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Authors of the publication
Head of the Energy Security Research Centre (hereinafter – Centre) – Prof. Dr. Habil. Juozas Augutis
Senior Researcher – Prof. Dr. Vylius Leonavičius
Senior Researcher – Prof. Dr. Ričardas Krikštolaitis
Senior Researcher – Assoc. Prof. Dr. Sigita Pečiulytė
Researcher – Assoc. Prof. Dr. Dainius Genys
Junior Researcher – Dr. Giedrius Česnakas
Junior Researcher – Dr. Linas Martišauskas
Junior Researcher – PhD Candidate Justinas Juozaitis

Contacts of the Energy Security Research Centre
Address: Vileikos str. 8, LT-44404 Kaunas, Lithuania
Web page: www.estc.lt
Telephone number of the Centre: +370 37 327 933
E-mails of coordinators of the Centre: r.krikstolaitis@if.vdu.lt
j.juozaitis@pmdf.vdu.lt

CONTENTS

INTRODUCTORY STATEMENT OF THE HEAD OF ENERGY SECURITY RESEARCH CENTRE

Last year can justly be called as the turning point in the Lithuanian energy system. Until recently Lithuania belonged to the 'Energy Island' of the Baltic States; however, this status no longer pertains to the country due to the LNG terminal, which started its commercial activity in 2015, and the successful completion of electricity links with Poland and Sweden. Lithuania has become a country of European Union with an integrated electricity system, which has a capacity to resist various disturbances. Thus the national energy security level was approaching the limit, which Lithuania can realistically achieve taking into account the possessed natural resources, geopolitical situation, and its technical and economic potential.

The LNG terminal disrupted the monopoly of 'Gazprom', but the electricity systems of Baltic States remain synchronically connected with IPS/UPS system, which is controlled by Moscow. Aiming at strengthening their energy security, the Baltic States must cross this 'Rubicon' and synchronize its electricity systems with the European Continental Networks. This requires a strong political will and active mutual cooperation. The expression of joint commitment to synchronize the electricity systems with the European Continental Networks in the Declaration on Energy Security of Supply, signed by the Ministers responsible for Energy Policy in the Baltic States, is a solid step towards this direction.

Energy security is undoubtedly impossible without large investment; therefore, all efforts have to be made to use the new infrastructure efficiently and reduce its maintenance costs. The energy infrastructure established in Lithuania opens opportunities for private businesses. The sector of renewable energy has been the first to take advantage of this opportunity. Almost all quotas allocated to build wind power plants have been used, solar energy has been expanded and in a

number of largest cities biomass has become the main raw material used to produce thermal energy for the centralized heating networks.

The European Union's contribution to strengthening of the Lithuanian energy security has been immense in terms of political and financial support for its strategic energy infrastructure projects. The new initiative of the European Commission, i.e. the European Energy Union, can become one of the major pillars of the Lithuanian energy security. The initiative takes into account a number energy security issues of the European Union, for instance, dependence on fossil fuels and on limited number of its suppliers, excessive and often inefficient consumption of energy sources, pollution of environment, etc. It is most important that the Energy Union encourages mutual trust among the member states and solidarity in solving the emerging and longstanding challenges for the energy security of the European Union.

Although Lithuania cannot complain about the lack of European Union support, but the political elite must complete the planned projects in the energy sector and respond to the important issues, which divide active civic society into separate camps. The second tender on the exploration and extraction of unconventional hydrocarbons remains suspended, decisions have not been made with regard to the construction of Visaginas Nuclear Power Plant, issues regarding waste burning plants have not been solved and the civic society of Lithuania has not been acquainted with the draft project of National energy strategy.

The publication presents academic insights related with a number of these issues. First, the public perception of energy security in Lithuania is analyzed. Second, the level of Lithuanian energy security is assessed and compared to the respective level in Latvia and Estonia. Finally, the scenarios of the Lithuanian energy sector development are analyzed by assessing the possible impact of the most important energy infrastructure projects, which have been planned or are still under discussions, upon the energy security level.

Prof. Dr. Habil. Juozas Augutis

1. PUBLIC PERCEPTION OF ENERGY SECURITY IN LITHUANIA[1]

Trying to identify the most important aspects of energy security for Lithuanian society, it was decided to provide the vast variety of different aspects of energy security (which were elaborated with the assistance of experts) and offer respondents to evaluate each of them according to their personal opinion. The aspects of energy security were formed in relation with Lithuanian strategic interests and covered different angles of energy security: *diversification* (of energy suppliers as well as resources), *reliability* (of supply and infrastructure), *independence* (from foreign states (mainly Russia) as well as monopolistic practices), *ability to take advantage of international political relations (e.g., EU, NATO) to defend Lithuanian interests*, lastly – *evaluation of strategic projects to be implemented in the upcoming future* (renewable energy, shale gas, nuclear energy).

Representative survey was conducted by public opinion research company 'Vilmorus' in May and June 2013. Number of respondents: N = 2002; interviewed 18 years old and older residents of Lithuania. Method of survey: questioning respondents at home using pre-made questionnaires. Method of selection: multi-stage, probabilistic sampling. Selection of respondents was prepared so that each resident of Lithuania should have an equal chance of being questioned. The results reflect the opinion of the entire population of Lithuania and distribution by age, sex, place of residence, education, purchasing power. Error of survey results – 3 % (probability – no less than 97 %).

The survey revealed that energy security is perceived by the public rather broadly. Among the fourteen aspects presented to

1 The data first appeard in the paper and reference should be made as follows: Leonavičius, V.; Genys, D.; Krikštolaitis, R. 2015. Public perception of energy security in Lithuania, *Journal of Security and Sustainability Issues* 4 (4): 311–322. DOI: http://dx.doi.org/10.9770/jssi.2015.4.4(1).

respondents for the assessment of its importance to Lithuanian energy security, certain trends were identified after evaluation.

First, all the listed energy security aspects are important or very important to the respondents. As might have been expected, the most prominent are *prices of energy resources* (89.7 % *important* or *very important*) and *reliability of energy supply services* (87.9 % *important* or *very important*).

Second, the study shows the continuing ambiguous evaluation of nuclear energy, when almost half say that this type of energy is *important*, almost a quarter (24.1 %) of respondents answered that the *'Development of nuclear energy'* was *absolutely unimportant* or *unimportant* for Lithuanian energy security, and a little more than a quarter (26.8 %) have not decided on this issue.

Third, evaluation of '*Development of shale gas extraction*' is extremely ambiguous: a little less than one-third (28.6 %) of respondents believe that it is an *unimportant* or *absolutely unimportant* aspect of Lithuanian energy security, and yet almost one-third (31.7 %) have not decided on this issue; however, 39.7 % of them believe that it is an *important* or a *very important* aspect.

