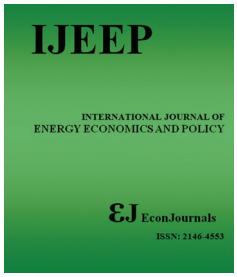

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Issues for Long-range Projection of International Energy Markets through the Prism of Sustainable Development

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ABSTRACT

Modern energy system development model requires incorporation of not only demand and supply sides of energy markets, but also reference of new technologies deployment throughout the whole value chain, governmental policies in place, and other non-market indicators that, however, provide for the whole market equilibration by indirect energy resources price regulation. Consequently, overcoming the traditional framework is getting basic precondition for achieving sustainable development in the energy sector, covering the whole energy system for research purposes due to global and coherent transition from forecasting of energy development to constructing of new alternatives and creating a new world which meet the goals of sustainable development. The next step will be a creation of ways of their achievement, and management systems, which allows countries, regions and the whole world to stay on that pathway. The article comes up with suggestions on making alterations to the current practice of energy systems forecasting process.

Keywords: Scenarios, Sustainable Development, International Relations, Global Energy Markets
JEL Classifications: O13, P28, Q47, Y3

1. INTRODUCTION

The Russian Federation is one of the largest international energy market players. Energy sector is vital for the Russian economy, and its development dynamics to a large extent affects economic sustainability. In this regard, development of scenario for world energy markets development in a long-term perspective proves to be essential. Being in the framework of recent geoeconomic and geopolitical processes affecting national economies, it should incorporate analysis of a wide range of specific factors that underpin energy markets development, and capture trends of sustainable development policies implemented in national legislation systems. The primary objective of such exercise is to evaluate trends in world energy markets development and capture country-specific instruments that might be employed for securing economic sustainability. With a focus on the Russian perspective, that requires identification, classification and assessment of factors currently determining the modes of operation of Russian energy market and its interplay with international markets, as well as analysis of effectiveness of various policy options adopted in support to sustainability.

The energy markets forecasting is important to adapt economic growth trajectories that remain in line with sustainability principles, and allow for securing sustainable development of national economy. It is worth mentioning that there is a contradiction concerning forecasting methods, instruments and approaches. On the one hand, the range of organizations forecast energy systems development, on the other hand – the forecasting is archaic. It is mostly bound to using simple and inadequate forecasting methods, which appear to be mechanistic procedures neglecting qualitative market developments. At the same time, significant developments have occurred forming the new global geo-economic view. Nowadays, the most complex objective is to establish a new concept described by quantitative indicators.

2. LITERATURE REVIEW

Overview of the existing literature suggests that the existing evaluations of energy resources demand in the mid and long-term perspective presented by specialized international organizations are mainly based on either extrapolation of present trends, without giving due consideration to different regional markets characteristics, or reflect particular interest of those providing these forecasts (Greene, 2001). Moreover, the forecasts have different aggregation by countries, which implies methodological complications while assessing energy system development issues on regional and global scale.

The initial evaluation of scenarios gives a clear understanding that fundamentally the results of each scenario are merely based on presumptions, expert opinions and certain preconditions, which the developers are guided by. It stipulates that there is no single pair of forecasts that may be characterized by similar quantitative estimation indicators. Nevertheless, qualitative estimations frequently coincide with each other, though there is no single combination reported.

Multiple global energy system development simulation results are primarily built upon a set of input data describing the current state of energy system, and their further prioritization with consideration of energy paradigm in a certain country (region, company). Yet, various data analysis approaches have a common goal of establishing a starting point for further analysis, which, in fact, are "forecasting" or "scenario-building."

It is obvious that the forecasting process implies achieving a particular state of the energy system based on the input value and change of indicators over time, as well as on a number of assumptions. The methodological approach for such modeling is based on the analysis starting from the lower levels of hierarchy (bottom-up approach). The scenario building process, in turn, includes a range of possible ways for further development and, therefore, multiple system states in the future, developed through top-down analysis. The latter is based on developing hypotheses and establishing the desired parameters and indicator values, with the subsequent development measures on how to achieve a certain state of energy system.

3. MODERN ENERGY SYSTEM MODELLING APPROACHES

Generally based on the individual goals, modeling is carried out by using a range of economic-mathematical models, taking into the account the list of indicators which are often similar with respect to their qualitative interpretation but with different quantitative estimation, as well as evaluation of their interplay and cross-factor correlation. Thus, a number of models include unique parameters, which are only necessary to realize a specific research task. Nowadays there are more than 50 models, developed by various specialized organizations and energy companies and they enable energy system development forecasting at global, regional and national levels (Gabrial and McGlade, 2012; Bhattacharyya and Timilsina, 2009). Models are regularly reviewed, supplemented by actual data and improved in order to ensure the most reliable results according to the developers. It is noteworthy that mathematical models are not used by private oil and gas companies which develop their own forecasts based on internal assessments and subjective assumptions regarding industrial development trends emerging on energy market in the future based on the investment climate, technology development, economic, environmental and geopolitical situation.

