DEVELOPMENT OF WIND POWER INDUSTRY IN RUSSIA

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The factors of expediency of the wide scale net electrical wind power engineering development in Russia were considered. The resources, energetic and economical ground of accelerated installation of wind power plants (WPP) expediency in Russia with total capacity up to 6–7 and 28–30 GW until 2020 and 2030 respectively are given. The problems and necessary conditions of WPP wide scale introduction and use are reflected.

Keywords: wind power engineering, wind power plants, power coefficient, primery cost of electricity, localization of wind turbine's production.

According to the Global Wind Energy Council, the installed capacity of offshore wind farms totaled 283 GW in 2012

Rapid development and the widespread use of renewable energy sources (RES) in the world – including wind-power plants (WPP) – points to a new tech revolution in the world's energy industry. It's success is facilitated by the new plans of the world community to cut fossil fuel use (20% reduction in Europe by 2020 and 50% reduction by 2050 worldwide) [1, 2].

In 2013 Global installed wind power capacity rose to over 300 GW, reaching 70 GW in China, 50 GW in USA and 32GW in Germany.

Regrettably, however, this revolution hasn't had such a dramatic effect on Russia's wind power industry. Installed wind power capacity of the WPPs operating in Russia now, in 2014, amounts to no more than 12–13 MW (that equals the amount being installed every 3 hours worldwide or 6 hours in China alone).

We believe that with the set goal of 3.6 GW of installed wind power capacity by 2020, government regulations 861-p [3] and 449-p [4] issued in 2013 do not have the scale and pace of development that Russia needs, and the outlined supporting mechanisms do not contain any indications regarding strategy and the long-term goals of developing Russia's wind power industry after the 2020. Otherwise it would indicate that the government is seriously invested in creating this new industry. The existing social doubt regarding the necessity of developing wind power industry in Russia and large scale use of wind power plants is based on the following questionable points:

- wind power industry development is driven by countries that lack alternative energy sources. Rich in fossil fuels, Russia may regard it as irrelevant;
- under the current market conditions WPPs in Russia are no competition to the thermal power plants (TPP) and their use leads to increased energy rates;
- wind resources in Russia are located in hardly accessible regions with difficult climate and with low energy demand;
- WPPs have a negative effect on the stability, operational reliability and economics of power grids;
- WPPs have a negative effect on the environment.

In order for the government to change its policies towards large-scale implementation of WPPs it is crucial to thoroughly and critically examine the arguments put forward by the opponents of the initiative. The result of such work are provided below in a form of counterarguments that we have come up with.

1. One of the most common argument about wind power industry being viable for countries that have no alternatives is prove wrong by the reality that there are many countries rich in other energy sources such as oil (UK, Germany, Denmark, Canada, US, China, Egype), gas (the Netherlands, Canada, USA, Australia, Norway), coal (Germany, Poland, Canada, USA, India, China, Turkey, Australia), uranium (France, USA, India), who nevertheless pursue the development of wind power industry.

The mentioned countries possess not only the resources but also the advanced technologies necessary to utilize them, and yet they effectively and on a large scale implement plans of pursuing the development of WPP as one of the basic energy sources. The example provided by a dozen of countries (Germany, Spain,

INFORMATION

GLOBAL WIND POWER PRODUCTION FIGURES

According to the Global Wind Energy Council, by the end of 2012 Global installed wind power capacity reached 283 GW (18.7% increase compared to 2011) including 5.4 GW installed offshore capacity (31.4% increase).

According to BP Statistical Review of World Energy 2013, Global wind power production that year reached 521.3 bln kWh (2.3% of the total Global power production).

Europe is ahead with 38.8% followed by Asia (34.5%) and North America (23.9%). Wind energy seems to be least used in Latin America and Caribbean (1.2%), countries of the Pacific Rim (1.1%), as well as Africa and the Middle East (0.4%). As for countries leading in the wind power development, 73.6% of the Global installed wind capacity is shared by five countries: China, USA, Germany, Spain and India.

Wind power industry in the second most developed renewable energy industry (after the hydropower industry), which is evident in its economic properties. For instance, electricity production costs for costal wind power plants are among the lowest compared to other alternative energy sources.

