Chapter 15
Russian Mechanism to Support Renewable Energy Investments: Before and After Analysis

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Abstract This chapter presents an analysis of how the new Russian support policy for renewable energy investments changes the expected profitability of renewable energy investments in Russia. A comparative analysis of investment profitability in the before and after support policy cases is presented for a wind farm investment to illustrate the effect of the policy. This chapter is among the first to comparatively analyze the effect of the Russian renewable energy support mechanism on investment project profitability.

15.1 Introduction

To ensure strategic investments in emerging technologies in the energy sector such as investments in renewable energy (RE) that cannot at this time compete with conventional solutions in industrial scale and in terms of profitability, policy makers may introduce support mechanisms. Design of support mechanisms has turned out to be a crucial element in being able to incentivize the deployment of RE technologies into the energy markets. This is due to the maturity level of the present day technology—RE power projects are typically not profitable without policy support. It remains to be seen how fast the development of technology is able to change the situation. Ideally, a supporting policy for RE should serve multiple goals, such as reducing the risks of investment and providing motivation to invest cost efficiently, it should also be feasible from the point of the society that is paying for the bill. Typically, the

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main RE support policy types used include a "remuneration scheme" that guarantees an investor supplemental income to strengthen profitability, if an investment fulfills the policy given criteria. The level of the supplemental income can be defined in different ways and common ways to do this include, e.g., using a special price to be paid for electricity produced by RE investments (feed-in tariffs); exploring the minimum acceptable electricity price through competitive auctions; and letting the markets define the price by establishment of RE certificate trade, which RE producers receive for their production (Boute 2015).

In this chapter we concentrate on studying the Russian RE support mechanism for the Russian wholesale energy market. Under the present day conditions, industrial-scale renewable energy production investments in Russia are seldom considered as a relevant option without the support mechanism and would be deemed "universally" unprofitable without one. The focus of this chapter is to study the effect the Russian RE incentive mechanism has on the profitability of Russian RE investments. The analysis presented is based on the codified details of the Russian RE mechanism and its pricing instructions that available in the original Russian language legislative procedures (Russian law) (Government of Russian Federation 2013a, b, 2015), in a policy report (International Finance Corporation 2013), and a recently published by academic paper (Kozlova and Collan 2016). Likely due to the lack of English language sources on the Russian RE policy it has received relatively little attention in the academic literature.

Previous literature that studies the Russian RE policy includes a qualitative study of the draft version of policy (Boute 2012), an analysis of its impact on the Russian electricity and capacity prices (Vasileva et al. 2015), and a number of investigations concerning RE investment profitability in Russia (Kozlova and Collan 2015, 2016; Kozlova et al. 2015). In this respect the recent paper (Kozlova and Collan 2016) is the closest match to the analysis presented in this chapter and studies the effects of different factors on RE project profitability under the Russian capacity-based support and examines the policy's interim success. The study is limited to using classical investment analysis and sensitivity analysis and in those terms offers a simplified picture. The aim of this research is to perform a comparative "before – after" study on the effect of the Russian RE policy to RE investments in Russia. To the best of our knowledge this is a first time the results of such a study are reported.

As a basis for the study, we use a previously presented (Kozlova 2015) system dynamic investment model and use simulation analysis to study the profitability of a wind farm investment in Russia with and without the supporting policy. The results show that the policy has a significant effect to project profitability, when a project fulfills the policy goals.

This chapter continues by shortly presenting the Russian support mechanism for renewable energy, then a simulation analysis of the profitability of a stylized wind farm investment case is made, ceteris paribus, with and without the supporting policy in place, and finally the paper is closed with a discussion and conclusions are drawn.

15.2 Russian Capacity Market and the Support Mechanism for RE Investments

Russian capacity mechanism for renewable energy support is an extension to the pre-existing Russian national capacity trade principles. The Russian power market consists of a capacity market that operates alongside the electricity market (Gore et al. 2012; Government of Russian Federation 2010a). The idea behind capacity trade is to assure ability of a power system to meet electricity demand in the long term by timely incentivizing investments in new power plants. Selling capacity means getting paid for being available to produce electricity (Olsina et al. 2014).