Among the foreign organizations absolute leaders are International Energy Agency and World Energy Council that form a global vision of energy development. At the same time, there is an extensive network of university research centers and laboratories involved in the energy development prospects. Among them it is worth to mention the U.S. Department of Energy's National Renewable Energy Laboratory, Paul Scherrer Institute (Switzerland), Duke University (USA), Cambridge Econometrics (UK), National Technical University of Athens (Greece), Finland Futures Research Centre (Finland), International Institute for Applied Systems Analysis (Austria) and others. Russian Academy of Science and the Russian Government Analytical Centre are the ones working in the sphere of forecasting of global energy tendencies (Makarov et al., 2013; Benichou and Mayr, 2014; Densing et al., 2013). In addition, such forecasts are done by the Russian and foreign companies in the fuel and energy complex, including LUKOIL, BP, Eni, ExxonMobil, Shell, Statoil and others. At the same time, fundamentally the results are based only on expert opinion and assumptions, by which certain developers are guided. It should be emphasized that the forecasts are based on multiple forecast general methods, models and approaches. The list of common predictions including the description of their characteristics is presented in Table 1 (Jose and Assis, 2015).

In addition to different approaches applied to the outlooks development, every organization focuses on its particular prioritized sphere. Apart from this, different interpretations of the term "sustainable development" imply that in fact data is not comparable. This study deals with 98 matching quantitative indicators examined in the outlooks, which are classified by 11 topic groups stated below: Access to modern energy; energy efficiency; energy production; energy security; environment; final energy consumption; final energy supply; global context; installed generation capacity; primary energy resources; technology. The data analysis allows demonstrating the indicator groups covered by organizations (Figure 1).

A detailed assessment of particularities of each of the energy development outlooks requires profound research, as each organization uses a certain model and applies it to build several scenarios, which mainly differ by degree of consistency between national economic and political measures aiming to achieve sustainable energy, as well as technological development incentives and changes in models of consumers' economic behavior (industry, transport sector and households) (Salygin and Litvinyuk, 2016).

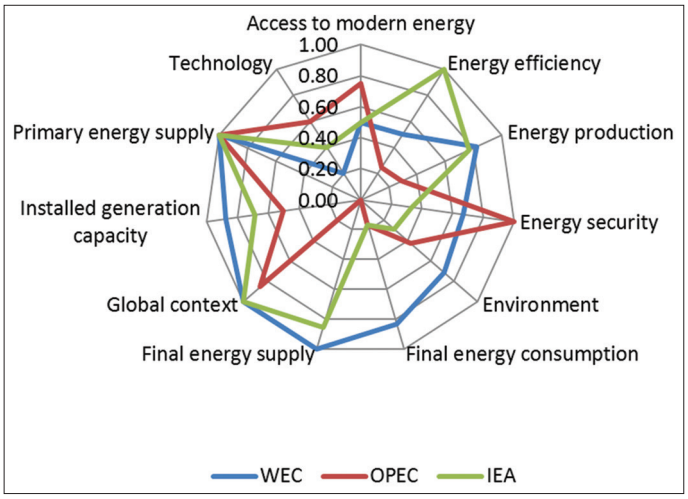
Nowadays, a significant interest is demonstrated in rethinking the very energy system structure considering global adoption

Table 1: World's most advanced models for energy development forecasting

Parameter	MARKAL	WEM	PRIMES	SCANER	POLES	NEMS
Approach	Bottom up	Bottom up, Top down	Top down	Bottom up, Top down	Bottom up, Top down	Bottom up, Top down
Coverage	WEC, 2013	OPEC, 2014 EIA, 2014	EU, 2013	ERI, 2013	EU, 2003	EIA, 2014
Time horizon	Over 80 years	25 years	35 years	Over 15 years	Over 25 years	Over 25 years
Step	10 years	5 years	5 years	5 years	10 years	10 years
Regional coverage	World, 8 regions	World, 17 regions, 3 regional grouping, 12 countries	World, 9 regions, 7 subregional grouping, 5 special countries grouping	World, 62 influential countries, 83 territorial entities of the Russian Federation	World, 7 regions, 3 subregional grouping	National level (USA)
Value chain	Production, transportation, distribution, consumption, CO_2 emissions	Production, distribution, consumption, pollution emissions	Investments, production, transportation, distribution, consumption, pollution emissions	Investments, production, transportation, consumption, CO_2 emissions	Production, distribution, consumption, CO_2 emissions	Production, transportation, distribution, consumption, pollution emissions
Amount of the considered energy source	15, with subsequent aggregation into 7 groups according to methodology	7	11	Able to incorporate over 20 sources	12	7 groups (no reliable data on the structure)

