Socio-economic and environmental effects of renewable energy policy in Russia

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Abstract: The development of renewable energy is associated with a number of economic and non-economic effects, such as, inter alia, reduction of greenhouse gas emissions, substitution of fossil fuels, improvement of trade balance, creation of high-tech production with a high share of added value, job creation, reduction of electricity prices on the wholesale market, growth of budget revenues etc. This article presents a theoretical and methodological approach to assess these effects for the case with the commissioning of 5.9 GW of new renewable energy capacity in Russia (2.5% of the national electricity mix) as a result of the implementation of the state renewable support program.

Keywords: renewable energy; energy costs; energy potentials; energy strategies; CO_2 emission; Russia.

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1 Introduction

Recently Russia has introduced renewable energy support mechanism, which should ensure the addition of new 5.9 GW of renewables (2.5% of electricity mix) by 2024. The government's official energy policy document, Russia's Energy Strategy through 2030, sees renewable energy share grow to only 4.9% by 2030 (IRENA, 2017). For the moment

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'green' electricity production in Russia is lower than 1%. In a country with huge reserves of natural gas and coal, renewable energies seem to be too expensive and economically unfeasible. Nevertheless, even in a country like Russia renewable energy deployment may generate many positive effects, such as for example expanding energy access in the remote and energy deficient areas, improvement of the ecological situation, creation of jobs etc. Moreover, it may open new export opportunities and allow entering foreign markets with engineering solutions and final products. The task of this research is to show that comprehensive development of renewables in Russia generates many economic and non-economic benefits. To that end, the article presents a methodological approach to the evaluation of the socio-economic and environmental effects of the implementation of the Russian renewables support scheme, which should ensure the addition of new 5.9 GW of renewables by 2024.

Since the beginning of the 21st century the global energy system is experiencing a transformation. The characteristic feature of this process is the shift towards low-carbon (renewable) technologies. As noticed the IEA Executive Director Fatih Birol, 'era of renewables as a niche is over' (Birol, 2016). For the moment renewables are the fastest-growing and the fastest-developing sector of the global energy: during the last 15 years total renewable power capacity showed a 12-fold increase: from 85 GW in 2004 to 1,246 GW by the end of 2018[1]. Including large hydropower, renewables accounted for estimated 30% of the world's power generating capacity. Overall, in 2018 renewable energies comprised 70% of power capacity net additions mostly due to continued efficiency growth and rapid cost reduction of solar and wind technologies that have led to significant improvements in their cost-competitiveness. By 2018, renewables provided approximately 20% of the world final energy consumption (REN 21, 2019).

Renewable energy support policies are implemented in 169 countries, also in Russia, where in 2013 was introduced a support mechanism on the wholesale electricity market (Ahamer, 2013). However, for the moment renewables are poorly represented in the Russia's energy mix: excluding large-scale hydro, total 'green' energy production lower than 1% (EEnergy Media, 2017).

There is a contradictory attitude towards renewable energy in Russia. Supporters of conventional generation are convinced that there is no need for expensive experiments with exotic energy sources in a country where gas, oil and coal reserves will be sufficient for decades, especially during the difficult economic period when final consumers of electricity are forced to pay these experiments (RIA Novosti, 2017; Miller, 2018; Sidorovich, 2015). At the last St. Petersburg Economic Forum, Deputy Prime Minister Arkady Dvorkovich said that renewables are still "infinitely expensive" and "we are just waiting for the technology to become cheaper" (Zubkov, 2016). This point of view is absolutely substantiated and rational. Comparison of the estimated levelised costs of electricity generation in Russia for different technologies shows that the RE generation (e.g., solar PV) is 6–8 times more expensive than the cheapest technology – gas generation (IRENA, 2017).