Fourth, despite certain evaluation trends indicated during the analysis, it is equally obvious that the public lacks information about certain aspects of Lithuanian energy security, which are less discussed in mass media or are more specific. For example, about a fifth of respondents have not decided about: a) *development of oil extraction*; b) *diversification (diversity) of energy resources*; c) *diversification (diversity) of energy suppliers*; d) *integration into the common European Union energy market*; e) *the ability to take advantage of international political relations (e.g., EU, NATO) to defend Lithuanian interests*. Thus during formation of the Lithuanian energy policy, it is necessary to take into account these provisions,

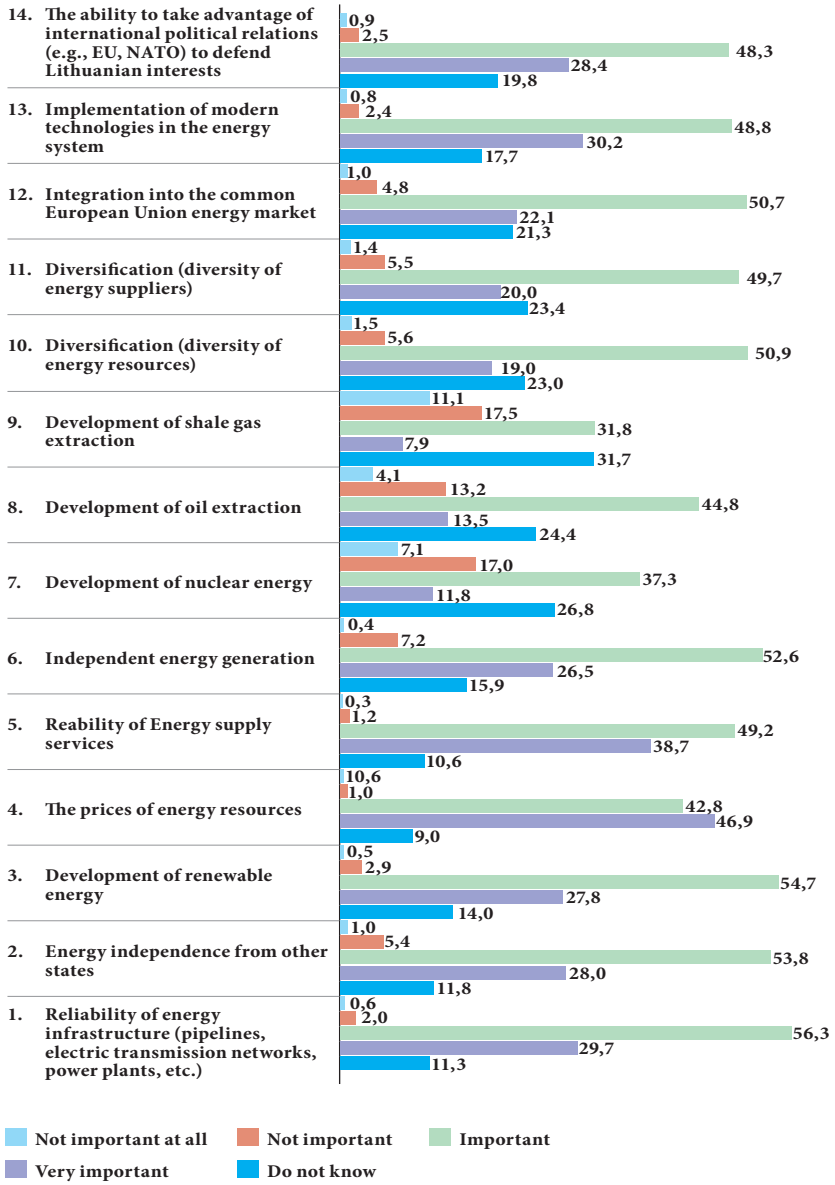

Figure 1. The importance of energy security aspects for Lithuania

because it is likely that a certain part of the society will take a negative position, which can disrupt certain projects[2] (see Figure 1).

1.1. The most important aspects of energy security in a public view

The five point *Likert scale* was used for the data analysis and interpretation. Respondent disapproval of a particular issue was marked 1, indecisiveness / not knowing – 3 and approval – 5. Increased average of the responses (e.g., when responses average is approaching 5) means a higher importance of the particular aspect from the point of respondents opinion and conversely, lower average – lower importance (e.g., when responses average is approaching 1).

The below provided table reveals the ratings of the most important aspects of energy security in Lithuania amongst respondents. The highest rank of 4.35 scored *'The prices of energy resources'*, while the lowest of 3.08 – *'Development of shale gas extraction'*. The aggregated average is 3.874, which means that all provided aspects according to respondents are very close to be important (where 1 = Not important at all, and 5 = Very important). We can see that only three aspects were evaluated distinctly below average: *'Development of shale gas extraction'* (3.08), *'Development of nuclear energy'* (3.30) and *'Development of oil extraction'* (3.50). While other three were close to the average: *'Integration into the common European Union energy market'* (3.88), *'Diversification (diversity) of energy suppliers'* (3.81) and *'Diversification (diversity) of energy resources'* (3.80). All eight other were evaluated above the average (see Table 1).

2 A referendum of a consultative character on the construction of a new nuclear power plant in the Republic of Lithuania took place on October 14, 2012. Contrary to what the ruling majority aimed at, only 34.09 % of the participants supported the construction of the nuclear power plant, while 62.68 % opposed it. The referendum can be regarded as an example of unsuccessful governmentality.

Table 1. The importance of energy security aspects. Summary of ratings (N 2002). 1 = Not important at all, 5 = Very important

Evaluate the importance of the following aspects for Lithuanian energy security	Mean	Min	Max	SD
The prices of energy resources	4.35	1	5	0.717
Reliability of energy supply services	4.25	1	5	0.715
Reliability of energy infrastructure (pipelines, electric transmission networks, power plants and so on)	4.12	1	5	0.730
Development of renewable energy	4.06	1	5	0.763
Implementation of modern technologies in the energy system	4.05	1	5	0.807
Energy independence from other states	4.02	1	5	0.838
The ability to take advantage of international political relations (e.g., EU, NATO) to defend Lithuanian interests	4.01	1	5	0.817
Independent energy generation	4.00	1	5	0.811
Integration into the common European Union energy market	3.88	1	5	0.842
Diversification (diversity) of energy suppliers	3.81	1	5	0.866
Diversification (diversity) of energy resources	3.80	1	5	0.860
Development of oil extraction	3.50	1	5	1.016
Development of nuclear energy	3.30	1	5	1.101
Development of shale gas extraction	3.08	1	5	1.117

1.2. Difference of public attitude amongst various social groups

Contemporary society is composed of different social groups which are usually fragmented to each other and often have different goals. Only part of them has sufficient social welfare to pursuit their interest independently, while many others have fewer opportunities. Therefore, they are more dependent on the social welfare of the state and state politics in general. Trying to build solid and optimal energy security policy it is important to identify existing differences in attitudes towards energy security between various social groups. Therefore, the differences in regard to the following aspects: *gender*, *age*, *education*, *occupation*, *income* and *living area* were analyzed and

are presented in the following parts of the paper. The assumptions for every analyzed group were based on theoretical insights (Knox-Hayes *et al* 2013; Perlavičiūtė, Steg 2015) and similar empirical research (Demski *et al* 2014; Strambo *et al* 2015) and are presented separately in each paragraph as follows.

1.2.1. Gender

The assumption made in the research expected women to prioritize environmental issues and *renewable energy* more than men. Meanwhile, it was expected men to prioritize *reliability* and *independent energy generation*.

Despite the anticipatory assumption, the research showed that in Lithuania there are almost no differences of attitudes towards most important aspects of energy security between men and women. The only noticeable differences were grasped on the attitudes on the first and the twelfth aspects (i.e. *'Reliability of energy infrastructure (pipelines, electric transmission networks, power plants, etc.)'*; and *'Integration into the common European Union energy market')* when the average of men responses at first reach 4.16 for men and for women 4.10, and at twelfth responses for men reach 3.92 and for women – 3.85. As we can see, even here the difference is only 0.07 meanwhile in the evaluation of other aspects differences haven't reached more than 0.03.

