# ENABLING PV in Russia

## Third edition

## A review of regional photovoltaic, small wind and heat pump markets


**Project partners**

eclareon

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### List of Acronyms

| Acronym | Definition |
|---|---|
| "a" | Per Annum |
| AEC | Active Energy Complex |
| ATS | Administrator of the Trade System |
| BM | Balancing Market |
| BRELL | Belorussia, Russia, Estonia, Latvia and Lithuania |
| BSW | Bundesverband Solarwirtschaft (German Solar Industry Association) |
| CAPEX | Capital Expenditures |
| CEPP | Condensation Electric Power Plant |
| CFR | Financial Settlement Centre |
| CHP | Combined Heat Plant |
| CHPP | Combined Heat and Power Plant |
| CIS | Commonwealth of Independent States |
| DAM | Day-Ahead Market |
| DC | Direct Current |
| DCode | Distribution Code |
| DFC | Discounted Cash Flow Analysis |
| DSCR | Debt Service Coverage Ratio |
| EEG | Erneuerbare Energien Gesetz (Renewable Energy Source Act, Germany) |
| EIA | Environmental Impact Assessment |
| EIRR | Economic Internal Rate of Return |
| EPC | Engineering, Procurement and Construction |
| ESIA | Environmental and Social Impact Assessment |
| EU | European Union |
| FCM | Free Contracts Market |
| FIT | Feed-in Tariff |
| FOREX | Foreign Exchange |
| FSA | Fuel Supply Agreement |
| FSK UPS | Federal Grid Operator |
| FX | Foreign Exchange |
| GDP | Gross Domestic Product |
| GHG | Green House Gas |
| GIZ | Gesellschaft für Internationale Zusammenarbeit |
| GOST | Gosstandard (*National Standard*) |
| GW(p) | Gigawatt peak |

| Acronym | Definition |
|---|---|
| GWh | Gigawatt hours |
| HPP | Hydropower Plant |
| HV | High Voltage |
| ICT | Information and Communication Technology |
| IDGC | Interregional Distribution Grid Companies |
| IEA | International Energy Agency |
| IEMS | Intelligent Energy Management System |
| IES | Integrated Power Systems of UPS |
| IFC | International Finance Corporation |
| IMF | International Monetary Fund |
| IPP | Independent Power Project |
| IRR | Internal Rate of Return |
| $I_{SC}$ | Short Circuit Current |
| JSC | Joint Stock Company |
| KPI | Key Performance Indicators |
| kV | Kilovolt |
| kW(p) | Kilowatt (peak) |
| kWh | Kilowatt hours |
| LCOE | Levelized Costs of Electricity |
| LLCR | Loan Life Cycle Coverage Ratio |
| LTD | Limited Company |
| LV | Low Voltage |
| $m^2$ | Square Meters |
| MDG | Millennium Development Goals |
| mps | Meters per second |
| MTS | Mobile TeleSystems |
| MW(p) | Megawatt (peak) |
| MWh | Megawatt hours |
| NGO | Non-Governmental Organization |
| NP | Non-commercial Partnership |
| NPV | Net Present Value |
| NRP | Non-Regulated Prices Market |
| O&M | Operation and Maintenance |
| OEM | Original Equipment Manufacturer |
| OPEX | Operational Expenditure |
| PJSC | Public Joint Stock Company |

| Acronym | Definition |
|---|---|
| PP | Power Plant |
| PPA | Power Purchase Agreement |
| PPP | Private Power Project |
| PV | Photovoltaic |
| PVPS | Photovoltaic Power Systems Program |
| R&D | Research and Development |
| RC | Regulated Contracts Market |
| RE | Renewable Energy |
| RES | Renewable Energy Source |
| ROE | Return on Equity |
| ROEK | Ryazan Oblast Electricity grid Company |
| ROI | Return on Investment |
| RP | Regulated Prices Market |
| RUB | Russian Ruble |
| SHS | Smart Home Systems |
| SME | Small and Medium-Sized Enterprise |
| SO UPS | Company Supervising the UPS |
| SPP | Solar Power Plant |
| SPV | Special Purpose Vehicle |
| SRS | Solar Residential Systems |
| TWh | Terawatt Hour |
| UN | United Nations |
| UPS | Unified Power System of Russia (Unified National Power Grid) |
| USD | United States Dollar |
| USSR | Union of Soviet Socialist Republics |
| VAT | Value Added Tax |
| WACC | Weighted Average Cost of Capital |

# Objectives of the project ENABLING PV in Russia

The market for solar PV installations has become more and more international over the last decade. While the first solar boom was mainly restricted to developed countries, who decided to support renewable energies with often similar support schemes mainly based on feed in tariffs, the landscape today for solar energy is different and much more diverse. Having already reached or being on the verge of reaching cost competitiveness with conventional energy sources in many countries, the number of markets and of business models that work in those markets have multiplied in the last years. And just as every project is different so are the framework conditions in every country.

It is in this context of a more and more international PV market that the German solar association BSW-Solar together with the consulting firm eclareon have started in 2013 to investigate business models and the business environment for PV in different countries under the label “ENABLING PV”. The first study was published in 2014 and the series covers today countries such as for example Tunisia, Jordan, Brazil, Argentina, Nigeria, Angola, Iran, Pakistan and Afghanistan.

The label also stands for the intention of this report: enabling the growth of solar, PV based energy around the globe. In order to achieve this, projects need to be realized and the first step towards this may be the generation, distribution and also discussion of country specific knowledge. **ENABLING PV reports shall provide a starting point for those investors and solar entrepreneurs who have a specific interest to expand their business in new markets.**

This report on the potential for PV in Russia is embedded in further activities implemented by eclareon together with the association EUROSOLAR Russia in the second half of 2018 in Russia. With **Kaliningrad and Krasnodar**, **and, since 2019, also Bashkortostan and Ulyanovsk**, four pilot regions were selected, and meetings and workshops were organized to discuss with the administration, companies, institutes, universities and potential investors about possible applications of PV systems and to identify pilot projects. Therefore, these four regions are presented in this report as example regions for the diffusion of photovoltaic solutions in Russia.

In the search for pilot projects, the focus has quickly expanded to include heat pump solutions for heat supply and small wind for energy supply. Several pilot projects in both regions are currently being further developed with German and Russian companies and investors.

For 2020 it is planned to implement the successful approach in two further Russian regions. In the course of this, this report will be expanded to include two additional regions and is to be published as the fourth edition in December 2020.

# Задачи проекта ENABLING PV в России

В течение последнего десятилетия, рынок солнечных фотоэлектрических установок становится все более интернациональным. Первый солнечный бум случился в основном в развитых странах, которые решили поддержать возобновляемые источники энергии используя зачастую аналогичные схемы поддержки, основанные главным образом на льготных тарифах. Сегодня ситуация в области солнечной энергетики уже иная и схемы стали разнообразнее. В последние годы, ВИЭ во многих странах уже стали конкурентоспособными или находятся на грани конкурирования с традиционными источниками энергии с точки зрения капитальных затрат, число рынков и бизнес-моделей, работающих на этих рынках, увеличилось в несколько раз. И, как различны между собой разные проекты, так и рамочные условия в каждой стране отличаются друг от друга.

Именно в этом контексте глобализации рынка солнечной энергетики в 2013 году Немецкая Ассоциация Солнечной Энергетики BSW-Solar совместно с консалтинговой фирмой eclareon приступила к изучению бизнес-моделей и бизнес-среды солнечной энергетики в разных странах. Этот масштабный и многогранный проект получил международное название, своеобразный узнаваемый лейбл "ENABLING PV". Первое исследование было опубликовано в 2014 году, и, на сегодняшний день, серия исследований охватывает такие страны, как Тунис, Иордания, Бразилия, Аргентина, Нигерия, Ангола, Иран, Пакистан и Афганистан.

Эта марка «Enabling PV» также отражает посыл данного отчета к способствованию росту солнечной, фотоэлектрической энергетики, по всему миру. Для этого необходима реализация проектов солнечной энергетики, и первым шагом на пути к этому может стать генерирование, распространение, а также обсуждение знаний и данных, специфичных для каждой конкретной страны. **Отчеты ENABLING PV станут отправной точкой для тех инвесторов и предпринимателей в области солнечной энергетики, которые заинтересованы в расширении своего бизнеса на новых рынках.**

Данный отчет о потенциале и перспективах фотоэлектричества в России является частью масштабных мероприятий, реализованных компанией eclareon совместно с ассоциацией НП «ЕВРОСОЛАР Россия» во второй половине 2018 года в России. При участии **Калининградской Области и Краснодарского Края,** были выбраны два пилотных региона, **а с 2019 года, к проекту присоединились также Ульяновская Область и Республика Башкортостан**. Наряду с этим, в целях обсуждения различных вопросов и определения пилотных проектов, были организованы встречи и семинары с представителями администрации регионов, компаниями, ВУЗами и потенциальными инвесторами, заинтересованными в развитии и применении фотоэлектрических систем. По этой причине, эти четыре региона представлены в данном отчете в качестве примеров применения и распространения фотоэлектрических решений в России.

В процессе поиска пилотных проектов, фокус исследования быстро расширился и теперь также включает в себя решения в области тепловых насосов для теплоснабжения, а также малого ветра для электрогенерации. Несколько пилотных проектов в обоих регионах в настоящее время находятся на стадии обсуждений и разработки при активном участии немецких и российских компаний и инвесторов.

В 2020 году планируется проведение подобной работы в двух дальнейших регионах России. В ходе этой работы, данный отчет будет расширен за счет включения в него двух следующих регионов и четвертая версия будет опубликована в Декабре 2020 года.

# Executive Summary

Until recently, renewable energies (other than large hydro) did not play a big role in the energy supply in the Russian Federation, despite the huge potential it has in the country. Simply put, the primary reasons have been the large national oil and gas reserves, which have led to low electricity prices and the lack of experience with using renewable technologies. However, recent market figures show that the wind energy and photovoltaics (PV) sectors are expanding, indicating that these technologies may play a more important and prevalent role in Russia in the future.

The question now is: where can projects be realized and which obstacles need to be removed to grow the solar PV market, despite low electricity prices? To answer this, it is important to highlight business models that can work. Standardizing PV business models that create win-win situations for all parties involved in a solar PV project is always challenging. It is particularly so in emerging PV markets like Russia, where "more" standardized models that can easily be reproduced still need to be developed and information on prices is fuzzier than in established PV markets with more experience. This ENABLING PV report presents different business models that each give direction as to how PV can be exploited in different segments and installation sizes.

It is in this context, that the international consulting company eclareon GmbH, specialized in the sector of renewable energy and energy efficiency, supported by the Russian partner EUROSOLAR Russia had analyzed the procedures and barriers of the Russian PV sector, both on a national level and in two Russian regions, Kaliningrad Oblast and Krasnodar Krai, for the first time in 2018. This report includes updated information on the regions and also the analysis of 2 new regions, Bashkortostan and Ulyanovsk Oblast.

The objective of the report is to provide practical information about the current status of the Russian PV, heat pump and small wind market in general and more specifically in the four regions. The information in this report will support the German and Russian solar and renewable energy industry as well as interested companies in the energy industry, regional economic development institutions and scientific institutions to further develop the Russian PV market. To achieve this the following activities were annexed to the Enabling PV project, going beyond the report:

- Presentation of the legal, regulatory and electricity market framework conditions for the development of grid-connected and off-grid solar PV systems in Russia
- Description and profitability analysis from the investor point of view for different business models for PV, heat pump and small wind power projects in Russia
- Roundtables in Germany, in Moscow and in the two new regions Ulyanovsk and Bashkortostan to present the project and to discuss interim results and to identify some pilot PV projects

The conditions for the development of PV are in particular favorable in Krasnodar. This is because the region is lacking in its own generation capacities, has high solar irradiation, PV is already installed and the overall environment favors the development of solar energy. The situation in Kaliningrad is different: not only does Kaliningrad have less natural solar irradiation than Krasnodar but the region is also unique due to its geographic seclusion from the Russian mainland meaning that energy security is the focus of the regional energy policy. This has led to vast generation capacity being installed in the region. Application options have been identified for some off-grid and weak-grid applications, for which diesel generators have hitherto been used. And there is a vital interest in initiating exemplary flagship projects to demonstrate technical solutions and for offering education like trainings for planners and installers. In addition, one would like to consider solar energy in the hot water and space heating supply for building.

With regards to the natural conditions for solar PV Bashkortostan and Ulyanovsk Oblast are located somewhere between Krasnodar and Kaliningrad.

In Krasnodar Krai all market segments of the business model have the potential to yield positive results due to the payback potential during the lifetime of the PV projects and their internal rate of return. And yet, the attractiveness of the three types of installations has varied and depends on many factors that may also go beyond pure economic considerations.

Diesel PV hybrid installations have yielded the most promising calculated results. Use cases for such applications were identified all regions. Large solar parks are much more likely to appear soon in Krasnodar given the higher irradiation levels but also in Bashkortostan and Ulyanovsk. Such parks are either built based on the federal wholesale market, using Decree 449, which has been a defining factor for the recent growth in RES in Russia, or on the retail market, using Decree 47 that aims to compensate grid losses with RES. Provisions in both decrees are challenging because of local content rules and transparency. In regards to payment calculations, the rules are complicated and leave room for interpretation.

Finally, the law on microgeneration ("15 kW decree") adopted in the Duma and signed by President Putin in December 2019, will provide private households the possibility to connect their PV, their heat pump or their small wind power generator to the local grid. As soon as the technical regulations for grid connection and net metering have been drawn up by the Russian Ministry of Energy, which is planned for July 2020, these decentralized renewable energy applications can develop in Russia for the first time. But our analysis of respective business cases shows that the economic benefits of doing so are rather limited. For residential grid-connected PV, heat pump or small wind power installations to be successful in Russia these solutions currently still require a local or federal proportionate grant for the investment, otherwise they will largely be installed by wealthy enthusiasts only, for whom the installation of such a system goes beyond economic considerations.

## Сводное Резюме (Executive Summary)

До недавнего времени возобновляемые источники энергии (за исключением крупных гидроэлектростанций) не играли большой роли в энергоснабжении Российской Федерации, несмотря на их теоретически хороший потенциал. Основными причинами такого положения вещей являются имеющиеся большие национальные запасы нефти и газа, которые приводят к низким ценам на электроэнергию, и отсутствие опыта использования возобновляемых технологий. Однако последние рыночные исследования свидетельствуют о расширении применения ветровой энергетики и фотоэлектричества (PV) и указывают на то, что эти технологии могут также играть более важную роль в России в будущем.

На данный момент, вопрос таков: где, несмотря на низкие цены на электроэнергию, можно реализовать мощности и какие препятствия существуют на пути развития солнечной электроэнергетики? Поэтому, важным этапом является определение бизнес-моделей, которые могут наиболее успешно работать в России. Стандартизация PV бизнес-моделей, которые создают беспроигрышные ситуации для всех участников проектов солнечной энергетики, всегда является проблемой. Особенно проблематична такая стандартизация на развивающихся рынках солнечной энергетики, таких как Россия, где еще только предстоит разработать стандартные модели, которые можно было бы легко мультиплицировать. В данном отчете ENABLING PV представлены различные бизнес-модели, каждая из которых дает направление, как солнечная энергетика может быть использована в различных сегментах рынка и какой мощности могут быть установленные системы.

Именно в этом контексте международная консалтинговая компания eclareon GmbH, специализирующаяся в области возобновляемой энергетики и энергоэффективности, при поддержке НП «ЕВРОСОЛАР Россия» впервые провела анализ процессов и актуальных барьеров, происходящих и существующих в российском фотоэлектрическом секторе как на национальном уровне, так и в двух конкретных российских регионах - Калининградской Области и Краснодарском Крае, в 2018 году. Настоящее исследование включает в себя обновленные данные по этим двум регионам и по ситуации в России в целом, а также анализ двух других регионов: Республики Башкортостан и Ульяновской Области

Основной целью проекта является предоставление практической информации о текущем состоянии российского фотоэлектрического рынка в целом, рынка малого ветра и тепловых насосов, и в особенности, в этих четырех регионах. Информация, содержащаяся в настоящем докладе, поможет немецкой и российской солнечной и вообще ВИЭ промышленности, а также заинтересованным компаниям энергетической отрасли, региональным институтам экономического развития и научным учреждениям обеих стран в дальнейшем развитии российского рынка солнечной энергетики. Для достижения этой цели в рамках проекта ENABLING PV, который выходит за рамки данного отчета, были проведены следующие мероприятия:

- Презентация правовых, регуляторных и рыночных условий для развития солнечных фотоэлектрических систем в России, как подключенных, так и не подключенных к электрическим сетям.
- Описание и анализ рентабельности с точки зрения инвестора для трех различных бизнес-моделей для фотоэлектрических систем в России
- Круглые столы и встречи в Германии, Москве и двух новых регионах – Ульяновской Области и Республике Башкортостан с целью презентации проекта и обсуждения промежуточных результатов, а также поиска и обсуждения некоторых пилотных проектов в регионах

По итогам этих мероприятий можно сказать, что в Краснодарском Крае условия для развития солнечной энергетики особенно благоприятны Это связано с тем, что регион имеет дефицит собственных генерирующих мощностей, имеет высокий уровень солнечного излучения, уже существуют фотоэлектрические системы, и общая обстановка в регионе благоприятствует развитию солнечной энергетики. Ситуация в Калининграде иная: в Калининграде не только меньше естественного солнечного излучения, чем в Краснодаре, но и уникальность региона обусловлена географической удаленностью от материковой части России, что делает энергетическую безопасность одним из основных направлений региональной энергетической политики. Это привело к развитию в регионе серьезных генерирующих мощностей. Были определены варианты применения солнечной энергетики для некоторых автономных районов и районов со слабой или изношенной сетевой инфраструктурой, для которых до сих пор использовались дизель-генераторы. ВИЭ, безусловно, представляют интерес, но условия для развития фотоэлектрических систем в целом менее благоприятны, чем в Краснодаре, где все три рассмотренные бизнес-модели скорее всего появятся и/или будут расти. В Калининграде, однако, существует жизненно важный интерес к инициированию образцовых флагманских проектов, чтобы продемонстрировать технические решения для всей России и предложить обучение, такое как обучение проектировщиков и монтажников. Кроме того, хотелось бы рассмотреть возможность использования солнечной энергии в горячем водоснабжении и отоплении зданий.

Что касается природных условий и предпосылок для солнечной энергетики, то по данной характеристике, Башкортостан и Ульяновская Область расположены где-то между Краснодаром и Калининградом.

В Краснодарском крае все сегменты рынка бизнес-моделей имеют потенциал для получения положительных результатов за счет окупаемости в течение всего срока реализации фотоэлектрических проектов и внутренней нормы доходности. И все же привлекательность этих трех типов установок варьируется и зависит от многих факторов, которые могут выходить за рамки чисто экономических соображений.

Гибридные установки дизель-солнце дали наиболее многообещающие расчетные результаты. Случаи использования таких систем были выявлены во всех анализируемых регионах. Крупные солнечные электростанции в Краснодаре, скорее всего, появятся в ближайшее время, учитывая более высокий уровень инсоляции, но также они уже успешно работают в Башкортостане и планируются в Ульяновской Области. Такие парки строятся либо на базе федерального оптового рынка с использованием Постановления № 449, что явилось определяющим фактором роста ВИЭ в России в последнее время, либо на розничном рынке с использованием Постановления № 47, целью которого является компенсация потерь в сетях за счет ВИЭ. Положения обоих указов создают определенные сложности для инвесторов и исполнителей проектов из-за правил локализации и некоторой неясности механизма их работы. На данный момент оба указа являются единственными нормативными документами, которые могут обязать сетевых операторов в России подключать электростанции, работающие на ВИЭ, к электрическим сетям. Что касается расчетов по платежам, то правила сложны и оставляют возможность для интерпретации.

Наконец, закон о микрогенерации («Закон 471 ФЗ») принятый в Думе и подписанный президентом Путиным в декабре 2019 года, предоставит частным домохозяйствам возможность подключить свои фотоэлектрические системы, тепловые насосы или небольшие ветрогенераторы к локальной электросети. Как только Минэнерго России разработает технический регламент по подключению к сетям и сетевому учету, который планируется ввести в действие в июле 2020 года, эти децентрализованные виды применения возобновляемых источников энергии могут впервые получить развитие в России. Но наш анализ соответствующих бизнес-кейсов показывает, что экономические выгоды от этого варианта весьма ограничены. Для того, чтобы такие частные ВИЭ системы были успешными в России, стоимость инвестиций должна быть более низкой, иначе частные объекты микрогенерации будут устанавливаться в основном только состоятельными энтузиастами, для которых установка фотоэлектрических систем выходит за рамки экономических соображений.

# 1. Introduction to the Russian Power Sector

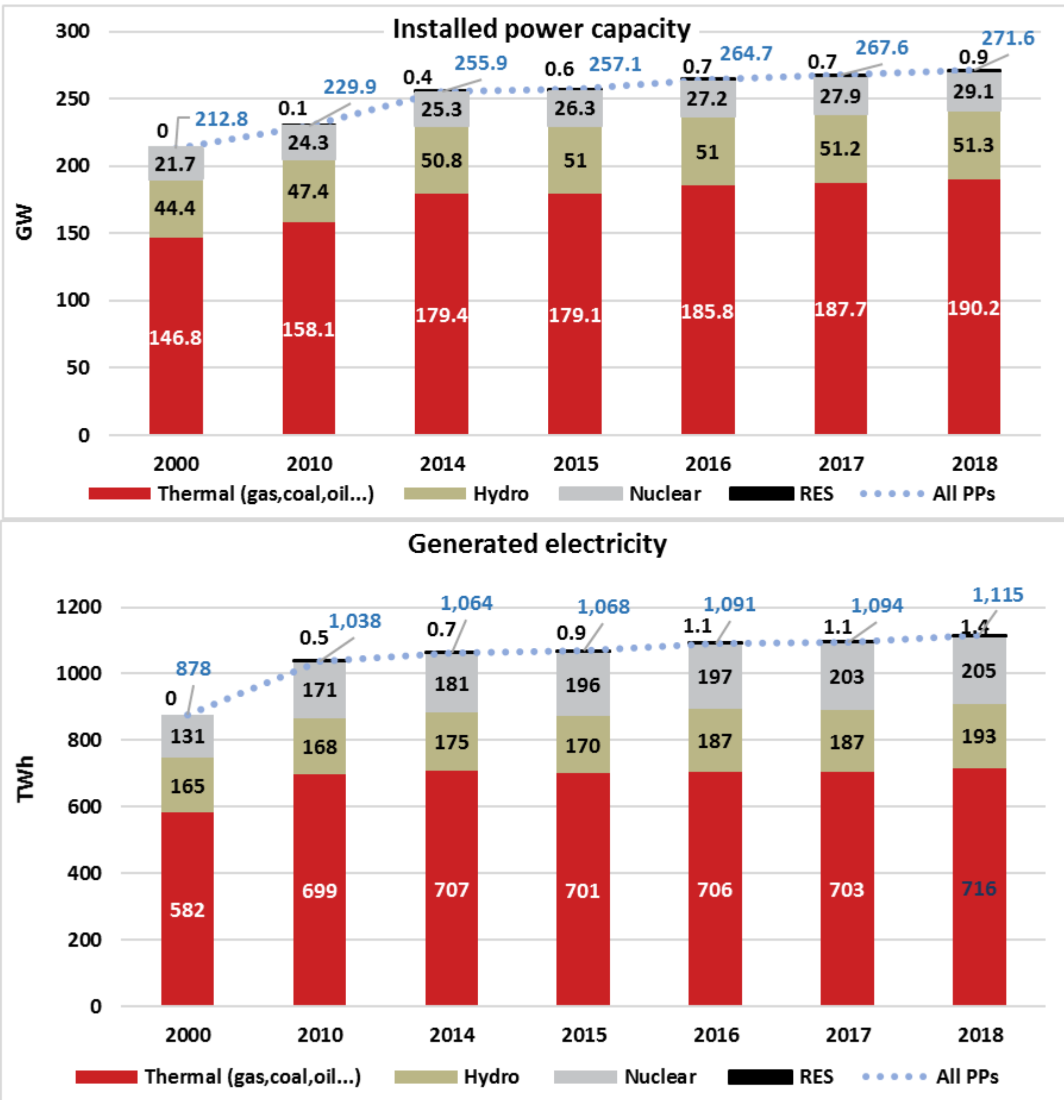
In order to be able to understand the role of renewable energy, in particular of solar PV, in the Russian Federation it is important to have a basic understanding of the framework in which renewables have to find their place.

## 1.1 Sector Infrastructure

### 1.1.1 Power Sector

The Russian power sector has several interconnected levels and the electricity system is complicated to understand. Russia is the world's leading primary energy exporter [1] and among the largest world energy producers. **The installed capacity for power generation in Russia is growing steadily**. Between 2000 and 2018, the total installed power capacity grew by 27.6% from 212.8 GW to 267.6 GW (see Figure 1). The power generation has also grown since 2000, gained more than one forth in capacity in 18 years.

**Figure 1 Total installed power capacity and total annual electricity generation for some years in Russia by type of power plant (including but not limited to UPS)**




**Source: Annual reports of the State Statistics Service of Russia, 2019 and earlier [279], [280]**

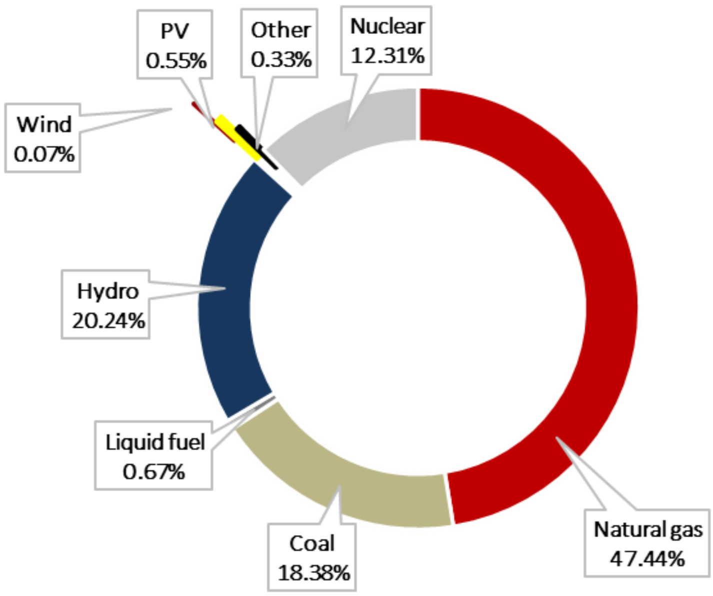
The per capita electricity consumption in Russia in the year 2017 was 6.8 MWh/capita. That was the result of a slow but stable growth of electricity consumption in the country since the fall of the USSR. In comparison, in Germany this index was 7 MWh/capita for the same year, in the USA it was 12.6 MWh/capita and 4.6 MWh/capita in China [2].

The central grid is the Unified Power System of Russia (UPS, also called United National Power Grid). The UPS unites all the power plants, power grids and transformer substations. The UPS network covers practically all of the country except some remote and isolated areas mainly in the Far East and Siberia. Therefore, official data on power generation and installed capacity usually includes the regions covered by the UPS. In 2018, the total installed generation capacity of power plants in the UPS of Russia was 243.24 GW, of which PV accounted for 0.34% [131]. **The total installed capacity of the power plants of the UPS as for January 2020 amounted to 246.34 GW of which PV's installed capacity was 0.55%[316]. In 2019, the share of PV in the electricity generation mix of Russia for the end of 2019 results into 0.12% (in 2018 this share was 0.07%) [316]**.

**Russia has enough installed capacity and generated electricity to cover its electricity needs.** In 2019, Russian power plants united by the UPS**,** generated 1,080.55 TWh of which 1,284.9 GWh were generated by solar power plants (SPPs) and 169.4 – by wind power plants (WPPs) [316]. The remaining energy was generated by the means of other energy sources s.a. gas, nuclear, hydro etc. In 2019, inside the UPS of Russia consumption resulted into 1,059.36 TWh [8][7]. According to the Ministry of Energy of the Russian Federation, the overall electricity generation (including but not limited to the UPS) was 1,091[1] TWh [5].

In the last few years renewable energy generation (except hydro) has expanded, however RES still only make up under 1% of electricity generated [8] (see Figure 2) and more than 60% of electricity is generated by the combustion of natural gas at fossil-fueled power plants.

**Figure 2 Installed electricity generating capacity in Russia in 2019 by technology**



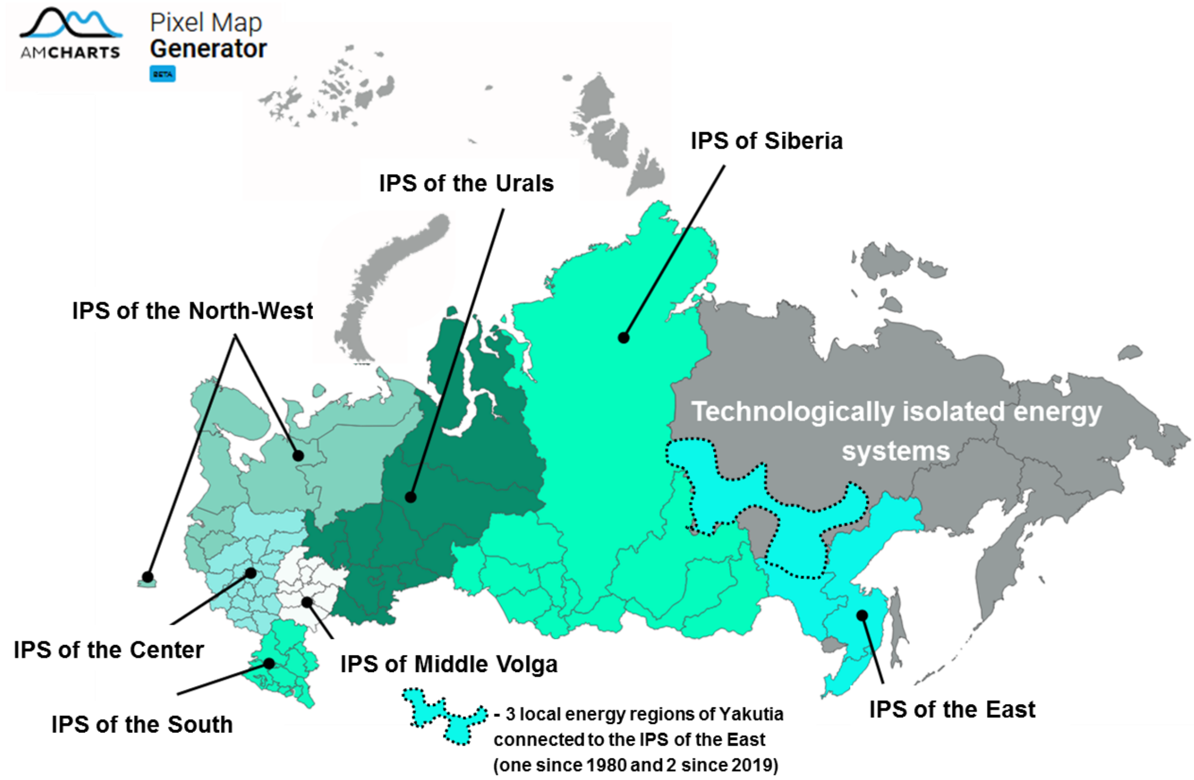

**Source: based on: SO UPS, "The Annual Report on functioning of the United Power System of Russia in 2019", 2020 [8][131] and Ministry of Energy of Russian Federation, 2019 [9]**

**The UPS is divided into seven sub-regional systems**, the so-called Integrated Power Systems (IPS) of the UPS (see Figure 3), representing a total of **71 regional power systems** and different owner structures [10]. An IPS is a set of several regional power systems united

[1] Important to mention, that the data provided by the SO UPS, managing the UPS or Russia, and the data collected by the Ministry of Energy of Russia differ due to a range of factors, including different calculation approaches, statistics collection methods and the fact that the Ministry of Energy also includes into the statistics energy generation happened outside the UPS.

by a common mode of operation, having a common dispatch control as the highest level of control in relation to the dispatching controls of its power systems. Along with them, there are isolated energy systems, not connected to the UPS and therefore not related to any of IPS. A regional power (energy) system is a combination of related energy resources, methods of electricity production, conversion, distribution and use, and supply of energy to consumers through grids [133]. Each energy system includes different participants, like grid companies, energy suppliers, energy generating companies and their interaction.

**Figure 3 The seven IPSs of the Russian UPS**

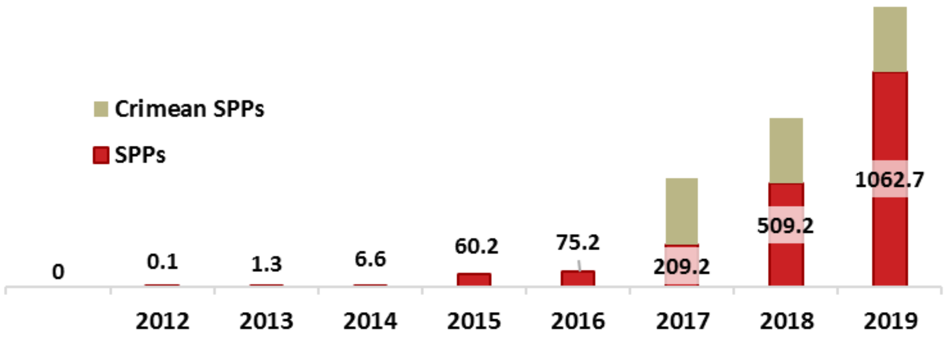



**Source: eclareon, 2019, based on SO UPS[10], generated with amCharts Pixel Map**

### 1.1.2 Solar PV Sector

**Solar PV has until now not played an important role in the electricity mix of the Russian Federation.** The first PV power plants appeared on the Russian market in 2012 and have become more frequent based on changes in RES legislation. In 2017, roughly 130 MW of PV capacity were installed in Russia, and additional 325 MW of Crimean SPPs. In 2018, an additional PV capacity of 300 MW was installed which resulted into a total volume of 834.2 MW PV installed capacity (incl. Crimean PV power plants) in Russia by the end of 2018. In 2019, another 553.5 MW newly installed PV capacity was installed. (see Figure 4). **At the end of 2019, the total installed PV capacity of the power plants, registered and qualified by the "Market Council" (see 1.2.1) was 1,387.7 GW (with Crimean SPPs)** [178].

**Figure 4 Installed PV capacity in Russia 2012-2019, MW**




**Source: based on SO UPS, "Informative Overview of the Energy System of Russia: the Subtotals", 2017, 2018 and 2019 [8] [228]; and a personal contact with specialists of SO UPS; NP "Market Council" 2020 [178]**

Some of the Russian regions are the leaders in terms of the installed (official) SPPs: Orenburg Oblast, known for its high solar irradiation level, has the highest solar PV capacity installed (260 MW) and is followed by Astrakhan Oblast with 255 MW. 120 MW PV is installed in Altai Republic, while the remaining volume is shared between 7 further regions nearly evenly [284].

In 2019, the major share of newly installed PV plants belonged to the "Hevel" company (13 SPPs with a total capacity 363.5 MW); 6 SPPs with a total capacity of 100 MW were constructed by "Solar Systems" and 6 SPPs with a total capacity of 90 were built by "Vershina Development" LLC (see 1.2.1 for more details).

Although this is fairly small with regards to overall installed generation capacity in Russia, time series data show the positive development in the recent past. The most important change being the introduction of the tender-based scheme for the promotion of RE which became effective in 2013 (Decree 449, please refer to chapter 2.1.1).

When looking at the capacity figures it is important to note, that the real volume of installed PV capacity is slightly larger due to the fact, that not all off-grid and private PV power generating facilities are registered and included in overall statistics.

When it comes to estimating the potential of such small-scale installations, assumptions vary. According to estimations of an article in Forbes.ru, the potential future cumulative integration of grid connected small scale PV (small private PV installations of 5-10 kWp) may be between 14 and 17 GW [11], while, according to estimations of the Moscow School of Management Skolkovo, already installed **RES based** microgeneration capacity in Russia for October 2018 was around 11 GW [132].

### 1.1.3 Heat Pumps Sector

Currently, there are not many heat pumps projects completed in Russia, as the technology is rather new for Russia and is not well known. The existing modern projects are usually not registered and are not reflected in statistical databases which makes it difficult to make any estimations regarding the size of this sector and the scope of the HP usage. The examples which can be found in open sources lead to the conclusion that heat pumps are normally installed by persons or companies which are motivated not by HP effectiveness or possible positive economic effects and created savings, but by pure interest in modern technologies and a wish to try "something new". The known examples represent the usage of ground HP, heat/cooling HP systems, as well as HP systems targeting the usage of the wastewater low potential heat from the mines and exclude HP/PV combination. Among for HP installations the following examples can be mentioned [285]:

- In Novosibirsk, one of Russian centres for heat supply, over 200 heat pumps of different capacity were implemented between 2010 and 2016 as part of the regional energy supply program.
- Hotel “Gamma” in Tuapse region, Krasnodar Krai, installed 1 MW of capacity in 2008 which makes the hotel one of the largest known HP/cooling installations in Russia.
- Shopping mall “Quartal” in Sochi, Krasnodar Krai: in 2014, a 1.4 MW groundwater HP system was installed.
- Apartment house in Moscow: a HP system aimed to heat water using the heat of the building's ventilation emissions in combination with the heat of the ground

In general, HP in Russia are, based on the current legal framework and market conditions (low costs of gas and other energy sources), considered to be rather inefficient and economically unattractive.

Still, there are some HP producers in Russia [285]:

- “Energia” Ltd. In Novosibirsk: produces steam compressor heat pumps with screw compressors 500 kW – 3 MW installed capacity per unit
- “Kazan-Compressormash” Ltd. In Kazan: production of steam-compression heat pumps with centrifugal compressors 8.5 – 11.5 MW capacity per unit

There are no large HP producers in Russia, and most of the equipment is imported from the EU, which increases its price for an end consumer drastically. Simultaneously, local installers and technicians are lacking skills, hence, installation and further maintenance of a HP is either done either by non-professionals which often results into failure of the whole project and creates a negative impression among potential customers, or by the user / owner which also decreases the attractiveness of the HP.

In some regions where geothermal power resources exist, geothermal heat pumps are used. For example, in one settlement near Barnaul city in Altai Krai (Siberia) near Novosibirsk city, a whole newly constructed apartment house was equipped with geothermal heat pumps which fully cover the heat demand of the inhabitants. For the house management company, the geothermal heat pump solution led to important savings, as central heating is associated with much higher tariffs per Gcal (in Russia, the tariffs for heat are very high and in winter times increase the usual bills for communal services by 1.5 to 2 times). However, the management company did not provide the households with the information regarding the type of heating the people were actually using and inhabitants of the house paid for heating as if they would have been switched to a central heating system. All the profit coming from the difference between the real heating costs and the price people paid was kept by the management company.

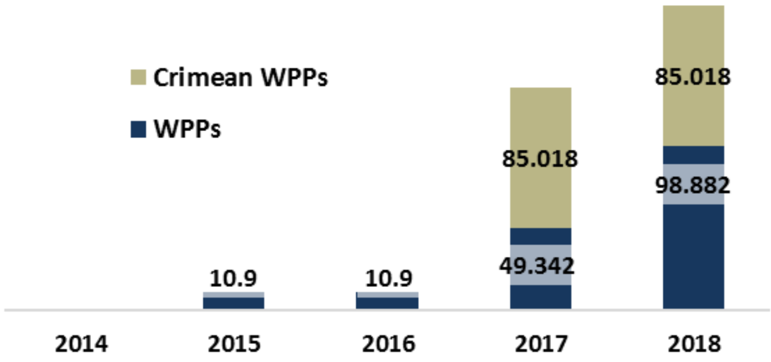
### 1.1.4 Small Wind Sector

In Russia, the wind power sector has been always attracted slightly more interest than the PV sector for several reasons such as, for example:

- Historical stereotypes about easiness of wind energy and its higher potential for Russia
- Historical pattern of RES development in Russia
- Lack of awareness about PV and wind energy in the past

In 2018, wind power objects participating in the electricity market in Russia had a total installed power capacity of 183.9 MW which is a 27% growth of installed capacity since 2017 (commissioning of the largest Russian industrial wind park in Ulyanovsk and a wind park in Kaliningrad Oblast) [228]. In 2017, the statistics of the UPS of Russia showed an additional 80 MW of wind power capacity, however these additional MW were not new installations but based on the inclusion of windmills installed on the annexed peninsula of Crimea. The figure below presents the installed wind power capacity in Russia. The mentioned installed wind capacity in Russia includes relatively large wind turbines. According to the "GIS RES of Russia", wind power installed capacity reaches 190.16 MW, which means that about 6 MW of this registered installed capacity refers to very small wind power plants excluded from the retail or wholesale electricity markets. Considering known examples of small residential wind installations and their absence on the GIS RES maps, an estimated total capacity of the installed small wind in Russia is about 10-12 MWp (estimations of eclareon 2019 based on literature research and interviews).

**Figure 5 Installed wind power capacity in Russia until 2018, MW**




**Source: based on SO UPS, "Informative Overview of the Energy System of Russia: the Subtotals", 2015, 2016, 2017, 2018 and 2019 [8] [228]**

The Russian Association of Wind Power (RAWI) uses the following categories for wind power installations with a capacity <500 kWp:

- "Very small" – between 25 Wp and 10 kWp
- "Small" – between 20 kWp and 150 kWp wind turbines [229].
- Wind power systems between 200 and 500 kWp refer to "Medium" wind power installations

**For the actual report, we use a combination of "very small" and "small" wind power and unite them in the term "small wind" meaning installations up to 150 kWp.**

The RAWI annual report for the year 2018 lists 12 Russian WPPs separately and a group of Crimean WPPs (with a total capacity of 85 MW) as one unit [230]. Among them, there are no wind power installations belonging to the "Small wind" category. Official statistics of UPS of Russia and annual reports of RAWI do not take into account neither small wind power facilities existing in remote areas and belonging to different entities and research institutions (e.g. Federal State Budgetary Institution "Arctic and Antarctic Research Institute"), nor privately owned small wind turbines, as Russian statistical bodies and System Operator of UPS do not consider these both types of installation to be power generating facilities.. It can be stated, that there is still no mass market for small wind in Russia. Nevertheless, small wind installations are operated in different Russian regions and the groups of operators may be described as follows:

- **Residential consumers** – small private wind turbines for self-consumption. One of the examples is the hybrid RES system in Krasnodar installed by Nikolay Driga (see chapter 3.4.3 Model 3: Residential PV Systems). The installed wind turbine has a capacity of 1.5 kWp and covers, in combination with PV panels, the largest part of the household's energy demand [231].
- Off-grid areas and remote settlements – small wind in combination with PV or/and diesel/petrol gensets or/ and storage systems. In such cases, the **operators are usually local municipalities, local energy or grid companies**. A good example for

such a case is the hybrid PV-wind system in Severny village in Bashkortostan (more detailed description in chapter 5.4.2).

- **Research institutions and scientific organizations, NGOs, research groups of national parks and reserves**, etc. as small wind operators. Many examples exist in different regions of Russia, such as a hybrid PV-wind system in "Wrangel Island Reserve" or a 1.2 kWp wind turbine at Cape Zhelaniya [232]. During the ARWE (All Renewable World Energy) Forum in May 2019 in Ulyanovsk, many speakers and representatives of research institutions addressed the critical role RES have to play for power supplies at remote measurement, research and radio communication support points. Especially such equipment is required in Arctic regions and hybrid solutions with small wind and PV are always seen as one of the optimal solutions.

- **Small entities, commercial users –** there is a little knowledge about the scope of small wind usage among commercial entities, such as small touristic areas (e.g. small campsites, motels and hotels), cafes, petrol stations, shops etc. One of the existing models of commercial entities using small wind / hybrid systems is the energy supply for radio masts. One of the largest mobile companies in Russia, MegaFon, uses 10 kWp wind turbines to supply its radio masts in the Krasnoyarsk region [233]; Beeline and MTS (other large telecommunication companies) use hybrid systems in the mountainous areas of Krasnodar Krai (see also chapter 3.4.2).

## 1.2 Electricity Market Stakeholders

The Russian electricity market is the result of a vast and long-lasting reformation process, including the liberalization of the power market and the creation of wholesale and retail electricity markets [12] both of which differ between regions. There is a variety of state- and private-owned companies active in the Russian energy market permitting the government to control the strategically important market from one side and leaving a window open for private capital inflows from the other side.

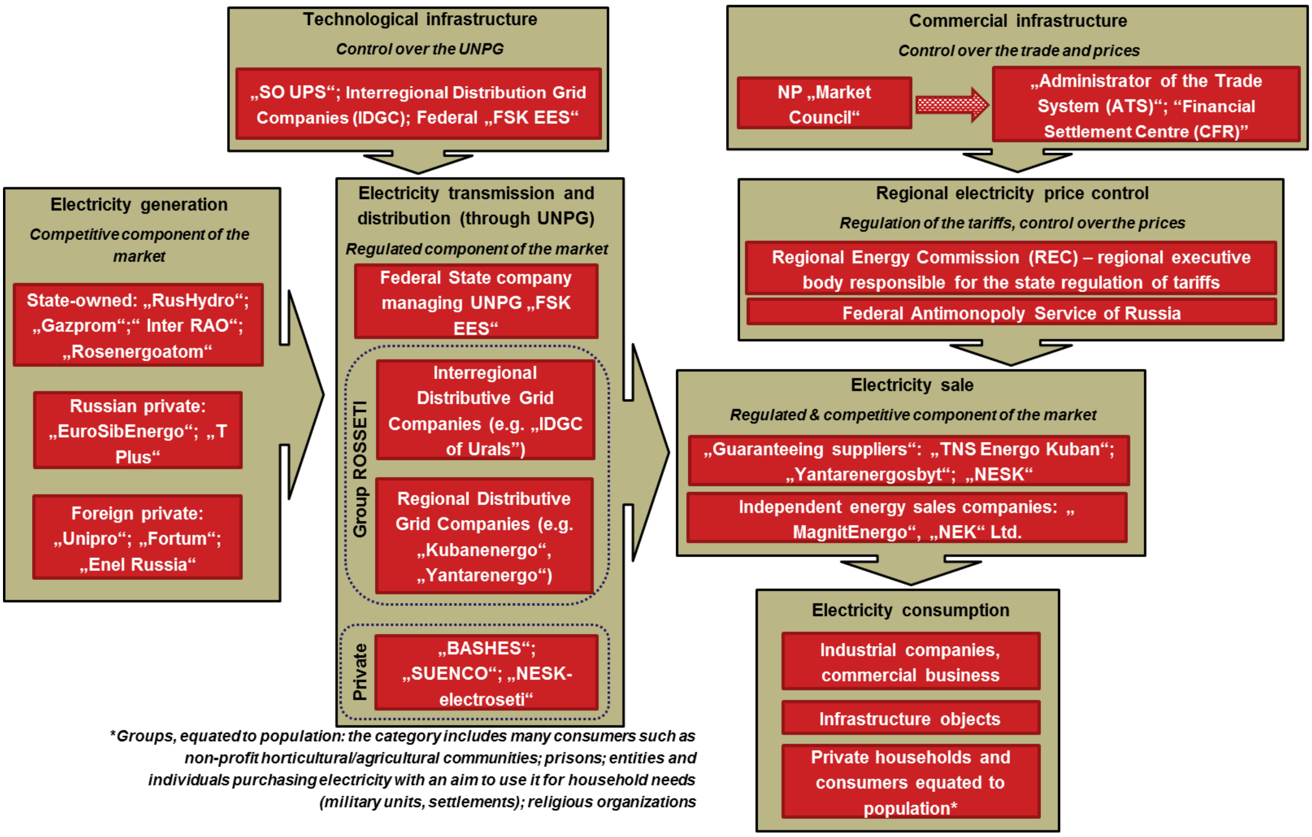
### 1.2.1 National Stakeholders

The stakeholders of the electricity market can be divided as follows:

- organizations of technical infrastructure (federal transmission grid operator "FSK of UPS", a company supervising the UPS SO UPS and Interregional Distribution Grid Companies (IDGC) controlling regional parts of the UPS (IPSs)) and collecting the major statistics inside the UPS of Russia;
- organizations of commercial infrastructure (such as "Administrator of the Trade System (ATS)", organizing capacity and energy trade on the wholesale market; "Financial Settlement Centre (CFR)", controlling financial relationship on the wholesale electricity market and NP "Market Council" created to ensure the balance between the participants of the energy and capacity markets and create a unite trade zone for them);
- power generating companies;
- regional power grid companies (there may be more than one such company in a region, some of them may be state-owned, while others may be private),
- distribution companies and
- consumers [13]

The schematic illustration of the relationships between the different stakeholders and the names of some of the most important actors is presented in Figure 6:

**Figure 6 Relations between the main stakeholders of the Russian electricity market**




**Source: Based on Ernst & Young Global Limited, “Overview of the electricity and power industry in Russia”, 2018 [14]**

Some of the most important companies and their roles within these stakeholder groups are the following:

- Commercial infrastructure: Association Non-profit partnership "**Market Council**” unites producers and buyers of the wholesale and retail electricity markets, ensuring the unity of commercial infrastructure, and owns two further organizations managing the wholesale electricity and capacity markets. Both technological and commercial infrastructures of the Russian electricity market fall under the government control. “Administrator of the Trade System (ATS)” (100% owned by “Market Council”) – organizes the trade of electricity and capacity on the wholesale market.

- Power generating companies: power producers generate and sell electricity to the distributing companies on the wholesale and retail markets. **There are both state- and private-owned power generating companies in Russia.** The largest state-owned companies are “Inter RAO” (the only company in Russia which exports and imports electricity[15]); “RusHydro”, “Rosenergoatom”, and “Gasprom Energoholding”. The largest private companies that are active nationally are “EuroSibEnergo” PLC, “T Plus”; the largest foreign private companies are Unipro PJSC (E.ON Russia JSC until June 2016), PJSC “Enel Russia” and Fortum[16]. The top 10 largest generating companies own about 80% of all the generating capacity of the UPS of Russia and produce more than 85% of electricity, see Table 1 [17].

**Table 1 Top 10 largest power generating companies of Russia in 2019**

| Company | Total installed power generating capacity, GW | Average annual power generation, thousand GWh |
|---|---|---|
| **RusHydro** | 39.4 | 144.2 |
| **Gasprom Energoholding** | 39 | 150.8 |
| **Inter RAO** | 33.7 | 132.5 |
| **Rosenergoatom** | 29 | 204.3 |
| **T-Plus** | 15.7 | 55 |
| **EuroSibEnergo** | 19.5 | 67.6 |
| **Unipro** | 11.2 | 46.6 |
| **Siberian Generating Company** | 10.9 | 46 |
| **Enel Russia** | 9.4 | 41.3 |
| **Fortum** | 4.9 | 28.1 |
| **Quadra** | 2.9 | 9.7 |

**Source: Ministry of Energy of Russian Federation, 2019 [17]**

- Transmission companies: **Most of the Russian grids (including regional grids) are owned and controlled by the state-owned JSC "ROSSETI"**, which is one of the largest grid companies of the world. The centralized dispatching control of the UPS and its infrastructure and control of all IES is committed by the 100% state-owned "System Operator of the United Power System" (SO UPS, JSC); general management of the UPS is under the leadership of the Federal Grid Company of the United Power Grid (FSK UPS, a subsidiary of „ROSSETI");

- Transregional distribution grid companies: These companies manage regional parts of UPS. **Most of them are owned by ROSSETI** (like "Yantarenergo" in Kaliningrad or "Kubanenergo" in Krasnodar and a larger companies like PJSC "IDGC of the South"); simultaneously, there are other similar grid companies, not owned by "ROSSETI", such as the private companies JSC "BASHES"[18], "NESK-electroseti" and "SUENCO" [19] owning the remaining small part of Russian grids.

- Distribution companies/energy sales companies: **these include numerous so-called "guaranteeing suppliers" and "independent distribution companies", which are, basically, utility companies.** "Guaranteeing suppliers" are energy sales companies and are the result of the reorganization of large regional power companies and wholesale resellers; these companies are obliged to sign a contract with consumers in its area of activity and sell the electricity under the state-regulated prices. "Independent distribution companies" have the right to refuse to enter into a contract with a consumer and electricity prices because they are not under the jurisdiction of the government.

- Electricity consumers: These are described in chapter 1.2.4.

There are also pioneers in the **Russian solar PV sector** who have put their efforts to propel solar energy forward together by found the non-profit, "Association of the Solar Energy Enterprises of Russia". Today, the association includes the following eight companies [20]:

1. AltEnergo: founded in 2009, the Belgorod based company is active in system integration and project development for innovative biogas, wind and solar PV energy solutions.
2. Wlibor Systems: founded in 1999 and specializing in anti-terrorist activities and infrastructure security; they have licenses from the Federal Security Service (FSB) of Russia.

3. aleo solar: German PV module manufacturer, established in 2001, and producing monocrystalline solar panels.
4. Helios Resource: founded in 2010, Helios Resource is a producer of multi-crystalline silicon wafers; in 2017 they had a wafer production of 99 MW; their wafers are used for cell and module manufacturing in China and finally supplied to Russian “Avelar Solar Technology” for the fulfillment of local content requirement rules
5. R&D Center TFTE: The Research and Development Center for “thin-film technologies in energetics (TFTE) is an R&D unit of Hevel Solar. It was founded in 2010 with the objective to develop a PV industry in Russia. R&D Center TFTE designs and produces PV modules and is also active in the field of PV system integration and operation.
6. Svjaz Engineering: Founded in 1997, they are a power electronics solution provider active in different industries (e.g. railway). They also do research in the field of converter technology for difficult climatic conditions
7. Hevel Solar (Hevel Group; owned by “Rosnano” and “Renova”): Hevel is the largest and probably most renowned PV company in Russia. They were founded in 2009 and are a vertically integrated solar company that integrates module manufacturing based on hetero-junction technology, project financing and development as well as plant operation. They have completed a total of 16 projects in Russia with an overall capacity of approx. 189 MW, nearly all of them are ground-mounted. In October 2018, 9 more PV parks with a combined capacity of 25 MW were under construction. SPPs have been constructed in Astrakhan Oblast, Saratov Oblast and the Republic of Altay. After having sold 3 SPPs to the Finish company “Fortum” and 1 SPP to “Lukoil” Hevel manages 12 grid-connected SPPs with an overall capacity of 129 MW.
8. Solar Systems Ltd., founded in 2014 by Chinese company “Amur Sirius Power Equipment” LTD is a PV installer; in 2017 their installed capacity reached 30 MW, a plan is to launch 365 MW of PV power until 2020.

Other companies active on a PV market in Russia: one of them is “Vershina Development” LLC – the company which earlier has been active in the sphere of boiler houses refurbishment, pellet plant construction and even in the oil and gas industry and since 2018 has switched to PV plants construction. In 2019, the total installed PV capacity constructed by the company and approved by the NP “Market Council” resulted into 90 MW, while 45 MW are still under construction [283].

### 1.2.2 On-grid Power Generation

As mentioned above, most of the Russian electricity grid is the property of the state-controlled company “ROSSETI”. In 2018, **the company managed 2.35 million kilometers of power lines and 507 thousand transformer substations with an overall capacity of 773,000 MVA** [21]. The company delivers energy to over 70% of the Russian population and to a range of industrial sites which together form more than 60% of the Russian GDP [22].

The UPS works with the “**BRELL ring**” (including energy systems of Belorussia, Russia, Estonia, Latvia and Lithuania) which was left after the fall of the USSR and with energy systems of Azerbaijan, Georgia, Kazakhstan, Mongolia and Ukraine [23]. The UPS in Russia includes more than 10,700 power lines most of which are overhead with the voltages between 110 and 1,150kV [23][24]. Practically all electricity generated in the country is grid-connected as the official statistical data normally does not consider off-grid generation. The image below (Figure 7) presents the power grids throughout the Russian territory. The European territory and Southern Russian borders have a well-developed grid, whereas major part of Siberia and the East of Russia are lacking it. There are some local large grids (in green) to be seen in different parts of the map, e.g. close to Norilsk city (upper part of Siberian federal district) in Yakutia (upper part of the Far Eastern federal district), Magadan Oblast (Eastern part, on the shore of the Okhotsk Sea), grids of Kamchatka. These grids are disconnected from the UPS and depend on the local power generating facilities and locally extracted and/or imported fuel.

**Figure 7 Map of the modern electrification and power grids of Russia**


**Source: SO UPS, 2017 [128]**

The table below contains information about electricity generation and consumption in Russia between 2010 and 2018. Adding-up energy consumption and energy losses may not equal 100% because of electricity imports and exports. As shown in Table 2, electricity generation in Russia has been growing while the total energy consumption has remained stable at around 99% of the produced energy. The peak consumption usually occurs on days with the lowest average temperature due to increased electricity usage. **Electricity losses account for > 2% of total production** and are due to old generation, transmission and distribution equipment, the imperfection of energy metering and simple theft of electricity.

Measures to prevent the losses are always planned for the year ahead and include energy efficiency measures, the installation of the energy saving equipment, and the renovation of the existing transformer stations etc. According to the calculations of "FSK UPS", in 2017 these measures helped to avoid the loss of 56,000 MW.

**Table 2 Electricity Generation Profile in the UPS, years 2010-2017)**

| Year | Total electricity generated (thousand GWh) | Total energy consumption (% from total electricity generation) | Total energy losses (% from total electricity generation) | Total PV electricity generation (% from total electricity generation) | Maximum peak consumption (GW) | Per capita electricity generation (MWh per capita) |
|---|---|---|---|---|---|---|
| **2018** | 1,070.9 | 98.6 | 2.3 | 0.071 | 151.9 | 7.6 |
| **2017** | 1,053.9 | 98.7 | 2.3 | 0.056 | 151.2 | 7.5 |
| **2016** | 1,048.5 | 97.9 | 2.4 | 0.007 | 151.1 | 7.4 |
| **2015** | 1,026.8 | 98.2 | 2.3 | 0.001 | 147.4 | 7.3 |
| **2014** | 1,024.9 | 98.9 | 2.1 | _ | 154.7 | 7.3 |
| **2013** | 1,023.5 | 98.7 | 2.2 | _ | 147 | 7.4 |
| **2012** | 1,032.3 | 98.5 | 2.1 | _ | 157.4 | 7.5 |
| **2011** | 1,019.4 | 98.1 | 2.2 | _ | 147.8 | 7.4 |
| **2010** | 1,004.7 | 98.4 | n.d. | _ | 149.1 | 7.3 |

**Source: SO UPS, "Report on the functioning of the UPS of Russia" (years 2010-2017); Annual report "FSK UPS" for 2015 "Illuminate the present – create the future", 2016 [125]; Annual report "FSK UPS" for 2017 "On the way towards the digital energy sector", 2018[126]; Federal State Statistics Service of the Russian**

Federation, “Electricity generation per capita”, 2018 [127], Annual report “FSK UPS” 2018 – “Development space”, 2019 [234]

**Grid-connected energy generation from renewables in Russia is also growing quickly.** Until 2014, there was no sign of grid generation for PV, and in the years since then its share of the overall electricity generation has risen to half a percent. In 2015, more solar power plants began to be constructed and connected to the UPS. In 2015, newly installed SPPs reached a capacity of 53.6MW; in 2017, the newly installed capacity reached 150MW (according to the data, published on the official web site of government of Russia [25] and an article published by the Ministry of Energy of Russia) [26] [27], in 2018, 300 MW of newly installed PV capacity were commissioned in Russia.

