluctuating depending on climatic conditions with small changes, and since 2006 contribution of bio-fuels, used as a motor fuel for the road transport, as well as of wind energy is increasing.

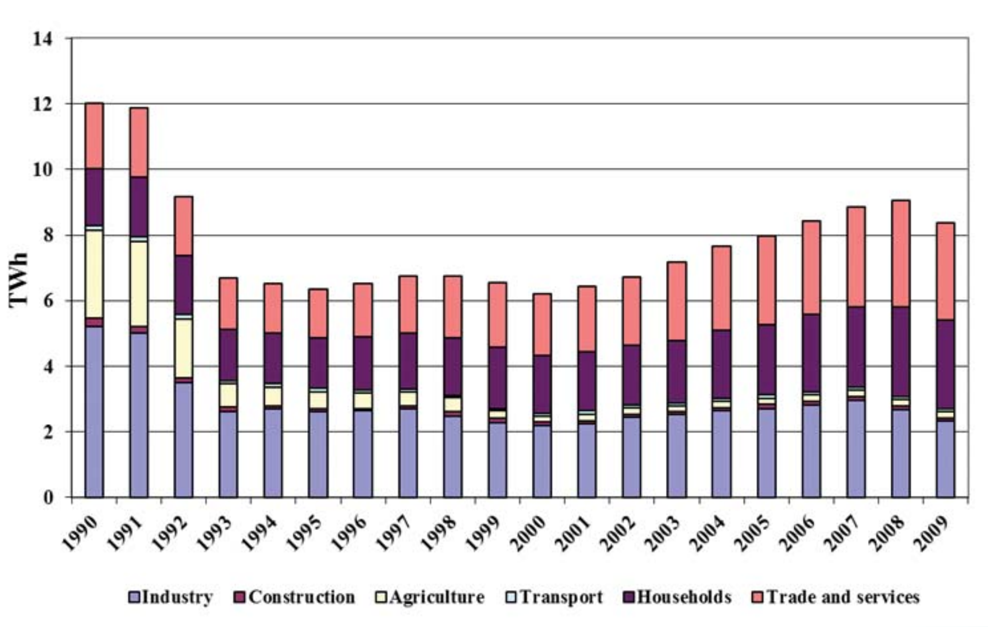

Figure 2: Final electricity consumption, TWh

Final electricity consumption decreased from 12 TWh in 1990 to 6.2 TWh in 2000 but was increasing by 4.8% per annum during the period 2000-2008 (Table 5). Electricity consumption was increasing in all sectors of the national economy (Fig.2). The highest growth rates during the period 2000-2008 were in the services sector (7.1%) and in households (5.6%). Electricity consumption was growing comparatively slowly in the industry and construction (2.5%) and in particular in agriculture (0.6%). In 2009, due to economic recession the total final electricity demand decreased by 7.4%, including its reduction in the construction sector by 20.4%, in manufacturing by 12.7%, the services sector by 8.8%, but in households reduction electricity demand was negligible.

ENERGY POLICY

Lithuania and the other Baltic States have no relevant gas or electricity interconnections with the rest of the EU. Dependence on single external supplier and status of an "energy island" in the EU are two main factors describing Lithuania's current energy situation and its energy policy objectives.

A number of projects are being developed which are expected to decrease Lithuania's dependence on single external energy supplier. These include, among others, the electricity interconnection "NordBalt" between Sweden and Lithuania, the electricity interconnection "LitPol Link" between Poland and Lithuania, new Visaginas Nuclear Power Plant in Lithuania (Visaginas NPP), an underground natural gas storage facility, and a liquefied natural gas (LNG) terminal.

From December 31, 2009, due to the shutdown of the state-owned Ignalina Nuclear Power Plant (Ignalina NPP), Lithuania's electricity generation structure has changed significantly and Lithuania changed from a net exporter of electricity to a net importer of electricity.

The energy sector is particularly important to the Lithuanian economy and energy security is a strategic priority for the Government. In October 2010, the National Energy (Energy Independence) Strategy was endorsed by the Government and submitted to the Parliament for the final approval. It foresees the most crucial assignments for Lithuania to achieve its energy independence until 2020. It will be ensured by breaking Lithuania's energy isolation (alternative ways to import energy resources will be established) and by securing sufficient and competitive internal capacities of energy production.

The shutdown of Ignalina NPP at the end of 2009 required clear thinking and strategic resolve to assess how the generation capacities of Ignalina NPP could be replaced by alternative generation capacities. National Energy (Energy Independence) Strategy states that sufficient local power generation capacities (estimated at 12–14 TWh in 2020) will be ensured by construction of a new Visaginas Nuclear Power Plant and by the increase of power generation from renewable energy sources (their contribution is increasing fast, Fig. 6), as well as power purchased in electricity market through existing and constructing power interconnections.

