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ASSESSMENT OF ELECTRICITY MARKET LIBERALIZATION IMPACT ON SUCCESS IN ACHIEVING EU ENERGY POLICY TARGETS IN LITHUANIA

Abstract. *The aim of the paper – to assess the impact of energy market liberalization on the priorities of EU energy policy: competiveness, security of supply and sustainability. Such type of assessment would allow to track the progress achieved in energy market liberalization in specific country and to assess the impact of this progress achieved on the main pillars of EU energy policy. There are a lot of studies conducted all over the world dealing with energy markets liberalization especially in electric power sector and most of them were performed by applying Steiner model. The Steiner model was also applied in this paper for assessing the impact of energy liberalization indicators on competitiveness of Lithuanian energy sector. The competitiveness of energy sector is measured by success in achieving EU energy policy targets. The results of assessment provided for energy policy recommendations development in Lithuania.*

Key words: *Steiner model, electricity market liberalization, assessment, competitiveness of energy sector.*

JEL classification: Q4, Q48; B23.

Introduction

Reliable energy supplies at reasonable prices for businesses and consumers and with the minimum environmental impact are crucial to the European economy. The European Union has therefore identified energy as one of its priorities. In the past, the electricity industry has been organized as vertically integrated monopolies that were sometimes also state owned. The growing ideological and political disaffection towards vertically integrated monopolies and the liberalization successes in other network industries have lead to liberalization initiatives world wide in the electricity industry. Vertically integrated utilities have been vertically separated or unbundled and barriers to entry in generation and supply are being removed to create competition, seen as a vehicle to increase the competitiveness of the electricity industry (Littlechild, 2001; Newbery, 2001). The first liberalisation directives were adopted in 1996 (electricity) and 1998 (gas) and should be transposed into Member States' legal systems by 1998 (electricity) and 2000 (gas). The second liberalisation directives were adopted in 2003 and were to be transposed into national law by Member States by 2004, with some provisions entering into force only in 2007. The Third electricity directive adopted in 2009 confirms the trend initiated by the precedent 2003 Directive of setting general guidelines for the government of the sector and further strengthen consumer protection, innovation and makes an attempt to merge national systems into one European electricity markets (Roggenkamp and Boisseleau, 2005; Bergeman et al 2000, Glachant 2001). Since the introduction of the first directive in 1998 opening EU energy markets to competition, the situation in energy sector has changed dramatically in member states (Buchan, 2010) it is important to assess impact of liberalization on the main three pillars around which EU energy policy is built – competitiveness, security of supply and sustainability.

The aim of the paper – to assess the impact of energy market liberalization on the competiveness, security of supply and sustainability. Such type of assessment would allow to track the progress achieved in energy market liberalization in specific country and to assess the impact of this progress achieved on the main pillars of EU energy policy.

Seeking to achieve this aim the following tasks were developed:

- to analyse EU energy policy priorities
- to develop framework for the assessment of energy market liberalization on competitiveness, security of supply and sustainability,
- to apply Steiner model for assessment of impact of energy markets liberalization indicators on progress in achieving EU energy policy goals in Lithuania.

The assessment would allow to develop policy recommendations for Lithuania taking into account the main institutional and legal drivers of energy markets development and their positive impact on competitiveness of the country, security of supply and environmental sustainability

1.EU energy policy priorities

The main EU energy policy documents are directives promoting energy efficiency and use of renewable energy sources, directives implementing greenhouse gas mitigation and atmospheric pollution reduction policies and other policy documents and strategies targeting energy sector.

The main priorities for EU energy strategy: competitiveness of the EU economy, environmental sustainability and security of energy supply

(Streimikiene,2013). The main issues related with competiveness are energy prices, energy intensity of GDP, costs of energy imports etc. The main issues related with environmental sustainability are related with GHG emission reduction including measures to increase energy efficiency and enhanced use of renewables, reduction of emissions of classical pollutants such as SO_2, NO_x and particulates emissions. Security of energy supply is related with diversification of energy supply, energy import dependency, energy supply quality including outage rate, the structure of energy balance etc.

Table 1 summarizes the priorities of EU energy policy and targeted indicators.

