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Growth of economic expediency from renewable energy sources as a factor of European energy market dynamics

Mejoramiento de la factibilidad económica de las fuentes de energía renovables como un factor de la dinámica del mercado energético europeo

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ABSTRACT:
Europe has already surely chosen its way to the so-called “new energy” and has accepted the full lack of options in this regard. The rapidly developing sector of the renewable energy sources is not only the key element of environmental policies, but also an integral part of innovative development and economic policies too. Basing on the methodologies of forecasting GDP growth for the EU countries and calculating GDP energy intensity, this study also outlines the key trends observed in the EU economic growth dependence upon the consumption of various energy sources. Dynamics of future growth of the European energy market has been forecasted taking into account the fact that this European market is integral part of the world system of trade in energy carriers.
Keywords: renewable sources of energy (RSE); energy sector; energy resources; innovations; modernization; the European Union

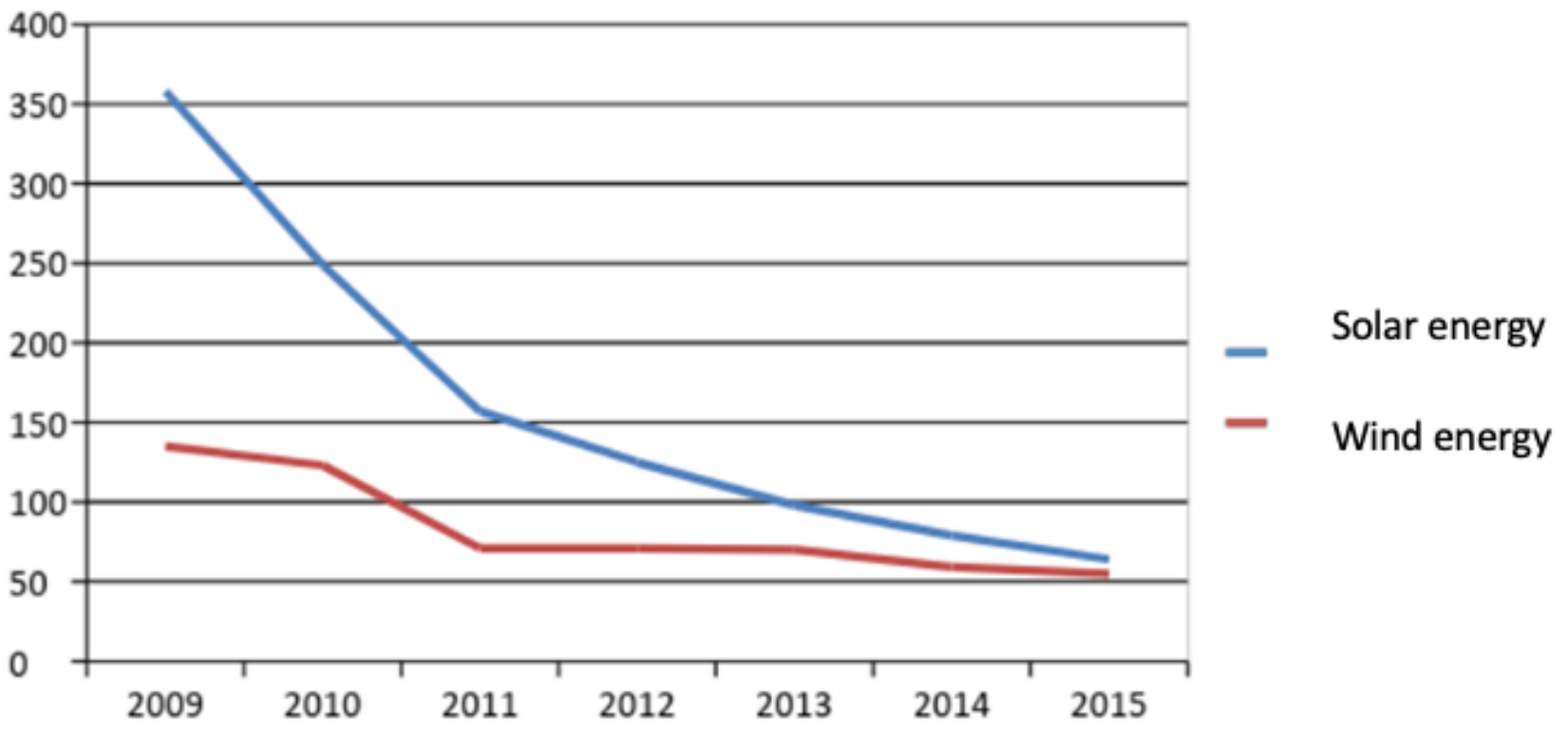
RESUMEN:
Europa seguramente ya ha elegido su camino hacia la llamada "nueva energía" y ha aceptado la falta total de opciones a este respecto. El sector de rápido desarrollo de las fuentes de energía renovables no solo es el elemento clave de las políticas ambientales, sino también una parte integral del desarrollo innovador y las políticas económicas. Basándose en las metodologías para pronosticar el crecimiento del PIB para los países de la UE y calcular la intensidad energética del PIB, este estudio también describe las tendencias clave observadas en la dependencia del crecimiento económico de la UE sobre el consumo de diversas fuentes de energía. La dinámica del crecimiento futuro del mercado energético europeo se ha previsto teniendo en cuenta el hecho de que este mercado europeo es parte integral del sistema mundial de comercio de transportistas de energía.
Palabras clave: fuentes renovables de energía (RSE); sector energético; Recursos energéticos; innovaciones; modernización; la Unión Europea

1. Introduction

There are numerous definitions of what are renewable sources of energy (RSE). Commonly to this category belong such forms of energy as solar, wind, sea-wave energy, tidal power, biomass energy as well as hydropower, geothermal energy, energy from solid biomasses, from biogas, liquid types of biological fuels, and finally, energy converted from biological wastes (Onyusheva et al, 2018).