**Table 3 Installed RES-based electricity generating capacity, MW**

<table>
<tr><th>Year, as for January 1st of the following year</th><th>Hydropower</th><th>Wind</th><th>PV</th><th>Biomass</th><th>Landfill gas</th><th>Geothermal</th></tr>
<tr><td>2019</td><td>-</td><td>-</td><td>1,387.7</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018</td><td>48,506.3</td><td>183.9</td><td>834.2</td><td>≈ 845</td><td>-</td><td>≈ 150</td></tr>
<tr><td>2017</td><td>48,449.6</td><td>134.4</td><td>534.2</td><td>X+ 0.526 new</td><td>-</td><td>-</td></tr>
<tr><td>2016</td><td>48,085.9</td><td>10.9</td><td>75.2</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2015</td><td>47,855.2</td><td>10.9</td><td>60.2</td><td>X+ 3.6 new</td><td>X+ 2.4 new</td><td>X+ 62 new</td></tr>
<tr><td>2014</td><td>47,712.4</td><td>-</td><td>6.6</td><td rowspan="6" colspan="3">n.d.</td></tr>
<tr><td>2013</td><td>46,654.4</td><td>-</td><td>1.3</td></tr>
<tr><td>2012</td><td>45,976.8</td><td>-</td><td>0.1</td></tr>
<tr><td>2011</td><td>44,569.2</td><td>-</td><td>-</td></tr>
<tr><td>2010</td><td>44,262.9</td><td>-</td><td>-</td></tr>
<tr><td>2009</td><td>46,040.7</td><td>-</td><td>-</td></tr>
</table>

Source: Annual reports of SO UPS, 2010 - 2019 [228]; Annual reports of FSK EES 2015, 2018, 2019 [125], [126], [234]; GIS RES 2020 [286], [287]; NP “Market Council” 2020 [178]

### 1.2.3 Off-Grid Power Generation

According to some expert estimations, 60% to 70% of Russian territory is not covered by the centralized power grid [28]. However, it is important to notice, that around 85% of Russian territory is not livable and 60% of its territory is covered by permafrost. **The largest part of Russia (3/4 of the territory) is Siberia and the Far East which together have around 13% of the Russian population which is around 20 million people** [28]). Hence, the overall electricity consumption in these regions is very low in comparison to the overall consumption in Russia.

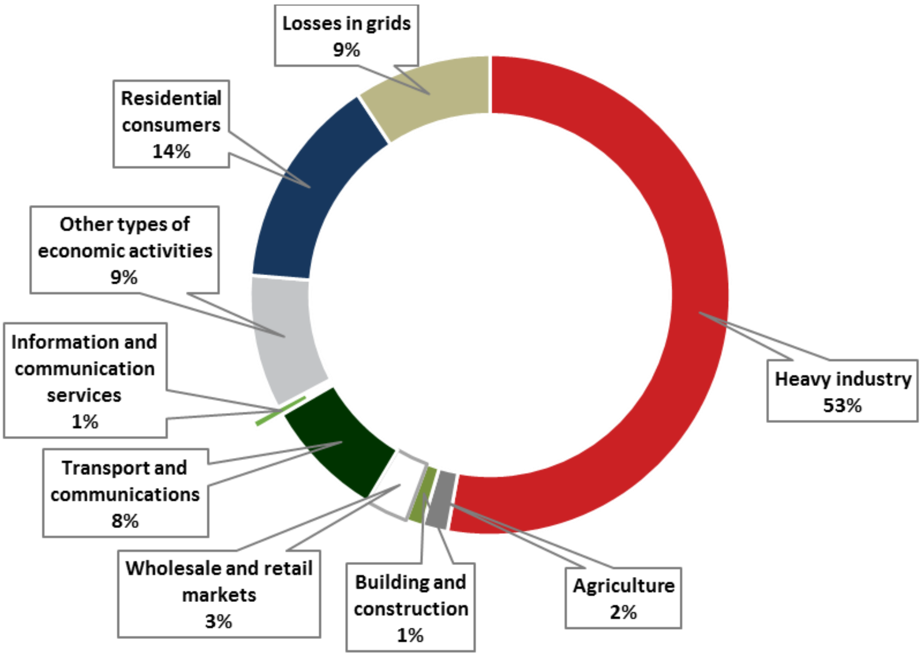
Exact data about off-grid installed power capacity, generation and consumption is not available in open sources. According to our assumptions, based on the estimated number of people living off-grid and an average electricity consumption per capita, **the off-grid electricity generation in Russia could be roughly 100GWh annually**, which is around 9% of the total power generation (generation, including but not limited to UPS, data from Ministry of Energy of Russia).

This off-grid electricity is generated by a number of power stations of different sizes and ages. **Most of these decentralized power stations are diesel generators** but some power stations work on gas, coal and renewables [132] (incl. some hybrid PV-diesel PPs). There is also a small number of independent private power generation facilities (e.g. own generation of industries, which they build to satisfy their own needs) that are not integrated into regional power systems and not included in official statistics.

### 1.2.4 Electricity Consumption and Demand

As already mentioned, the total amount of the energy consumed accounts for 99-99.5% of the energy produced (based on [29]). **The largest share of generated electricity in Russia is consumed by the industrial sector.** Figure 8 below illustrates electricity consumption in Russia (incl. UPS) in 2018 by sector [30]. Heavy industries include mining and manufacturing industry (e.g. steel production), production and distribution of natural gas, electricity and water.

**Figure 8 Electricity consumption by sector in Russia in 2018**




**Source: Federal State Statistics service of the Russian Federation, 2019 [30]**

**Electricity demand in the country has stagnated for several years** and no drastic growth in demand is expected in the near future. In 2016, the demand increased by 1.7% because of the additional day of the leap year, colder than usual winter and warmer than usual summer [31]. In 2017, the demand growth increased by 0.5% due to lower temperatures in February and from April to August in some regions [31]. In 2018, energy demand grew further by 1.6% in comparison to 2017, so did the energy generation [235]. In 2019, a slight increase of both energy production and consumption is expected to be sees in the statistical data (that will be available in Q2 2020. This increase is based on the following 2 reasons: firstly, official statistics mainly consider figures on demand and consumption for the UPS of Russia. Secondly, in 2019 a large part of Yakutia's energy system was connected to the UPS and data for 2019 will consequently also reflect generation by power plants in Yakutia and consumption in this region.

### 1.2.5 Electricity Markets, Prices, Tariffs and Costs

In Russia one needs to distinguish, as in many other countries, between **wholesale and retail markets** for electricity, and regarding pricing mechanism between **price zones, non-price zones and technologically isolated areas.**

#### 1.2.5.1 Wholesale and retail markets

The Russian **wholesale electricity market** is divided into several segments [34]:

- The day-ahead market (DAM): covers distribution of 75% of all electricity generated in the country.
- Regulated contracts market (RC): covers some 14% of electricity sold. Prices (tariffs) are calculated in accordance with formulas established by the federal executive bodies.
- Balancing market (BM): covers around 4% of electricity being sold in the country.
- Free contracts market (FCM): also covers around 4% of electricity sales in the country. Participants negotiate about the price, electricity volume and counteragents individually.

Generating facilities with a capacity below 5 MW are not permitted to be active on the wholesale market [32].

**Table 4 Possibilities of participation on different types of market depending on the installed power capacity**

| Installed capacity, MW | Wholesale electricity market | Retail electricity market |
|---|---|---|
| **≤5 MW** | | ✓ |
| **5-25 MW** | ✓ | ✓ |
| **≥25 MW** | ✓ | |

**Source: eclareon 2019**

The Russian **retail electricity market** has two segments (based on[14]):

- Regulated prices market (RP) for private residential energy consumers (also referred to as population or households) where the price is established by the executive authority of state tariff regulations in each region/oblast. Prices are set for the year ahead and are based on the analytical data and prognoses of the electricity market development. Prices, as well as minimal and maximal tariffs may vary depending on the season and the region of the country and taking into consideration peculiarities of the energy system of each concrete region. The ceiling price is controlled by the Federal Antimonopoly Service of Russia.
- Non-regulated prices market (NRP) for all non-residential energy consumers including commercial SMEs, larger industries, agricultural sector and public services (hospitals, administration, schools etc.) NRP exists only in the price zones of the retail electricity market.

Since 2018, the term “electricity tariffs” for non-residential consumers is no longer used. Instead, there are now “electricity prices”. The term “electricity tariffs” is still used to designate electricity prices [40] of private households. Electricity price for large industrial consumers is established on a case by case basis, based on hourly consumption.

#### 1.2.5.2 Price and non-price zones

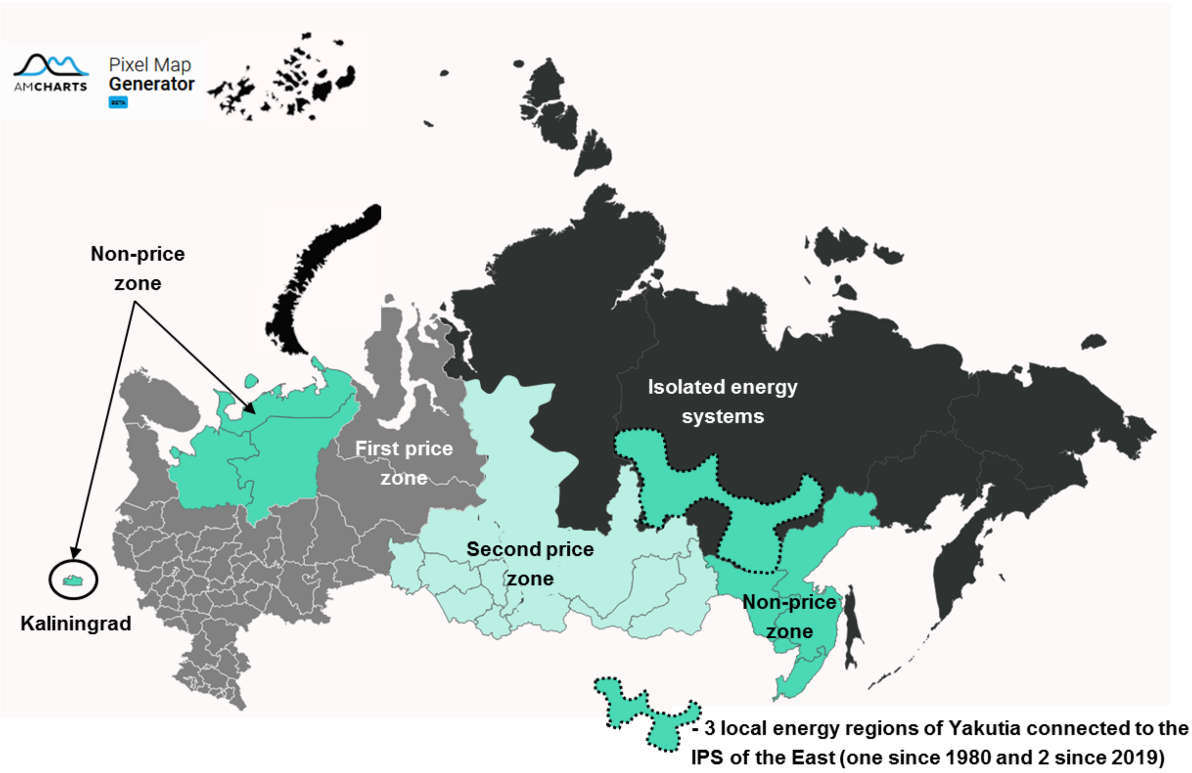
**The territory of Russia is split between 4 zones** (see Figure 9):

- 2 price zones: prices for the consumers on the wholesale market and the retail market (**except for residential consumers**) are non-regulated
- Non-price zone (covering different territories of Russia but having the same rules): prices and tariffs for **all** consumers are regulated

- Isolated energy systems: prices and tariffs for all consumers are regulated

Electricity tariffs for residential consumers and groups equated to population are always regulated, regardless of which zone they belong to. Groups, equated to population includes many consumers such as non-profit horticultural/agricultural communities, prisons, entities and individuals purchasing electricity with an aim to use it for household needs (military units, settlements), and religious organizations.

**Figure 9 Geography of the Russian electricity market**




**Source: eclareon 2019, based on E&Y, "Overview of the electricity and power industry in Russia", 2018 [14], generated with amCharts Pixel Map**

The **two price zones** are located in the Russian federal districts **(partly) Northwestern, Central, Southern, North Caucasian, Ural and Volga region** and are characterized by a large number of suppliers and purchasers of electricity, as well as well-developed network infrastructure availability that enables a competitive electricity market. In these two zones, price formation on the wholesale market is mostly free as long as it remains below a ceiling price defined by the "Administrator of the Trade System (ATS)" and except for the regulated contracts, see further explanation below.

The **non-price zone** is located in the federal districts **Northwestern (its larger part), part of Siberia, small part of Far Eastern region and Kaliningrad Oblast.** In these zones, electricity tariffs both on the wholesale and retail electricity markets are established by the "Administrator of the Trade System" in accordance to the Decree № 1172 of December 26th 2010 and Decree № 1178 of December 29th 2011 and by the Federal Executive Authorities based on the corresponding legal framework, the Tariffs Regulation.

Regarding our two example regions described in the following chapters, Kaliningrad Oblast is included in the non-price zone, while Krasnodar Krai, Ulyanovsk Oblast and Republic of Bashkortostan are in the first price zone. All in all, there are three main price categories on the electricity market:

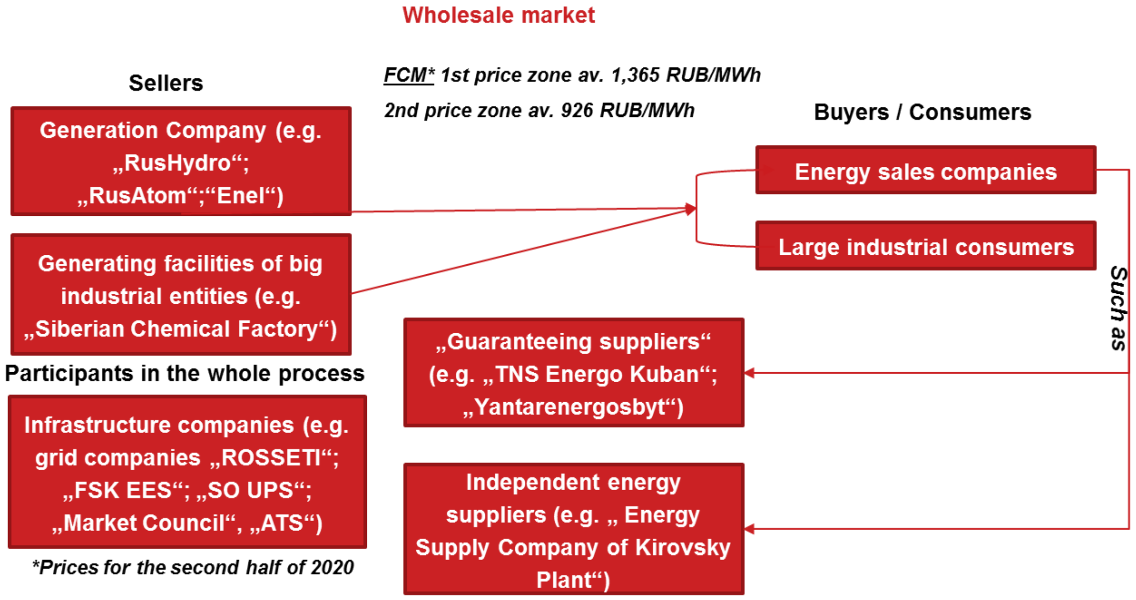
1. Electricity prices for consumers on the wholesale market: price formation is defined in non-price zones and technologically isolated areas or generally free in price zones but a ceiling price is fixed by "ATS"

2. Electricity prices for industrial consumers on the retail market: this price can be freely negotiated in price zones as a general rule but there are price ceilings defined by "ATS".
3. Electricity tariffs for private residential customers (retail market): their electricity price is always established by the local executive body in the field of the state tariffs regulation in accordance to the ceiling tariffs published by the "Federal Tariff Service of Russia".

### 1.2.5.3 Development of electricity prices

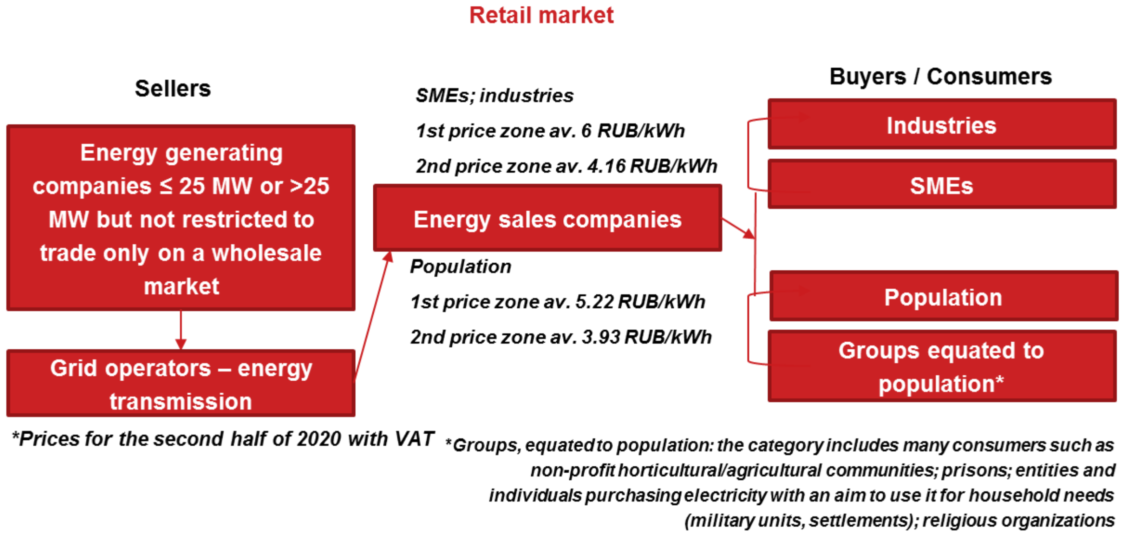
Figure 10 and Figure 11 illustrate the schematic functioning of the both wholesale and retail markets and mention the resulting electricity prices for the 1st and 2nd price zones in second half of 2019.

**Figure 10 Scheme of the functioning of the wholesale electricity market with prices for 2019**



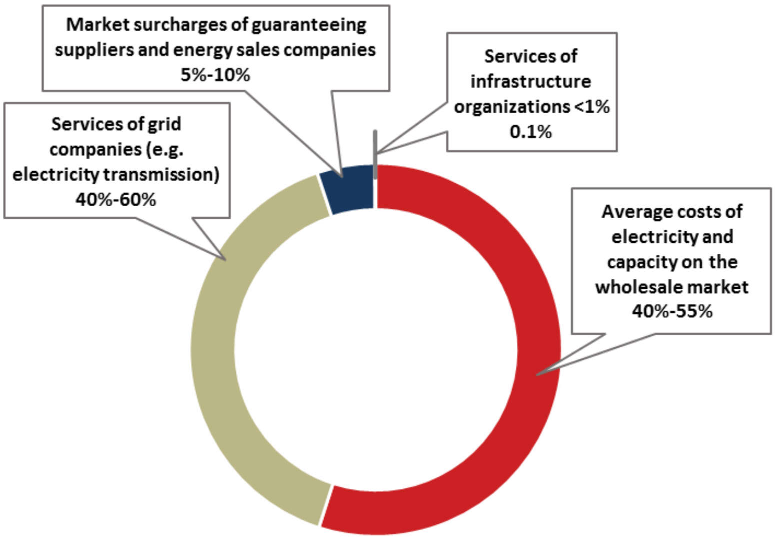

**Source: "ATS", "Prognose of the free (non-regulated) electricity (capacity) prices by region for 2019 and initial data for prognoses" [34], August 2019**

**Figure 11 Scheme of the functioning of the retail electricity market with prices for 2019**




**Source: "ATS", "Prognose of the electricity price for the end consumers 2019", 2019 [33]**

**Figure 12 Scheme of the electricity price formation for the industrial consumers on the retail market (for first and second price zones)**




**Source: En-Mart "Costs of electricity for industries", 2019 [40]**

Sales premiums of guaranteeing suppliers and simple energy sales companies are composed of costs of services needed to ensure the energy sale process and of internal expenses of the company. A tariff and a ceiling level for those premiums is set by a Regional Price and Tariff Committee (a regional executive state body).

**For residential consumers (population) and groups that are equated to population (s.a. prisons, military units, see a footnote on Figure 11), the electricity tariff is set at regulated prices, regardless of the price zone or the location of the settlement, even in the isolated power system** [236]. Residential electricity tariffs are strictly regulated by the state, prices are indexed once a year with the indexation being linked to an inflation rate. Nevertheless, electricity tariffs differ from region to region as they depend on many factors including the level of the regional energy generation development, availability of power sources (e.g. extraction of gas in the same region or a necessity to import it from other regions), development of power grids etc. **The final regional tariff for both residential and non-residential consumers is set by the Regional Energy Commission (REC)** which is an executive body for the state regulation of tariffs based on the tariff applications from energy suppliers, while the Federal Antimonopoly Service (FAS) of Russia controls the tariff regulation process [237].

**For other groups of consumers (non-residential)** who purchase electricity in price zones, the tariff (price) is established within the limits of the ceiling price controlled by FAS (Federal Antimonopoly Service) of Russia. The price for non-residential consumers depends on a range of factors, including [236]:

- The level of voltage – 4 classes: high voltage ≥110 kV; first medium 35 kV; second medium 1-20 kV and low voltage ≤0.4 kV
- Exact price category, which again depends on many factors. There are 6 price categories, each category has its own peculiarities and terms of payment. For instance:
    - Consumers of the first price category pay electricity bills once a month and this bill is based on the electricity meters
    - The second price category means that the energy consumption is split between the time zones of the day, there are two variants: a three-day zone (night, peak consumption and semi peak consumption) or a double day tariff, where energy

at night and during the day is priced differently. In addition, there is also a three-day zone tariff with price differentiation for day, night and peak times.

- Other categories, including payments for power capacity along with electricity tariffs and other peculiarities

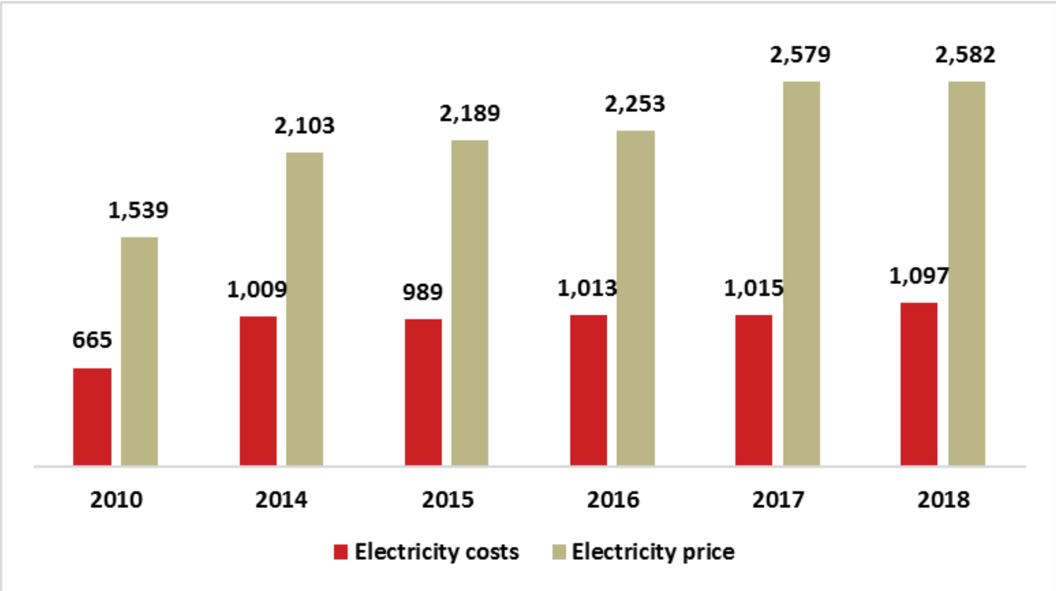
In addition, there are three groups of energy consumers with various load maximums (based on maximum power of energy receiving equipment):

- maximal load up to 670 kW;
- between 670 kW and 10 MW and
- more than 10 MW.

Consumers with the first load variant may choose for themselves one of the six price categories; consumers of the second and the fourth group have a choice between the third and the sixth price category. The average electricity price for the non-residential entities[2] in the retail market in the first price zone in the second half of 2019 was 5.71 RUB[3]/kWh (0.08EUR/kWh) including national VAT of 20%; in the second price zone it was 4.11 RUB/kWh (0.06 EUR/kWh) [41].

Looking at the evolution of prices in recent years, **companies pay more and more for electricity each year**. In 2017, the average price for 1MW of power in Russia cost 67% more than in 2010, while energy generation costs increased by 52% within the same period. Figure 13 illustrates, how average electricity costs and prices have changed in the last 6 years.

**Figure 13 Average in Russia electricity generation costs and electricity consumer prices, RUB/MWh, 1 RUB=0.014 EUR**




**Source: Federal State Statistics Service of Russia, annual reports, 2017, 2018, 2019 [6], [288]**

According to Ministry of Energy of the Russian Federation, the increase of electricity prices for non-residential consumers is also due to the fact that **more and more industry consumers prefer to switch to their own electricity generation or direct connection to the state grids regulated by the "FSK UPS"**, and thereby avoid local transmission companies and power sales companies. Independent generation permits companies to avoid costs of electricity transmission (collected by grid operators) and premiums from energy sales companies. And

---

[2] Entities" is a term used for non-residential consumers and include commercial SMEs (offices, hair salons, shops, cafes), industries (like farms, caning factories, cement factories etc.)) and public services (hospitals, administration, schools etc

[3] 1 EUR = 69.82 RUB as for February 2020. The exchange rate is valid for the whole report

large companies and dominant industries have the capacity to invest time and money in a direct connection to these high-voltage grids. Both options create the possibility to avoid cross-subsidization (see 1.2.5.5) and stop spending money on supporting the population [37] [132].

In the period between 2009 and 2017, about 7GW of generating capacity was installed by industrial consumers trying to avoid participation in cross-subsidization [38]. Usually, independent generation of industries is based on gas (gas turbines) [39] due its low price (4-6 RUB per cubic meter (5 – 8 €ct)). As a result**, SMEs are left alone in a battle against rising electricity prices**.

#### 1.2.5.4 Perspectives for energy prices and tariffs and their interconnection

Currently, the wholesale prices seem to be rather low, but they are predicted to increase in the period 2020-2022 mainly because RoI requirements for the development of new CHPPs, NPPs and HPPs will be re-introduced. More than 80% of the tariffs that electricity consumers in Russia pay for the capacity of power plants can be attributed to non-market surcharges. Thus, in 2021, non-market premiums will account for 81% (667 billion RUB) of the total capacity payments of 823 billion RUB, while in 2011 this was only 14%. Any new power generating facility in Russia which enters the market puts pressure on all other consumers, as returns on investments for those facilities are based on the market price. For example, in 2017, energy prices for retail consumers all over Russia increased by 12-20%, while prices for capacity on the wholesale marked increased by nearly 50%. This happened due to the add-on of 2 GW of nuclear power that year (Beloyarskaja NPP and 2 new energy blocks of Novovoronezh-2 NPP). 1 MWp of newly built capacity for both power plants cost 3.5 million RUB (50.1 thousand EUR), which was 10 times higher than the normal capacity price on the wholesale market [267]. Hence, any new large power plant, especially NPPs, leads to an increase of consumer prices.

Tariff growth and introduction of special surcharges motivate regions to consider their withdrawal from the national wholesale market back to regulated tariffs, but such a withdrawal would lead to price increases in other regions. Since September 1st 2019 FAS (Federal Antimonopoly Service of Russia) has already reduced energy tariffs for Buryatia's[4] industry by 25% by re-distributing the corresponding income losses to price zones of the wholesale market. The list of such "beneficiaries" already includes regions of the North Caucasus and Tuva. Applications for similar benefits have already been submitted to the Market Council and the Ministry of Energy by Kalmykia, Karelia, Khakassia, the Republic of Altai, Transbaikal and Stavropol Territories.

The growth of the single-rate wholesale market price has a significant impact on the growth of electricity prices for enterprises in many Russian regions, including the ones considered in the study. At the same time, the electricity price directly depends on price fluctuations on the wholesale market, as well as on the basic characteristics of the price components, which the company is entitled to choose on its own: price category, conditions of hourly consumption planning and type of tariff for electricity transmission service.

According to the expert estimations and the forecasted social and economic development of Russia, the annual costs of energy transmission, included in the electricity tariff for residential consumers, will grow by 5% p.a. between 2020 and 2024 which is more than the respective growth rate for non-residential consumers which is forecasted to be at 3% p.a.. Influenced by this factor and some others, the energy prices for non-residential consumers are planned to grow by 5.6% in 2020 and between 2.9 and 3.5% in 2021-2024 [290].

#### 1.2.5.5 Electricity tariffs for residential energy consumers

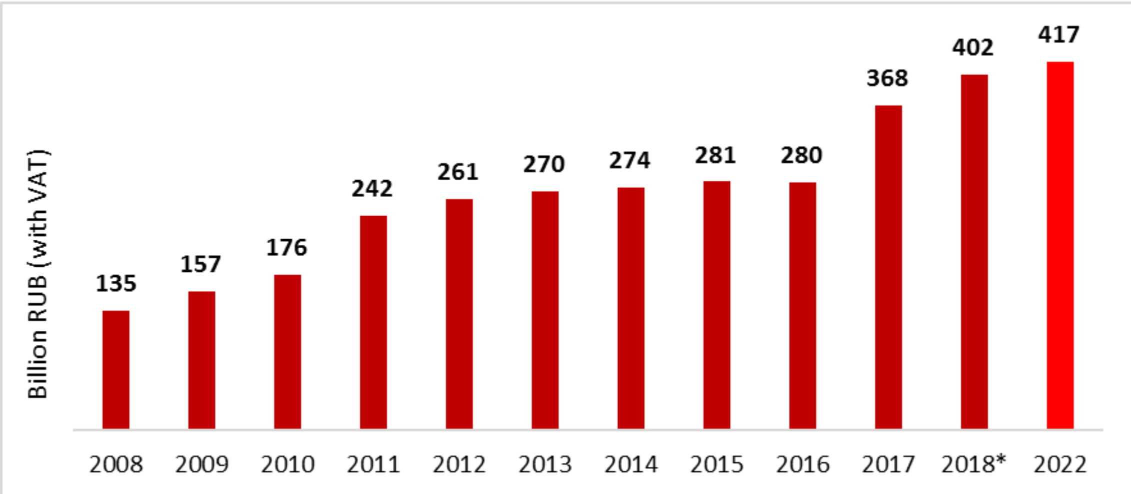
Tariffs for the population differ drastically depending on the region, tariffs for Krasnodar Krai, Kaliningrad Oblast, Ulyanovsk Oblast and Republic of Bashkortostan are mentioned in the chapters 3, 4, 5 and 6. **But basically, retail market tariffs for private residential customers**

[4] Russian Region, part of the Far Eastern Federal District on the border with Mongolia, part of the second price zone

**are kept low with subsidization.** On average, these prices are 40% lower than the prices paid by so-called entities on the retail market who cross-subsidize (cross-subsidization) the electricity prices of private households. This is very untypical in Germany but is widespread in CIS (Commonwealth of Independent States) countries. To keep household prices low, there are **two main types of subsidization** of energy sector in Russia.

- The first is a **direct subsidization**, which includes the allocation of money from the federal budget to local budgets to partly cover the costs of coal, diesel and other fuel types used for energy generation targets. In other words, these subsidies finance operational costs of energy generation. The strongest support is given to the Far East and, according to government plans, subsidization of the regions will continue.
- The second is more widespread and developed, it is **cross-subsidization of three types** [35] (and defined by eclareon). First type: non-residential consumers partly pay for residential consumers which allows electricity tariffs for the population to remain relatively low. Second type: Russian regions basically have higher electricity tariffs and partly "pay" for the consumer of the Far Eastern Russian regions which allows electricity tariffs in these regions to remain relatively low as well. In 2019, the total amount needed for support of the energy tariffs' decline in the Far Eastern regions reached 32 billion RUB [291]. Third type: costs of the new power capacities entering the market are put into the energy price (costs for the capacity, see Figure 12) and are then split between the wholesale consumers, raising the energy price for them (also see 1.2.5.4).

**Figure 14 Dynamics of cross subsidization of energy sector in Russia between 2008-2018 and a prognosis for 2022**




**Source: Government of Russian Federation, "Cross Subsidization in electricity sector: Problems and solutions", 2017 [35]; Novaya Gazeta 2019, [289]; *-according to the estimations of the Ministry of Economic Development of Russia in 2019**

**The volume of cross-subsidizing has increased drastically in the last 5 years.** This is due to different factors, including the overall imperfection of the subsidization system, the historic of cross-subsidization and the absence of an alternative variant of consumers' support. Often the electricity price includes up to 25% of cross subsidies and this share is growing annually. These costs have to be paid by large, small and medium industrial consumers, budget organizations, housing and communal services organizations [36]. By 2022 the sum of cross-subsidization may reach 417 billion RUB (5,971 billion EUR). As described earlier, costs of the newly built power capacities are added into the energy price of the wholesale market consumers. In 2019, Ministry of economic development of Russia suggested including the costs of the CHPP in Kaliningrad Oblast (15 billion RUB) and construction of waste incineration plants into the budget instead of splitting the costs between the wholesale energy consumers [291].

#### 1.2.5.6 LCOE and established tariffs of PV and wind electricity

**LCOE**

For some companies, PV generation or hybrid PV-diesel/gas/petrol generation can become a reasonable solution too especially in sunny regions such as Krasnodar Krai. **Regarding costs of PV based electricity, there are a number of different estimations of Russian energy market experts**, based on different assumptions and the fact that there is no mass market in which past costs of similar projects could be taken as a more reliable basis for cost assumptions.

For instance, an analyst of “VTB Capital” [42], Vladimir Sklyar, stated that LCOE for “green” (renewable energy based) energy in Russia is currently 3-6 times higher than wholesale prices of traditional electricity [43]. According to “Market Council”, in 2018, LCOE for PV in Russia was the highest and fluctuated between a range of 24 - 26.5 RUB/kWh (34 – 38 €ct /kWh)[44]. According to the more recent data from “VTB Capital”, cited by “Kommersant” in February 2019, an average LCOE for large PV (wholesale projects under Decree 449) was around 19.01 RUB/kWh (27 €ct /kWh), which is the most expensive among different types of energy compared by “VTB Capital”. While for large wind it was 8.16 RUB/kWh (12 €ct /kWh). Interesting is that the LCOE for nuclear power was estimated to be the second most expensive – 9.61 RUB/kWh (14 €ct /kWh) [298]. While after the tenders **in June 2019, estimated LCOE for large PV**, based on the PV CAPEX, 14% PV plant efficiency and return of the capital investments of a project of 12% were reported to have **dropped to approx. 6 RUB/kWh** (9 €ct /kWh**)** [299]. LCOE for CHPPs fueled by gas as well as coal-fueled power plants is still the lowest. Should loan rates by the Central Bank decrease for RES projects with a simultaneous further drop of CAPEX for PV equipment, then, large scale PV may become competitive with traditional energy sources (oil, gas, and especially nuclear) by 2030.

There are some stakeholders in Russia arguing that the situation for residential PV generation is different, assuming that costs for residential solar energy do not exceed 9 RUB/kWh (13 €ct /kWh). This difference is explained by a lower CAPEX assumption (e.g. absence of land costs, as a stakeholder simply uses an own roof/land for PV modules; absence of grid connection costs), shorter construction periods and no tax implications in that PV application segment [45].

A study of the Russian Presidential Academy of National Economy and Public Administration published in 2018 calculated LCOEs for different installation sizes and under varying financing conditions. This study illustrates the huge bandwidth of possible costs of PV depending on the underlying assumptions of the calculations: using a WACC of 17.5% for discounting project cashflows, LCOEs vary between approx. ~11 €ct/kWh as a minimum for large scale PV and approx. 76 €ct for residential PV. Reducing the WACC to 7.7% brings down these values to 6 €ct/kWh and 43€ct/kWh respectively. The high end LCOE values in this study account for carbon capture and compression without costs of storage and transportation.

**The base case scenarios of the profitability analysis calculations undertaken by the authors in chapter 5 of this report resulted in LCOEs between 7.23 RUB/kWh (10 €ct/kWh.) and 14.42 RUB/kWh (20 €ct/kWh).** However, depending on the variation of key assumptions such as installation costs and solar irradiation, very different LCOE levels can be calculated. For instance, as PV is becoming more prevalent in a region, competition among suppliers increases and turnkey installation prices continue to decline, including the LCOE for PV power.

What remains true, regardless of the underlying calculation, is that low electricity prices in Russia remain a challenge for the cost competitiveness of solar PV and other RES. A diligent planning process and good site selection (high irradiation, relatively high electricity prices of consumers, bad or no grid connection), or a personal interest/motivation in trying out renewable energy sources is important to be successful in the nascent Russian PV market.

**Established tariffs**

Under the „established tariffs for PV and wind energy, two types of tariffs are meant in the current study:

- **Tariffs for energy, generated by RES power plants**, which is purchased in order to cover the losses in grids. This refers to the RES generating objects constructed under the Decree 47 (see 2.1.2 for more details). The tariff is calculated for each RES facility individually according to the Methodological Recommendations of FAS of Russia N900/15 of 30.09.2015. This energy is traded **on the retail energy market**.

- Payments for the capacity of the RES power plants constructed under the frames of the Decree 449, **and the resulting from them energy prices per 1 kWh traded on the wholesale market**. The guaranteed payments for capacity are calculated in accordance to the recommendations provided by the Decree 449 (see 2.1.1 for more details).

In 2018, the average single rate tariff for PV energy in Russia was 9.05 RUB/kWh (13 €ct /kWh). For wind energy, the tariff was on average 8.97 RUB/kWh (13 €ct /kWh), however there were case of a higher tariff for wind energy, for instance, in Orenburg Oblast (10.31 RUB/kWh) and in Bashkortostan (11.1 RUB/kWh / 16 €ct /kWh). The lowest tariff was established for biomass energy (3.78 RUB/kWh / 5 €ct /kWh). At the same time, energy on the wholesale market, generated by the means of traditional energy sources, such as gas, hydro and nuclear was on average 2.07 RUB/kWh (3 €ct /kWh). For the objects functioning on the wholesale market, the main role is played by the payments for the capacity (in accordance to the mechanism of the Decree 449). These payments differ depending on the region, the price zone where the object is situated and the current situation on the market, as well as on the CAPEX/kWp of the RES facility. The CAPEX volumes drop steadily from year to year, while the payments for capacity get lower accordingly. For example, for 2020, the "Market Council" has forecasted the freely negotiated prices for RES capacity on average at 56,529 RUB/MWp (809 EUR/MWp) for the RES objects of the first price zone and 32,029 RUB/MWp (458 EUR/MWp) for the second price zone.

## 1.3 Russian Business Models for Solar PV and small wind

Business models on the Russian PV/SW markets can be divided into the following two categories:

1. **Regulative-driven business models** that are directly defined by an energy specific law and can profit from support mechanisms. The following business models belong into this category:

    - **Wholesale market projects**, including those participating in the contract competition of the long-term capacity delivery agreements under the Decree 449 managed by "ATS". These projects are normally ground mounted PV parks with several megawatts of installed capacity, but not less than 5 MW. Afterwards they are connected to the grid (UPS) - this market segment is dominated by multinational companies such as Fortum, Enel and Hevel. According to "ATS", there have not been any PV projects in Krasnodar Krai, Kaliningrad Oblast or Ulyanovsk Oblast under the power delivery agreements competition since its introduction in 2013. The main reasons for this are: high costs of PV equipment and CAPEX, too long payback periods in comparison with other investment options (5-10 years [45]) and the lack of local government support for both producers (potential generators, PV-based) and consumers of PV-based energy. For Kaliningrad Oblast an additional reason is the limited sunny days in comparison to Krasnodar, Republic of Bashkortostan or even Ulyanovsk Oblast. An additional important challenge for building large scale projects under Decree

449 is the fulfilment of a high local content quota of 70%. Further details are given in chapter 2.1.1.

- **Retail markets projects**: Such groupings occurred after the Decree 47 entered into force in 2015. They differ from the projects in the wholesale market. For example, the contract competition for PV power plants of the retail market is held by local federal units and "SO UPS" is excluded from the management of the SPP. Additionally, the installed capacity of such power plants cannot exceed 25MW, otherwise such plant can become part of the wholesale market. An important note is that Decree 47 should be adapted to regional conditions and be legalized in each region separately. That is done through additional decrees and local laws, created by regional legislative bodies, which are aimed at enforcing Decree 47. Further details are given in chapter 2.1.2.

- **Micro-generation (residential) up to 15 kW as part of the retail market:** This group will develop and become part of the grid in the next years, as the Law on Microgeneration (Federal Law 471) has been already implemented and it will take some time before the market adapts to its rules and further complementing necessary legal basis will be developed. Here private "prosumers" are able to generate electricity with the aim of covering their demand as well as officially having the right to sell the surpluses/send them into the grid. Currently, micro-generation does already exist but is reduced to rooftop PV/ground mounted small wind etc. that are disconnected from the grid and not registered or included in official energy statistics. Further details are given in chapter 2.1.5.

- **Projects for the isolated energy system**: Various RES power plants of different capacities have already been built in Kamchatka, Yakutia and Chukotka. These SPPs are local, are cut from the UPS and usually have small capacities aimed at providing energy for a chosen area or settlement. Not mainly based on a specific law, but because of the obligation of a guaranteeing, usually the state-owned, supplier to ensure electricity supply in these regions.

2. **Self-supporting** business models that are not directly defined in an energy specific law but come from private initiatives of individuals and companies: Installed capacity of such projects may vary from kilowatts to several megawatts. Examples of these projects are installations initiated by industrial consumers who want to reduce their exposure to rising electricity prices from the above-mentioned cross-subsidization of electricity prices of private households. Such PPs are constructed either by entities or by third parties with the aim of generating electricity for the own needs.

**This report will examine the profitability of four of the aforementioned business models in detail and in specific application for power generation** (see chapter 7). We have selected those that are currently the most interesting for Russian and German SMEs who want to become active together in the Russian solar PV (potentially, also SW) market. These four segments are:

1. **Ground-mounted grid-connected photovoltaic power plants (PV parks)** with a capacity of up to 25MW; such installations are built using tenders in the wholesale market or the retail market, whereas this report focuses on retail market installations.
2. **Diesel-PV hybrid systems** with a capacity between approx. 50 kW and a maximum of several MW; these installations supply power in off-grid areas (remote or isolated territories) or function as back-up systems in weak grid areas.
3. **Grid-connected residential photovoltaic (potentially, also SW) rooftop/ground-mounted systems** of up to 15 KW capacity, operated based on a net-metering scheme.
4. **Self-supporting PV/SW systems** owned by both private companies and state entities. Although this model is still not widely used in Russia, there are already such cases

which are showing effectiveness and a relative economic profitability. The interest towards such models is rising, also being pushed forward by the activities and the planned pilot projects undertaken in the frames of the “Enabling PV in Russia” project.

These business models cover a wide range of PV system configurations (grid-connected and off grid) and system sizes. Moreover, the business cases address different customer groups (grid operators, commercial and residential) and their economic availability is based on different business models. While large MW systems under law 449 and 47 receive beneficial tariffs, the profitability of diesel PV hybrid installations is mainly determined by diesel savings and the profitability of the residential model come from savings in the electricity bill. The profitability calculations, investment assumptions and sensitivities for the attainable profitability are presented in detail in section 7 of this report.

# 2. Regulatory and Business Framework

## 2.1 PV Regulations and Support Schemes

There are currently three support schemes in Russia for the generation of electricity from renewable energy sources on the wholesale and retail market, including PV. The regulations for PV installations differ depending on the respective market.

### 2.1.1 Capacity Supply Tender (Wholesale Market)

#### 2.1.1.1 Introduction

The perhaps most visible support of renewable energy development and electricity generation from RES in Russia began in 2013 with the **Decree № 449**, drafted by the Ministry of Energy of the Russian Federation and adopted by the government on 28 May 2013. This decree established a mechanism for encouraging RES use in both the wholesale electricity and the capacity markets. The adopted resolution was the first step of RE development in Russia.

The main idea of the mechanism, that supports RE on the wholesale market, is that renewable electricity suppliers (investors), both Russian and foreign, **get long-term agreements for the supply of operating PV capacity** after their projects are selected in a competitive tender process for RE installations. The scheme offers the awarded bidders – contrary to other European tender schemes – payment per capacity (MW) instead of per electricity output (MWh). According to the capacity supply agreements, wholesale market consumers (large electricity consumers) are obliged to remunerate the supplied capacity by paying beneficial tariffs over the course of 15 years (duration of agreements).

It should be noted that **supporting renewable energies through capacity contracts (MW) is a unique concept**, opposed to remuneration based on electricity supplied (MWh).

**Such capacity tenders** (covering solar power, wind power, small-sized hydropower and waste-to-energy) **have been organized every year since 2013** by the regulatory body "Market Council" [46] and every year several projects have been selected. In 2018 there were two winning parties (Fortum, a Finish power utility, and Avelar Solar Technology which is the subsidiary of Russian company Hevel) [47]. Taken together, both will realize 10 PV projects with a total capacity of 148.5 MW. The seven projects proposed by Fortum, with a total planned capacity of 110 MW, have a proposed CAPEX almost half of that proposed by Avelar Solar Technology.

#### 2.1.1.2 Process Steps

As mentioned above, the regulatory body "Market Council" invites potential suppliers of electricity generated from renewable energy sources to participate in the capacity tender, which occurs annually.

The project **selection procedure is comprised of two rounds:**

1. In the first selection round, it is determined whether the project meets all the requirements for participating in the scheme such as:
    - maximum capital costs per 1kW
    - local content requirements etc.
2. In the second selection round, the winning projects are selected based on a single parameter, the capital costs of the project.

Once the project is selected, **the investor will be remunerated on a monthly basis depending on the plant's capacity.** The remuneration is calculated for each plant, and is based on the capital costs indicated in the bid submitted by the investor during the tender. The tender winners sign an agreement for the supply of capacity with the wholesale market consumers through the intermediary, the JSC "Financial Settlement Center (CFR)" [48]. The winning party receives guarantees of stable profitability and beneficial tariffs for electricity but is obliged to complete the construction of the RE installation and to ensure that local content requirements are fulfilled (see chapter 2.1.1.4).

To be eligible for support under the capacity supply tender scheme, RES installations need to be qualified as generating facilities operating on renewable energy (or certified) by the regulatory body "Market Council", in line with the government Decree № 426 'On the Qualification of RES Installations' and have to be included in the official version of the regional "Scheme and Program of the Perspective Development of the Regional Energy Sector" (a document prepared by each region individually on an annual basis, also mentioned in section 3.3 "Region-specific regulatory & legal framework" for Krasnodar Krai), approved by the executive authority of the regional subject of Russia (there are different types of regions in Russia, including republics, krai, oblast, autonomous oblast, and cities of Federal importance).

Moreover, to calculate the capacity price, the **expected revenue from selling electricity on the wholesale market is taken into consideration**. Thus, an investor has two revenue streams which combined should ensure a return of the capital investments of a project by 12% for the 15-year payback time. The current practice in Russia has shown that such projects are paid back within approx. 10 years.

#### 2.1.1.3 Support Scheme Requirements

As mentioned in the previous section, **RE installations have to be approved by the regulatory body "Market Council"** and given the status "generating facility operating on renewable energy" to receive support under the capacity supply tender scheme. This status can only be given if the installation has been constructed, is connected to the grid and commissioned.

Moreover, the capacity supply tender scheme is eligible for **RE installations with at least 5MW** of installed capacity [12], i.e. wholesale market participants. To participate in the capacity tender, an investor needs to be registered as a provisional supplier on the wholesale market [31].

A further important requirement for this support scheme is that the **RE plant has to meet certain availability criteria**, such as the minimum capacity factor over a year. This should be 0.14 for PV plants. The capacity factor is reflected in the amount of electricity that the RE producers sell for a year. If the capacity factor of the plant is lower than 0.14, the capacity remuneration will be reduced respectively.

Moreover, the **maximum capital investments of the project** (expressed in RUB/kW) (expressed in RUB/kW per year) **are fixed** and specified by the government Executive Order № 1472-r. For example, the maximum allowed capital expenditure for plants commissioned in 2019 was 105,262 RUB/kW (approx. 1,507 EUR/kW[5]), whereas for the plants commissioned in 2020 the limit was decreased to 103,157 RUB/kW (approx. 1,477 EUR/kW); for 2021 the ceiling CAPEX is set at 101,094 RUB/kW (approx. 1,448 EUR/kW) [309] [317].

The **capacity supply tenders** for selecting the power plants operating on renewable energy sources **are organized only for the 1st and 2nd price zones** (see section 1.2.5 Electricity Markets, Prices, Tariffs and Costs), i.e. Decree № 449, regulating capacity tenders, is not applicable to RE installations in isolated regions and non-price zones.

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[5] Please note, that the currency exchange rate used in the document is approx. 70 RUB per 1 EUR

Based on the currently available information, the mechanism of the Decree 449 is going to be prolonged after 2024, but with some changes. Not only the local content requirements are supposed to be changed, but possibly also the entire calculation method for the support scheme may change. The Ministry of Economic Development of Russia in 2019 suggested basing the tender mechanism not on CAPEX as it is now (the lowest CAPEX wins), but on the LCOE, which includes CAPEX, OPEX and profitability with an annual slight decline of the ceiling level for LCOE based on the results of the new tenders [298]. In case such a scheme is implemented the overall profitability and payback period of RES wholesale projects will probably be negatively impacted. Therefore, the current RES players on the Russian market are mostly against the suggested scheme and share the opinion, that it would slow down the further development of RES in Russia. For the prolongation of the wholesale support mechanism, 10 more GW of RES based capacities are planned for implementation until 2049 with a total estimated cost of 1.3-1.7 billion RUB (18.6 – 24.3 million EUR) [300].

#### 2.1.1.4 Local Content Rule

Another important factor for PV investors is the local content rule, which stipulates that **70% of the equipment used for the construction of the PV plants, as well as project development work, needs to originate from Russia** (used to be 50% in 2014-2015 and increased to 70% for the period 2016-2024) [50]. The way in which the localization coefficient is determined is described in chapter 2.3.4.

If PV investors fail to fulfil the local content requirement of 70%, they are subject to a significant penalty coefficient of 0.35 (for wind power plants the penalty coefficient is 0.45) in case the project has been chosen on a tender before January 1st 2020. **In accordance to some projected changes of the legislation, this coefficient might be changed for the projects to 0.05 for PV plants which do not fulfill the 70% local content requirement and have won the tender after January 1st 2020** (Source: Project of the Changes to some Decrees supporting RES in Russia, received from EUROSOLAR Russia)**.** Respectively, if the PV plant developer does not satisfy the minimum localization of 70%, the developer will only receive 35% of the calculated tariff (65% lower than the corresponded tariff). These issues/risks have the potential to adversely impact the projects [52].

**This rule is a barrier for raising the RES share** since the Russian manufacturing industry for RE equipment and technology is still small. Hence, it is more difficult and expensive to supply the equipment needed to comply with the local content rule. Moreover, it is questionable to which extent it will be possible to scale up capacities to achieve the RES targets in the given timeframe put forward by the government - a 4.5% RES share by 2024 [51].

The current decree provides support to RES projects until 2024. Now, the prolongation of the scheme until 2035 is considered by the Ministry of Energy of Russia and Ministry of Trade and Industry of Russia. In case the mechanism will be extended beyond 2024, the local content requirements are planned to reach 100% for PV and 90% for wind projects by 2035 [295], [296].

### 2.1.2 Electricity Supply Tender (Retail Market)

#### 2.1.2.1 Introduction

In January 2015, the **Decree № 47** “On Amending Certain Acts of the Government of the Russian Federation on Promoting the Use of Renewable Energy Sources in Retail Electricity Markets” was adopted. The decree introduced a **support mechanism for renewable electricity generating facilities with an installed capacity of up to 25 MW in the retail electricity market**.

The decree contains common directives which are not specified for individual regions. Thus, **all regions in Russia enforce Decree 47 separately** through the implementation of respective legislative acts, decrees and laws. Bashkortostan has implemented such laws, while Kaliningrad Oblast has not. The decree obliges regions to enforce these laws, but does not specify when and lacks non-compliance measures.

According to the scheme, **local grid operators in respective regions are obliged to purchase electricity generated by RE facilities to compensate their projected grid losses**. **However, the purchase is limited to 5% of the projected grid losses in the region.**

Projects which qualify as “renewable” by the regulatory body “Market Council” enjoy long-term tariffs for the period of 15 years (same as in the wholesale market) [53]. To get this compensation, RE generating facility operators need to participate in the competitive selection procedure - electricity supply tenders, organized in each of the regional subjects of the Russian Federation (see chapter 2.1.2.4).

According to Decree № 47, the inclusion of a generating facility operating on renewable energy in the price and non-price retail market and in isolated regions should occur according to the following principles:

- Minimization of the increase of prices (tariffs) for electricity (power) for the end-consumers in the retail market
- For non-price and price zones, the amount of electricity purchased from RE facilities should not exceed 5% of the projected losses of electricity by the grid companies
- For isolated areas, the project implementation should result in the price reduction of electricity in the respective region
- Minimization of environmental damage
- Addressing social problems in the area where the project is implemented
- Transparency.

It is estimated that the **total capacity of RE facilities that could be installed based on this support mechanism is approximately 3,000 MW** with a total required investment of 8 billion dollars (approx. 7 billion EUR) [54].

#### 2.1.2.2 Responsibilities and requirements

In contrast to the capacity supply tender scheme (Decree № 449), regional, non-federal authorities [55] play an important role in the development of renewable energy projects in the retail market. **It is up to the regions to choose between organizing tenders for specific RE technologies or technology neutral ones**.

Federal authorities are not entirely excluded, because **regional authorities can only define preferential tariffs for RE installations for a maximum of 5 years**. Tariffs for longer periods need to be approved by federal authorities. Moreover, it is a federal authority, namely the regulatory body “Market Council”, which has to formally approve an installation as “renewable”.

The **maximum capital investments of the project** (expressed in RUB/kW) **as well as the O&M costs** (expressed in RUB/kW per year) **are fixed** and specified by the government Executive Order № 1-r. For example, the maximum allowed capital expenditure for plants commissioned in 2019 for PV projects was 110,525 RUB/kW (approx. 1,578 EUR/kW), whereas for the plants commissioned **in 2020 the limit was decreased to 108,315 RUB/kW (approx. 1,547 EUR/kW); for 2021 the ceiling CAPEX is set at 106,149 RUB/kW (approx. 1,516 EUR/kW).** The maximum allowed basic[6]O&M costs for the year 2019 were 2,777 RUB/kW (approx. 39.77 EUR/kW per year), and in the year 2020 the value increased to 2,880 RUB/kW (approx. 41.24 EUR/kW per year) and 2,987 RUB/kW for 2021 (42 EUR/kW). [317].

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[6] Basic maximum allowed CAPEX per 1 kW are the ones excluding the indexation because of the inflation and other influencing factors

#### 2.1.2.3 Tariff Calculation

The preferential tariff for RE facilities is calculated using the methodology approved by Order № 900/15 of the Federal Antimonopoly Service on "The approval of the methodology for the establishment of the tariffs and (or) extreme (minimum and (or) maximum) levels of tariffs for electricity (power) from renewable energy facility in order to compensate for losses in grid" from 30 September 2015.

According to this methodology, **preferential tariffs are calculated so that the basic level of the return on investment capital (ROIC) is 12%** (for the projects commissioned since January 2017). These tariffs are usually several times higher compared to the tariffs for conventional electricity used for the same purposes.

On the retail market, like the wholesale market, a **PV project has to satisfy localization requirements of at least 70%,** otherwise the preferential tariff is decreased by 65% (see Section 2.1.1.4)

A major difference between the support scheme for RE projects in the retail market and the one applied to the wholesale market is that the **preferential tariff on the retail market is calculated per MWh**, while on the wholesale market the tariff is paid for the capacity (capacity price) expressed per MW (Decree № 449)[56]. It means that there is no need to make any adjustments of the preferential tariff when the electricity market price changes [57].

The Order № 900/15 was amended on 15 March 2018 when the Order № 317/18 entered into force, introducing the tariff calculation methodology for power plants installed in isolated regions; an important aspect which had previously been missed.

#### 2.1.2.4 Process Steps

According to the Decree № 47, there are **seven stages to receive support** (preferential tariff) under the electricity supply tender scheme, including PV projects [58] (see Figure 15).

**Figure 15 Process steps for obtaining support for a RE project in the retail market**


**Source: eclareon & EUROSOLAR Russia, 2019**

RE projects that are supported by the electricity supply tender scheme are selected in a **competitive selection procedure** (tender), which is held by regional executive authorities. Decree № 47 does not determine how often these tenders have to be organized, meaning that regional executive authorities are free to decide on their own. Selected RE projects are then included in the regional electricity sector development schemes and programs. Only with the inclusion in the regional “Scheme and Program of the Perspective Development of Energy Sector…”, can RE installations be certified as renewable by the regulatory body Market Council (similar to the wholesale market). Qualification is carried out in accordance with the “Procedure for the qualification of the generating facility operating on renewable energy sources”, approved in June 2008 by the Decree № 426.

Based on the qualification certificate, the **regional regulatory authority sets the preferential tariff for the capacity and for the electricity generated from renewable energy sources for grid loss compensations purposes, which is paid for 15 years.** When an RE facility starts generating electricity, the volume generated is certified by the regulatory “Market Council” and, based on these certificates, the grid operator remunerates for the supplied renewable electricity and capacity [59].

#### 2.1.2.5 Effectiveness of the Support Scheme

Currently, more new PV projects occur in the Russian regions aimed at energy generation for the retail energy market and the model as such is getting popular. In 2019, Hevel won the project in the frames of the Decree 47 in Krasnodar Krai – a construction of a 73.5 MW PV park in the region with the CAPEX of 92,700 RUB/kW (lower, than the ceiling allowed CAPEX in accordance to the Resolution N1-r). In March 2020, another large player of the Russian PV market, Solar Systems, won a 10 MW project in the Republic of Bashkortostan with a CAPEX per 1kW of around 92,000 RUB. The tendered capacity was included in the Scheme and Program of Development of Energy Sphere of Krasnodar Krai and the Republic of Bashkortostan.

