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Analysis of energy transition possibilities after the decommission of a nuclear power plant in Ignalina region in Lithuania

Vygandas Gaigalis [a,*], Antanas Markevicius [b], Vladislovas Katinas [b], Romualdas Skema [a], Algis Tumosa [c]

[a] Energy Efficiency Research and Information Centre, Lithuanian Energy Institute, Breslaujos g. 3, LT-44403 Kaunas, Lithuania
[b] Laboratory of Renewable Energy, Lithuanian Energy Institute, Breslaujos g. 3, LT-44403 Kaunas, Lithuania
[c] Information Department, Lithuanian Energy Institute, Breslaujos g. 3, LT-44403 Kaunas, Lithuania

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ABSTRACT

The article describes the Lithuanian energy policy, energy and economical problems before and after the decommissioning of Ignalina nuclear power plant (INPP). After the decommission of INPP, the dominant kind of primary energy in the region became a imported natural gas which amounted to 74.8%, wood and waste provided 22%, and imported heavy fuel oil brought 3.2% of the primary energy. In the article the generation possibilities of electricity and heat from the renewable energy sources (RES) in INPP region are shown, technical and economically-based potentials of solar heat and solar electricity are evaluated, technical potential of wind power plants is disclosed, the potential of wood fuel use is predicted, theoretical possibilities of shallow geothermal energy use are revealed. The calculated total technical potential of RES usage in the region is around 30.1 thousand tonnes of oil equivalent (toe), from which wood fuel amounts to 14.7, wind power—11.3, solar heat and photo electricity—3.3, and hydro energy—0.8 thousand toe. INPP region consists of Ignalina and Zarasai district municipalities and Visaginas town municipality. In Zarasai and Ignalina districts, RES potential is 11.5 and 11.3 thousand toe, respectively, and Visaginas town potential is around 7.3 thousand toe. The measures to be taken to achieve the set objectives in Lithuanian INPP region are analyzed in this article.

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1. Introduction

About 30 years Lithuanian Ignalina and Zarasai countries with Visaginas town were related with Ignalina nuclear power plant (INPP) [1]. According the requirements of European Union (EU), for

Abbreviations: CHP, Combined heat and power; EU, European Union; HPP, Hydro power plant; INPP, Ignalina nuclear power plant; JSC, Joint Stock Company; LEI, Lithuanian Energy Institute; NPP, Nuclear power plant; PEA, Public energy alternatives; RES, Renewable energy sources; toe, tones of oil equivalent; TW h, tera watt hour (tera—10^{12}); W, watt (electrical power unit)

* Corresponding author. Tel.: +370 37 401855; fax: +370 37 351271.
E-mail address: vygas@mail.lei.lt (V. Gaigalis).

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the usage of unsafe technologies, such insecure plant was decommissioned and yet 30 years will be dismantling. The unexpected demand of the EU to develop a program of rapid closure of the INPP—the cheapest source of electricity throughout the region was the condition for the Lithuanian membership in the EU. The main argument for this demand was that nuclear power reactors in Lithuania were the same type as in the Chernobyl NPP and according to western experts cannot be considered safe. Lithuania agreed with the requirement that membership of Lithuania in the EU is possible only if the Ignalina nuclear power plant will be closed within a predetermined period of time. The deadlines were set that the first of two working INPP block units would have to close by the end of 2004 [2] and the second block—by the end of 2009 [3].

INPP Region was founded in 2002 after the EU requirements and decisions for decommissioning unsafe INPP [4]. The forces of the region municipalities were concentrated for the solution of common problems and INPP Regional Development Agency was established. The region development program was formulated and gradually implemented by applying the EU structural funds. But, despite all efforts to soften the sub-sequences of decommissioning of a nuclear plant, the prices of energy increased, the unemployment overgrew, trades were disappearing, and the level of emigration increased. The largest decline and heaviest consequences will be felt in Visaginas town municipality. From the start of operation INPP till the 31st of December 2009 it provided the residents, institutions and enterprises with waste heat from power generation. The residents were granted the benefit of "protected" electricity price equal to 50%. Upon the shutdown of INPP the heat prices and services increased significantly: heat prices—4 times, hot water price—2 times. It caused the social shock in the municipality and continues to negatively affect the life quality of population and activities of public-spending entities (budgetary authorities). The sharp increase in prices leads to the extended amount of compensations to be paid out for residents. All these factors induce the migration to other districts and abroad. The Lithuanian national and regional interests were to stabilize the emigration processes, to return the attraction of country and provide people with the possibilities to create the welfare on their land.