The Russian capacity market is organized through competitive capacity selection that is carried out by the centralized infrastructure organization System Operator (SO), where existing power generators submit their bids with available volumes of installed capacity for a pre-specified period (NP Market Council 2012). In addition, new planned projects compete for long-term capacity delivery agreements with regulated price (Boute 2012). Capacity power generators that have won contracts are obliged to follow dispatching orders from the SO that enable the management of the power system operation. On the demand side, each electricity buyer in the wholesale market is obliged to buy capacity according to the buyer's peak demand. The price of capacity is defined as a weighted average of contracted and auctioned capacity prices that include the "winning bids" of auctions and the regulated tariffs of long-term capacity delivery agreements (Gore and Viljainen 2014). Notably, the procedure of capacity price calculation for the long-term agreements is designed to assure a risk-less return on each investment project (Government of Russian Federation 2010b). This mechanism is taken as a foundation for designing the remuneration scheme for renewable energy support. In May 2013, the Government of Russian Federation presented an extended capacity mechanism that is specific to RE power generation, with the aim to support the deployment of almost 6 GW of new renewable energy capacity by the year 2020 (Government of Russian Federation 2013a, b). Once a year, competitive capacity auctions are conducted for investment projects into wind, solar PV, and small (<25 MW) hydropower. The selection of projects is carried out for a four-years-ahead commercialization window and is based on (i) compliance to participation requirements and on (ii) the least planned capital costs criterion. There is a set yearly target installed capacity volume for each particular RE technology, up to which projects are selected. The participation requirements include a technology-specific capital expenditure limit and a requirement to procure a share of the used equipment from local Russian manufacturers (local content) (International Finance Corporation 2013).

The selected projects are eligible for a long-term capacity delivery agreement that allows them to benefit from monthly capacity payments for fifteen years, starting from these projects' commercialization date. The capacity agreement comes into force only after a qualification procedure after the construction end in accordance with (Government of Russian Federation 2008). The procedure registers a power plant as one operating on a renewable energy source and controls and confirms the

fulfillment of the local content requirement. The policy obliges the winning RE projects to start operations on time and penalizes for delays, while the obligation that in place for "conventional energy production" facilities to follow dispatching orders is "softened" to the requirement of complying with SO orders to switch off electricity production (Government of Russian Federation 2013a).

The RE capacity price calculation is centralized and the procedure is designed to guarantee a specific return on investment regardless of the changing market conditions. The guaranteed return is defined as 12% annually corrected by changes in market interest rates (or 15% for projects auctioned before 1.01.2016). The market interest rates are represented by long-term Russian government bond yield. The capacity payments are designed to cover project costs and to provide some return over it. The estimated project costs comprise of capital expenditures (CapEx), operating expenses (OpEx), and of taxes. The capital expenditures are directly taken from the submitted bid information and are project-specific. They are converted into monthly payments by means of variable rate annuity. The 'foreign' share of the capital costs is translated to rubles during the project investment phase. For operating expenses the mechanism sets technology-specific norms that are corrected with inflation, which is incorporated into the calculation by using the consumer price index as a proxy. Project-specific property tax forecast, based on planned capital costs and a 20% income tax are included in the estimated project expenses for capacity price calculation.

The complex calculation of the capacity payments introduces a complicated "effect" that influences project profitability analysis. The key market and project-internal factors directly affect project profitability, while they also enter in the capacity price payment computations and create "cross-effects" on project profitability (see Fig. 15.1). It can be understood that the procedure is rather complex. For details we refer the interested reader to study Appendix 2 of (Kozlova and Collan 2016).