**The following four observable features of the support scheme might limit its effectiveness**:

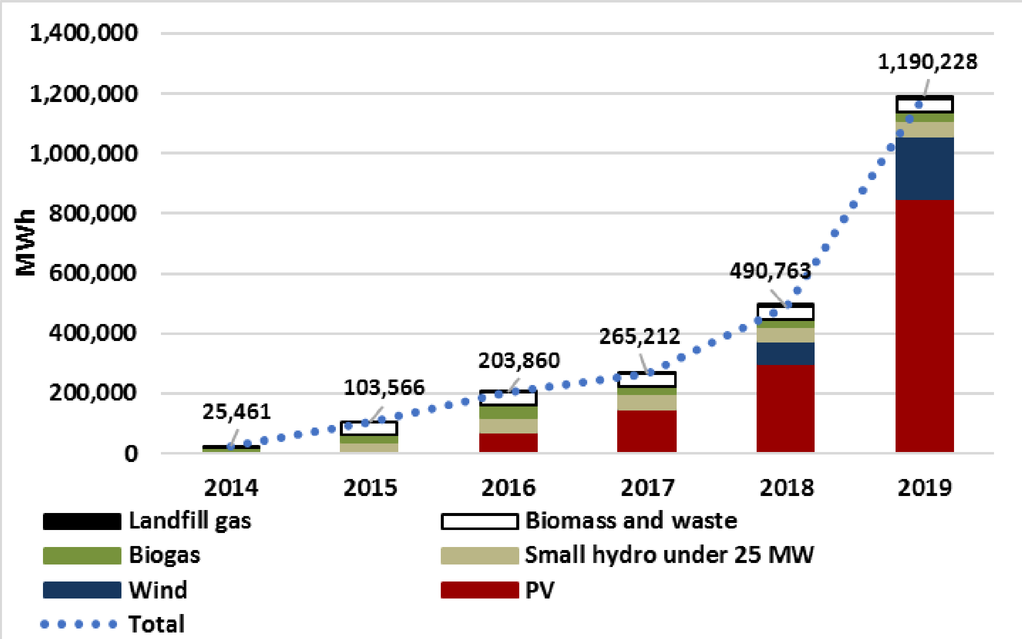
1. Preferential tariffs are only determined once the project is qualified as “renewable” by the regulatory body “Market Council”. RE installations can only qualify when constructed, meaning that project developers/investors are only eligible for preferential tariffs after the investment is done, so there is of uncertainty regarding the project revenues.
2. The limitation of the renewable power purchase in the retail market of up to 5% of total transmission grid losses, resulting in limited purchases of renewable electricity by the transmission grid operator [60]. The total transmission grid losses in Kaliningrad in 2017 amounted to 762.6 GWh. This implies that through the support scheme for the retail market a maximum of 3,100MWh of energy can be sold a month, which corresponds roughly to the production of 30MW solar PV plants in Kaliningrad. In Krasnodar Krai, the total losses in 2017 were 3,980GWh, where 5% is equivalent to 199,020MWh of renewable electricity that can benefit from the support scheme in a month, corresponding to the production of a 174MW solar PV plants in the region.
3. Moreover, according to the tariff regulation, preferential tariffs that last for more than 5 years need approval from the federal authorities, raising uncertainty further about whether long-term tariffs will be granted.
4. As mentioned above, the tariffs are calculated using the methodology approved by Order № 900/15, both for the installed capacity and for the electricity sold on the retail market [61]. When developing the methodology, officials did not take into account that, according to Decree № 442 (retail market rules) the amount of electricity that can be sold to a grid company to compensate for 5% of its losses, must be confirmed by a special certificate which is issued by the regulatory “Market Council”. In Decree № 442, however, there is no reference to the capacity as a commodity. Respectively, a situation in which plant operator cannot sell capacity because certificates were not issued is possible [59].

### 2.1.3 Current results of the both schemes

The two support schemes have positively influenced the Russian RES market and resulted in a growing volume of energy generated by facilities qualifying as renewable energy power plants by NP “Market Council”. While in 2016 there was nearly no competition of the Russian RES market, in 2018 new players and companies entered the market and completed projects within framework of the both Decrees 449 and 47. As a result, CAPEX of RES systems have started to decrease.

The scheme below illustrates electricity generation by the RES facilities qualified by “Market Council” and applies to the wholesale and retail energy markets.

**Figure 16 Electricity generated by the qualified RES power plants on the wholesale and retail power markets of Russia, 2014-2019**




**Source: Based on NP „Market Council", 2019 [178]**

Since 2014, volume of electricity generated by the qualified RES objects constructed under the Decrees 449 and 47 increased by more than 46 times.

### 2.1.4 RES capacity targets

The existing RES supporting schemes, among others, included target indexes of the RES capacity to be installed in Russia under the conditions of the both Decrees 449 and 47. Those targets have been slightly changed in April 2020 with the amendment of the Decree of the Government of Russia N 1081-r as of April 18th 2020 and currently are the following:

**Table 5 Targets of RES capacity to be installed under the Decrees 449 and 47 in Russia until 2024**

| Type of RES, MWp | 2020 | 2021 | 2022 | 2023 | 2024 | Total |
|---|---|---|---|---|---|---|
| **PV** | 270 | 162.6 | 162.6 | 240 | 238.6 | 1,073.8 |
| **Wind** | 500 | 500 | 500 | 500 | 500 | 2,500 |
| **Hydro under 25 MW** | 16 | 24.9 | 33 | 23.8 | 41.8 | 139.5 |
| **Other** | 786 | 687.5 | 695.6 | 763.8 | 495.1 | 3,428 |

**Source: Order of the Government N 1-r, 2020 [317]**

The major changes have happened to the planned installed PV and wind capacity, which has been increased. **For PV, the target numbers both for 2022 and 2023 have drastically increased more than 2 times in comparison to the older targets for the same years respectively**. For wind power installed capacity, the target for 2024 has been changed and resulted into a growth by 17.5%. Basically, this also means, that between 2022 and 2024, there is a larger pool of tendered RES projects available for investors on the Russian energy market. **The total targets of RES capacity to be installed within the whole period (2014-2024) of the functioning of the current supporting programs' have also risen slightly: in total, 32.1 more MWp for wind; 279.6 MW more for PV and 311.7 MW more installed capacity for other RES (excluding small hydro).**

### 2.1.5 Microgeneration

The discussion surrounding the long awaited amendment of the law on microgeneration in Russia (*see report "Enabling PV in Russia" published in 2019*) has finished in December 2019: the law on microgeneration was signed by the Russian President on December 23rd 2019 and has the official name Federal Law of December 27, 2019 N 471-FZ "On Amendments to the Federal Law "On Electric Power Industry" with regard to the development of microgeneration" [292].

**The law establishes the following principles:**

- The microgeneration facility can be functioning "on the basis of energy sources, including RES"
- Installed capacity of a microgeneration facility must not exceed 15 kWp
- A microgeneration facility shall be owned by a user or belong to the owner by other legal bases
- Power receiving devices of such facility shall be technologically connected to power grid facilities with voltage level up to 1,000 volts. The order of connection and accounting will be specified in the draft government decree to be submitted by the Russian Ministry of Energy by July 2020
- The microgeneration object shall aim to fulfil its own energy demand for households or other users or supply the own production needs
- Owners or users of a microgeneration facilities are the participants of the retail energy market of Russia
- Selling of the surpluses of electricity by the owner/user is not considered as an entrepreneurship (therefore, does not fall under legal requirements and taxation applicable to entities)
- Guaranteeing supplier active in the price and non-price zones of the energy market in a concrete region/are is obliged to conclude the contracts with the microgeneration owners (which are a part of the retail market) and purchase the surpluses of electricity from a facility
- The price of the purchase for the electricity from microgeneration systems (basically, feed-in tariff) must not exceed the energy prices of the wholesale market
- The grid companies are obliged to conclude the PPAs with the microgeneration owners/users and purchase the energy from those objects in order to compensate the losses in grids (basically, same mechanism type is defined by the Decree 47)
- The law is only for private stand-alone houses and other users, apartment houses are excluded from the list of potential users

Generally, the law is written in such a way that also owners/users of diesel/biomass/petrol/coal/peat energy generation facilities under 15 kWp installed capacity are counted as microgeneration producers and are able to participate on the Russian retail energy market. Although the law itself is already in place, the official mechanism of grid connection of microgeneration facilities as well as the mechanism of energy metering still lacks. According to some sources these will be defined by a separate Decree prepared by the Ministry of Energy of Russia until July 2020. This means that before July 2020 grid companies will still have a strong incentive not to connect RES generating systems to their grids. On a positive note, this technical connection is planned to be simplified.

According to the law, selling electricity surplus from the microgeneration facility is not considered a business activity, thus it is not taxed like individual income. However, the Tax Code of Russia has not been adapted accordingly. The amendments to the Tax Code, initiated by the government in late 2018, state that "micro-generators" will be exempt from personal income tax only until 1 January 2029 [293].

Many questions arise when it comes to “feed-in tariffs” for microgeneration facilities (if, in fact, such energy purchased at wholesale prices can be labelled “feed-in tariff”). In Russia, only ceiling prices are set, while the minimum tariff is not mentioned in the law. Considering the wholesale price level, the “feed-in tariff” for microgeneration is unlikely to surpass 1.5 RUB/kWh (2 €ct /kWh). This price is 2-4 times lower than the tariff paid by residential and small non-residential retail consumers per kWh from the grid. Although even such a low price positively affects the payback period of a RES microgeneration facility, it would be much more effective to set feed-in tariffs above grid electricity prices. The Ministry of Energy of Russia has commented that prices are kept at wholesale level because retail prices include transmission and distribution costs as well as other services provided by guaranteeing suppliers and grid companies, whereas the microgeneration facility merely produces the energy, which then can be sold at pure energy generation costs/kWh [294]. Despite the low sales price for access electricity, the amendment of the Law 471 on microgeneration is seen as an important next step towards RES support and small-scale RES development.

### 2.1.6 Further Support Mechanisms

Decree № 850 from 20 October 2010 defines the criteria for subsidizing technical RE connections to the electricity grid for up to 25 MW from the federal budget. According to those criteria

- the electricity has to be generated from RES
- the installed capacity of the RES facility cannot exceed 25 MW
- the owner of the generating facility does not have tax arrears, is not bankrupt etc.

In 2016, the Decree № 961 from 23 September 2016 complemented Decree № 850; the latter one being a part of the government program ‘Energy Efficiency and Development of the Power Sector’. Decree № 961 establishes certain rules and procedural steps for receiving federal subsidies for the connection of RE generating facilities of up to 25 MW to the electricity grid.

The decree stipulates that decisions on providing subsidies are made by a special commission created by the Ministry of Energy. **Subsidies cannot exceed 70% of the overall costs of the connection of the RE facility to the grid and cannot cost more than 15 million RUB (approx. 202 thousand EUR).** Finally, technical grid connection costs are defined as the actual cost of grid connection, determined in accordance with the legislation of the Russian Federation on electricity [65].

Also, in 2016, Directive 1634-r “On approval of the territorial planning scheme of the Russian Federation in the field of energy” entered into force. This directive sets a timeline for the construction of RES and other power generating facilities along with high voltage power lines and transformer station refurbishment and construction across Russia for the period until 2030. According to the document, the newly installed RES capacity shall reach: 771 MWp of wind power, of which 310 MWp are to be constructed in Krasnodar Krai and Adygea Republic (inside Krasnodar Krai); 2.9 GWp of large hydropower plants until 2030. PV parks are not mentioned in the document and are excluded from the territorial schemes [238].

Along with the mentioned legislative acts, a resolution 1-r of January 2009 with the changes from July 2019, frames the overall concept of RES development for the country. Without specification by type of energy source, however, and the exclusion of large hydro, the document provides figures for shares of RES generation in electricity mix of the country: 1.5% for 2010; 2.5% for 2015 and 4.5% for 2024. Before the amendment in 2019, a target of 4.5% RES had been established until 2020. According the resolution, cumulated newly installed (after the year 2014) PV capacity is to reach 1.9 GWp by 2024; for wind this figure reaches 3.4 GWp [239].

Decree N 1145 of September 2018 establishes some changes to the existing legislative acts, laws and regulations. All changes have the aim to support RES development and attracting investors to RES technologies, making RES facility launching simpler and faster, avoiding additional unnecessary expenses during RES power plant construction. Among such changes are:

- The requirement to equip each generating facility with a measuring device was eliminated. Before that, each generating unit (e.g. wind turbine) had to be equipped with an individual metering device. Today, a metering device shall be installed in such a way that the entire electricity production of the array can be captured, for example at the grid connection point. The major requirement is that the metering device records the total volume of the energy generated by all generating units of the RES power plant.

- An investor constructing a RES generating facility under the conditions of the Decree 449 for the wholesale market now has a right to change (restructure) the planned installed power capacity of the planned RES objects for which they tendered before the start of energy selling process. However, the plans can only be changed once. Moreover, the change of the installed capacity must not exceed 0,5 MWp; the final total installed capacity still must not be less 5 MWp; the total planned installed capacity in the frames of one company must stay the same as tendered before; the energy delivery to the wholesale energy market from the planned RES objects shall stay the same, too. In other words, in case an investor has won the competition and received 11 MW of PV (or wind) power in region X, the total capacity may be split into 2 PV parks of 5.5 MW each. Under the new amendment, the investor is allowed to change the plan and construct one PV park of 5 MW and another with 6 MW capacity.

## 2.2 Heat Pumps and Small Wind Support Sector

When analyzing the legislative support for RES in Russia, one can find a range of decrees and laws aimed to support these modern technologies. However, the major share of this support is aimed at technologies such as PV, wind power, hydropower, biogas and waste to energy. The heat pump (HP) sector in Russia, for example, is underdeveloped, both with regards to residential and industrial consumers. At the same time, heat pumps in Russia are considered an affordable option for heat consumers: according to the “Russian State information system in the field of energy saving and energy efficiency”, the costs of 1 kWh heat from a geothermal heat pump is about 0.9 RUB, which is the cheapest option ( even cheaper than a natural gas heating systems) [247]. However, CAPEX for heat pumps in Russia is still very high and a major bulk of equipment is imported from foreign countries, which increases CAPEX.

Currently, there is only one legislative act in Russia which provides indirect support to the heat pump sector in Russia – a Decree N 600 of June 2015 [241].

The Decree N 600 defines heat pumps as an energy efficient technology and stipulates tax benefits for users of HP:

- Provision of investment tax credit to the organizations investing in energy efficient technologies (including but not limited to HP) [243]

- Taxpayers have the right to apply a special coefficient to the basic depreciation rate in respect of depreciable fixed assets related to the high energy efficiency (HP) [244]

- Organizations that have newly registered energy-efficient equipment (incl. HP) are exempt from taxes for 3 years [245]

Although the support mechanisms listed above are rather attractive, they are rarely applied. The first reason is that there is a lack of regulatory framework required for designing and constructing HP systems in Russia. Without clear standards and regulations an owner has difficulties registering the HP system and proving that it counts as energy efficient technology. Without such a registration, tax benefits do not apply. The second reason is the low awareness of tax officials of the heat pump technology and of Decree 600. Often HP operators have to prove to their local tax service that the HP installation owned deserves tax benefits [246].

Regarding small wind, there are no specific regulations supporting this type of RES installation, as the SW market in Russia does not exist. For larger wind parks, constructed under Decree 449 or 47, the same rules are applicable, as for PV, which are described in the sections above. The difference between WPPs and PV plants is only in the requirements regarding the local content share of the equipment and the CAPEX ceiling. For wind projects for the wholesale market, the local content required between 2019 and 2024 is 65%, while the maximum CAPEX/kWp are: 109,561 RUB/kWp (1,568 EUR/kWp) in 2019; 109,451 (1,567 EUR/kWp) in 2020; 109,349 (1,565 EUR) in 2021; 109,232 (1,564 EUR) in 2022; 109,123 in 2023 and 109,014 (1,561 EUR) in 2024 [265].

## 2.3 Codes and Standards

### 2.3.1 Transmission Rules and Grid Connection

The most important legislation that governs transmission operations is **Governmental Resolution № 861** “On the Approval of the Rules for Non-Discriminatory Access to Electricity Transmission Services and the Provision of these Services, of the Rules for Non-Discriminatory Access to Dispatch Management Services in the Electric Power Industry and the Provision of these Services, of the Rules for Non-Discriminatory Access to the Services of the Trading System Administrator and the Provision of these Services and the Rules for Technological Connection of Power Receivers (Power Units) of Legal and Natural Persons to Power Networks”.

As the name indicates, **the resolution establishes four sets of rules**: the first three provide equal rights to all electricity consumers to access the electric power transmission and its related services, while the fourth is meant to provide guidance and set technical requirements for the connection of a generating object to the grid [66].

Regarding connection of RES facilities to the grid, the process lacks transparency. Currently, both operators of RES installations and grid companies understand the process of grid connection for the following RES systems only:

- Power generating facilities constructed in accordance with Decree 449 aimed to sell energy and capacity to the wholesale market
- Power generating facilities constructed in accordance with Decree 47 aimed to sell energy to the retail market
- RES systems in pure off-grid areas, which require connection to a small local power grid, which are located in the boundaries of one settlement that is not interconnected with the UPS of Russia and larger transregional power lines
- (in the near future) – connection of small residential RES systems under 15 kWp

**Grid connection of any other RES system is neither explicitly allowed nor forbidden by the existing laws.** This creates a legislative “grey area” for the grid connection of such power facilities which, as a consequence, needs to be negotiated individually between the operator of a RES plant and the responsible grid company.

There is very little experience with connecting such unregulated systems to the grid but the following observations can be made:

- Grid operators lack experience of connecting RES installations to the grid. Since RES is generally new to them and clear regulations are missing, there is a lot of uncertainty, which leads to passive behavior as people tend to “avoid the unknown”.
- Given that RES has only appeared fairly recently in Russia, grid operators do not yet dispose of any official certificates and/ or technical conditions for RES specific equipment, for instance PV inverters, which are needed for the grid connection. As a consequence, the missing experience of electricians and technicians of working with such equipment is often used as an argument “against” grid connection
- Each case is individual and each grid company differs: while in one region or settlement the grid company does not provide any support to a customer wanting to connect a RES system to the grid, this may be the opposite in another region. A good example for the proactive role that grid operator can play is the case of JSC “Yantarenergo” in Kaliningrad who supported the grid connection of a residential PV system (see chapter 4)
- There are no payments for electricity from a PV (or any other RES) power system injected into the grid. In case the grid operator allows the connection, any injection will therefore be free of charge until the relevant regulations are adopted.
- In case the RES system is very small (< 1-2 kWp) and is not owned by a residential consumer (e.g. small commercial business such as fuel stations, cafés etc.), often no negotiation with a grid company is needed at all. This would be very unusual in EU countries, however in Russia there are many cases, in which such a small system is connected to the local grid and do not cause any complaints from the grid operator.

### 2.3.2 National Standards for Solar Energy

The executive body responsible for standards in Russia is the **Federal Agency for Technical Regulation and Metrology** (*Росстандарт*, in engl. Rosstandart). From 2013-2018 the body approved a series of GOST (abbreviation from “*государственный стандарт*” or in engl. “Gosstandard”, i.e. national standard) standards in the energy field.

In the field of solar power engineering specifically, including PV systems, there are 69 national standards, most of which were approved between 2013-2016 [67]. The fact that most of the standards were approved in such a short time indicates that the country wants to push ahead with the development of its PV industry.

A GOST certificate is a document attesting that the product conforms to the Russian national GOST standards. This certificate may be required to import, manufacture or sell products in the Russian Federation. In 2009, the Russian government adopted Resolution № 982 (adopted on 1 December 2009 and entered into force on 15 February 2010), containing **the list of products that are subject to mandatory certification** [68]. If the product is part of that list, it has to be certified before it can be sold in the market. **PV modules and PV inverters are not included in the list.** The only current GOST for PV modules is GOST P 51597-2000 “Nontraditional power engineering. This certification is too old and is not suitable anymore for actual materials and technologies. Nevertheless, some other components needed for the construction of the PV plant (i.e. transformers) can be a part of the list and thus subject to mandatory certification [69].

### 2.3.3 National Standards for Heat Pumps

Before 2011 there was only one major document in Russia regulating the use of heat pumps – SNiP 41-01-2003 (*СНиП – Свод Норм и Правил* – in eng. The Code of Norms and Rules) “Heating, ventilation and conditioning” updated in 2012 to SP 60.13330.2012. The document just mentioned heat pumps as a technology and did not include any specific recommendations on the usage of HP and standards the HP shall follow [248]. In 2011, GOST P 54865-2011 "Heat supply of buildings. Methods for calculation of energy requirements and efficiencies for heat generation with heat pump system" came out which is devoted to heat pump systems only. This standard defines the methodology for calculating the energy consumption and energy efficiency of heat supply systems equipped with HP and uses the experience of European HP functioning and technical characteristics of the major and secondary HP equipment [249].

In 2014, National Association of Builders of Russian Federation united several authoring organizations and created a STO NOSTROY 2.23.166-2014 (from Rus. Standard of the National Association of Builders) "Internal buildings and structures utilities Constructing of cooling and heating heat pump systems of buildings Rules, monitoring control, requirements to the results of works" [250]. The standard was developed as a follow-up of SP 60.13330.2012 making the process and regimentation of the HP usage concreter and clarifying the technical guide "Guidelines for the use of heat pumps using secondary energy resources and non-conventional renewable energy sources" created by "Insolar" Group of companies [251].

According to the Russian classification for standards and in accordance to international standards, heat pumps have number 27.080 in the group "Energy and heat engineering" [252].

In addition, there is a list of other GOSTS indirectly or directly related to heat pumps, but they are less relevant and detailed than the abovementioned.

## 2.4 Trade, Investment and Import Conditions

### 2.4.1 Trade and Investment

Russian support mechanisms for renewable electricity generation have the potential to minimize some risks and aim at securing investments as well as protecting the investment profitability from changing market conditions [70]. This can be specifically inferred by the support mechanism for the wholesale market, which has proven to work well for several years.

From the tender results it can be observed that most of the project winners are big companies either from Russia or in collaboration with Russian companies with experience in PV manufacturing or PV project development.

However, when it comes to the support mechanism for the retail market, Decree № 47, it is not clear to what extent it will offer sufficient support in increasing the share of RE technology. One important drawback of the support scheme is its complexity and the high number of institutions that are involved in the process of selecting the project, both on a regional and federal level.

**One of the most stringent requirements that is seen as an impediment for increasing foreign investment is the strict local content requirement of 70% for PV projects** (see Section 2.1.1.4). Under these conditions, the easiest and most secure way to profit from the support mechanisms is to partner with companies located in Russia.

### 2.4.2 Inflation and Interest Rates

In 2019 the Bank of Russia stated that **the annual inflation reached 3%, which is 1% less than forecasted in the beginning of 2019.** In 2020, the annual inflation is expected to stay under 3%.

The **baseline interest rates** at which banks can lend money from the central bank is based on the so-called key rate which is currently (01/2020) kept at **6.25%.**

### 2.4.3 Import Conditions for PV and other energy generating equipment

The main countries from which Russia imports PV modules are the US, China and Germany [71]. However, in recent years PV modules imports have decreased as a result of EU and US sanctions in conjunction with the significant effort the country has made to increase its local production of PV components.

As already described in section 2.1.1.4, for PV installations to qualify for support in both for the wholesale and retail market, it has to comply with the rules laid down in the Government Decree № 426 "On the Qualification of a Generating Object Operating Using Renewable Energy Sources" [72]. One important criterion for project selection is the local content rule that requires that more than 70% of the PV equipment as we all project development work has to be located in Russia, according to the Decree № 1472-r of 28 July 2015 [73].

The decision about whether the project/installation meets these criteria is made by the regulatory body "Market Council". To determine the localization level of the power plant, the origin of all of its constituent components has to be confirmed. Moreover, the localization level also takes into consideration the origin of the project development work. If 70% are not achieved, the project does not qualify or preferential tariffs for selling the produced renewable electricity are significantly reduced, by applying a coefficient of 0.35 (for the retail projects). In this case the business case would deteriorate. As a result of the local content requirements, a PV manufacturing and construction industry has developed in Russia, ranging from research and development (R&D) to the production of PV modules and the construction of PV plants [74]. The other result is that imports of PV modules to Russia have decreased.

Nevertheless, **foreign PV equipment is still available on the Russian market. However, this equipment cannot be used for tendered projects, but only for private electricity generation where local content rules are not applicable.**

In case PV equipment such as PV modules and inverters, heat pumps or wind generators are imported for a commercial project (not under Decrees 47 or 449), several points shall be considered:

- Mode of transportation and target destination. Currently, most of the equipment is produced in China. Hence, depending on the destination in Russia, it may sometimes make sense to import equipment from Chinese factories directly to avoid double customs China-Germany – Germany-Russia.
- Choice of a suitable logistics company, which has working experience in Russia. Since it is not unlikely that document might be prepared incorrectly or questions arise with Russian customs, it is important to use the services of a logistics company which has local contacts to customs in Russia and are able to solve potential problems on site and quickly.
- Existence of a reception side – a local partner, which shall be either a registered individual entrepreneur, or an entity/company (state or private), able to receive cargo and sign a handover protocol.
- Correct preparation of the necessary documents for the customs and description of the cargo.

In Russia, the document "On approval of a single commodity nomenclature of foreign economic activity of the Eurasian Economic Union and a single customs tariff of the Eurasian Economic Union" applies. According to the document, each product entering Russia shall have a specific code in accordance with the "Commodity nomenclature of foreign economic activity" – TN VED (*Rus. ТН ВЭД*). In accordance to TN VED, the following codes are in place for energy generating equipment [315]:

- PV modules: solar panels, solar panel kits, silicon solar cells assembled in modules; non-electric water heating device (solar thermal collector) etc. – code 8541 40 900 0, import duty – 0%; excise tax – no; VAT-20%; necessary technical requirements proofs (that

PV modules are aimed at energy generation); certificate proving safety of the product; other documents which can be provided by a logistics company.

- PV inverters: solar inverter with integrated controller from solar panels with 24v power supply – code 8504 40 84 …, base import duty – 0%; excise tax – no; VAT-20%; necessary technical requirements proofs; certificate proving safety of the product; other documents which can be provided by a logistics company.
- Wind turbines: as wind equipment is very complex and often consists of many smaller different parts, each of them has an own code which needs to be searched in the TN VED catalogue. As an example, the following codes may be used: 8502 31 000 0 - Wind turbines: ISTA BREEZE wind turbines for converting wind energy into electrical energy; wind turbine generator (wind turbine or abbreviated RES) - a device for converting the kinetic energy of a wind flow into mechanical; 8538 90 910 0 - controller (module) between DNC and the TTETHERNET system of the wind generator (base import duty 5%), etc.
- Heat pumps: more than 3 kWp capacity – code 8418 61 001 9, base import duty – 7.5%; excise tax – no; VAT-20%; necessary technical requirements proofs; certificate proving safety of the product; other documents which can be provided by a logistics company; other air or vacuum pumps – code 8414 80 800 0; …, base import duty – 0%; excise tax – no; VAT-20%.

### 2.4.4 Determination of the Local Content (localisation) Coefficient

One of the most important criteria determining to what extent specific RE power plants can benefit from the capacity supply tender scheme and the electricity supply tender scheme (Decrees № 449 and № 47) is its localization coefficient (local content). The localization coefficient indicates how many of the components comes from Russia. The localization coefficient is determined according by Decree № 426 "On the Qualification of a Generating Object Operating Using Renewable Energy Sources". Each component of the PV installation or project development work has a specific percentage weight (see Table 6). Similar to PV projects, wind power plants must also meet the requirements regarding the local content (see Table 7). Those requirements are to be considered only in cases when the RES PP is constructed under the framework of Decree 449 or 47 and do not apply to private/state financed systems, microgeneration facilities or hybrid systems, neither including PV, nor small wind or a combination.

Regarding PV, the **calculation of the localization coefficient depends on the type of PV installation used: crystallin silicon or thin-film.** The overall localization coefficient for the plant is determined as the sum of its components, grouped in the categories indicated in the Table 6 (refers to silicon PV). It is important to note that the percentage set in Decree № 426 for each category cannot deviate from the value specified in Table 6 (i.e. it is either zero or the value specified per category). For example, if in category 4, the electrical connections between cells and modules are produced in Russia but the encapsulation material for the PV module is imported, the overall percentage for this category will be zero. Moreover, in case the origin of the constituent element of the power plant or work cannot be proved, the respective category will be assigned a zero-percentage level [75].

**Table 6 List of conditions for determining the localization of the generating facility operating on the basis of photoelectric conversion of solar energy using crystalline silicon technology**

| Category | | Percentage |
|---|---|---|
| 1. | Silicon (including recycled) and silicon ingots used in photocells produced in Russia | 20% |
| 2. | Silicon wafer (silicon cell) produced in Russia | 15% |
| 3. | Crystalline silicon solar cells produced in Russia, including the processing of the silicon wafer, | 25% |

| Category | | Percentage |
|---|---|---|
| | the additional structure for electricity flow as well as the final surface treatment | |
| **4.** | Electrical connection between the solar cells and modules as well the encapsulation materials for the PV modules produced in Russia | 5% |
| **5.** | Assembly, final connection of wiring elements and inverter testing performed in Russia | 12% |
| **6.** | Details and components of the supporting structures is produced in Russia, the needed metal is produced in Russia, as well as assembly of the supporting structure in completed in Russia | 5% |
| **7.** | The wiring and electrical equipment not listed above is provided by a supplier from Russia | 3% |
| **8.** | Site survey as well as the design of the power plant, including the drawings, is produced in Russia | 5% |
| **9.** | Assembly, inverter connections as well as other electrical installation work on the power plant site, except the work related to the connection to the grid, is performed in Russia | 5% |
| **10.** | Mounting on the power plant site for the construction of the foundation, assembly and installation of supporting structures, auxiliary elements and their components are produced in Russia | 5% |

**Source: Decree № 426, 2017 [75]**

As previously mentioned, since 2016 the localization coefficient for PV plants has been 70% to fully benefit from the support schemes on the wholesale as well as the retail market. This might seem as a high percentage requirement for a country only starting to develop its renewable energy sector, however, it has been reported that power plants with a localization coefficient of even 100% are already being constructed in Russia [76].

Regarding wind, the overall local content coefficient for wind plants is determined as the sum of its components, grouped in the categories indicated in Table 7. The same rules for the shares' calculation for PV systems apply to wind projects. For wind power plants there are more elements graded with different local content percentage rates due to the technical complexity of the wind power plant set up.

**Table 7 List of conditions for determining the localization of the generating facility operating on the basis of conversion of wind energy**

| Category | | Percentage |
|---|---|---|
| 1. | Wind turbine blades produced in Russia | 18% |
| 2. | Wind turbine blade angle control system produced in Russia | 3% |
| 3. | Wind generator gondola angle control system | 6% |
| 4. | Generator hub blank and its headband produced in Russia | 2% |
| 5. | Assembly of the wind turbine hub performed in Russia | 3% |
| 6. | Gearbox produced in Russia | 10% |
| 7. | Generator of a wind power turbine gearbox produced in Russia | 5% |
| 8. | Gearless wind power plant generator produced in Russia | 15% |
| 9. | Cooling system produced in Russia | 2% |
| 10. | Wind turbine drive shaft produced in Russia | 2% |
| 11. | Electricity invertor/convertor produced in Russia | 8% |
| 12. | Wind turret produced in Russia | 13% |
| 13. | Site survey and wind power plant design committed by Russian companies | 7% |
| 14. | Mounting on the power plant site for the construction of the foundation, assembly and installation of supporting structures, auxiliary elements and their components are produced in Russia | 7% |
| 15. | Assembly, connection of the control panel and electronics, wiring, cabling and testing, as well as other electrical installation work in a wind power plant, except for work on the technological connection to the grid | 7% |
| 16. | Wind turbine gondola frame produced in Russia | 2% |
| 17. | Assembly of the gondola in Russia | 3% |
| 18. | Electric transformers produced in Russia | 4% |

**Source: Order N1-r, 2020 [317]**

In total, local content share in a final setup of a wind power plant constructed between 2019 and 2024 shall reach 65%.

## 2.5 Financing of PV Power Plants

**Bank loans and credits to investors usually have an average interest rate of 10-11%.** One possible measure to bring the installed RE capacity to the planned level and attract more investors is be to bring down the loan rate to an estimated level of around 8%-9%. This would mean subsidizing from the state budget [77]. Currently, these measures are being discussed in the government, as such a decision could cost the state an additional 27 billion RUB (approx. 364 million EUR) [77].

As project financing, understood as non-recourse finance where the payback of loans is secured by project cashflows only, is restricted to large PV plants with an investment volume of several million EUR, **credits will likely be granted as private or corporate loans**, depending on the type of PV investor (private or corporate). The creditworthiness of the individual investor and, only to a lesser extent the risk profile of the project itself, will determine the interest rate and whether the loan will be granted at all.

## 2.6 Legal Framework Analysis

A legal framework for **regulative-driven PV investments** that include support schemes for PV investments is an important first step for igniting the Russian PV market. However, the **current support system entails a number of risks for PV investors** that can substantially reduce interest for PV investments both in the retail and the wholesale market.

The identified risks are structured according to their appearance:

- in the framework of the implementation of the support scheme
- within the legal framework governing the support scheme
- in the financial framework as a consequence of the support scheme and other factors

### 2.6.1 Risks Concerning Implementation of the Support Scheme

During the implementation of the support scheme, PV investors face several risks that could impede their projects. A group of risks for investors result from their dependency on a large number of authorities selecting projects, be it on the regional or federal level.

The most telling example for this risk is that **the federal authorities have to formally approve an installation as being 'renewable' to benefit from the support scheme**. This is a requirement for investments in both the retail and the wholesale market. However, **this approval can be only issued after the installation has been built.** As a consequence, investors have to build the PV installations before knowing whether or not their investment is eligible. Russian experts report that this risk is realistically quite low because a PV system is a PV system, which is difficult dispute.

Another example is that **the amount of the financial support installation get is calculated only when the construction phase is finalized** and the objects are connected to the grid and qualified as "renewable" generating facilities. Experience from other European PV markets shows that such fundamental decisions at the very end of a project process have a very negative impact on planning security and therefore the investment security of PV projects.

For the retail market, another risk, besides the abovementioned ones, is the **inconsistency of legislative acts.** The investor has to present a special certificate required for the successful transaction of the generated power and to receive the remuneration for the energy as well as for the capacity. However, the capacity is not considered a commodity in retail market rules and thus it is not clear how a certificate can be issued. Plant operators can end up in a situation where they are unable to sell their capacity because the respective certificates have not been issued.

Another risk is that PV plants receiving support under the capacity supply tender scheme in the wholesale market have to **fulfil certain availability criteria expressed in the capacity factor** of the installation. If they fail to meet these criteria, the remuneration will be reduced.

Since the sun, the source for PV plants, is intermittent, it is possible that plant operators suffer from reduced income for reasons out of their control. This requirement is an additional risk from the perspective of investors.

The **local content regulation** in Russia constitutes an additional risk for project developers because of the development of costs, the installation and the O&M. This depends on the extent to which the Russian PV market develops. If there is a sufficient market and enough producers for components to create competition, this risk should be relatively low. However, if the market stays small, these risks will increase.

### 2.6.2 Risks Concerning the Framework Governing the Support Schemes

With regard to the legal framework that governs the support schemes, a major risk is **the lack of transparency when assessing the funding of PV projects**. Financing RE projects that are part of regional programs is carried out in a manner established by the budget legislation of Russian Federation. The distribution of these budgets is not published. For that reason, it is unclear whether or not the foreseen budget is sufficient to cover the costs of the support schemes, which increases the risks for investors even further.

Another risk is related to the **complex structure and wording of the legal texts** on which the support schemes for RE are based. This point was illustrated by the law firm Rödl & Partner in 2017 with regards to Decree 449: “it is questionable how much legal certainty Decree No. 449 actually offers, since the calculation of capacity prices is based on an extremely complex form, which for many is still rather opaque” [78]. The authors of this study, having discussed this topic with Russian stakeholders, believe that this comment is still true today and could also be extended to other legal documents and acts.

**Seeking early legal advice** with regards to the relevant national laws and their “correct” interpretation is an important step for business development activities in every new target market and Russia is certainly no exception to this rule.

### 2.6.3 Risks Concerning Financial Framework

**The risks described above have a negative impact on the bankability of projects.** These risks are also reflected in risk premiums that lead to significantly higher cost of debt from banks: Investors have to deal with interest rates of 10-11% for their debts which are 5 to 10 times higher than current interest rates for PV projects in Germany. In addition, investors may ask for higher returns because of a higher perceived risk, which has to be generated by project revenues.

This, in turn, **leads to higher macroeconomic costs for the deployment of PV**, which again, leads to higher insecurity that the support scheme will be amended. Therefore, the high interest rates are both a consequence of risks and risks in themselves.

# 3. PV Market and Potentials in Krasnodar Krai

In the following chapter, general information on Krasnodar Krai's power sector and specific data concerning the local PV market is outlined and relevant PV business models in Krasnodar Krai are introduced. The regionally-specific regulatory framework for renewable energy development is also discussed.

## 3.1 Energy Market of Krasnodar Krai

### 3.1.1 Electricity Generation, Consumption and Demand

Krasnodar Krai is one of the **fastest growing and, at the same time, most energy deficient regions of Russia.** Unlike most other Russian regions, the peak electricity consumption in Krasnodar Krai occurs during summer due to its climatic condition. The region has relatively mild winters and hot summers with temperatures exceeding 35°C. Industrial buildings, offices and private households widely use air conditioning systems during the hot summers[79]. Energy consumption has increased by 31.2% from 18,333 GWh in 2007 to 26,639 GWh in 2018.

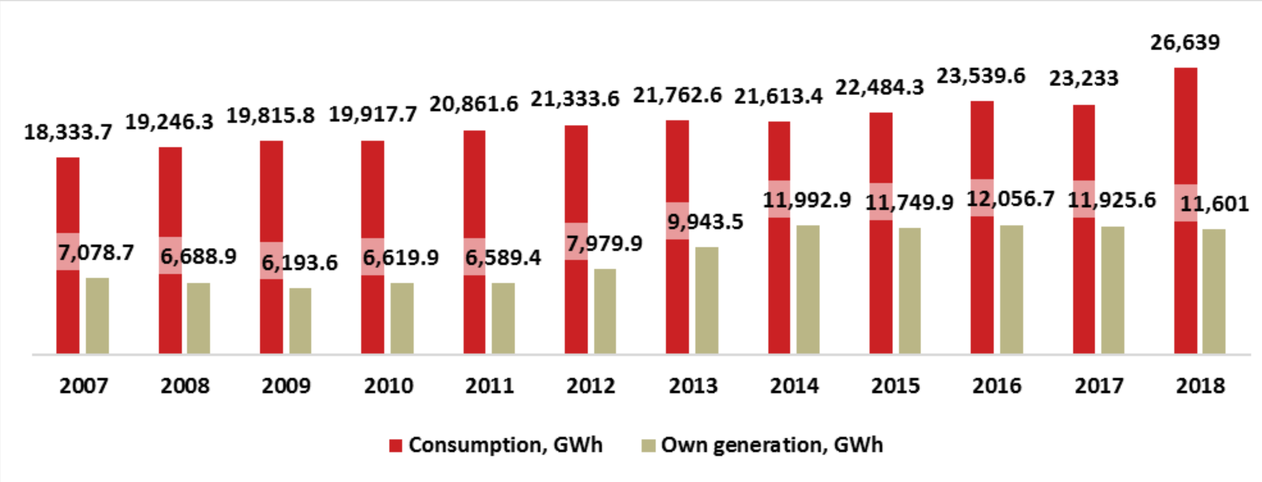
**Figure 17 Map of Russia, Krasnodar Krai on the map**


**Source: eclareon 2020 generated with amCharts Pixel Map**

The annexation of the Crimean Peninsula put additional pressure on the regional power system: After the Ukrainian power system stopped supplying electricity to the peninsula, Crimea has become fully dependent on the UPS and Krasnodar Krai's power system was forced to bridge this supply gap and "share" its energy with Crimea.

As a result of rising pressure on the grid and power generating facilities, **blackouts happen on a regular basis and disrupt businesses and the population**. Figure 18 illustrates how regional electricity consumption has developed throughout the years and compares energy consumption and domestic energy generation in Krasnodar Krai.

**Figure 18 Energy consumption and domestic energy generation in Krasnodar Krai within latest 11 years, GWh**




**Source: Federal State Statistics service of the Russian Federation, 2018 [30]; data for 2018 – directly from Ministry of Fuel and Energy and Communal Services of Krasnodar Krai, 2020**

On August 8th 2018, regional electricity peak consumption (load) broke a historic record and reached a load of 5.03 GW, which was 433 MW higher than the previous peak consumption in July 2016 [80].

**Currently, the region produces up to 44% of the electricity it consumes annually**. The supply gap is imported from neighboring regions and purchased on the wholesale market. In 2018, regional electricity generation in Krasnodar was only 11.6 TWh while electricity consumption amounted to 26.64 TWh [82]. The growth of consumption from 2017 to 2018 was 15%, while domestic generation for the same period dropped by 2.7%.

**Experts forecast drastic growth in the power consumption of the region** due to the expansion of industries, the development of seaports and intensive housing construction. The annual growth of electricity consumption is assumed to reach 1.7% which may result in an overall increase 12.4% for the period 2016-2023 [83].

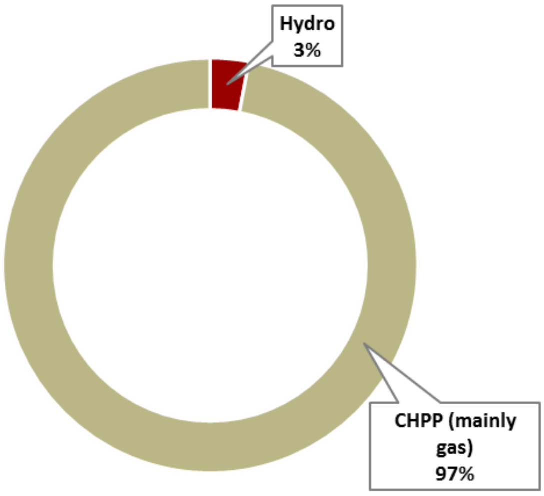
### 3.1.2 Regional Electricity Market Stakeholders

The electricity market in the region has several stakeholders:

- Two main electricity retailing companies (guaranteeing suppliers): "TNS Energo Kuban" and "NESK"
- Electricity transmission companies: two majors are "Kubanenergo (ROSSETI)" and "NESK-electroseti" (independent); other private small grid operators
- Eight major electricity generating facilities (including Krasnodar CHPP (1.12 GW); Krasnopolyansk HPP (28.9 MW), Sochi and Dzhubga fossil fueled power plans (160 MW and 198 MW), Adler fossil fueled power plant (351 MW)
- Some energy blocks (power units) of industries and own generation facilities (entities and private) – in total 303.7 MW installed capacity [84].

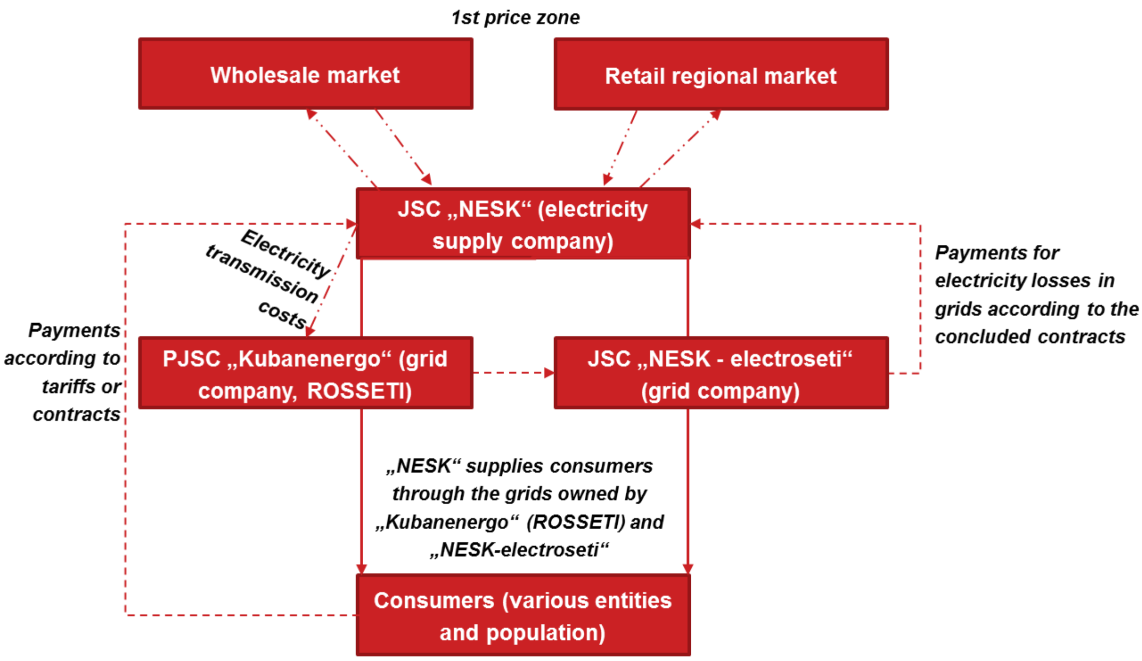
In 2018 the power plants belonging to different electricity generation companies had a **capacity of 2,321.3 MW**, mainly formed by gas-fueled CHPPs (see Figure 19) the largest generating object is the "Krasnodar CHPP" owned by "Lukoil-Kubanenergo" [82]. The majority of currently installed and operating power plants in the region is gas-fueled. In 2019, a construction of a new large CHPP in Taman region started, the installed capacity will reach 500 MW, the launch is planned for spring 2021. However, it is likely that the opening of the power plant and its connection to the energy system of the region will be postponed for 1-2 years due to ongoing negotiations with the gas infrastructure owner in the region [303].

**Figure 19 Installed capacity of UPS-connected power plants in Krasnodar Krai in 2018**




**Source: eclareon 2020 based on data from Ministry of Fuel and Energy and Communal Services of Krasnodar Krai [310]**

**Figure 20 Scheme of functioning of the electricity markets in Krasnodar Krai**




**Source: eclareon 2019**

The **electricity retailing companies** are also called “guaranteeing suppliers”, the first “TNS Energo Kuban” PJSC, which is the main electricity retailer in the region, covers about 55% of the territory. The second, “NESK” JSC, was created in 2003 with the aim to form a natural competitor for the “TNS Energo Kuban” and avoid a monopoly in the market. “NESK” manages about 30% of the territory of Krasnodar Krai.

Both companies purchase electricity from the wholesale and retail markets and sell it to consumers in the retail market (population, industries) and to consumers in the wholesale market [85]. Other energy retailers generate the remaining 15% electricity for the territory.

The **electricity distribution and transmission companies** (grid companies) present in the region are: “Kubanenergo” owned by ROSSETI (responsible for the grid 0.4-110 kV), JSC “NESK electricity grids” owned by “NESK - electroseti”, two grid companies owned by “FSK UPS” and some small private grid operators. “Kubanenergo” and “NESK - electroseti” manage a major part of the grids. “Kubanenergo” is responsible for rural and high-voltage grids in the region, while “NESK - electroseti” manages urban grids.

As electricity prices in the region grow, electricity sales companies are raising sales surcharges and grid companies are increasing the costs of transmission, and **more industry consumers are switching to the self-generation**. Examples are the butter factory “Krasnodarsky”, “Verhebakansky Cement Plant”, wine factory “Fanagoria”, winery “Abrau-Durso”, a retail food supermarket chain “Magnit” [86]. The majority of these private plants are powered by natural gas. Examples include:

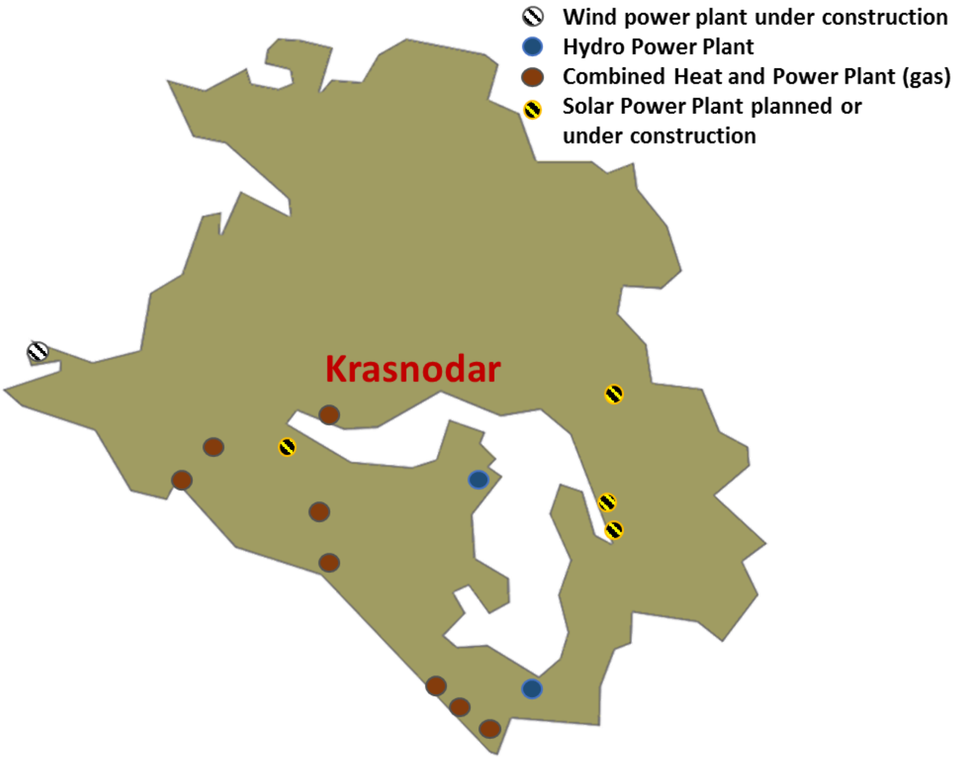
- The winery “Abrau-Durso” has installed gas turbines with a capacity of about 500 kW;
- The “Krasnaja Poljana” ski resort near Sochi has 10 MW of gas generation turbine;
- The Guest house “Mys Vidny” in Sochi has installed 1.8 MW of gas turbine in addition to the existing grid [87].

One of the reasons for the rise in electricity prices in Russia is that a heft of power is being generated with the help of natural gas, whereas in Krasnodar, the **price for gas on the wholesale market is 7-10% higher than average gas prices in central Russian regions** [88]. In 2018, electricity generation in the part of UPS of Krasnodar Krai increased by 4% (see Table 8), whereas in-house generation (at registered power plants not connected into the UPS, incl. the own generating facilities of industries) grew by 12.5% to 340.9 GWh. **Construction energy generating facilities fueled by gas is more profitable than purchasing the same electricity volume from the grid.** According to calculations made by Andrej Smirnov, the analyst of “Energo Capital”, a self-owned 2 MW power plant will have a payback period of 5 years, whereas the annual electricity demand volume generated by it will cost 58% less than if purchased from the grid [88].

The energy retailing and generating company “Magnit Energo” (a subsidiary of the “Magnit” supermarket chain), has costs of 1 kWh of electricity for their own needs resulting in 1.5 RUB (approx. 2 €ct), which is cheaper than residential tariffs for private households [89]. “Magnit Energo” use mostly gas turbines to generate electricity. Simultaneously, the company may sell the surpluses to other consumers on the retail market for ≈3.48 RUB/kWh (5 €ct/kWh) [89] which is cheaper than the prices for entities on the same retail market (see information on prices in Table 9). “Magnit Energo” has 33.6 MW of installed energy generating capacity in Krasnodar Krai and more in other Russian regions [90].

Figure 12 in the previous chapter illustrated a relation of different parts of electricity prices. It clearly shows that **40 to 70% of the end energy price which consumers pay are services of grid operators**, basically, fees for energy transportation and market surcharges of energy sales companies. In cases of independently owned in-house generation, these parts of the end price are abolished or minimized due to various factors which include: shorter distances for electricity transportation; own grids; no distributors (energy producer = energy sales company).

**Figure 21 Schematic map of Krasnodar Krai with the location of major power generating facilities in 2020**




**Source: eclareon 2020 generated with amCharts Pixel Map**

### 3.1.3 On-Grid Generation

In Krasnodar Krai, **more than 90% of the electricity is produced by energy generating facilities connected to the grid.** These grids are also a part of the UPS of Russia. As it has already been mentioned in the text above, Krasnodar Krai is an energy deficient region, with more than 40% of consumed electricity being imported.

Table 8 below includes information about privately owned in-house electricity generation in the region, imported energy and per capita generation.

The table shows that in-house electricity generation is increasing and that Krasnodar Krai is one of the most energy deficient regions in the country.

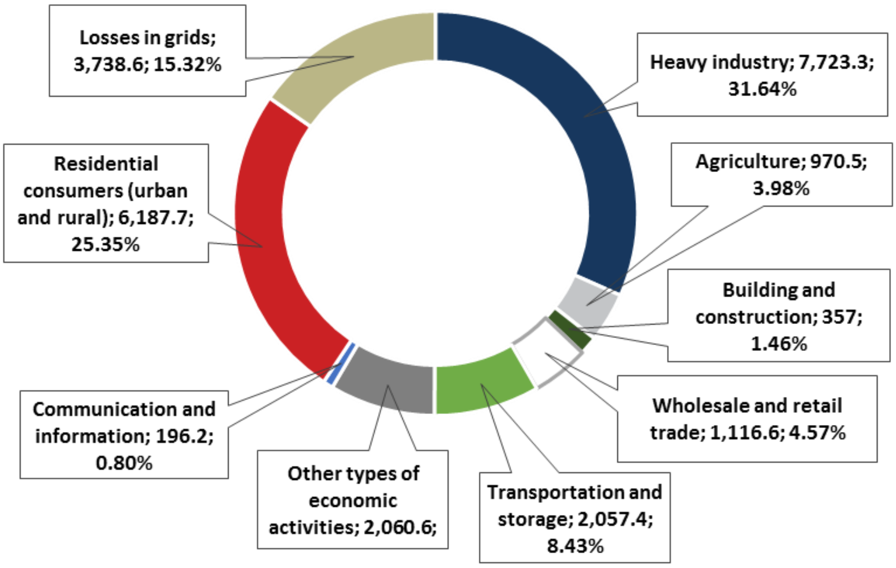
**Table 8 Electricity Generation Profile in Krasnodar Krai, years 2010-2018**

| Year | Total electricity generated (thousand GWh) | Total energy consumption (% from electricity generation) | Total electricity import (% of consumption) | Per capita electricity generation (MWh per capita) |
|---|---|---|---|---|
| 2018 | 11.60 | 229.6 | 56.5 | 2.2 |
| 2017 | 11.93 | 194.8 | 48.7 | 2.1 |
| 2016 | 12.06 | 195.2 | 48.8 | 2.1 |
| 2015 | 11.75 | 191.4 | 47.7 | 2.1 |
| 2014 | 11.99 | 180.2 | 44.5 | 2.2 |
| 2013 | 9.94 | 218.9 | 54.3 | 1.8 |
| 2012 | 7.98 | 267.4 | 62.6 | 1.5 |
| 2011 | 6.59 | 316.6 | 68.4 | 1.2 |
| 2010 | 6.62 | 300.9 | 66.8 | 1.2 |

**Source: Based on Federal State Statistics Service of the Russian Federation, “Electricity Balances 2018” [30]; Federal State Statistics Service of the Russian Federation, “Electricity generation per capita”, 2019 [127]**

The bulk of electricity consumption in the region is committed by industrial facilities (30% of the total consumption), while the second largest group of consumers is are residential consumers consuming 26% of energy in the region. Losses in grids amount to over 15%, a high rate which indicates depreciated power grids. Another reason for such high grid losses in grids is the fact that nearly half of the consumed energy in the region is imported and transmitted through high voltage grids from neighboring regions. The further the distance to the end consumer, the more energy is lost.

**Figure 22 Electricity consumption by sector in Krasnodar Krai, 2018, million kWh and %**




**Source: Federal State Statistics Service of the Russian Federation, "Electricity Balances 2018", 2019 [30]**

### 3.1.4 Off-Grid Generation

There is little data on off-grid generation in Krasnodar Krai. According to media sources, there are examples of private gas, diesel, hybrid and PV generating facilities which are not connected to the grid and are not part of UPS. It is hard to estimate the volume of such electricity generation, due to the fact that most of it is not registered and/or published. Generating facilities owned and built by entities (see chapter 3.1) may be also sometimes seen as off-grid generation.

## 3.2 Investment Framework for PV

### 3.2.1 Solar Irradiation

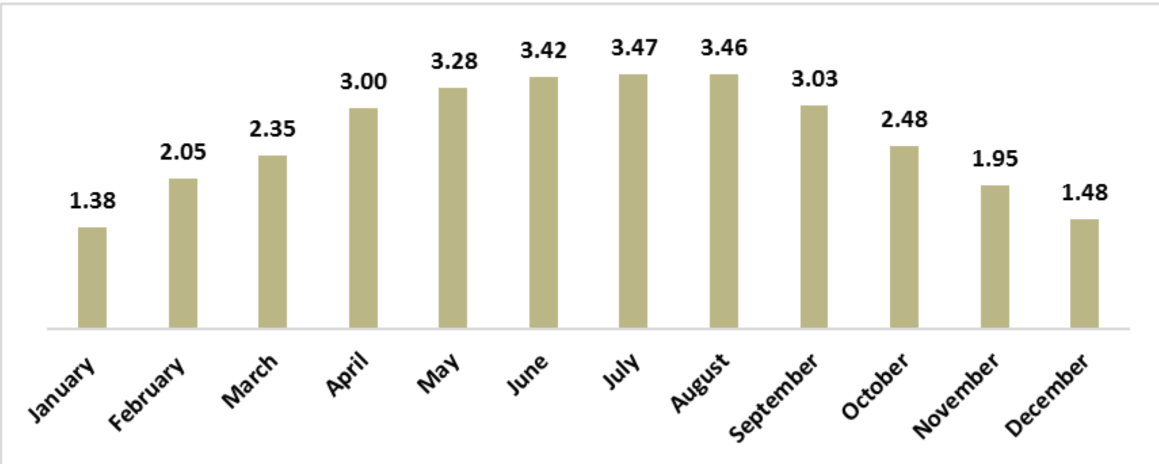
**Krasnodar Krai is one of the Russian regions with the highest solar irradiation**. The map of the region (Figure 23) gives an overview of the solar radiation intensity, which is highest in the coastal area close to Anapa and the Kerch Strait and lowest in the south-western mountainous areas.

**Figure 23 Annual Global Tilted Irradiation (GTI) Krasnodar Krai**


**Source: Global Solar Atlas [130]**

The region gets over 2,000 hours of sun annually, which is around 280 days per year. In comparison, Moscow get 10 times less sun. The average yield on the horizontal surface reaches 1,400-1,700 kWh/m$^2$/year [92]. Figure 24 presents information on how much energy a 1 kW PV system generates on average.