Table 1. Review of EU energy policy priorities

Indicators	Directive or policy document	Target	Date for achieve ment
Competitiveness			
Energy prices	EU Communication Energy 2020 - A strategy for competitive, sustainable and secure energy COM (2010) 639 final	Boosting the competitiveness of European industry by securing the availability of energy at affordable prices.	2020
Costs of energy imports	EU Communication Energy 2020 - A strategy for competitive, sustainable and secure energy COM (2010) 639 final	Reducing costs of energy imports	2020
End-use energy intensity of GDP	Directive 2006/32/EC on end-use efficiency and energy services	To reduce by 9% the current level (2006)	2016
Energy savings	Directive 2012/27/EU on energy efficiency.	To achieve energy savings of 20%	2020
Security of supply			
Energy independency	The EU Green paper on European Strategy for Sustainable, Competitive and Secure Energy	50%	2030
Environmental sustainability			
Energy saved in buildings	2002/91/EC Directive on the energy performance of buildings	22% of energy used in buildings	2010
Savings of primary energy supply	The Commission's new Green Paper on energy efficiency COM (2005) 265	20% from year 2005 level	2020
The share of CHP in electricity production	2004/8/EC Directive on the promotion of cogeneration national energy strategy	Double the current share	2010
The share of renewables in primary energy supply	The White Paper on renewable sources	12%	2010
The share of	Directive 2001/77/EC on the	22.1%	2010

Indicators	Directive or policy document	Target	Date for achieve ment
renewables in electricity generation	promotion of electricity produced from renewable energy sources in the internal electricity market		
The share of renewables in heat production	Proposal for Directive promoting the renewable heating and cooling	25%	2020
The share of renewables in fuel used in transport	2003/30/EC Directive on the promotion of the use of biofuels or other renewable fuels in transport	2% 5.75% 20%	2005 2010 2020
The share of renewables in final energy	EU energy and climate package: proposal for a Directive of EP and EC on the promotion of the use of energy from renewable sources {COM(2008) 30 final}	20%	2020
Greenhouse gas emissions (CO_2 emissions from energy sector)	Kyoto protocol	Reduction by 8% of year 1990 level Reduction by 20% of year 1990 level	2008-2012 2020
SO2 emissions, NOx emissions, VOC emissions, NH3 emissions SO2 emissions, NOx emissions, VOC emissions, NH3 emissions	Gothenburg protocol NEC directive 2001/81EC	Reduction by 35%, 30 %, 11% 0% comparing to 1990 level, Reduction by 87%, by 50%, by 46% by 41% compared to 2000 level	2010 2020

Therefore seeking to assess the impact of electricity market liberalization of achievement of EU energy policy goals the integrated indicators approach can be developed allowing to integrate various indicators representing three pillars of EU energy policy.

2. Framework for assessing the impact of energy liberalization on EU energy policy priorities

Taking into account the priorities of EU energy policy the framework of indicators for assessing energy market liberalization impact on the three main pillars of EU energy policy needs to be developed. The success in achieving EU energy policy targets can be treated as competitiveness of energy sector of the country.

There are several frameworks developed to assess the sustainability of energy systems or progress achieved towards implementing sustainable energy policy priorities. The World Economic Forum in collaboration with Accenture and a panel of experts have developed an Energy Architecture Performance Index (EAPI). The EAPI developed was selected as the basis for the development of EU energy policy assessment tool which can be applied for assessing the energy markets liberalization impact on priorities of EU energy policy as the EAPI also measures an energy system's specific contribution to the three imperatives of the energy triangle: economic growth and development, environmental sustainability, and access and security of supply (WEF, 2012). It comprises 16 indicators aggregated into three baskets relating to these three imperatives (WEF, 2012).

The Table 2 below details each of the indicators selected, the weight attributed to it within its basket (or sub-index), what it measures and the energy system objective it contributes to, either positively or negatively.

Table 2.Energy Architecture Performance Index (EAPI) framework

Energy system objective	Measure (of)	Indicator Name	Indicator weight
Economic growth and development	Efficiency	Energy intensity (GDP per unit of energy use (PPP US$ per kg of oil equivalent))	0.25
	Lack of distortion/ affordability	Degree of artificial distortion to gasoline pricing (index)	0.125
		Degree of artificial distortion to diesel pricing (index)	0.125
		Electricity prices for industry (US$ per kilowatt-hour)	0.25
	Supportive/detracts from growth	Cost of energy imports (% GDP)	0.125
		Value of energy exports (% GDP)	0.125
Environmental sustainability	Share of low-carbon fuel sources in the energy mix	Alternative and nuclear energy (% of total energy use, incl. biomass)	0.2
	Emissions impact	Nitrous oxide emissions in energy sector (thousand metric tonnes of CO_2 equivalent)/total population	0.2
		CO_2 emissions from electricity and heat production, total/total population	0.2
		PM10, country level (micrograms per cubic metre)	0.2
Energy access and security	Level and quality of access	Average fuel economy for passenger cars (l/100 km)	0.2
		Electrification rate (% of population)	0.2
		Quality of electricity supply (1-7)	0.2
		Percentage of population using solid fuels for cooking (%)	0.2
	Self-sufficiency	Import dependence (energy imports, net % energy use)	0.2
	Diversity of supply	Diversity of total primary energy supply (Herfindahl index)	0.2

Each indicator is equally weighted within the three baskets, with the exception of the economic growth and development basket (Streimikiene et al, 2013).