Capacity sales are not the only source of revenues for a power plant project, there is also income from the electricity sales. This is why the capacity payments do not cover all the estimated project costs, but only the share of costs that is computed via
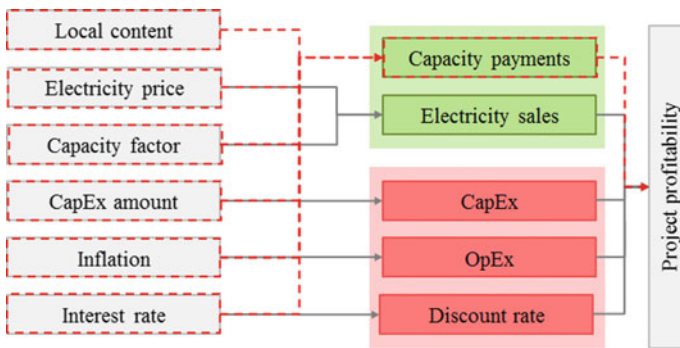

Fig. 15.1 The factors affecting Russian RE investment profitability

an analysis of an averaged project. This share of expenses is also a subject to annual recalculation, based on changing electricity prices and changes in other conditions (Government of Russian Federation 2013a, 2015).

The mechanism uses several ways to shape investor motivation to invest in RE projects, typically non-conformity with requirements decreases the support received, such cases include situations where, the plant qualification procedure reveals that the local content requirement is not fulfilled, the volume of the yearly produced electricity is too low, and orders of the System Operator to switch off the electricity production to maintain the balance in the system are not followed.

To summarize, the RE capacity price is calculated for each project on an annual basis and the aim is to provide a riskless return on the RE investment. The capacity price is adjusted based on the changing market conditions that include interest rates, electricity prices, inflation, and exchange rates. Project-specific factors such as capital costs, local content, and electricity production performance are taken into account. More detailed information about the policy and the capacity pricing can be found in (Boute 2012; International Finance Corporation 2013; Kozlova and Collan 2016) and from the original Russian legislation (Government of Russian Federation 2013a, b, 2015).

In the following section of this chapter we present a case and a numerical illustration that uncovers the effect of the Russian RE support mechanism on the profitability of a wind farm investment.

15.3 Case: Effect of the Russian RE Support Mechanism on a Wind Farm Investment Profitability

The analysis presented is based on the use of a system dynamic model built to study the profitability of a stylized wind farm investment. The model used has been presented in detail in (Kozlova 2015). The model realized with Matlab Simulink®, is built to fully represent the details of the Russian RE support mechanism, and the profitability calculation part of the model is based on using a typical discounted cash-flow logic that returns the project net present value (NPV) as a result. The model is used as the basis for a Monte Carlo simulation (Hacura et al. 2001; Kwak and Ingall 2007). The simulated NPV results are presented as histograms. We have chosen a 10 MW wind farm as the case to be studied, solar PV and small hydropower projects generate very similar results. The wind farm is assumed to be commissioned in 2017, and to start generating cash-flows immediately thereafter for the next 20 years. In the base case investment the total capital costs are assumed to be equal to cost level set by the Russian legislation limit of 110 Mrub./MW. The operating costs are assumed to be equal to the normative 188 Krub./MW per month, adjusted with inflation. We assume inflation to be an uncertain variable and assume it to stay within a range of 1 to 1.7, in terms of consumer price index. The revenues are treated as uncertain and they are modeled to consist of electricity sales with uncertain price that are assumed

Table 15.1 Summary of the parameter values and settings for the simulation runs

Run	Policy	CapEx (of the limit 110 Mrub./MW)	Capacity factor (from target 27%)	Local content	Electricity price	Consumer price index
A	*Not in place*	*Uncertain 100–150%*	*Uncertain 30–100%*	–	*Uncertain 1–3 rub./kWh*	*Uncertain 1–1.7*
B	In place	*Uncertain 100–150%*	*Uncertain 30–100%*	*Uncertain*	*Uncertain 1–3 rub./kWh*	*Uncertain 1–1.7*
C	In place	Certain 100%	High 90–100%	Fulfilled	*Uncertain 1–3 rub./kWh*	*Uncertain 1–1.7*

to range from 1 to 3 rub./kWh (corresponding to typical prices on the markets), by a capacity factor that is equal to the target, and the capacity payments that are calculated according to the support mechanism procedure. Values of the uncertain variables are expected to have a uniform distribution, except for the "local content" variable that is binary and may only take the value zero or one. The Russian risk-free rate used in all calculations is assumed to be fixed at ten percent—its effects are studied separately.