1.2.2. Age

The assumption made in the research expected elderly groups to be concern with *energy prices* and *reliability of supply*. While younger groups – with *long term interest* and *strategic projects* (e.g., renewable energy, implementation of modern technologies in the energy system, ability to take advantage of international political relations).

The below provided table shows how groups of different age ranks each of the aspect of energy security according to their importance and the mean of the responses.

Table 2. The importance of energy security aspects by different age groups

Question / age	18–25		26–35		36–45		46–55		56–65		66 and more	
	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Q 4	1	4.42	1	4.42	1	4.35	1	4.33	1	4.33	1	4.30
Q 5	2	4.26	2	4.31	2	4.20	2	4.26	2	4.24	2	4.23
Q 1	3	4.17	3	4.18	3	4.15	4	4.08	3	4.10	3	4.11
Q 14	4	4.16	5	4.16	8	3.94	8	3.96	7	3.99	8	3.93
Q 13	5	4.13	4	4.16	6	3.99	6	4.03	4	4.03	4	4.02
Q 3	6	4.08	6	4.14	4	4.08	3	4.10	5	4.02	6	3.99
Q 2	7	4.01	7	4.11	5	4.06	5	4.03	8	3.97	7	3.99
Q 6	8	3.96	8	4.07	7	3.98	7	3.97	6	4.00	5	4.01
Q 12	9	3.90	9	3.92	9	3.83	9	3.85	9	3.90	9	3.89
Q 11	10	3.88	10	3.91	10	3.79	10	3.77	10	3.82	11	3.76
Q 10	11	3.83	11	3.91	11	3.75	11	3.75	11	3.81	10	3.79
Q 8	12	3.57	12	3.60	12	3.57	12	3.41	12	3.47	12	3.46
Q 7	13	3.37	13	3.40	13	3.38	13	3.25	13	3.24	13	3.21
Q 9	14	3.22	14	3.19	14	3.11	14	3.01	14	2.98	14	3.05

The analysis showed that there are no differences in opinion on the most important aspects of energy security between different age groups in Lithuania. The three most important aspects were named the same: *'The prices of energy resources'*, *'Reliability of energy supply services'* and *'Reliability of energy infrastructure (pipelines, electric transmission networks, power plants, etc.)'*. It corresponds with assumption made for elderly groups; however, it seems that in relatively poor society the same aspects are actual to all age groups of society.

Meanwhile more noticeable differences emerge in the following aspects. As it was pointed in the assumption: younger groups (age *18–25* and *26–35*) are indeed more concern with *'Ability to take advantage of international political relations'* (rank 4 and 5), *'Implementation of modern technologies in the energy system'* (rank 5 and 4) and *'The development of renewable energy'* (rank 6 for both groups). Interestingly enough for all the other groups *'The development*

of renewable energy' also is important (ranked from 3 to 6 with very similar mean of responses). Unexpectedly the *'Implementation of modern technologies in the energy system'* was highly ranked (4th place) by the elderly groups (*56–65* and *66 and more*).

The middle age groups (*36–45* and *46–55*) are concerned with *'Energy independence from other states'* and *'Independent energy generation'* above all others (rank 5 and 7).

Lastly the three most ambivalently ranked aspects were *'Development of oil extraction'*, *'Development of nuclear energy'* and *'Development of shale gas extraction'* – accordingly 12th, 13th and 14th ranks for all age groups. The *'Development of shale gas extraction'* also scored the lowest mean of responses average. As it was mentioned before, this might be related with information shortage on these relevant issues in society, which hinders clear understanding of its importance to energy security.

1.2.3. Education

The assumption made in the research expected those with higher education to be more concerned with *diversification* (of resources as well as suppliers), *independent energy generation* and *implementation of modern technologies* in energy system. While those who haven't obtained a degree of higher education – to be more concerned with *energy prices* and *reliability of supply*.

The below provided table shows what are the most important aspects for groups of different education and what are the differences amongst them.

As it was in previous case, the same most important aspects ('*The prices of energy resources'*, *'Reliability of energy supply services'* and *'Reliability of energy infrastructure (pipelines, electric transmission networks, power plants, etc.)'* emerged here and there are almost no differences (except that those with *Vocational training* and *Unfinished high education*, where the aspect of *reliability of supply* was ranked

accordingly in 4th and 6th place) between different education groups. Although it is worth mentioning that the means of the responses average between different groups, they are not as consistent as it was in previous case (see Table 3).

Table 3. The importance of energy security aspects by different education groups

Education / Question	Primary education		Secondary education		Vocational training		Further education		Unfinished higher education		Higher education	
	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Q 4	1	4.06	1	4.32	1	4.34	1	4.36	1	4.39	1	4.48
Q 5	2	3.98	2	4.18	2	4.21	2	4.28	3	4.24	2	4.41
Q 1	3	3.90	3	4.08	4	4.05	3	4.16	6	4.17	3	4.25
Q 3	4	3.83	5	3.99	5	4.02	4	4.08	2	4.30	6	4.19
Q 2	5	3.79	6	3.98	8	3.92	7	4.01	5	4.19	5	4.19
Q 13	6	3.79	7	3.98	3	4.11	6	4.01	4	4.20	4	4.21
Q 6	7	3.79	8	3.96	9	3.92	5	4.02	8	4.07	8	4.13
Q 14	8	3.72	4	4.01	6	3.98	8	3.98	7	4.13	7	4.16
Q 12	9	3.70	9	3.80	7	3.95	9	3.87	10	4.00	10	3.99
Q 10	10	3.59	11	3.74	10	3.80	10	3.76	11	3.89	11	3.98
Q 11	11	3.57	10	3.74	11	3.80	11	3.76	9	4.04	9	4.00
Q 8	12	3.49	12	3.53	12	3.50	12	3.51	12	3.57	12	3.46
Q 7	13	3.32	13	3.30	13	3.31	13	3.23	13	3.57	13	3.29
Q 9	14	3.22	14	3.10	14	3.08	14	2.98	14	3.46	14	3.01

The high rank of aspects *'Energy independence from other states'* and *'Development of renewable energy'* between *Primary* and *Secondary education* groups comes with a little surprise. On the other hand, this might be related with the popular demand for the cheap energy in society in general. The same aspect of *'Development of renewable energy'* was ranked in the second place in case of *Unfinished higher education*.

The assumption for those with *Higher education* corresponds only in part. The aspects of diversification (of resources as well as suppliers) didn't receive much approval and were ranked only in 11th

and 9th places. Meanwhile the aspects of *'Independent energy generation'* and *'Implementation of modern technologies in energy system'* scored much higher means and were ranked in 5th and 4th places (this was also the case for those with *Unfinished higher education*).

'Development of oil extraction', *'Development of nuclear energy'* and *'Development of shale gas extraction'* were also evaluated as most irrelevant as in previous case. Even though they scored much less than aggregated average (3.87) the difference between these groups are quite noticeable (see Table 3).

1.2.4. Occupation

The assumption made in the research expected those from private sector to prioritize market principles (*diversification* and *independent generation*). Meanwhile, employees of state enterprises to prioritize involvement of diplomacy (*ability to take advantage of international political relations* and *energy independence*) while those who are retired and unemployed will be similar to the elderly groups (the importance of *energy prices* and *reliability of supply*).