**Figure 24 Average hourly generation by 1 kWp PV system in Krasnodar city, kWh**

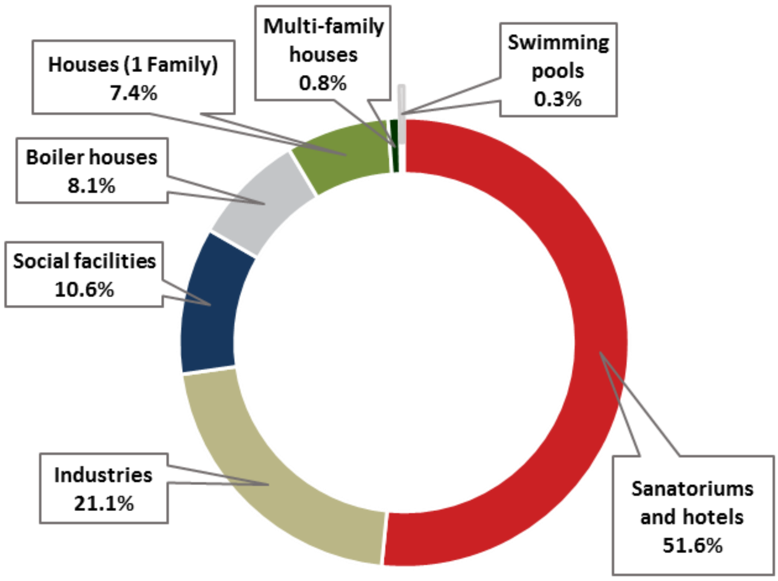



**Source: "NSiA" PV installing company, Krasnodar, "Characteristics of a complex 1 kWp PV system "Datscha", 2018 [93]**

### 3.2.2 Target Customers

Although there is no official data, different sources say that in 2013, there were **151 known PV and solar thermal systems in Krasnodar Krai with a total estimated capacity of 5.3 MW**. Most of this capacity (over 2.5 MW) served the needs of sanatoriums and hotels in electricity and heat [105], only some more than 8% of PV systems were used by residential customers. Figure 25 shows the structure of the known PV systems in Krasnodar Krai in 2016 by type of consumer [104].

**Figure 25 Structure of PV systems by type of user in Krasnodar Krai**




**Source: Based on "Sustainable Building Technologies", 2016 [105]**

According to research done by eclareon, the overall installed PV capacity is most likely higher and reached up to 12 MW by the end of 2019. There are currently no large-scale solar power plants participating in the retail or wholesale energy markets but **solar energy is used locally in smaller projects**. Until 2018, there have been no projects under the long-term power delivery agreement (see 2.1) [94]. The price for electricity generated by PV systems is estimated to be competitive with the price of energy from the grid, this is discussed further in section 3.4.3. Electricity prices and tariffs for residential consumers and average entities are presented in Table 9, while Table 10 presents electricity prices for non-residential consumers of different groups for September 2019 (latest freely available data on the moment of the data search).

**Table 9 Some electricity prices in Krasnodar Krai**

| | Time period | | | |
|---|---|---|---|---|
| | 2020 2/2 | 2020 1/2 | 2019 2/2 | 2019 1/2 |
| | Retail market, RUB/kWh (€ct /kWh) with VAT 20% | | | |
| Urban population with gas stoves and groups equated to them (single rate tariff only) | 5.02 (7) | 4.81 (7) | 4.81 (7) | 4.69 (7) |
| Urban population with electric stoves and rural population, (single rate tariff only) | 3.52 (5) | 3.37 (4.8) | 3.37 (4.8) | 3.28 (4.7) |
| Some entities, average electricity price in 2018, RUB/MWh (€ct /kWh) with VAT 18% (since 2019, VAT is 20%) | | | | |
| Constructing and building companies | 7,115 (10.2) | | | |
| Agricultural consumers (e.g. farms, canneries, etc) | 7,647 (11) | | | |

**Source: *Federal State Statistics Service, Krasnodar Krai department, "Krasnodar Krai in Numbers, 2018", 2018 [96], ** Time2Save, "Base of electricity tariffs for enterprises", 2019 [97]**

**Table 10 Some electricity prices for non-residential consumers in Krasnodar Krai, September 2019**

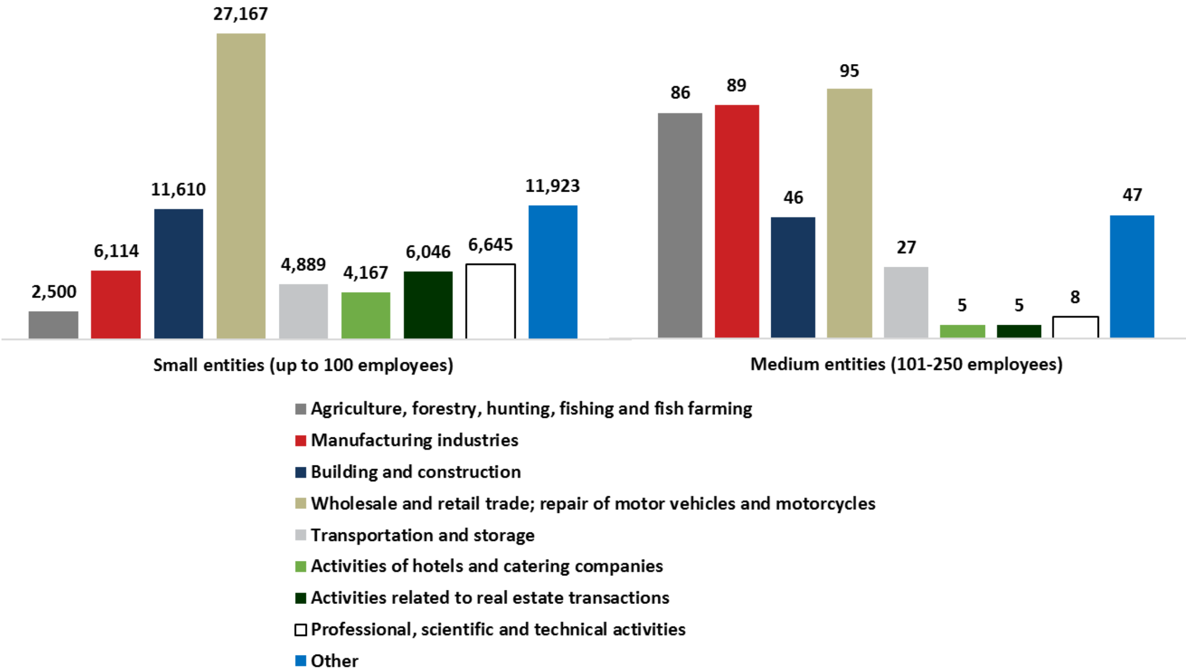
| Type of voltage / type of tariff | High voltage (110 kV and higher) | Middle first voltage (35 kV) | Middle second voltage (20-1 kV) | Low voltage (0,4 kV and less) |
|---|---|---|---|---|
| The first price category, RUB / MWh (EUR/MWh) (with VAT), for September 2019, non-residential consumers under 670 kW loads | | | | |
| Single-rate tariff | 6,636.36 (95.05) | 7,020.13 (100.5) | 8,517.86 (122) | 9,947.00 (142.4) |
| The second price category, double day zone tariff, RUB / kWh (EUR/kWh) (with VAT), for September2019, non-residential consumers under 670 kW loads | | | | |
| Night zone | 4,095.91 (58.7) | 4,479.68 (64.2) | 5,977.42 (85.6) | 7,406.56 (106.1) |
| Day zone | 8,818.15 (126.3) | 9,201.92 (131.8) | 10,699.66 (153.2) | 12,128.80 (173.7) |
| The second price category, three day-zones tariff, RUB / MWh (EUR/MWh) (with VAT), for September 2019, non-residential consumers under 670 kW loads | | | | |
| Peak zone | 19,434.6 (278.3) | 19,818.4 (283.8) | 21,316.1 (305.3) | 22,745.3 (325.7) |
| Semi-peak zone | 6,794.9 (97.3) | 7,178.7 (102.8) | 8,676.4 (124.3) | 10,105.5 (144.7) |
| Night zone | 4,095.9 (58.7) | 4,479.7 (64.2) | 5,977.4 (85.6) | 7,406.6 (106.1) |
| The third price category, RUB / MWh (EUR/MWh) (with VAT), for September 2019, non-residential consumers between 670 kW and 10 MW loads | | | | |
| Non-regulated price, differs depending on the contract type, hour and month | Av. 3,840-4,900 (55-70) | Av. 4,200-5,040 (60.1-72) | Av. 5,640-6,720 (80.8-96.2) | Av. 7,080-8,160 (101.4-117) |
| The third price category, RUB / MWh (EUR/MWh) (with VAT), for September 2019, non-residential consumers over 10 MW loads | | | | |
| Non-regulated price, differs depending on the contract type, hour and month | Av. 3,696-4,860 (52.9-69.6) | Av. 4,080-5,040 (58.4-72) | Av. 5.020-6.600 (71.9-94.5) | Av. 6,960-8,040 (99.7-115) |

**Source: Time2Save, "Base of electricity tariffs for enterprises", 2020 [97]**

**The price for entities is often much higher than the average in Russia and in Krasnodar Krai in 2018 it reached 9 RUB/kWh (13 €ct/kWh).** The load ranges are as follows: SMEs have loads up to 670 kW per month and rarely more, while large entities and industries consume up to 10 and more MW each month.

In 2017, there were 408 small and 81,061 medium size entities in Krasnodar Krai, Figure 26 below illustrates major representatives of small and medium entities of Krasnodar Krai in 2017. An important fact is that similar statistical numbers for 2018 presented by other agencies or state structures, e.g. the official web page of small and medium business in Krasnodar Krai, drastically differ from the ones used by the State Statistical Service of Russia (Krasnodar Krai department), for the same and the previous year [304], [305]. According to them, **in 2018, there were 1,142 companies of different size offering sleep-over services (basically, hotels, motels, hostels and similar); while the total number of companies connected to touristic activities (incl. also restaurants) was 4,977**. As this category is of special interest within the scope of this study, forming a part of potential PV consumer group, and these numbers match to figures from 2017, eclareon assumes this number to be a close to the actual number.

**Figure 26 Quantitative and qualitative composition of medium and small enterprises in Krasnodar Krai, 2017**




**Source: Federal State Statistics Service, Krasnodar Krai department, 2018 [98]**

### 3.2.3 General Perception and Acceptance of PV

In Krasnodar Krai, there is increasing interest in deploying renewable energy to increase electricity generation. The **municipalities and administration are aware of the possibilities and generally have a positive attitude towards solar power**, as statements from the Deputy Chairman of the Legislative Assembly of Krasnodar Krai, Sergey Altukhov [99], vice-mayor of Krasnodar Krai, Vasiliy Shvetz [100] and other policy makers indicate. However, the big leap towards PV development in the region has not happened due to the lack of regional regulatory support and high local turnkey system costs leading to long payback times for PV installations [104].

At the same time, there is **growing interest in application of solar PV from SMEs and industries**. There are examples of companies in agriculture, tourism and other sectors in the region that are eager to decrease their operational expenditures and use PV or hybrid PV-diesel/gas energy generating facilities. These solutions lead to a decrease in fuel costs and allow them to build agricultural or commercial sites independently from grids. Companies become interested in PV and other sustainable power technologies and energy efficiency solutions when they get more information about them. Hence, one of the push-factors for such technologies is capacity building to increase the awareness and spread knowledge about renewable energy and energy efficiency technologies.

**Different from the SMEs knowledge about PV solutions is limited among ordinary citizens.** Addressing renewable energy use should be committed in conjunction with global climate change which are usually discussed by a rather narrow circle of NGOs and scientists in Russia. Ordinary people hardly think about the alternative variant of electricity production Some do not care about PV development; others do not see the necessity in PV and think that a new coal or gas power plant would be the best solution. It is to be hoped that the situation changes soon due to the amendment of the law on microgeneration (Law 471) (see section 2.1.5). The fact, that this law allows to cover not only personal energy demand, but also production needs, gives small entities the possibility to use the mechanism of the law, which grants opportunities for both for residential consumers and SMEs, raising the attractiveness of RES.

## 3.3 Region-specific regulatory & legal framework

**Federal support schemes for renewable power generation are also applicable to Krasnodar Krai**. The support scheme for the wholesale market – capacity supply tender (see Section 2.1.1), defined in Decree № 449, is not Oblast specific and therefore projects from all regions, including the Krasnodar Krai can participate in the tender. Currently, there are no such projects in Krasnodar Krai and none are planned.

In the **retail market**, as defined by the Decree № 47 (see chapter 2.1.2), electricity supply tenders are organized at the regional level following the rules stipulated by decree and its related regulations. On 30 August 2016, the Ministry of Fuel and Energy Complex and Housing and Communal Services of Krasnodar Krai approved the Order № 289.1 "On Approving the procedure and conditions for the competitive selection of generating facilities that operate on the basis of renewable energy sources, for which the sale of electricity is planned for the retail market, in the scheme of development of the power of Krasnodar region, requirements for appropriate investment projects and the criteria for their selection" [101].

The first tender for the selection of projects for electricity generation for the retail market that will compensate for the transmission grid losses in Krasnodar Krai took place at the beginning of 2018 [101].[102] The call for applications was announced by the Ministry of Fuel and Energy Complex and Housing and Communal Services of Krasnodar Krai. After the application period closed on 25 January 2018, there was only one single application. The project envisaged the construction of 18 PV power generating facilities with individual capacities up to 5 MW that in sum will have 90 MW. The total planned investments are 9.8 billion RUB (about 111 thousand RUB investments for 1 kWp) [306].

According to the decisions published on 20 February 2018 by the Commission for Project Selection, the bid was evaluated based on the following criteria:

- Capital expenditure for the construction of 1kW of power generation
- Payback time
- Planned operation and maintenance (O&M) expenditure for 1 kW installed capacity
- Expected variable cost for the production of 1 MWh
- The number of previously implemented projects
- The local content coefficient

Each criterion was evaluated on a 10-point scale. The bidding project accumulated 40 points and was selected as the winning project. However, the project is still not launched and has not been included in the official "Scheme and Programme of the Development of the Energy sector of Krasnodar Krai for the period 2019-2023", which is an annual report describing the current regional energy sector and major plans of its development. Similar documents are published every year for each region.

The company which won the tender ("Renewable Energy Sources" Ltd.) was given directions to design a process of technological connection of the planned SPP to the power grids, which is currently lacking, otherwise, it is impossible to calculate energy costs and end electricity tariff which is to be paid to the company [103]. The tariff will be calculated once the construction phase is finalized and the objects are connected to the grid and qualified as generating facility operating on renewable sources in accordance with Decree № 426. The qualification is done by the regulatory body NP "Market Council". The other PV project is to be implemented by "Avelar Solar Technology" ("Hevel") with a total capacity of 73.5 MW [310].

Additionally, a wind power park of 76.23 MW installed capacity consisting of 22 wind turbines is planned as in investment project, initiated by Spanish company "Elwan Power" LLC. The land has already been allocated; total planned investments reach 7.87 billion RUB. The WPP is planned for 2020 [310].

Besides the federal laws promoting renewable energy sources, **Krasnodar Krai also has regional specific regulations**. The law № 723-K3 'On the use of renewable energy resources in Krasnodar Krai was adopted on 7 June 2004 establishing the following main principles for the use of RE sources:

- The economic profitability of using RES instead of conventional ones
- Advantages in terms of energy savings
- The environmental advantages of using RES instead of conventional energy
- Legal support and economic incentives from the authorities of the Krasnodar Krai to support the RES use.
- Priority of construction of RES generating facilities is given to areas that are remote or have a low-quality electricity grid; tourism areas with high population density and polluted air; for natural reserves and specially protected natural areas in ecologically clean areas, places of mass recreation and treatment of the population RES are the most preferable sources of energy supply

**The financing of renewable energy (RE) projects is not described and explained in detail in the law, therefore leaving room for interpretation**: It simply states that financing projects that are part of the regional programs is carried out in a manner established by the budget legislation of the Russian Federation. For other RE projects, that are not part of the regional program, financing can be obtained from the regional budget on the condition that the money be returned. Additionally, investment can be obtained from Russian or foreign investments or other sources stipulated by the country's legislation. The tariffs for the electricity generated from the RE sources are calculated in line with federal laws for tariff calculation.

The current RES share in the region is 2.6%. In order to increase this share, **Krasnodar Krai adopted three programs to promote RES use for the period of four, five and ten years** respectively. According to the ten years' program, namely the "Energy saving and increasing the energy efficiency of Krasnodar Region for the period 2011-2020", by exploiting the RES potential of the region, the electricity generated could be increased by 1,300 MW replacing the conventional power facilities. At the same time this will result in increasing the energy supply for households, the public sector, tourist and recreational objects from renewable and environmentally friendly sources [104].

## 3.4 Regional PV business models

Following the classifications of business models, chosen for this report and described in section 1.3, the situation pertaining to these 3 business models in Krasnodar Krai is described in the following subsections.

### 3.4.1 Model 1: PV parks

There are no large MW SPPs in Krasnodar Krai so far, the first projects are currently in a preparation stage (see chapter 3.3). In case of realization, the cumulated installed PV capacity in the region will result into 163.5 MWp (excluding existing small scale and off-grid PV).

Simultaneously, there are examples of enterprises and budget organizations that get electricity from PV modules simultaneously having a grid electricity available. As mentioned in chapter 3.1, for entities (commercial companies, industrial consumers, various registered businesses incl. offices) it is often cheaper to construct an independent energy generating facility rather than invest time and money in the grid connection process or buy electricity from an energy sales company. Some examples:

- In Anapa, a coastal touristic city, one of the largest rooftop PV plants was installed in 2019 on the roof of the corporate recreational center “SIBUR-South” owned by “SIBUR” (a company producing and selling petrochemical products on the Russian and international markets). The installed capacity is 471.5 kWp, the project contractor is Hevel. The system is located on the roofs of several buildings and covers up to 100% of the daily consumption [307].
- Several rooftop PV power plants at industrial facilities and office buildings in Krasnodar Krai, completed by “NSIA-ENERGY” company, e.g. a PV plant at 2 office buildings in Krasnodar (60 kWp and 50 kWp); at an industrial facility (120 kWp); at 2 agricultural facilities in the village of Staronizhnestebliyevskaya (see Figure 28) (according to the assumptions of eclareon based on the photos of the facilities) (100 and 50 kWp) [308].
- In Timaschowski (Krasnodar Krai) an autonomous 4.5 kW PV power plant at an agricultural entity Premix (producer of compound feedstuff)
- Rooftop water heating system in a state hospital of Anapa city (solar thermal)
- 5.4 kW PV power station at the Ust-Labinsk city hospital
- 70 kW rooftop PV system on the railway station in Anapa (yearly generation exceeds 84,000 kWh), installed by German “Viessmann”[107]
- 30 kWp (120 solar modules 270 W each) rooftop PV system in Krasnodar, on the roof of “Aloe Center”, a local spa-center. The existing PV system covers most of the energy consumption at daytime during the summer, the remainder is automatically taken from the grid. A managing director initiated this project and was willing to comply with the brand of environmentally friendly enterprise (basically, marketing reasons). The secondary reason was a desire to save energy costs because a spa center consumes a lot of electricity - a PV system helped them to reduce their usual electricity bills by 30%.

**Based on the available information, eclareon estimates the total installed capacity of private non-residential rooftop/ground mounted PV systems in Krasnodar Krai to be between 4 and 6 MWp.**

**Figure 27 Hybrid PV-grid system; rooftop 30 kW PV solution on the roof of "Aloe Spa" Center in Krasnodar**


**Source: eclareon 2018**

**Figure 28 Satellite shot of a 100-kWp rooftop PV system in village Staronizhnestebliyevskaya in the middle of construction activities, 2019**


**Source: eclareon 2020, screenshot from "Yandex.maps"**

### 3.4.2 Model 2: Off-grid PV & Hybrid Systems

**Diesel (or petrol) generators are the most well-known solutions for remote areas with no grid connection or with regular blackouts. In Krasnodar Krai, many households and entities also use gas generators, especially during summer.** In 2020, the price for 1 l diesel reached 46 RUB (66 €ct), 1 $m^3$ natural gas cost 6.43 RUB (9 €ct).

Southern Krasnodar Krai is a mountainous region where **resorts, sanatoriums and camp sites** are situated. Examples are the ski resorts and sanatoriums of Lago-Naki, mountainous part of Mostovsky district, areas of the Malaya Laba river with their developing tourism industry, coastal areas of the Black and the Azov seas, hotels on the banks of lakes rich in fish. There are around 20 registered large sanatoriums in mountainous areas and some small private hotels and camps (approx.15-20), which are not often mentioned in official statistics.

Additionally, **about 4 to 10 settlements still have no connection to the electricity grid** due to the hilly terrain. Furthermore, off grid areas exist on flatland, for example, **new settlements or newly built districts of existing settlements, where grid and gas pipes have not been connected to houses during construction**. Very often, services for connection to the grid and gas pipes are expensive, therefore consumers need to search for other solutions, such as diesel generation. For example, for a private household (gas consumption less than 5 cubic meters/hour), connection to a gas pipeline in 2019 could reach 100,000-200,000 RUB (1,432-2,864 EUR), while for an entity (non-residential consumer) consuming up to 15 cubic meters/hour, the technical connection could overstep 10 million RUB (143,204 EUR) [109]. Along with the development of technologies and growth of the popularity of RES, PV generation enters the market as well and hybrid PV-diesel systems gain popularity.

One of the industrial sites producing particleboards installed a 27-kW rooftop PV system to supply itself with electricity [110]. The building was constructed in Krasnodar Krai in an area far from the grid and was firstly equipped with a 30-kW diesel generator. Later, the PV system was built and afterwards the building was connected to the grid. Now the PV system produces enough electricity to feed the working process, air-condition during summer and heat in winter. The automatic controlling system switches on the diesel generator when there is no sun, the battery levels are low and there is a blackout in the grid. In April 2018, independent power generation reached 3.5 MWh, while the peak generation is supposed to reach 5 MWh/month. The payback period of the PV system was estimated to be 4 years under current conditions.

Such autonomous solar systems do not need certifications as long as the energy generated by them is used exclusively by the owner and is not fed into the power grid.

Solar energy is also popular among mobile network operators. In Krasnodar Krai, many mountainous regions are cut from the grid and from the radio signal due to its terrain. Mobile operators “Beeline” and “MTS” were the pioneers in using PV for such case. As early as 2004, “Beeline” used a PV powered station to transmit a mobile signal and internet to the remote settlements. The solution is 5 times cheaper than stretching the electricity grid and cables through mountains and relic forest [99]. Similar story happened with “MTS” in 2007, PV stations made it possible to provide remote villages (Guzeripl’, Tyumenskiy, 3-Ya Rota) in mountainous areas with speed mobile internet and communications [108]. During sunny days in summer the PV stations generate up to 70 kWh/day.

**Figure 29 Autonomous 10.8 kW PV system, "MTS" mobile phone station for signal transmission, Lago-Naki, Krasnodar Krai**

**Source: "Igor Samorodov, “Solar Center” PV company, Krasnodar Krai, 2007**

### 3.4.3 Model 3: Residential PV Systems

Until the microgeneration law entered into force (see chapter 2.1.5), **the electricity produced by households was used for either own needs or consumed from other sources (incl. grid) in case of low sun irradiation levels.** One of the most relevant examples is the Autonomous House, designed and owned by Nikolay Driga: the combination of PV panels, a wind turbine and a water heating system fueled by wood pellets makes the household fully independent from the grid, with energy and heat costs 4 times lower than if the power came from the grid [113]. More than 50 households have been inspired by this example and equipped houses with RES including PV. No special certification or permission is needed for similar small-scale private power generation. This may change in the nearest future after all necessary additional requirements regarding the grid connection of microgeneration facilities are created and enter into force (please refer to section.2.1.5).

The construction of a PV system is characterized by a combination of relatively high upfront investments and relatively low operational expenses. According to our own estimations, based on analyses of realized projects on websites of PV installing companies in Krasnodar Krai, like “Solar Center” “Ecoproject Energo”, “NSIA”, “Clever Energy” and others, **the current number of private households in Krasnodar Krai owning an autonomous PV/hybrid PV diesel/wind/gas/ system is between 170 and 300**. It is hard to estimate an exact number of such households due to the absence of a centralized statistical database and there is no obligation to register such systems.

One can find various offers from numerous companies; the price range differs depending on the installed capacity and origin of the equipment. The “Clever Energy” company working together with Nikolay Driga, the creator of the “Autonomous House” in Krasnodar Krai and the CEO of “Svoya Energiya Ltd.”, lists a range of implemented projects on their website with sizes between 3 and 120 kW. As does the local PV installer “Solar Center” who has realized projects for both industrial consumers and private households.

Often, PV systems which are not grid connected combined a grid connection and/or other generation technologies such as wind or diesel. On average, a household needs to invest about 250,000-350,000 RUB (ca. 3,580 to 5,012 EUR) to equip private households with a hybrid system including solar PV suitable to more or less cover the energy demand (which is on average 4 kW).

After analysis of prices for various PV solutions for private households, offered by different PV installing companies in Krasnodar Krai eclareon calculated an **average price** for 1 kW installed PV capacity, including price of hardware, mounting equipment and installation services for a hybrid PV-grid solution, varying **between 65,000 and 87,500 RUB/kWp (930-1,253 EUR/kWp)**, while the price for 1 kW installed capacity for an autonomous standalone PV system (including storage, other hardware and services) can reach up to 142,000 RUB (about 2,033 EUR) mainly due to additional costs of a storage system [111].

This pricing information given by local stakeholders has been acknowledged by the authors of this report and has been taken into account for the profitability analysis presented in chapter 7. Especially the lower ends of the prices mentioned seem to be rather optimistic. However, taking into account lower labor costs it cannot be excluded that prices are as low as stated. The base price chosen for the profitability analysis of residential systems, which are grid connected and only include the PV system costs of the energy system was 100,000 RUB/kWp (approx. 1,432 EUR/kWp). Lower prices were included in the sensitivity analysis.

**Figure 30 Autonomous rooftop PV system in Nikitino, an off-grid village in mountainous areas of Krasnodar Krai**

**Source: Igor Samorodov, “Solar Center” PV company, Krasnodar Krai, 2015**

According to the estimations of Nikolay Driga, in Krasnodar Krai, the cost of 1 kWh of PV based electricity could eventually be as low as:

- 2.5-3 RUB/kWh (3.6 – 4.3 €ct/kWh) for systems combined with the grid and without batteries
- 3.5-4 RUB/kWh (5 – 5.7 €ct/kWh) for hybrid PV systems with batteries
- 7 RUB/kWh (10 €ct/kWh) and more for autonomous systems

All his calculations were said to include CAPEX, costs of transportation, mounting equipment, manpower, OPEX (for 25 years).

**PV based electricity costs of around 4 RUB/kWh (5.7 €ct/kWh) would be lower than electricity purchased from the grid** [112] (also see Table 9). It needs to be added that the calculations undertaken for this report did not match these estimations but resulted in higher LCOEs which, of course, could be decreased further by assuming lower system prices.

### 3.4.4 Conclusions and Perspectives

**Krasnodar Krai is a promising region for PV development** for the following reasons:

1. it is one of the sunniest regions in Russia;
2. generation capacity is missing and;
3. electricity tariffs for private households as well as electricity prices on the retail and wholesale market will likely increase in the future.

However, because most of the region is connected to UPS's power grid and **electricity tariffs for residential customers are subsidized and kept artificially low**, investments in households' photovoltaic systems connected to the grid are rare and will gain popularity slowly.

This may change soon with the **Microgeneration Law** which came into force at the end of 2019. Additional motivations need to complement or substitute economic considerations to motivate private households to invest in private PV installations. These motivations could be technical curiosity, the desire to increase energy independence or the desire to do good for the environment. However, while these motivating factors exist only few are concerned with them. Economic reasons are by far the most important driver for investing in PV, taking into consideration that the average Russian household income is > 50% lower than in Germany, limiting private investments [114]. Key target PV customer groups could be described as follows:

**Private households**:

- Residential users **in newly built or remote/mountainous areas** can be targeted: These households need to pay for the connection to the grid and sometimes to gas pipelines before they get access to the low electricity tariffs. Often the connection is costly and takes a long time, so investing in PV and/or hybrid system is attractive.
- The microgeneration law is supposed to also make solar PV installations more attractive for **people living in cities with a holiday**. Electricity produced by a PV system in this house during the remaining time could be sold to the grid, generating a source of an additional income for a household. However, it remains to be seen how electricity sales will be actually compensated under the law. Most likely, excess electricity will be valued with the wholesale price which fluctuates around 1.3 RUB/ kWh (2 €ct/kWh).

The **peninsula Taman** in Krasnodar Krai may be especially attractive for solar PV for the following reasons: Taman is vulnerable to regular blackouts which have already caused serious discontent amongst households. For instance, food was spoiled because of unpowered fridges. As a consequence, people consider alternative energy solutions. Secondly, the construction of a big port and new industrial zones that also need to be powered has already started and shall be completed by 2021.

**Industrial, commercial and public consumers (entities)**:

- Both entities connected to the grid and those located in remote areas have to pay higher grid electricity prices and also have to bear higher grid connection costs than private consumers. Moreover, their power consumption peaks during the day and rises in the summer when air conditioning systems are on. Therefore, in-house PV or PV hybrid systems can be a viable alternative to the grid. An additional stimulation for such projects is created by the new law on microgeneration (Law 471), which leaves room for small entities in the microgeneration sector, stating that the microgeneration facility may also be used to cover the productional energy needs. This means that small entities may now install a 15 or less – kW system and also use the advantages of the "feed-in tariff" offered by the Law's mechanism.

- **Industrial consumers, farms and fisheries and supermarket chains** have started to construct their own generating facilities and have even founded their own power production companies (as in the case of "Magnit Energo") to decrease the expenditures on electricity and heat or even profit from electricity trade in case of surpluses. The installation of PV systems is sometimes perceived as a good combination between saving money for fuel/grid electricity and get a better image of an environmentally friendly company (e.g. in the case of a "SIBUR" rooftop PV system, see 3.4.1).

# 4. PV Market and Potentials in Kaliningrad Oblast.

In the following chapter, general information on the power sector of Kaliningrad Oblast and specific data concerning the PV market is introduced. The importance of two selected PV business models in Kaliningrad Oblast is described. The regionally-specific regulatory framework for renewable energy development is also discussed.

## 4.1 Power Sector of Kaliningrad Oblast

### 4.1.1 Electricity Generation, Consumption and Demand

Kaliningrad Oblast is a region with an interesting and rich history, an enclave located outside of Russia's borders. The region is included in the UPS of Russia ("United Power Grids of the North-West" part of UPS), however grids of UPS and Kaliningrad Oblast are interconnected through the BRELL (Belorussia, Russia, Estonia, Latvia and Lithuania) ring, in particular, its Latvian and Belorussian parts.

**Figure 31 Map of Russia, Kaliningrad Oblast on the map**


**Source: eclareon 2020 generated with amCharts Pixel Map**

**The region produces enough electricity in a bid to to meet its needs, while demand has grown slowly and steadily**. Surplus is sent to neighboring electricity grids of 110 kV and 330 kV [115].. The region is currently still dependent on the BRELL ring and is realizing the necessity of generating enough capacity to fully supply itself should it ever be disconnected from BRELL and UPS. **Thus, the fuel and power sector of the region is developing quickly and is receiving legislative and economic support from the federal government.**

In 2018, energy consumption in the region amounted to 4,438.6 GWh, while energy generation was 7,383 GWh [312].Table 11 below includes information on regional generation, imported energy and per capita generation. Until 2010, the region had problems with electricity generation and the majority of energy was imported. Starting in 2011, regional generation was stable with slight fluctuations.

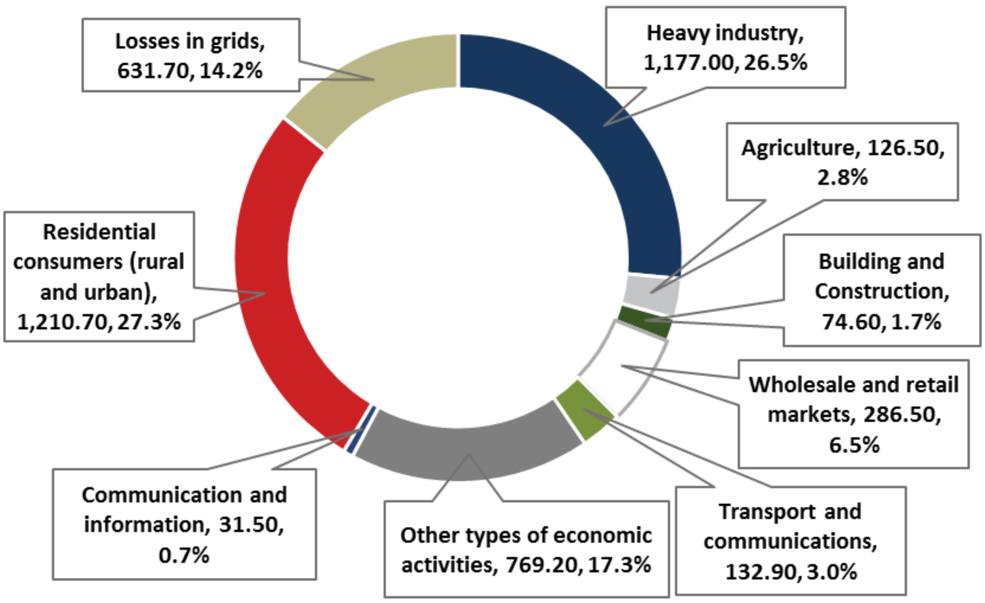
**Table 11 Electricity Generation Profile in Kaliningrad Oblast, years 2010-2018**

| Year | Total electricity generated (thosand GWh) | Total energy consumption (% from electricity generation) | Total electricity export (% of generation) | Per capita electricity generation (MWh per capita) |
|---|---|---|---|---|
| 2018 | 7.38 | 60.1 | 33.6 | 7.4 |
| 2017 | 7.11 | 62.0 | 38.0 | 7.2 |
| 2016 | 6.70 | 66.3 | 33.7 | 6.8 |
| 2015 | 6.20 | 71.2 | 28.8 | 6.4 |
| 2014 | 6.44 | 70.1 | 29.9 | 6.7 |
| 2013 | 6.39 | 69.5 | 30.5 | 6.6 |
| 2012 | 6.85 | 62.2 | 37.8 | 7.2 |
| 2011 | 6.45 | 63.6 | 36.4 | 6.8 |
| 2010 | 3.14 | 127.8 | -27.8 | 3.3 |

**Source: Based on Federal State Statistics Service of the Russian Federation, "Electricity Balances 2017" [30]; Federal State Statistics Service of the Russian Federation, "Electricity generation per capita", 2018 [127]; "Scheme and Programme of the perspective development of energy sector of Kaliningrad Oblast 2020-2024", 2019 [312]**

Unlike in Krasnodar Krai, the **largest electricity consumers in Kaliningrad oblast are private households** (residential consumers, 28%). Industrial companies account for around 27% of electricity consumption. Losses in grids account for 14% of the total consumption.

**Figure 32 Electricity consumption by sector in Kaliningrad Oblast, 2018, million kWh and %**




**Source: Federal State Statistics Service of the Russian Federation, 2019 [30]**

## 4.1.2 Regional Stakeholders

The regional electricity market has several stakeholders:

- the one main electricity sales company "Yantarenergosbyt" and 11 additional electricity retailers,
- 12 grid companies, including the major one, "Yantarenergo" (subsidiary of "ROSSETI")
- one large and 3 new smaller, combined heat and power plants and several additional energy generating facilities belonging to "Inter RAO UES"

**The overall installed generating capacity at the end of 2018 was 1,709.7 MW**, of which 900 MW belonged to the by far largest CHPP power plant "Kaliningrad CHP-2" (belongs to "Inter RAO") [116]. Between 2017 and 2019, 3 new gas fueled CHPPs have been launched and joined the energy system of the region, adding 771.6 MW to the existing generating capacity [311].. **Over 90% of electricity in the region is generated with the help of natural gas**, which is also the main fuel for boiler houses and heat generation at CHPPs.

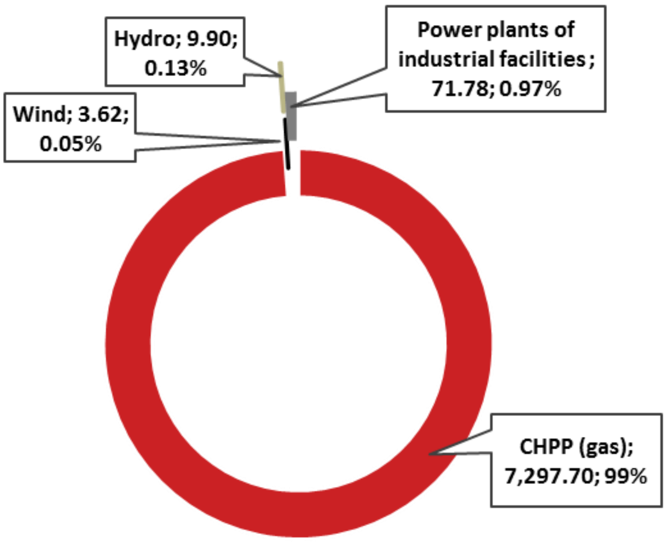
The largest electricity retailer is the regional guaranteeing supplier JSC "Yantarenergosbyt" created in 2011 by JSC "Yantarenergo" to split electricity transmission and electricity retail functions between the two companies. The largest grid company is JSC "Yantarenergo", a subsidiary of "ROSSETI". Other energy retailers include JSC "Oboronenergosbyt" owned by the Ministry of Defense of the Russian Federation and "Rusenergosbyt".

### 4.1.3 On-Grid Generation

As stated above, local energy production is larger than consumption: in 2018, generation in the region amounted into 7,383 GWh, 98.8% of which was generated by "Kaliningrad CHP-2".

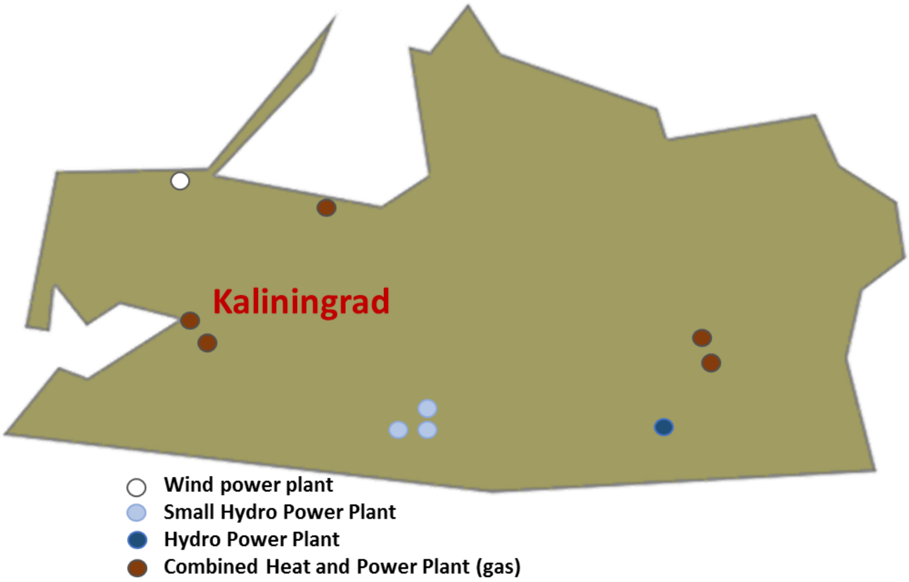
Power plants owned by "Yantarenergo" all work on hydropower and generated 9.9 GWh. 99.6% of the capacity installed in the region refers to CHPPs that are fueled by natural gas, 0.1% are hydro power plants and 0.3% - wind power installations[312]. **Close to 100% of electricity produced in the region is on-grid generation by CHPPs**.

**Figure 33 Energy generation in Kaliningrad in 2018 by source, million kWh and % of total generation**




**Source: "Scheme and Programme of the perspective development of energy sector of Kaliningrad Oblast 2020-2024", 2019 [312]**

**Figure 34 Schematic map of Kaliningrad Oblast with the location of major power generating facilities in 2020**




**Source: eclareon 2020 generated with amCharts Pixel Map, based on "Scheme and Programme of the perspective development of energy sector of Kaliningrad Oblast 2020-2024"[312]**

### 4.1.4 Off-Grid Generation

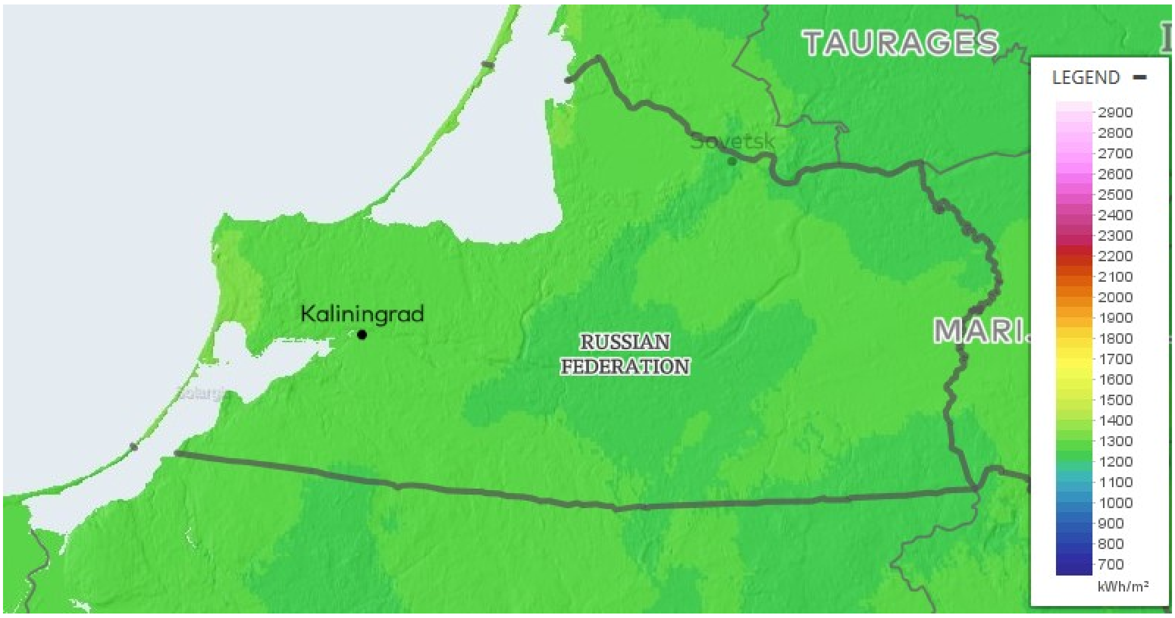
Off-grid generation in Kaliningrad Oblast consist of some isolated examples of mainly residential PV. Although this region is well-developed, there are settlements without grid connection or with bad connection resulting in frequent power cuts. One of the examples is Orlovka village, where inhabitants frequently suffer from blackouts for various reasons, including outdated transformer stations and storm warnings followed by planned power outages. In this village, most of the houses use diesel generators for backup [122].

## 4.2 Investment Framework for PV

### 4.2.1 Solar Irradiation

Kaliningrad oblast has about 180 sunny days per year, **with an average yield of 1,100-1,250 kWh/m$^2$/year** [118], one of the highest for the north-western Russian territories. There are no large solar projects and no SPPs in the region, all PV systems existing the region are presented by small PV projects such as street lighting and private PV systems in residential sector.

**Figure 35 Annual Global Tilted Irradiation (GTI) Kaliningrad Oblast**




**Source: Global Solar Atlas [130]**

## 4.2.2 Target Customers

Kaliningrad Oblast is included in the first non-price zone, which means there is no free price formation on the wholesale electricity market in the region, **prices on the retail market are also strictly controlled and pre-established.** The core electricity prices and tariffs are presented in
Table 12.

**Table 12 Electricity prices in Kaliningrad Oblast**

| | Time period | | | |
|---|---|---|---|---|
| | 2020 2/2 | 2020 1/2 | 2019 2/2 | 2019 1/2 |
| | Retail market, RUB/kWh (€ct /kWh) with VAT 20% | | | |
| Urban population with gas stoves and groups equated to them (single rate tariff only) | 4.36 (6) | 4.20 (6) | 4.20 (6) | 4.12 (5.9) |
| Urban population with electric stoves and rural population (single rate tariff only) | 4.36 (6.2) | 3.05 (4.4) | 2.94 (4.2) | 2.88 (4.1) |
| Type of voltage / type of tariff | High voltage (110 kV and higher) | Middle first voltage (35 kV) | Middle second voltage (20-1 kV) | Low voltage (0,4 kV and less) |
| The first price category, RUB / MWh (EUR/MWh) (with VAT), for December 2019, non-residential consumers under 670 kW loads | | | | |
| Single-rate tariff | 4,749.65 (68) | - | 5,431.01 (77.8) | 7,447.1 (106.6) |
| The second price category, double day zone tariff, RUB / kWh (EUR/kWh) (with VAT), for December 2019, non-residential consumers under 670 kW loads | | | | |
| Night zone | 3,384.39 (48.5) | - | 4,065.75 (58.2) | 6,081.84 (87.1) |
| Day zone | 5,185.09 (74.3) | - | 5,866.45 (84) | 7,882.54 (112.9) |
| The second price category, three day-zones tariff, RUB / MWh (EUR/MWh) (with VAT), for September 2019, non-residential consumers under 670 kW loads | | | | |
| Peak zone | 5,789.03 (48.5) | - | 6,470.39 (58.2) | 8,486.48 (87.1) |
| Semi-peak zone | 4,692.62 (67.2) | - | 5,373.98 (77) | 7,390.08 (105.8) |
| Night zone | 3,384.39 (48.5) | - | 4,065.75 (58.2) | 6,081.84 (87.1) |

| Type of voltage / type of tariff | High voltage (110 kV and higher) | Middle first voltage (35 kV) | Middle second voltage (20-1 kV) | Low voltage (0,4 kV and less) |
|---|---|---|---|---|
| The first price category, RUB / MWh (EUR/MWh) (with VAT), for December 2019, non-residential consumers between 670 kW and 10 MW loads | | | | |
| Non-regulated price, differs depending on the contract type, hour and month | 4,567.63 (65.4) | - | 5,248.99 (75.2) | 7,265.09 (104) |
| The first price category, RUB / MWh (EUR/MWh) (with VAT), for December 2019, non-residential consumers over 10 MW loads | | | | |
| Non-regulated price, differs depending on the contract type, hour and month | 4,446.17 (63.7) | - | 5,127.53 (73.4) | 7,143.62 (102.3) |

Source: "Yantarenergosbyt", 2020 [121], "Yantarenergosbyt", 2019, 2020 [313]

### 4.2.3 General Perception and Acceptance of PV

The **general attitude towards renewable energy is positive in Kaliningrad Oblast**. Wind energy projects are developed, reflecting a willingness to "go green": In 2018, a new 6.9 MW wind power plant was installed near the Ushakovo settlement. It replaced an old wind park in Kulikovo and was a project of "ROSSETI", more precisely, its regional subsidiary "Yantarenergo".

**With regards to PV, the number of enthusiasts may be in the hundreds** [120]. A variety of PV systems are offered online, with people sharing their ideas and experiences in forums and blogs and sharing examples of private houses equipped with solar panels being evidence of the rising popularity of this technology among ordinary people. However, there is not specific information about realized PV projects: Due to the limited number of sunny days the development of electricity generation based on PV in the area is not regarded as a priority by the local administration. Moreover, the relatively low irradiation in combination with low, regulated electricity prices does not promote the use of PV, especially when there are no PV specific support schemes.

In the past, the development of renewable energy sources in the region has been supported by the energy retailer and distributor "Yantarenergo". For instance, **the company was the first in Russia to allow a household connect a private PV system to the grid**. This system was built by a private businessman who was not interested in saving money but who installed the PV installation because of technological curiosity and to become electricity independent.

After long negotiations, the company accepted to install a bidirectional electricity meter which allowed to feed electricity produced by his PV system into the grid and save electricity costs. However, this installation is an individual case rather than a representative business model that will be copied by other citizens

## 4.3 Region-specific regulatory & legal framework

**The federal support schemes for renewable power generation are applicable to Kaliningrad Oblast**. The support scheme for the wholesale market – contract supplied capacity (see Section 2.1.1), defined in Decree № 449, is not oblast specific and therefore projects from all regions, including the Kaliningrad Oblast can participate in the tender. In the retail market, as defined by the Decree № 47, the electricity supply tenders (see Section 2.1.2) are to be organized at the regional level following the rules stipulated by the decree and its related regulations.

Until now, no projects chosen under the conditions of the contract supplied capacity were in Kaliningrad. **Decree 47 has not been implemented in Kaliningrad Oblast** and not adapted to the region through local legislative acts and enforcing decrees.

**Currently, there are no specific regulative or legislative acts targeting the support of RES in Kaliningrad Oblast**. Energy independency from neighboring countries is the center of regional energy politics: The “Scheme and program of the development of energy sector of Kaliningrad Oblast 2018-2022” targets the independence of the regional energy system from foreign countries, especially from Lithuania, as the main gas pipeline delivering gas to the CHPPs in Kaliningrad Oblast stretches through Lithuanian territory. The question of energy security became even more important after economic sanctions were enforced between Russia and European countries. According to this document, Kaliningrad Oblast shall pay more attention to the development of RES in the region, particularly hydropower, bioenergy (including waste) and wind energy due to its potential in the region. The document refers to national normative legal acts and a Russian Energy Roadmap 2030 but does not mention any concrete local legislative acts which may help the RES development in the region.

## 4.4 Business Models for Solar PV

As per the classification of business models chosen for this report and were described in chapter 1.3, the situation pertaining to the three business models in Kaliningrad oblast are described in the following subsections.

### 4.4.1 Model 1: PV parks

There are no large PV power plants in Kaliningrad Oblast and currently **there are no plans to develop such projects or support them in this region**. Nevertheless, there are opportunities to use PV to supply socially important facilities with energy. In Kaliningrad Oblast there is already a case of Lugowoje village where a rooftop PV system generates up to 50 kWh daily for a street lighting [123]. The PV power station was a pilot project financed by the European Union under a project of energy efficiency development and costed 40,000 EUR. Currently this PV system permits Lugowoje to save electricity worth approx. 100 thousand RUB annually (approx. 1,430 EUR).

### 4.4.2 Model 2: Off-Grid PV & Hybrid Systems

Having a **country/holiday house** is usual in Russia and so new houses are being built in rural areas, which are not connected to the grid. If there is a grid close the connection costs are often high, and comparable to the cost of a rooftop PV system.

In 2014, a family from Tscherepanowo village invested about 160,000 RUB (2,291 EUR) in 6 PV modules and a battery which now fully supplies their house, while “Yantarenergo” offered a grid connection for 150,000 RUB (2,148 EUR) [123]. Tscherepanowo is still disconnected from the power grid and everybody except for this family uses diesel generators.

According to some estimations, there are **about 250 small residential PV systems in Kaliningrad Oblast which function autonomously** and usually in combination with diesel or petrol gensets [124]. The average payback period for a residential PV system (as for 2016) is assumed to be 5-8 years. The calculations undertaken in this report suggest, that the payback periods for hybrid PV systems will most likely be longer, even in areas with a higher solar irradiation than Kaliningrad.

### 4.4.3 Model 3: Residential PV systems

There is no official statistical data on the exact installed capacity of residential PV systems in Kaliningrad Oblast.

In 2014, a precedent was set when an official connection between a PV system and the grid was set up in Kaliningrad. A local businessman, Mr. Rigikov, installed 5.4 kW with a peak production of 35 kWh. After negotiations with "Yantarenergo", the Mr Rigikov got permission to feed into the city's power grid on days when his system generates surplus energy. Moreover, he is permitted to rotate the electricity meter backwards, generating compensation. This was a first example of a "prosumer" in Russia.

Another similar case happened in Orlovka, a village close to Kaliningrad. The settlement is connected to the power grid, **but blackouts happen so frequently that most households have diesel generators**. One family decided to invest in a rooftop PV system combined with batteries, permitting the house to be fully autonomous for up to two days [122]. The household is mainly supplied by PV modules which simultaneously charge the batteries. During the night and on cloudy days the batteries switch on and in case of a discharge of power, the system is taken from the grid.

### 4.4.4 Conclusions and Perspectives

Kaliningrad Oblast has less solar irradiation than other Russian regions, the electricity prices are low and fully regulated and electricity consumers are connected to the grid, although some exceptions exist. Kaliningrad Oblast has no concrete regional support scheme for the development of RES, however there have been some examples of successful PV use. The most promising directions for enabling PV in this region are:

- **Development of residential PV hybrid** systems in areas with no or weak grids. Such areas are newly built settlements, where connection to the grid is expensive or takes a lot of time. As described above, there are villages where the existing grid cannot provide stable electricity supply. Furthermore, after enforcement of the Law on microgeneration (Law 471), private households may shorten the payback period for their PV systems and this may encourage more private persons to install PV or hybrid solutions.

- **Pilot projects**. Because Kaliningrad Oblast is an enclave, it is relatively easy to experiment with modern technical solutions in the region. Both the administration of the region and local energy companies are open to new technologies and experiments and are in a tight cooperation with "Skolkovo", a Russian analogue to "Silicon Valley" – a modern scientific complex near Moscow intended to develop, support and commercialize new technologies, R&Ds, ideas in whatever sphere. For example, there is a project by "ROSSETI", which aims to test grid digitalization in the region. The same applies to RES sources: Kaliningrad Oblast was the first to connect a residential PV system to the state power grid and wants to keep its status as an innovative frontrunner.

- **PV & heat pump water and space heating systems**. Such combined solutions are mainly connected to the construction of energy efficient houses. Such systems are already used in Kaliningrad and may become more popular over time.

# 5. Solar and Heat Pumps Markets and Potentials in the Republic of Bashkortostan

In the following chapter, general information on the power sector in Bashkortostan and specific data concerning the local PV and heat pump market is given and relevant PV and heat pump business models in Bashkortostan are introduced. Moreover, the regionally specific regulatory framework for renewable energy development is discussed.

## 5.1 Energy Market of Bashkortostan

### 5.1.1 Electricity Generation, Consumption and Demand

The Republic of Bashkortostan (or Bashkortostan) is located on the border between Europe and Asia and has more than 4 million citizens. Bashkortostan has continental climate, with relatively warm summers and an average July temperature of +20 C. In the long cool winter periods temperatures reach -15 C in January [179]. Ufa, the capital, is the 11$^{th}$ largest city in Russia. However, less than 30% of the region's population lives in the city. **Bashkortostan is one of the leading industrial and agricultural regions in Russia, one of the main oil-producing regions and the center of the chemical and mechanical engineering industry** [180]. Major energy consumption happens during the winter period and hot summer days. The maximal loads in the power system of Bashkortostan are attained in December or January, which are usually the coldest months in the region. Between 2011 and 2017, the highest annual load was attained on December 21$^{st}$ 2016 with 4,145 MW [181].

**Figure 36 Map of Russia, Republic of Bashkortostan of the map**

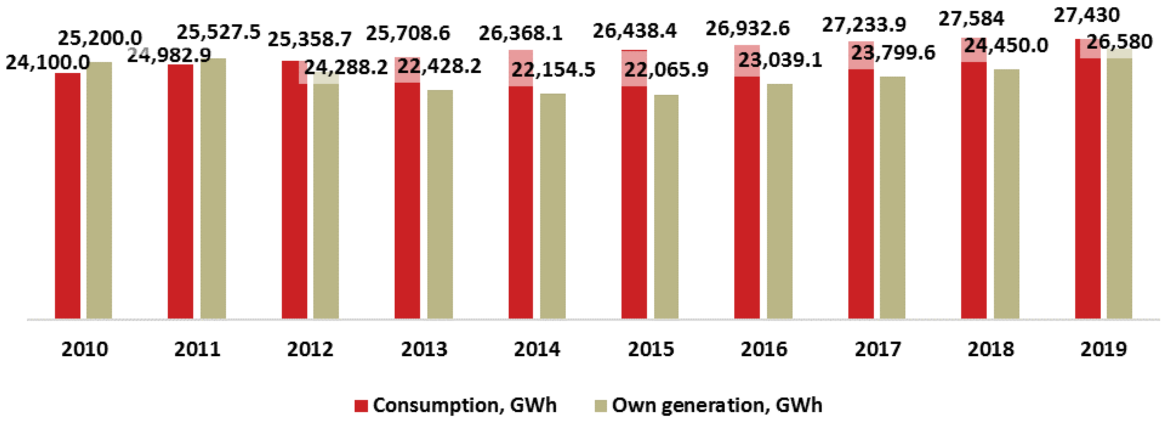

**Source: eclareon 2019 generated with amCharts Pixel Map**

Since 2011, both electricity consumption and generation are steadily growing. In 2018, the region produced 89% of electricity it consumed [181]; in 2019 own generation covered 97% of demand [314]. Although domestic energy generation mostly covers demand, there are some problematic areas within the region which suffer from a lack of energy sources. **The majority**

**of energy generating facilities in the region are concentrated in the north-western areas, while the central and southern parts of the Bashkirian energy system suffer from a lack of generation capacity** [181]. Hence, additional generating capacity is needed in those areas. Favorable irradiation conditions in the southern parts of Bashkortostan, combined with a lack of energy generation capacity, creates great potential for PV development in this region.

Figure 37 illustrates how regional electricity consumption in Bashkortostan has developed throughout the years, comparing energy consumption and domestic energy generation.

**Figure 37 Energy consumption and domestic energy generation in Bashkortostan within latest 9 years, GWh**

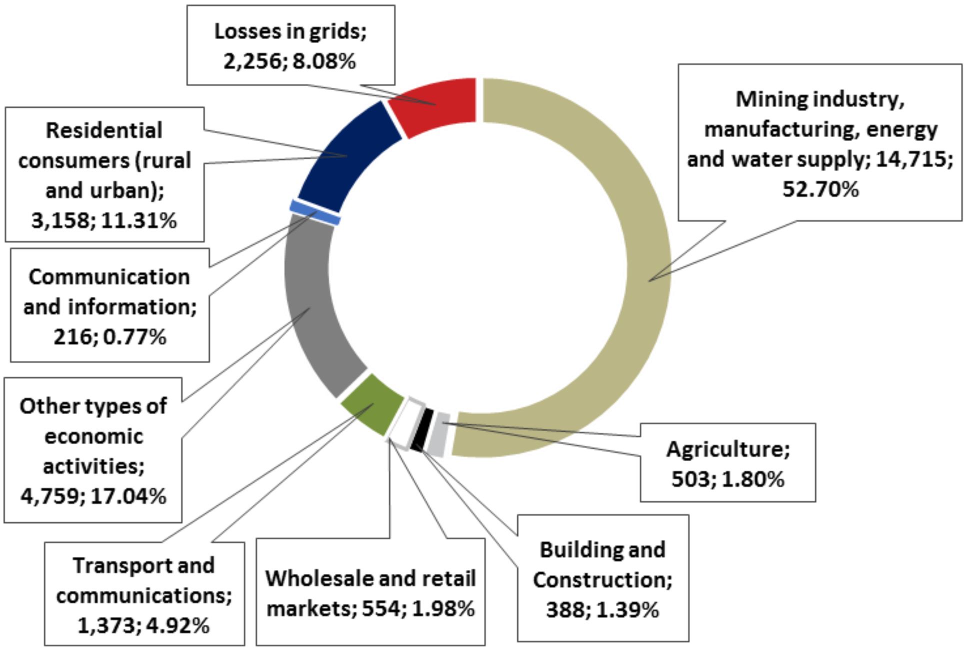



**Source: Ministry of Industry and Innovation Policy of the Republic of Bashkortostan, 2019 [181], SO UPS 2020 [221]**

To cover the supply gap, energy is imported from neighboring regions, such as Chelyabinsk and Orenburg, and purchased on the wholesale market. According to SO UPS, domestic electricity generation in 2019 amounted to 26,580 GWh and domestic consumption to 27,430 GWh [182]. The highest energy consumption is observed in the central power zone which includes Ufa city.