Table 3 summarizes the indicators framework of EAPI index developed by WEF based on Table 2.

Table 3. Indicators framework of EAPI index

Economic growth and development basket					
Energy intensity (GDP per unit of energy use in PPP USS per toe	Electricity prices for industry (US $ per kilowatt-hour)	Cost of energy imports (% GDP)	Value of energy exports (% GDP)	Diesel –level of price distortion through subsidy or tax (Index 0-1)	Super gasoline-level of price distortions through subsidy or tax (Index 0-1)

Environmental sustainability basket				
CO_2 emissions from electricity and heat, thou thou/capita	Particulate emission country level, mcg/m3	NOx emissions from energy sector, thou t/capita	Alternative and nuclear energy share (% of total energy use)	Average fuel economy for passenger cars (1/100 km)
Energy access and security basket				
Diversity of total primary energy supply (Herfindahl index)	Quality of electricity supply (survey score between 1-7)	Percentage of population using solid fuels for cooking (%)	Electrification rate (% of population)	Import dependence (energy imports, net % energy use)

Therefore EAPI index represents well the EU energy policy priorities: competitiveness, environmental sustainability and security of supply and can represent EU energy policy priorities generalized in Table 1.

The scores of electricity market liberalization for EU member states were developed based on simplified OXERA model (OXERA, 2001). The statistical data on energy provided by EUROSTAT was applied for the assessing electricity market liberalization indicators for year 2012. The scores of electricity market liberalization for EU member states and their ranking are provided in Table 4. In the same Table 4 the scores according three dimensions of EU EAPI for EU members states developed by applying EUROSTAT data were presented for year 2013 (Streimikiene et al, 2013).

Table 4. Ranking of EU member states based on electricity liberalization indicators and success in implementing EU energy policy targets based on EAPI (2013)

EU member states	Score of electricity market liberalization	Rank	Competitiveness	Sustainability	Security of energy supply	Overall score	Rank
Belgium	3.55	14	0.51	0.56	0.77	0.61	16
Denmark	5.24	10	0.64	0.56	0.82	0.67	4
Germany	5.88	7	0.6	0.58	0.79	0.66	9
Greece	1.73	20	0.63	0.48	0.7	0.60	18
Spain	4.83	11	0.71	0.55	0.75	0.67	5
France	3.18	17	0.58	0.76	0.8	0.70	2
Ireland	2.46	20	0.61	0.63	0.74	0.66	8
Italy	5.57	8	0.48	0.53	0.72	0.58	22
Netherlands	5.84	6	0.5	0.5	0.77	0.59	21
Austria	6.45	4	0.61	0.52	0.79	0.64	13
Portugal	2.55	19	0.64	0.56	0.75	0.65	12
Finland	6.5	3	0.58	0.47	0.81	0.6	20
Sweden	6.37	5	0.58	0.76	0.8	0.71	1
UK	7.69	1	0.59	0.63	0.78	0.67	6
Bulgaria	3.27	16	0.56	0.55	0.62	0.57	23
Czech Republic	4.46	12	0.5	0.4	0.78	0.56	24
Estonia	0.35	23	0.56	0.59	0.67	0.61	17
Hungary	5.46	9	0.53	0.67	0.76	0.65	10
Latvia	0.16	23	0.62	0.74	0.71	0.69	3
Lithuania	0.7	22	0.58	0.64	0.73	0.63	14
Poland	7.3	2	0.6	0.48	0.71	0.6	19
Romania	1.09	21	0.65	0.63	0.73	0.67	7
Slovak Republic	3.13	18	0.48	0.69	0.78	0.65	11
Slovenia	3.70	13	0.55	0.56	0.77	0.63	15

As one can see from information provided in Table 4 the UK is ranked as the best performing country in terms of electricity market liberalization however the country is ranked as 6-th accordingly EAPI. The second mostly advanced country in terms of electricity market liberalization – Poland is ranked just as 19-th accordingly EAPI. The Estonia which ranked as having the lowest electricity market liberalization indicator according EAPI is ranked as 17^{th}.

Therefore countries ranked with high energy market liberalization indicators not necessarily have been ranked with high scores according the EAPI

Index providing for the evaluation of success of countries in implementing EU energy policy goals: competitiveness of the EU economy, environmental sustainability and security of energy supply.

Nevertheless other important issues which are not addressed in electricity market liberalization index need to be addressed when assessing the impact of energy market liberalization on EU energy policy performance or the impact of specific indicators of energy market liberalization need to be investigated.