However, in recent years the need of energy transition and the role of renewables in this process has been receiving greater recognition at high levels of the Russian Government. President V. Putin defined renewable energy as "the proper path" for transformation of the global energy sector, while the then Deputy Energy Minister A. Teksler stated last year "renewables are no longer referred to as alternative energy, they are traditional" (Financial Times, 2017).

The Russia's RE support mechanism was launched through the Government Decree No. 449 of 28 May 2013 (Government of the Russian Federation, 2013a, 2013b), which established a legal framework for development of renewable energies in Russia. According to this resolution, support of renewable energy technologies is carried out through the capacity supply contracts, so-called agreements for the supply of capacity (ASC), which set the right of investors to receive benefits from regulated prices determined on the basis of the installed capacity of corresponding plants. Under this support mechanism, RE suppliers are paid both for the installed capacity they add to the energy system, and for the electricity they supply, basing on long-term contracts.

Renewable energy projects are being selected within the maximum volume of installed capacity determined for each year. Following the logic of regulator, that should ensure the implementation of the medium-term national goal for renewables (2.5% of electricity mix by 2024 (Government of the Russian Federation, 2015), and on the other – limit from above the total capacity of renewable energy generation facilities and the amount of state support to projects. In addition, the establishment of the maximum amount of commissioning of new renewable energy capacities should take into account the localisation potential. Limits for RE installed capacity for the period 2014–2024 are fixed in the RF Governmental Order of 28 July 2015, No. 1472-p (Government of the Russian Federation, 2015).

Table 1 Target indicators of annual input volumes of installed capacity of renewable energy facilities [for wholesale electricity and capacity market (WECM) price zones]

RE type	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*MW, total*
Wind	-	51	50	200	400	500	500	500	500	500	399	3,600
Solar	120	140	200	250	270	270	270	-	-	-	-	1,520
Small hydro	18	26	124	124	141	159	159	-	-	-	-	751
Total	138	217	374	574	811	929	929	500	500	500	399	5,871

Note: Units: MW.

Source: Government of the Russian Federation (2015)

An annual competitive selection of renewable energy projects for four years in advance takes place from 2013. The selection of projects is based on the criteria of the least capital costs, which are set by the state taking into account foreign experience (Barkin, 2017).

Table 2 Limits of CAPEX and OPEX for RE technologies

RE type	*Capital costs (K rubles/kW) (2014–2024)*	*Unit operating costs (K rubles/MW per month)*
Solar	116.5–103.2	170.0
Wind	116.5–103.1	118.0
Small hydro	146.0	100.0

Source: Government of the Russian Federation (2015)

An important condition for a competition is the requirement imposed on wind and solar generators, as well as small hydropower plants to localise the production of equipment in varying degrees in different years. The government sets targets on local content requirements for each type of RE technology for the period up to 2024 (Table 3). In case of non-fulfilment of the target degree of localisation, significant penalty factors are applied to the calculated value of the capacity fee: the coefficient for wind and small hydro is 0.45, for solar – 0.35.

Table 3 Target indicators of the degree of localisation of the production of primary or auxiliary generating equipment for the RE on the territory of the Russian Federation

RE type	*Commissioning year*	*Local content requirement (target), %*
Wind	2016	25
	2017	40
	2018	55
	From 2019 to 2024	65
Solar	From 2014 to 2015	50
	From 2016 to 2024	70
Small hydro	From 2014 to 2015	20
	From 2016 to 2017	45
	From 2018 to 2024	65

Source: Government of the Russian Federation (2013a)

Ensuring the effective use of installed renewable energy capacity is provided by a support scheme introducing an installed capacity utilisation factor (ICUF), which expresses the minimum amount of electricity that a renewable energy plant must produce per year. If the plant does not produce this minimum volume of electricity, the power capacity charge is reduced. Table 4 presents the minimum levels of capacity utilisation that the renewable energy plants must comply with during the year, as well as the coefficients in calculating the price for power capacity.