THE DYNAMICS OF THE CAPITAL COST OF WPP TURBINES AND THE ELECTRICITY THEY PRODUCED

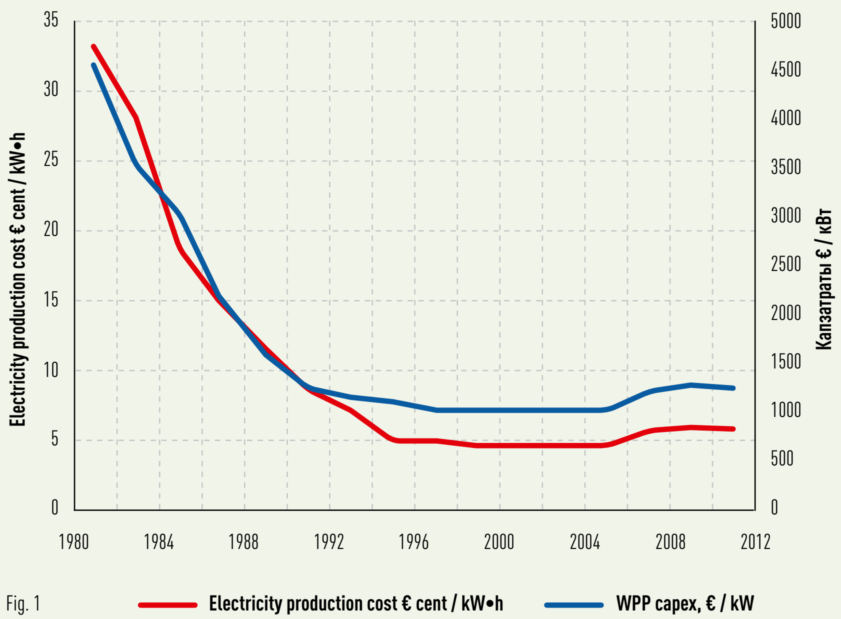

Fig. 1

COMPARISON OF COST OF ELECTRICITY PRODUCED BY WPP AND THERMAL POWER PLANT

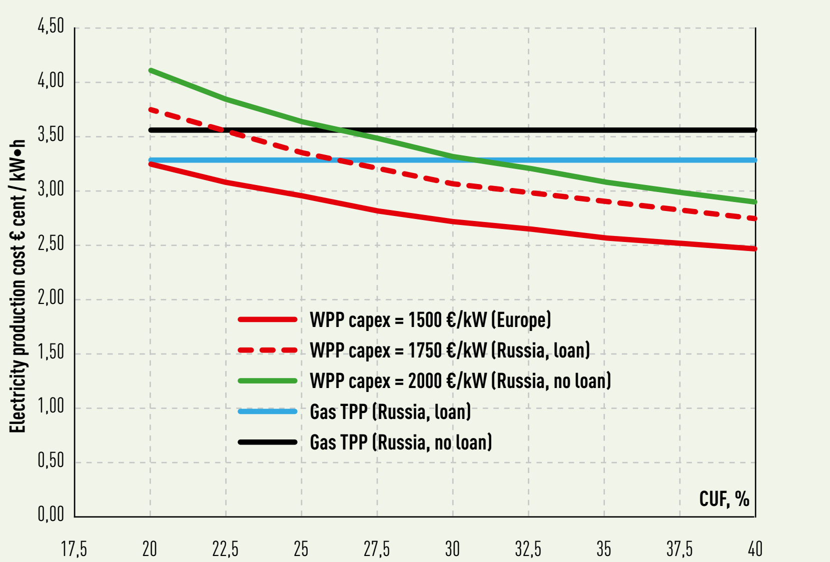

Fig. 2

Denmark etc.) shows that WPP amounting to up to 10% of country's total power generation is both technologically feasible, financially viable and with government support can be achived within 10-12 years [1, 2].

The importance of developing wind power energy in Russia is caused not only by the need to be at the edge of modern technologies but also by the economic and social realities of increasing hydrocarbon production costs which drive the prices of fossil fuels as well as electricity and heating prices.

It is, therefore, of the utmost importance to refute the second argument which talks about the price of WPP-produced energy being much higher than that produced by thermal power plants.

2. The proof of economic viability of wind power industry is in the growing demand for WPPs in the world. This growth caused an expansion both in the geography and in production of wind power, driving investment to the industry. In 2012, the sale volumes in wind power industry reached over $80 bln [1]. The list of wind power equipment manufacturers is growing rapidly, not without help of oil and energy corporations investing in wind power industry and thus diversifying their business. A case in point is the state of Texas, one of the US top oil producers, leading in the installed wind power capacity thanks to the invesmtents from the oil industry [2].

The most objective criteria for determining financial viability is the production costs of the electric energy it produces, which is determined by the capital and operational expenditures and the plant's electricity output. In the years when WPP prices were the lowest (2003-2004) capital expenditures were as low as $900/kW, and electricity production cost –

ESTIMATION OF ELECTRICITY PRODUCTION COSTS IN 2015 AND 2030 FOR THE EU

Year	Power plant type		
	Coal TPP	Gas TPP	WPP
2015	82 €/MW•h	101 €/MW•h	75 €/MW•h
2030	79 €/MW•h	113 €/MW•h	68 €/MW•h

Table 1

$0,04/kW·h, thus competing with that of thermal and nuclear power plants (fig. 1).

Such per-unit figures for the wind power equipment have significantly changed over the last 10 years [2]. Wind power equipment prices from European manufacturers rose from 780€/kW in 2004 to 950€/kW in 2006, and to 1150€/kW in 2008 [5] due to the mass production of higher performance wind power equipment (through increased tower hight and longer fan blades) and due to the fact that because of increased oil and natural gas prices as well as prices on metal, cables, certain WPP components and electronics in general, the demand for wind power equipment on the market was significantly higher than the supply. Nevertheless the prices mentioned above were still financially viable and the investment appeal of wind power plants in the world grew significantly.