3. The impact of specific energy market liberalization indicators on EU energy policy targets: Lithuanian case study

There are a lot of studies conducted all over the world dealing with energy markets liberalization especially in electric power sector and most of them were performed by applying Steiner model as one of the first studies aiming to develop models for assessing impact of regulatory regimes on electricity market environments and performances was conducted by Steiner (2001).

Steiner analyzed the effect of regulatory reforms on the retail price for large industrial customers as well as the ratio of industrial price to residential price, using panel data for 19 OECD countries for the period 1986– 1996. Steiner found that regulatory reforms to introduce competition into the industry, including the creation of a wholesale spot market and the unbundling of electricity generation from transmission, generally induced a decline in the industrial price and an increase in the price differential between industrial customers and residential customers, indicating that industrial customers benefit more from the reform. These results support some policy recommendations currently made by the OECD. For example, in its policy recommendation of structural separation in the network industries, OECD (2001) judges that the results show signs of enhanced competition in the electricity supply industry from the unbundling of generation. Although the analysis was carefully conducted as a first step in assessing the impact of the reforms, it has several shortcomings and needs to be improved before reaching a consensus as to the policy recommendation.

The Steiner (2001) applied regression analysis for assessing the linkages between electricity liberalization model and electricity prices for 19 countries. Sterner (2001) used as indicators of competitiveness: industrial electricity prices, the ratio of industrial to residential prices, utilization rates and reserve margins. In his study the author concluded that the unbundling of generation and transmission, the expansion of third party access (TPA) and introduction of electricity markets reduce industrial and-users prices.

Hatori and Tsutsui (2004) applied the Sterner's model for the same 19 OECD countries and extended it through 1999. The study re-examined the impact of the regulatory reforms on price in the electricity supply industry and compares results with those found in an earlier study by Sterner (2000). The study provided results for both random and fixed effect estimation. They found significant positive impact on electricity prices in the presence of wholesale electricity market and that

TpA has negative impact. In addition Hatori and Tsutsui proved that the private ownership coefficient is significantly negative for prices. Some results obtained by Hatori and Tsutsui are contradictory to Sterner results. They also found that the extended retail access is likely to lower the industrial price and increase the price differential between industrial consumers and households.

The results of various studies (Zhang et al, 208; Nagayama, 2009; Joskow, 2006) showed that the development of liberalization models in electricity sector does not necessarily reduce electricity prices and can cause economic cycles. In fact, contrary to expectation in some cases prices had tendency to rise. Therefore more attention has to be paid to selection of a liberalization model and careful considerations should be given to the types of reforms that would best suit to expected priority goals of EU energy policy (Streimikiene et al, 2003).

The Steiner regression analysis for assessing the impact of energy liberalization indicators on competitiveness expressed by EAPI can be assessed by applying EUROSTAT data. Sterner used as indicators of competitiveness: industrial electricity prices, the ratio of industrial to residential prices, utilization rates and reserve margins however we are more interesting in assessing overall energy market liberalization impact on EU energy policy performance including such important areas as security of supply, share of renewables, energy intensity etc.

The Sterner model of the impact of liberalization on EAPI

$$EPPI_e = \alpha + \beta R + \gamma NR + \varepsilon \qquad (1)$$

Here: $EPPIp_e$–EU energy policy performance index or EAPI, R – regulatory variables; NR- non-regulatory variables; α, β and γ are vectors of coefficients that were estimated and ε – is residual term.

The main regulatory variables were selected: unbundling of generation from transmission, Third party Access (TpA), Wholesale competition, Retail Competition, Ownership. The main independent non-regulatory variables: hydropower share, nuclear share and GDP. The two share variables reflect differences in generating technologies across economies, which affect the marginal costs and hence the price of generating electricity. Finally the inclusion of GDP adjusts for differences in the size of economies and is also an overall measure of national income. The modified Steiner model for assessing the impact of energy market liberalization on EU energy policy performance index is presented in Table 3. Regulation quality plays important role in ensuring that energy market liberalization would deliver EU energy policy priority goals. There are several important criteria which describes the quality of regulation: ensuring competition, efficiency and consumer protection.

In order to promote competition, a regulator must be able to assess how competitive a market is. It is necessary to watch three indicators to do this: barriers to entry; cross-subsidies between regulated and competitive activities; and collusion.