Table 4 Coefficient of use of installed capacity for renewable energy technologies

RE type	*ICUF*
Wind	14%
Solar	27%
Small hydro	38%
Achievement of normative ICUF, %	Coefficient applied to calculation of the price of capacity
<50%	0
50%–75%	0.8
<75%	1

Source: Government of the Russian Federation (2013a)

According to IEA and IRENA, the development of renewable energy leads to a number of socio-economic and environmental effects, which include, in particular (IRENA, 2014):

- replacement of hydrocarbons burned to generate electricity at traditional power plants
- trade balance improvements

- multiplicative (cascade) effects from RE deployment in related industries, the creation of a new added value
- reduction of greenhouse gas emissions
- lowing of kWh-prices in the wholesale electricity markets (the merit order effect)
- reduction in costs of environmental measures and health protection measures on the territories of traditional generation power plants
- jobs creation (also in the sectors of generating and auxiliary equipment)
- growth in budget revenues through additional fiscal fees
- reduction in freshwater volume used to cool aggregates of thermal stations working on hydrocarbon fuel (Verbruggen and Lauber, 2012).

When assessing the various positive effects of renewable energy deployment in Russia, it is proceed from the projected new RE-capacities, established by the RF Governmental Order of 28 July 2015, No. 1472-p (Table 1), that should ensure the implementation of the national medium-term goal for renewables of 2.5% by 2024 (Government of the Russian Federation, 2015).

2 Replacement of fossil fuels burned in the production of energy in traditional power plants

In the power market the price for kWh is determined by the 'merit order' – the sequence in which power plants contribute electricity to the market, with the cheapest offer made by the generator (power plant) with the lowest operating costs setting the starting point. Electricity from RE generators such as wind turbines and photovoltaic installations is also trading on the power market, but the operating costs of these suppliers are almost zero (as they do not need fuel or much manpower). So, they lower the entrance price and shift more expensive conventional generators down the merit order. That means that power plants with relatively high operational costs such as gas-fired and coal-fired plants are risking being pushed out of the market as they cannot compete at the lower prices. Then the market value of the saved fossil fuel will be equal to the cost of RE-electricity in the wholesale power market or to the revenues of renewable energy suppliers.

The estimation of the possible fuel savings is based on the expected amount of renewable energy production and the current kWh-price forecasts by zones for 2024 (Table 5).

Then for the first price zone (for the first five UESs) the average price for 2024 will be 2.199 RUB/kWh, and for the second (UES Siberian and Far East) – 1.090 RUB/kWh.

Thus, with expected total commissioning of renewable capacity of 5,871 MW, total generation of 11.586 billion kWh and distribution of total generation among the price zones 8:1, the production volume on the basis of renewables in the 1st price zone will be 10.3 billion kWh, and in the 2nd – 1.286 billion kWh. As a result, in 2024 the monetary value of fuel saving will be equal to 24.05 billion rubles.

Table 5 Forecast of prices for kWh in 2024 by regions

Zone	*2024 price (rubles/kWh)*
UES of the Centre	2,304
UES of the North-West	1,970
UES of the Volga	2,127
UES of the South	2,306
UES of the URAL	2,289
UES of Siberia	1,011
UES of the East	1,170

Notes: UES = unified energy system, Russian regional energy systems.

Source: Ministry of Energy of the Russian Federation Agency for Forecasting Balances in the Electric Power Industry (2010)

3 Trade balance improvement

Wind, solar, hydro, geothermal and ocean energy are the country's internal resources, so the development of RE may have a positive impact on the trade balance if the reduction in energy imports is greater than the import of RE-technologies (Haas, 2011).

For example, the Oeko-Institute (2018) estimates that in 2015 renewable energy in Germany alone will offset 8.16 billion euros in energy imports.

Implementation of the roadmap for transition to renewables in the EU by 2030 may ensure a reduction in energy imports worth $25 billion emissions per year by 2030 (a total of approximately $165 billion). US$165 billion over the period from 2020 to 2030 (IRENA, 2018).