In 2009–2010, during the world crisis, capital expenditures related to erecting large land-based wind generator rose to 1350–1450€/kW [5]. But even with such prices, judjing by the growing demand, WPPs are still considered a financially viable energy source. Case in point, total installed wind power capacity in Europe and US for the last 3–5 years has been equal or more than that of the thermal power plants installed [1].

Annual operational expenditures of foreign WPPs wary from 12 to 35 €/kW (0.012–0.022 €/kW•h) depending on their output and location accessibility, with maintenance costs around 6–10 €/kW during 5th–10th years of operation and growing to about twice as much by 16th–20th years of operation [2, 6]. With the WPP output capacities growing and new generations of WPPs emerging, operational expenditures decrease [1, 2, 6].

According to the EU's experience, with WPP electricity production costs rise by about 3–4 €/MW•h due to addtitional implementation and integration costs. Balancing and backup generation facilities costs additional 1–2 €/MW•h in case of WPP amounting to <10% of the total grid's capacity or 2–4 €/MW•h if the number is higher. Power grid modernization would cost an additional 0,1–4,7 €/MW•h depending on wind power capacities expansion scale [2, 6]. The total maximum expenditures due to integrating WWP into a centralized power grid with WPP amounting to 10% or more of the total grid's capacity, would thus be within 10–13 €/MW•h.

For foreign WPSs based on more efficient and durable wind turbine generators with nominal capacity starting with 1.5 MW and more the integration and operation expenditures amount to 22–25 €/kW/year.

Electricity production costs estimation provided by the IEA for Europe in 2015 and 2030 is shown in table 1 [2]. According to these estimations, by 2015 WPP electricity cost production will be about 10% and 40% lower than that coal and gas TPPs respectively.

In order for this goal to be reached, the capacity use factor (CUF) needs to reach 28% by 2015 and 32% by 2030, with per-unit capital expenditures being around 1400 €/kW [2, 6].

Therefore, in terms of electricity production costs, experience that other countries had, indicates that wind power plants can be much more economically efficient than their thermal counterparts.

In applying this conclusion to Russia, some further verifications are required, because high inflation and rising fuel and electricity prices make it difficult to create long term forecasts of WPP and TPP expenditures.

Gas and coal thermal power plants as well as nucler power plants form the basis of Russia's energy industry, as they account for over 80% of the country's electric energy production (table 2) [1]. According to data provided by Gazprom and RF Ministry of Energy as well as the energy sources

THE STRUCTURE AND EXPENDITURE BREAKDOWN OF ELECTRIC ENERGY PRODUCTION IN RUSSIA IN 2008

Type of a power plant	Thermal	Nuclear	Water	
Installed capacity, mln kW	155.2	24.6	47.1	
Electricity output, bln kW•h	690	165	184	
Electricity output, %	66.4	17.7	15.7	
Mean power plant CUF, %	50.8	76.6	44.6	
Types of thermal power plants:	Gas	Coal	Fuel oil	Diesel fuel
Oil equivalent usage in 2008 г., mln tons	224.1	75.2	6.1	2,1
Fuel usage in 2008, mln tons [182]	111.3	86.1	4.3	1.35
Projected figures on fuel power plants for 2014–2015				
Fuel price in Russia in 2014, €/ton	160–170	90–100	215–235	600–660
Power plant fuel costs for Russia in 2014, bln €	18.24+3%	8.18+5%	0.96 + 5%	0.85 + 5%
Per-unit fuel usage for new power plants, kg/kW•ч	0.20	0.38	0.26	0.20
Fuel's contribution to the costs in 2014, € /MW•h	32–34	34–38	55–61	162–175
Emissions penalty with 10 €/ton CO_2, € /MW•h	5.5	7.5	7.5	8.0
Power plant maintenance costs, € /MW•h	14–18	16–20	15–20	15 – 20
Power plant capex, € /MW•h	1,200–1,350	1,350–1,500	1,200–1,400	1,200–1,400
Capex contribution to the electricity production costs with 20-year WPP life span and CUF= 55%, € /MW•h	12.5–14.0	14.0–15.6	12.5–14.5	12.5–14.5
Electricity production costs, €/MW•h	64–71	67–81	88–101	197–216

Table 2

price dynamics in Russia over the last few years [1, 2], by 2015 energy production cost are estimated to be as follows: 64–71 €/MW•h for gas TPPs; 67–81 €/MW•h for coal TPPs; 88–101 €/MW•h – for fuel oil power stations and 197–216 €/MW•h for diesel power plant [2].

A breakdown of estimated WPP related capital expenditures in Russia is provided in table 3 [2]. According to these estimates per-unit WPP capex in Russia may be 30–35% higher that in other countries (1,500 €/kW in EU compared to 1,750 €/kW and 2,000 €/kW in Russia – without and with a bank loan respectively).

WPP maintenance costs in Russia are defined by the government legislation 449-p and amounts to 1 Rub/kW•h, which is the upper limit for such costs in the EU (0.022 €/kW•h) and that of operational costs for gas thermal power plants here in Russia.