**The most energy intensive sectors in Bashkortostan are the manufacturing industry and the mining industry.** In 2018 they were responsible for more than a half of the total power consumption in the region (see Figure 38). The manufacturing industry is represented by a number of branches, among which the largest are coke and petroleum production, chemical production, non-metallic mineral product manufacturing. These branches together consumed 9,576 GWh in 2018. In 2018 the mining industry consumed 5,139 GWh of electricity [181], [185]. The same year, residential consumers were responsible for 11.3% of the overall energy consumption in the region, which made them the third largest consumer group. Energy losses in the grids accounted for 8% of total energy consumption in Bashkortostan. Despite the fact that this figure is relatively small in comparison to the losses in other Russian regions, it amounts to financial losses of more than 4 billion RUB (about 57.3 million EUR) [186]. Grid losses are unevenly distributed across Bashkortostan regions: in Ufa city, where a program of grids modernization has been completed, losses reached 12.2% in 2018, while in other regions with outdated distribution systems and worn-out grids losses often amount to 40% of district consumption [186]. More detailed information on energy consumers is presented in Figure 38.

**Figure 38 Electricity consumption by sector in Bashkortostan in 2017, GWh and %**




**Source: Ministry of Industry and Energyof the Republic of Bashkortostan, 2019 [181]**

Considering the ongoing industrial and economic development of the region and an overall trend of energy consumption, the annual growth of domestic electricity consumption is assumed to fluctuate around 2% p.a. (assumptions of eclareon GmbH based on [181]).

### 5.1.2 Heat pump sector in Bashkortostan

Consumers of Bashkortostan are mainly supplied with heat through:

- Centralized district heating (residential and industrial consumers in large cities and regional centers). Annually, the State Tariff Committee of the Republic of Bashkortostan sets the norms of heat consumption (in Gcal) per 1 m3 and the corresponding tariff for energy companies in RUB per 1 Gcal. Thus, as of the end of 2019, the heat consumption rate for the population varies from 0.0234 to 0.034 Gcal/1m3, while the tariff is 2,134.16 RUB/Gcal (ca. 30,5 EUR/Gcal). This means that for a 60 m3 flat, a monthly bill for heating services would be around 3,841.48 RUB (ca. 55 EUR) [253],[254].

- Individual gas boilers. Usually these are installed by private households or SMEs, in regions with no centralized district heating system, such as rural areas, industrial parks or new city districts.

- Individual electric boilers. Used these are installed used by private households, SMEs or municipal entities in areas with no gas network close to the consumer or if connection to the gas pipe is not economically feasible

- Wood stoves and solid fuel boilers. These are mostly used by private households and small businesses in remote areas and standalone settlements, or in areas with access to appropriate solid fuels (e.g. in villages close to forests local inhabitants use timber they harvest themselves and do not pay for this type of fuel).

- Heat pumps and solar collectors. Installed by private households with a high level of prosperity and interest in using innovative equipment or by entrepreneurs testing the new technology, this option is the least widespread. Low awareness concerning modern RES technologies and energy efficiency hinders the spread of this technology.

It should be noted that the use of heat pumps and solar collectors was considered by the relevant ministries in Bashkortostan as a possible option for heat supply to budget-funded institutions within the framework of energy service contracts. However, given the lack of the set requirements and the uncertainty of the legal framework, the projects were not implemented.

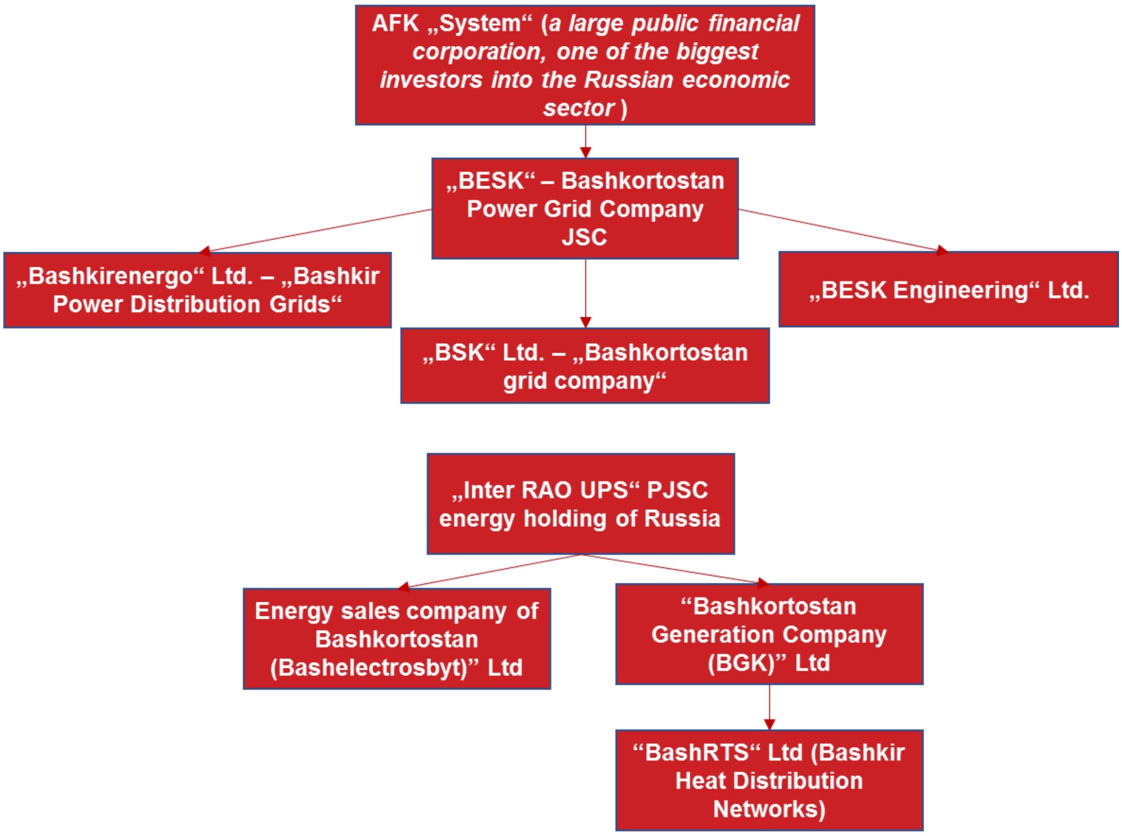
### 5.1.3 Regional Energy Market Stakeholders

The Republic of Bashkortostan is part of the Integrated Power Systems (IPS) of Ural. Its power sector is divided into 10 zones, so-called regional power systems, each of them usually dominated by "Bashkirenergo" Ltd. (described below). The ten systems are interconnected and are a part of the UPS of Russia [181].

The electricity market in the region has several key stakeholders:

- Electricity retailing companies. The guaranteeing supplier is usually "Energy sales company of Bashkortostan (Bashelectrosbyt)" Ltd. (subsidiary of state-owned PJSC "RAO UES". Another large retailer is "RN-Energo" Ltd., a former subsidiary of "Rosneft" and currently a subsidiary of PJSC "Inter RAO UES". Smaller energy sellers are "Rusenergoresurs" Ltd., "MagnitEnergo" Ltd., "Rusenergosbyt" Ltd. and 19 others.
- Electricity transmission companies (grid companies). The largest is "Bashkir Power Grid Company (BESK)" JSC, which controls the high voltage power lines (220-500 kV) and transformer substations, followed by "Bashkirenergo" Ltd. and its direct subsidiaries. 40 smaller grid operators are also participating on the market.
- Power generating companies. The largest are "Bashkortostan Generation Company (BGK)" Ltd., working under the umbrella of the "Inter RAO" PJSC and "Novo-Salavat CHP" Ltd. (subsidiary of "Gazprom Neftechim Salavat" Ltd.), with 882 MW installed heat generating capacity for oil refinery, petrochemicals production and fertilizer production in Russia's largest petrochemical complex in the city of Salavat. Since 2016 "SEGC" JSC (Sverdlov energy and gas company) owns a coal fueled CHP "Kumertauskaya CHP" with 120 MW installed capacity.

**Figure 39 Relations between large energy sector participants in Bashkortostan**



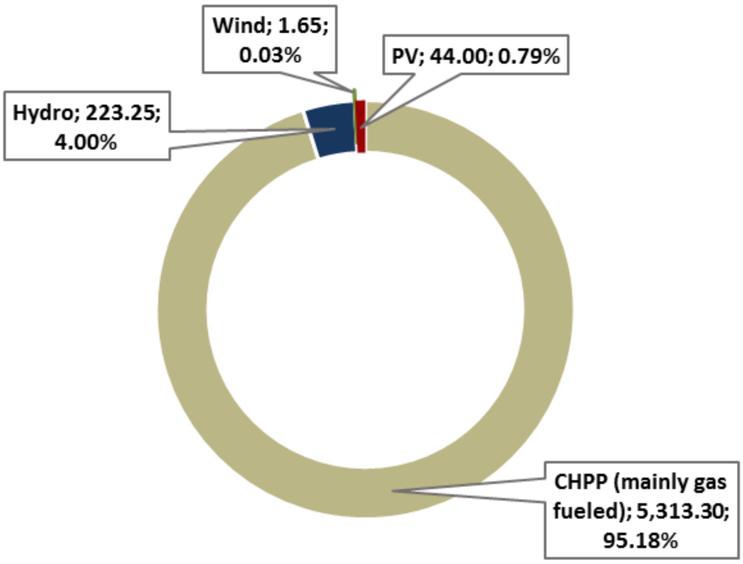

**Source: “BESK” official web site [183]**

In 2018, a little bit more than 50% of electricity consumed in the region was purchased by „Bashelectrosbyt” on the wholesale market and sold to domestic consumers on the retail market. The other half was purchased directly by consumers on the wholesale market [221]. “Bashelectrosbyt” is the only energy retailing company with a status of “guaranteeing supplier” in Bashkortostan.

Power grids in the region are managed by a number of companies. “BESK” and “BSK” manage high voltage grids (220-500 kV) and transformer stations. Grids with lower voltage of 0.4-10 kV are managed by other grid companies, such as “Belebeevsk urban power grids” Ltd. “Grid company” Ltd, “Belorezk urban power grids” and a number of other both public and private grid companies. “BESK” owns about 74% of all regional grids. Municipal unitary grid enterprises (state owned s.a. “Belorezk urban power grids”) own about 9% of the grids; 15% are owned by other grid operators [186].

**In 2018, the overall installed power generating capacity of 35 power plants in Bashkortostan was 5,581.33 MW**, the largest installed power generating capacity in Bashkortostan’s history. 79% of this capacity belonged to “BGK” Ltd. Together, all CHPPs in the region in 2018 had an installed capacity of 5,313.4 MW. The region’s largest power plant is the gas-fueled Karmanovskaya CEPP (Condensation Electric Power Plant) which generates electricity only [181] [221]. The figure below illustrates the installed capacity by power plant type. 59 MWp of the gas-powered installed capacity refers to own power generating facilities of approximately 5 enterprises, covering their own demand [221].

**Figure 40 Installed power generating capacity in Bashkortostan in 2018, MW and %**




**Source: SO UPS, 2019 [221]**

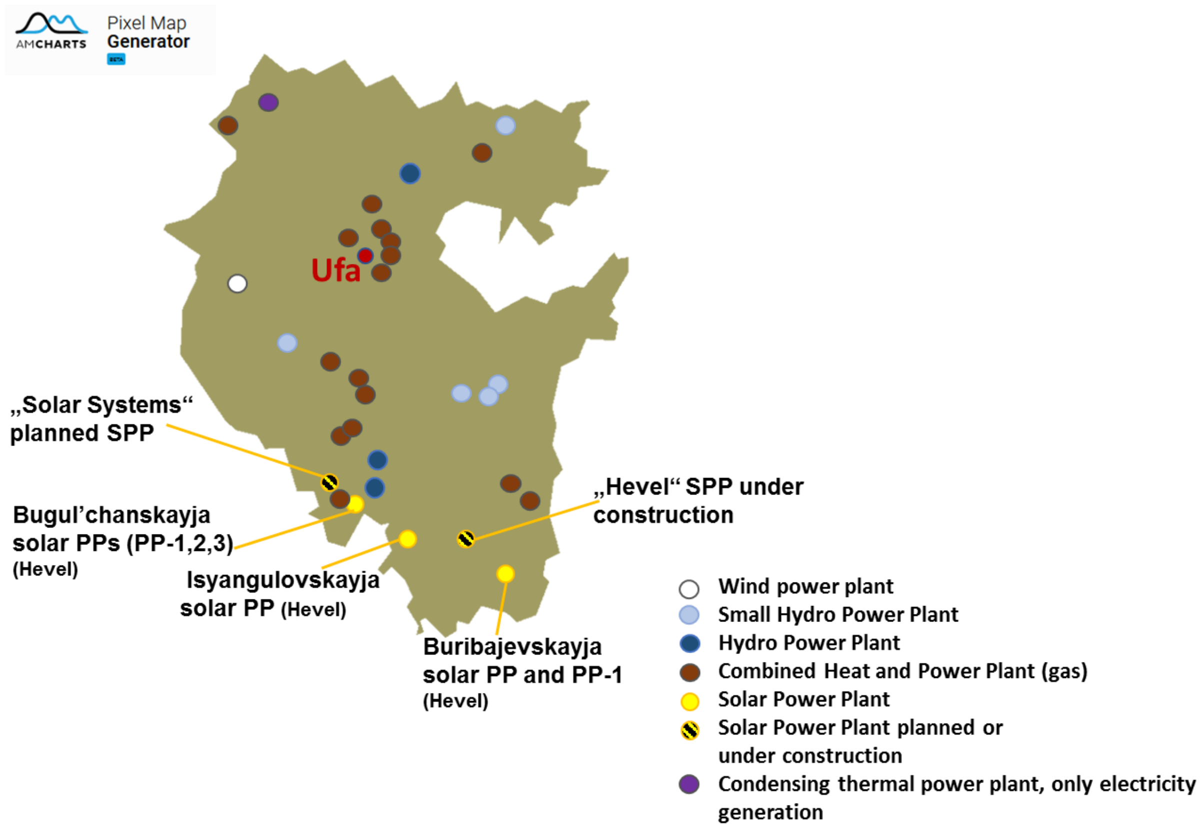
Hydropower plant (HPP) capacity includes 0.745 MW of small hydropower plants and 2 larger HPPs. The largest is Pavlovskaya HPP ("BGK") with 166.5 MW installed capacity [181].

There is only one wind park in the region, "Tupkildy", consisting of 3 wind turbines (used to be 4 turbines), also owned by "BGK". It was launched in 2001 [187]. In 2015, the WPP was labeled by "Market Council" as a RES energy generating facility in accordance with federal Law 35-FZ and is currently delivering energy to the retail electricity market to compensate for grid losses of "Bashkirenergo". Such labeling was needed for getting a feed-in tariff which was established in accordance to the Decree of Federal Antimonopoly Service of Russia 900/15 of 30-09-2015 and by the Decree of Government of Russia 1178. Due to the fact that WPP was built in 2001 and is not a new object, the green tariff for it is calculated considering OPEX only, while newly constructed objects receive tariffs calculated both considering CAPEX and OPEX [196]. In 2018, "Bashkirenergo" was buying electricity from the WPP for 11.78 RUB/kWh (17 €ct/kWh) [197].

The Large PV sector in Bashkortostan is currently represented by the only stakeholder, "Avelar Solar Technology" (Hevel's subsidiary) and its 3 ground mounted PV parks [181]. The PV parks were constructed from 2015 to 2017, all under Decree 449, and deliver electricity to the wholesale power and capacity market [198]. Buribaevskayja PV plant cost about 1.1 billion RUB (about 15.7 mio EUR) [199]. Investments into Bugul'chanskayja and Isyangolovskayja PV plants were over 1.5 billion RUB each (about 21.5 mio EUR) [200]. "Hevel", a group of companies, was the main investor and general contractor for all the projects and now owns the PV parks. In 2018, PV plants in Bashkortostan generated 55 GWh, which was 33.1% more than in 2017 due to a commissioning of a new PV park "Isyangulovskayja" at the end of 2017 [221].

Construction of several more PV plants is announced. A 20 MW PV park is planned by "Solar Systems" Ltd. (Chinese company) until 2020. The PV park will deliver power and capacity to the wholesale energy market (under the Decree 449). Overall investments are to reach 3.7 billion RUB (about 53 million EUR) [191] [188] and "Hevel" started construction of the 10 MW PV plant in Burzyanskiy district of Bashkortostan (investment costs ≈800 mio RUB ≈11.4 mio EUR) [190] combined with an 8 MW storage system, aimed to generate electricity for the retail energy market (under the Decree 47) [201]. The new power plant from "Hevel" is to be launched in early 2020 [189] [190]. "Hevel" is considering to further expand PV installed capacity in Bashkortostan with the help of 4 more PV parks construction with a total installed capacity of 100 MWp [190]. In the form of state support for new energy facilities, a reduced land lease rate and a number of other preferences will be established.

**Figure 41 Schematic map of Bashkortostan with the location of major power generating facilities in 2019**




**Source: eclareon 2019 generated with amCharts Pixel Map, based on “BGK” 2019 [192], Hevel 2019 [193], RBC2018 [189] and RBC 2019 [194],**

### 5.1.4 On-Grid Generation

Almost all of the electricity produced by power plants in Bashkortostan is connected to the UPS grid. Around 13% of power consumption in the region is covered by importing from neighboring energy systems. Table 13 presents information on in-house energy generation in the region as well as domestic consumption. The drop in electricity generation between 2010 and 2012 and fluctuations within other years can be explained by capacity commissioning and decommissioning: between 2011 and 2015, 153 MW of power generating facilities were newly commissioned and 668 MW were decommissioned. In 2010, 333 MW were retired and in 2012 144 MW [203]. In 2018, electricity generation grew due to commissioning of the new “Zatonskaya” CHPP with 2 gas turbines and a total installed capacity of 440 MW.

**Table 13 Electricity Generation Profile in Bashkortostan, years 2010-2018**

| Year | Total electricity generated (thousand GWh) | Total energy consumption (% from electricity generation) | Total electricity import (% of consumption) | Per capita electricity generation (MWh per capita) |
|---|---|---|---|---|
| 2018 | 24.45 | 112.8 | 11.4 | 6.00 |
| 2017 | 23.79 | 114.4 | 12.6 | 5.80 |
| 2016 | 23.04 | 116.9 | 14.5 | 5.60 |
| 2015 | 22.06 | 119.8 | 16.5 | 5.40 |
| 2014 | 22.15 | 119.0 | 16.0 | 5.40 |
| 2013 | 22.43 | 114.6 | 12.8 | 5.50 |
| 2012 | 24.28 | 104.4 | 4.2 | 5.90 |

| Year | Total electricity generated (thousand GWh) | Total energy consumption (% from electricity generation) | Total electricity import (% of consumption) | Per capita electricity generation (MWh per capita) |
|---|---|---|---|---|
| 2011 | 25.53 | 97.9 | -2.2 | 6.30 |
| 2010 | 25.16 | 96.0 | -4.1 | 6.20 |

**Source: Based on Ministry of Industry and Innovation Policy of the Republic of Bashkortostan, 2019; 2017 [181]; Unified interagency information and statistical system, 2019 [148]; Federal State Statistics Service of the Russian Federation, "Electricity generation per capita", 2019 [202], SO UPS 2019 [221]**

### 5.1.5 Off-Grid Generation

Remote regions in Bashkortostan are often connected to the grid system with only outdated power lines. Such regions are the first to suffer from outages as soon as grid emergencies happens. The Burzyanskiy district, for example, is connected to the grid by only one 100 km long power line with 110 kV voltage stretches. In order to ensure a stable power supply for Burzyanskiy's 16,000 inhabitants, the authorities of Bashkortostan first considered installing a diesel power plant. However, in 2019 a decision to construct a PV park consisting of 2 PV plants 5 MWp each and a 4 MW storage system for each PV plant was made [204].

The construction of a hybrid PV-Wind-diesel system with a storage system in Severny followed a similar logic. The aim was to ensure emergency energy supply for the settlement due to the bad condition of the outdated grid connecting the settlement, as well as the high cost of repair and replacement of power grid equipment. Investments were allocated by a local grid company and helped to avoid costly grid refurbishment, decreasing the company's expenditure by 10 times [206].

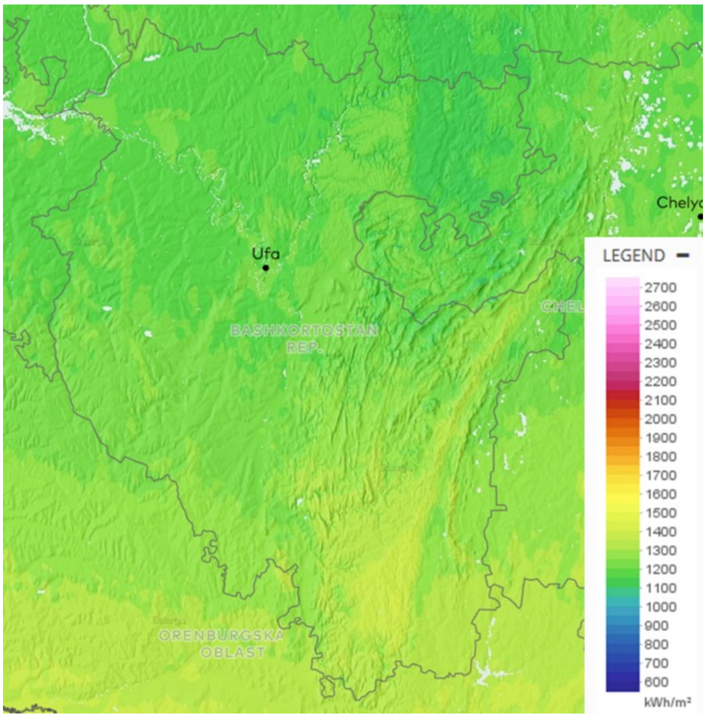
However, according to information collected by eclareon and its partners, off-grid generation in Bashkortostan is of little importance. The estimated installed decentralized RES-based generating capacity is about 300 kWp, which mainly stems from small privately-owned generation facilities. Along with off-grid RES generation, there are a number of diesel and petrol gensets (about 1,400 items) sized between 3 and 500 kWp with an estimated total power capacity of ≈60 MWp. Such gensets are mostly used by municipalities, energy companies and local branches of the Ministry of the Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters. The gensets are used as back-up energy sources for power generation in case of an emergency situation. Hence, such gensets as well as private small RES systems are not reflected by the official statistics of the region and are not described in the "Scheme and Programme of the perspective development of energy sector of the Republic of Bashkortostan".

## 5.2 Investment Framework for solar PV and heat pump applications

### 5.2.1 Solar Irradiation

Bashkortostan has different levels of solar irradiation. On average, the territory of has between 170 and 200 days of sunshine. **In northern regions, close to Ufa, the average yield on the horizontal surface reaches 1,100 kWh/m$^2$/year, while in southern regions, where "Hevel" PV parks are located, the average yield is 1,200 – 1,300 kWh/m$^2$/year [153].**

**Figure 42 Annual Global Tilted Irradiation (GTI) Republic of Bashkortostan**




**Source: Global Solar Atlas [130]**

In 2019, the PV potential in Bashkortostan was estimated to be 116 MWp [204]. The sunniest months in Bashkortostan are March – August, when the average monthly yield reaches 5.5 kWh/m$^2$/day [205].

## 5.2.2 Target Customers

**The major consumers in Bashkortostan are mining and oil refinery companies, which are either already connected to the grid, or have own energy generating facilities. In addition, the conditions necessary for ensuring the operation of these enterprises does not allow using RES for full power supply. Therefore, these companies cannot be considered a serious consumer target group.** Costs of 1 kWh from gas fueled large power plants in Bashkortostan are influenced by gas prices, as practically every CHPP in the region is fueled by gas. Gas prices differ depending on the type of consumption and are lower for large volumes aimed at energy generation. Gas price in the region increase on average 3-3.5% per year. In 2019, 1 m$^3$ for energy generation targets cost 5.53 RUB (8 €ct) [195]. Costs of 1 kWh generated by a gas CHPP are around 1.5 RUB (2 €ct/kWh). Electricity tariffs for entities in Bashkortostan are the lowest in the Volga Federal District and, therefore, do not put a serious pressure on industry. Bashkortostan is in the first price zone and is among those Russian regions with relatively low electricity tariffs both for residential and non-residential consumers (see Table 14).

**Table 14 Electricity prices in Bashkortostan**

| | Time period | | | |
|---|---|---|---|---|
| | 2020 2/2 | 2020 1/2 | 2019 2/2 | 2019 1/2 |
| | Retail market, RUB/kWh (€ct /kWh) with VAT 20% | | | |
| Urban population with gas stoves and groups equated to them (single rate tariff only) | 3.33 (4.7) | 3.17 (4.5) | 3.17 (4.5) | 3.06 (4.4) |
| Urban population with electric stoves and rural population, (single rate tariff only) | 2.33 (3.3) | 2.22 (3.2) | 2.22 (3.2) | 2.14 (3.1) |

| Non-residential consumers, average prices, RUB/MWh (EUR/MWh) with VAT 20% | | | | |
|---|---|---|---|---|
| SMEs, purchased capacity (load) less than 670 kW/month, differs depending on the month, voltage and type of contract | | | | 4.32 – 5.71 (6.2-8.2) |
| Large industrial consumers, purchased capacity (load) 10 and more MW/month, differs depending on the month, voltage and type of contract | | | | 2 – 4.44 (3-6.4) |
| Type of voltage / type of tariff | High voltage (110 kV and higher) | Middle first voltage (35 kV) | Middle second voltage (20-1 kV) | Low voltage (0,4 kV and less) |
| The first price category, RUB / MWh (EUR/MWh) (with VAT), for December 2019, non-residential consumers under 670 kW loads | | | | |
| Single-rate tariff | 4,606.12 (66) | 5,560.30 (79.6) | 5,493.30 (78.7) | 6,083.72 (87.1) |
| The second price category, double day zone tariff, RUB / MWh (EUR/MWh) (with VAT), for September2019, non-residential consumers under 670 kW loads | | | | |
| Night zone | 3,091.81 (44.3) | 4,045.99 (57.9) | 3,979.00 (57) | 4,569.42 (65.4) |
| Day zone | 7,269.94 (104.1) | 8,224.12 (117.8) | 8,157.12 (16.8) | 8,747.54 (125.3) |
| The second price category, three day-zones tariff, RUB / MWh (EUR/MWh) (with VAT), for December 2019, non-residential consumers under 670 kW loads | | | | |
| Peak zone | 10,946.45 (156.8) | 11,900.63 (170.4) | 11,833.63 (169.5) | 12,424.06 (177.9) |
| Semi-peak zone | 4,748.75 (68) | 5,702.93 (81.7) | 5,635.93 (80.7) | 6,226.36 (89.2) |
| Night zone | 3,091.81 (44.3) | 4,045.99 (57.9) | 3,979.00 (57) | 4,569.42 (65.4) |
| The third price category, RUB / MWh (EUR/MWh) (with VAT), for December 2019, non-residential consumers between 670 kW and 10 MW loads | | | | |
| Non-regulated price, differs depending on the contract type, hour and month | Av. 2,400-2,800 (34.4-40) | Av. 3,200-3,650 (45.8-52.3) | Av. 3,130-3,460 (44.8-49.5) | Av. 3,600-4,050 (51.6-58) |
| The third price category, RUB / MWh (EUR/MWh) (with VAT), for December 2019, non-residential consumers over 10 MW loads | | | | |
| Non-regulated price, differs depending on the contract type, hour and month | Av. 2,300-2,640 (32.9-37.8) | Av. 3,110-3,450 (44.5-49.4) | Av. 3,050-3,460 (43.7-49.5) | Av. 3,440-4,000 (49.3-57.3) |

**Source: "Bashelectrosbyt" 2018, 2019 [207], [208], [209]**

The cheapest RES-based energy in the region is produced by small hydropower plants operated by "BGK". Generation costs for 1 kWh fluctuate between 2.46 and 5.86 RUB/kWh (3.5-8.4 €ct), which are higher than the normal electricity tariffs in the region. Hence, "BGK" is considering closing down these generating plants due to their low profitability. Costs of 1 kWh from WPP are about 14 RUB (20 €ct/kWh) [210]. In 2015, losses from this WPP overstepped 4.78 million RUB (≈68.4 thousand EUR). The real costs for PV generation at current conditions are unknown as "Hevel" representatives do not disclose the economic performance of their installations. Since RES based energy generation is most often more expensive compared to the low electricity tariffs in Bashkortostan, there is a decline in interest in PV among major consumers. PV is mainly seen as either a solution for unusual circumstances (e.g. remote settlements with old grids) or an alternative for wealthy private consumers, willing to use RES regardless of its price, or in case of PV plant construction under the Decree 449 or 47 with state support (e.g. low profit taxes, lower lease on land, etc).

**Still, PV capacity expansion is feasible for remote regions with outdated local grids and located on network deadlocks**. Target customers are local grid operators and energy suppliers along with municipalities for whom construction of a new PV plant would be cheaper and easier than the construction of a new power line. According to the Deputy Prime Minister of Bashkortostan, Dmitry Sharonov, 1 kWh from "Buribaevskayja" PV plant was purchased for 8 RUB/kWh in 2016. While this number is four times higher than the average market electricity price, it was thought to be economically more viable than constructing new power lines and refurbishing electrical equipment in that area [199]. Moreover, outdated power lines lead to an increase in energy losses and high financial losses for the grid operators. Based on data on annual grid losses and the fact that Decree 47 obliges grid companies to cover 5% of their losses with energy from RES sources, the average annual potential for RES energy is ≈110GWh. For instance, in July 2019 "Bashkirenergo" purchased 67 MWh generated by "Tupkildy" WPP (retail market) [211]; currently existing SPPs deliver energy to the wholesale market.

**There is still a deficit of power capacity in Bashkortostan**, which has a negative impact on the economic development on the whole region. Generally, Bashkortostan is developing fast, leading to the opening of new industrial sites and a rising interest of investors. However, economic development is hindered due to the lack of high voltage power grids (220/500 kV) and the lack of power generating capacity needed for business development [199]. **Therefore, another two potential target groups are investors who need energy for industrial facilities willing to own generating facilities, as well as municipalities willing to attract investors into the region with ready-made infrastructure.**

Lastly, a smaller group of customers for PV power are beekeepers. Bashkortostan is the largest honey producing region in Russia. There are around 350.000 beehives in the region [218] [219]. Often apiaries are in forests and mountainous areas with honey-bearing herbs, potentially requiring off-grid energy solutions. The region most attractive for honeybee farming districts is the Burzyanskiy district, where a new PV park is being constructed by "Hevel".

### 5.2.3 Heat pump sector and HP target customers in Bashkortostan

Official data sources of the Republic of Bashkortostan lack information on heat pump (HP) installation projects. However, there are some well-known examples of heat pump projects, mainly installed in private households or by small entrepreneurs (see chapter 5.4).

Currently, the majority of HP-related equipment available in the region is of EU (mainly, German), Chinese and Russian origin. However, usage trends among private households or SMEs are impossible to assess.

Generally, consumers prefer using electrical heating equipment, electrical boilers or solid fuel installations (pellets, firewood, other) if capital costs are high for HP connection to the gas network. Therefore, potential consumers for HP technology in the region are solvent private households and SMEs, with access to service providers able to guarantee HP installation and equipment.

Other potential HP consumers are proponents of sustainable technologies (enthusiasts).

However, the following reasons hinder the dissemination of HP technology:

- Lack of awareness of heat pump and, as a consequence, lack of confidence in the reliability and (economic) efficiency of its use
- Lack of integrated services (with a warranty) for the installation and maintenance of HP equipment

- Absence of the energy service contract model for municipal and state organizations on the market
- Comparability in terms of CAPEX for the installation of HP equipment with gas boilers, which have proven to be a reliable source of heat energy. Additionally, the installation, services, O&M of gas equipment is carried out by a large variety of specialized companies, including state-owned (subsidiaries of PJSC "Gazprom")
- Reliable availability of gas and electricity grids to provide heat to buildings and settlements
- Low tariffs for gas and electricity or firewood
- Habit of looking at capital expenditures and not taking into account operating expenses in a long run

### 5.2.4 General perception and acceptance of solar energy and heat pumps in the region

Bashkortostan was one of the pioneers implementing Decree 47 and one of the first regions to build a PV park under the conditions of the Decree 449 in 2015 [212]. **The overall attitude towards RES generally, as well as PV and heat pumps in particular, is very positive in the region. The local government is ready to discuss the construction of new RES capacities and support investors**. For instance, the regional government and municipalities of the target districts ensure lower land lease prices for PV parks, grace periods, support and fast administrative approval. For the planned PV park in Burzyanskiy district, local authorities received a directive from the regional government to help adjust the project plan and provide help during power line construction [189].

At the same time, it should be noted that the use of heat pumps and heat collectors was considered in the relevant ministries as a possible option for heat supply to budget-funded institutions and municipal organizations (e.g. schools, hospitals, kindergartens), within the framework of energy service contracts. However, given the absence of a clear regulatory framework for this equipment, these considerations were foregone.

**Knowledge about PV and heat pumps solutions is limited among ordinary citizens in Bashkortostan.** Even with the entry into force of the law on microgeneration, it will be difficult to convince domestic consumers to switch to RES generation. Therefore, it is suggested to frame RES in the context climate change mitigation. The level of public awareness could be improved by educational programs, pilot installations and media. For larger consumers and businesses, it makes sense to hold workshops and forums showing the versatility of RES usage and profitability analysis.

## 5.3 Region-specific regulatory & legal framework

**Federal support schemes for RES are available in Bashkortostan.** Decree 449 and the supportive scheme defined in it apply for all of Russia's territory, including Bashkortostan, while Decree 47 is to be implemented by each region individually.

In 2017, the Government of the Republic of Bashkortostan passed resolution N124 defining a procedure of carrying out a tender process for RES power plants aimed at the retail energy market. The resolution describes the steps for tender preparation, conditions, and execution, defines the responsible participants and supervising bodies and describes the major features for an investment project [214]. It enabled the tender and approved the construction of the PV park in Burzyanskiy district in 2019. The results of the tender were officially registered by a competition committee on April 17$^{th}$, 2019 and signed by all participants.

According to the Law of Bashkortostan N339-з of December 24th, 2010, there are a range of regional supportive schemes and exemptions for investors, among which are [215]:

- Subsidies of the part of the bank interest rates in the size of ½ CBR refinancing rate (Refinancing Rate of the Central Bank of the Russian Federation) valid for the date of loan approval for 5 years of the project's payback period
- Compensation of a part of expenses on acquisition of lease items
- Provision of privileges on lease of land plots
- Non-financial measures of state support of investment activities carried out in the form of capital investments

Additionally, Law N 454-з of October 31st 2011[7] foresees reductions of the corporate profit tax rate by 4.5% and exemption from corporate property tax depending on the volume of **priority** investments made for a period of up to 10 years. Depending on the size of investments, there is a different tax grace period: for investments between 30 and 300 million RUB (408.8 – 4.088 thousand EUR), the grace period is one year, for bigger CAPEX, the tax grace periods is up to 10 years.

**A mandatory requirement for receiving state support is an investment agreement between the investor and the Government of the Republic of Bashkortostan, as well as compliance with its terms.** The conditions for receiving priority status, according to the Decree N 292 of August 19th 2011, are:

- Size of investment more or equal to 100 mio RUB (1.4 mio EUR) *or* creation of 20 or more local workplaces with a level of a paid salary not lower than the average salary in Bashkortostan [216].
- Compliance with the major targets of social and economic development of Bashkortostan (among which are the increase of RES capacity)
- Implementation of modern technologies aimed to enable production of the goods and services with a high value added, leading to a reducing the export of raw materials outside the Republic of Bashkortostan;

Besides the federal laws promoting renewable energy sources, there are additional RES supportive initiatives in Bashkortostan, which are described in the following paragraphs.

The Complex Program of the Republic of Bashkortostan "Energy Saving and Energy Efficiency Improvement for 2010 - 2014 and for the period up to 2020"[8] (hereinafter referred to as the "Integrated Programme") [260] applies. The guiding document's main purpose is to reduce the energy intensity of the gross regional product, increase the efficiency of the regional economy and save state budget through energy saving measures.

The document describes the general state of the energy sector and resource supply to consumers in the Republic of Bashkortostan, and sets targets for technical measures in a bid to improve the energy efficiency of budget-funded institutions (automation of energy supply, smart temperature control systems, installation of energy metering systems, insulation measures, purchase and installation of energy efficient equipment, etc.).

However, the document is considered to be outdated and requires concretization of the oversight body responsible for its implementation (today it is the Ministry of Economic Development of the Republic of Bashkortostan).

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[7] Law N 454-з "On the establishment of the reduced tax rate of the profit tax of the organizations to the investors who carry out investment activity in the form of capital investments in the Republic of Bashkortostan".

[8] This law was approved by the Resolution of the Government of the Republic of Bashkortostan No. 296 on 30.07.2010.

At the same time, energy saving activities became a new area of responsibility of the "Bashelectrosbyt" Ltd. (guaranteeing electricity supplier in the Republic of Bashkortostan, a subsidiary of PJSC "Inter RAO").

It should be noted that some municipalities are acting as separate initiators of the energy saving activities. The most prominent example is the Neftekamsk city administration, which became a regional pilot site for the implementation of a joint project of Skolkovo and DENA in the field of energy saving.

Financial support of the "Integrated Program" activities was supposed to be provided from the budgets of all levels (federal/regional/municipal), as well as from other sources: raised funds, including the Regional Fund of the Republic of Bashkortostan and the Industrial Development Fund of the Republic of Bashkortostan.

## 5.4 Regional solar and heat pumps business models

Following the classifications of business models chosen for the report and described in section 1.3, the situation pertaining to these PV business models and Heat Pumps business model in the Republic of Bashkortostan is described in the following sections.

### 5.4.1 PV Model 1: PV parks

There are 3 large PV parks in Bashkortostan with 9, 15 and 20 MWp installed capacity. Currently, another 10 MW PV park consisting of 2 PV power plants with 5 MWp each is under construction. A 20 MWp PV park is planned for construction in 2020.

All functioning regional PV parks are constructed under the conditions of the Decree 449 with the aim to deliver energy to the wholesale market. The new PV power plants of 5 MWp installed capacity each will be realized under the conditions of the Decree 47. Due to a lack of power generation capacity in the Ural regions, a developing industry and aging grids, PV parks have already proven to be a reasonable solution in Bashkortostan. Both local settlements and new industrial facilities need energy which can be delivered by PV ground-mounted parks.

Burzyanskiy district is one of the regions requiring new power sources. In April 2019 the Ministry of Industry and Innovation Policy of Bashkortostan issued order 113-O, including the new SPP into the future "Scheme and Programme of the perspective development of energy sector of the Republic of Bashkortostan" as an investment project which won the tender under the conditions of the Decree 47 [213]. The announced costs of 1 kWp are 102,990 RUB (1,474 EUR/kWp).

### 5.4.2 PV Model 2: PV & hybrid systems for remote and off-grid areas

Despite the fact, that Bashkortostan has a developed grid, many settlements are located in remote areas, of which some are off-grid settlements.

Officially, there are no off-grid settlements, and in the case of small newly founded settlements (or the revival of previously abandoned ones), the local administration tries to provide/restore centralized electricity supply. In such cases it is advisable for administrations to consider electricity supply by means of renewable energy sources, considering the high costs of grid stretching.

Mobile and spare energy sources can fulfill different objectives. For Bashkortostan, this model is relevant for smaller villages as independent energy supply and as a backup solution in natural and biodiversity reserves. In such reserves, grid construction might be prohibited or technically impossible and diesel gensets unsuitable due to environmental reasons. Currently, the following options are used as off-grid solutions:

- One of the examples is a hybrid PV (12 kWp)-wind (3 kWp) system with a backup petrol genset (6.5 kWp), generating about 15,000 kWh/year and storage (50 kWh) in Severny village (≈290 inhabitants). This system has proven its economic effectiveness in comparison to the costs of refurbishing the power lines and transformers in the district.

- Another example is the usage of PV systems in the “Iremel” Natural Park and reserve. There are no grids on the whole park territory. Several small PV panels, 100W each, are installed in different parts of the park and at the checkpoints to allow communication between the park keepers [217].

- Hybrid PV-wind-storage system for a hunting lodge in the Tashly village. An autonomous system covers energy demand with the help of a 2.4 kWp PV system, 3 kWp wind turbine, one inverter and an energy storage unit.

- “Greentok” PV system serving the tourist complex “Muradym Gorge” in Kugarchinsky area. Consists of 400 Wp PV system, a solar invertor and an energy storage unit.

- Several autonomous energy supply systems for WiFi transition points, billboards, bus stations, charging stations for mobile devices, police emergency connection points of 200 Wp - 2 kWp installed PV capacity.

Potential groups of customers for this model are honeybee keepers which often require affordable and clean energy sources for their farmstead. Moreover, operators of natural reserves and touristic areas are a potential target group, as well as energy suppliers for small energy demanding systems like mobile phone towers, emergency points or waste disposal objects.

### 5.4.3 PV Model 3: Residential PV Systems

There is little information on microgeneration in Bashkortostan. As in every other Russian region, there are some active private consumers which use own RES-based generation. A number of small companies in Bashkortostan offers ready-made solutions for countryside houses with, on average, 1 - 5 and up to 9 kWp installed capacity. Due to the fact that there is no obligation to register residential RES systems, these projects are not reflected in regional statistical reports. Hence, it is hard to determine the total installed capacity of currently existing residential systems. Below there are known examples of residential PV systems:

- Novye Chishmy village (Chishminsky district) a hybrid PV-storage solution for a countryside house, aimed to improve the quality of centralized power supply and daily consumption of 8.9 kWh. Equipment includes: 2 kWp installed PV capacity; gel energy storage 1,600 Ah; 4,000 W (24V) solar inverter and a 60 A charge controller.

- Village Maloprijutovo in Beloretskiy district of Bashkortostan, an autonomous hybrid PV-petrol energy supply for a private house, 7 kWh/day consumption. Composition of the system: 1.6 kWp PV; 1 petrol genset; 1,200 Ah gel energy storage; 3 kW inverter; 60 A charging controller.

- Another system in village Maloprijutovo in Beloretskiy district of Bashkortostan for a countryside house with a daily consumption 0.895 kWh. The system consists of: 200 Wp PV; a solar inverter of 2 kW and a 110 Ah gel energy storage.

- Hybrid PV-storage solution for a countryside house with a daily consumption of 3.5 kWh in the village of the Ural-Buzdyaksky District. The system improves the quality of the centralized energy supply and serves as a backup solution. System’s composition: 800 Wp PV; gel storage system of 300 Ah; 2 kW solar inverter and a 30 A charge controller.

Taking into account the low cost of electricity in Bashkortostan for private consumers, as well as the preferential terms for technological connection to the grid of up to 15 kWp (ca. 550 RUB), the use of RES for power supply of the majority of private households is impractical.

Nevertheless, existing residential models show that private consumers are interested in RES technologies even in the areas already covered by power grid. Their major interest is to improve the electricity quality and create reliable backup.

The number of private home photovoltaic systems is expected to increase with the enactment of the law on microgeneration.

### 5.4.4 HP Model 1: Residential and small non-residential systems

The most widely known private HP system is installed in a private household (owner Alfred Faizullin, Director, LLC "Green Houses", 2012):

- A residential house, 178 $m^2$ surface in Taptykovo settlement near Ufa city. The house has a rooftop solar thermal system. Both heat and hot water used by the household are supplied by a ground source heat pump (2 wells 63 m depth each) and by a solar thermal system on the roof. In addition, the house is equipped with a 1.7 kW electrical power capacity heat pump from "Viessmann". The solar thermal system works simultaneously with the heat and geothermal pump. Hot water is stored in a boiler of 300 liters capacity ("Viessmann Vitocell 100"). CAPEX for the whole heat and HW supply system was about 1 mio RUB (ca. 14,300 EUR) [255], [256]. The owner furthermore plans to equip the house with a PV system and a wind turbine.

- Another case is a HP installation in an office building in Kumetau city, 300 $m^2$, installed in 2013. The building is supplied with the help of 5 wells of 60m depth each and a distribution well with flow meters for 5 outputs. The heat pump capacity is 17 kW ("Nibe F1145-17") [257].

- In the Sterlitamak district of Bashkortostan, a residential building is equipped with a HP system in 2018. One HP well has a depth of 18.5 m. In addition, there is a backup HW and heat system installed, consisting of a 24-kW electric boiler and a 100 liters water storage tank. The project CAPEX was 150,000 RUB (ca. 2,148 EUR) [258]

- Furthermore, a two-store information and service center in the Shulgan-Tash Reserve receives HW and heat from a rooftop solar thermal system and a ground source heat pump ("BROSK"). The system is supplemented by a heat recovery system, warm skirting boards and a 500 litres HW storage. The project was implemented by "Green Houses" LLC. This project is planned to be used as a model for a modern historical and cultural complex of "Shulgan-Tash" with an area of 4,137.25 $m^2$ [259].

The target customers for heat pumps installations are mainly residential consumers and small enterprises, both with a high income and a specific interest in RES and sustainable technologies.  Usually HP cases in Bashkortostan are combined with solar thermal systems and electric boilers. In order to raise interest of a potential customer, it seems recommendable to provide not only equipment, but also a professional installation, operation and maintenance services to a customer.

### 5.4.5 Conclusions and Perspectives

Given the willingness of the regional administration to support investors and the necessity of new power generating sources, the potential for the development of PV projects is present in the following areas:

- On the wholesale electricity and capacity market, due to the extension of the RES supportive mechanisms provided by the Decree 449 up to 2035.

- In the retail market, for implementation of several small projects (Decree 47). However, the potential currently available for such PV capacity projects has been recently addressed by "Hevel", therefore this niche is most likely to disappear in the near future up until the new pool of projects under the regulations of the Decree 47 opens up.

- Solutions for the local energy supply in remote settlements and tourist infrastructure (e.g. biosphere reserves, national parks).
- Autonomous energy supply for small projects mainly between 200 Wp and 2 kWp, such as advertising pieces (billboards), street lighting and bus stations, mobile phone connection towers, emergency points or WiFi distribution points.
- Autonomous supply for honeybee farming sites. Here the major barrier for implementation is the lack of knowledge among farmers, awareness campaigns necessary before trying to address the potential consumers directly.
- Development of PV-microgeneration projects for private households both in areas with already existing grid infrastructure and in areas with the outdated or absent power grids.
- Medium sized projects for municipal buildings using electricity powered water heating systems, such as kindergartens, schools or hospitals. The major difficulty here is to convince municipal administrations to allocate budgets for PV system construction.
- Enthusiastic residential consumers and small entrepreneurs interested in HP technologies for HW and heat production with sufficient financial resources (very small market).

It is important to note that the creation of a company in the region, providing domestic production of relevant equipment, materials and components would constitute a significant incentive for the development of PV generation and projects in the region as well. This would moreover, help to fulfill the local content requirements of the Decrees 449 and 47.

# 6. Solar and Small Wind Markets and Potentials in Ulyanovsk Oblast

The following section provides general information on the power sector in Ulyanovsk Oblast and specific data concerning the local PV and small wind markets. Moreover, relevant PV and small wind business models in Ulyanovsk Oblast are described, as well as the regionally specific regulatory framework for renewable energy development.

## 6.1 Energy Market of Ulyanovsk Oblast

### 6.1.1 Electricity Generation, Consumption and Demand

Ulyanovsk Oblast is located in the south-east of Russia, in the Middle Volga region. The region stretches 250 km from north to south and 290 km from west to east. It is an industrial region with a large investment potential and developed R&D programs. In 2017, the region ranked 12th among Russian regions with the highest science and technology development [135]. Ulyanovsk Oblast's economy is characterized by automobile, buses and aircraft manufacturing as well as energy-intensive cement production. 73% of the population lives in urban areas [136]. The region is rich in water resources. More than 2,030 waterways flow through the territory, amongst them the largest European river, the Volga.

**Figure 43 Map of Russia and Ulyanovsk Oblast**


**Source: eclareon 2019 generated with amCharts Pixel Map**

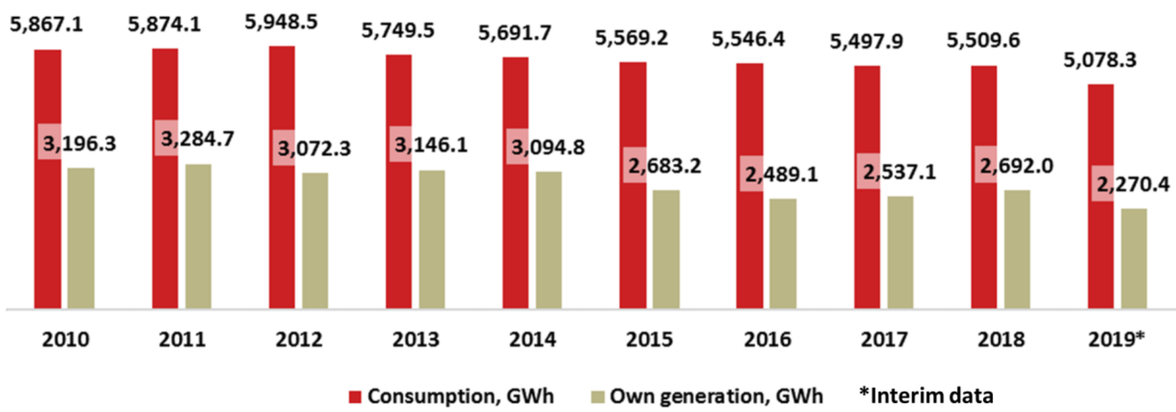
**Currently, the region has the largest energy-deficit in Russia, producing merely 46% of annual electricity consumption**. This deficit is purchased on the wholesale market and imported from neighboring power systems, such as Saratov, Samara, Penza, Tatarstan and Nizny Novgorod.

Following a slight decline of energy consumption between 2014 and 2017 and a downward trend in energy generation between 2013 and 2017, energy consumption has increased slightly from 5,833.3 GWh in 2017 to 5,845.5 GWh in 2018. According to "SO UPS", electricity consumption in Ulyanovsk Oblast will be steadily growing by approx. 0.56% p.a. according to the scenarios presented in the "Scheme and Programme of Perspective Development of

Electricity Sector in Ulyanovsk Oblast 2020-2024” [138]. The consumption growth is driven by industry development and intensive housing construction.

Figure 44 illustrates how regional electricity consumption in Ulyanovsk Oblast has developed over the years and compares energy consumption to regional energy generation. The graph indicates a widening gap between consumption and generation.

**Figure 44 Electricity consumption and generation in Ulyanovsk Oblast within latest 8 years, GWh**



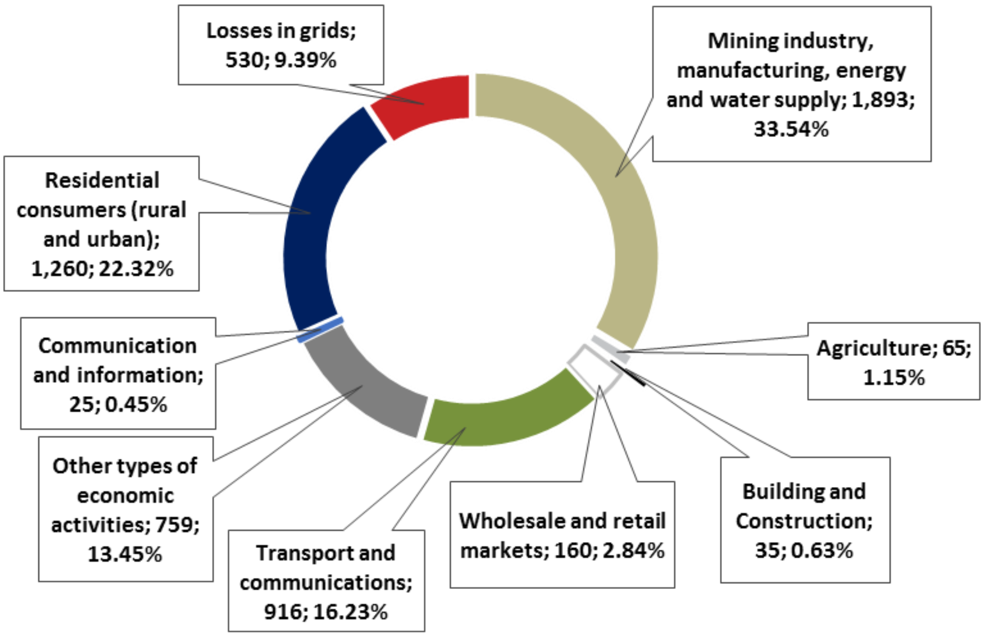

**Source: Scheme and Programme of the perspective development of energy sector of Ulyanovsk Oblast for 2019-2023, 2018; [134] (…) 2020-2024, 2019 [138]**

Missing energy generation capacity has always been a problem for the region. Therefore, the local government has decided to invest in up-to-date technology to make the regional energy system more independent. In order to do so, the first major steps were undertaken in 2013 with the amendment of the Decree 449. **As a result, Ulyanovsk has become the first Russian federal unit with a wind park delivering energy to the wholesale electricity and capacity market.** The region positions itself as a “RES-friendly” region, with a focus on wind energy, an image perpetuated by the positive attitude of local Administration and the Governor towards RES and local wind turbine production [137].

In 2018, over 75.7% of electricity in the region was consumed by the industry. 19.1% was consumed by the residential sector and approximately 5% of energy was lost in grids [138]. Among the largest electricity consumers of the region are “RZD (Russian Railways)” with 66.7 MW of active capacity consumption, “UAZ (Ulyanovsk Automobile Plant) LLC” with 44.1 MW active capacity consumption, and “Transneft Druzhba, JSC” (hydrocarbons transporting company), “Aviastar-SP JSC” (aircraft manufacturer), “DAAZ (Dmitrovsky Automobile Unit Plant) JSC”, each consuming about 26 MW capacity per annum. There is no industry consuming more than 100 MW in the region.

Figure 45 illustrates electricity consumption in Ulyanovsk Oblast for 2018 by consumer type.

**Figure 45 Electricity consumption by sector in Ulyanovsk Oblast, 2018, GWh and %**




**Source: Based on[9] Federal State Statistics Service of the Russian Federation, "Electricity Balances 2017", 2018 [30] and Scheme and Programme of the perspective development of energy sector of Ulyanovsk Oblast for 2020-2024, 2019 [138]**

### 6.1.2 Wind power in the Ulyanovsk Oblast energy sector

Ulyanovsk Oblast is well-known in Russia as a "wind region" but this is mainly due to large industrial installations and not small wind. There is only one small wind installation owned by DMG "MORI" plant (more information in 6.4.3).

The region was a pioneer in the construction of large WPPs, participated in the electricity wholesale and capacity market and pushed the manufacturing of wind turbines' parts on its territory to fulfil local content rules (see description of the Decrees 47 and 449).

In comparison to other Russian regions, wind plays a concrete role in the regional energy sector. The technology is expected to expand within the coming years. 85 MWp of wind power are already installed. This figure is expected to reach up to 200 MWp until 2021 [138]. Currently existing WPPs are:

- PJSC "Fortum" WPP (originally a Finnish company) with 35 MWp of installed power capacity on 85 ha of land. The power plant officially became a part of the Russian wholesale energy market on January 1st 2018. It consists of 14 wind turbines with 2.5 MWp each. The generated electricity is transmitted to the grid through 110 kV power lines. Each tower is 88 m high, reaching 145 m at the upper point of the blade. The overall local content level for the WPP reached 28%[10]. According to the agreements and capacity delivery contracts governed by Decree 449, the WPP is going to receive guaranteed payments for 15 years (for more details, see 2.1.1). In Q1 2018, the WPP generated 48.6 GWh.

[9] Due to differences in calculation methods, data provided by the Federal State Statistics Service of Russia and internal data of the Ulyanovsk Oblast have slight discrepancy. For the graph, numbers for residential consumption and losses in grids is taken directly from the official "Scheme and Programme of the perspective development of energy sector of Ulyanovsk Oblast for 2020-2024", while splitting of the remaining consumption is the result of the own calculations of eclareon based on the proportions of the electricity consumption by sector in the region for 2017 provided by the the Federal State Statistics Service of Russia.

[10] Since 2019 the local content level for wind power projects is set at 65%

- 50 MWp WPP from “First Windpark FRV (Wind Energy Development Fund)“ Ltd. The project was implemented under the program of the Wind Energy Development Fund, established by “Fortum” PJSC and “RUSNANO” JSC on a parity basis in 2017. “Vestas” (Danish company), a world leader in the production, installation and maintenance of wind turbines, had been selected as the technological partner of the Wind Energy Development Fund. Construction works took less time than planned and the WPP was commissioned in December 2018, while the official participation on the wholesale energy and capacity market started on January 1st 2020. This WPP consists of 14 wind turbines with a capacity of 3.6 MW each. 110 kV power lines are used for energy transmission from the power plant to the centralized grid. The towers are 87 m high, reaching 150 m with the blade at the upper point. Local content level for this WPP was increased and reached 55% in accordance to the requirements of the Decree 449 for 2018 [265]. In Q1 2019, the WPP generated more than 50 GWh.

Both projects were strongly subsidized by the regional government and „Ulyanovsk Region Development Corporation” JSC (100% state owned institution).

### 6.1.3 Regional Energy Market Stakeholders

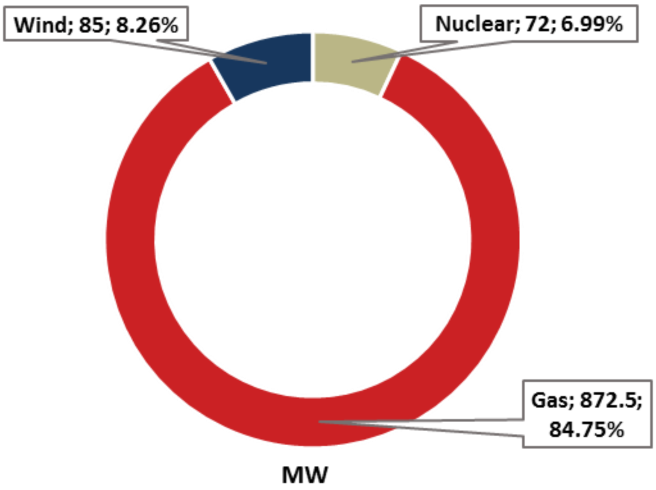
The energy system of the Ulyanovsk region is divided into 4 energy zones. The whole territory has an evolved power grid and is connected to the UPS, the Middle Volga Integrated Power System (IPS). The IPS is controlled by ROSSETI through the “Ulyanovsk Distribution Grids”, Branch of IDGC of Volga, PJSC (“Interregional Distribution Grid Company of Volga” JSC).

The electricity market in the region has several stakeholders:

- 17 energy supply companies, which are at the same time the regional guaranteeing suppliers. All of them are participants in the wholesale energy market. The largest is “Ulyanovskenergo” PJSC. Other electricity retailers include JSC “SSC RIAR”, owned by the state corporation Rosatom, “Rusenergosbyt” LLC, which sells electricity to Russian Railways and other consumers.
- 38 territorial grid operators manage small parts of power grids and major high-voltage grids.
- 4 electricity generating companies. The largest is “T-Plus” PJSC (controlling stake belongs to a private business group “Renova”), managing 6 power generating facilities.