Table 5. The Steiner's model of assessing impact of electricity market liberalization on electricity prices

Variables	Measurements
Dependent variables	
EAPI	EU energy policy performance index
Independent regulatory variables	
Unbundling of generation from transmission R01	Dummy variable (1= accounting separation or separate companies; 0=otherwise)
Third-party access R02	Dummy variable (1= regulated or negotiated third-party access; 0=otherwise)
Wholesale competition R03	Dummy variable (1= presence of wholesale electricity markets; 0=otherwise)
Retail competition R04	Dummy variable (1= presence of retail electricity markets; 0=otherwise)
Quality of regulation R05	Dummy variable (1= presence of high quality regulation; 0=otherwise)
Ownership R06 U1; U2; U3	Discrete variable (4= private ownership; 3- mostly private ownership; 2= mixed; 1= mostly public; 0=public)
Independent non-regulatory environmental variables	
Hydro share N07	Share of electricity generated from hydropower sources
Nuclear share N08	Share of electricity generated from nuclear sources
Gross domestic product N09	Gross domestic product (expressed in USPPP$ billion)

Barriers to Entry: Excluding economic barriers to entry (that is, the capital intensive nature of the industry, technical expertise, etc.).

Cross-subsidies: Revenues from regulated services must not cross-subsidize competitive or unregulated services.

Collusion: Credible monitoring of collusion - and real penalties for those who engage in it - must be both evident and effective.

In measuring the effectiveness of regulator in promoting efficiency, there are four "vital signs" to monitor: investor confidence; asset management; price behavior and contract structures; and public confidence.

Investor Confidence: Investor confidence is reflected in the adequacy and pace of new investment, differences between rates of return demanded by investors at home and in other jurisdictions, and the creditworthiness of participating companies.

Asset Management: Asset management performance can be measured in terms of levels of reliability and security of supply, as well as the returns earned by owners on the services they provide under regulated rates.

Price Behavior and Contract Structures: In examining price behavior and contract structures, it is not the job of regulator to set market prices, but rather to ensure that the markets are sufficiently competitive that they do this well without outside assistance.

Public Confidence: While public confidence is difficult to measure directly it is essential – both in validating the integrity of the market, as well for maintaining stability and predictability.

Consumer Protection can be ensured by controlling regulated prices, promoting industry health and policing interactions with customers.

Regulation quality can be assessed by applying scores for criteria indicated above. Table 6 presents the scores for the assessing quality of regulation

Table 6. Scores for assessing the quality of regulation

Indicators	**Scores**
Barriers to Entry	(1= no barriers to entry; 0=otherwise)
Cross-subsidies	(1= no cross subsidies; 0=otherwise)
Collusion	(1= credible monitoring of collusion; 0=otherwise)
Investor Confidence	(1= high investor confidence; 0=otherwise)
Asset Management	(1= no barriers to entry; 0=otherwise)
Price Behavior and Contract Structures	(1= the regulator is able to ensure that the markets are sufficiently competitive; 0=otherwise)
Public Confidence	(1= high public confidence; 0=otherwise)
Independent non-regulatory environmental variables	(1= high independence ; 0=otherwise)
Controlling Regulated Prices	(1= efficient control of regulated prices; 0=otherwise)
Promoting Industry Health	(1= regulator is able to create the policies and conditions needed to support the industry; 0=otherwise)
Policing Interactions with Consumers	(1= the regulator is able to discipline the participants who are not in compliance with the rules; 0=otherwise)

The 11 indicators of quality of regulation provide the scoring of countries in terms of quality of regulation. The scoring from 11 to 7 provides for high quality of regulation and scoring from 6 to 0 – for pour quality of regulation. All six regulatory coefficients: for separating generation from transmission, allowing TpA to the transmission grid, allowing the wholesale and retail electricity market, the quality of regulator and privatization should lead to higher ranking of countries in terms of EAPI.

The regulatory variables in Steiner model focus on the key economic regulation needed to establish competitive generation sector- vertical unbundling of the generation system from the transmission system, whether third parties can access the transmission system, and whether a wholesale market exists. Dummy variables are used to indicate 4 key economic regulations needed to establish a competitive generation sector: Unbundling of generation from transmission (R01); Third-party access (R02); Wholesale competition (R03); Retail competition (R04). As quality of regulation has important impact on effective functioning of electricity market the fifth independent regulatory indicator Quality of regulation (R05) also is included in Steiner model as dummy variable. The sixth independent regulatory variable Ownership (R06) is discrete variable. The prepared model as in the case of Steiner's also includes 3 non-regulatory variables – the share of electricity generated from hydro (NR07); the share of electricity generated from nuclear (NR08) and the GDP (NR09). The two share variables reflect differences in generating technologies across economies which affect the marginal costs and hence the price of generating electricity. Finally, the inclusion of GDP adjusts for differences in the size of economies and is also an overall measure of national income (Table 6). The model was tested for Lithuania for period 1990-2012. Data for Lithuania provided in Table 7.