For fuel-exporting countries that subsidise domestic prices, the development of renewables can minimise domestic fuel consumption and maximise the volume of exports (Grechukhina, 2016, 2017). In the Middle East and North Africa, the intensity of solar radiation is so high that at midday hours, when electricity consumption is highest, solar generation can fully cover this peak demand. Currently, the peak electricity consumption is covered by expensive backup generation based on oil or liquefied gas, which makes solar power commercially profitable without any subsidies (Mills, R. Emirates Solar Industry Association, 2012; RBC, 2018; Rusnano, 2018).

In the Russian context, the aspect of substitution of hydrocarbon fuel as a result of expansion of RES generation to 11.586 billion kWh in 2024 considered above makes it possible to make a hypothesis about 'withdrawal' of these fuel volumes from the electric balance of the country and its sale for export. In this case it is possible to apply international fuel prices in 2024 to the saved volume.

4 Creation of added value

As is known, the development of one industry leads to the appearance of multiplier effects in related industries and activities. As practice shows in other countries, the development of renewables is taking place in the format of small and medium business and concerns primarily the power engineering industries (equipment for HPPs, wind farms, biomass and biogas heating plants, solar power plants), the development of solar panel production (solar panel elements, silicon wafers, fasteners, etc.), the production of auxiliary power equipment (cables, transformers, switches, etc.) (Kopylov, 2015). For example, in 2016 the German RE industry provided a value-added increase of 15.6 billion euros (Brandt, 2016).

The development of local production of renewable energy technologies in many countries, including Russia, is stimulated by including the requirement of localisation (local content) in the support mechanism, i.e., investors in renewable energy projects should use domestic technologies in a certain percentage to receive support. This should contribute to the development of domestic industries, the creation of additional value-added and jobs in the country. Developed economies having a solid technological base can achieve a high degree of localisation in a short time by establishing manufacture of necessary equipment and components, technology transfer and/or technology import, etc. (Porfiryev, 2013).

However, the localisation requirement is not always optimal and acceptable for a specific level of economic development. In this case, it becomes a serious barrier to investment in RE projects, which took place, for example, in Russia (Kopylov, 2013).

The fundamental correctness of the Russian Government's course on localisation of RE equipment as a condition of support implementation was confirmed by successful completion of tenders for solar energy projects in 2013 and 2014 as part of the decisions taken to localise production in this industry. The localisation issue was resolved by two winners of the solar capacity selection: the Hevel Group built the plant in Chuvashia, and the Chinese solar systems built manufacturing plants in Tatarstan (Kopylov, 2015). Currently, the Hevel Group produces 160 MW of heterojunction solar modules per year in Russia. This year the company plans to enter international markets.

In contrast to solar generation, localisation of equipment in wind power and small hydropower in Russia has faced serious limitations. Until 2018, there was almost no production of any equipment for wind power plants in the country.

This situation did not allow to reach the localisation level of 65% required by the support scheme, which became a significant brake on the industry development and the main reason for the weak activity of investors and developers at tenders for 2013–2016.

It took more than a year to correct the situation with errors in the legislation by reducing the localisation requirement and at the same time doubling the maximum allowable level of capital expenditures, which turned out to be too low due to the currency crisis of 2014. These changes became critical and radically changed the market situation.

As a result, in December 2015 was presented a project of Fortum JSC with a capacity of 35 MW in the Ulyanovsk region. The wind park, placed in operation in January 2018, has become the first wind energy facility in the new history of Russian wind energy.

The attractiveness of the market was vividly illustrated by the entry in 2016 of the state corporation Rosatom and Rusnano.

In June 2016, a subsidiary of GC Rosatom, JSC VetroOGK, submitted the largest package of 610 MW to the selection of renewable energy projects. According to the results of the 2017–2018 tender, the company received the right to build another 360 MW of wind farm capacity.