WEC: World Energy Council, OPEC: Organization of Petroleum Exporting Countries, EU: European Union

Figure 1: Scope of the indicator groups covered by World Energy Council, Organization of Petroleum Exporting Countries and International Energy Agency according to the classification



of sustainable development concept, which subsequently may contribute to gradual change in the energy paradigm. However, Russian scientific centers are currently mainly guided by traditional views on the energy development.

Existing methods of forecasting of global energy development mainly represent stochastic models of economic-mathematical analysis. At the same time, a modern energy development model requires consideration of not only of supply and demand in energy markets, but also the results of deployment of modern technologies in the industry within the value chain, the current state energy policy and other non-market values, which, however, secure market equilibrium through indirect regulation of energy prices.

The architecture of global energy system remains one of the most controversial issues. The development of potentially possible ways for energy development, which is both a cause and a solution for overcoming global challenges, will be able to assist in the identification of consequences of their implementation and improvement of validity of taken decisions.

In order to identify global trends of energy development and predict its future state a number of specialized international organizations, research institutes and industry experts direct their efforts to the search for the key factors and driving forces characterizing the dynamics and direction of global energy system development. They monitor and analyze quantitative and qualitative assessment of global energy system development indicators, ensure the alignment of the global energy picture at a time in the future.

As for the indicators classification, their significant variation by covered scope is to be mentioned. The greatest number of matching indicators is encountered in the global context, which underlines global economic growth, population growth, poverty reduction as well as ongoing role of fossil fuels as the foundation of the most countries' energy mix. Ongoing changes of energy markets currently hold orientation towards the Asian region, which already has high demand for energy due to rapid economic development (Belogoryev et al., 2011).

Consensus among outlooks is also observed in terms of the evident fact that all kinds of energy resources suffice to meet the needs of the next generations, which is basic conception of sustainable development in terms of energy. Depletion of fossil fuels is not subject of the research, however, the significance of conventional fuel reserves threat is stressed in the future.

Moreover, estimations are remarkably diverged considering different views of experts regarding the current development tendencies. Such diversions imply the fact that references to a certain scenario are quite unfounded. In order to use calculated indicators for energy markets, more calculations are to be processed and practically implemented scenarios are to be taken into account.

World-widely used energy development models including regional integrations analysis along with considered indicators include thousands of endogenous variables. Since these sets of variables are often different by structure, the question arises whether it is worth developing new models, which could potentially integrate a wider range of indicators providing better representation and interconnection.

Thus, the key factor to achieve sustainable energy development is to holistically overcome traditional framework regulating the scope for energy system analysis, through coordinated transition from "forecasting" of energy systems development to "scenario building." Considering insufficient transparency applied for modeling methodologies, it is critically important to ensure interconnection between specific international organizations, governments, research centers and energy companies in order to develop coordinated approaches to the problems of energy system modeling, and instruments allowing to balance the interests of the parties, in energy, economy, social aspects, geopolitics, environment and technological development.

4. SUGGESTED METHODOLOGICAL CHANGE IN APPROACH TO ENERGY SYSTEM MODELLING

It is impossible to predict the future. However, it is quite an affordable aim to anticipate the trends in global energy development. Is it possible to achieve the goals of sustainable development or to coordinate the efforts of every country in terms of climate change? What will be the development of energy technologies? Will their application be economically viable, founded and world-widely used? How the global energy mix will look like in the future? Will renewable energy become the global solution? How will the state policy be pursued in terms of energy subsidies and tariffs? For these and related questions to be answered, it is necessary to profoundly analyze indicators, identify interlinkages between the factors, define the impact of national energy policies on regional and global development, and evaluate changes in consumers' market behavior. Key issues for energy system forecasts in terms of sustainable development along with the relevant factors and possible impact of these factors on further energy system development are demonstrated in Table 2 (Guliyev, 2012; Makarov et al., 2013; Elzinga and Litvinyuk, 2015; Karjalainen et al., 2014; Mai et al., 2013).

Also, factors that can be used as describing characteristics of the future international economic relations systems classified by three groups: Macroeconomic, mesoeconomic and microeconomic. These levels are essential for energy forecasts. The list of these factors is stated in Table 3.