Back in 2010 the most competitive among all of them, as compared to traditional energy sources and from the viewpoint of prime cost of electric energy generation was wind energy (Samarina et al, 2018). At that time, solar energy was more expensive than the energy obtained from diesel generator, while production of electric energy from biomasses was not able to compete with natural gas. However, rapid development of truly innovative technologies in the sector of renewables during the last 5 years has lowered the costs of energy generation by nearly half, therefore, the costs of renewable energy generation (see Figure 1) became nearly equal to the costs of energy generation from natural gas, at least as it is done in the countries of the European Union and in the USA (Lazard, 2015).

Figure 1
Costs of wind and solar electric energy generation
in the USA, 2009 to 2015, in USD



Source: Russia Energy News, 2016

This technological progress has its direct impact on:

- rapid growth of electric energy generation from renewables in the leading countries of the EU. For example, in Germany alone the growth rate of renewables was around 44%, this made Germany one of the world leaders in the green energy sector, with its 4000 plants processing energy from biomasses (according to some forecasts, up to 2020 the share of biofuels in Germany will reach at least one third of all renewables in the country (Weiland, 2011);
- gradual cheapening of all projects directly related to new wind generators' placement and construction of new plants processing biomass. In parallel to that we can also observe how coal electric plants are gradually adapting to consuming biomass as their new key material. Significant cuts in the subsidiary policy of the European Union have also stimulated many agrarian businesses to consider alternative sources of income and to use biomass more actively. Back in the 1970s the level of subsidies to European farmers reached its possible maximum, while as of 2013 it was already reduced to the very minimum, that is, threefold (Maraseni & Maroulis, 2008). Farmers also get an additional subsidy of 45 EUR per 1 ha provided they use their lands to grow plants for further biofuel production;
- development of the unique joint (within EU) projects in the field of RSE (for example,

creation of one common energy network for all types of renewable energy in the North Sea region (Electricity information, 2011). This project involves Belgium, UK, Germany, Denmark, Ireland, Luxembourg, Netherlands, Norway and France and has the total cost of 30 bln EUR).

As a result, in 2015 already the share of RSE went up significantly reaching the level of 13,8% of the total primary offering at the energy market (Eadaily, 2016).

Therefore, increasing production volumes of RSE and their larger share in the energy balance together have contributed to higher efficiency of economic activity performed by various (in terms of energy consumption volume) agents. And this, indirectly, has strengthened trust inside countries - in the relations between the state, businesses and civil society.

Europe has already chosen its way to new energy and RSE in particular, thus admitting the lack of alternatives on the way of innovative development. According to some of the forecasts, the world spending on RSE as of 2030 would reach 7 trln USD (BNEF, 2016). Despite all the external pressure imposed on RSE (primarily through gradual lowering of subsidies and other preferences), this segment, being one of the key elements in the innovative and environmental clean energy sector, becomes a significant economic player at today's markets. Thus, its further development simply must be taken into account when long-term forecasts are being made for the energy markets of the so-called Old World. And this fact predetermines our research objectives along with the topicality of the study presented below.

The research objective is to use forecasting methods in relation to GDP growth in the EU countries along with the author's approach to calculation of GDP's energy intensity so that to determine and outline the key trends in the dependence of European economic growth from the consumption of energy resources of different types. On this basis, the author also plans to forecast the dynamics of European energy market development treating the latter as integral part in the global system of trade in energy carriers.

The research tasks:

- to provide a forecast on economic dynamics for the countries of the European Union using Holt's model as the basis for long-term prospects of the world economic conditions;

- to outline the key trends in the use of RSE by the countries of the European Union and then to assess the competitive advantages along with the innovative prospects of the alternative energy sector development;

- to analyze the dynamics of various energy carriers' contributions into the growth of European GDP in the period since 1990 till 2015;

- to offer own method of forecasting the volumes of primary energy consumption, taking into account the key trends of RSE innovative development along with all changes in the structure of energy production in Europe.

In the course of this research we expect to test and confirm (or reject) the following hypotheses:

The process of gradual substitution of traditional energy carriers by RSE is always accompanied by the gradual decrease of energy intensity of the real GDP in the case of the EU countries. We can observe parallel decrease of the traditional energy sources' share along with gradual increase of the RSE share. In both mid-range and long-term perspectives this would reduce European needs in crude oil and natural gas calculated as per unit of GDP.

Demand for natural gas imports in the EU countries will continue to grow in the near future, despite all the reductions in its internal consumption within the EU.

The shares of biofuels, geothermal and solar energy consumption per unit of the EU GDP will be steadily growing, demonstrating quite high rates. By 2020, they are expected to change their status from being "alternative sources" to becoming significant element in the energy balance of the European Union. At the end, this also means all three will eventually become quite relevant substitutes to oil and gas.

2. Literature review

One of the first to demonstrate and prove the economic role and the value of the renewable energy was S.A. Podolinskiy (1991). This researcher has managed to combine the so-called political economy with its physical basis, thus providing own definition of sustainable development (first, for agriculture only). Later on, directions for further theoretical research in the same field have been outlined (see, for example, Martinez & Schlupmann, 1984).

The issues with finiteness of fossil fuels and also with the environmental consequences from using them have been raised by the Soviet academician N.N. Semenov (1985). Inter alia, this author along with his team have become the pioneers in the research of solar energy, of industrial production of bioethanol and biogas from agricultural wastes and so on.

At the same time, despite all obvious positive consequences from the development and use of RSE, this type of energy has alway had a range of opponents, some of them being quite famous in the academic field.