**In 2019, the total installed electric generating capacity in Ulyanovsk Oblast was 1,029.5 MW.** A major share of electricity in the region is generated from natural gas combustion. However, both CHPPs have backup mazut generators. The largest power plants in Ulyanovsk Oblast belong to “T-Plus” PJSC. These are CHPP-1 and CHPP-2 with a total installed electrical capacity of 852 MW [141]. 72 MW refer to the nuclear power reactors of the “SSC RIAR (State Scientific Center – Research Institute of Atomic Reactors)” JSC and 20.5 MW CHPP of “SSC RIAR-Generation”. 85 MW refer to the two wind parks owned by “Fortum” PJSC (Finnish power generating company active on Russian market). WPP-1 has been generating electricity since 2018. In January 2019, WPP-2 started operations and now delivers electricity to the wholesale market also. Due to WPP-1 the share of gas in installed electrical capacity dropped from 98% in 2017 to 85% in 2018. In 2020, 36 MW of wind-powered capacity are planned for commissioning. In 2021 additional 200 MW are planned [138].

**Figure 46 Shares of fuel types in the installed electric capacity in 2019 MW and %**

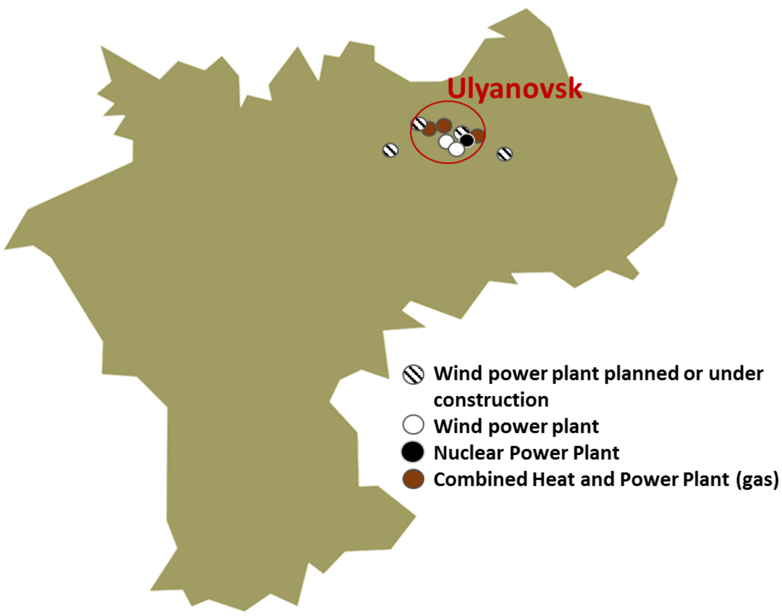



**Source: Scheme and Programme of the perspective development of energy sector of Ulyanovsk Oblast for 2020-2024, 2019 [138]**

High voltage power grids (220 – 500 kV) in the region are managed by “FSK UPS (the Federal Grid Company of the United Power Grid)”, a subsidiary of “ROSSETI“. Grids with 110 kV are managed by the “Ulyanovsk Distribution Grids” (ROSSETI group). Low voltage grids between 35 and 6 kV have both state and private operators.

PJSC “Ulyanovskenergo”, is the largest guaranteeing supplier in the region, controlling 70% of the regional power market. Additionally, there are 15 other guaranteeing suppliers with the status of wholesale market player. Other energy supply companies are allowed to complete energy trade on the retail market only. The second and third largest guaranteeing suppliers in the region with the market shares of ca. 6% each are “Rusenergosbyt” Ltd. (large private company active in 17 Russian regions) and “SESNA (Simbirsk Energy Sales Nomination)” Ltd. [142].

**Figure 47 Schematic map of Ulyanovsk Oblast with the location of major power generating facilities in 2019**




**Source: eclareon 2019 generated with amCharts Pixel Map, based on Scheme and Programme of the perspective development of energy sector of Ulyanovsk Oblast for 2020-2024, 2019 [138]**

### 6.1.4 On-Grid Generation

There are no official off-grid generating facilities in Ulyanovsk Oblast. The total electricity consumed by the region either comes from local power plants or is imported. Since Ulyanovsk Oblast is an energy deficient region, more than 50% of electricity comes from neighboring energy systems, mainly from Samara and Lipetsk Oblasts. Domestic power plants feed generated electricity into the local grid and supply all types of consumers.

Table 15 shows data of electricity generation, electricity consumption share, per capita power generation and share of imported electricity.

In 2015, regional electricity generation dropped. The last three years indicate fluctuations of around 2,500 GWh per annum, whereas power consumption fluctuated around 5,900 GWh within the 11 years analyzed. Since 2016, the electricity generation in the region has been growing gradually, mainly driven by the commissioning of new power generating capacities: the wind power plant, which produced 88 GWh in 2018 [138] and the commissioning of Ulyanovsk CHPP-1 in 2018 with an installed capacity of 35 MW. In 2019 another wind power plant with installed capacity of 50 MW was commissioned [262].

**Table 15 Electricity Generation Profile in Ulyanovsk Oblast, years 2010-2018**

| Year | Total electricity generated (thousand GWh) | Total energy consumption (% from electricity generation) | Total electricity import (% of consumption) | Per capita electricity generation (MWh per capita) |
|---|---|---|---|---|
| *2019[11]* | *2,270.4* | *223.7* | *55.3* | - |
| 2018 | 2,692.0 | 217.1 | 53.9 | 2,2 |
| 2017 | 2,538.1 | 229.8 | 56.5 | 2,1 |
| 2016 | 2,493.6 | 237.1 | 57.8 | 2,0 |
| 2015 | 2,683.2 | 220.5 | 54.6 | 2,4 |
| 2014 | 3,094.8 | 194.2 | 48.5 | 2,4 |
| 2013 | 3,146.1 | 189.6 | 47.3 | 2,5 |
| 2012 | 3,072.3 | 193.6 | 48.4 | 2,4 |
| 2011 | 3,284.7 | 178.8 | 44.1 | 2,5 |
| 2010 | 3,196.3 | 183.6 | 45.5 | 2,4 |

**Source: Based on Scheme and Programme of the perspective development of energy sector of Ulyanovsk Oblast for 2016-2020, 2015 [150] & 2017-2021, 2016 [149], 2020-2024, 2019 [138]; data for 2019 is interim, SO UPS Annual Interim Report 2019 [263]**

In 2018, the power plants of the Ulyanovsk Oblast generated 2,692 million kWh, which is 6.1% more than in 2017. The volume of electricity generated by the Ulyanovsk WPP-2 in 2018 resulted into 5.4 million kWh.

### 6.1.5 Off-Grid Generation

There is little data on off-grid generation in Ulyanovsk Oblast. However, it is possible to state that there is no separate sector of off-grid generation. There are examples of private gas, diesel, hybrid and photovoltaic generating facilities which are not connected to the grid and are therefore, not part of the UPS. It is difficult to estimate the volume and scale of such off-grid power generation, as most of it is not registered.

Regarding RES generating facilities, there are a couple well known examples of off-grid RES-based generation, which are described in sections 6.2.3 and 6.4.

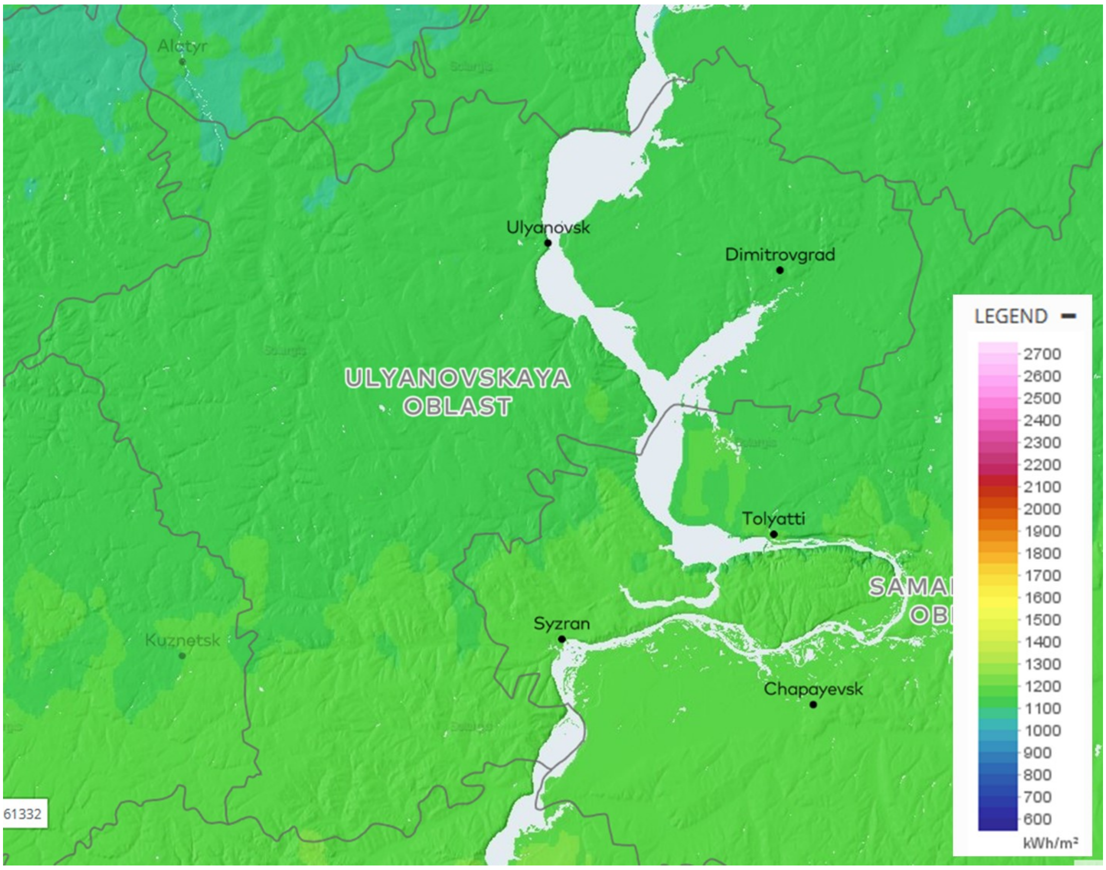
[11] Interim data for 2019, final numbers will be available in Q1 2020 and deviate from the interim ones

## 6.2 Investment Framework for solar PV and small wind applications

### 6.2.1 Solar Irradiation

**Ulyanovsk Oblast is primarily known as a wind power region but the region also has solar PV potential.** On average, there are 150-180 days with sunshine each year [156]. The map taken from the Global Solar Atlas presented in Figure 48 gives an overview of the solar radiation level for horizontal surfaces in the region.

**Figure 48 Annual Global Tilted Irradiation (GTI) Ulyanovsk Oblast**




**Source: Global Solar Atlas [130]**

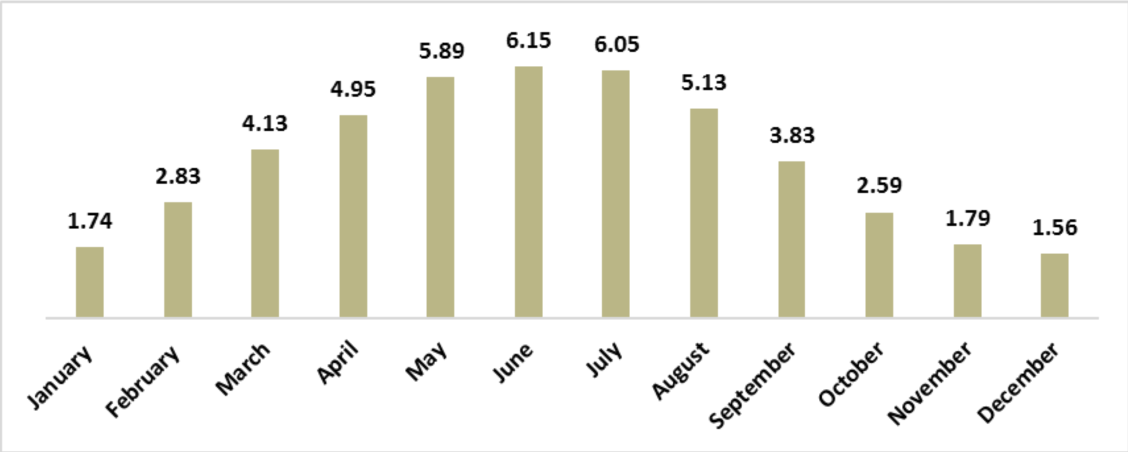
**The average yield on the horizontal surface reaches 1,070-1,160 kWh/m²/year** [130][153][92]. Average daily yield is between 3.2 and 3.4 kWh/m²/day. The southern border of the region has slightly better conditions for PV than northern territories and reaches 3.8 kWh/m²/day[153] .

Due to the geographical location of Ulyanovsk Oblast, the natural limitation of solar irradiation is below 4 kWh/m². This requires careful planning of PV projects. Using equipment with increased efficiency (monocrystalline silicon, PERC[12], HJT[13]) as well as sun tracking systems could increase the yields of a PV system but would also increase the investment costs at the same time. Moderate insolation values will potentially increase the payback period, therefore there is a need of attracting preferential financing and other types of direct and indirect subsidies for the owners of PV systems and investors.

[12] Passivated Emitter and Rear Cell. You also find the term Passivated Emitter and Rear Contact - a new technology aimed to achieve higher energy conversion efficiency by adding a dielectric passivation layer on the rear of the cell.

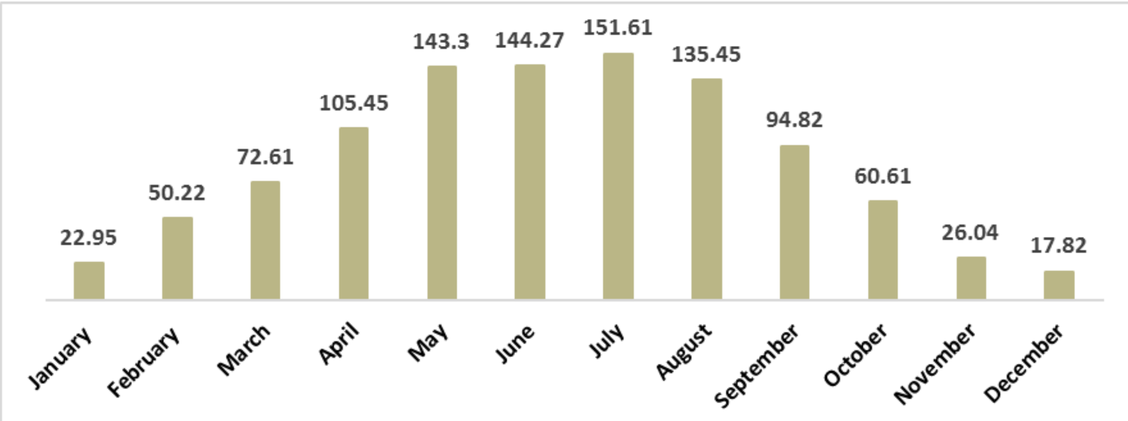
[13] Heterojunction-Technology with higher than usual efficiency

**Figure 49 Average solar irradiation per 1 m² in Ulyanovsk by month**




**Source: Betaenergy [157]**

**Figure 50: Estimation of the average annual output of a 1 kWp crystalline silicone PV system with a modules' tilt of 35⁰**




**Source: European Commission PV tool [264]**

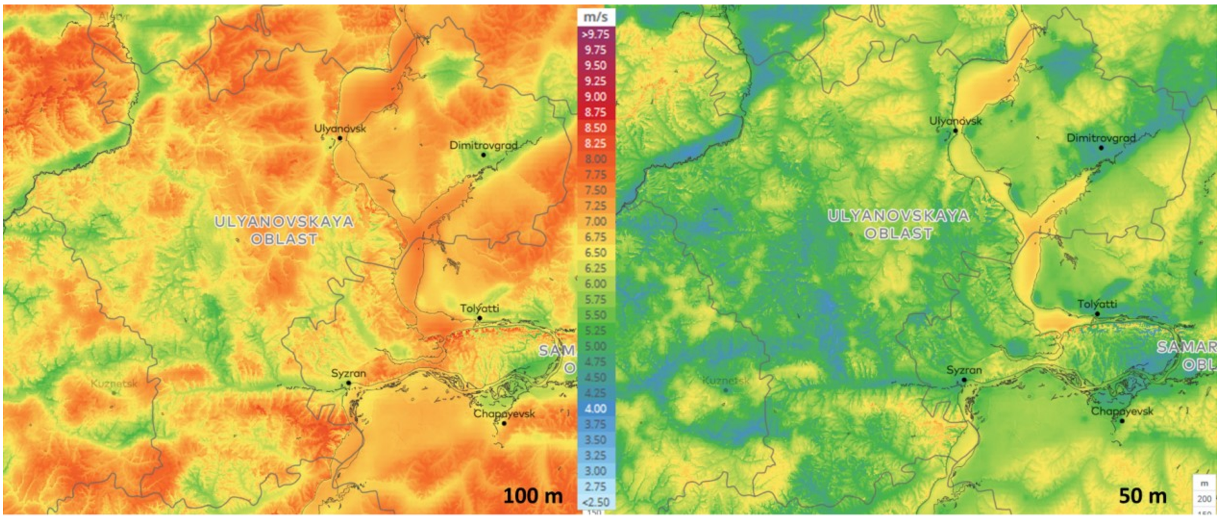
Figure 49 shows the average solar irradiation in Ulyanovsk city. May, June and September show the highest values. Figure 50 estimates the potential electricity generated by a 1 kWp PV system (with crystalline silicone PV modules, have a $35^0$ tilt, the system losses are set at 14%). It fully corresponds to the solar irradiation data: the warmest half of the year (April to September) is the most effective and productive period for a PV system.

### 6.2.2 Wind power potential

Generally, Ulyanovsk Oblast has a high potential for wind power development, both for large wind parks and small wind. According to the maps of "GIS Renewable Energy Sources of Russia", meteorological stations METAR (meteorological stations of airports), "Ulyanovsk-Vostochny", "Kurumoch", Samara, Saratov and satellite data from NCAR[14], wind potential in Ulyanovsk Oblast at an altitude of 10 meters is between 3.1 - 4.1 mps (depending on the altitude above sea level). For 30 meters altitude it is between 3.4 - 4.4 mps, for 42 m altitude wind speed it is estimated to be at 4.8 - 5.15 mps. The potential for those figures is on average 174 MWh/year [226]. The southern regions of Ulyanovsk Oblast show slightly better wind power potential. However, existing and planned wind parks are located in the northern territories around Ulyanovsk, as the regional capital city concentrates many residential consumers and electricity demand is higher.

[14] National Center for Atmospheric Research

**Figure 51: Average annual wind speed for 100 and 50 m above the ground level**




**Source: Global Wind Atlas [266]**

A very positive attitude of regional authorities and business towards wind energy constitutes a good basis for wind energy development. Ulyanovsk Oblast was the first region in Russia where large-scale commercial wind power projects were built. In 2014 the region launched a comprehensive wind measurement campaign, which unveiled its potential for wind-based power generation. The annual wind speed measurements were conducted in three districts. The annual average wind speed at 100 m altitude, defined as the result of the measurement campaigns, was 6 -7.2 mps. Suitable wind resources for WPPs are distributed unevenly throughout the territory. Hence, locations of each wind power plant, including small wind, need to be carefully planned.

With regards to small wind it can be said that the Russian market is underdeveloped. Small wind is even less known than small PV, the market is therefore even smaller. In Ulyanovsk Oblast there is only one known example for a small wind system by “DMG Mori” is (see 6.4.3 for more details).

### 6.2.3 Target Customers

There is very little official data on existing non-industrial PV projects in the region, rendering the identification of target customers difficult. Currently, there are few well-known examples of PV and wind power projects in the region [154] [155]:

- a hybrid PV-small wind-storage system on the balance of “DMG Mori” factory
- a PV-solar thermal system on the roof of the hospital
- a rooftop PV system on an apartment house in Ulyanovsk
- likely existing, but unregistered private RES systems
- large wind parks (wholesale market, large wind)
- likely existing, but unregistered private PV or small wind installations

According to the research and estimations of eclareon, the total installed PV capacity in Ulyanovsk Oblast is currently unlikely to exceed 500 kWp, of which 398.9 kWp is the verified capacity. In the region, there are no large SPPs working on the wholesale market, solar energy is yet used for show-cases.

The estimated installed capacity for small wind in Ulyanovsk is unlikely to exceed 40 kWp, of which 20 kW is verified capacity owned by “DMG Mori”. The remaining volume is likely split between various unregistered private users. The advantages of those actual RES systems will be described in more detail in section 6.4.

Consumers have different reasons for switching to RES energy sources or for combining them with the traditional energy grid access. The main driver is an economic advantage or profit associated with RES energy sources.

Heat and electricity prices in Russia, especially in regions with a developed power grid, are very low compared to most EU countries. However, it is important to distinguish between the 'undistorted' price per 1 kWh and the purchasing power of end consumers. In the second half of 2018, Ulyanovsk Oblast was ranked 59 among 85 Russian regions in terms of electricity volume purchasable on an average monthly salary. In Ulyanovsk, a person can purchase 7,351 kWh electricity in a month, whereas in Irkutsk Oblast, where electricity prices are the lowest in the country due to a huge hydropower plant, one could purchase 5 times more, 37,082 kWh [158]. Regarding 'undistorted' tariffs for 1 kWh, Ulyanovsk Oblast ranked 34 among 85 Russian regions in 2018, with middle-priced electricity tariffs [159].

Ulyanovsk Oblast is a part of the first non-price zone. This means that **there is strict control and predetermination of prices on the retail electricity market.** Since 2011, all non-residential consumers in the region pay unregulated electricity prices, while tariffs for residential consumers are regulated as everywhere in Russia.

The tariff policy of the Ulyanovsk region aims to contain price and tariff growth in accordance with objectives set by the Russian government. Electricity tariffs for residential consumers are presented in Table 16. The table contains only single rate and double rate tariffs (see section 1.2.5.3 for more details).

**Table 16 Some electricity tariffs for residential consumers in Ulyanovsk Oblast in 2019 and 2020**

| | Time period | | | |
|---|---|---|---|---|
| | 2020 2/2 | 2020 1/2 | 2019 2/2 | 2019 1/2 |
| | Retail market, RUB/kWh (€ct /kWh) with VAT 20% | | | |
| Urban population with gas stoves and groups equated to them (single rate tariff only) | 3.90 (5.6) | 3.77 (5.4) | 3.77 (5.4) | 3.74 (5.4) |
| Urban population with electric stoves and rural population, (single rate tariff only) | 2.73 (3.9) | 2.64 (3.8) | 2.64 (3.8) | 2.62 (3.8) |

**Source: Price and Tariffs Regulation Department of Ulyanovsk Oblast, 2019 and 2020 [160], [161]**

The electricity tariffs are set yearly by the Ministry of Competition and Economic Development of Ulyanovsk Oblast. In 2018, this was done through the Order 06-501 of December 20$^{th}$ 2018 [163]. The tariffs apply for the whole territory and vary depending on consumer type: Prices for the rural and urban population and are capped and established by the Federal Antimonopoly Service of the Russian Federation. Tariffs are increased once a year and are adjusted to the inflation rate. Since 2019 also VAT increase by 2% is taken into consideration.

Electricity for enterprises in Ulyanovsk is sold at unregulated prices. Therefore, electricity prices are influenced by the price fluctuations on the wholesale market and by a number of other criteria, such as price category, conditions of hourly consumption planning, loads, and electricity transmission service. The growth of the single-rate wholesale market price has a significant impact on the growth of electricity prices for enterprises in the Ulyanovsk region (see 1.2.5.4).

Table 17 depicts electricity prices for non-residential consumers, including SMEs, large entities and factories. As written in section 1.2.5.3, which further describes different price types for non-residential consumers, prices are influenced by consumer type, capacity needed, methods of energy metering, type of tariff and grid voltage. To render the table below understandable, only prices for the first and second price categories for small consumers (less than 670 kW loads) and very large consumers (over 10 MW loads) are shown, aimed at displaying the difference between the “lowest” and “highest” prices.

**Table 17 Some electricity prices for non-residential consumers in Ulyanovsk Oblast, November 2019**

| Type of voltage / type of tariff | High voltage (110 kV and higher) | Middle first voltage (35 kV) | Middle second voltage (20-1 kV) | Low voltage (0,4 kV and less) |
|---|---|---|---|---|
| The first price category, RUB / MWh (EUR/MWh) (with VAT), for November 2019, non-residential consumers under 670 kW loads | | | | |
| Single-rate tariff | 5,755.43 (82.4) | 6,199 (88.8) | 6,942.29 (99.4) | 7,463.99 (106.9) |
| The second price category, double day zone tariff, RUB / MWh (EUR/MWh) (with VAT), for November 2019, non-residential consumers under 670 kW loads | | | | |
| Night zone | 3,859.41 (55.3) | 4,302.99 (61.6) | 5,046.28 (72.3) | 5,567.97 (79.7) |
| Day zone | 8,323.54 (119.2) | 8,767.11 (125.5) | 8,083.83 (115.8) | 10,032.10 (143.7) |
| The second price category, three day-zones tariff, RUB / MWh (EUR/MWh) (with VAT), for November 2019, non-residential consumers under 670 kW loads | | | | |
| Peak zone | 10,769.96 (154.2) | 11,213.54 (160.6) | 11,956.82 (171.2) | 12,478.52 (178.7) |
| Semi-peak zone | 5,983.78 (85.7) | 6,427.36 (92) | 7,170.64 (102.7) | 7,692.34 (110.2) |
| Night zone | 3,859.42 (55.3) | 4,303 (61.6) | 5,046.28 (72.3) | 5,567.98 (79.7) |
| The third price category, RUB / MWh (EUR/MWh) (with VAT), for November 2019, non-residential consumers over 10 MW loads | | | | |
| Non-regulated price, differs depending on the contract type, hour and month | Av.2,800-3,550 (40.1-50.9) | Av. 3,220-3,850 (46.1-55.2) | Av. 3,650-4,470 (52.3-64.1) | Av. 4,300-4,930 (61.6-70.6) |

**Source: “Ulyanovskenergo” 2019 [162]**

**For a range of non-residential consumers, including budget organizations (s.a. hospitals and sports centers) with the fix contracts, electricity tariff ranged between 6.50 and 7.7 RUB/kWh (9.3-11 €ct/kWh) in 2019**.

Prices for some non-residential retail consumers fluctuate throughout the year. In the first half of 2019, electricity prices for non-residential consumers in Ulyanovsk Oblast decreased in comparison to 2018 due to a 5% drop of electricity distribution costs. However, there is a general trend towards higher prices. The increase in electricity and capacity prices and the prospects of further significant price increases due to non-market price premiums for capacity (see also 1.2.5.4), makes some industrial consumers consider construction of own generating facilities (similar to industry behavior in Krasnodar Krai, see 3.1.2). Such examples already exist in Ulyanovsk Oblast:

- In 2014, JSC “Teplichnoye”, the largest greenhouse enterprise in Ulyanovsk Oblast, commissioned a 6.4 MW gas power plant. This plant helped reduce the company’s energy bills. The cost of 1 kWh of own gas generation was 1.8 RUB, which was 2.5 times lower than the grid electricity price. In winter periods the company still purchases additional energy, as demand exceeds generation capabilities.
- The cement plant Sengileevsky installed a cogeneration facility consisting of 2 gas turbines with a total installed capacity of 25.8 MW. The turbines supply the cement plant with both electricity and heat, while exhausted fumes are used in the cement drying process. According to unofficial information, costs of 1 kWh from the gas plant

are much lower than energy supplied by the grid; savings on electricity and heat bills decrease the costs of the end product, increasing the firm's competitiveness.

Each region of Russia historically has debts both to the state and electricity transmission and distribution companies on payment for electricity and heating, as both residential and non-residential consumers often are not able to pay the bills or simply violate them. Thus the debts of regional housing and communal services management companies and electricity suppliers debts are increasing: in 2018, a total accounts receivable of Ulyanovsk Oblast for electricity rose by 450 million RUB to 3 billion RUB [169]. In 2018, the Governor of Ulyanovsk Oblast stated that tariffs should stay the same for the region. This was met with dissatisfaction on sides of regional energy suppliers. Growth of tariffs puts more pressure on consumers, while grid operators and energy producers are unwilling to accept fixed tariffs as their receivables increase further.

In the end of 2017, there were 27,597 registered companies in Ulyanovsk Oblast. More than one fourth were classified as "trade and refurbishment". About 84% of all companies were private, about 10% in municipal and state ownership. 68% of all companies were small and micro companies (up to 100 employees) [164]. These numbers give a good overview of the regional business development status. There are numerous private and state-owned companies, all of which consume electricity in different volumes and many of which could potentially be interested in PV development and solar power capacity building in general.

### 6.2.4 General perception and acceptance of solar and wind energy in the region.

Ulyanovsk Oblast is positioning itself as a modern region. It targets RES creation and a sustainable technologies cluster in the region and supports the development of both clean energy generation and manufacturing of RES equipment.

The region was the first in Russia to launch an industrial wind park supplying energy to the wholesale electricity and capacity market. The Governor, Sergey Morozov, intends to make Ulyanovsk Oblast a leader in renewable energy development and is personally a supporter of RES (experience of eclareon based on visiting the ARWE Forum in Ulyanovsk). Hence, new RES-related ideas usually attract interest on sides of the regional authorities and it is easier than in other Russian regions to convince decision makers to agree with project developers. Since the authorities of Ulyanovsk Oblast have a positive attitude towards RES, they are planning to increase the share of RES in the energy generation mix up to 30% until 2030 (the current share is 8%) [222].

Currently, the region has 2 WPPs. In May 2019 it was planned to construct another WPP in the region with a total installed capacity of 75 MW. The project will include an investment of a 6.5 billion RUB from the German company EAB New Energy GmbH [175]. At the same time, the region is interested in developing PV projects as well. There are already some examples of pilot projects and a plan to build a photovoltaic module manufacturing plant with the help of two German companies, Green Source GmbH and "Core Value Capital" GmbH [173] which target to take advantage of the local content rules for PV projects as mandated by Decrees 47 and 449.

Local universities have created new RES study programs. While these mainly focus on wind, PV is slowly gaining traction. Such regional RES skill development is likely to further strengthen the positive attitude towards RES in the region.

At the same time, also SMEs and industries have shown a **growing interest in building their own power generating facilities**. Not only increasing retail energy prices make enterprises seriously consider the issue, but the general attitude towards energy efficient technologies and clean energy is shifting. As Ulyanovsk Oblast has created favorable conditions for investors and industrial development by constructing industrial parks and establishing special economic zones[15], numerous international companies have opened offices and industrial plants in the region. Among them are for example the above mentioned “DMG Mori”, “Mars”, “Efes”, “Leroy Merlin” and “Shaeffler” [268].

**Lastly, awareness for renewable energy sources among ordinary citizens,** especially **those in Ulyanovsk and surrounding areas is increasing.** One major driver for this increase is the physical existence of the large white wind turbines on the horizon. Gathered from talks with Ulyanovsk citizens, the region takes pride in its role as the first region with an industrial wind park in Russia. With improving knowledge on RES and the growing dissatisfaction with rising electricity prices, people have begun to consider to become their own power suppliers. However, this will rather be possible for wealthy individuals, as the majority of people in the region do not have enough financial resources to invest in a small PV system or a wind turbine (an average monthly salary in Ulyanovsk Oblast in 2019 was around 340 Euro [176]).

## 6.3 Region-specific regulatory & legal framework

There are a number of legislative acts and laws in Ulyanovsk Oblast intended to support RES based power generation on the regional level:

- Decree of the Government of Ulyanovsk Oblast "On approval of the regulation of the procedure and conditions for competitive selection for inclusion of generating facilities operating on the basis of renewable energy sources, in respect of which energy (capacity) sale is planned on retail markets, in the scheme of electric power industry development in the Ulyanovsk region, as well as on requirements for the relevant investment projects and on criteria for their selection" No. 591-П amended on November 18th 2019 [269].

This decree implements the Federal Decree 47 on the regional level. It aims to include RES generating facilities, regarding the sale of electric energy (capacity) in retail markets into the “scheme and program of the perspective development of energy sector of Ulyanovsk Oblast”. The inclusion of RES facilities is of key importance for the development of RE in any region, as the document serves as an official guideline for all stakeholders of the regional energy market. Decree 591-П contains a description of the mechanism of return on investment for RES projects, types of generation receiving support under the mechanism, criteria for selecting investment projects during a tendering process as well as the procedure for conducting competitive selection.

- For the functioning of the RES support model on the retail market in accordance with Decree 591-П, it is planned to issue corresponding orders of the Ministry of Energy, Housing and Communal Services and Urban Environment of the Ulyanovsk region. Those orders shall regulate and approve the composition and regulation of the competition commission which then makes decisions concerning the choice of concrete RES objects to be constructed.

- Scheme and Program of the prospective development of Ulyanovsk Oblast’s energy sector 2020-2024, approved by the Decree of the Governor of Ulyanovsk Oblast amended on April 25th 2019 № 29. This document is established every year in each Russian region and developed in accordance with the Decree of the Government of the Russian Federation of October 17th 2009 № 823 "On the schemes and Programs of the prospective development of the energy sector". The document for Ulyanovsk Oblast was developed on the basis of data from the “SO UPS”, Ulyanovsk Oblast department, the Department for price and tariff regulation of the Ministry of Digital

[15] Territories inside the region(s), having special legal status, preferential economic conditions s.a. lower tax or grace periods, lover land lease rates, subsidies and overall support from the regional government etc.

Economy and Competition of Ulyanovsk Oblast and data from the grid companies active in the region.

The main purposes of the document are:

- promotion of the power grids and power generating capacity development
- meet long-term and mid-term demand for electricity and power capacity
- provision of the reliable functioning of the energy system of Ulyanovsk Oblast in the long run
- coordinate planning for construction and commissioning (decommissioning) of grid infrastructure and generating facilities
- provide information for the development of the electric power industry, taking into account completed and forthcoming tasks of commercial and technological infrastructure organizations, electric power industry entities, consumers and investors.

In addition, there are also regional legislative acts aimed at creating favorable conditions for the construction, commission and connection of newly constructed power generating objects to the grid infrastructure:

- Order of the Government of Ulyanovsk Oblast № 620-pr, amended on November 3rd 2015. “On measures aimed at simplifying the procedure for heat supply connections, hot and cold-water supply, water disposal and gas supply network” establishes reduced terms for issuance of technical specifications for connection (technological connection)
- Order of the Government of Ulyanovsk Oblast No. 778-pr of November 29th 2013 “On some measures aimed at simplifying the procedure of power grid connection” establishes reduced terms of issuing contracts and technical specifications by power supply companies and establishes term of technological connection to power grids by the power supply company
- Decree of the Government of Ulyanovsk Oblast No. 39-P of January 23rd 2018 “On reduction of the terms for conducting the state expert examination of project documentation and results of engineering surveys conducted by executive bodies of Ulyanovsk Oblast (subordinate and state institutions)”. The decree establishes reduced terms for conducting the state examination of project documentation and results of engineering surveys - up to 50 days and up to 40 days for certain categories of objects.
- Setting maximal and minimum energy tariffs for the electricity generated by qualified RES facilities and sold to the grid companies with the aim to compensate for losses in grids (in accordance to the Decree 47) are regulated by the Ministry of Digital Economy and Competition of Ulyanovsk Oblast which is set by the Decree N8/125-П of April 14th 2014.

## 6.4 Regional solar and wind business models

Currently, the most successful business models for Ulyanovsk Oblast are large wind parks under Decree 449, functioning as a part on the wholesale electricity market. However, this business model is not presented in detail in this study who focuses on solar applications and small wind.

Following the classifications of business models chosen for this report and described in section 1.3, the 3 business models for Ulyanovsk Oblast are described in the following sections.

### 6.4.1 PV Model 1: PV parks

Although there are no large MW SPPs in Ulyanovsk Oblast yet, this may change in the future for the following reasons:

- high interest on government and administration level in the development of PV parks and a willingness to support such projects to raise the status of Ulyanovsk Oblast as a fast-developing innovative Russian region
- serious deficit of energy generating facilities along with a growing electricity demand
- availability of support measures and legislative acts enabling the construction of large PV parks, including the possibility of low land lease rates, and general willingness of local authorities to provide investors with necessary infrastructure (roads, grids, water connection etc.)
- cluster of power plants around Ulyanovsk and absence of large power plants in southern districts (see Figure 47)

This last reason leads to additional grid loss in the region, since electricity needs to be delivered hundreds of kilometers either from existing power plants to settlements or imported from neighboring regions.

The support mechanisms of Decree 47 limit the available total installed capacity of such projects to 5% of the total regional grid losses. Based on the amount of grid losses in Ulyanovsk Oblast, the existing available capacity to be covered by the PV parks is up to 25 MW, and 16 MW for wind. For realizing such projects it is necessary to participate in the regional tendering process to include the object into the 'Regional Scheme and Program of the Prospective Development of Ulyanovsk Oblast's Energy Sector' (see also 6.3). According to the program requirements, it is also necessary to achieve the local content targets (70% for PV and 65% for WPP from 2019).

### 6.4.2 PV Model 2: Off-grid PV/diesel Hybrid Systems

In the chapters on Krasnodar Krai, Kaliningrad (and partly Bashkortostan) the second business model established was a pure off grid hybrid solution for remote settlements. In each region the potential of this niche is different, depending, amongst others, on regional conditions and the quality of the local grid. In Ulyanovsk Oblast, the grid is well developed and although the region itself is energy deficient, it does not suffer from serious power outages. No remote settlements with no or a weak grid connection could be identified during the research for this report. Nevertheless, there is potential for off-grid hybrid solutions, which could also be combinations of PV/small wind, diesel/petrol genset and storage solutions for the following cases:

- **National parks and biodiversity reserves, ecotourism objects**. In Ulyanovsk Oblast, there are more than 150 natural reserves, natural protected areas and protected park zones. In total, more than 282,000 ha of land are protected areas, which indicates potential for small scale off grid RES development [272]. Ecotourism is becoming more and more popular [271]. In national parks, energy demand is rather low but electricity is still needed to supply rangers, which manage the territories, tourist infrastructure and information centers. In addition, in case touristic pedestrian routes exist, there is sometimes a need for lighting and charging stations for mobile devices.
    - The development of ecotourism is included in the "Strategy for Touristic Development of Ulyanovsk Oblast until 2030" and includes the creation of touristic clusters (tourist-recreational zones), equipment of existing zones with infrastructure and creation of new zones, including construction of hotels, transport, information centers. Moreover, the strategy stipulates the inclusion of the new territories into recreational and tourist zones, support and development

of new tourism types, such as ecotourism, industrial and agricultural tourism, car tourism (car camping sites) etc. [270]. The new facilities will all require energy supply. Since in most cases protected areas have legal restrictions regarding grid construction, there is good potential for small off grid RES or hybrid solutions. While there is currently scarce information on existing RES or hybrid solutions for such areas in the region, this niche is estimated to be potentially attractive considering the development plans of regional authorities as well as their willingness to keep Ulyanovsk Oblast's status of being an innovative region with a strong RES cluster. According to estimations by eclareon, the overall installed capacity needed for such areas and objects might be up to 3 MW for PV and small wind, split between small power generating facilities of 2-10 kWp.

- **Remote/'eco' farms and greenhouses**. Although Ulyanovsk Oblast is not a very agricultural region, there are numerous farms and greenhouses. In section 6.2.3 the example of the greenhouse enterprise JSC "Teplichnoye" was mentioned, which currently uses own energy generating facilities, fueled by natural gas. In case of new facility construction, an electricity grid is not always in place and connection to the grid is comparable to the investments needed for an own PV system (see chapter 3). It is important to mention the "Strategy for Sustainable Development of Rural Areas of Majnsky District of Ulyanovsk Oblast until 2030" developed within the scope of the federal "Strategy for Sustainable Development of Rural Areas of the Russian Federation until 2030". While this strategy mentions the importance of energy efficiency technologies, energy saving measures and decrease of energy intensity of agricultural products, it does not directly mention RES development as a target. Nevertheless, RES suits these targets (lowering the energy intensity and at the same time create an alternative to the gas-powered facilities or steadily growing energy tariffs from the state grid) very well. However, making estimations regarding the potential PV/small wind capacity for agricultural facilities is difficult due to a lack of information.

In conclusion, there is a niche market potential for off-grid projects in the region but this market is not yet developed. RE in natural reserves may be pushed by the local government and is likely to qualify for state support. The deployment of RES solutions on farms and in rural areas may be more time consuming: Before project initiation, an awareness raising program may be needed in the region to inform potential customers about RES solutions and in order to positively influence their attitude towards clean energy supply solutions.

### 6.4.3 PV Model 3: PV/SW systems for non-residential consumers

This model is also referred to as captive PV solutions. Such power systems are disconnected from the city grid and used to cover the electricity demand of the user fully or partly. The installations can be both rooftop and ground-mounted. These PV cases refer to the systems with an installed capacity that of approx. 15 kWp to several hundreds of kWp. There is no legislative act or law regulating the connection of any RES system over 15 kWp, which are not part of the Decrees 47 and 449. This means, that such installations are purely private without any state support. In some cases, the potential connection to the grid can be negotiated with the local grid company. In case of an agreement, the surpluses from a PV system may be fed into the grid for free (in case there is no storage). In Ulyanovsk, there are three known examples of the rooftop PV systems belonging to non-residential consumers:

1. PV/Solar thermal rooftop system at a regional Ulyanovsk hospital in the Ischeevsky district. The pilot project was completed in 2017. In 2015, the hospital had very high electricity bills and therefore considered covering its own energy needs by installing an in-house energy generation system that is able to generate both heat and electricity. This rooftop PV/ solar thermal system takes up 650 $m^2$ and has an installed PV capacity of 75 kWp and 1,500 liters of hot water storage. other known technical features include:
    - BLD SOLAR 250-60M monocrystalline solar modules, 300 pcs
    - 3 three-phase grid inverter Sofar 30000 TL, 3 pcs

- Voltage Stabilizer CH·LCD·12, 3 pcs
- DUALEX pressureless solar thermal system, 2 pcs, 1,500 liters capacity
- Implementation of LED lightning as an energy efficiency measure

Daily PV generation reaches up to 352.5 kWh, monthly generation is up to 10,575 kWh.

CAPEX for the entire system (incl. PV and solar thermal) was 21.42 million RUB (ca 309 thousand EUR), the investment was split over 3 years in order to decrease financial pressure on the hospital budget. Own generation covers about 85-90% of the basic consumption in summer time and up to 40% in winter. According to some sources, the hospital's rooftop PV system sometimes generates an electricity surplus, which is injected into the grid for free [227]. Additional benefits are:

- self-supply of hot water and heat through a solar thermal system, and no more payments for heat and central hot water services during the summer
- up to 5 times lower energy consumption in dark daytimes due to LED lightning
- much better room illumination

Based on data received from the authorities of Ulyanovsk Oblast and the hospital, the following Table 18 was made, combining de-facto savings in 2017 reached with the PV system:

**Table 18 Savings received through the rooftop PV system in Isheevsk hospital for 9 months in 2017**

| Month/Savings | January | February | March | April | May | June | July | August | September |
|---|---|---|---|---|---|---|---|---|---|
| Savings of electricity, kWh, in comparison to 2016 | 4680 | 420 | 2970 | 2760 | -660 | -3720 | 7740 | 7320 | 11340 |
| Savings on bills, RUB, in comparison to 2016 | 27,986.4 | 2,776.2 | 17,827.2 | 17,884.8 | -4,184.4 | -23,101.2 | 52,941.6 | 50,508 | 79,039.8 |

The payback period calculated by the owners is approximately 9 years. Regional authorities are interested in expanding similar projects to other hospitals and state entities in the region. It is likely that the approach will be included into a regional sustainable development program and with support from the Ulyanovsk government.

2. A hybrid PV/small wind power plant at "Ulyanovsk Machine Factory" Ltd., a part of the German-Japanese machine tool company "DMG Mori" aimed at supplying electric forklift trucks and two E-cars with electricity. The area allocated to the RES power systems is 10,000 $m^2$, a total installed power capacity is more than 300 kW. The energy generating system consists of:

   - 38 installations from "SunCarrier22" with tracking system, total installed capacity of 163.4 kW, annual power generation may reach 5,350 kWh. One electrical engine rotates 11 modules. A sun tracking system increases power generation by 38%, maximal allowed wind speed is 144 km/h, which is an extreme wind speed not typical for those areas.
   - 3 SunCarrier260 systems 53 kWp each, with 159 kW in total. The surface area of each module is 247.52 $m^2$; annual power generation may reach 60,000 kWh. These systems are also equipped with a tracking system which increases power generation by 40%. Maximal allowed wind speed is also 144 km/h.
   - 2 small wind turbines Wind Carrier, 10 kWp each. Rotating wind speed is 3 mps; independently from wind direction.
   - storage system CellCube 63 kW power and capacity up to 130 kWh.

Annual generation reaches 320,000 kWh and allows to cover about 11% of electricity demand of the factory. $CO_2$ emission savings are reported to reach 105 tons/a.

**Figure 52 PV system and wind generators at “DGM MORI”, Ulyanovsk**

**Source: eclareon 2019**

3. Another reported example of a rooftop PV system in Ulyanovsk Oblast is an energy efficient apartment house in the capital [177]. Although the house was already constructed, there is scarce information on whether the system has already been installed and its installed capacity.

The examples show that captive PV is already in place. Numerous international enterprises, such as “DMG Mori” are located in the region. Among them are “Mars”, “Efes Beverage group”, local branches of “Loroy Merlin” and “Auchan”. They all need to adhere to their corporate sustainable development strategies (as most companies voluntarily or involuntarily have agreed to), including targets for lowering their carbon footprint and implementing climate protection measures which, among others, include usage of RES [275],[276],[277]. This means that the facilities located in the region belonging to international brands will be obliged to use to some extent renewable energy sources to cover their energy demand, in the short- or mid-term perspective.

### 6.4.4 PV Model 4: Residential PV Systems

Similar to other Russian regions, the development of this part of the RES market was expected after the Law on microgeneration (Law 471) in Russia entered into force. Since the income level of Ulyanovsk Oblast’s population is rather low, the development of the residential PV market will, most likely, be rather slow. Nevertheless, a number of enthusiasts with sufficient financial resources to invest in their own RE installation are likely to start their own power generation as soon as they will be entitled to receive payments from the grid operator. Moreover, prices for PV equipment are continuously decreasing all over the world, rendering the technology more affordable.

Currently, Law 471 guarantees microgeneration owners a feed-in tariff, albeit at a low rate. Nevertheless, this positively influences the payback period (also see chapter 7.4). Ulyanovsk Oblast, as an active RES development region, has plans regarding the implementation of additional support mechanisms for residential consumers willing to install RES microgeneration systems. Those mechanisms will include subsidies for the RES equipment purchases. In addition, in 2018 the region was planning to develop a legislative mechanism aimed at establishing additional regional feed-it tariffs and oblige grid operators to purchase the surplus energy from households for an attractive price [278].

During visits in the region, eclareon and its local partners were unable to identify examples of residential PV or small wind systems. However, this does not mean that there are not at least a couple of RES microgeneration facilities in Ulyanovsk Oblast. Similar to other regions, residential RES systems do not need to be registered, thus there is no official data. In every region there are RES enthusiasts, interested in EE technologies. Therefore, it is likely that also in Ulyanovsk Oblast there are a few microgeneration RES systems, disconnected from the grid but it can also be said that the market for such installations still needs to be developed.

### 6.4.5 Conclusions and Perspectives

**Ulyanovsk Oblast is a promising region for PV and small wind development** for the following reasons:

1. It is one of the most active and pro-RES regions in Russia fighting for its official status as a RES region.
2. There is strong support for RES and RES initiatives by the local government and its ministries, along with a readiness to cooperate with foreign companies.
3. There is a lack of own power generating capacity in the region.
4. Ulyanovsk Oblast has good PV irradiation levels and great wind potential.
5. The region has special industrial zones with preferential conditions for investors.
6. There are branches of international companies present in the region, which pursue a sustainable development strategy.

**Barriers to both industrial and residential RES implementation are, as in most other Russian regions, relatively low electricity prices** (in comparison to the EU tariffs). While tariffs for residential consumers are subsidized by the Government and are kept low enough, they put considerable strain on non-residential consumers, forcing many of them to switch to their own generation. Currently, the cheapest option in Russia is natural gas. Lacking knowledge on the advantages of PV and small wind who have the image of being expensive and rather inefficient make it difficult to convince companies to choose RES instead of gas or energy from the grid. Another barrier is the expectation of public and private investors that no investment shall have a payback period of more than 5 years. **Therefore, it is necessary to inform objectively about the pros and cons of RES in order to change attitudes towards the deployment of RES**. Such information does not only need to be provided to companies and public bodies but also to residential consumers. The recently enacted law on microgeneration may further help to better understand renewable energies and may ultimately lead to an attitude change.

Ulyanovsk Oblast is connected to the UPS and has a well-developed grid, and not many remote off-grid areas. This is positive for consumers and the environment but does not support the development of RES generation.

The key target PV and small wind customer groups in Ulyanovsk Oblast can be described as follows:

**Industrial consumers, commercial and public entities:**

- Commercial companies already connected to the grid, which suffer from rising electricity prices. **While the tariffs rise, the prices for RES equipment decrease, which leads to more attractive business cases and payback periods**, potentially increasing public interest in renewable energy sources. Located in a pro-RES region, owners of systems and investors become less critical about RES.
- **International companies with subsidiaries in Ulyanovsk Oblast, who are more and more obliged to follow the corporate sustainability strategies of their**

**headquarters**, potentially entailing the switch to clean power generation. For this group of companies, it is possible that RES projects are accepted even in case natural gas generation were cheaper or had a shorter payback period.

- **Newly constructed agricultural and industrial facilities**. The existing facilities in the region's industrial and special economic zones and willingness of the authorities to support the development of the regional economy attracts entrepreneurs to Ulyanovsk Oblast. High grid connection costs, an increasing popularity of both clean technologies and 'eco' production has started to raise interest in renewables. **As entities save cost on lower land lease payments, lower taxes on profit and low expenses for infrastructure construction** (regional industrial zones provide for road and water/sewage systems construction in the area of a future facility)**, they have more possibilities to invest in RES in the facility planning stage**. The "DMG Mori" factory, for example, followed this model. Moreover, new special economic zones are being created in the region, such as the Port Special Economic Zone (PSEZ). This zone is located on the bank of the Volga river, which flows through 15 Russian regions, including Moscow, and is an important waterway enabling cost-effective transportation of cargo. There are plans to create so-called Active Energy Complexes (AEC) on such special economic zones. AEC combine power generating facilities, grids, power devices of large commercial centers and enterprises, while being a part of Russia's UPS. Only one of the AEC facilities has a connection to the external grid (UPS) while additional consumers are bundled into the internal AEC grid, which does not belong to any grid operator in the region. This makes grid connection much cheaper and electricity prices lower as no payments to power distributors and grid companies need to be made. Creating a PV or a WPP within an AEC is relatively easy since it will not require any negotiations with grid or energy supply companies.

- **Tourist centers in natural reserves and protected areas, car camping sites**. This niche is relatively small and potential PV and small wind projects for these types of consumers range only between 1-10 kWp each and are of a hybrid type, meaning a combination of RES and/or storage and diesel/petrol generator. Taking into account the current growing popularity of ecotourism, the local government plans to expand recreational areas.

**Residential consumers (microgeneration):**

- **Enthusiasts and adherents of modern technologies and RES.** In Ulyanovsk Oblast, the market for residential RES systems (microgeneration) is unlikely to be created on a large scale in the next years. **The major barriers are: low grid electricity tariffs, relatively low income of citizens, absence of external push-factors (such as the power outages experienced in Krasnodar Krai).** Although the Microgeneration Law has entered into force, the feed-in tariff offered is not high enough to encourage residential consumers to invest in their own power generation facilities. It is likely that some microgeneration systems will be built in the region but theses will most likely be restricted to the minority of households with a higher income who are interested in RES and who are not primarily interested in the economic attractiveness of RES. This situation might, however, change in case local authorities allocate support programs and instruments such as subsidizing parts of the equipment costs, ensuring lower interest rates for bank loans aimed at RES equipment purchases or allocating subsidies to the current feed-in tariff to render it comparable to 'usual energy tariffs' or the 'retail prices' level etc.

# 7. Selected Business Cases

This section is dedicated to the profitability analysis of three selected PV business cases. Sample calculations of typical projects include: cash-flow modelling and sensitivity analyses to provide an outlook of profitability changes related to changes in system prices, energy yield and remuneration.

**For the business cases we have used the best possible solar radiation values.** For Krasnodar Krai, the region in this report with the highest solar irradiation, this solar radiation corresponds to approx. 1,600 kWh / m$^2$ / a (global tilted irradiation (GTI) at optimum angle. After applying a performance ratio of 0.82 to this irradiation, the specific yield used (and shown in the graphs and figures) is 1,312 kWh / kWp / a. For the other regions these values are lower:

- For Kaliningrad, highest GTI is approx. 1,300 kWh / m$^2$ / a which results into a specific yield of 1,066 kWh / kWp / a.
- For Ulyanowsk, highest GTI is approx. 1,400 kWh / m$^2$ / a which results into a specific yield of 1,148 kWh / kWp / a.
- For Bashkortostan, highest GTI is approx. 1,500 kWh / m$^2$ / a which results into a specific yield of 1,230 kWh / kWp / a.

In the business case section, we will calculate the results for selected regions.

## 7.1 Methodology of profitability analysis

**An excel based discounted cash flow analysis (DCF) was used for profitability analysis in this report**. The DCF methodology evaluates a project using the concept of the time value of money.

All future cash flows are estimated and discounted to give their present values. The **net present value** (NPV) is the sum of all positive and negative cash flows' present values including the initial investment. The NPV allows for the comparison of investments with different durations and cash flow profiles over their lifetime at the present point in time. Besides NPV, the **internal rate of return** (IRR) for both the equity and the entire project were calculated as well as the **amortization period** (payback time) for the invested capital. These parameters give investors an indication of the attractiveness of an investment. Please note that we have used discounted cashflows for the calculation of the amortization period but we also show an undiscounted payback period in the project overview charts. By definition, these undiscounted payback periods are always shorter than the discounted payback periods because the time value of money concept is ignored which basically means that 1RUB today will still be worth 1 RUB at any time in the future.

Another key parameter calculated is the **levelized cost of electricity** (LCOE) which makes it possible to compare power plants of different generation and cost structures.

Finally, ratios such as the **debt service coverage ratio** (DSCR) and **loan life cycle coverage ratio** (LLCR) provide information about whether the project cash flows suffice to reimburse the debt invested in a project. These values should be at least > 1 which would mean that free project cash flows would suffice to pay back debt.

## 7.2 PV Parks

Large scale photovoltaic systems , also known as **solar PV parks are usually designed to supply power to the electricity grid**. They are differentiated from most roof-mounted and other decentralized solar power applications because they supply bulk power at the utility level, rather than to a local user. Large scale PV plants are generally the type of projects most institutional investors and developers invest in.

As described in previous chapters **ground-mounted PV parks are currently built in Russia either on the provisions of Decree 449** (wholesale market, federal auctions) **or Decree 47** (retail market, regional auctions). Regarding support payments the Federal Decree 449 and Decree 47 differ mainly on the basis of the support payments: While Decree 449 foresees to pay a beneficial tariff based on installed capacity (MW), Decree 47 does so based on electricity generation (in MWh). **The calculations for solar parks in this report were made under the assumption that they are built under the provisions of the regional retail market Decree 47** which aims at compensating 5% of grid losses by RES.

Still, both regulations also have similar provisions: projects are awarded based on tenders with the investment costs (CAPEX) playing a key role in the assessment of the bids and the calculation of the support granted. Moreover, both regulations share important local content provisions (70%), minimum capacity factor requirements (14%), a payment period for the beneficial tariff of 15 years and a targeted return for the investor of 12%.

Given these similarities it should be possible to draw conclusions for projects built on the grounds of Decree 449 which does not aim at compensating grid losses but may be seen as the main instrument to create a national PV industry and increase the RES share. In order to do so we have also calculated an annual capacity premium that would correspond to the beneficial tariff paid under Decree 47.

With regards to this business segment, the following 2 detailed profitability analysis were undertaken:

1. A 10 MW park in Krasnodar with no storage
2. A 5 MW park in Bashkortostan with storage

### 7.2.1 PV Park without storage

#### Profitability Analysis (Inputs, Outputs, Scenarios, Sensitivities)

**A profitability analysis for a large-scale PV project (10 MW) is presented below.**

### Figure 53 Project Overview - Large Scale PV (Krasnodar Krai)

| PV Project | | | |
|---|---|---|---|
| PV System Size | | kWp | 10.000 |
| Specific System Cost | | RUB/kWp | 75.000 |
| Investment Subsidy | | RUB | - |
| Total System Cost | | RUB | 750.000.000 |
| Fixed Operation Costs | | RUB p.a. | 15.000.000 |
| Variable Operation Costs | | RUB/kWh | - |

| PV Generation | | |
|---|---|---|
| Yield | kWh/qm/a | 1.600 |
| Performance Factor | % | 82% |
| Specific Yield | kWh/kWp/a | 1.312 |
| Degradation | % p.a. | 0,70% |

| Investment | | | |
|---|---|---|---|
| Project Duration | | Years | 20 |
| Beneficial tariff payments | | Years | 15 |
| Equity | | RUB | 170.093.832 |
| Debt (Gearing) | 80% | RUB | 600.000.000 |
| Loan Tenor | | Years | 10 |
| Interest Rate | | % | 9,75% |
| Discount Rate | | % | 12,00% |
| Inflation Rate | | % | 3% |

| PV Business Model | | | |
|---|---|---|---|
| Beneficial tariff | 100% | RUB/kWh | 6,50 |
| Targeted capacity factor | | % | 14,00% |
| Avg. capacity factor achieved | | % | 14,17% |
| Fees | | RUB/kWh | - |
| Retail electricity market price | | RUB/kWh | 3,50 |
| Undersupply Penalty | | RUB/kWh | - |
| Inflation Adjustment | | % | - |
| Calculatory average capacity premium | | RUB/kWp/a | 8.008 |

| Results | | |
|---|---|---|
| Net-Present Value | RUB | 19.968.196 |
| Project IRR | % | 10,93% |
| Equity IRR | % | 13,30% |
| Amortization - discounted payback period | Years | 14,00 |
| Undiscounted payback period | Years | 10,50 |
| LCOE (no subsidy) | RUB/kWh | 8,90 |
| Min DSCR** | x | 1,06 x |
| Min LLCR*** | x | 1,06 x |

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

**Source: eclareon, 2020**

## About the assumptions for this PV Business Case

The site selection is based on many considerations, such as whether the PV plant is close to the grid, and whether the process for obtaining a grid connection agreement is transparent and predictable. The assumed solar radiation is reached in Krasnodar Krai.

The analysis of the solar resource and projected energy yield are critical inputs for the financial analysis. The energy yield is a critical parameter that determines (along with the capital costs and the tariff) the financial viability of the project. Probability based energy yield are modelled over the operating life of the PV system. The total system costs reflect the current favorable world market prices for PV components. Large-scale PV power plants are designed with **decentralized or centralized PV inverter** technology.

Central inverters offer high reliability and simplicity of installation. Central inverters are usually three-phase and can include grid frequency transformers.