Lithuania has recently taken steps to liberalise its electricity market and expects the Lithuanian electricity market to be fully liberalised for all consumers by 2015. Lithuania intends to use "Nord Pool", the single power market for the Nordic countries, as the model for its electricity market. The liberalisation of the Lithuanian electricity market is expected to be a crucial step towards the creation of a common electricity market in the Baltic States and Lithuania's subsequent integration into the "Nord Pool" and the electricity market of continental Europe.

As a consequence of the shutdown of Ignalina NPP from the of January 1, 2010, the average electricity price for households, which is regulated, increased by approximately 30 % as compared to the price on December 31, 2009. January 1, 2010 also marked the official start of the electricity market in Lithuania (in the first among the Baltic States) – a crucial step towards the common Baltic electricity market. In 2010 approximately 70% of all Lithuania's electricity needs were purchased through the electricity market and this market platform conditioned the cheapest available power for the consumers. However, absent sufficient domestic competitive generation capacities Lithuania was forced to import a huge part of the electricity. In 2010, Lithuania imported more than 62% of the electricity needed to satisfy its demand. It is the highest import score among the EU member states.

In June 2010, the Government approved National Renewable Energy Sources Development Strategy, which aims in 2020 to achieve at least 23% share in the gross final energy consumption to be produced from renewables. The biggest potential is foreseen in wind energy, hydro energy (for power generation), and biomass (mostly for heat production). At the end of 2009, renewables comprised 17% of all energy used by final consumers, 9 % of electricity produced in the gross electricity consumption.

THE ELECTRICITY SYSTEM

In January 2009, the Ministry of Energy of the Republic of Lithuania was re-established for the purpose to reform the Lithuanian energy sector. Since then, a number of reforms have been undertaken in the energy sector.

In 2009, the EU adopted the Third Energy Package, a package of legislative measures aimed at liberalising EU energy markets. Based on the ownership unbundling requirements of the Third Energy Package, Lithuania is successfully reforming the electricity sector by separating transmission from generation and supply activities. In 2010, four blocks of energy companies were established (consisting of energy transmission, production, distribution and maintenance activities). The ownership unbundling will increase the overall efficiency of the power system, prevent discrimination against new market participants willing to connect to the grid, optimize the use and development of infrastructure, incentivise economic investment and ensure competitive prices for electricity consumers.

Due to historical factors, Lithuania's high voltage electricity transmission grid is directly interconnected with the high voltage grids of Latvia, Belarus and the Kaliningrad Region of the Russian Federation. These interconnections allow extensive exchanges of power with such neighbouring systems. However, a core objective of Lithuania's energy strategy is the integration of its power system into the common European electricity market as well as synchronous interconnection with Continental system of ENTSO-E. Seeking integration into EU energy systems, a number of energy projects are being carried out.

A marine underwater high voltage cable (Estlink) was completed in 2006 as a result of a joint venture between power companies in Finland and the Baltic States. Estlink allows the transportation of electricity between Finland and Estonia. The electricity is then transported from Estonia through the electricity transmission grid to Lithuania and Latvia. As key parts of the integration of the Baltic electricity market into the common European electricity market, new interconnection lines with Sweden (NordBalt) and Poland (LitPol Link) are in the process of being implemented.

NordBalt is a planned 700 MW submarine power cable between Lithuania and Sweden. In an effort to further exploit renewable energy sources, NordBalt will be constructed with the capability to access energy produced by offshore wind farms that may be constructed in the future. NordBalt is expected to cost EUR 516–738 million, of which EUR 175 million will be provided by the European Economy Recovery Plan. NordBalt is currently targeted for completion by the end of 2015. A number of preparation works for the construction of the interconnection has already been completed, including: a) a seabed survey for the NordBalt interconnection in the Baltic Sea, b) the preparation of the technical specifications for the NordBalt cable and converters, c) the tender process has successfully finished and on December, 2010 Swedish (Svenska Kraftnät) and Lithuanian (Litgrid) transmission system operators have signed a EUR 270 million worth contract with the Swedish energy and automated technologies company ABB, which will produce and install the 300 kV HVDC cable for the NordBalt interconnection.