Over 40 years ago, the world-known Soviet academician P.L. Kapitsa (1976) was already considering low power capacities of wind energy, tidal energy and of some other renewable types of energy as well. He eventually came to the conclusion that this direction in research and energy production has incredibly low efficiency overall and thus he stated that these types of energy, even taken together, would never be able to become a serious alternative to traditional sources of energy.

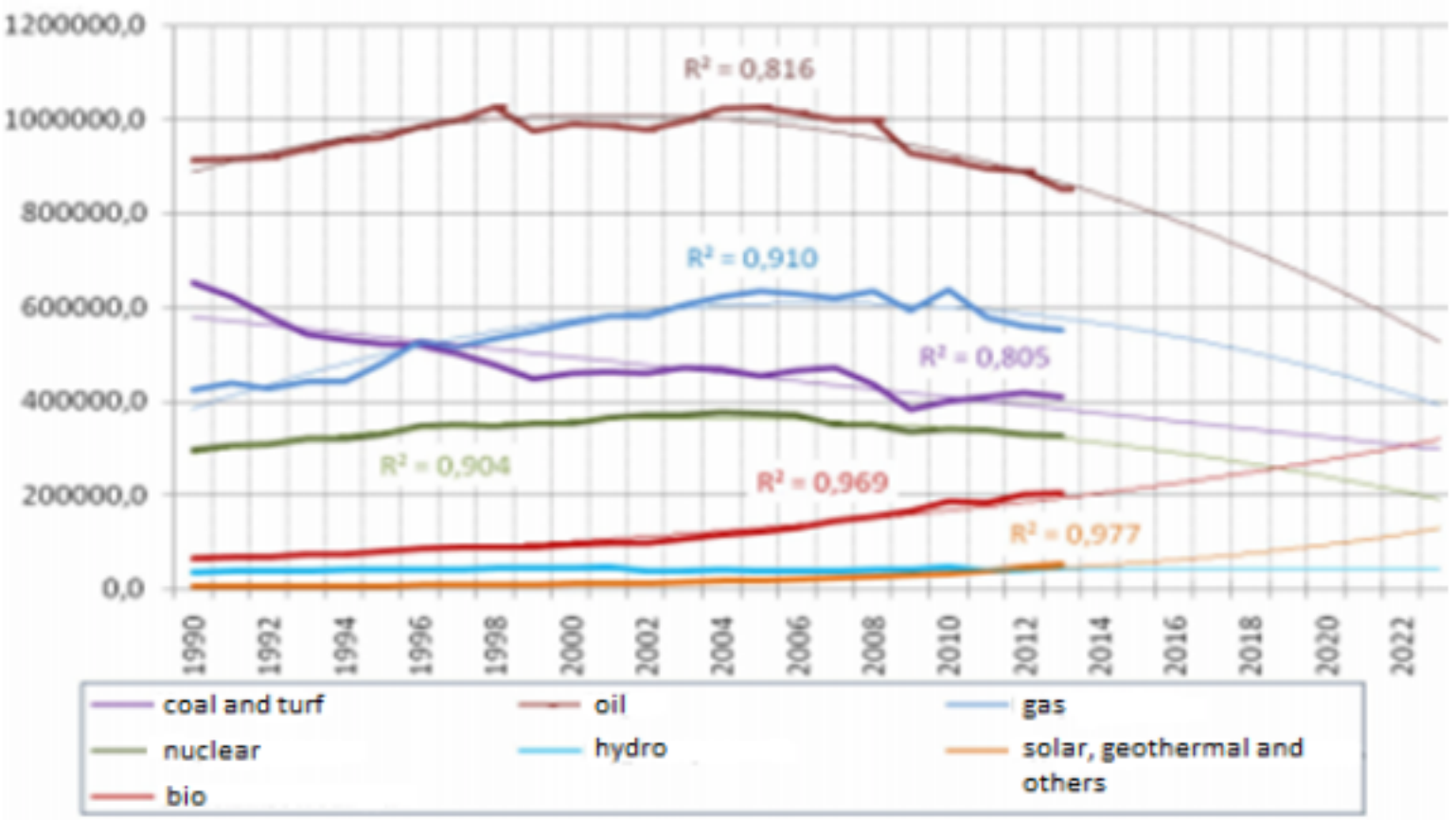
Quite similar assessments of RSE can be found among Western researchers too, including those who used to be serving as experts in various international organizations (see, for example, in Neporozhniy, Popkov, 1985).

Overall, there is a widely spread opinion that demand for electric energy has and will always have its own fluctuations which are never synced with “natural fluctuations” (times of the strongest wind, number of the sunniest days a year etc.). Besides that, technologies involved in renewable energy production are still quite expensive while accumulation of the generated energy is still not economically feasible. The market is still waiting for a truly breakthrough innovation which would cheapen the production of renewable energy to the necessary level, so far there is none. Moreover, since this market is still underdeveloped and there is no scale effect observed on it, renewable energy remains to be inaccessible to a mass consumer in most countries of the world.

One of the first steps in the provision of information and maybe also political support for the development of the RSE market became UNEP - United Nations Environment Programme founded back in 1972 and producing various reports on the development of this sector. The next step was uniting efforts globally by means of creating special working groups of experts within the UN - on renewable energy overall and also subgroups for solar and wind energy separately.

In 2009 IRENA was founded - the International Renewable Energy Agency. Over 140 countries of the world have quickly volunteered to become its members. This became yet another solid proof that the agenda of renewable energy source has rather wide political, economic and information support.