Data in table 3, showing a comparative analysis of the projected TPP and WPP electricity production costs – with maintenance costs as set in [4] – is presented in fig. 2. In terms of electricity production costs, wind power plants begin to be more financially viable than gas TPPs with CUF more than 26% and 30% for loan and non-loan scenarios respectively; for coal TPPs the figures are 22% and 26% respectively.

In order to develop wind power industry in Russia without causing the increase of electricity rates, it is essential to decrease electricity production costs to the level below that of gas TPPs. And in order to achieve it, CUF for WPPs in Russia should be above 30%.

3. The latest research [2, 7] shows that there and tells us which are the regions with wind resources capable of providing the required economic viability (with CUF > 30 %).

ESTIMATED 2012 CAPEX BREAKDOWN FOR WIND POWER PLANTS IN RUSSIA, €/KW [2]

Items of capital expenditures when constructing WPPs	Range, %	Real avg. % for Russia	Projected prices for 2012, €/kW
Price for the imported WPPs including delivery to the Russian border, assemblage and 2-year warranty	100	100	1100–1150
Designing WPPs	5–6	5.5	60,6 + 2,12
Official and unforeseen expenditures when importing WPPs	0.3–0.5	0.4	4.5 + 0.09
VAT paid at the border (18% of the WPP's price)	1.1–1.6	1	11.3 + 0.25
WPP vehicle transportation within Russia	3–5	4.0	45 + 0,65
Construction of roads and access routes to WPP	3–10	7	78.8 + 1.75
Construction of WPP's foundation	3–8	7	78.8 + 1.75
Construction of power lines and electric substations	11–20	15.5	146.3 + 4.75
WPP assemblage	4–6	5	54 + 1.13
Leasing of specialized machinery	2–3	2.5	27 + 0.50
Construction of structures and buildings	0.5–2	1	11.3 + 0.25
WPP access to the Central power station (reasonable upper level)	100 €/kW	10	100.0 + 10.0
Repayment of a 15% bank loan	35–40		
Repayment of a viable 7% loan		12.5	140.6 + 3.12
Unforeseen expenditures	4–6	5	56.3 + 1.25
Bottom line: total per-unit WPP expenditures with a loan	197–244	170.3	2030 + 44.5
Bottom line: total per-unit WPP expenditures without loans	181–222	156.8	1820 + 45.0
Bottom line: total per-unit WPP expenditures in EU	130–140		1450–1550

Table 3

Among the regions where WPP electricity production costs are lower than these of gas TPPs (fig. 3, 4), are not only the well-known North and Far-East regions, but also much of the RF European territories as well as Urals and West Siberia. According to [2] estimated total output of such WPPs is over 1100 bln kW·h/year (more than the whole of Russia's electricity consumption for 2013).

According to [2, 7] Russia's technical potential wind power capacity equals at least 11000 bln kW•h/year, which is more than 11 times larger than country's electricity consumption level.

With that said, the technical potential wind power capacity of the Central and North-West, Volga and South Federal Districts, where 73% of population lives, amounts to at least 3,500 bln kW•h/year (fig. 3).

The data provided clearly proves wrong the argument about Russia wind resources being located in hardly accessible area, which would make a large-scale implementation difficult.

4. The argument about WPPs having negative effect on the stability, operational reliability of power grids is also a weak one. This fact is supported by the extensive experience of the countries leading in the wind power industry, such as Denmark, Germany, India, Spain, China, Portugal, USA, Ukraine and tenths of others. We believe the persistence of this questionable statement in Russia is caused by the fact that many are simply unfamiliar with the positive practices of utilizing wind power plants in other countries as well as some parts of Russia (i.e.

CUF DISTRIBUTION DATA IN RUSSIA BASED ON VESTAS V 90, A 3 MW WIND POWER PLANT WITH D=90M WINDWHEELS AND 100M TOWER HEIGHT