In contrast, the string inverter concept uses multiple inverters for multiple strings of modules. String inverters provide MPPT on a string level with all strings being independent of each other. This is useful in cases where modules cannot be installed with the same orientation or where modules of different specifications are used or when there are shading issues.

String inverters, which are usually used in single or three phases, can be serviced and replaced by non-specialist personnel and it is practical to keep spare string inverters on site. This makes it easy to handle unforeseen circumstances, as in the case of an inverter failure. In comparison, the failure of a large central inverter, with a long lead time for repair, can lead to significant yield loss before it can be replaced.

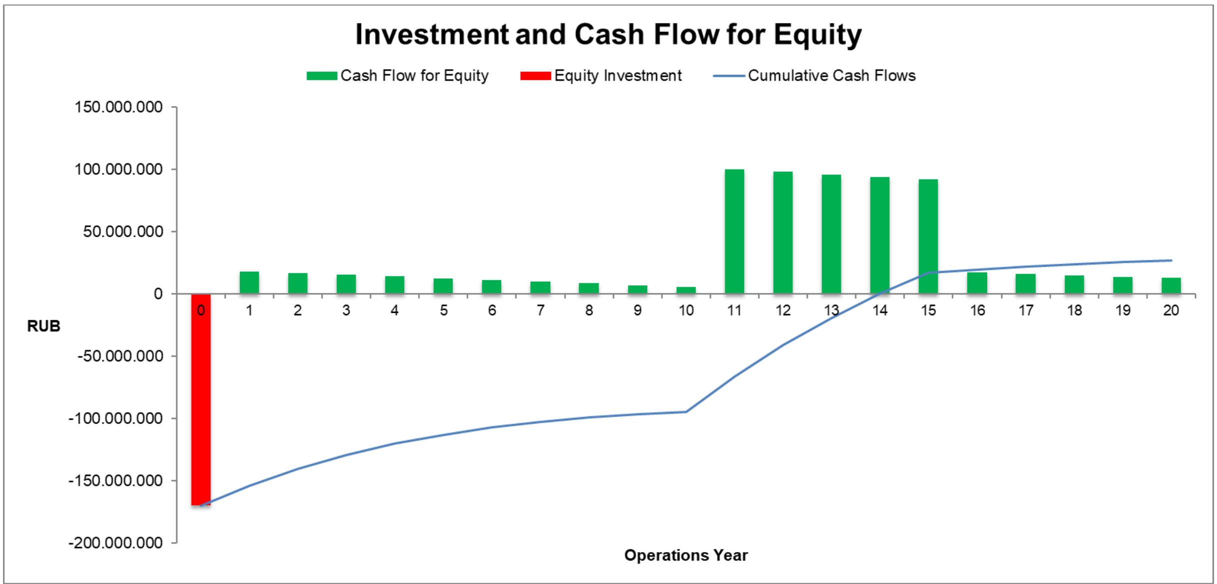
The assumptions regarding the financing conditions correspond to the possible terms and conditions of January 2020. The lifetime of the system is set to, rather conservative 20 years, an increase based on the on the lifetime of the PV modules to 25 years would be reasonable as well. All cash flows including financing for this first case are in RUB and interest rates and inflation rate are also RUB based. For the underlying beneficial tariff to be paid please see chapter 2.1.2.3 of this study.

### Financial results for this PV Business Case

As Figure 53 shows the **discounted payback period** is **about 14 years (shorter if cashflows are not discounted),** the **equity IRR** is **13.3% and the project IRR is around 11%.** Notice that both values represent approximations to the target values set in the provisions of Decrees 47 and 449: projects shall be paid back in accordance with the payment duration of the beneficial tariff. Moreover, the return for the investor is targeted at approx. 12%. IRR are not in the strict sense, measures of project return but rather a calculated theoretic interest rate that would bring discounted cashflows to 0.

Still, given that based on the provisions on the law itself it is not clear what kind of investor return is meant (return on investment, return on equity, real rates of return or nominal ones), the IRR seems a good enough approximation for the purpose of this report. The input parameter into the model that decisively determines the payback period is the beneficial tariff that is paid on a monthly basis. Taking into consideration electricity sales on the retail market and keeping other input variables stable, the beneficial tariff corresponds to 6.5 RUB/kWh paid over 15 years. **If the project was built under the provisions of Decree 449, the calculated capacity tariff would correspond to approx. 8,000 RUB/kWp/ year (112 EUR/kWp/year)** or, as tariffs are in reality paid per month and per MW, to approx. 667,500 RUB/MWp/month (9,345 EUR/MWp/month). The cash flow for the case is as follows:

**Figure 54 Equity Cash Flow - Large Scale PV (Krasnodar Krai)**

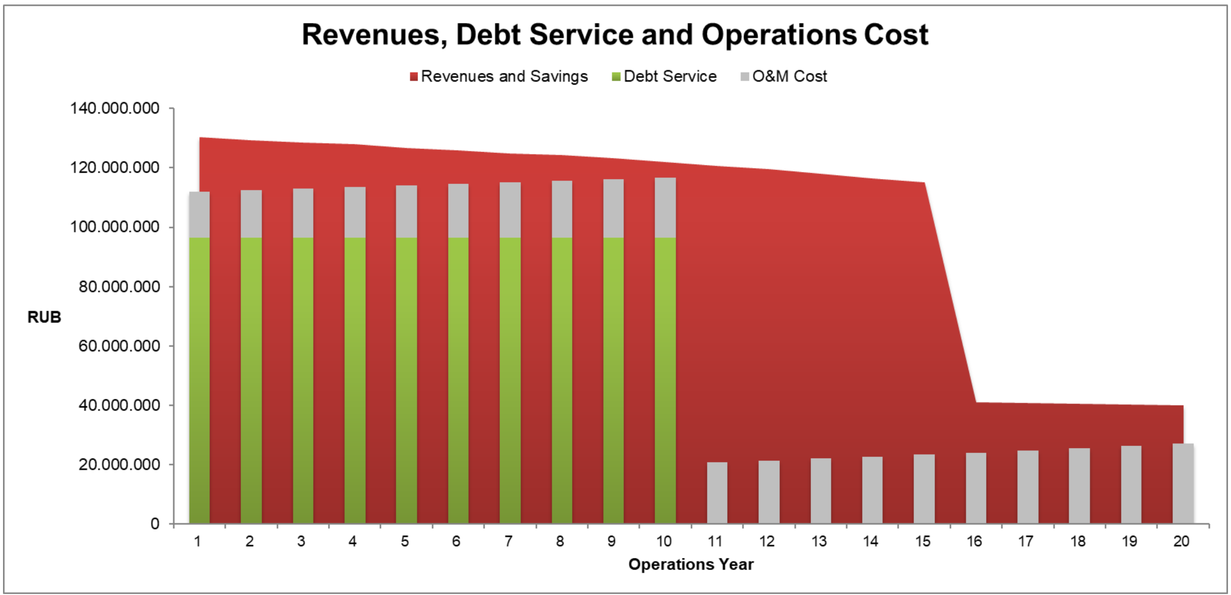



**Source: eclareon, 2020**

**Due to module degradation and missing inflation adjustment for the beneficial tariff, the yearly cash flows for equity are gradually reduced.** The sudden increase after year 10 is caused by the end of the debt tenor and the full reimbursement of the loan. The decrease in year 16 is explained by the end of the payment period of the beneficial tariff: After 15 years the project continues to generate revenues but purely based on electricity sales on the retail market. For this calculation the, compared to German electricity prices, fairly low retail market price chosen was 3.5 RUB/kWh for the whole life of the project. Depending on the region and the consumer group, this price may vary but it needs be taken into account that the provisions of Decree 47 state that solar PV installations shall, after payments of beneficial tariffs will have ceased, lead to reduced retail market prices.

The sudden reduction of revenues after year 15 is also shown in the next graph which, in addition, also shows decreasing real revenues because OPEX costs are escalated based on the inflation while revenues are based on a stable electricity sales price and plant performance is naturally decreasing over time as the equipment ages and the plant performance goes down (0.7% per year).

**Figure 55 Project Cash Flows - Large Scale PV (Krasnodar Krai)**



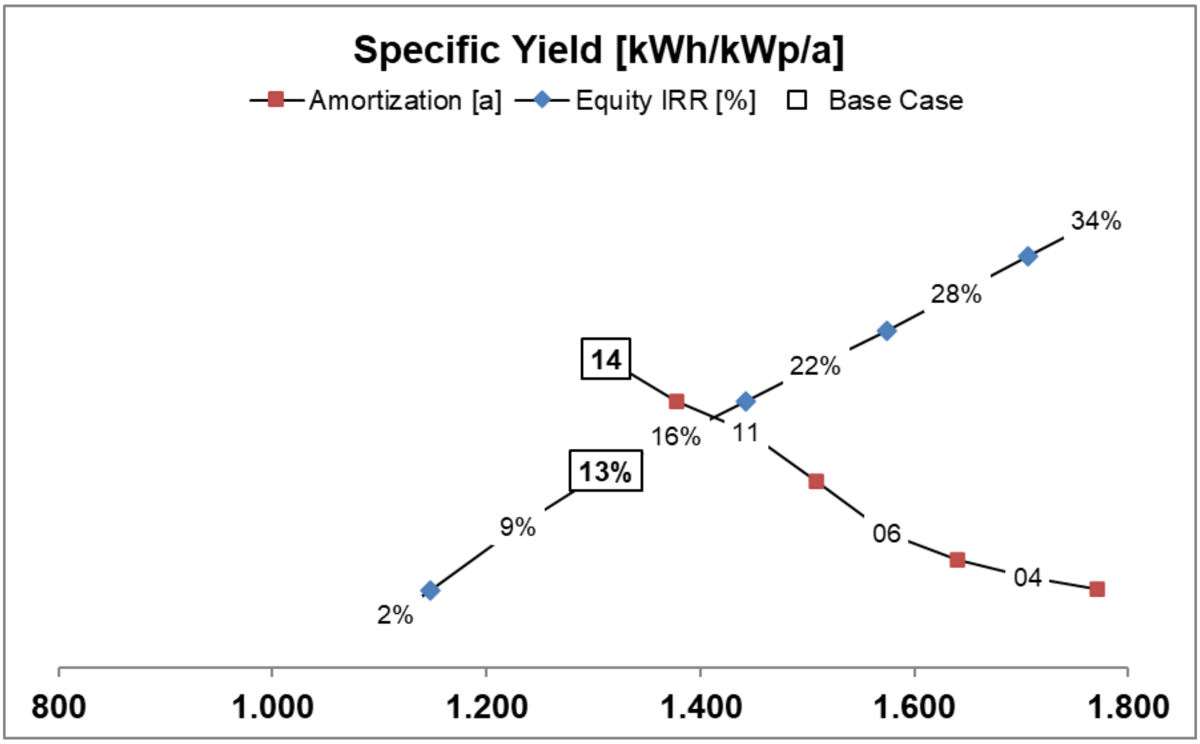

**Source: eclareon, 2020**

## Sensitivity of results for this PV Business Case

**The following figures show how the two key economic performance indicators for the investment, discounted payback period (Amortization) and return on equity (Equity IRR) change when certain assumptions about the investment framework conditions are modified.** The figures show which modification in individual assumptions influence the profitability of the investment particularly strongly (→ high sensitivity). This needs to be carefully observed when making investments.

The specific yield shown below are the kilowatt hours produced by the PV system per kWp capacity and per year. It is calculated on the basis of the solar radiation multiplied by the performance factor of the PV system. This factor, which is always less than 1, includes the technical conditions for the efficiency of the PV system, the efficiency, orientation and inclination of PV modules, possible shadowing, etc.

**Figure 56 Specific Yield Sensitivity - Large Scale PV (Krasnodar Krai)**




**Source: eclareon, 2020**

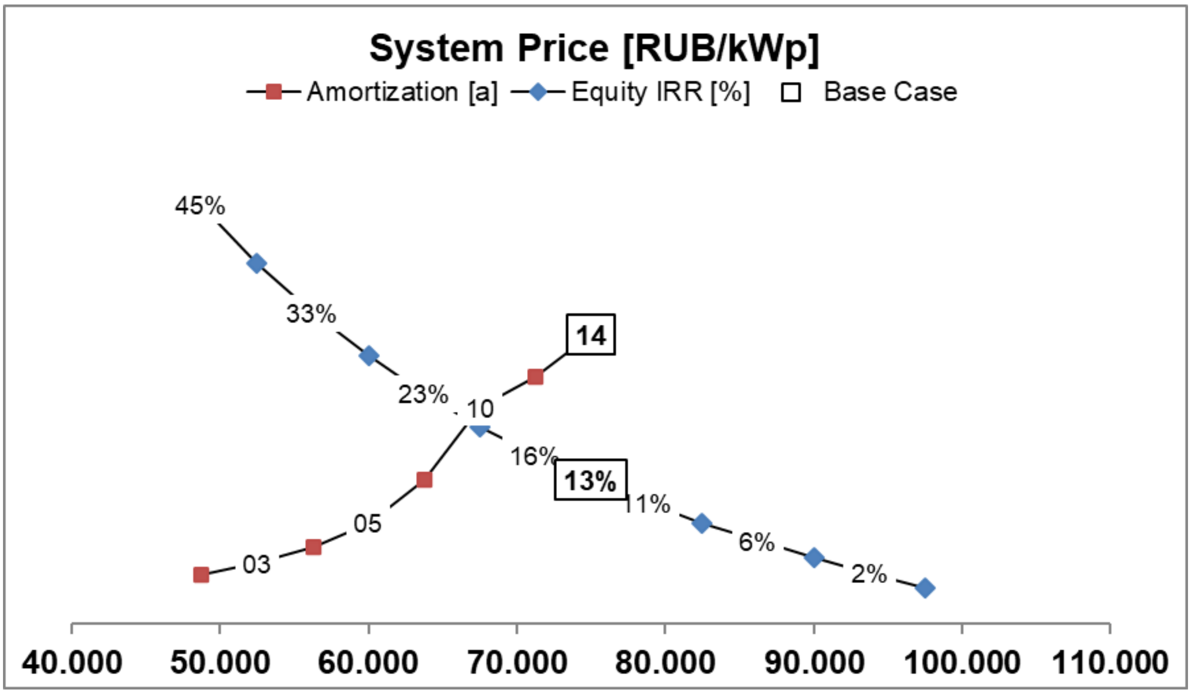
The **same plant in the other 3 regions would lead to the following results**:

| Scenarios | Specific Yield | Payback | NPV |
|---|---|---|---|
| Kaliningrad | 1.066 | #NV | (207.690.919) |
| Ulyanowsk | 1.148 | #NV | (130.631.910) |
| Bashkortostan | 1.230 | #NV | (49.307.830) |

Everything else kept equal, the net present value (NPV) **for the same installation would be negative and it could not be paid back given the lower irradiations**. If similar results in terms of payback period and IRR were to be achieved, the beneficial tariff would have to be increased and/or combined with lower investment costs (CAPEX) which could be achieved, for example, by providing direct regional subsidies.

Going back to using the more favorable solar irradiation at Krasnodar Krai, the following figures show the influence of changing other key input parameters on the equity IRR and the payback period:

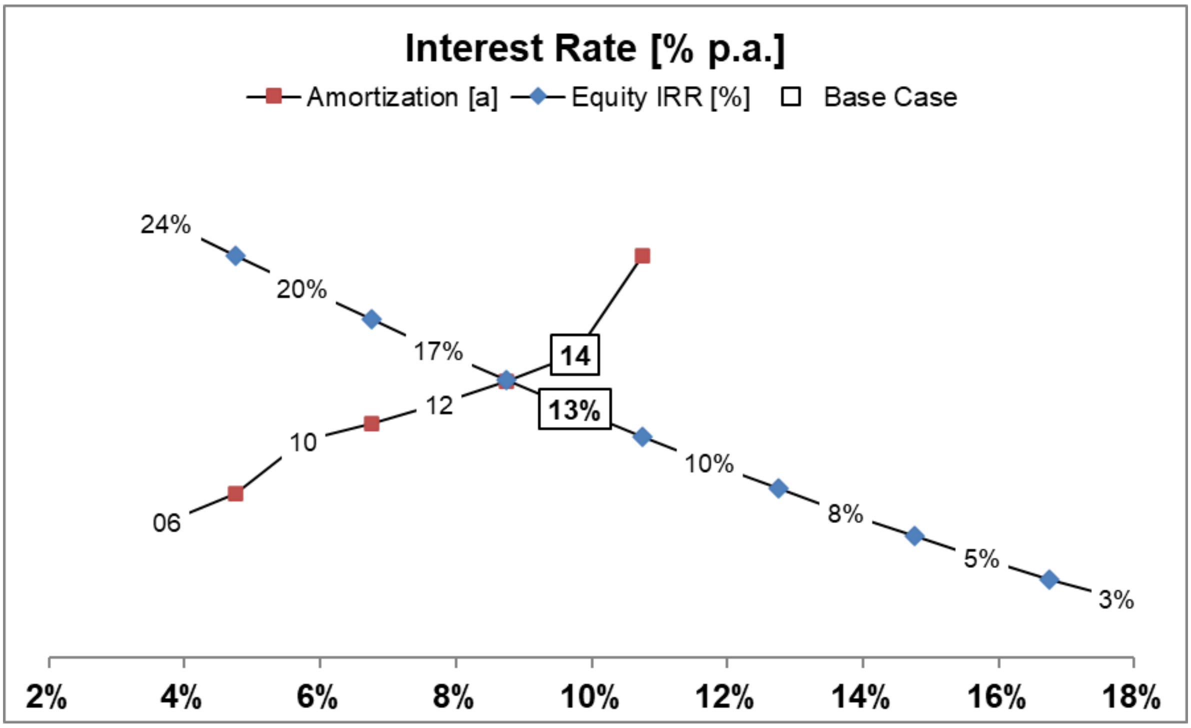
**Figure 57 System Price Sensitivity - Large Scale PV (Krasnodar Krai)**




**Source: eclareon, 2020**

The profitability of projects is strongly influenced by the yield, the beneficial tariff and the system price because of their strong impact on revenues and overall costs.

**Figure 58 Interest Rate Sensitivity - Large Scale PV (Krasnodar Krai)**




**Source: eclareon, 2020**

Compared with other examples, the debt leverage of 80% is quite high and the debt tenor is 10 years, so we see a strong impact of the interest rate as well. The interest rate for debt in the base case is assumed to be at 10%. From the sensitivity analysis we can see that the project does not sustain much higher interests if the other input parameters are kept as is.

### 7.2.2 PV Park with storage

At the moment there are 2 new SPPs planned to be built in Bashkortostan (please see also section 5.4.1). The projects shall be realized with the following target parameters:

- Size of the park: 5 MW each,
- Storage planned: 4 MWh
- CAPEX: 102,990 RUB/ kWp;
- Planned investment payback period: 15 years,
- base rate of return 12%
- Planned costs of generation of 1 kWh is 13.87 RUB/kWh. / month – pure construction works, planned annual generation 6.351 MWh (more than 6 MWh)

In accordance with this target data eclareon modeled a 5 MWp PV park with storage

#### Profitability Analysis (Inputs, Outputs, Scenarios, Sensitivities)

**A profitability analysis for a large-scale PV project with storage (5MW) is presented below.**

**Figure 59 Project Overview - Large Scale PV with storage (Bashkortostan)**

| PV Project | | | |
|---|---|---|---|
| PV System Size | | kWp | 5.000 |
| Specific System Cost w/o storage | | RUB/kWp | 80.000 |
| Specific Battery Costs | | RUB/kWh | 30.000 |
| Investment Subsidy | | RUB | - |
| Battery Capacity | | kWh | 4.052 |
| Total System Cost | | RUB | 521.567.808 |
| Total System Cost per kWp | | RUB/kWp | 104.314 |
| Fixed Operation Costs | | RUB p.a. | 10.431.356 |
| Variable Operation Costs | | RUB/kWh | - |
| **PV Generation** | | | |
| Yield | | kWh/qm/a | 1.500 |
| Performance Factor | | % | 82% |
| Specific Yield | | kWh/kWp/a | 1.230 |
| Degradation | | % p.a. | 0,70% |
| **Investment** | | | |
| Project Duration | | Years | 20 |
| Beneficial tariff payments | | Years | 15 |
| Equity | | RUB | 113.961.325 |
| Debt (Gearing) | 80% | RUB | 417.254.247 |
| Loan Tenor | | Years | 10 |
| Interest Rate | | % | 10,25% |
| Discount Rate | | % | 12,00% |
| Inflation Rate | | % | 3% |

| PV Business Model | | | |
|---|---|---|---|
| Beneficial tariff | 100% | RUB/kWh | 13,50 |
| Targeted capacity factor | | % | 14,00% |
| Avg. capacity factor achieved | | % | 13,28% |
| Fees | | RUB/kWh | - |
| Retail electricity market price | | RUB/kWh | 3,00 |
| Undersupply Penalty | | RUB/kWh | - |
| Inflation Adjustment | | % | - |
| Calculatory average capacity premium | | RUB/kWp/a | 14.919 |
| **Results** | | | |
| Net-Present Value | | RUB | 8.484.282 |
| Project IRR | | % | 11,06% |
| Equity IRR | | % | 13,09% |
| Amortization - discounted payback period | | Years | 13,35 |
| Undiscounted payback period | | Years | 6,97 |
| LCOE (no subsidy) | | RUB/kWh | 14,42 |
| Min DSCR** | | x | (0,09 x) |
| Min LLCR*** | | x | 0,67 x |

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

**Source: eclareon, 2020**

#### About the assumptions for this PV Business Case

The assumed solar radiation is the best available radiation in Bashkortostan. The analysis of the solar resource and projected energy yield are critical inputs for the financial analysis.

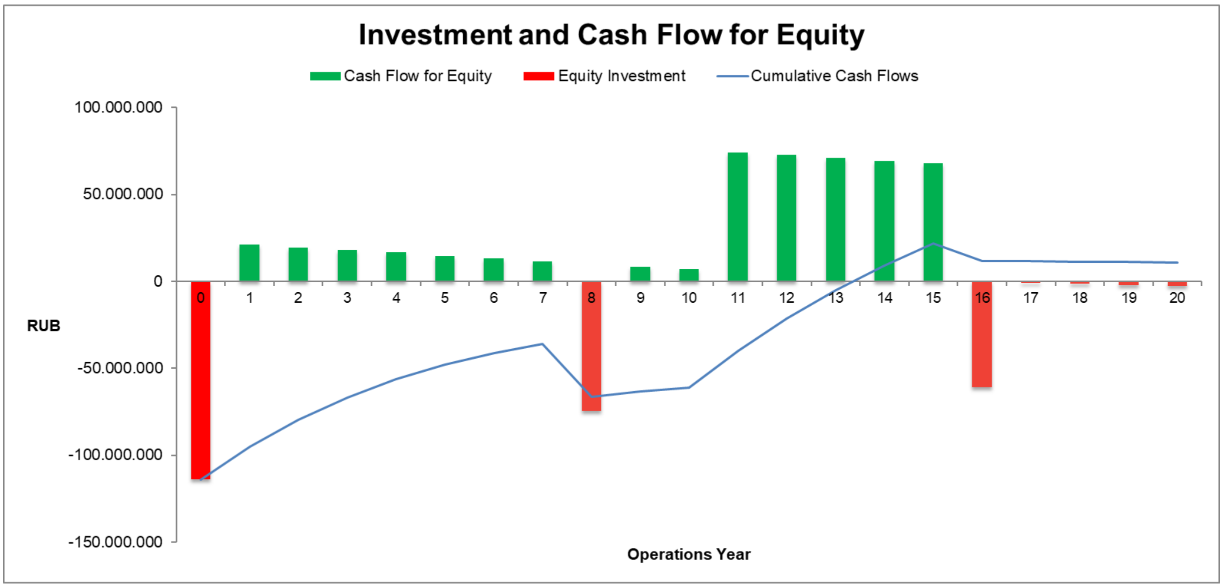
The assumptions regarding the financing conditions correspond to the possible terms and conditions of January 2020. The lifetime of the system is set to 20 years as before. All cash flows including financing for this first case are in RUB and interest rates and inflation rate are also RUB based. For the underlying beneficial tariff to be paid please see chapter 2.1.2.3 of this study.

### Financial results for this PV Business Case

As Figure 60 shows the **discounted payback period** is **about 13 years (shorter if cashflows are not discounted),** the **equity IRR** is **13.1% and the project IRR is around 11%.** Notice that both values represent approximations to the target values set in the provisions of Decrees 47 and 449: projects shall be paid back in accordance with the payment duration of the beneficial tariff. Moreover, the return for the investor is targeted at approx. 12%. IRR are not in the strict sense, measures of project return but rather a calculated theoretic interest rate that would bring discounted cashflows to 0.

Still, given that based on the provisions on the law itself it is not clear what kind of investor return is meant (return on investment, return on equity, real rates of return or nominal ones), the IRR seems a good enough approximation for the purpose of this report. The input parameter into the model that decisively determines the payback period is the beneficial tariff that is paid on a monthly basis. Taking into consideration electricity sales on the retail market and keeping other input variables stable, the beneficial tariff corresponds to 12.5 RUB/kWh paid over 15 years. **If the project were built under the provisions of Decree 449, the calculated capacity tariff would correspond to approx. 15,000 RUB/kWp/ year (210 EUR/kWp/year).** Both, the beneficial tariff and the capacity tariff are higher than for the previous business case calculation, a 10 MWp in Krasnodar. The reason for this is that the required CAPEX per kWp for a 5 MWp park with storage is higher than for a 10 MW park without storage. In addition, solar irradiation is less favorable in Bashkortostan, therefore, by keeping IRRs and discounted payback times comparable to the first case, the price per kWp or per kWh needs to be higher. The equity cash flow for the case is as follows:

**Figure 60 Equity Cash Flow - Large Scale PV with storage (Bashkortostan)**




**Source: eclareon, 2020**

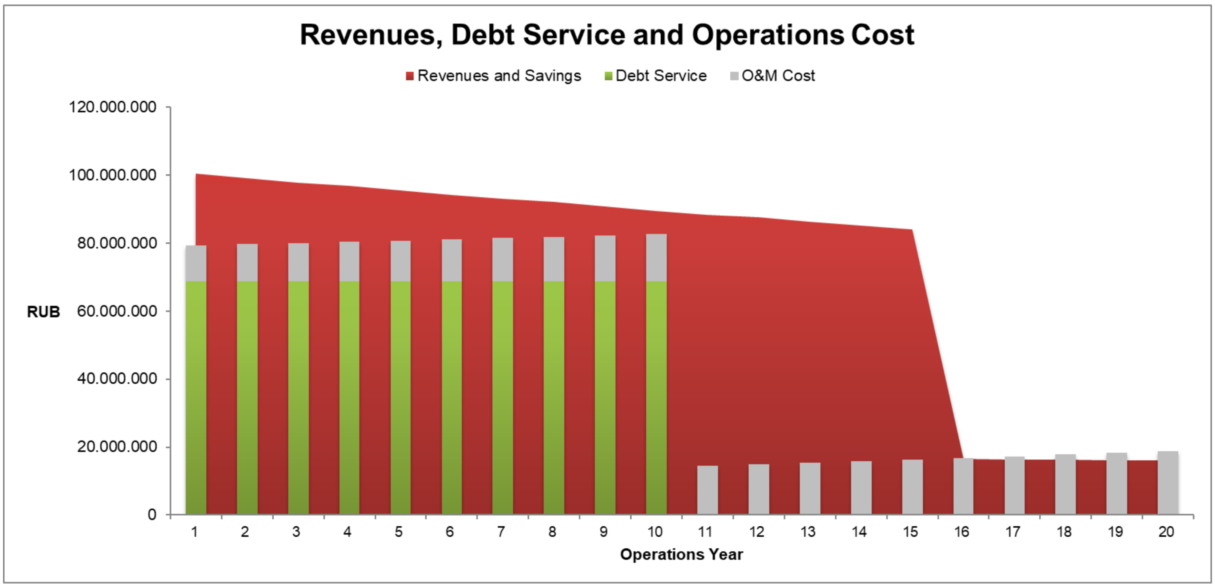
**Due to module degradation and missing inflation adjustment for the beneficial tariff, the yearly cash flows for equity are gradually reduced.** The sudden increase after year 10 is caused by the end of the debt tenor and the full reimbursement of the loan. The decrease in year 16 is explained by the end of the payment period of the beneficial tariff: After 15 years the project continues to generate revenues but purely based on electricity sales on the retail market. For this calculation the, compared to German electricity prices, fairly low retail market price chosen was 3 RUB/kWh for the whole life of the project. Depending on the region and the consumer group, this price may vary but it needs be taken into account that the provisions of Decree 47 state that solar PV installations shall, after payments of beneficial tariffs will have ceased, lead to reduced retail market prices. For this business case, the retail market price was set even lower than this was the case for the previous business case calculation in Krasnodar in order to account for the fact that electricity prices in Bashkortostan tend to be lower than in Krasnodar, albeit by a small margin.

The negative red investments in years 8 and 16 are due to needed battery replacements. The calculations include a decrease for storage costs in the future. The investments into the battery also have an impact on the cover ratios for the debt service (DSCR and LLCR): given the extra expense for battery replacement, the project cash flows alone would not allow to pay the debt service in all periods during the loan tenure.

An interesting observation can be made for year 17 until the end of the project: after no more beneficial tariffs paid after 15 years, the income based on a low market price alone would lead to negative cashflows. This could incentivize an operator to shut down the plant before the end of its useful life if no other reasons, such as contractual obligations to run the plant during a minimum period, prevents him from doing so.

The sudden reduction of revenues after year 15 is also shown in the next graph which, in addition, also shows decreasing real revenues because OPEX costs are escalated based on the inflation while revenues are based on a stable electricity sales price and plant performance is naturally decreasing over time as the equipment ages and the plant performance goes down (0.7% per year).

**Figure 61 Project Cash Flows - Large Scale PV with storage (Bashkortostan)**



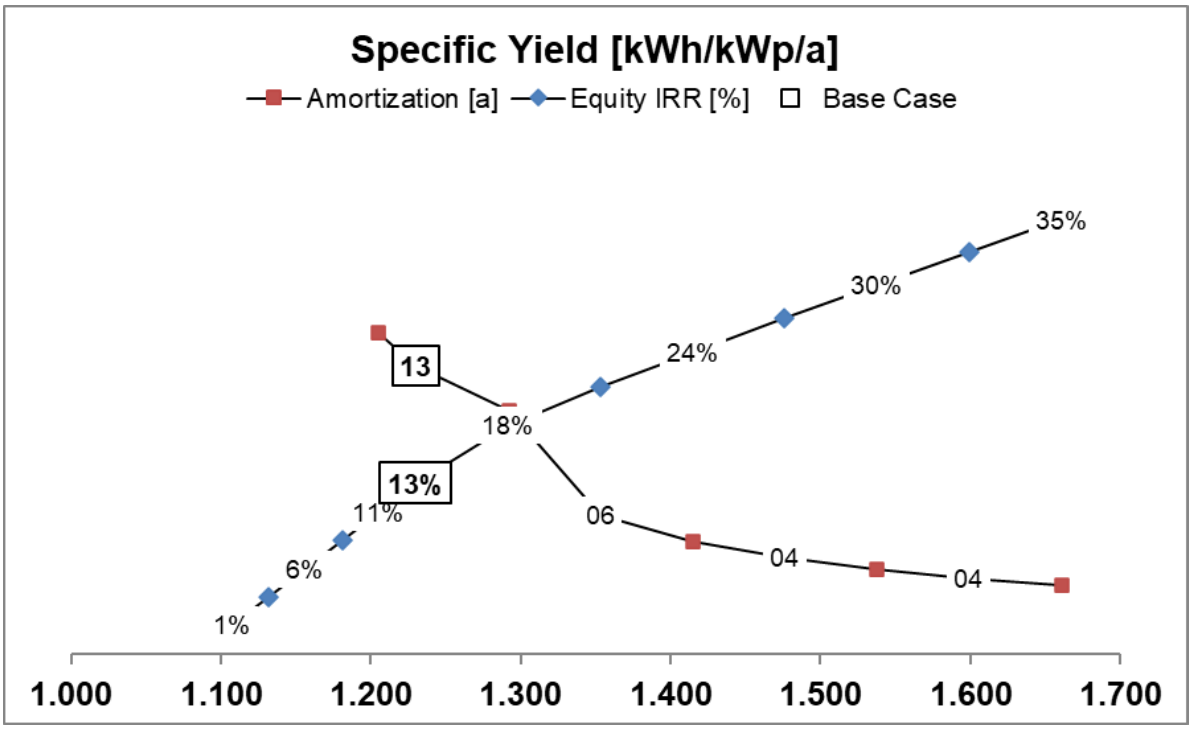

**Source: eclareon, 2020**

## Sensitivity of results for this PV Business Case

**The following figures show how the two key economic performance indicators for the investment, discounted payback period (Amortization) and return on equity (Equity IRR) change when certain assumptions about the investment framework conditions are modified.** The figures show which modification in individual assumptions influence the profitability of the investment particularly strongly (→ high sensitivity). This needs to be carefully observed when making investments.

The specific yield shown below are the kilowatt hours produced by the PV system per kWp capacity and per year. It is calculated on the basis of the solar radiation multiplied by the performance factor of the PV system. This factor, which is always less than 1, includes the technical conditions for the efficiency of the PV system, the efficiency, orientation and inclination of PV modules, possible shadowing, etc.

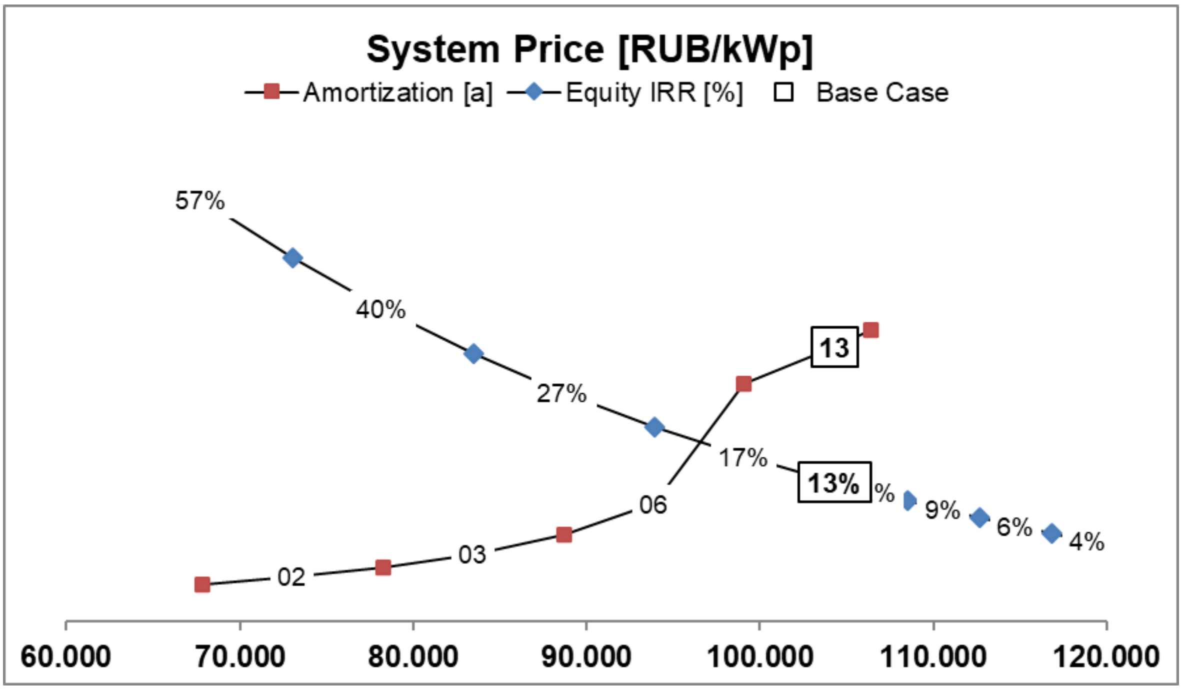
**Figure 62 Specific Yield Sensitivity - Large Scale PV with storage (Bashkortostan)**




**Source: eclareon, 2020**

The following figures show the influence of changing other key input parameters on the equity IRR and the payback period:

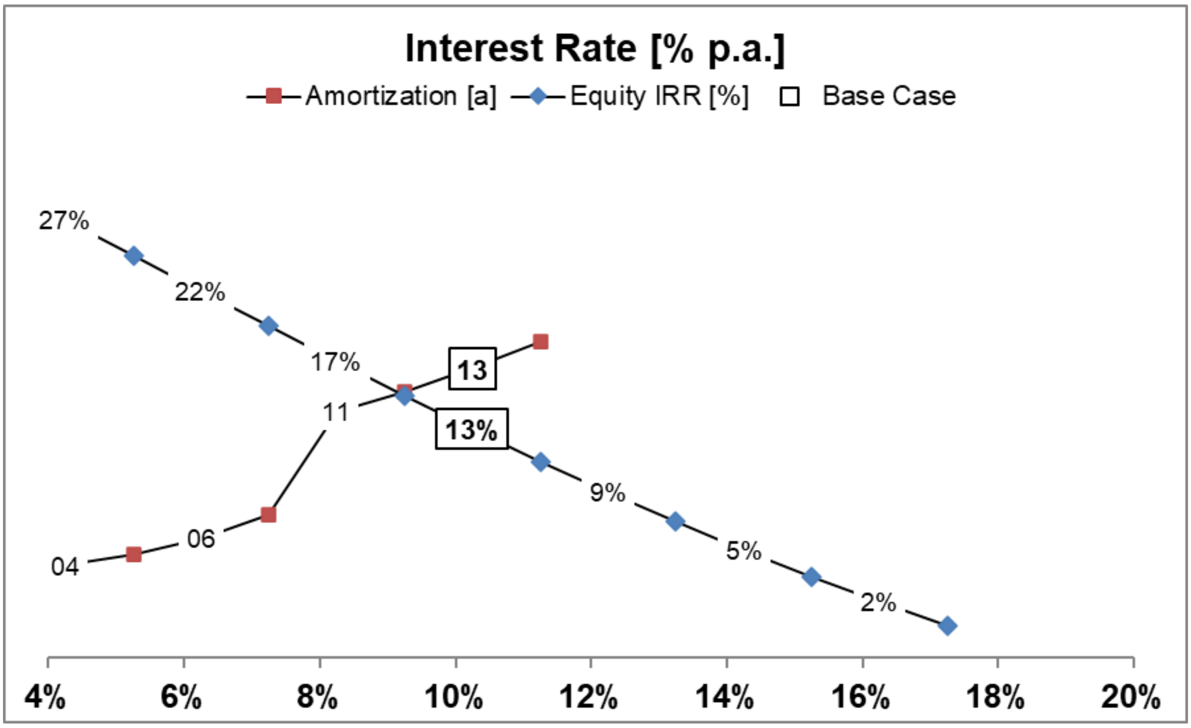
**Figure 63 System Price Sensitivity - Large Scale PV with storage (Bashkortostan)**




**Source: eclareon, 2020**

The profitability of projects is strongly influenced by the yield, the beneficial tariff and the system price because of their strong impact on revenues and overall costs.

**Figure 64 Interest Rate Sensitivity - Large Scale PV with storage (Bashkortostan)**




**Source: eclareon, 2020**

Compared with other examples, the debt leverage of 80% is quite high and the debt tenor is 10 years, so we see a strong impact of the interest rate as well. The interest rate for debt in the base case is assumed to be at 10%. From the sensitivity analysis we can see that the project does not sustain much higher interests if the other input parameters are kept as is.

## 7.3 PV-Diesel hybrid System

**A solar-PV diesel hybrid system combines the power output of PV arrays and diesel generators.** The control system draws power in such a way that it maximizes the load contribution of PV and minimizes diesel generators. If there are multiple generators and there is sufficient power from PV, the control system will shut off some of the generators completely to minimize fuel consumption.

Most electricity consumers in Russia are connected to the grid and pay relatively low electricity prices. **Still, diesel solutions can be found in many remote areas and isolated territories and in new settlements without a grid connection. Moreover, diesel gensets are used as a backup solution in those areas where the grid is rather weak and hence prone to blackouts.**

PV-diesel solutions are a convincing alternative for existing diesel powered grids. Today, a cost advantage of PV-diesel hybrid systems compared to conventional stand-alone diesel gensets can be achieved.

**In principle two main basic system solutions are suitable and commercially available on the market**.

- **Hybridization without storage technology**
- **Hybridization with storage technology**

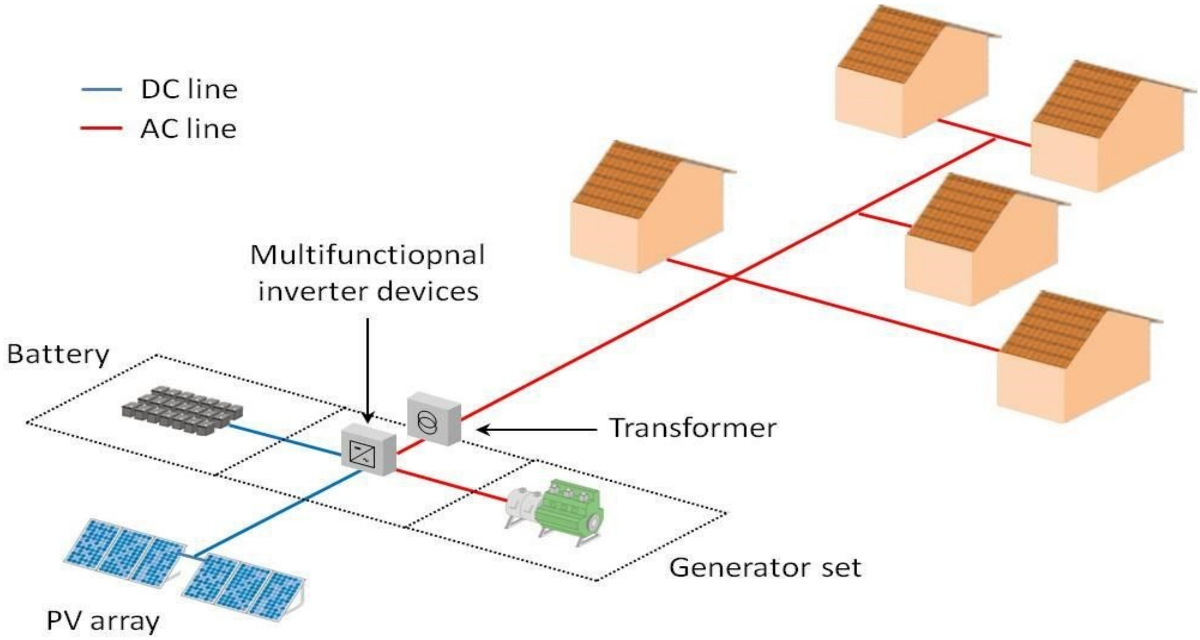
The integration of a PV plant with a high PV penetration rate (ratio between PV peak power and genset nominal power) is only possible with an additional intelligent control unit. A so-called fuel save controller unit can be integrated into both new and existing power supply systems. The integration of a fuel save controller unit allows a significantly higher PV penetration level up to 60% (ratio between PV peak power and genset nominal power).For each MW installed genset capacity, a photovoltaic plant with 600 kWp can be added to the genset power supply system. The fuel save controller manages the feed-in of PV and the diesel genset remains unaffected.

The additional integration of battery storage power can compensate for the fluctuations in load and irradiation to further increase the overall system efficiency by providing spinning reserves and facilitating optimized genset operation.

Ancillary services include frequency-dependent control of active power feed-in, voltage stability, black start capability after a grid failure and grid congestion management. These services provide renewable energy with the same grid-stabilizing characteristics as conventional power plants. Thus, storage systems enable the provision of high-quality energy at any time and balance the fluctuations caused by the rapid rise in solar energy use. The same storage system can also be used for other purposes, such as an uninterruptible power supply. As generators become more adjustable and controllable, the number of conventional units can be significantly reduced while future grid requirements can still be met, and supply reliability can be guaranteed at any time. Depending on the storage size a diesel off-mode is applicable.

The figure below indicates the setup of a PV-diesel hybrid system for rural grid electrification.

**Figure 65 Schematic view of a PV / diesel hybrid system for rural electrification**




**Source: IEA-PVPS T9, 2013**

### Profitability Analysis (Inputs, Outputs, Scenarios, Sensitivities)

### Option 1: PV-Diesel-PV hybrid system without storage

A profitability analysis for a PV-Diesel hybrid system without storage and based on diesel savings is presented below.

### Figure 66 Project Overview - Captive PV without storage

| PV Project | | | |
|---|---|---|---|
| PV System Size | | kWp | 250 |
| Specific System Cost | | RUB/kWp | 90.000 |
| PV Battery Size | | kWh | - |
| Specific Battery Costs | | RUB/kWh | - |
| Total System Cost | | RUB | 22.500.000 |
| Fixed Operation Costs | | RUB p.a. | 450.000 |
| Variable Operation Costs | | RUB/kWh | - |

| PV Business Model | | |
|---|---|---|
| Direct PV Consumption | % | 80% |
| PV Consumption via Battery | % | - |
| Battery Losses | % | - |
| Effective fuel costs | RUB/ liter | 46 |
| Diesel Generation Costs | RUB/kWh | 15 |
| Fuel cost escalation | % p.a. | 4% |

| PV Generation | | |
|---|---|---|
| Global Tilted Irradiation (GTI) | kWh/qm/a | 1600 |
| Performance Factor | % | 82% |
| Specific Yield | kWh/kWp/a | 1.312 |
| Degradation | % p.a. | 0,70% |

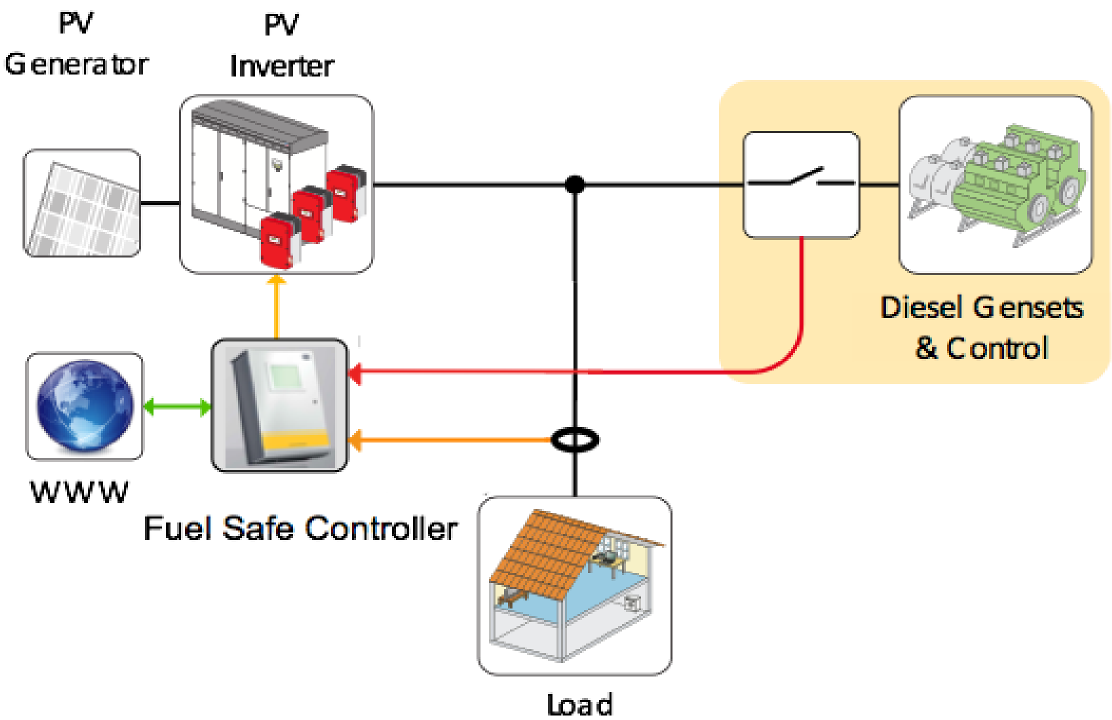
| Results | | |
|---|---|---|
| Net-Present Value | RUB | 16.130.598 |
| Project IRR | % | 19% |
| Equity IRR | % | 27% |
| Amortization - discounted payback period | Years | 6,76 |
| Undiscounted payback period | Years | 4,70 |
| LCOE (no subsidy) | RUB/kWh | 11 |
| Min DSCR** | x | 1,49 x |
| Min LLCR*** | x | 1,69 x |

| Investment | | | |
|---|---|---|---|
| Project Duration | | Years | 25 |
| Equity | | RUB | 7.127.621 |
| Debt (Gearing) | 70% | RUB | 15.750.000 |
| Loan Tenor | | Years | 10 |
| Interest Rate | | % | 10,25% |
| Discount Rate | | % | 12,00% |
| Inflation Rate | | % | 3% |

**Source: eclareon, 2020**

## About the assumptions for this PV Business Case

### Figure 67 Intelligent and fast interfacing between load, genset and PV inverter, Fuel Save Controller




**Source: SMA Solar Technology**

The diesel genset together with the connected load is the overlaid system and builds the electrical network. That is still valid even if the PV supplies energy into this grid. The PV can be seen as a negative load. The fuel save controller unit does not control the genset, it controls the PV power system to keep the genset within allowed operation conditions.

Diesel generators have to operate at at least 30% of installed capacity in order to avoid inefficient operation. 24h/7days genset operation is required. An adequate load profile during the day (sunshine) to reduce fuel consumption is assumed. In general, a share of 60% PV with fuel save controller without storage is advised.

Regarding direct PV consumption: a PV system that is neither connected to the grid nor to a battery will most likely not be able to self-consume the entire electrcity produced. In the business case, the self-consumption rate was set at 80% which means that 20% of the electrcity generated by the PV system is lost. This happens when electrcity demand falls below the electrcity generation of the hybrid PV system.

The assumptions regarding the financing conditions correspond to the possible terms and conditions of February 2019. Both captive diesel projects (without and with storage) are also calculated in RUB since the revenues are generated from diesel savings which are assumed to be paid in RUB.

**The lifetime of the system is set at 25 years and is based on the lifetime of the PV modules. Again, the solar radiation is set to 1,600 kWh / m$^2$ / a which represent irradiation levels in Krasnodar Krai.**

**After analyzing the diesel prices for the target customer groups of this business case we have assumed a price of about 46 RUB per liter.** This amounts to about 15 RUB (0.21 EUR) per kWh generation costs with common diesel generators under the assumption that the genset eficiency is at 3 kWh/ liter. Fuel cost escalation is 4% p.a.

For this case and also for the captive case with storage, no additional savings of maintenance costs for the on-going diesel generators were taken into account for the lifetime of the PV investment. Operation costs used are restricted to the PV system (inlcuding storage) itself but does not extend to the diesel genset. This is, however, a simplification since one could also consider savings in the maintenace costs for the diesel in favor of the profitability of the PV investment, because some of the generators can be switched off after installation of the PV and thus reduce the maintenance costs and create additional savings.

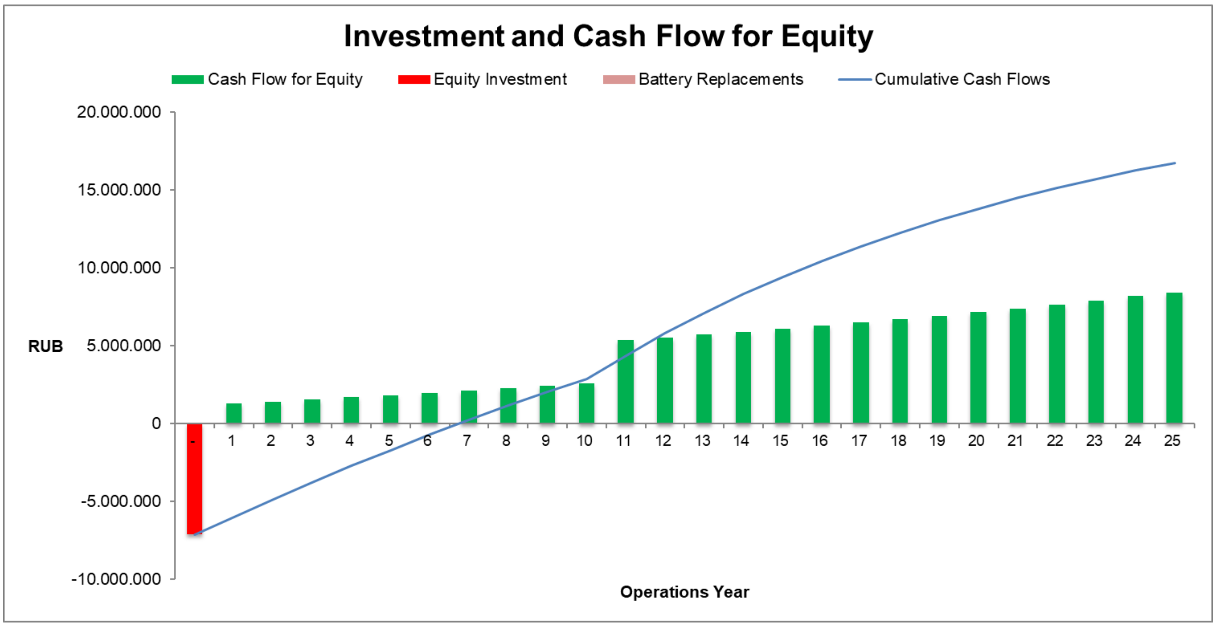
These diesel genset maintenace cost savings are more important the longer the diesel genset can be switched off completely. This would be the case for an installation with storage, because such a system configuration would allow the PV system to cover up to 100% of the load. Moreover, another simplicfication is the assumption that both cases were calculated for a 250kWp system in order to compare both cases as much as possible.

However, given a specific project with an individual load and consumption profile, an installtion with storage technology could integrate a larger share of PV and cover up to 100% of consumption. Hence, an instllation with a battery would be larger which could consequently also lead to economies of scale which could reduce system costs / kWp.

### Financial results for this PV Business Case

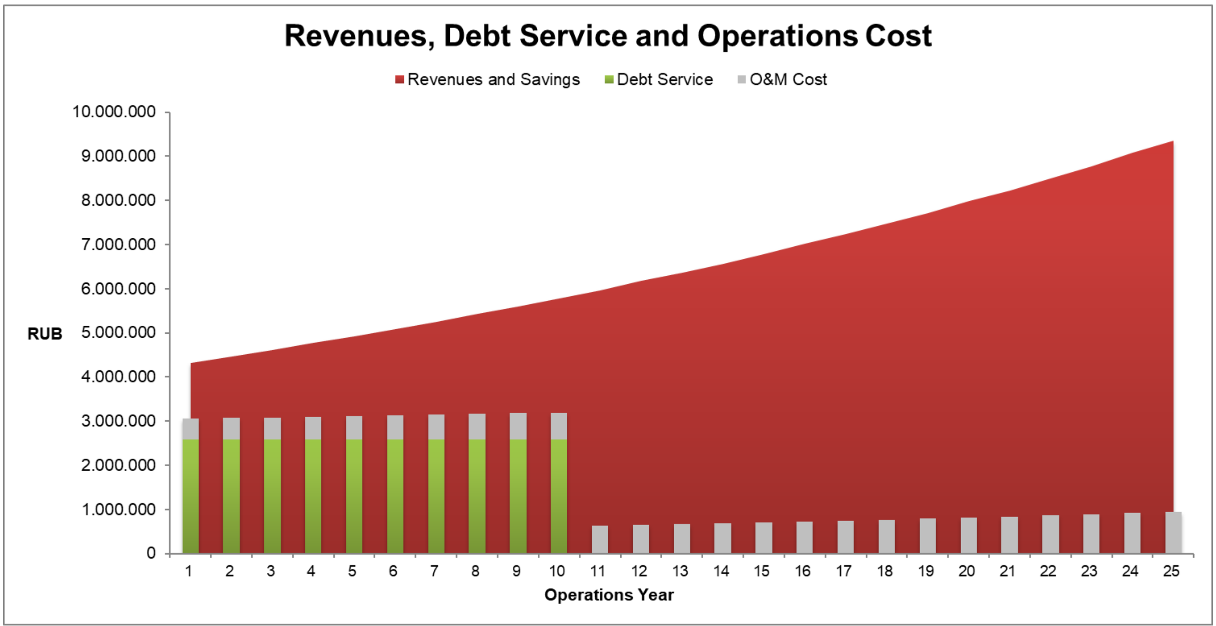
As can be seen from Figure 67, with best possible solar irradiation conditions in Krasnodar Krai the **discounted payback period is 6.8 years** only and the **equity IRR** is **27%.** The cash flow for the case is as follows:

**Figure 68 Equity Cash Flows - Captive PV without storage**




**Source: eclareon, 2020**

**Figure 69 Project Cash Flows - Captive PV without storage**

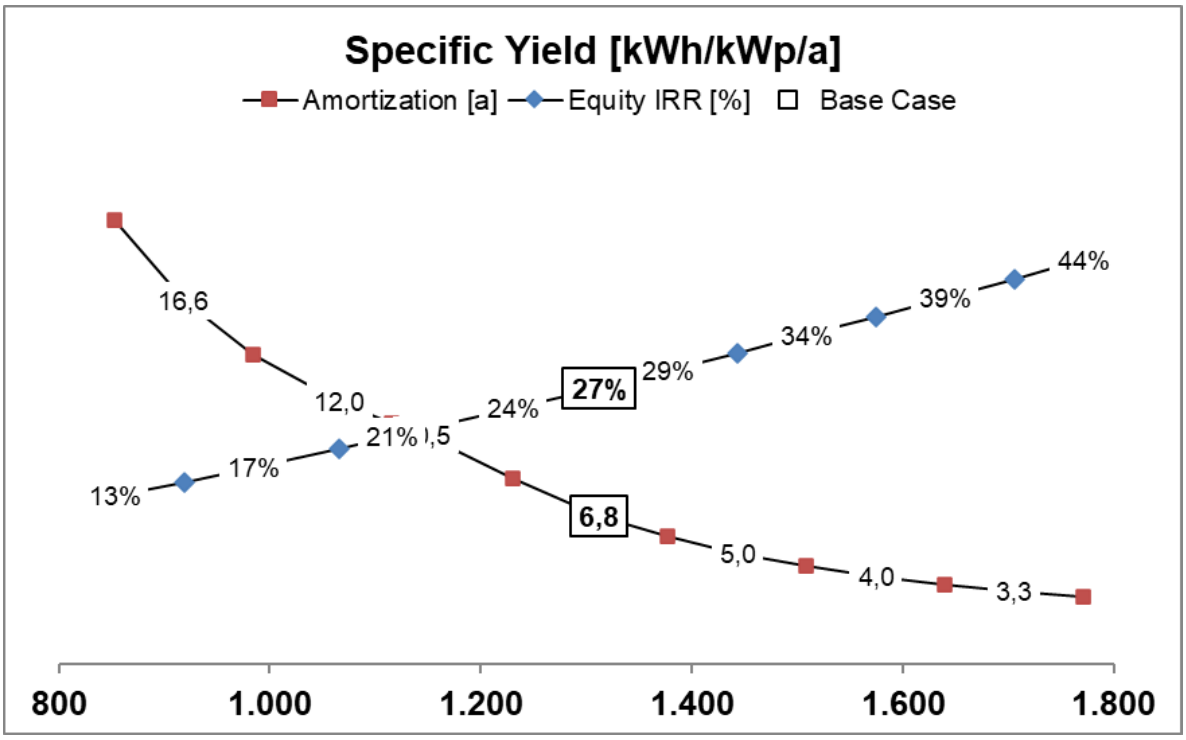



**Source: eclareon, 2020**

## Sensitivity of results for this PV Business Case

The following figures show how the two key economic performance indicators for the investment, payback period (amortization) and return on equity (equity IRR) change when certain assumptions about the investment framework conditions are modified. The figures show which alterations of the individual assumptions influence the profitability of the investment particularly strongly (→ high sensitivity). This needs to be carefully observed when making the investment.