Figure 2
Trends in the development
of energy types in Europe



(constructed by the author on the basis of: Lazard's levelized cost of energy analysis - version 9.0, Lazard 2015; https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-90/)

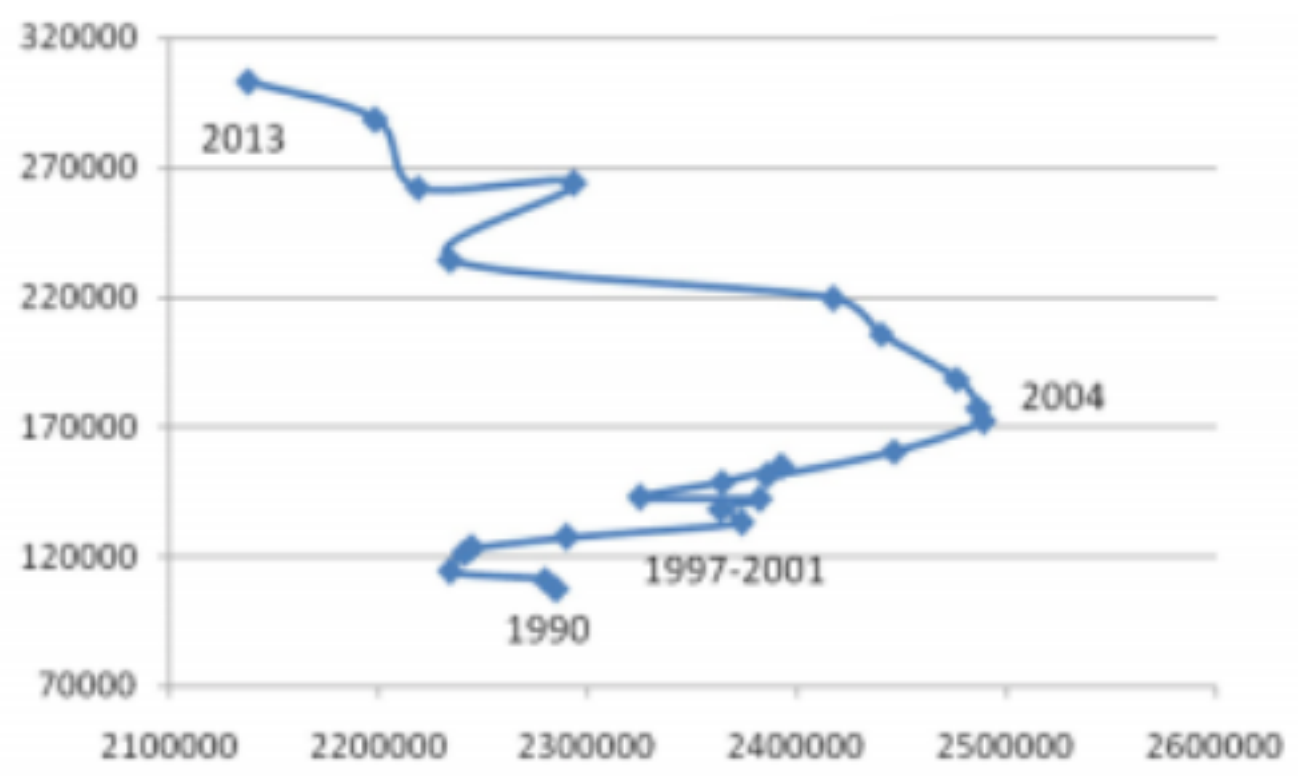
Therefore, today we can observe two parallel sound approaches to the issues of RSE: the first one emphasizes on the necessity to improve all RSE technically, first and foremost through various innovations and pioneering research. The second approach reiterates the issue of economic efficiency growth in what concerns RSE.

Let us consider the key trends observed in the dynamics of energy use within the European Union, by types of energy sources. Approximation of dynamics (see Figure 2) of changes in supply of the key energy types in the EU clearly shows us how European energy policy has been changing within the last couple decades.

In the near future continuation of the intensive growth is expected for all types of RSE, except hydropower. The latter is forecasted to have a slowdown in growth. Most probably, biofuels will become the first of all RSE to reach the level of supply comparable in volume with the traditional sources of the carbon group.

For a more detailed assessment of renewable vs traditional sources of energy let’s group them all in two groups (see Figure 3). Until 2003, the volumes of traditional sources were demonstrating only a steady growth, in parallel to the growth of RSE (which was not that impressive). After 2003 though we can already observe gradual decrease in the volumes of traditional energy carriers, while RSE growth is becoming more and more stable.

Figure 3
The ratio of traditional and renewable sources of energy in their dynamics for 23 years