The above provided table once again stressed the importance of *'The prices of energy resources'*, *'Reliability of energy supply services'* and *'Reliability of energy infrastructure (pipelines, electric transmission networks, power plants, etc.)'* within Lithuanian society. They are also most popular aspects despite the differences between different occupation groups.

The results confirmed the assumption in case of *State enterprises employee*: *'Energy independence from other states'* (Q4) was ranked as the most important aspect for energy security right after those three which importance are unquestioned in Lithuania. *'The ability to take advantage of international political relations (e.g., EU, NATO) to defend Lithuanian interests'* took 6th place and in between of these two the aspect of *'Development of renewable energy'* intervened in group of *State enterprises employee*.

Table 4. The importance of energy security aspects by different occupation groups

Question / occupation	State enterprises employee		Private business owner		Private company employee		Student / Pupil		Unemployed		Retired		Other activities	
	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Q 4	1	4.40	1	4.35	1	4.44	1	4.48	1	4.13	1	4.30	1	4.10
Q 5	2	4.33	2	4.27	2	4.32	3	4.26	2	3.95	2	4.24	2	4.04
Q 1	3	4.18	3	4.23	3	4.19	4	4.22	5	3.83	3	4.11	4	3.88
Q 2	4	4.11	7	4.03	5	4.15	7	4.06	7	3.77	7	3.97	7	3.79
Q 3	5	4.08	4	4.16	4	4.17	6	4.12	3	3.88	5	4.01	3	3.91
Q 14	6	4.07	8	3.99	7	4.10	2	4.27	6	3.80	8	3.93	5	3.83
Q 6	7	4.06	5	4.15	8	4.05	8	4.00	8	3.76	6	4.00	8	3.75
Q 13	8	4.05	6	4.13	6	4.15	5	4.16	4	3.88	4	4.01	6	3.82
Q 10	9	3.85	11	3.80	11	3.92	10	3.86	11	3.56	10	3.76	9	3.69
Q 11	10	3.84	9	3.87	10	3.96	11	3.85	10	3.57	11	3.75	10	3.65
Q 12	11	3.83	10	3.85	9	4.01	9	3.93	9	3.70	9	3.88	11	3.61
Q 8	12	3.55	12	3.61	12	3.48	12	3.51	12	3.47	12	3.47	12	3.56
Q 7	13	3.27	13	3.38	13	3.35	13	3.28	13	3.35	13	3.24	14	3.35
Q 9	14	2.95	14	3.04	14	3.15	14	3.14	14	3.17	14	3.03	13	3.38

The assumption for those from private sector was proved only in part. Different from what was expected, the aspects of *diversification* (of supply not resources) did not attract much approval and were ranked in 11th and 9/10th places in *Private business owners* and *Private company employee* groups. Meanwhile the other aspect *'Energy independence from other states'* was ranked in 5th place by *Private company employees* and in 7th place by *Private business owners*. *'Independent energy generation'* was also important for both groups (rank 5 and 8). It is worth mentioning that '*Development of renewable energy'* scored the fourth highest rank in both groups.

Some other mentionable aspects are: *'The ability to take advantage of international political relations'* which was ranked in 2nd place in group of *Students* and *Pupils*; *'Development of renewable energy'* was ranked at 3rd place in *Unemployed* and *Other activity*

groups; *'Implementation of modern technologies in the energy system'* was ranked in 5th place in *Students* and *Pupils* and in 4th place in *Unemployed* and *Retired* groups.

1.2.5. Income

The assumption made in the research obviously expected groups with lower income to be concern with *energy price* and *reliability of supply*. Meanwhile, groups with higher income were expected to be more concerned with *development of renewable energy*, *independent energy generation* and *implementation of modern technologies*.

Table 5. The importance of energy security aspects by different income groups

Question / Income per person	Under 300 Lt[3] (86,89 Eur)		301–600 Lt (87.18–173.77 Eur)		601–900 Lt (174.06–260.66 Eur)		901–1200 Lt (260.95–347.54 Eur)		1201–1500 Lt (347.83–434.43 Eur)		1501–1800 Lt (434.72–521.32 Eur)		1801–2100 Lt (521.61–608.20 Eur)		2101 Lt and more (608.49 and more)	
	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Q 4	1	4.11	1	4.22	1	4.35	1	4.41	1	4.60	3	4.53	1	4.39	1	4.63
Q 5	2	4.00	2	4.09	2	4.26	2	4.34	2	4.45	2	4.53	3	4.29	2	4.59
Q 1	3	3.89	3	3.99	3	4.12	3	4.24	3	4.31	8	4.26	2	4.35	3	4.44
Q 13	4	3.87	6	3.94	7	3.97	4	4.17	5	4.28	1	4.58	6	4.16	5	4.39
Q 3	5	3.85	4	3.99	4	4.05	5	4.10	4	4.30	5	4.37	5	4.20	6	4.39
Q 14	6	3.85	7	3.92	8	3.93	8	4.08	6	4.27	4	4.47	8	4.12	4	4.44
Q 6	7	3.84	8	3.90	6	4.00	6	4.09	8	4.16	11	4.00	9	4.08	10	4.24
Q 2	8	3.75	5	3.96	5	4.04	7	4.08	7	4.20	7	4.32	4	4.29	8	4.29
Q 12	9	3.72	9	3.77	9	3.82	9	3.97	9	4.11	10	4.26	7	4.14	7	4.32
Q 10	10	3.68	11	3.67	11	3.76	10	3.94	11	4.01	9	4.26	11	3.88	11	4.20
Q 11	11	3.68	10	3.69	10	3.77	11	3.90	10	4.06	6	4.37	10	3.96	9	4.27
Q 8	12	3.52	12	3.55	12	3.43	12	3.52	12	3.55	12	3.58	13	3.35	12	3.80
Q 7	13	3.40	13	3.37	13	3.21	13	3.28	13	3.34	13	3.05	12	3.37	13	3.56
Q 9	14	2.95	14	3.15	14	2.99	14	3.06	14	3.06	14	2.95	14	3.25	14	3.34

3 The public poll was carried out in 2013 when national currency Litas was still in use, therefore in further analysis in this article income in Litas is used as a category. The analogue amount in Euros is provided in the brackets.

The below provided table shows what are the most important aspects for groups of different income and what are the most noticeable differences amongst them.

This is the first time when at least one group broke the settled tendency of the most important aspects. The usual three aspects *('The prices of energy resources'*, *'Reliability of energy supply services'* and *'Reliability of energy infrastructure (pipelines, electric transmission networks, power plants, etc.)'*) were common for most of the groups except one (income of *1501–1800*) which *'Implementation of modern technologies in the energy system'* ranked as the most important aspect for energy security. The other not usual surprise was noticed in the other settled tendency of the most irrelevant aspects where the group of those with *1801–2100* income aspect Q7 ranked over Q8.

The results in this case fully corresponded with the assumptions. Groups with higher income (*901–1200*; *1201–1500*; *1501–1800*; *1801–2100*; *2101 and more*) gave priority (especially group *1501–1800*) to *'Implementation of modern technologies'* (rank 1), *'Development of renewable energy'* (rank 5). The additional aspect *'The ability to take advantage of international political relations'* was also important (rank 4) for groups of *1501–1800* and *2101 and more*. Meanwhile *'Independent energy generation'* was important for all groups except those with the lowest and those with the highest income. Both groups ranked it for 8th place but the mean of the response was quite different (accordingly 3.75 and 4.29).