Thanks to the parent corporation, the company has the opportunity not only to develop wind farms while investing independently in their construction but also to fully produce wind generators of the multimegawatt class. The Dutch company Lagerwey became the technological partner of the company.

In October 2016, Rusnano's management company announced its ambitious plans to enter the wind energy market through blade production. The company Ulnanotech, a subsidiary of Rusnano, in cooperation with the government of the Ulyanovsk region, is establishing production of wind turbines with their implementation on its own projects of wind farms, controlling both production and marketing of its products.

In 2016 a memorandum was signed between the authorities of the Ulyanovsk region, Fortum, Rusnano and the Chinese company Dongfang Electric Wind (DEW) Power Co., Ltd. Fortum and the Rusnano Group have agreed to establish a Wind Power Development Fund in Russia, the purpose of which is to invest in the construction of wind parks and launch projects to localise the production of wind turbines and venture projects in the field of renewable energy.

In May 2018, a program for localisation of wind energy equipment production was launched in Russia. An industrial site was opened in Nizhny Novgorod region, where gondolas for wind turbines, gondola angle control systems and cooling systems will be produced. The establishment of the site was the first step in the implementation of the program for localisation of wind power equipment production in Russia. The new industrial site was created by Danish company Vestas, which was chosen as a supplier of wind energy equipment for the above mentioned Wind Development Fund, which is currently implementing projects for the construction of wind parks with a total capacity of up to 1 GW.

5 New jobs creation

Renewable energy deployment can solve some employment problems. The renewable energy sector is already the largest employer: it employed 11 million people in 2018. Leaders for employment in the renewable energy sector are China, Brazil, the USA, India, Germany, Spain and Bangladesh. As in past years, China was the largest RE employer, accounting for 43% of the world's total (REN 21, 2019).

There is a significant potential of job creation in the construction, operation, and maintenance segments of the RE value chain. Jobs in the construction and installation segments are created at the early stage of project realisation whereas those in operation and maintenance are created throughout the operational lifetime of a project. Evidence from various RE projects show that, in general, renewable energy technologies create more installation jobs per MW of new capacity and more operation and maintenance jobs per MW of cumulative installed capacity than conventional energy technologies (Rutovitz et al., 2015).

Based on the projected volume of energy production based on RE and its correlation with German data on generation growth, the possible increase in the number of permanent jobs in Russia can be estimated at 90,000–105,000 jobs.

6 Emissions reduction and sustainable development

There is an opinion that the RE generation is carbon neutral. This is not entirely correct since RE technologies have a fundamentally different spectrum of environmental impacts in comparison with conventional technologies (Porfiryev, 2013, 2011). In addition, some environmental impacts of renewable energy are not clear and have to be studied and explored. Thus, all forms of energy supply, including renewable energy, cause negative environmental impacts (Shaytanov, n.d.). Nevertheless, considering the entire life cycle of energy generation (from the production of equipment to its complete decommissioning and disposal), the aggregate impact from renewable energy sources is much less than that of conventional energy. Most renewable energy technologies do not consume fuel during operation and do not use exhaustible natural resources. At the same time, renewable energy technologies consume significantly less water than traditional electricity generation.

The largest negative impact of energy sector on the environment is its contribution to climate change. Power sector accounts for 40% of carbon dioxide emissions. It is possible to carry out a comparative analysis of CO_2 emissions per kWh produced by different technologies throughout their life cycle[2]. To determine the total emissions of the power plant, it is necessary to take it into account at every stage of its life cycle. In the sectors where fuels are used it is necessary to take into account the supply chain, uncontrolled GHG-emissions during the production and combustion [not only carbon dioxide (CO_2), but also methane (CH_4), nitrogen oxide (NO_x) and other greenhouse gases], production of equipment for exploration of deposits, infrastructure emissions and emissions associated with transportation. It is also necessary to consider emissions related to the provision of electricity and to the heat of the generating facilities themselves, with the production of cement and metals necessary for their construction, etc. (Weizsäcker et al., 2013).