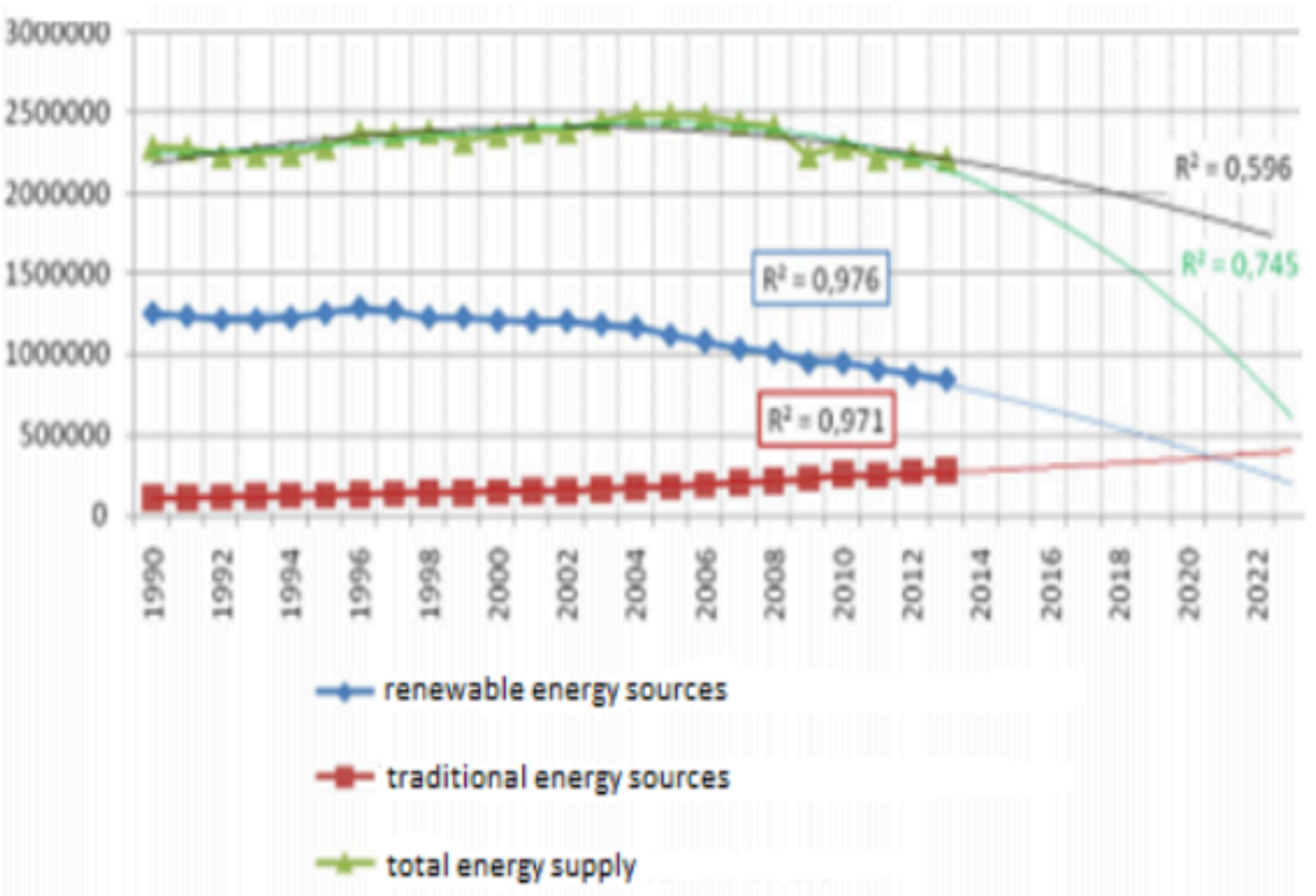


constructed by the author on the basis of: Lazard's levelized cost of energy analysis - version 9.0, Lazard 2015
https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-90/

Approximation of dynamics when these two competing groups are combined also reveals somewhat obvious trends (see Figure 4).

Since the confidence level is quite high (R2=0,976), we can confidently assume that after the year 2020 the volumes of traditional energy production and those of renewable energy production would be if not equal, than quite close to being equal.

Figure 4
Cumulative trend for two types of energy sources, including their own trends



constructed by the author on the basis of: Lazard's levelized cost of energy analysis - version 9.0, Lazard 2015
https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-90/)

3. Results

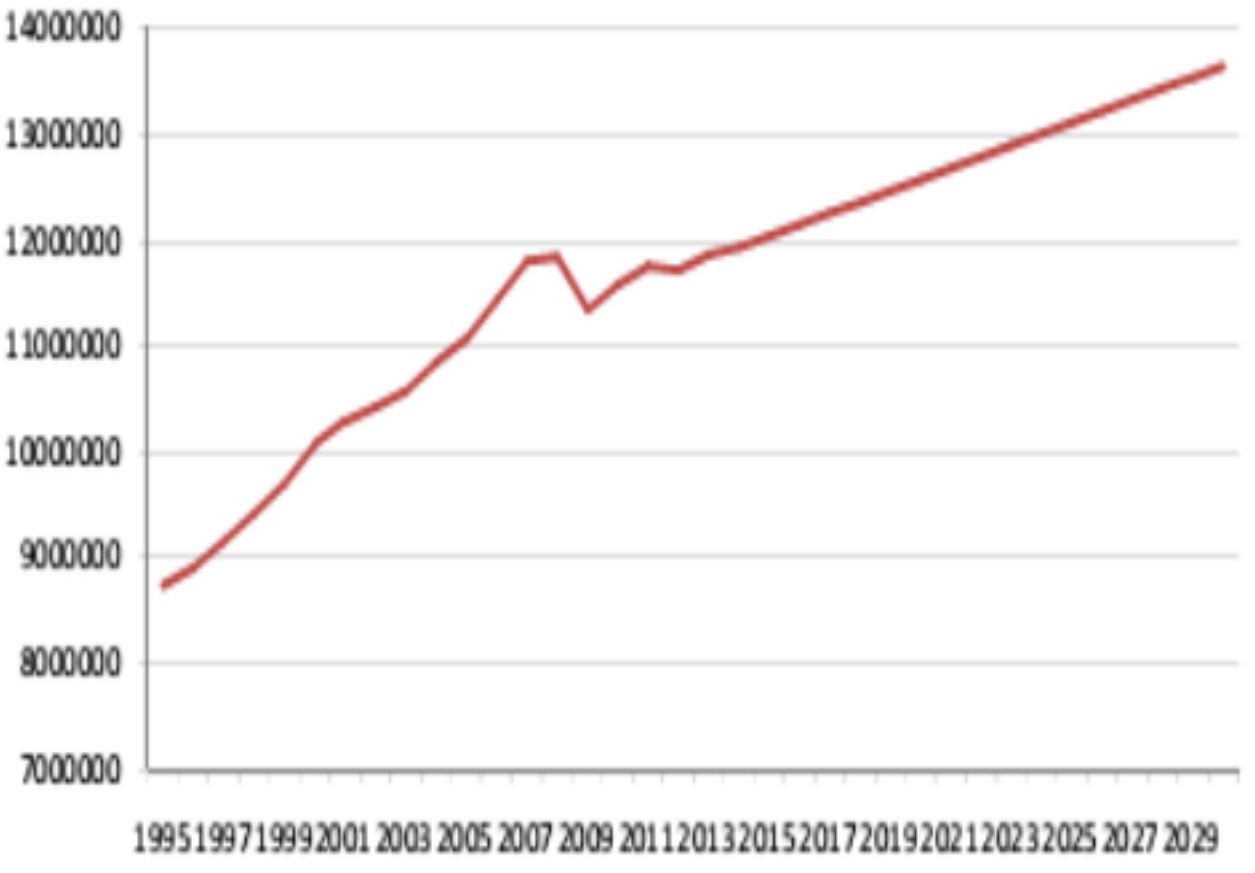
The process of gradual substitution of traditional energy carriers by RSE is characterized by the lowering share of traditional energy sources' energy intensity in the real GDP of the EU and by the growing, in parallel to that, share of renewable energy sources' energy intensity. Provided this trend will remain the same for some time, in both mid-range and long-term prospects European demand in crude oil and natural gas per unit of created GDP will go significantly down (thus, our very first hypothesis is confirmed).