1.2.6. Living area

The assumption made in the research expected to reveal the main difference between those living in cities and those living out of cities. This opposition derives from objective living condition differences – those living in big cities expected to be concerned more with *renewable energy* and *modern technologies* and those living small towns to be concern with *diversification of resources*.

Table 6. The importance of energy security aspects by different living area groups

Question / living area	Main Cities		District Centers		Small Towns		Rural Settlements and single farms	
	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Q 4	1	4.54	1	4.12	1	4.22	1	4.32
Q 5	2	4.41	2	4.08	5	4.02	2	4.21
Q 1	3	4.27	7	3.97	7	3.97	3	4.09
Q 13	4	4.18	5	3.97	3	4.12	6	3.94
Q 3	5	4.16	6	3.97	8	3.92	4	4.04
Q 14	6	4.13	8	3.91	2	4.13	7	3.92
Q 6	7	4.10	4	3.99	11	3.72	8	3.90
Q 2	8	4.09	3	4.00	13	3.58	5	4.00
Q 12	9	3.95	9	3.89	4	4.02	9	3.77
Q 10	10	3.93	11	3.82	6	4.00	11	3.59
Q 11	11	3.93	10	3.84	9	3.92	10	3.61
Q 8	12	3.49	12	3.50	10	3.77	12	3.50
Q 7	13	3.21	13	3.27	14	3.55	13	3.41
Q 9	14	3.01	14	3.18	12	3.67	14	3.00

The analysis showed that *'The prices of energy resources'* remains as the most important aspect of energy security in Lithuanian throughout all different social groups. However, *'Reliability of energy supply services'* was ranked in 2nd place for all groups except those living in *Small towns* (rank 5). The importance of the *'Reliability of energy infrastructure'* aspect divided into two groups depending on living area. It was equally important for those living in *Main cities* as well as in *Rural districts* (both ranked in 3rd place) and less important for those living *District centers* and *Small towns*.

Another interesting difference between those living *District centers* and *Small towns* was fixated towards *'Independent energy*

generation' and *'Energy independence from other states'*. For the first mentioned group it was important (rank 4 and 3), but for the second group somehow almost not important at all (rank 11 and 13).

The results confirmed the assumption: the aspects *'Development of renewable energy'* and *'Implementation of modern technologies'* were ranked accordingly at 4th and 5th places (right after the three that are most important for society in general) for *Main cities* group. Meanwhile the importance of *'Diversification of energy resources'* for those living in *Small towns* was ranked in 4th place.

Lastly, *'Development of oil extraction'*, *'Development of nuclear energy'* and *'Development of shale gas extraction'* were also evaluated as most irrelevant aspects for most of the groups with an exception of *Small town* group (which as the most irrelevant ranked *'Development of nuclear energy'*) and 'Development of oil extraction' was ranked a bit higher – in 10th place.

1.3. Concluding Statements

The research showed that variety of different aspects is taken into account in public perception on energy security. However there are two aspects which dominated throughout different social groups: *'The prices of energy resources'* (mean – 4.35) and *'Reliability of energy supply services'* (mean – 4.25). Another aspect *'Reliability of energy infrastructure (pipelines, electric transmission networks, power plants, etc.)'* (mean – 4.12) is also very important in public opinion (but is not as dominating as previous two). The three most ambivalently ranked aspects were *'Development of oil extraction'* (mean – 3.50), *'Development of nuclear energy'* (mean – 3.30) and *'Development of shale gas extraction'* (mean – 3.08). This indicates that the developers of energy policy do not manage to successfully link these specific projects to the public interest.

An effective energy policy is based on the rationality of society and its trust in public interest. But if society believes that the developers of energy policy do not represent their interests, it becomes difficult to guarantee the implementation of smooth policy. Great amount of those who are undecided or do not know (on such aspects as *'Development of nuclear energy'* (26.8 %), *'Development of oil extraction'* (24.4 %), *'Development of shale gas extraction'* (31.7 %), *'Diversification (diversity) of energy resources'* (23 %), *'Diversification (diversity) of energy suppliers'* (23.4 %), *'Integration into the common European Union energy market'* (21.3 %), *'The ability to take advantage of international political relations (e.g., EU, NATO) to defend Lithuanian interests'* (19.8 %) points to the important issue – lack of public communication – in energy policy formation processes. This is important not only because of untapped potential for the energy security impact on sustainable development and social cohesion, but also due to the fact that undecided part of society might become an object for radical movements or even hostile foreign policy.

Despite the increasing academic debate on the sustainable development of energy security, the research showed that in Lithuania, the interests of different social groups are not aligned with each other, and the policy of energy security simply aims to correspond to the average of public opinion. It is important to recognize the interests and needs of each society groups, it is inevitable to ground the policy with tangible evidence and argue its value and compatibility with interests of each group (and public interest in general) if aiming to build effective and sustainable energy security policy. As it was mentioned before, the empirical data of 2013 year was used in the study which indicates situation of that time, meanwhile in recent years the energy sector has undergone a number of significant changes[4] that most likely will have an effect on public perception. On the one hand, this

4 More about main significant events in Lithuanian energy sector in 2014 see: Augutis *et al* 2015.

most probably will have a positive impact on public attitude, on the other hand, we will have to wait until the benefit of realized projects will become visible and the actual effect of their impact on society will be possible to measure. However, if the public opinion will continue to be treated not as a subject but as an object, without further discussion of its demands, it may be that the amount of those who are undecided and do not know will remain high and it will serve as an obstacle for the implementation of energy policy.

2. THE LITHUANIAN ENERGY SECURITY LEVEL IN 2007–2014

The integral security level of the country can only be assessed with regard to all factors influencing energy security. There are more than 60 factors (indicators). All of them are divided into three blocks – technical, economic and socio-political. Each block and each indicator have their value in the overall estimate that integrates the influence of all factors for energy security. This estimate is called the energy security level (measured in the scale from 0 (the worst case) to 100 % (the best case).

2.1. The overall Lithuanian energy security level

The assessment of Lithuanian energy security level has started since 2007, when the energy security level had reached 53.6 % in comparison to the maximum – 100 %. Over the past years, the highest security level was achieved in 2008 – 56.9 %, and the lowest was noted in 2012 – 52.3 %. Starting from 2013, an increase of the energy security level is observable, which in 2014 reached 55.5 %. The biggest impact on the increase of the energy security level was the decrease of natural gas and increase of biofuel components weight in the country's fuel and energy balance, as well as decrease of energy intensity. The dynamics of energy security level is illustrated in Figure 2.

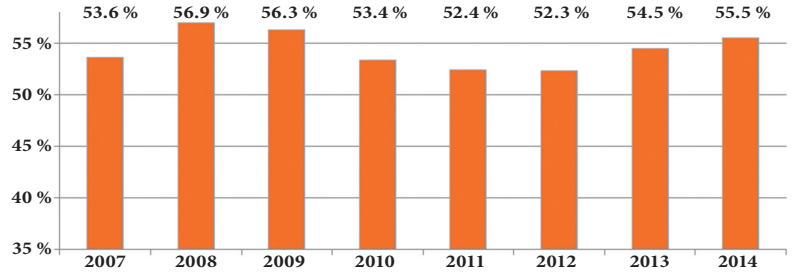

Figure 2. The dynamics of energy security level in 2007–2014

In 2010, the situation in the energy sector changed due to the shutdown of Ignalina NPP and the resulted change of the prevailing resource of electricity energy production – basic production of electricity energy was ensured by power plants fueled with natural gas. Natural gas supply is the most sensitive to economic and geopolitical factors; therefore, the domination of this kind of fuel in the energy production process reduces energy security.