Table 7. Data for Steiner model (Lithuanian case)

T	Year	EAPI	R01	R02	R03	R04	R05	R06	R07	R08	R09
1	1990	0.33	0	0	0	0	0	0	1.81	51.19	10395
2	1991	0.33	0	0	0	0	0	0	1.5	57.9	10287
3	1992	0.33	0	0	0	0	0	0	1.7	78.9	8562
4	1993	0.39	0	0	0	0	0	0	2,8	88	7424
5	1994	0.39	0	0	0	0	0	0	4.6	79	6958
6	1995	0.4	0	0	0	0	0	1	2.8	85.8	7904
7	1996	0.42	0	0	0	0	0	1	2	83.6	8429
8	1997	0.43	1	0	0	0	0	1	2	79	10128
9	1998	0.46	1	0	0	0	0	1	2.4	75.4	11254
10	1999	0.45	1	0	0	0	0	2	3.2	75.7	10971
11	2000	0.45	1	0	0	0	0	2	3	65	11500
12	2001	0.48	1	0	0	0	1	2	4.7	45.7	12219
13	2002	0.47	1	1	0	0	1	2	4.4	75.9	14251

14	2003	0.49	1	1	0	0	1	2	5	79.4	18704
T	Year	EAPI	R01	R02	R03	R04	R05	R06	NR07	NR08	NR09
15	2004	0.53	1	1	1	0	1	2	4.9	78.4	22654
16	2005	0.48	1	1	1	0	1	2	5.5	70	26094
17	2006	0.49	1	1	1	0	1	3	6.5	27.2	30250
18	2007	0.52	1	1	1	0	1	3	7.1	27	39329
19	2008	0.56	1	1	1	0	1	2	7.1	26	47486
20	2009	0.58	1	1	1	0	1	2	7.4	0	37067
21	2010	0.62	1	1	1	1	1	2	22.5	0	36568
22	2011	0.66	1	1	1	1	1	2	21.8	0	42861
23	2012	0.63	1	1	1	1	1	2	21.7	0	42234

As one can see from information provided in Table 7 the impact of electricity market liberalization on EAPI index is assessed by several independent energy market liberalization variables In our case these variables are mostly dummy variables. The linear regression model was applied. For the analysis of linear regression the discrete variable R06 (Ownership) was replaced by 4 fictitious dummy: U1, U2, U3, U4 (Table 8). The dummy variable U4 was not analysed as the private ownership value for Ownership indicator (R06=4) was not available for Lithuanian data (Table 8).

Table 8. The Fictitious variables for ordinal variables

Variable (U)	Private ownership	Mostly private ownership	Mixed ownership	Mostly public ownership	Public ownership
U1	0	1	0	0	0
U2	0	0	1	0	0
U3	0	0	0	1	0
U4	0	0	0	0	1

The linear regression model according Steiner model was prepared based on Lithuanian data (Table 7):

$$EAPI=\alpha + ß_1R_{01} + ß_2R_{02} + ß_3R_{03} + ß_4R_{04} + ß_5R_{05} + ß_{61}U_1 + ß_{62}U_2 + ß_{63}U_3 + \gamma_1NR_{07} + \gamma_2NR_{08} + \gamma_3NR_{09}$$

Spearman's rank correlation coefficient allows you to identify whether two discrete variables relate in a monotonic function (i.e., that when one number increases, so does the other, or vice-versa). The close to -1 - negative correlation; close to 0 - no linear correlation, close to 1 - positive correlation. If Spearman's rank correlation coefficient is lower than 0.1 – there are no correlation and if the value is in interval [0.1-0.4] – weak correlation, if the coefficient is in interval [0.4-0.6] – average correlation and if it is in interval [0.6-0.8] – strong correlation and very strong than coefficient is higher than 0.8.

The Spearman's rank correlation is provided in Table 9 and indicates the correlation between discrete variables however it does not provide for existence of causal relationships between variables.

Table 9. Spearman's rank correlation between discrete variables of Steiner model

		EAPI	R06	R07	R08	R09
	N	23	23	23	23	23
EAPI	Correlation Coefficient	1	0.808592	0.926679	-0.67238	0.913863
	Sig. (2-tailed)		3.03E-06	0.000001	0.00044	0.000001
R06	Correlation Coefficient	0.808592	1	0.770711	-0.54782	0.810758
	Sig. (2-tailed)	3.03E-06		1.68E-05	0.006809	2.71E-06
R07	Correlation Coefficient	**0.926679**	0.770711	1	-0.65865	**0.841533**
	Sig. (2-tailed)	0.000001	1.68E-05		0.000632	0.000001
R08	Correlation Coefficient	**-0.67238**	-0.54782	-0.65865	1	**-0.81794**
	Sig. (2-tailed)	0.00044	0.006809	0.000632	.	1.87E-06
R09	Correlation Coefficient	**0.913863**	0.810758	0.841533	-0.81794	1
	Sig. (2-tailed)	0.000001	2.71E-06	0.000001	1.87E-06	

As one can see from information provided in Table 9 there is strong correlation between variables N08 and N09 therefore because of multicollinearity just one of these variables needs to be included in linear regression (N09). One can notice that the closure of Ignalina NPP in 2008 has impact on reduction of GDP in Lithuania, i.e. reduction of the share of nuclear in electricity generation is directly related with GDP development trends in Lithuania.