The scope of the above research allows exposing certain strengths and weaknesses as well as opportunities and threats for sustainable energy development scenario building exercise, and allows conducting strengths, weaknesses opportunities, threats - analysis presented in Table 4.

5. CONCLUSION

The broad sense of the sustainability concept is reflected in national and regional energy strategies, which leads to varying approaches and results. Governments of certain states define consistent energy generation as complete refusal of exhaustible energy resources and full switch to the use of renewable resources in the short-run where greenhouse gas emission reduction is an integral part. Representatives of other countries stress the necessity to increase energy efficiency and make energy sources available to the poor. While the identification of priorities concerning conservation of climate is underway, certain countries are not ready to stop using exhaustible energy resources concentrating on carbon dioxide emission reduction. Every state follows its energy strategy, based on its own priorities and views regarding considered issues such as climate change mitigation, sustainable development, environmental protection, poverty reduction, improvement of the quality of life, etc. (Gabrial and McGlade, 2012).

Sustainable development of the whole energy system in the future is considered to be a basic element, which is supposed to combine ecological, economic and social aspects. Such system will include every aspect of energy system development according to national requirements and problems including climate change and use of natural resources, job creation and energy security.

It seems important to define the concept of sustainability with respect to energy, both in the context of mitigating negative environmental effects and it the context of ensuring the security of energy system for sustainable economic development.

Within the scope of this project it would be possible to develop methodology and tools for conducting assessment of global energy development scenarios, systematic research of various forecasts, comparison of existing (reference) and newly developed scenarios, which will provide an opportunity to conduct research of alternate strategic opportunities and priorities for achieving the goals of sustainable development in energy sector. In the project it is intended to develop sustainable development indicators for energy sector. The development will be based on the conceptual approach "purpose-objectives-indicators" embodied in Sustainable Development Goals adopted at the UN in September 2016 for all countries worldwide for the period of 2016-2030. Certain goals are connected to energy development either directly or implicitly. The analysis of the restrictions for the energy sector due to the adoption by Russia of the Paris climate agreement will be also

Table 2: Key topics to forecast the energy systems development under sustainable development

Topic	Influenced factors	Possible factors' influence on energy system development
Consumer energy needs in the period ahead. Economic choice criteria for consumers	Dependency factor of the electrical grid consumption	Energy efficiency
		Electricity price, grid parity
		Availability or deficit of electricity
		Development of electricity infrastructure
		Individual generation technology
	Population growth	Energy safety in a bread sense (energy importers and exporters positions)
		Growth of middle class
		Lack of knowledge and skills
		Consumption pattern modification
	Quality of energy service	Distributed generation
		Development of energy service companies
		Evolvement of "client-first" approach
		Energy distribution and consumption
	Legal framework	Trade development via law incentives
		Legislation development in developing countries
		Legislation development including ecological principles
		Decentralization, liberalization, deregulation
Disruptive technologies, which provide the electric generation structure modification	Business model	Consumer oriented commercial model
		Price of the new technologies model
		Driver for disruptive technologies model (objective necessity for the "survival" goals or the innovation solution realization)
		Technical solutions model
		Commercial model modification from "based on the technology development level" to "based on the market conditions"
		Innovation technologies implementation opportunity
	Basic energy resources structure for electricity generation	Modification of electric generation technologies
		Fuel energy production growth
		Energy consumption trends
		Role of energy resources in the country's development
		Local component requirements
	Energy resources supply	Energy interconnectivity
		Supply chain limits
		Price of fossil fuels
		System risks (cross-border infrastructure projects in energy)
	New technologies implementation (key energy markets)	Role of the selected countries' energy markets in the global context
		Consistent development of technology along with technological break thoughts
		The balance between innovations and market demand
		Traditional technical solutions, that manage energy based on culture of energy consumption
		Development of energy storage
		Business struggle between traditional energy and renewable source energy
		Results of technical and economical study for feasibility of integration of innovative technologies
	Role of telecommunications and media in energy sector	Telecommunication technologies development
		Commercial models in the sector
		Strategy plan for keeping the public informed
		Technological improvement opportunities
		Role of telecommunication sector in energy management
	Education	Poverty problem
		Education improvement
		Ability to follow technology development
		Human factor and its characteristic
		Labor capacity

(Contd...)