When assessing the overall energy security level, all indicator results are added up; therefore, the worse situation in one energy sector is partially compensated by better results from another sector. Still, indicators signifying a critical state show that there are essential issues in the energy sector that need to be solved. Starting from 2010, indicators of economic and technical blocks, related to nuclear power production and fuel supply, are not counted, because at the end of 2009, Ignalina NPP was shutdown.

Starting from 2009, a major part of indicators fall into pre-critical condition, and less than one third – into normal condition. Such distribution of indicators shows a significant negative influence on the overall energy security level.

Table 7. Distribution of indicators according to conditions

	2007	2008	2009	2010	2011	2012	2013	2014
Critical state	22	20	21	17	16	18	17	17
Pre-critical state	21	23	21	24	26	24	25	25
Normal state	25	26	19	18	18	18	18	18

Most of the indicators falling under the category of critical condition are related with the natural gas system: the ratio of natural gas buying price with the average purchase price in the EU countries, the amount of natural gas bought from the biggest supplier, high electricity and heat energy production dependency from natural gas. A number of indicators get into the critical zone due to the lack of market conditions, especially in the heat production sector. The socio-political block of indicators shows that the greatest negative

influence on energy security is caused by Lithuania's high dependency on import from one country and disproportionally high expenses of inhabitants for energy services in comparison to average income, as well as the negative attitude of population to new energy projects and low political rating of the analyzed countries.

2.2. The energy security level of the technical block

The energy security level in the technical block in 2007–2014 varies from 59.4 % (in 2011) to 64.1 % (in 2008). Technical area is the strongest part of Lithuanian energy sector. High and often surplus energy production capacities, well developed network for energy transmission and distribution, an opportunity to use alternative fuel for production equipment allow maintaining the technical aspect of Lithuanian energy sector that satisfies the country's energy security needs. The situation is worsened by the age of energy production equipment and concentration of energy production in natural gas fueled power plants using a small number of technologies. Due to natural aging of equipment for a while, some indicators of the technical block were decreasing, but with the introduction of new facilities and technologies, the energy security level in the technical block in the last few years has stabilized.

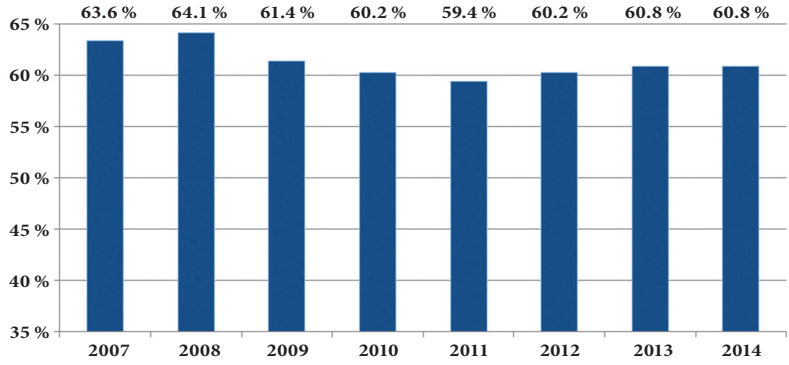

Figure 3. Dynamics of energy security level in the technical block in 2007–2014

2.3. The energy security level of the economic block

In the analyzed period, the economic block energy security level increased by more than 10 percentage points, and in 2014, it reached 53.1 %. The improved situation in district heating had the greatest impact. Nevertheless, the security level of this indicator block is the lowest comparing with other indicator blocks. The main indicators of the economic block signifying the critical state are connected with the natural gas sector, the forming concentration of biofuel suppliers and with imported energy resources. The dynamics of the energy security level of the block is demonstrated in Figure 4.

The overall growth of the security level of the block is related to the development of free markets in the energy sector, first of all in the electricity system. A very large part of electricity import has reduced the overall level of the block since 2010, but after Lithuania's joining 'Balt Pool' energy exchange, the growing use of biofuel and the formation of the biofuel market compensate the decrease and create the potential for the rise of the overall block security level.

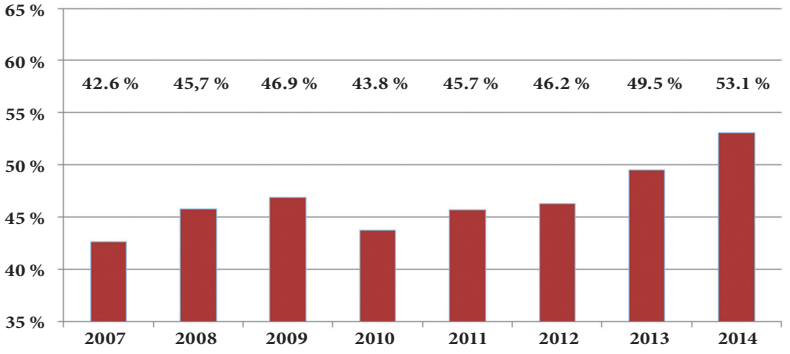

Figure 4. The dynamics of energy security level in the economic block in 2007–2014

2.4. The energy security level of the sociopolitical block

Lithuanian energy security level in this block in the period of 2007–2014 was characterized by obvious decrease tendencies. The overall security level of the block in 2008 was 60.9 %, and in 2012 – only 50.3 %; the security level decreased by 10.6 percentage point and almost equalled the security level of the economic block. However, in the last two years, the situation has improved. This occurred due to the improved Lithuanian political risk factor (International Country Risk Guide), published by the agency PRS Group. Still, in a longer period of time, the energy security level of the block should acquire the tendencies of growth in relation to the implementation of energy projects. The dynamics of the block energy security level is illustrated in Figure 5.

The overall decrease of the energy security level of this block is related to the growing import of energy resources, import dependence on one state and the increasing part of the population income devoted to covering heating and electricity. The overall security level of the block slightly increased due to the obligations for energy saving.

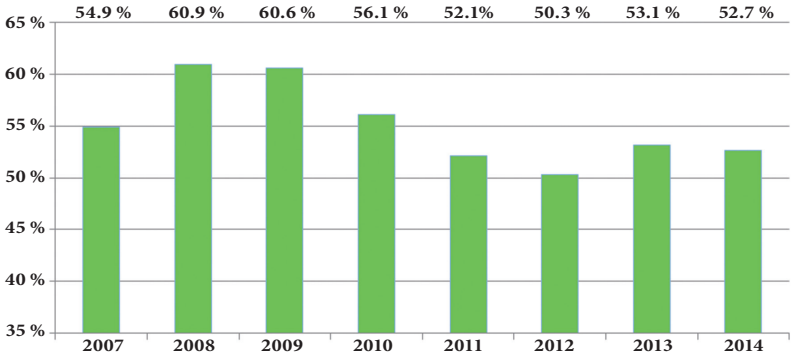

Figure 5. The dynamics of energy security level in the sociopolitical block in 2007–2014

3. THE COMPARISON OF THE LITHUANIAN ENERGY SECURITY LEVEL WITH THE LATVIAN AND ESTONIAN ENERGY SECURITY LEVEL

To compare Lithuanian energy security level with other countries in this survey, the energy security level of Latvia and Estonia was assessed using the same methodology. The data are presented in Figure 6. These results show that energy security levels in Latvia and Estonia are higher than those in Lithuania. The security level in Estonia falls under the normal condition, and in Latvia, it is close to the normal condition.