The major impact on energy policy in Lithuania on such time had preparation for accession to the European Union. It was necessary to harmonize the Lithuanian energy policy with EU policy and with a number of binding directives. Undoubtedly, the fate of the Ignalina nuclear power plant, the source of the cheapest electricity, which provided nearly 80% of the country's electricity supply, had a special impact on future of the electricity sector in all Lithuania. In order to prepare a more or less reliable and realistic strategy for the period after shutdown of INPP, it was necessary to conduct a thorough modelling of the most probable scenarios for the future development of the energy sector, taking into account not only the closure of the INPP, but also possible developments in international energy markets, actions and plans of Lithuania's neighbours. It was necessary to forecast the overall development of the economy and thus the future demand for energy resources. The analysis of all possible scenarios was carried out by the experts of the Lithuanian Energy Institute (LEI) on Lithuanian National Energy Strategy 2007 [5]. Some of the most important strategic objectives outlined in such strategy should be highlighted. They were: (1) energy security, (2) efficient use of energy; (3) introduction of competitive principles in the energy sector; (4) gradual integration into the energy systems of the European Union; (5) diversification of primary energy sources and ways of their imports, the rapid increase of renewable and local energy resources, and reducing the share of natural gas in the energy mix in Lithuania.

In order to achieve these objectives, the most important following activities were identified:

1. Implement the EU directives on the liberalization of electricity and natural gas markets;
2. Create a common electricity market of the Baltic countries and continue to integrate with the EU markets;
3. Ensure continuity in the use of nuclear energy by building a new nuclear power plant capable of ensuring the needs of all three Baltic States and the region;
4. Connect the electrical transmission network of Lithuania with the networks of the Nordic countries and Poland;
5. Ensure compliance with the EU directives related to the accumulation of reserves of oil and natural gas;
6. Increase the share of renewables in the primary energy balance up to 20% by 2025. Increase the share of electricity produced at cogeneration power plants up to 35%.
7. Continuously improve the consumption efficiency of all types of energy, so that by 2025 it would be possible to achieve the efficiency levels of developed countries of the EU.

The Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources (RES) sets the overall target to reach 20% renewable energy in gross final energy consumption in 2020 [6]. This target is bind with individual Member State targets. Energy consumption from RES in 2005, progress in 2010 and targets for 2020 years for Lithuania and the EU-27 are shown in Fig. 1, [7].

The Lithuanian target is to increase the share of renewables in gross final energy consumption from 17 to 23% to 2020. Reaching these targets will require a huge mobilization of investments in renewable energies not only for Lithuania but also for all EU 27 countries.

As shown in Fig. 1, the targets on the share of RES in final energy consumption in Baltic Sea Region countries are quite different. While Finland and Latvia already had a share of around 30% in 2005, Poland and Germany shares were below 10%. Thus the range of increasing the share of RES of such countries varies from around 20% (Latvia) to 200% (Germany). The Lithuanian range of increasing the share of RES is around 35%.

In Lithuania, the possibilities of wider use of local fossil resources (oil, peat) are limited. Therefore, it is extremely important to use the RES as widely as possible. The development of RES will ensure an attractive alternative to traditional energy because the combustion of fossil energy sources substantially increases the environmental pollution [8]. The sector of RES became the driving force of the country's economy. The goal of Lithuania is that sector of RES would fully satisfy the country's demand for heating and electricity would be produced at power plants that are neutral in terms of carbon dioxide. The use of RES in Lithuania is increased so as meet economical conditions of our country as well as in other countries [9]. Other countries also increasing to use renewable energy technologies and taking positive steps towards carbon emissions, cleaning the air and ensuring a more sustainable future [10]. The coming sustainable energy transition in the world, its history, strategies and outlook were analyzed by USA specialists [11]. The transitions from traditional to sustainable energy development for developing countries were studied in [12].

This article on RES implementation possibilities in Ignalina NPP region was prepared using the LEI material, collected and analyzed by implementing the Baltic Sea Region 2007–2013 programme project PEA "Public Energy Alternatives—Sustainable energy strategies as a chance for regional development" [13]. It is partially EU-funded project through which the RES are to be promoted as a driving force for business, technology, and engineering in the whole Baltic Sea Region. Twenty-one partners from six countries (Estonia, Finland, Germany, Latvia, Lithuania, and Poland) around