Applying the life cycle approach, it is necessary to take into account the GHG-emissions from solar panels manufacturing, from the transportation of fuels to power plants, the emissions associated with the decommissioning of nuclear power plants and the disposal of nuclear waste. In the course of its life time, renewable energy plants emit 10–120 times less than a gas power plant (the cleanest of traditional technologies) and up to 250 times less than coal plants. Thus, the potential for reducing greenhouse gas emissions deriving from renewable energy technologies means that they must play a key role in combating climate change.

According to the Ministry of Economics and Energy of Germany, in 2017 the renewable energy sector provided a reduction in emissions in Germany of 177 million tons of CO_2 equivalent (135 million tons in the electricity sector) (BMWI, 2018).

Let us try to give a quantitative estimate of the reduction in CO_2 emissions in Russia as a result of the adding of 5.9 GW of new RE-capacities by 2024.

As the share of low-carbon technologies increases, the total GHG emissions decrease proportionally. Based on the known proportion of 1 MWh = 0.456 t of CO_2 emissions, the emission reductions in 2024 will be 11.586 billion kWh × 0.456 t/MWh = 5.283 million tons.

Monetary valuation of this CO_2 reduction depends on the price of CO_2 in 2024. Due to the high volatility in the emissions trading market, it is proposed to base the estimation on the average price per ton of CO_2 in the European emission trading system (EU ETS) over the period of its existence (since 2012) at 8.5 euros per ton (BDEW, 2018). Then, taking the euro rate of 70 rubles per euro, the value of this savings in 2024 will be 3.15 billion rubles (€45 million).

7 Lowing of kWh-prices in the wholesale electricity markets

Significant growth of renewable power in some energy markets has forced down wholesale electricity prices. In Germany during the 2008–2018 period, average electricity prices in the short-term market decreased by 46.7%, and in the long-term market segment – by 61.5% (BDEW, 2018; Menanteau et al. 2003). The main factor of the decline is the increase in energy production from the wind and solar plants.

In view of the fact that renewable energy in the Russian market is represented in a very insignificant amount (with the exception of large HPPs), it is not possible to talk about the occurrence of this effect in the market.

8 Additional fiscal revenues

8.1 Trade tariff

Assuming the possibility of export of the saved hydrocarbon fuel, the budget will receive additional revenue from export duties. The regime for regulating export revenues depends on the type of fuel and has a different economic result. The largest tax is imposed on oil exports, but the share of oil and fuel oil in electricity production is moderate. Natural gas constitutes a significant share in the electric balance and can be considered as a justification for this hypothesis. At 11.586 billion kWh of electric power, there is 45% of the gas efficiency factor. The average industry gas consumption for electricity generation is the following: 11.586 billion kWh × 94.304 m^3/MWh: 0.45 = 2.428 billion m^3 of gas in 2024.

The Agency for Forecasting Balance Sheets in the Electric Power Industry (AFBE) set the projected gas price for 2024 at $369 per 1,000 m^3 (Ministry of Energy of the Russian Federation Agency for Forecasting Balances in the Electric Power Industry, 2010). Then, taking the dollar exchange rate for 2024 for 70 rubles/dollar, the value of the conventional value of exported fuel can reach 58.236 billion rubles (2.428 × 369 × 65). Thus, the amount of export duty at a conventionally unchanged rate of 30% will be equal to 18.81 billion rubles (€268.7 million) in 2024 (Government of the Russian Federation, 2012).

8.2 Profit tax

The tax on the profit of new generating firms can be calculated based on the expected 10% return and the current income tax rate of 24%. The volume of proceeds is calculated on the basis of the distribution of the expected volumes of renewable energy plants electricity production 11.586 billion kWh by price zones and tariffs. Then the amount of the profit tax will be [10.31 billion kWh × 2.199 rubles/kWh + 1.28 billion kWh × 1.09 RUR/kWh] × 0.1 × 0.24 = 0.58 billion rubles (€8.3 million).