Three simulation runs are performed with the model, one without the support policy (run A), one with the support policy (run B), and a third one to illustrate the situation, where a project is able to completely fulfill the requirements of the support policy and thus being able to enjoy the full benefits of the said policy (run C). Each simulation run consisted of 100,000 simulation rounds. Details for the three simulation runs are visible in Table 15.1.

Market uncertainty represented in the model by electricity prices and inflation is modeled equally through the all three runs. The run A represents no policy situation, thus the project receives no capacity payments and benefits only from electricity sales. We assume possibility of CapEx increase to a maximum of 150% of the basic value of 110 Mrub./MW. The capacity factor used in the RE support mechanism depends on resource availability and we assume it to vary within a broad range from 30 to 100% of the target capacity factor that is equal to 27% for wind power.

The difference in run A without the supporting policy in place and run B, where the policy is in place, is the appearance of the supporting subsidy payments and the "local content" variable. The local content is typically fulfilled, as the investors most likely will not start project construction if the local content requirement cannot be fulfilled, because this would mean almost certainly that the project is unprofitable.

Run C illustrates the situation when the project is able to comply with all policy requirements and achieves the full support payments without any penalties for underperformance. Figure 15.2 presents the resulting NPV distributions from the three runs as histograms.

We can see from Fig. 15.2 how the introduction of the supporting mechanism changes the NPV distribution of the investment (Fig. 15.2a, b). What is important to notice is that the distribution resulting from the "no support mechanism" case
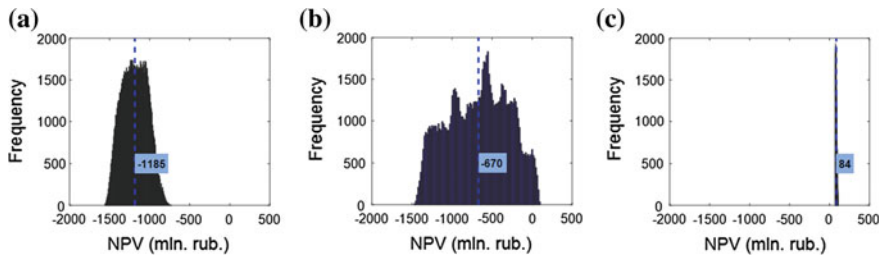
Fig. 15.2 NPV distributions for three scenarios (expected mean highlighted)

(run A) consists of only negative profitability outcomes, while the presence of the supporting mechanism shifts the distribution to the right and creates a possibility for profitable investment.

Results from run A are realistic in the sense that industrial-scale RE investments have not been profitable in Russia without support. The distribution that results from run B has a multi-peak shape that is caused by complex rules behind the support mechanism that determines the capacity remuneration paid to the investment under different circumstances. The lower bound of the distribution remains the same in both cases, because in case of poor project performance also a project "under" the support mechanism remains without any support. The difference between the two distributions can be simply calculated as the difference between the mean NPV values of runs A and B, which amounts to 515 million rubles for the investment project or more generally 52 million rubles per 1 MW of wind power installed capacity. This can also be interpreted as a real option value that is generated by the support mechanism. Comparing the means may not be very useful while both are negative, therefore we have also separately studied the situation of a project that is able to fulfill all the requirements of the support policy (run C).

The resulting distribution from run C is very concentrated and entirely in the positive area. This means that under the studied conditions a project that is able to fulfill all the set requirements of the support policy is able to guarantee positive NPV with a small variation of outcomes even in the presence of the uncertain market factors. This highlights the fact that it makes sense for the investors to be proactive in pushing their performance to fulfill the requirements of the policy. This is also in line with the policy objectives. For such projects the value of the support policy, in comparison to the preceding situation without the policy, is quite remarkable and stands at 1269 million rubles, or 127 million rubles per MW. This can be considered a real option value.