Table 2: ***(Continued)***

Topic	Influenced factors	Possible factors' influence on energy system development
	Rhetoric of international negotiating process	Cooperative solutions development and coordinated actions implementation
		Institutional failures
		Motivation for decision makers
		Public awareness drivers in the world key energy markets
		Partnership and communication between government and business
	National industrial policies	Influence of legislation and politics on technology and business
		Decentralized electricity generation
		Renewable energy facilities as major companies' assets
		Incorporation of environmental element and its prioritization into national policies
Common energy market. Architecture and target model of regional electric energy markets. Price convergence of energy	Energy service accessibility	Technological transfer
		New sources of energy
		Labor integration
		Energy price ("affordability")
		Role of nongovernmental agencies and business sector
		Decentralized generation, local power grids
		Meaning of the energy for humanity in general
	Living standards	Obligations, contracted by the poorest countries
	Common energy system or isolated national energy systems	Correspondence of political efforts to real requests of consumers
		Fair energy price
		Common electric energy market
		Regional energy market target model (trade, energy balance, coordination)
	Global climate agreements	Price of greenhouse gases emissions
		Development and implementation of commercial models based on sustainable development principles
		Rhetoric change of the negotiation process including questions of achieving sustainable development goals at the global level

Table 3: Descriptive characteristics of international economic relations (by levels of impact) for the purpose of energy development forecasting

Characteristics	Macroeconomics	Mesoeconomics	Microeconomics
Key unknown factors	Global economic environment		Optimal generation structure based on balance of renewable and conventional energy
	Objectives coordination of universal access to energy sources with actions to combat climate change		Achieving sustainable development goals on national levels
Key participants	Major states (population, production levels, energy consumption)	ASEAN member states	
	Sustainability of energy products export from major energy-exporting countries		
	Issues of water-energy-food nexus		
	Economic availability of new energy sources (development of technologies)	Uncertainty with respect to the development of small countries	
		Geopolitical and economic sustainability of world's largest economies	
	Demographics and energy consumption growth		
	Deployment of available (including economically) energy technologies	Centralized or distributed generation	
	Interplay between telecommunication and energy (remote control of networks, consumption control)	Local energy systems	
	Limited resources (including water-energy-food nexus)	Water supply deficit	
	Energy storage technologies and their availability for end-users	Labor efficiency	

(Contd...)

Table 3: ***(Continued)***

Characteristics	Macroeconomics	Mesoeconomics	Microeconomics
	The role of consumers in creating energy systems, which meet their demand	Availability and transparency of information sources	
Major factors	International cooperation on challenges concerning measures to combat climate change		
		Alteration of traditional business model	
	Social request concerning environmental quality		
	Potential for atomic energy industry development		
Pre-defined elements	Fossil fuels supplies will retain their role in consumption pattern		
	Global leadership of certain states with respect to environment-oriented issues and actions mitigating the effects of climate change		
Social aspects	Urban population increase	Population increase	
		Educational level	
	Social inequality and its effects on economic growth		
	Healthcare (connection to ecological issues)		
Economic aspects	Quality of life	Diversion in economic growth rate on the sub-regional level might exert pressure on the relations between countries	
Ecological aspects	Issues of pollutant emissions	Development of pollutant capture and sequestration technologies	
Political (geopolitical) and legal aspects	Governmental influence on economic and political situation in other states	Political support of standards harmonization process	Practical implementation of the developed standards
	Development of technical regulations, rules and standards		
Technological aspects	Role of states in achieving goal to establish a sustainable energy system		

Table 4: SWOT-analysis of factors that influence energy development

Strengths	Weaknesses
Significant financial resources	More of a political dialogue rather than actual interest of states
High level of education, knowledge and skills	"Developed states forgot how to struggle against socio-economic difficulties" (Gurtner, 2009)
Access to basic energy technologies at fair price	
Potential for renewable energy development	Lack of coordination at interstate level
Regional cooperation	Varying goals and priorities of states (especially with respect to energy security)
	Low level of energy efficiency in certain parts of the world and inability to increase it (Tromop et al., 2015)
Opportunities	**Threats**
Promotion of cooperation on common issues	Absence of shared vision of the development strategy on the regional level, unrealized gains
Technological progress	
Harmonization of standards	Varying opinions and interpretations of the term "sustainability" by the states, which leads to non-compliance of national policies
Increase in existing assets' energy efficiency	
Use of low-cost energy sources technologies	Conflict of interests
Investments in energy infrastructure, ensuring its flexibility	Low efficiency of reorganization due to human factor
Investments in energy efficiency	
Investments in renewable energy	
Global energy security system	
Exchange of experience and best practices at a country and company levels	
Relations to facilitate the assurance of non-confrontational coexistence	

SWOT: Strengths, weaknesses opportunities, threats

carried out. Based on the outcomes, a new forecasting method of energy markets development will be developed, considering geo-economic, geopolitical and geo-ecological processes. According to the new forecasting, practical recommendations concerning the development of concept for transition to sustainable development will be proposed.

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