8.3 Tax on land or rent

The use of plots for the housing of renewable energy plants is profit tax or rent charged. The main large-scale users of land among renewable energy technologies are wind farms (on average, 3–4 hectares for 1 MW of installed capacity), solar plants (2–3 hectares for

1 MW of installed capacity), biomass and biogas stations using plant material from especially sown fields. Assuming that an average of 3 hectares of land is used for each megawatt of installed capacity, in order to accommodate the projected capacity of these power stations by 2024 additional 17,613 hectares (5,871 MW × 3) will be required. Recently, leasing rates (2% of cadastral property) were legally fixed, that with a minimum cadastral value of 6,000 rubles for 1 hectare is 17,613 hectares × 6,000 rubles × 0.02 = 0.002 billion rubles (or €0.03 million) in 2024.

8.3.1 Income tax

Based on the number of newly created jobs in the renewable energy sector (30% of the potential 90,000 jobs), income tax rate of 13% and an average salary of about 700,000 rubles per year, the income tax will amount to 2.46 billion rubles (or €35 million) in 2024.

8.3.2 Payment for water

The payment for water is calculated on the basis of the average value of this charge for small hydropower plants in the amount of 9 rubles/MWh and of the projected value of electricity production at small hydropower plants (1.971 billion kWh on the wholesale market). Thus, in 2020, the payment for water will be 1.971 billion kWh × 9 rubles/MWh = 17.7 million rubles (€0.24 million).

Table 6 The total economic effect from the development of the renewable energy in 2024

Type of economic effect from the development of renewable energy	*Valuation (billion rubles per year) for 2024*	*Valuation (€ million per year) for 2024**
Replacement of organic fuel	24.05	343.57
Reduction of greenhouse gas emissions	3.15	45.00
Total amount of additional fiscal fees, including:	*21.87*	*312.43*
Export duties for gas	18.81	268.71
Profit tax	0.58	8.29
Tax on land or rent	0.002	0.03
Income tax	2.46	35.10
Payment for water	0.017	0.24
Total	*49.07*	*701*
Results without economic valuation		
Reduction of the environmental activities cost	-	-
New jobs creation	90,000–105,000	

Note: At the exchange rate of 70 rubles per euro.

An important advantage of renewable energy is the fact that there is no need to increase investment in operating costs in associated industries such as extraction and processing, transportation and storage of fossil fuels, utilisation and storage of waste from its processing and incineration, which in Russian conditions constitutes a significant share of the cost of fuel stations. The total economic effect from the development of the renewable energy industry at the wholesale electric energy market in 2024 will thus amount to 49.07 billion rubles per year in 2024 (or €701 million).

These results can call into question the need for any government support of renewable energy. However, this point of view is incorrect: the costs for the development of renewable energy are carried out by one group of economic agents, but the other one erodes the gains. And therefore the participation of the state is necessary to redistribute this additional product among agents through its distribution tools.

9 Conclusions

The resubmitted evaluation methodology of the macroeconomic effect from the implementation of the support mechanism suggests to consider the identified aspects [hydrocarbons savings, GHG-emissions reduction, kWh-price reduction on the wholesale electricity markets, creation of new jobs, additional fiscal revenues, multiplicative (cascade) effects in related industries] as particular elements of this effect. According to the resubmitted calculations, the cumulative effect of the implementation of the RE support mechanism in Russia will be 49.07 billion rubles per year (701 million euros) for 2024. The model developed has a methodological significance for further scientific research on the regulatory impact of the support mechanism for renewable energy, social and environmental consequences of its development.

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Notes

1 Not including hydropower.

2 The life cycle of generating technology means the entire period of its existence – from the production of building blocks and equipment of the power plant to the electricity generation and the power plant's decommissioning.