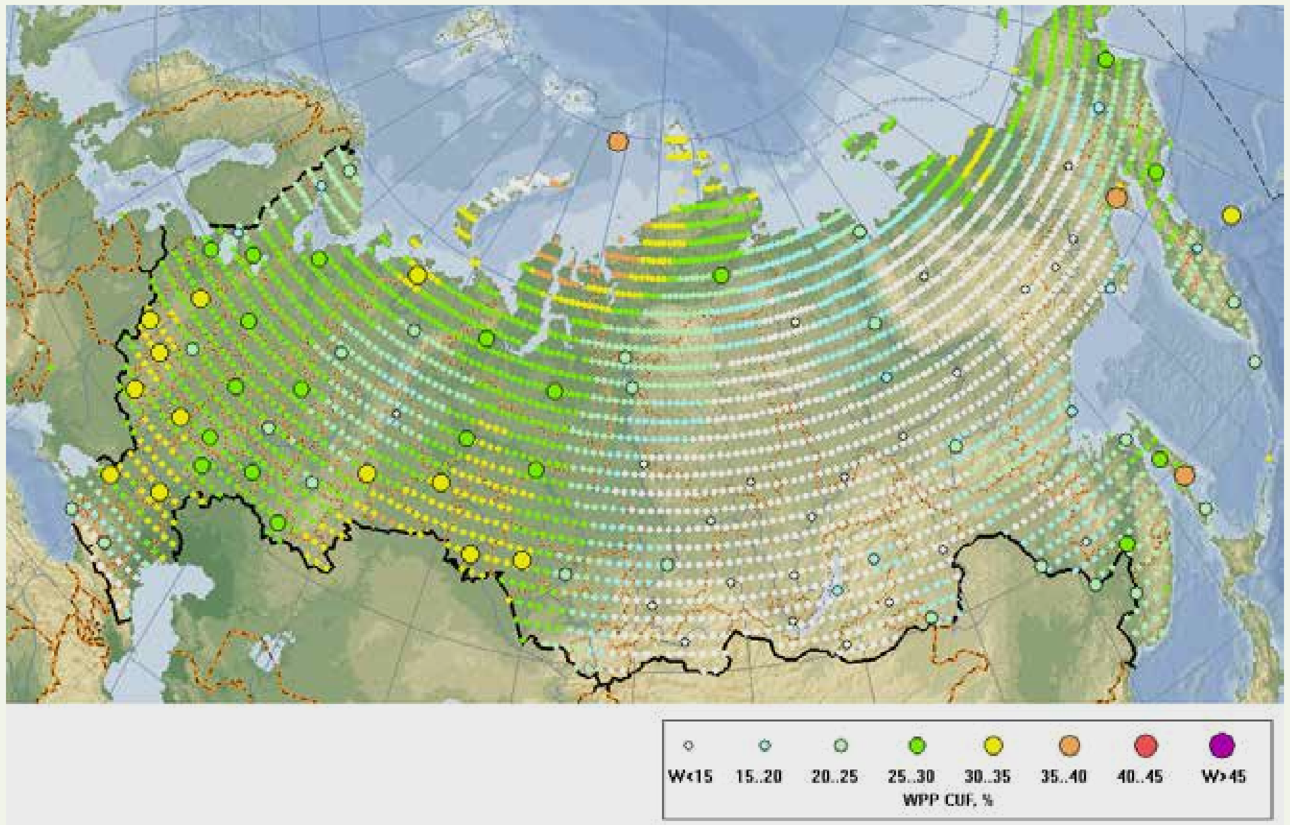

Fig. 3

Vorkutinskaya and Kulikovskaya TPPs and others)

In other countries stability of power grids that work with large WPPs is ensured by the means of modernizing networks, as well as balancing and reserving existing power generating facilities. All that requires resolving some technical and organizational issues and according to our foreign colleagues, the coasts are well within the range of 7–9 €/MW•h. Our local engineers are quite capable to resolve the technical issues that might arise.

However in the current situation of lack of integration between the facility owners and their competing economic interests make organizational aspect very difficult. As more economically efficient type of generators WPPs pose competition to TPPs, especially to those working at midrange loads. As such, the commonly used argument that WPPs need to be backed by almost identical amount of alternative power sources in case of a standstill, seems like it might have been planted by the competitors.

However, according to research [8], using a TPP at midrange loads in conjunction with a limited (up to 50% of TPP capacity) use of a WPP of a high CUF (>30%), may have an economic interest to the owners of the former as it allows to save fuel thus decreasing final electricity production costs.

5. The argument about WPPs having a negative effect on the biosphere is one of those used by opponents and it also probably emerged as a result of one side trying to fight off the competition. Indeed, the wind power plants designed in the 1970s – 80s had among their "features" high levels of noise and vibration, including low-frequency vibrations. However, as the new millennium had approached, all of the dangers coming from WPPs were eliminated, thanks to technological and aerodynamic improvements [6]. Ecologic

REGIONS PROMISING FOR INSTALLING ECONOMICALLY VIABLE WIND POWER PLANTS [4]