To verify it, we have applied the adaptive method (Numerical methods and optimization in finance, 2012): the energy consumption volume has been presented as the product of real GDP per energy intensity of real GDP in shares for each energy carrier (you can see the input data in Tables 1 and 2).

Figure 5 also presents our forecast for the dynamics of European real GDP according to Holt's model.

The real GDP of Europe fell by 4,5% back in 2009, later, during 2010-2011 economic growth somewhat restored. The growth indicators as of 2012 and 2013 were very close to zero, but extrapolation of the long-term trend revealed using the Holt's model allows us reasonably expect that on the time horizon till 2030 the rates of the EU GDP growth would be slightly over 1% per year.

Figure 5
EU GDP in constant prices, ths EUR



This expected economic growth serves as the factor contributing to increases in the consumption of energy carriers and also in their import. However, in parallel to this trend there is also an opposing trend - it is related to the development and introduction of energy-saving technologies and gradual switching to alternative sources of energy. This transfer to the use of alternative energy causes the reduction in energy intensity of GDP in part of traditional energy sources. This logically also means reductions in their overall consumption and import.

Let us calculate the energy intensity of real GDP (as the ratio of energy consumption to GDP). For this, we will operate the historical record on each energy carrier (see Table 2), and then we will build the forecast of energy intensity of GDP according to Holt's model (Figure 6).

Table 1
Overall primary energy supply, in thousand tons

of reference fuel (fragment of the larger table)

	Nuclear	Hydropower	Other non-traditional carriers
1990	296249	35641,6	4922,8
1995	328146,7	40728,2	6098,9
2000	352026,4	43885,4	10184,3
2005	371766,3	38392	17556
2010	341516	43120	32190
2015	326717,9	45467,9	53306,9