LitPol Link is a planned 1,000 MW electricity link between Lithuania and Poland and is listed among the EU's priority energy infrastructure projects. According to the pre-feasibility study the cost of establishing LitPol Link is expected to be EUR 237 million and the project is expected to be completed by the end of 2015. In addition, Poland will invest EUR 650 million and Lithuania EUR 262 million to upgrade existing energy infrastructure. Preparation for the construction of the LitPol Link has already commenced in the form of:

- the financial and action plan for the interconnection;
- territorial planning; and
- environmental impact assessments for the 400 kV overhead power transmission line and Lithuanian substation.

HYDROGEN R, D&D SPECIFICS

In 2011, the researchers of the Center actively participated in International Energy Agency Hydrogen Implementation Agreement (IEA HIA) Task 22, Fundamental and Applied Hydrogen Storage Materials Development. In this activity, chemical destabilisation of metals and their alloy hydrides was carried out by introducing new elements into materials, which form intermediate derivatives during hydride decomposition and, thus not allowing the system to get fully relaxed to the lowest energy state, or form a destabilized hydride during hydrogenation.

In 2011, a state subsidy funded project "Synthesis and Property Analysis of Nano-crystalline Metal Hydrides, Designed for Energy Storage and Optical Devices" was continued. In the modern world, the greatest share of energy is obtained from oil, but its resources are finite.

The use of oil causes global problems which could be solved by replacing oil with an energy carrier, hydrogen. Hydrogen may be stored in metal hydrides: one of such hydrides currently under the most exhaustive research is magnesium hydride. However, due to the issued related to hydrogen absorption/desorption kinetics and excessively high formation/decomposition temperature, magnesium hydride has not yet been widely used in the energy sector. The most efficient methods for improving the properties of this hydride is to introduce small amounts of various additives (e.g. Ti) and in this way destabilise the Mg-H system.

During the implementation of this work, the researchers aimed at obtaining thin-layer Mg7TiHx structures by applying physical vapour deposition method for the synthesis of magnesium-titanium on silicon plates, which were cleaned before the process using plasma based pre-treatment. Hydrogenation of the resulting structures was performed by applying high-pressure and temperature hydrogenation chamber. The received samples were then tested by profilometer, scanning electronic microscope, energy dispersive X-ray spectrometer, X-ray diffractometer, and glow discharge optical emission spectroscope. The results of the experiments demonstrated that the compounds developing in the hydride depend on the material, used for synthesis, and its surface structure.

During the implementation of the EU SF project "Foundation of National Open Access Scientific Center for Future Energy Technologies," ULVAC-PHI X-ray photoelectron spectroscopy equipment (standard abbreviation XPS or ESCA) Versaprobe 5000 was bought and installed in LEI Center for Hydrogen Energy Technologies in 2010. It is the highest-quality analytical equipment, which distinguishes from other XPS by the lowest probing diameter as its size may be set from 300 to only 10 μm. This enables carrying out high special resolution XPS analysis encompassing the identification of separate elements, resolution of their chemical state and formation of extremely accurate phase maps.

Moreover, the spectroscope is equipped with a unique patented function of dual-beam charge neutralisation (low-energy ions and electrons). For this reason, both conductive and dialectric materials may be easily tested. In order to observe the material distribution in depth, an angle-dependent XPS (ADXPS) analysis may be performed, or the sample may be sputtered using the installed argon ion gun in order to carry out the grading of samples.

In cooperation with lectors and students at Department of Physics of Vytautas Magnus University and Department of Physics of Kaunas University of Technology, the Center for Hydrogen Energy Technologies concentrates equipment necessary for investigations, allowing teachers at Department of Physics of Vytautas Magnus University and Department of Physics of Kaunas University of Technology to use modern educational aids, prepare high-qualified specialists (including all study cycles) and develop competitive research. It is equally important that LEI has become a powerful centre of attraction for young researchers.

On 25 November 2011 the researchers of the Center for Hydrogen Energy Technologies were granted patent No. 5789 "Hydrogenation method of metals and their alloys," registered in the State Patent Bureau of the republic of Lithuania. The patent application for the metal hydrogenation technology developed by the researchers of the Center is currently processed in the European Patent Office in order to obtain a European patent: https://data.epo.org/publication-server/rest/v1.0/publication-dates/20110629/patents/EP2338834NWA1/document.pdf.

In 2011 a two-year project "Hydrogen Extraction from Water Vapour Plasma by Molecular Implantation" was completed as a part of the programme "Future Energy" financed by Research Council of Lithuania. The work has demonstrated that proton conductive oxide electrolyte fuel cells (PCFC) are capable of successfully changing solid oxide fuel cells (SOFC) and operating at lower temperatures by noticeably reducing the total price of fuel cell system. This project was one of the four hydrogen-related projects funded by Research Council of Lithuania

REFERENCES

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