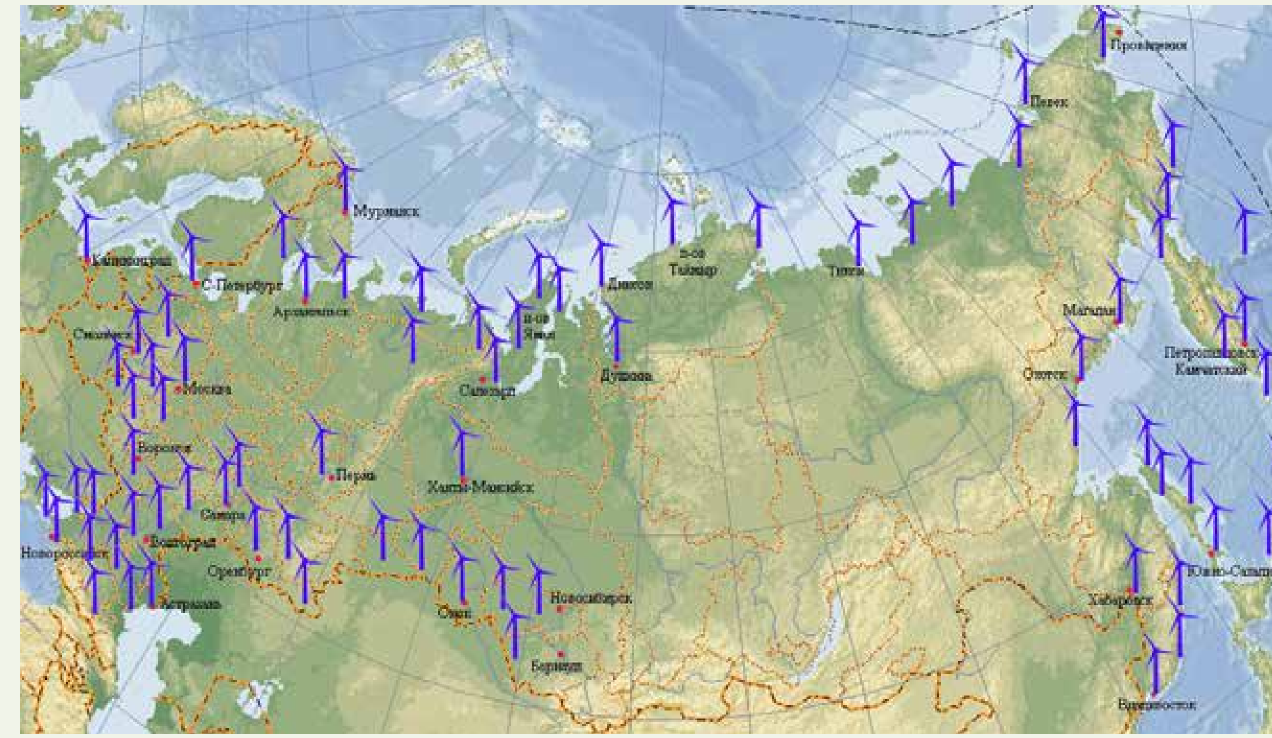

Fig. 4

safety of WPPs has been convincingly proven by the worldwide and specifically European practice, and one can definitely rely upon those, especial when it comes to ecology. We believe that this assertion of WPPs' negative ecological effects can be refuted with the help of 2–3 high-profile international conferences on the topic – with the participation of field's leading experts – being held in Russia.

6. It is also necessary to evaluate the assertion that the legal and economic steps in creating environment for developing wind power industry in Russia have been successfully executed.

Unfortunately, we have to note that the resolutions made by the government [3, 4] seem to be concerned not with facilitating but rather with limiting wind power industry development in Russia. This seemingly bold statement is supported by the following facts:

– The RF government regulations 861-p and 449-p prohibit electricity rates increase due to introduction of WPPs (not more than 2,5% by 2020), and that in turn limits the number of WPPs that can be launched annually till 2020, as shown in table 4. At the same time in the case of underperformance in installing WPPs the number of uninstalled WPPs does not get transferred to the next year, which leads to a lower number of WPPs installed by 2020.
– According to the legislation 449-p, the increase of electricity rates due to WPP implementation is prevented by limiting the budget-supported maintenance costs (1 rub/kW•h) and per-unit capital expenditures (table 4), as well as by the fact that competitive selection of the WPP projects to fund is performed based on the criteria of the lowers possible capex.
– The legislation 449-p is based on a princi-

TARGET-FIGURES FOR INSTALLED CAPACITIES AND CUF RATES

	2014	2015	2016	2017	2018	2019	2020	Total
Permitted wind power capacity, MW	100	250	250	500	750	750	1000	3600
Permitted WPP output, GW•h	219	547.5	547.5	1095	1642.5	1642.5	2190	7884
WPP CUF based on 861-p legisl., %	25.0	25.0	25.0	25.0	25.0	25.0	25.0	
Permitted WPP capex, rub/kW	65,762	65,696	65,630	65,565	65,499	65,434	65,368	
% of domestic WPP production	35.0	55.0	65.0	65.0	65.0	65.0	65.0	

Table 4

ple of mostly (75–80%) paying for the installed wind power capacity and then significantly less (<25–30%) for the electricity by the wholesale market prices. Thus in order to ensure WPP viability, the projected CUF is set to 27% without envisaging it to rise in the years to come (table 4). Moreover, the 449-p permits a CUF decrease – from the planned 27% to up to 21.5% without any economic sanctions. Setting the planned rates to 25% till 2020 while also allowing for a such a dramatic decrease is contradictory not only to the Europe's most recent practices ordering CUF in 2015 to be at least at 28% and it is also far below the mentioned earlier level of CUF > 30 % necessary for the WPP production costs to reach those of gas TPPs.

It is worth noting that such high priority of "smallest capex possible"-criteria when selecting projects to get government funding, along with low (compared to international standards) planned WPP CUF rate (21.5–27%) do not to allow to realize all the benefits of WPPs. With the set maximum capex of 65,762 rub/kW (1350 €/kW), in order to receive government support within the rules of 449-p, one either has to rely on the most cheap, simple and inefficient WPPs (with low performance and therefore high electricity production costs) or by utilizing used hardware.