Figure 6
Forecasting the energy intensity
of GDP, as per Holt's model

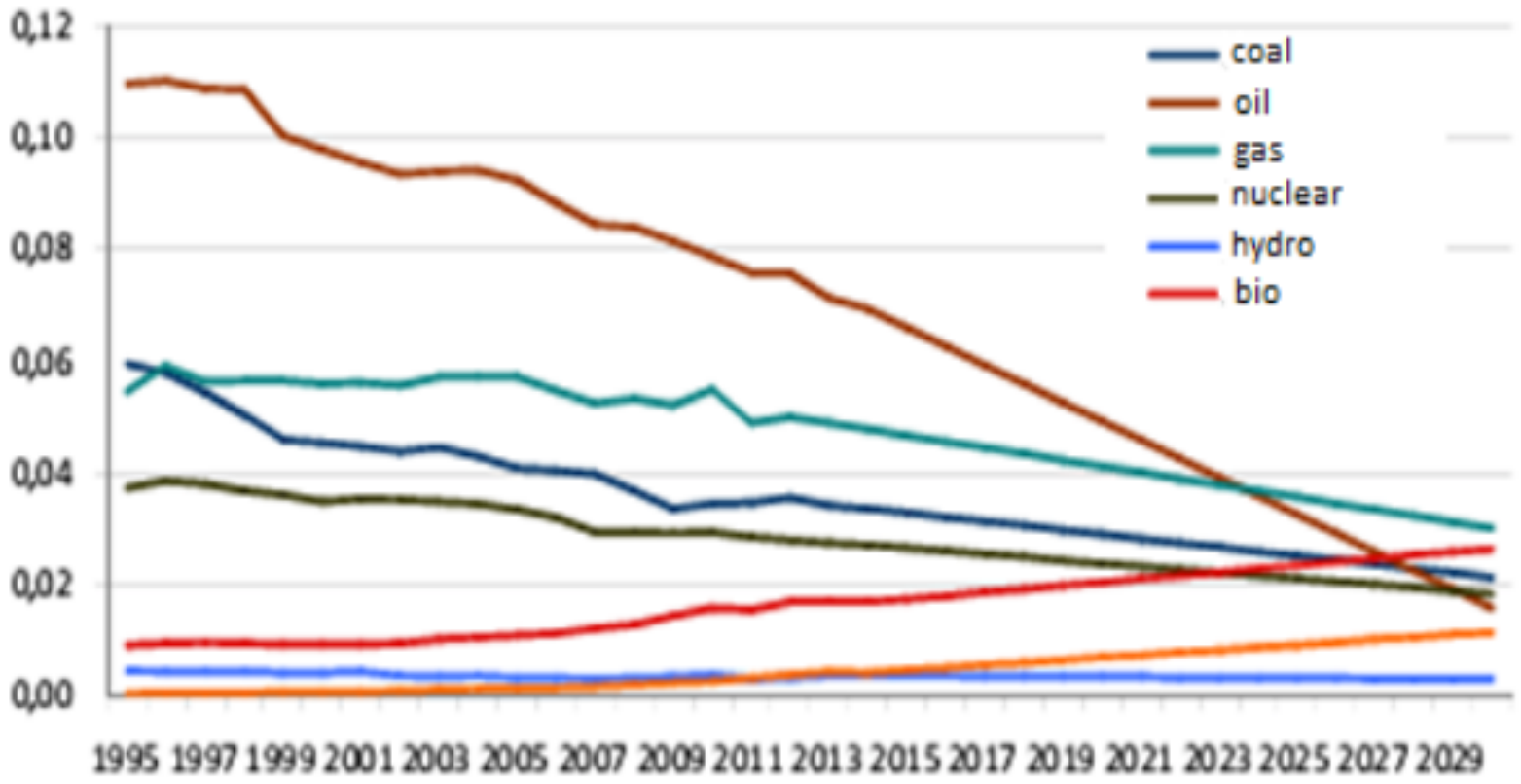


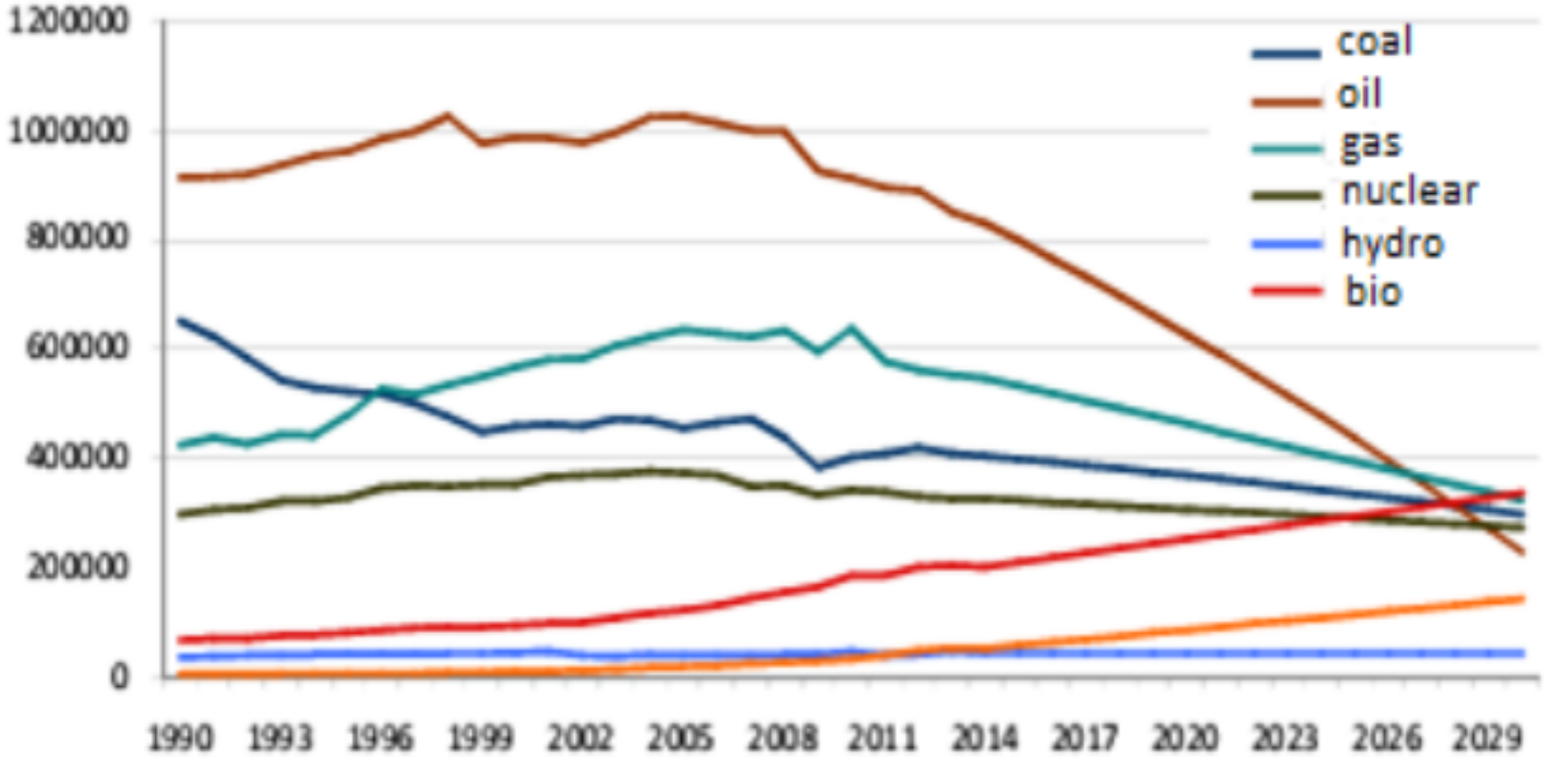
Table 2
Energy intensity of real GDP by types of energy carriers
used in the EU countries (fragment of a larger table)

	Coal	Oil	Gas	Nuclear	Hydro	Bio	Other RSE
1995	0,06	0,11	0,05	0,038	0,005	0,009	0,001
2000	0,046	0,098	0,056	0,035	0,004	0,009	0,001
2005	0,041	0,089	0,055	0,032	0,003	0,011	0,002
2010	0,035	0,079	0,055	0,029	0,004	0,015	0,003

2015	0,035	0,076	0,049	0,029	0,003	0,016	0,003

Next, let us calculate the consumption forecast (see Figure 7) separately for each type of the energy carriers in question. Consumption here is considered to be the product of forecasted real GDP and energy intensity.