As one can see from Table 9 there is strong correlation between variables R06 (ownership) and EAPI (Spearman's correlation coefficient =0.8086). There are also strong correlation between all non regulatory variables (the share of hydro energy in electricity balance, the share of nuclear in electricity balance and GDP) and EAPI.

The standardized B coefficients for linear regression provided in Table 10 allow to define the independent variables having the highest impact on EAPI. The unstandardized coefficient of an independent variable (also called B or slope) measures the strength of its relationship with the dependent variable. It is interpreted as the size of the average difference in the dependent variable that corresponds with a one-unit difference in the independent variable. A coefficient of 0 means that the values of the dependent variable do not consistently differ as the values of the independent variable increase. In that case, we would conclude that there is linear relationship between the variables. The B column also shows the constant, a statistic indicating the intercept — the predicted value of the dependent variable when the independent variable has a value of 0. The intercept also has a significance level associated with it, but this statistic is usually ignored.

Table 10. Unstandardized and standardized B coefficients for linear regression

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
6	(Constant)	0.295	0.013		23.253	0.000
	R09	0.000	0.000	0.189	1.748	0.100
	U2	0.044	0.013	0.238	3.285	0.005
	U1	0.058	0.014	0.242	4.276	0.001
	R07	0.019	0.005	1.315	3.877	0.001
	R04	0.209	0.075	0.770	2.801	0.013
	R01	0.035	0.015	0.178	2.410	0.028

As linear regression analysis indicated that values of coefficients for other variables are not consistently differ as the values of the independent variable increase these variables are not included in Steiner model. The following model is obtained:

$$EAPI = 0,295+0,035R_{01}-,02R_{04}+0,044_{U1}+0,019_{NR07}+1,6x10^{-6}\ NR_{09}.$$

As one can see from this linear regression the highest standardized B coefficient is obtained for variable NR_{07} (the share of hydro energy in electricity balance). As the share of hydro energy in electricity balance is also reflected in EAPI (as the share of renewables in electricity generation) therefore it is natural that this indicator has direct impact on development of EAPI therefore in the next stage just independent regulatory variables will be left in the Steiner model.

As one can see from Table 10 the independent regulatory variable R04 (Existence of retail market) has also strong impact on EAPI.

For assessment of dummy variables impact on EAPI the mean statistics analysis was applied (Table 11).

Table 11. The mean values of dummy variables

Dummy variables	Values	N	Mean	Std. Deviation	Std. Error Mean
R01	1	16	0.5188	0.07117	0.01779
	0	7	0.3700	0.03873	0.01464
R02	1	11	0.5482	0.06646	0.02004
	0	12	0.4050	0.05300	0.01530
R03	1	9	0.5633	0.06384	0.02128
	0	14	0.4157	0.05598	0.01496
R04	1	3	0.6367	0.02082	0.01202
	0	20	0.4490	0.07254	0.01622
R05	1	12	0.5425	0.06635	0.01915
	0	11	0.3982	0.04976	0.01500

As one can see from information provided in Table 11 the dispersions of all variables are equal therefore the hypothesis about their equality is not being rejected.

In Table 12 the statistical significance analysis of mean differences by testing hypothesis about equalities of dispersions is being provided. First of all hypothesis about equality of mean differences is being tested. As obtained p values (the probability to make mistake by rejecting the null hypothesis) is lower than 0.005, therefore for each regulated variable mean differences are statistically significant.

In last column of Table 12 the confidence intervals of the mean differences are presented, for example for variable R02 (Third party Access to the grid) the mean difference is (0.5482-0.4050)=0.14318, therefore with guaranty of 95% we can say that mean difference for population is in interval [0.09128-0.19508] and is statistically significant.

Therefore the analysis of mean difference presented in Tables above indicated that existence of all independent regulatory variables (R01, R02, R03, R04, R05) expressed as dummy variables has positive impact on increase of EAPI.