The Russian RE capacity mechanism shields investors not only from the price risk, but also from the interest rate risk. Therefore, the effects of changing interest rates on the project profitability require separate attention. The capacity price is computed as an annuity with variable rate that is adjusted to the changes in the local risk-free rate. Thus, an increase in the risk-free rate leads to higher capacity payments, and consequently to a higher internal rate of return of the project. Technically speaking,
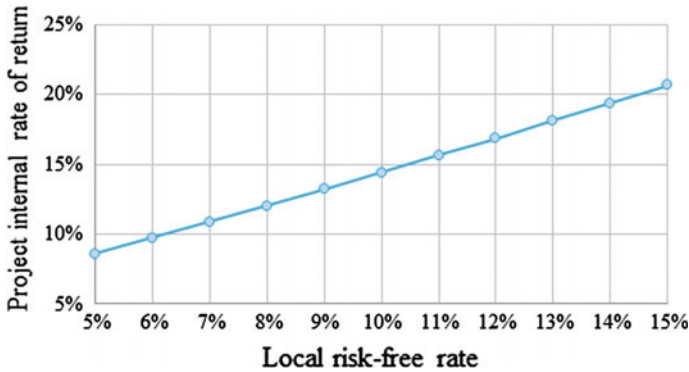
Fig. 15.3 Sensitivity of project internal rate of return (IRR) to the Russian risk-free rate under the support policy

without such mechanism in place the higher interest rates would reduce the NPV due to higher discount rates. The design of Russian RE support offsets this reduction effect by offering an increased capacity price when interest rates rise and aims to keep project profitability on the same level. This feature is designed to enable investors to cope with higher costs of financing without harming the project profitability.

A numerical sensitivity analysis performed of the effect of the Russian risk-free rate to the project profitability shows that there is a close to linear positive relationship between the project IRR and the risk-free rate arising from the remuneration design, see Fig. 15.3.

This is a non-insignificant analysis in the Russian context, where the risk-free rate may experience considerable changes over time. What is interesting and important to note is that the choice of contract in terms of floating or fixed interest on the project debt plays a role in project profitability: change in the interest rate of a floating rate loan is most likely offset by the support mechanism to a large extent.

In general, the results show that the Russian RE support mechanism is able to provide higher profitability to RE projects and projects that are able to consistently fulfill the set requirements may enjoy a situation of low risk profitability. This also means that investors should proactively try to steer their investments into meeting the set criteria.

15.4 Discussion and Conclusions

In this chapter we showed how the Russian renewable energy support mechanism works and how it changes the profitability outlook of RE power investments in Russia. The Russian RE support mechanism is unique in terms of its construct, which is rather complex. The mechanism aims to guarantee profitability for investments that fulfill the set criteria by offering capacity payments to RE investments. The capacity pricing mechanism that determines the size of the payments starts by defining the required

return on investment and then uses it to compute a remuneration amount needed for a particular project to achieve this return. This remuneration is a subject to yearly recalculations in that take into account the changing market environment and the project performance in the long-term. As the result, the mechanism allows investors a lower risk with regards to the project profitability and allows them to enjoy a greater level of independence from Russian market conditions if they comply with set policy requirements. Real world results from the implementation of the said policy so far suggest that the support mechanism is able to provide sufficient incentive for investors for investment in solar power. Experience with wind and small hydropower shows that the selection of parameter values for the support mechanism needs more work with regards to these technologies.

We demonstrated with a system dynamic model of a wind power generation investment how the Russian RE support mechanism changes the profitability landscape of the investment—there is a significant and an important effect that allows projects that fulfill the set policy requirements to be profitable. This chapter is among the first, if not the first, to comparatively analyze the effect of the Russian support mechanism on the profitability of renewable energy investments in Russia.

Further research into this topic will include comparing the results with results from using other commonly used RE support mechanisms.

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