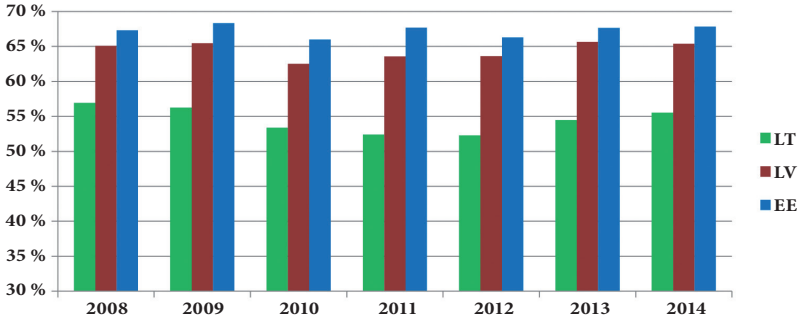

Figure 6. The dynamics of energy security level in Baltic States

All three countries are in the similar environment of threats and risks. Significant differences in energy security level are decided by technical and economic blocks. As has been mentioned, the indicators denoting a critical condition in the economic block are mostly those related to the natural gas sector. A similar situation exists in Latvia and Estonia. Still, during the assessment of the energy security level of the three Baltic States, differences emerge mostly related to the part of the gas sector in the energy balance of the countries. In the energy security level of Lithuania, the natural gas sector takes up

about 30 %, in Latvia it amounts to 15 %, in Estonia – 7 %. The biofuel sector receives the best assessment in all three states. In Lithuania and Estonia, it makes up about 22 %, and in Latvia – more than 39 %, depending on the energy security level (Table 8).

Table 8. Average group values in the technical and economic blocks of the Baltic States[5]

	Lithuania	Latvia	Estonia
Electricity	19.63 %	21.75 %	33.68 %
Gas	29.56 %	15.28 %	7.09 %
Oil	3.81 %	0.15 %	0.52 %
Coal	3.76 %	2.92 %	4.71 %
Biofuel	22.13 %	39.40 %	21.81 %
Heating	21.11 %	20.49 %	32.18 %

The energy security level in Latvia increases due to two reconstructed blocks of Combined Heat and Power Plants in Riga and gas depository in the country. Estonia is the exporter of electricity, and electricity is produced by using country's own resources. These factors are exceptionally favorable for the Estonian energy security.

5 The groups of technical and economic indicator blocks were divided according to the type of fuel used in the energy system: gas, oil, coal, nuclear and biofuel. In addition, electricity and heat were included in the composition of these indicator blocks as separate groups of indicators, because they are ones of the essential elements of the energy system.

4. TENDENCIES OF LITHUANIAN ENERGY SECURITY FOR DIFFERENT DEVELOPMENT SCENARIOS

One of the most important energy security assurance requirements is capacity of the Lithuanian energy sector to resist possible external and internal threats. For this purpose energy security study of different development scenarios was carried out. In order to determine energy security for various development scenarios, which reflect the perspective development of the state, i.e. to assess the development scenarios of national energy sector with regard to energy security, the methodology was applied which is based on the analysis of various possible threats leading to certain disturbances and their consequences in the energy sector. Each of the possible threats for the Lithuanian energy security can manifest itself by the disturbance of energy supply or increase in the cost of energy sources. Aiming at resisting the totality of these threats and disturbances, the development of the Lithuanian energy sector is formed with due regard to the impact of new energy system strategic projects upon the national energy security. A particular attention is devoted to the projects that increase or ensure the country's national security in various energy sectors and are listed as strategic measures to assure the national energy security.

In the performed study applied methodology enabled analyzing the external and internal threat environment in the energy sector which can have impact upon energy security. It was investigated how these threats can manifest themselves in the energy sector as one or another disturbance described by various parameters. The emergent disturbances can lead to various consequences in the energy sector, such as energy cost increase or likely unsupplied energy for consumers. A certain indicator, which is called energy security coefficient, was used to assess the ability of Lithuanian energy sector to resist the negative impact of emerging disturbances. For different scenarios

energy security coefficient is determined both in time and in regard to comparing its average values in terms of energy security. It allows evaluating the perspective of energy security of various development scenarios in comparison with each other.

In this study three development scenarios (SC1, SC2 and SC3) were analyzed that focus on representation of the conditions characterizing perspective development of the Lithuanian energy sector, which correlate well with the current EU energy policy and orient the national energy sector towards wider integration into international energy market and better use of the energy infrastructure of separate states. In case of these scenarios it is pursued to make the best use of the emerged internal and external situation to satisfy the national interests. Besides, the scenarios analyze the period of 2015–2035 involving the main development projects which have already been launched, such as Liquefied Natural Gas terminal and power links with Poland and Sweden, and projects which are planned to be implemented in the nearest future, such as the second stage of power link with Poland, Gas Interconnection between Poland and Lithuania (GIPL), synchronization of Lithuanian power system with the European Continental Network (ECN), etc. However, the scenarios differ from each other in some assumptions and events, which are reflected in the perspective of each scenario (Table 9).

The main assumptions by which the analyzed scenarios differ are the following: first, the scenarios assess Visaginas NPP differently. In SC1 scenario VNPP exploitation is launched in 2025, whereas in scenarios SC2 and SC3 – this NPP is not constructed at all. Then SC2 and SC3 scenarios differently assess the power plant installed capacity necessary to have in the country, which exerts impact upon energy security level. In case of SC2 scenario, beginning with 2025, it is necessary to maintain such installed power capacity in the country which could reliably produce no less than 50 % power necessary for the state at any time. In case of SC3 scenario, it is necessary to

maintain such installed capacity of power plants working in the country that could produce no less than 100 % of the power necessary in the country at any time beginning with 2025. The capacity of such power plants as wind, solar or pumped storage plant is not included here, as they cannot supply power in a reliable way. These assumptions of the scenario determine the distribution of capacities of the installed power and heat production technologies of the country in each of the scenarios.

Table 9. Chronology of the main events and projects of energy sector in the analysed scenarios in particular years[6]

Year / Scenario	2015	2016	2020	2025
SC1	+ LNGT	+ NB + LPL 1 – LPP 5–8 units – VCHPP-3 –KCHPP	+ GIPL	+ SINCHRO + LPL 2 + VNPP
SC2	+ LNGT	+ NB + LPL 1 – LPP 5–8 units – VCHPP-3 –KCHPP	+ GIPL	+ SINCHRO + LPL 2
SC3	+ LNGT	+ NB + LPL 1 – LPP 5–6 units – KCHPP + CCGT 455 MW	+ GIPL	+ SINCHRO + LPL 2

Having performed the study of energy security development scenarios, the results were obtained which reflect tendencies in the Lithuanian energy security for different development scenarios (Figure 7).

6 Marking: + start exploitation, – terminate exploitation, GIPL – Gas Interconnection Poland-Lithuania, CCGT – Combined Cycle Gas Turbine, KCHPP – Kaunas Combined Heat and Power Plant, LPP – Lithuanian Power Plant, LPL – Lithuanian-Poland Power interconnection 'LitPol Link', NB – power connection with Sweden 'NordBalt', SC1 – Scenario One, SC2 – Scenario Two, SC3 – Scenario Three, LNGT – Liquefied Natural Gas terminal, SINCHRO – synchronisation with the European Continental Network, VNPP – Visaginas Nuclear Power Plant, VCHPP – Vilnius Combined Heat and Power Plant.