The second option kills prospects for domestic WPP production and the first one is detrimental in case of large-scale implementation of wind power, as it would reinforce the wrong assumption about economical unviability of wind power plants. The negative effect that the last two points of 449-p have, is illustrated in the fig. 5, where a link between WPP capex, output and electricity production costs is shown. The diagram is based on a hypothetical WPP stationed near Saratov and equipped with Germany's Furhlander FL 80, 90 and 100 wind turbines, 100 m tower height and windwheels of 80, 90 and 100 meters in diameter. Wind turbine prices are in a direct correlation with the windwheel diameter. With the diameter growing from 80m to 100m, capex grows around 20% while CUF is raised from 23% to 31% and the output grows by 58%, lowering electricity production costs by 25%.

The mechanism defined in the 449-p legislation, sets an unjustifiably low CUF levels and does not stimulate its growth, thus blocking the expansion of cheap electricity production by WPPs.

449-p legislation was supposed to ensure the creation of high-end production of wind turbines in Russia, but the set unrealistic goals for the scale and pace of this process (exceeding even those of China), with the lack of competition with world's modern technologies, may lead to

the Russian WPP production lagging far behind.

449-p implies the WPP investments to be returned within 15 years after which the only source of income will be the revenue from electricity being sold at wholesale market prices (fig. 6), which is very little in comparison to the WPP maintenance costs. This creates another obstacle for effectively using WPP in Russia: lack of revenue after 15 years of operation may encourage WPP owners to cut maintenance expenditures thus substantially reducing equipment's lifespan and increasing the electricity production costs.

A serious gap in the 449-p legislation is a lack of seismic and climate zonation when determining WPP capex. We believe that the legislation should introduce coefficients of seismic impact (1÷1.13) and climate zones (1÷1.3) set for TPPs in the RF legislation 238 [5].

Another thing that hinders development of wind power industry in Russia is the difficulty of implementing 449-p; this due to the fact that some long term factors that determine mechanisms of government support (such as inflation, discount factor, electricity and fuel wholesale market prices) are difficult to predict.

The most suitable (transparent, economically effective, easy-to-implement) system of economic support of WPPs is a system based on subsidies with payments in addition to the wholesale market prices of their electricity, in amount equal to regional costs of placing fuel (gas, coal, diesel fuel) substituted by them during the whole operation period. And considering the possibility of exporting the unused fuel with a higher than domestic price tag, this approach would definitely be beneficial for both fuel suppliers and the consumers [4].

In all of the today's leading countries the development of wind power industry always began with developing national programmes and strategies, which defined long term objectives. And as such, decision to develop wind power industry was a result of analyzing all kinds of factors related to energy, economics, production, environment, society and more, and then determining what the possible effects are. Moreover, this process was accompanied by a comprehensive look at best international practices and by wide public discussions, which ultimately led to a professional and social consensus. Obviously, this way of implementing wind energy in Russia is most desirable [1, 2, 7, 9–11].

We will mention the most important arguments and concepts regarding developing wind power in Russia. Based on the analysis of economically and energetically desirable scale of WPP use, provided in [1, 2, 9, 10, 11], the total installed wind power capacity can reach up to 6–7 GW by 2020 and 30 GW by 2030 with annual output of up to 16–17 and 80–85 bln kW·h amounting to 5–7% of projected total power consumption in Russia by 2030.

Concurrently WPP usage in Russia could reach 30 GW in the energy sector, 17 GW in transport and 2 GW in agriculture [1, 2, 10]. Total wind power installed capacity in power grids by 2020 and 2030 could reach 1 GW and 5 GW respectively with annual electricity output of 2 bln kW·h and 10 bln kW·h respectively, annually substituting 2.5–3 bln ton of oil equivalent by 2030.

Annual fuel substitution in Russia's energy sector can reach 25–30 mln ton by 2030, reducing annual CO_2 emission by up to 50 mln ton. Moreover, the total land required for such a 30–35 GW project is within 1.0% of total Russia's territory.