Figure 7
Consumption forecast for the
selected types of energy carriers



Analysis of dynamic changes in the energy intensity of real GDP of the European Union for crude oil alone clearly shows that during 1995-2012 quite a stable trend was formed - gradual but steady reduction of the crude oil share per unit of real GDP. Noteworthy, in the recent years this reduction in crude oil share was over 3% per annum.

Extrapolation of this trend for mid-range and long-term prospects demonstrates that the effect from this reduction in crude oil share overlays the effect from the growth of real GDP. Thus, the rates of crude oil consumption growth turn out to be negative and equal to roughly -2% per annum.

Analysis of dynamic changes in energy intensity of European real GDP for natural gas shows that during 1995-2012 consumption of gas per unit of real GDP was also going down. Extrapolation of this trend for mid-range and long-term prospects demonstrates that the reducing share of gas overlays the growth effect of real GDP. Thus, the growth rate of natural gas consumption turns out to be negative too, it is equal to approximately -1,6% per annum.

Multidirectional development of production and export of natural gas by the EU countries causes serious uncertainty when it comes to forecasting the dynamics of gas imports by the same European countries. Trends that have been formed in the recent years, demonstrate the reducing volumes of production, while the volumes of export are only growing. Extrapolation of these trends according to Holt’s model leads to the situation when the forecast shows that the demand for import of natural gas inside the EU will continue to grow even when the volumes of internal consumption will be steadily going down. For this very reason when forecasting the volumes of natural gas imports in the EU we have been considering two development options.

The first one assumes the reduction of production volumes and the increase of export volumes at the same time. In other words, the first approach assumes the today’s trends will remain valid for the future development as well. The second option assumes the volumes of both production and export of natural gas in the EU countries will be

maintained on the stable level in both mid range and long term.

If we stick to the assumptions as per the first option above, our forecast for natural gas import to the EU demonstrates the annual growth of about 1%. If we stick to the assumptions of the second option, our forecast for the natural gas import to the EU will show its reduction by about 2% a year. This means that our second hypothesis is partially confirmed.

Similar forecasting for the energy intensity of coal and peat per unit of GDP is a complicated task due to serious incoherence between the long-term development strategy (to reduce all production and consumption indicators as to coal and peat) on the one hand and the actual energy intensity of these fossil fuels on the other (in fact, for both coal and peat the energy intensity went up, same applies to their consumption in some of European countries).

The standard Holt's model is able to interpret this phenomenon as a temporary deviation from a long-term trend. Thus, we can still forecast there will be a quick decrease in the energy share of coal in GDP. Moreover, till 2030 (the finishing point in our forecasting horizon) the energy intensity of coal in real GDP of the EU is expected to be at the zero level already.

However, we can also assume that this growth in consumption of coal and peat by the EU countries was not of random nature. It may have been predetermined by rather high (and growing) prices for oil. This situation with oil prices has led to the substitution of boiler oil and gas by coal and peat (and this, in turn, has caused higher energy intensity of the latter two).

For this very reason in case oil prices go up again (at least to the level of USD 90 per barrel), then energy intensity of real GDP will not be lowering that quickly, as it follows from the extrapolation according to Holt's model.

During the recent years we have been also observing the trend of reducing volumes of the electric energy production at nuclear plants throughout the EU. Dynamics of hydropower production has been highly volatile during the same years, still, Holt's model shows there is a slight trend of going up.

The shares of biofuels, geothermal and solar energy per unit of real GDP in the European Union are growing steadily and at quite persuasive rates. Extrapolation of their trends according to Holt's model leads us to the conclusion that after 2020 all these alternative sources of energy will be playing a much more significant role in European energy balance. Moreover, they may really become a solid alternative to oil and gas.

By the year 2023 consumption of energy produced from biofuels has all the chances to reach the level of coal and peat consumption and also the level of the energy produced by nuclear plants. And by 2030, by the level of consumption, biofuels might easily be comparable with natural gas!

In a longer term, the volumes of geothermal and solar energy production will outrun the capacities of hydropower production. The joint contribution of the former two in the energy balance of the EU is expected to be steadily growing. This will eventually lead to lower volumes of both oil and gas imports to European countries, thus, impacting negatively on the economic status of the countries producing these types of fossils in huge volumes (including Russia and also selected countries of the Middle East). Therefore, we can state that our third hypothesis is confirmed. This conclusion of ours has been many times confirmed by a range of involved politicians, including, inter alia, former German Chancellor Gerhard Schroder, who stated that Russian natural gas is vitally needed for German economy as some sort of transition fuel, until the country is fully ready to substitute fossils with alternative sources of energy (International Conference for Renewable Energies Bonn 2004).

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4. Conclusions and recommendations

In this article we have used the experience of the EU countries as our case study to test the developed methodology of forecasting the volumes of primary energy consumption,

taking into account the influence of RSE in their lightning-speed development on the structure of both production and consumption of energy.

Application of the author's original methodology has allowed us prove there is quite high probability that the share of RSE in the energy balance of the EU will only increase - from roughly 15% to about 30% as of 2030. Calculations stemming from our own econometric model of forecasted volumes of the primary energy forecast, taking into account the share of RSE and the trends of reducing energy intensity, allowed us evaluate how quick and serious is the reduction in European demand for imported energy carriers. According to our calculations, this reduction, by the year 2030, will be in the range from 25 to 30%, as compared to 2015.

Noteworthy here, such radical changes in the energy consumption and thus, in energy policy as well will inevitably lead to radical institutional transformations at all levels of the existing systems.

We have all reasons to state that the world economy has already passed through the key stage here - the one when RSE have been introduced and promoted most actively, while overall organizational structure and institutional framework have been formed for their further development.

Finally, in this article we have proved that substitution of carbon fuels as the most traditional energy source is taking place not only due to a certain political agenda and quite active campaigning of RSE, but also because there are solid, well grounded and completely understandable economic reasons for this shift.

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