Table 12. Levene's Test for Equality of Variances

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	P values Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
R01	2.770	0.111	5.160	21	0.000	0.14875	0.02883	0.08880	0.20870
R02	1.121	0.302	5.737	21	0.000	0.14318	0.02496	0.09128	0.19508
R03	0.245	0.625	5.846	21	0.000	0.14762	0.02525	0.09511	0.20013
R04	2.739	0.113	4.374	21	0.000	0.18767	0.04291	0.09844	0.27689
R05	1.784	0.196	5.856	21	0.000	0.14432	0.02464	0.09307	0.19557

As the share of hydro energy in electricity balance is also reflected in EAPI (as the share of renewables in electricity generation, %) in the next stage just independent regulatory variables are left in the Steiner model. The standardized B coefficients for new linear regression are developed in Table 13. The linear regression can be applied for forecast of EAPI in the future. It presents the relationship between EAPI and independent regulatory variables.

Table 13. Unstandardized and standardized B coefficients for linear regression

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	0.398	0.018		22,370	0.000
R05	0.144	0.025	0.788	5,856	0.000
(Constant)	0.398	0.013		30,410	0.000
R05	0.113	0.020	0.616	5,786	0.000
R04	0.126	0.029	0,462	4,337	0.000
(Constant)	0.370	0.013		28,491	0.000
R05	0.064	0.021	**0.347**	3,081	0.000
R04	0.126	0.023	**0.462**	5,481	0.000
R01	0.078	0.022	**0.390**	3,599	0.002

Therefore new linear regression has been developed based on results provided by Table 13:

$$EAPI = 0,370+0,078R_{01}+0,126R_{04}+0,064R_{05}.$$

As one can see from information provided in Table 13 the biggest impact on EAPI development has independent regulatory variable R04 (Existence of retail market). The other independent regulatory variables R01 (Unbundling of generation from transmission) and Quality of regulation (R05) have also significant impact on EAPI. As values of other coefficients differs from 0 not statistically significant therefore these independent regulatory variables R02 (Third party access to the grid) and R03 (Existence of wholesale market) are not included in Steiner regression. The main conclusion based on analysis of electricity market development in Lithuania by applying Steiner models the following: the biggest impact on competiveness of Lithuania measured by EAPI during the period of 23 years (1990 -2012) has the unbundling of generation from transmission (R01), introduction of retail market (R04) and quality of regulation (R05). The statistical analysis indicated that it is not possible to define that other regulatory variables such as wholesale market and third party access to the grid and privatisation have positive impact on growth of competitiveness of Lithuania. Therefore in the energy market opening in other sectors (natural gas and heat sector) the priorities should be allocated to unbundling of generation from transmission, introduction of retail market and quality of regulation.

The Steiner model developed for Lithuania should be further applied for all EU member states having the longer experience of electricity market opening. The results obtained for other EU member states and their comparative analysis would provide for more robust results in assessments of electricity market opening on competitiveness.

CONCLUSIONS

1. The results of reviewed studies dealing with the impacts of liberalization on competitiveness showed that the development of liberalization models in electricity sector does not necessarily reduce electricity prices and can cause economic cycles. They revealed that relationships between energy market liberalization and electricity prices are complicated and reciprocal. In addition the impact on other important issues such as energy supply security, sustainability needs more broad investigations.
2. WEF report on Energy Architecture Performance Index (EAPI) ranks energy systems of 105 countries from an economic, environmental and energy security perspective. Norway, Sweden and France top the ranking according to EAPI;
3. The scores of electricity market liberalization for EU member states were developed based on simplified OXERA model and using the statistical data on energy provided by EUROSTAT;
4. Analysis of electricity market liberalization impact on EU energy policy priorities indicated that countries ranked with high energy market

liberalization indicator developed by OREXA not necessarily have been ranked with high scores according the EU Energy Policy Performance Index (EAPI) providing for the evaluation of success of countries in implementing EU energy policy goals: competitiveness of the EU economy, environmental sustainability and security of energy supply.

5. The Steiner's model was applied to assess the impact of specific regulatory (unbundling, retail market, wholesale market, third party access to the grid; privatization, regulation quality) and non-regulatory (GDP, the share of nuclear and hydro in electricity generation balance) variables impact on EAPI in Lithuania;
6. The analysis electricity market development in Lithuania by applying Steiner model revealed that the biggest positive impact on competiveness of Lithuanian energy sector measured by EAPI during the period of 23 years (1990 -2012) has the unbundling of generation from transmission, introduction of retail market and quality of regulation.
7. The statistical analysis also revealed that it is not possible to define that other regulatory variables such as wholesale market and third party access to the grid and privatization have positive impact on growth of competitiveness of Lithuania. Therefore in the energy market opening in other sectors (natural gas and heat sector) the priorities should be allocated to unbundling of generation from transmission, introduction of retail market and quality of regulation.

Acknowledgements: the research was funded by a grant (No. IEP-01/2012 from Research Council of Lithuania).

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