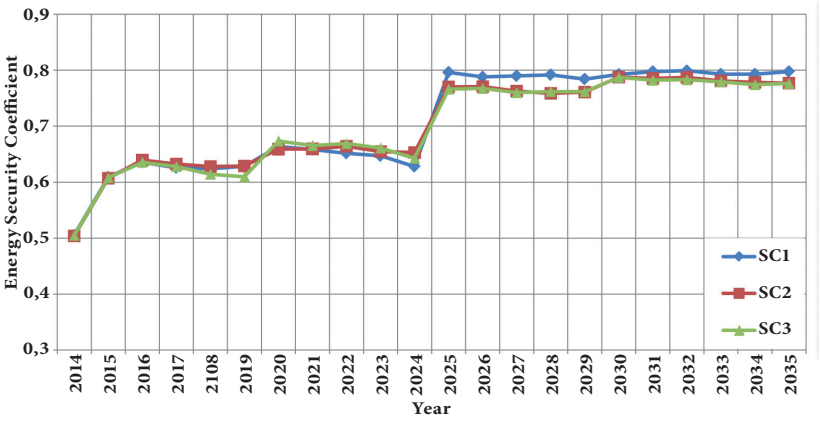

Figure 7. Timescale of changes in energy security coefficient of development scenarios

In all the analyzed scenarios, the energy security analysis includes the period of 2015–2035; however, the results from 2014 have also been presented. The value of this year's energy security was not assessed while modeling as it was proportionally determined from previously performed research, aiming at showing the impact of LNG terminal upon the increase of energy security. Having analyzed the results obtained during the research, the major strategic national energy security assurance measures were determined as well as their impact upon the long-term development of the national energy sector.

LNG terminal has had a significant impact upon Lithuanian energy security, as it diversifies the supply of natural gas and has removed the threat of total dependence of Lithuania on natural gas supplied from Russia, for which the country had to pay a monopoly price; besides, the threat of political pressure has also been softened. As at present the use of natural gas is decreasing in Lithuania, additional possibilities for LNG terminal activity have to be sought for, aiming at more efficient use of the terminal, for instance, re-export of natural gas or its transit to avoid new threats due to inaccessibility of the terminal or absence of full preparedness at the necessary moment.

Power connections with Sweden and Poland have exerted a positive impact upon energy security due to electricity import and market diversification; therefore, implementation of these development projects and development of connection with Poland in the future (the second stage of 'LitPol link') would have a positive effect upon the Lithuanian energy security. Launching the exploitation of these connections also opens possibilities to purchase power in the competitive market and import it under reasonable prices, which is one of the constituents of energy security. Implementation of these projects removes the threat arising from a great part of electricity import from Eastern countries.

Gas Interconnection Poland-Lithuania is one of the projects which can contribute to the assurance of national energy security. However, with regard to energy security, under normal exploitation of LNG terminal GIPL is not a critically indispensable development project, however it is a very important one. Gas interconnection between Poland and Lithuania would increase the Lithuanian energy security due to diversification of natural gas supply sources and routes and would integrate the isolated Baltic country markets into the common EU gas market, thus creating the basis of competitive regional gas market. The opportunity to use this gas interconnection not only for gas import from other countries but also for gas re-export to other countries from LNG terminal could contribute to rational increase in the use of LNG terminal and maintenance of its accessibility, thus assuring natural gas supply security and reliability in Lithuania.

Disconnection of the Lithuanian power system from synchronous work with IPS/UPS and synchronization with the European Continental Network or implementation of other technical measures which ensure reliable and stable work of power system is mandatory for energy security assurance and sustainability. This would prevent from possible total 'black-out' of power network of the Baltic States or unreliable work of the network and would remove

possible geopolitical threats from the Eastern countries, which manifest themselves through disturbances in the power system.

After 2025, one of the possible alternatives to sustain the Lithuanian energy security is Visaginas NPP; however, its demand is not critical as due to various implemented or planned to be implemented energy system development projects (LNG terminal, power connections with Poland and Sweden, gas link between Poland and Lithuania, synchronization with ECN, development of renewable energy sources, etc.) Lithuanian energy security should achieve a rather high level. Due to this reason the impact of Visaginas NPP would be no longer that significant as it could have been if the nuclear power plant had been constructed considerably earlier and if the mentioned above projects had not been implemented. The impact of Visaginas NPP upon energy security manifests itself due to higher diversification of fuel in power production and increased resistance of the energy sector to electricity import disturbances and price changes. On the other hand, large initial investment into Visaginas NPP, negative societal attitude to nuclear energy, incomplete negotiations with neighboring countries with regard to the project and other uncertainties decrease the probability to implement the project in general, and this can have a negative impact upon the country's energy security. In order for Visaginas NPP to have a more significant contribution to the national energy security, more favorable project realization conditions as well as political agreement with neighboring countries with regard to project realization must be sought for. In case additional threats emerge for the Lithuanian energy security due to considerable increase in prices of energy sources, Visaginas NPP could have a higher positive impact for energy security.

The use of renewable energy sources (RES) for power production and their development have a positive impact upon energy security; however, up to a certain level, until one of the types of this energy starts dominating in power production. Increasing the part of RES in

the total final consumption can be risky due to considerable increase in energy cost, large reserve capacity needs for balancing of wind and solar power plants, predominant use of biofuel as one of energy sources in heat production, and etc. However, RES, enhancement of fumeless technologies in particular, including decentralized sector, could also contribute to the improvement of country's energy security. To ensure the increased development of renewable energy sources, more than recommended in the European energy security strategy, is also possible through non-governmental sector when these technologies become cheaper.

One of the main ways of energy security assurance in heat sector is to avoid concentrating heat production on technologies, which use only one type of fuel, i.e. it is necessary to maintain the diversification of primary energy sources. It is important to prevent the predominant use of one type of fuel in heat supply sector. For this, one attractive way is increasing the part of biomass burning facilities, installing biofuel/waste burning facilities in high heat demand points (technical security dimension manifesting through diversification of primary energy sources). Biofuel and municipal solid waste is an attractive alternative to ensure basic and half peak heat demands. However, here again the threat to transfer from natural gas dominating to biomass dominating arises which could lead to economically ungrounded rise in biomass prices. Due to this reason, the systems of centralized heat supply should have heat production sources that use another fuel, thus, preventing the emergence of a possibility for predominant use of any sole energy source.

The necessity for strategic national energy security assurance measures is based on the most probable external and internal threats for the national energy security. However, the changing threat environment and threat probability may require different energy security assurance measures, which can be tightened or softened. For instance, in the situation when opportunities for the import of

electricity decrease, the demand for local electricity production increases. In this case it can be necessary to increase the capacities of the installed and prepared for work power plants, and they will be exploited more intensively. In order to enlarge the scope of electricity produced in the country, it is also necessary to expand the use of local and renewable energy sources. A considerable reduction in opportunities of electricity import or more rapid development of other technologies can change the attractiveness of Visaginas Nuclear Power Plant. By analogy, in case some threat changes occur in gas supply system, the necessity for GIPL can also change. In this way, for the sake of the Lithuanian energy security it is particularly important to ensure a possibility of timely identification of the tendencies of the changed situation and its scope, and provide maximum, economically grounded flexibility to the sector itself to adequately respond to the changing situation.

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