CORRELATION BETWEEN CUF AND WIND TURBINE PROPERTIES IN WPP EQUIPPED WITH FL 80, FL 90 AND FL 100, STATIONED IN SARATOV

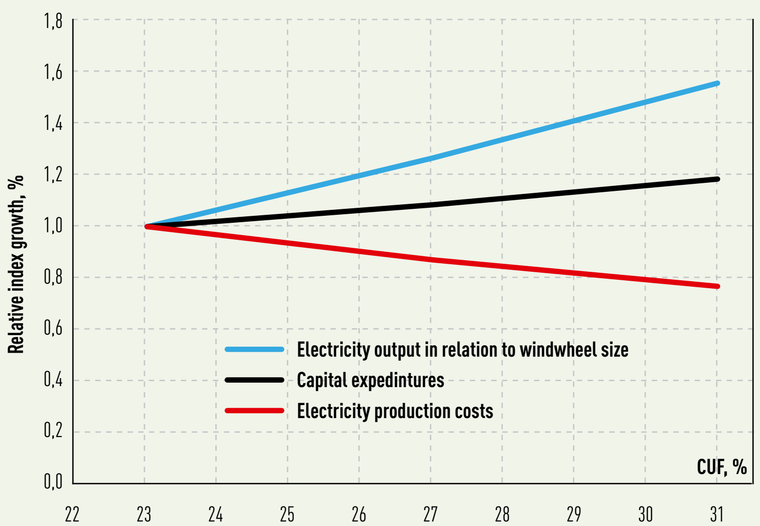

Fig. 5

WPP REVENUE GROWTH (ACCRUALS BASIS), WITH DIFFERENT LEVELS OF PRODUCTION LOCALIZATION

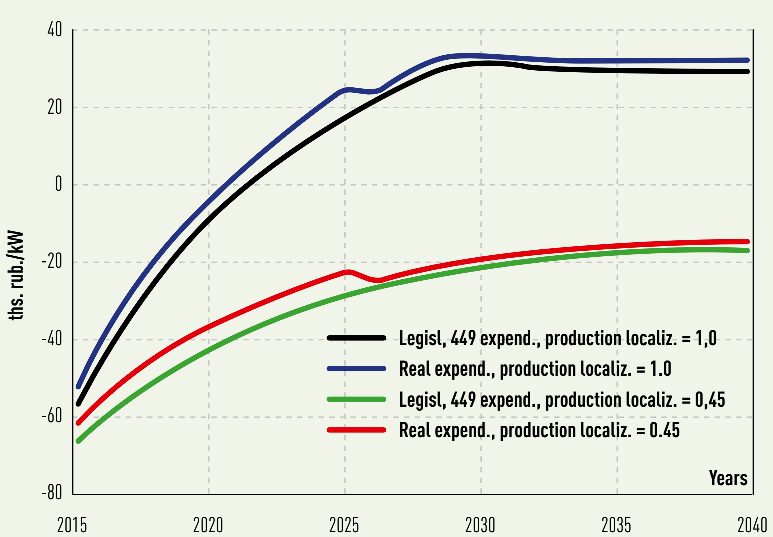

Fig. 6

Development of wind power industry in Russia will lead to creation of a new high-end industry with the ability to export wind power equipment to CIS and Baltic states. The number of people involved in this new industry, including the high-end tech positions, should reach over 200,000 employees by 2030. Assessing Russia's technological and production capabilities as a basis for large scale R&D, production and operation of WPPs leads to the following conclusions [10–12]:

- in order for a large-scale production of average-performance (200–800 kW) and high-performance (1.5–3 MW) wind turbines in Russia, an advanced large-scale industrial complex is required (up to 15–20 factories);
- during the first stages of the process (till around 2017–2018 or with the first 1.5–2 GW WPPs) the installed WPPs should likely consist of imported equipment, which is a good thing with regards to training Russian scientists, engineers, construction workers as well as the WPP staff. As a result, localization of WPP production up until 2017–2018 would unlikely go beyond 25–30%;
- Russia already possess most of the resources, technologies and production capacities required for building wind turbines' core elements. There are also all the conditions in place for setting up domestic production and launching it within 3–5 years.

Before Russian wind power industry can be created there is a number of global steps one needs:

- to create a designing framework, that would involve specialized research institutes and design engineering bureaus, properly staffed with scientific and engineering workers;
- to create a construction-assemblage function supplied with the necessary equipment and experienced staff;
- to create a domestic framework for testing middle- to high-performance WPPs; it should consist of 5 – 8 test facilities with appropriate equipment and qualified staff;
- to create a maintenance infrastructure with a network of service outlets featuring modern equipment along with qualified staff.

Taking these steps can only be a centralized government-controlled initiative. International best practices show us that development of power industry and a large-scale implementation of WPPs in Russia requires special support such as:

- long term development programmes lasting till at least 2030;
- legal framework for developing wind power industry consisting of clear, binding (and preferably – directly applicable) laws;
- an effective government support of the industry by the means of adjusting conditions for WPPs to match those of nuclear and thermal power plants in respects to existing fuel subsidies, etc.

First of all, developing Russia's wind power industry requires fixed preferential rates for electricity produced by wind power plants and reasonable prices for connecting them to the grid; there is also a need for soft loans, lower equipment import taxes as well as lower taxes for domestic production.

It is also necessary to adopt a general WPP deployment plan which would take into account infrastructure condition, technological limitations, energy and economic viability as well as the expected effect from using WPPs in specific industries, RF entities and in Russia on the whole [9, 11].

It is worthwhile to say, that despite having good potential for developing wind power industry in the 90s, Russia was unable to take part in the process for obvious reasons, and ended up being an outsider. However, experience of other countries and our research reveal apparent capabilities of WPP and other renewables to turn Russia's economy away from oil and gas and towards new modern technologically-sophisticated approach to energy and production with the improved social and environmental climate.

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