**Figure 70 Specific Yield Sensitivity - Captive PV without storage**



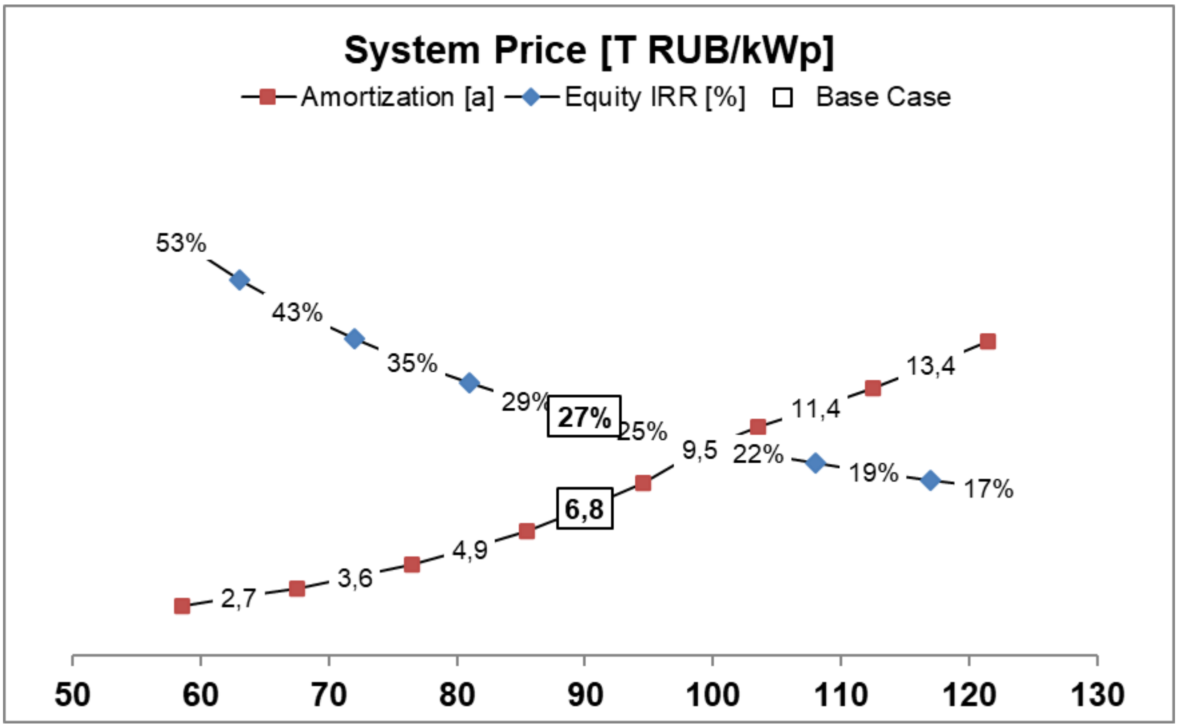

**Source: eclareon, 2020**

**As before, it was also looked at the results of an identical installation in the other 3 regions examined** where the irradiation (specific yield) would be lower. The results show that an investment in a diesel PV hybrid system, everything else being equal, would also be repaid in less sunny regions albeit the payback period would increase.

| Scenarios | Specific Yield | Payback | NPV (RUB) |
|---|---|---|---|
| Kaliningrad | 1.066 | 11,99 | 8.293.086 |
| Ulyanowsk | 1.148 | 10,45 | 10.905.590 |
| Bashkortostan | 1.230 | 8,45 | 13.518.094 |

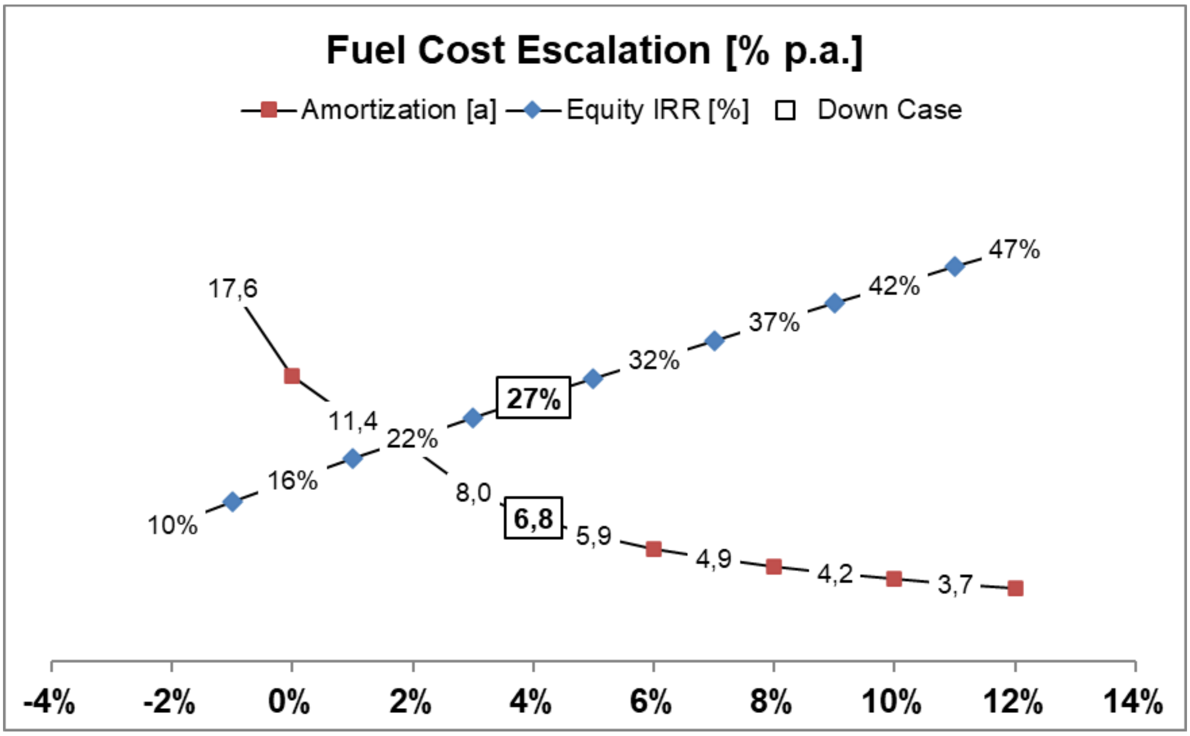
Going back to using the more favorable solar irradiation at Krasnodar Krai, the following figures show the influence of changing other key input parameters on the equity IRR and the payback period:

**Figure 71 System Price Sensitivity - Captive PV without storage**



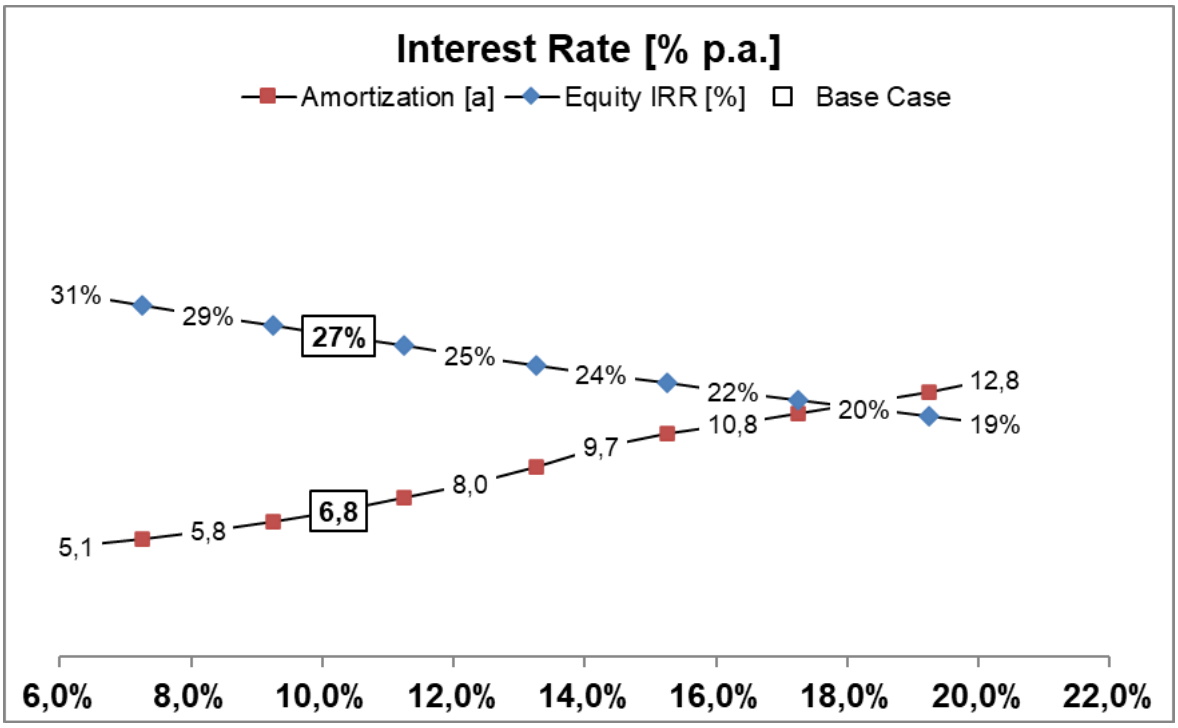

**Source: eclareon, 2020**

**Figure 72 Fuel Cost Escalation Sensitivity - Captive PV without storage**




**Source: eclareon, 2020**

**Figure 73 Interest Rate Sensitivity - Captive PV without storage**




**Source: eclareon, 2020**

## Option 2: Captive Diesel-PV hybrid with storage

Below an exemplary profitability analysis for a PV-Diesel hybrid project with storage and based on diesel savings is presented.

**Figure 74 Project Overview - Captive PV with storage**

| PV Project | | | |
|---|---|---|---|
| PV System Size | | kWp | 250 |
| Specific System Cost | | RUB/kWp | 90.000 |
| PV Battery Size | | kWh | 135 |
| Specific Battery Costs | | RUB/kWh | 35.000 |
| Total System Cost | | RUB | 27.217.808 |
| Fixed Operation Costs | | RUB p.a. | 544.356 |
| Variable Operation Costs | | RUB/kWh | - |

| PV Generation | | | |
|---|---|---|---|
| Global Tilted Irradiation (GTI) | | kWh/qm/a | 1.600 |
| Performance Factor | | % | 82% |
| Specific Yield | | kWh/kWp/a | 1.312 |
| Degradation | | % p.a. | 0,70% |

| Investment | | | |
|---|---|---|---|
| Project Duration | | Years | 25 |
| Equity | | RUB | 8.622.143 |
| Debt (Gearing) | 70% | RUB | 19.052.466 |
| Loan Tenor | | Years | 10 |
| Interest Rate | | % | 10,25% |
| Discount Rate | | % | 12,00% |
| Inflation Rate (Intial year) | | % | 3% |

| PV Business Model | | |
|---|---|---|
| Direct PV Consumption | % | 80% |
| PV Consumption via Battery | % | 15% |
| Battery Losses | % | 20% |
| Effective fuel costs | RUB/ltr | 46 |
| Diesel Generation Costs | RUB/kWh | 15 |
| Fuel cost escalation | % p.a. | 4% |

| Results | | |
|---|---|---|
| Net-Present Value | RUB | 15.085.196 |
| Project IRR | % | 18% |
| Equity IRR | % | 24% |
| Amortization - discounted payback period | Years | 9,70 |
| Undiscounted payback period | Years | 5,35 |
| LCOE (no subsidy) | RUB/kWh | 13,55 |
| Min DSCR** | x | 0,57 x |
| Min LLCR*** | x | 1,38 x |

**Source: eclareon, 2020**

### About the assumptions for this PV Business Case

**The integration of a storage system reduces the operating time of the diesel genset and the fuel consumption**. The storage ensures power quality and grid stability (voltage, frequency, reactive power) and can substitute spinning reserve and idle genset operation. Moreover, the risk that there are times when the electricity generated than the actual demand is reduced.

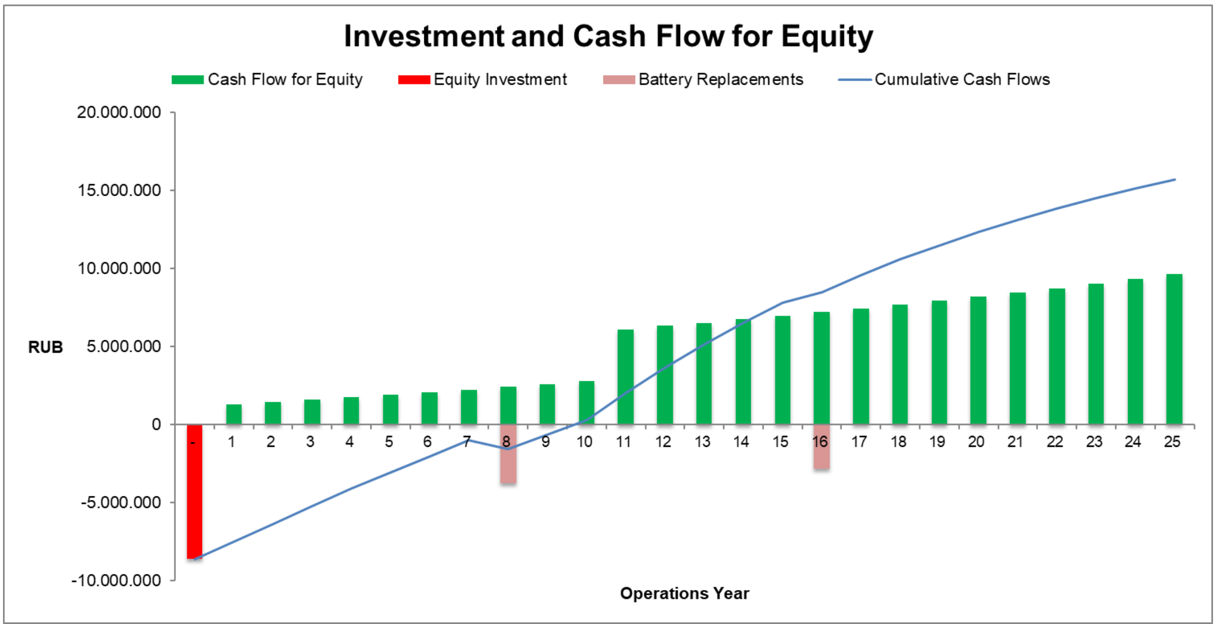
The PV penetration and storage capacity can be extended to the economic optimum and a diesel off-mode can be supported. Power sharing among generation units may help to meet the load demand in the most economical way. An additional control unit is needed.

**The above calculation for the PV project is done with a lead acid storage technology with lower specific battery costs than lithium based technologies**. This case assumes two battery replacements in years 8 and 16, with decreasing costs because the present value of this investment is considered and future cost reduction is very likely.

### Financial results for this PV Business Case

As can be seen from Figure 74, the **payback period** is **9.7 years** and the **equity IRR** is **24%.** The cash flow for the case is as follows:

**Figure 75 Equity Cash Flows - Captive PV with storage**

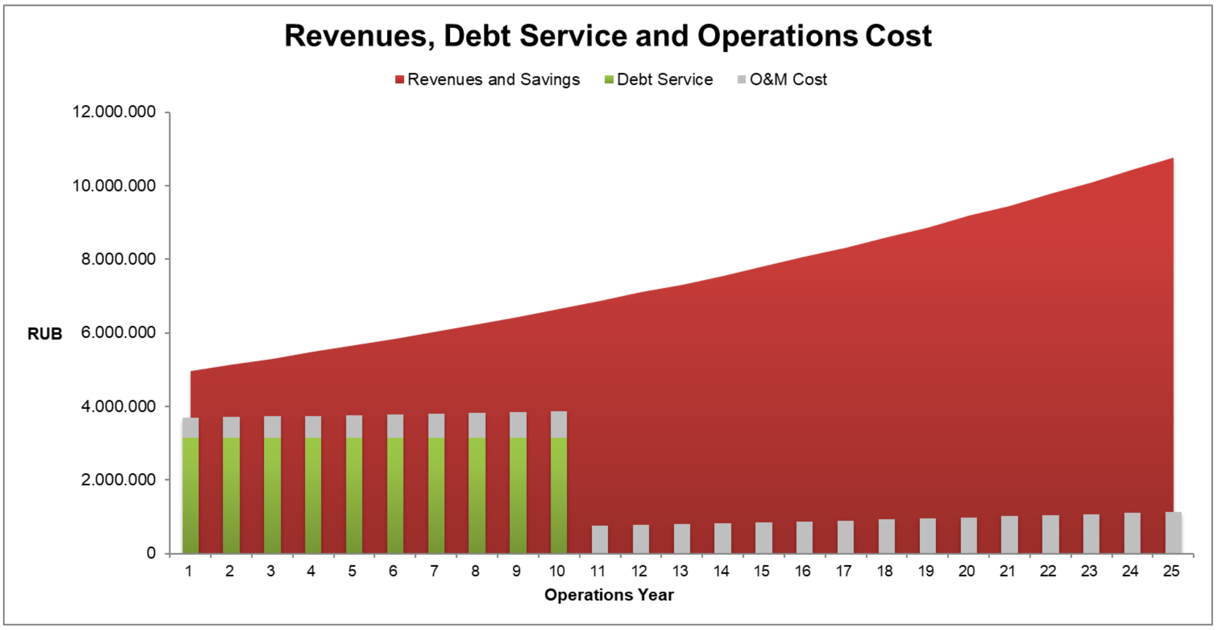



**Source: eclareon, 2020**

As described in the assumptions, the captive diesel-PV case with storage assumes two battery replacements in years 8 and 16. In this case the long-term inflation rate (3% during the lifetime of the project) applied to the O&M costs is lower than the fuel cost escalation (4%) that drives the increased savings over time. Thus, towards the end of the project the absolute O&M costs increase less than the revenues/savings.

It can also be argued that a 3$^{rd}$ battery replacement would be needed in year 24 to stay in line with an 8-year replacement cycle. However, this was not done since it was judged unlikely that 1 year before the end of the project the battery would be exchanged. Moreover, it can be assumed that the battery technology in 16 year when the battery is replaced for the second time is so advanced that replacement intervals can be extended further.

**Figure 76 Project Cash Flows - Captive PV with storage**

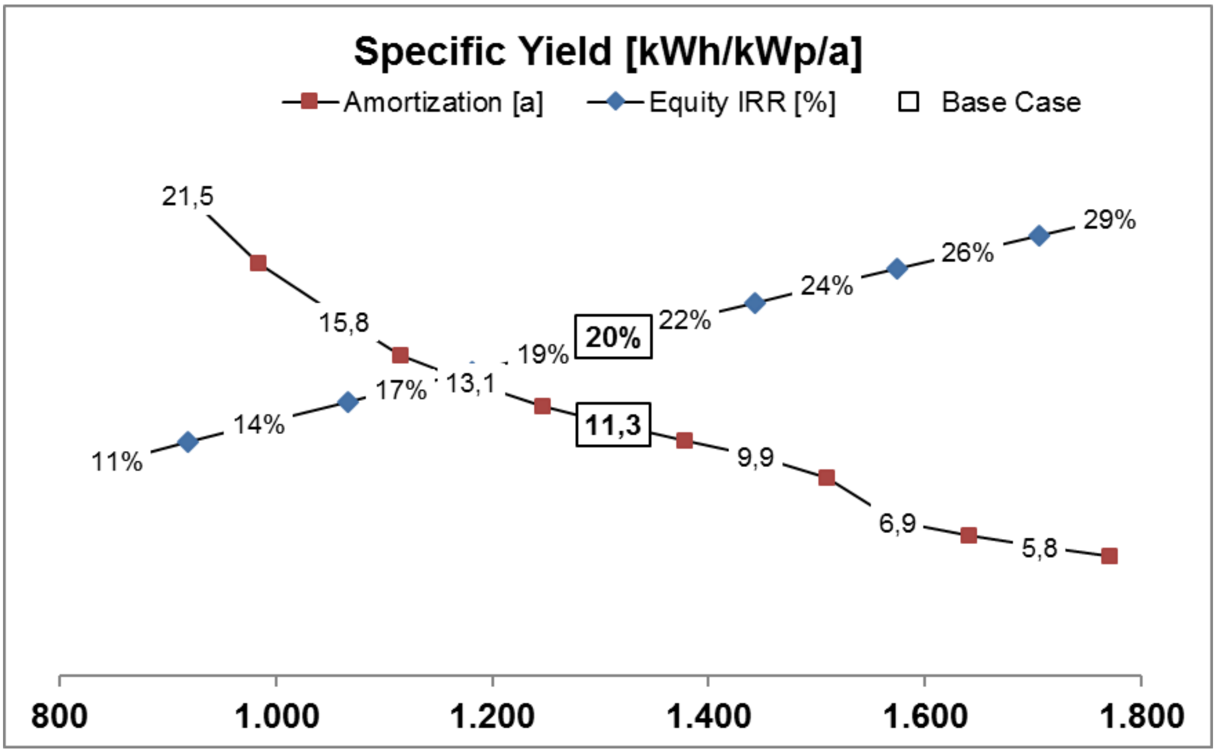



**Source: eclareon, 2020**

## Sensitivity of results for this PV Business Case

The following figures show how the two key economic performance indicators for the investment, payback period (amortization) and return on equity (equity IRR) change when certain assumptions about the investment framework conditions are altered.

**Figure 77 Specific Yield Sensitivity - Captive PV with storage**



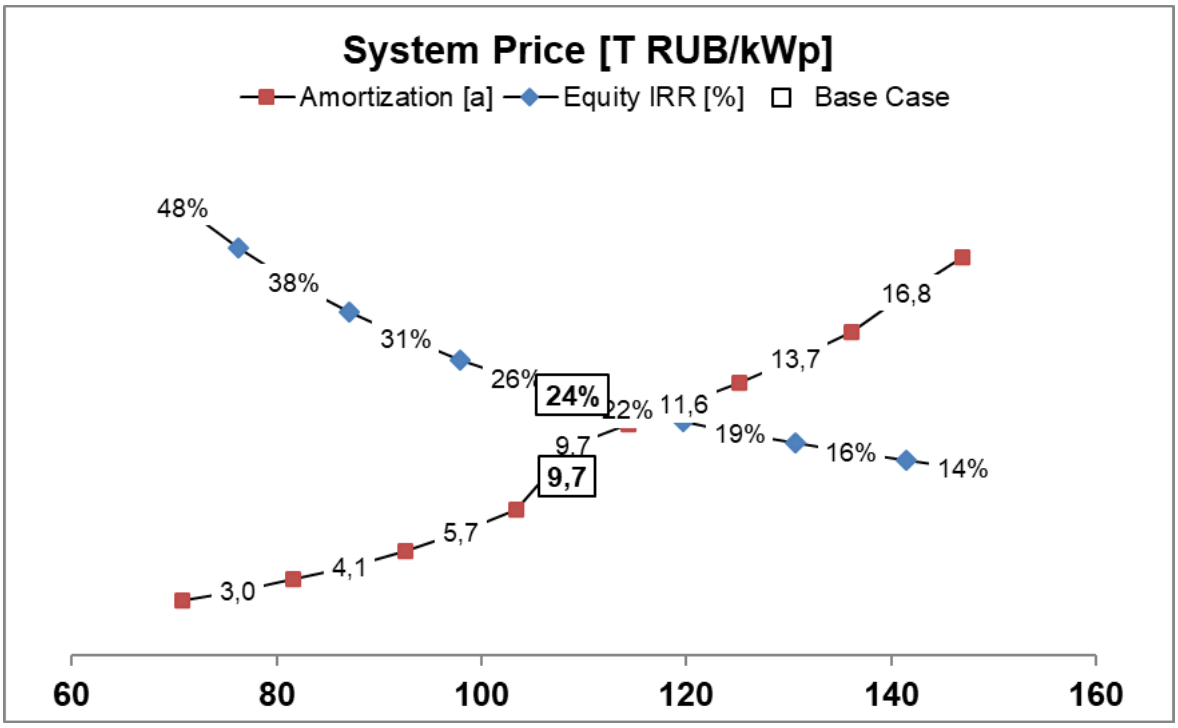

**Source: eclareon, 2020**

As before, looking at the results for an identical system in the other regions it can be acknowledged that a PV diesel hybrid installation with lead acid storage would also be paid back in less sunnier regions.

| Scenarios | Specific Yield | Payback | NPV (RUB) |
|---|---|---|---|
| Kaliningrad | 1.066 | 13,50 | 7.443.697 |
| Ulyanowsk | 1.148 | 11,96 | 9.990.863 |
| Bashkortostan | 1.230 | 10,79 | 12.538.030 |

Going back to using the more favorable solar irradiation at Krasnodar Krai, the following figures show the influence of changing other key input parameters on the equity IRR and the payback period:

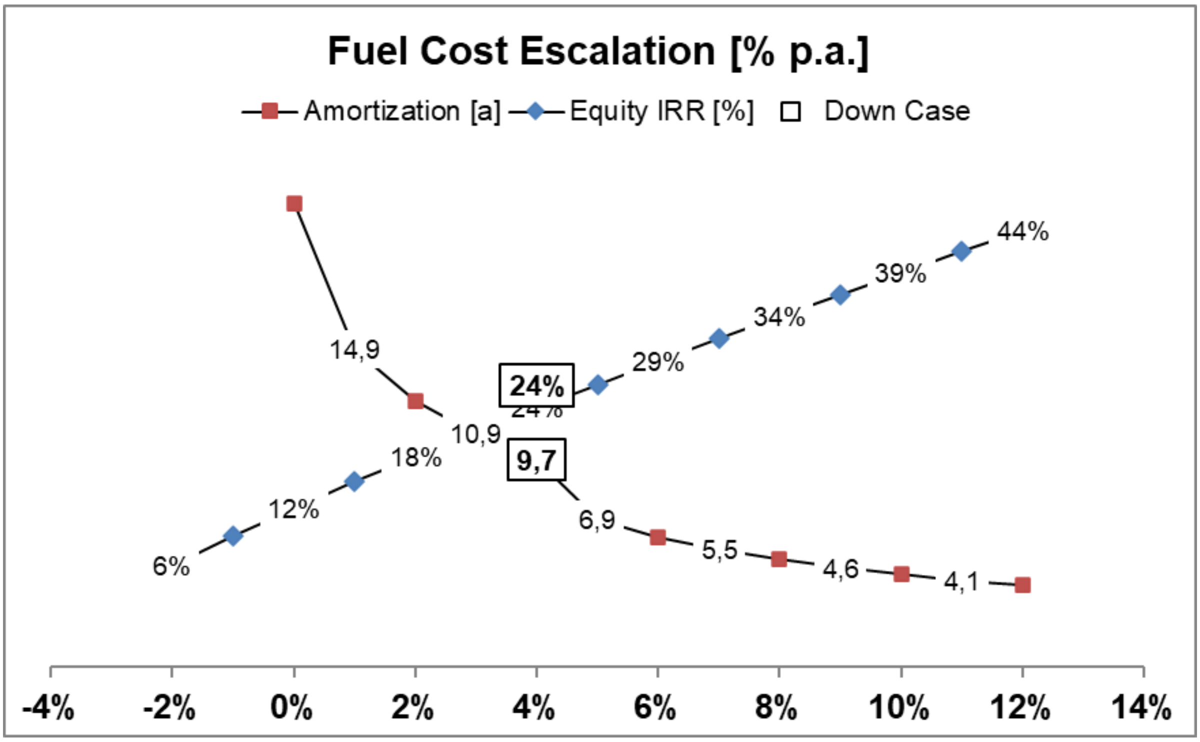
**Figure 78 System Price Sensitivity - Captive PV with storage**




**Source: eclareon, 2020**

The yield and the system price have a strong impact on the profitability of a project.

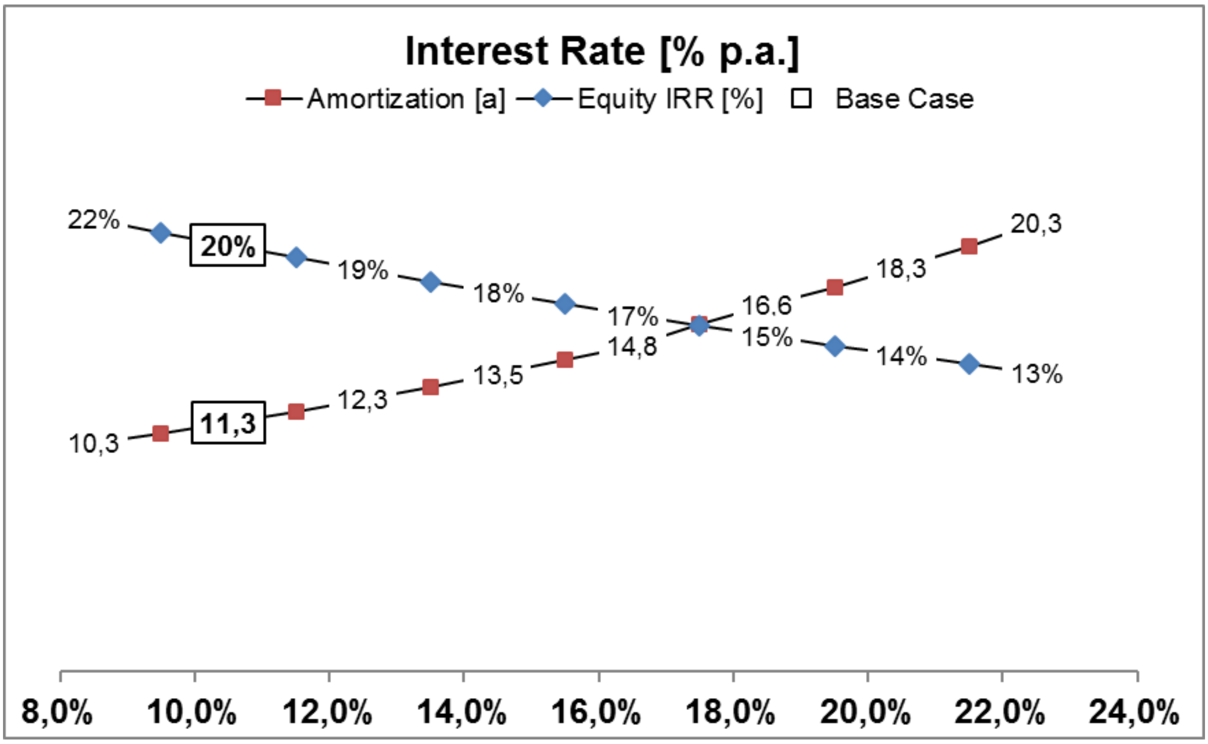
**Figure 79 Fuel Cost Escalation Sensitivity - Captive PV with storage**




**Source: eclareon, 2020**

The rate at which the fuel costs are escalated over the project period has a strong impact on the profitability of the project.

**Figure 80 Interest Rate Sensitivity - Captive PV with storage**




**Source: eclareon, 2020**

## 7.4 Residential PV systems

**A grid connected residential solar PV system combines the power output of PV arrays with a grid connection. The legislation in Russia to allow private households to connect their PV installation to the grid has been finally enacted at the end of 2019** (microgeneration law see section 2.1.5 on this topic).

**As described, there are still many question s with regards to the** "feed-in tariffs" paid. A minimum tariff is not explicitly mentioned in the law but the wholesale market price level is referenced and it is believed that compensation for feeding surplus electricity to the grid is unlikely to surpass 1.5 RUB/kWh (2 €ct /kWh). If this is confirmed by and large, excess electricity sales would be limited because savings of (higher) retail electricity prices would be more attractive.

With regards to this business segment, the following 2 detailed profitability analysis were undertaken:

1. A 15 kW installation in Krasnodar with no regional subsidies
2. A 15 kW installation in Ulyanovsk with regional investment subsidies

### 7.4.1 Residential PV system (no subsides)

#### Profitability Analysis (Inputs, Outputs, Scenarios, Sensitivities)

A profitability analysis for a residential PV system based on the microgeneration law is presented below.

**Figure 81 Project Overview – Residential PV**

| PV Project | | | |
|---|---|---|---|
| PV System Size | | kWp | 15,00 |
| Specific System Cost | | RUB/kWp | 100.000 |
| Investment Subsidy | | % | - |
| Total System Cost | | RUB | 1.500.000 |
| Fixed Operation Costs | | RUB p.a. | 15.000 |
| Variable Operation Costs | | RUB/kWh | - |
| Additional CapEx (e.g. Batterie) | | RUB | - |
| **PV Generation** | | | |
| Specific Yield | | kWh/qm/a | 1600 |
| Performance Factor | | % | 82% |
| Specific System Performance | | kWh/kWp/a | 1.312 |
| Degradation | | % p.a. | 0,70% |
| **Investment** | | | |
| Project Duration | | Years | 25 |
| Equity | | RUB | 1.500.000 |
| Debt (Gearing) | - | RUB | - |
| Loan Tenor | | Years | 10 |
| Interest Rate | | % | 10,3% |
| Discount Rate | | % | 5,0% |
| Initial inflation rate | | % | 3,0% |

| PV Business Model | | | |
|---|---|---|---|
| Category | Share | Unit | Price |
| Feed-in Tariff | - | RUB/kWh | - |
| Self-consumption | - | RUB/kWh | - |
| Fees | | RUB/kWh | - |
| Self-consumption II | 100% | RUB/kWh | 5,02 |
| Fees | | RUB/kWh | - |
| Excess Electricty | | RUB/kWh | 1,50 |
| PPA Tariff | - | RUB/kWh | - |
| Fees | | RUB/kWh | - |

| Results | | |
|---|---|---|
| Net-Present Value | RUB | 366.199 |
| Project IRR | % | 6,92% |
| Equity IRR | % | 6,92% |
| Amortization - discounted payback period | Years | 20,42 |
| Undiscounted payback period | Years | 13,79 |
| LCOE* (w/o subsidy) | RUB/kWh | 7,23 |
| LCOE (w subsidy) | RUB/kWh | 7,23 |
| Electricity Price Escalation | % p.a. | 5,00% |

**Source: eclareon, 2020**

#### About the assumptions for this PV Business Case

As in the previous cases, the solar irradiation for Krasnodar Krai was applied in the base case. It was assumed that **a residential household under the microgeneration law will become a prosumer who can either consume electricity directly or sell excess electricty to the**

**grid**. Consuming electrcity instead of buying it from the grid was **evaluated with a rather high residential tariff of 5.02 RUB/kWh (retail market price) that can be found in Krasnodar Krai.** The annual increase of electricity prices is set at 5%. Excess electricity could only be sold at the wholesale market price which is evaluated at 1.5 RUB/kWh. Under these assumptions, it was calculated that direct consumption will be as high as possible (in the model account for 95% of generated electrcity) and sales of excess electricity only account for 5%. The assumptions regarding the financing conditions asume that these installations attract rather wealthy individuals who can afford the investment and will buy the system based on their own funds alone. Moreover it is assumed, that these individuals do not primarily invest in order to make a profit but rather in order to make a statement of being innovation firendly and environmentally conscious. Therefore, the discount rate was set at 5% as opposed to 12 % in the previous buisness cases. As mentionned before the average disposable income of Russian households is less than 50% of the household income in Germany which means that many households will not be able to afford the upfront investment and, given the rather low economic returns and long payback time due to low grid electricity prices it is not likely that banks will finance such installations for low-income households.

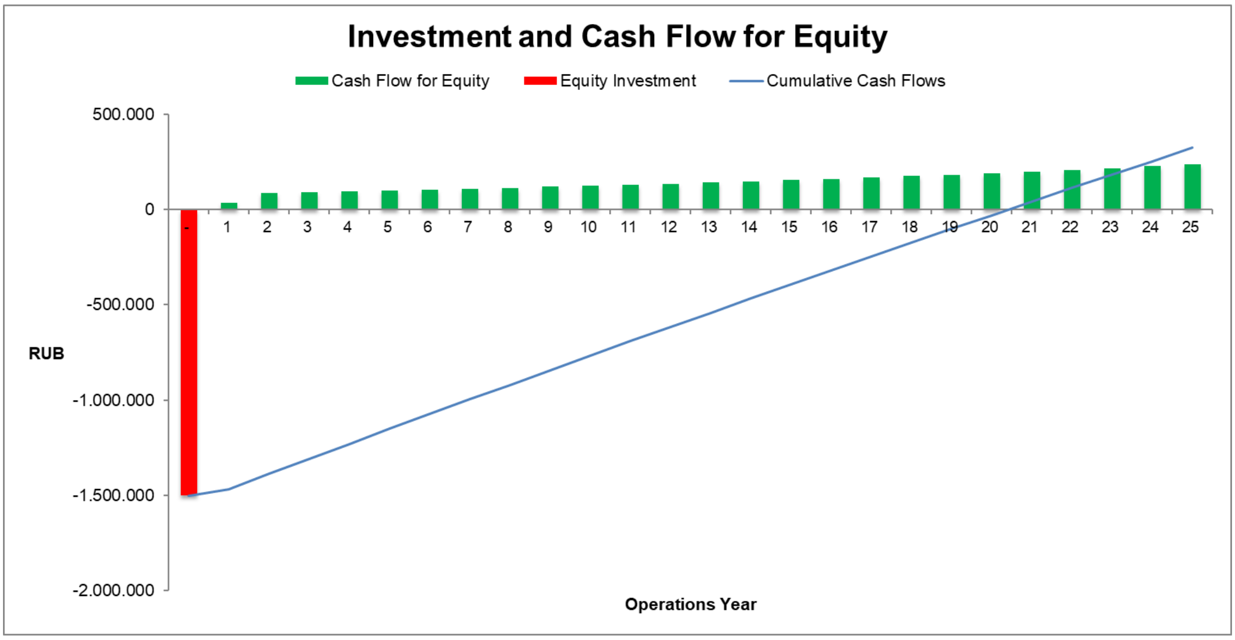
Still, based on some of the pricing information received in Krasnodar, the system costs may in fact be lower than the 100,000 RUB/kWp used in the base case calaculation which would positively impact the IRR and shorten the payback period. This effect is shown in the sensitivity analysis pertaining to system prices.

The lifetime of the system is set to 25 years and is based on the lifetime of the PV modules. Again, the solar radiation is set to 1,600 kWh / m$^2$ / a.

### Financial results for this PV Business Case

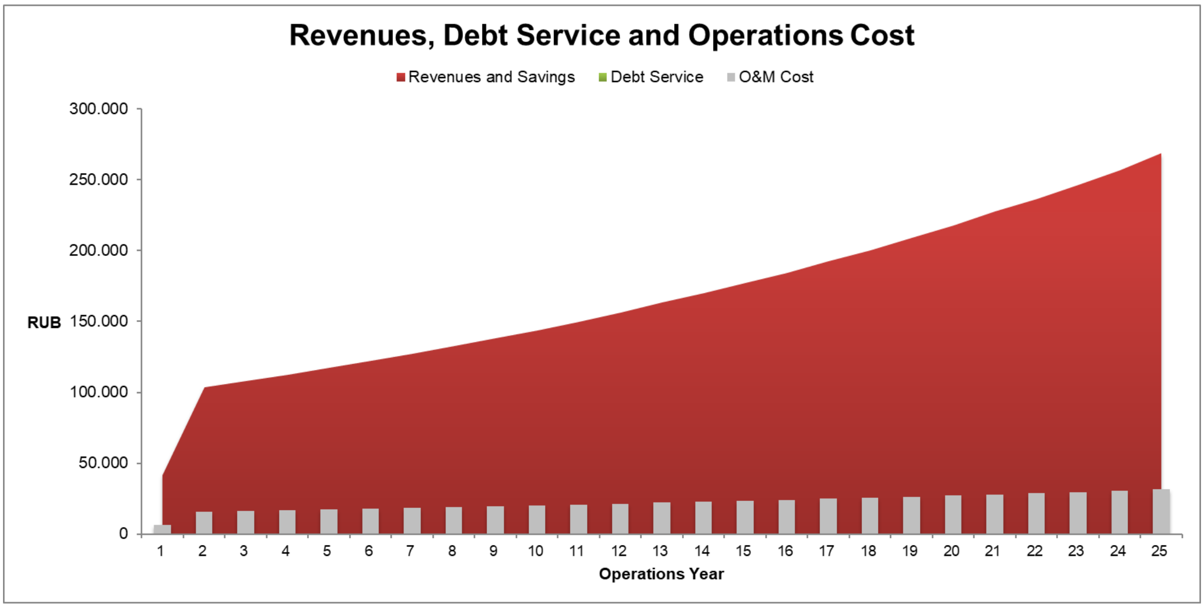
As can be seen from Figure 81, with best possible solar irradiation conditions in Krasnodar Krai the **payback period is 20.39 years** and the **equity IRR** is **6.92%.** The equity cash flow for the case is as follows:

**Figure 82 Equity Cash Flows - Residential PV**




**Source: eclareon, 2020**

**Figure 83 Project Cash Flows - Residential PV**

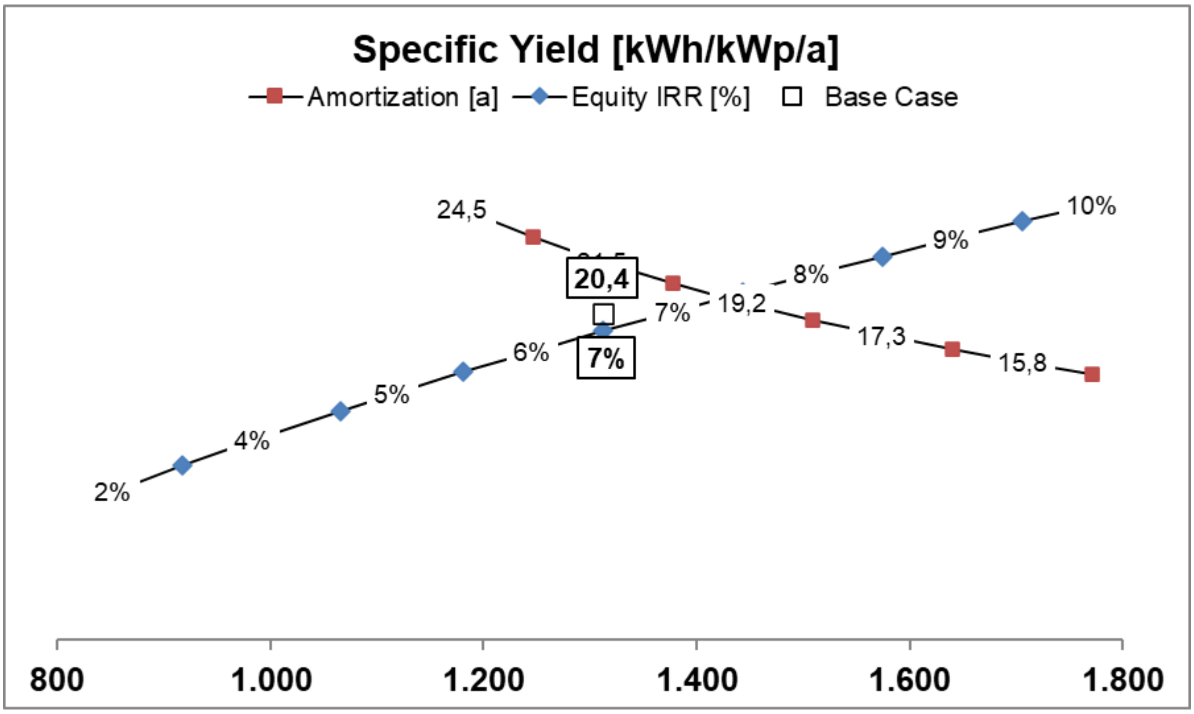



**Source: eclareon, 2020**

## Sensitivity of results for this PV Business Case

Again, the following figures show how the two key economic performance indicators for the investment, payback period (amortization) and return on equity (equity IRR) change when certain assumptions about the investment framework conditions are modified. The figures show which alterations of the individual assumptions influence the profitability of the investment particularly strongly (→ high sensitivity). This needs to be carefully observed when making the investment.

**Figure 84 Specific Yield Sensitivity - Residential PV**




**Source: eclareon, 2020**

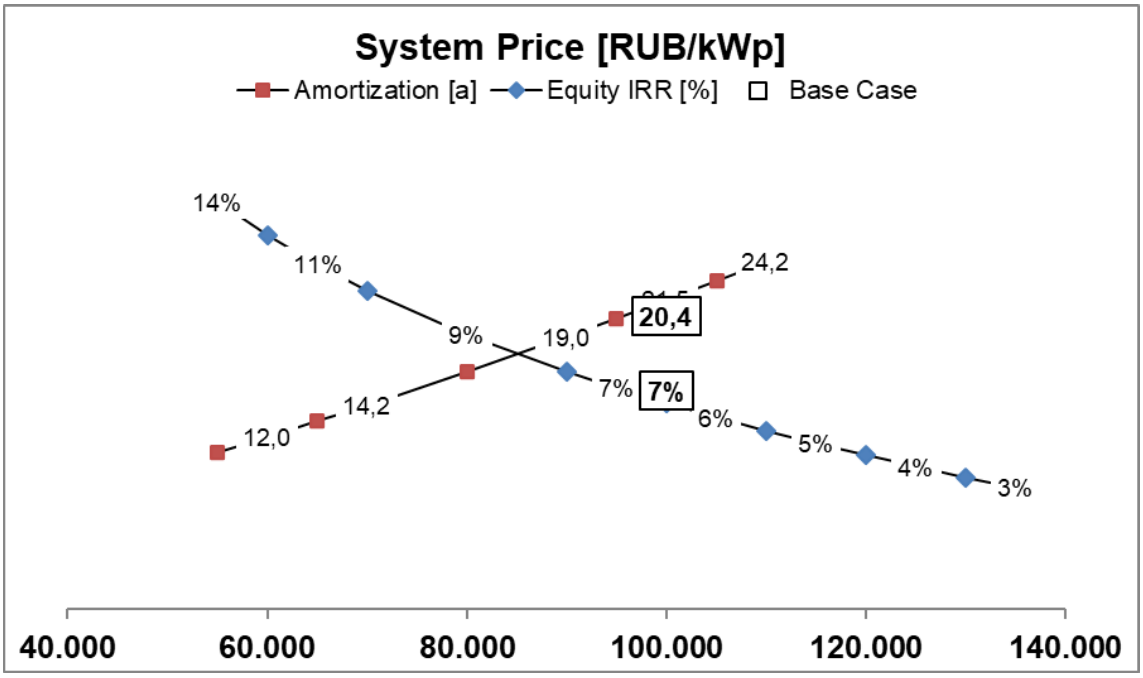
Looking at the other regions it becomes instinctively clear that installations built in areas with lower solar irradiation will have a hard time to compete with low grid electricity prices.

Under the same conditions, such installations could also be paid back in Ulyanowsk and Bashkortostan albeit with a longer payback period. In Kaliningrad discounted payback within 25 years would not be possible.

| Scenarios | Specific Yield | Amortization | NPV (RUB) |
|---|---|---|---|
| Kaliningrad | **1.066** | **#NV** | **(113.304)** |
| Ulyanowsk | 1.181 | 24,48 | 67.199 |
| Bashkortostan | 1.246 | 22,91 | 169.222 |

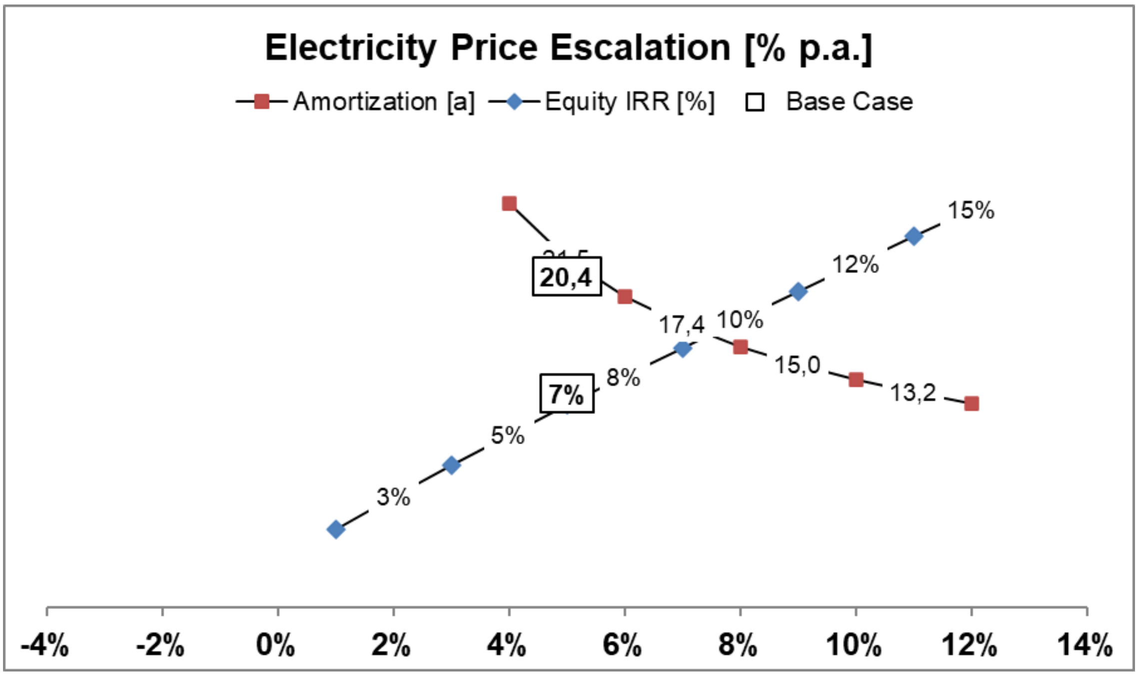
Taking again the irradiation levels in Krasnodar, the effects of lower (but also higher) overall system prices can be seen in Figure 85:

**Figure 85 System Price Sensitivity - Residential PV**




**Source: eclareon, 2020**

**Figure 86 Electricity Cost Escalation Sensitivity - Residential PV**




**Source: eclareon, 2020**

### 7.4.2 Residential PV system with regional subsidies

#### Profitability Analysis (Inputs, Outputs, Scenarios, Sensitivities)

A 2nd profitability analysis for a residential PV system based on the law for microgeneration was calculated for Ulyanovsk. Besides the solar irradiation that is lower than in Krasnodar, this 2nd residential business case differs from the first one by the following criteria:

1. The residential electricity prices in Ulyanovsk are higher than in the other 3 regions covered in this report
2. An additional investment subsidy was applied based on the information provided by regional stakeholders.

**Figure 87 Project Overview – Residential PV with subsidies (Ulyanovsk Oblast)**

| PV Project | | |
|---|---|---|
| PV System Size | kWp | 15,00 |
| Specific System Cost | RUB/kWp | 100.000 |
| Investment Subsidy | % | 10% |
| Total System Cost | RUB | 1.350.000 |
| Fixed Operation Costs | RUB p.a. | 13.500 |
| Variable Operation Costs | RUB/kWh | - |
| Additional CapEx (e.g. Batterie) | RUB | - |
| **PV Generation** | | |
| Specific Yield | kWh/qm/a | 1400 |
| Performance Factor | % | 82% |
| Specific System Performance | kWh/kWp/a | 1.148 |
| Degradation | % p.a. | 0,70% |

| Investment | | | |
|---|---|---|---|
| Project Duration | | Years | 25 |
| Equity | | RUB | 1.350.000 |
| Debt (Gearing) | - | RUB | - |
| Loan Tenor | | Years | 10 |
| Interest Rate | | % | 10,3% |
| Discount Rate | | % | 5,0% |
| Initial inflation rate | | % | 3,0% |

| PV Business Model | | | |
|---|---|---|---|
| **Category** | **Share** | **Unit** | **Price** |
| Feed-in Tariff | - | RUB/kWh | - |
| Self-consumption | - | RUB/kWh | - |
| Fees | | RUB/kWh | - |
| Self-consumption II | 100% | RUB/kWh | 6,94 |
| Fees | | RUB/kWh | - |
| Excess Electricity | | RUB/kWh | 1,50 |
| PPA Tariff | - | RUB/kWh | - |
| Fees | | RUB/kWh | - |

| Results | | |
|---|---|---|
| Net-Present Value | RUB | 989.851 |
| Project IRR | % | 10,25% |
| Equity IRR | % | 10,25% |
| Amortization - discounted payback period | Years | 14,55 |
| Undiscounted payback period | Years | 10,73 |
| LCOE* (w/o subsidy) | RUB/kWh | 8,13 |
| LCOE (w subsidy) | RUB/kWh | 7,43 |
| Electricity Price Escalation | % p.a. | 5,00% |

**Source: eclareon, 2020**

#### About the assumptions for this PV Business Case

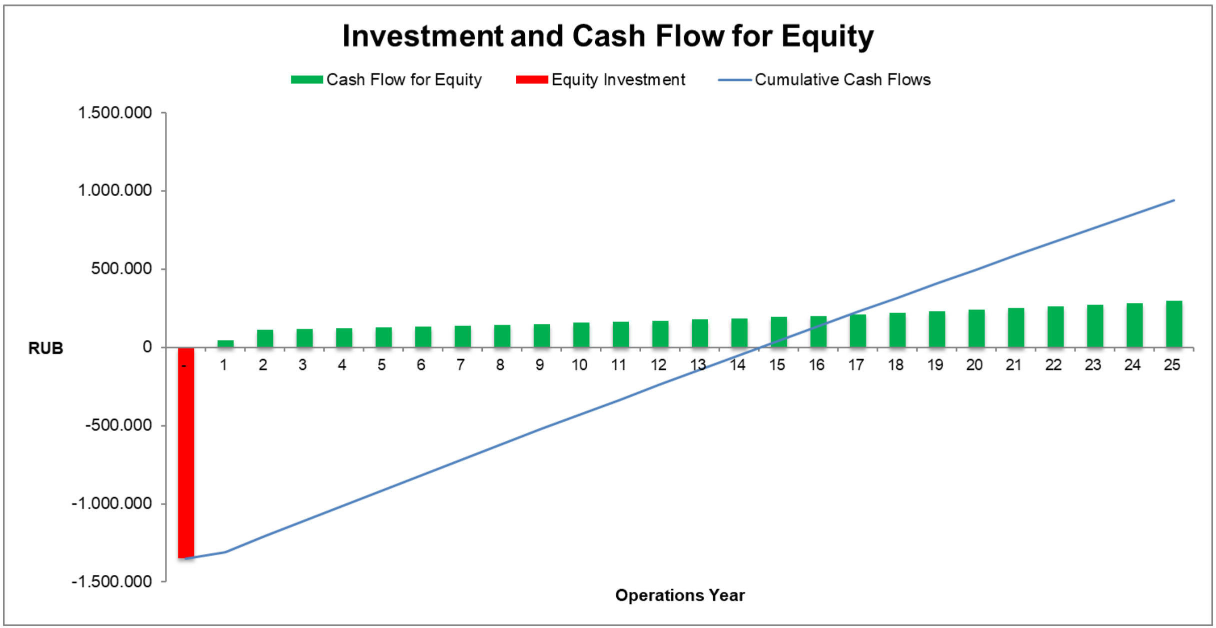
The solar irradiation for Ulyanovsk was applied in the base case (1,400 kWh / m$^2$ / a). It was assumed that **a residential household under the microgeneration law will become a prosumer who can either consume electricity directly or sell excess electricty to the grid**. Cosmuming electrcity insetad of buying it from the grid was **evaluated with a residential tariff of 6.94 RUB/kWh (retail market price) that can be found in Ulyanovsk Oblast who has the highest residential traiffs among all the regions reviewed for this report.** As before, the annual increase of electricity prices is set at 5%. Excess electricity could only be sold at the wholesale market price which is evaluated at 1.5 RUB/kWh. Under these assumptions, it was calculated that direct consumption will be as high as possible (in the model account for 95% of generated electrcity) and sales of excess electricity only account for 5%. As before, the assumptions regarding the financing conditions asume that these installations attract rather wealthy individuals who can afford the investment and will buy the system based on their own funds alone. Moreover it is assumed, that these individuals do not primarily invest in order to make a profit but rather in order to make a statement of being innovation firendly and environmentally conscious. Therefore, the discount rate was set at 5% as opposed to 12 % in the previous buisness cases. As before, the system costs in the base case were set at 100,000 RUB/kWp. Potential lower and higher system costs are accounted for in the sensitivity analysis. Moreover, in this case a (regional) investment subsidy of 10% on the system price was applied.

The lifetime of the system is set to 25 years and is based on the lifetime of the PV modules.

### Financial results for this PV Business Case

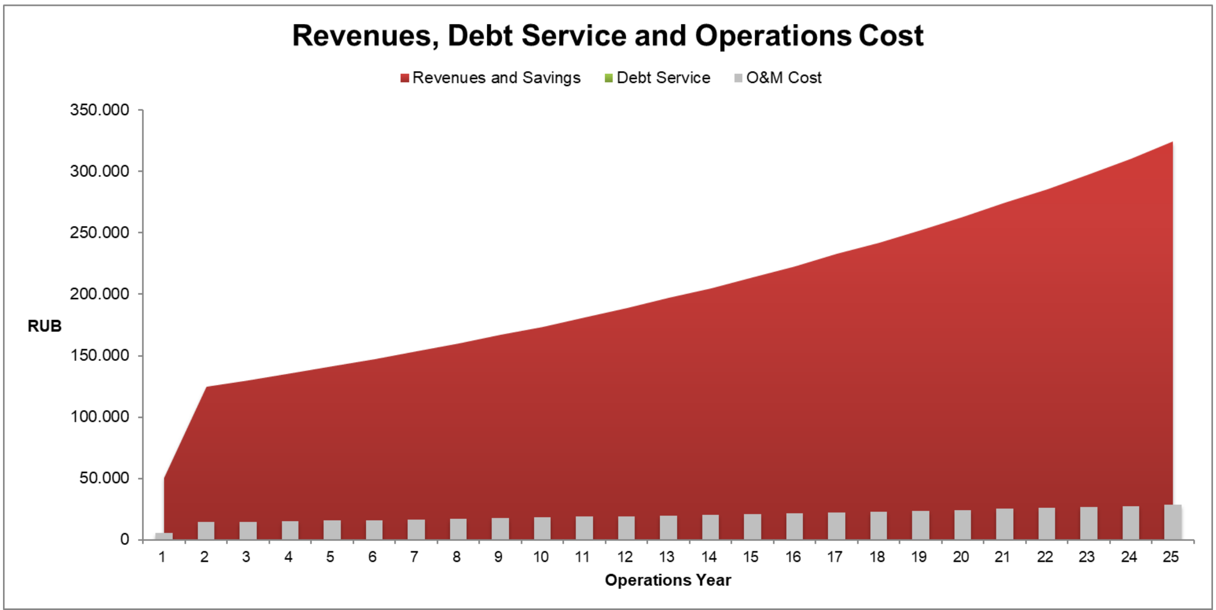
As can be seen from Figure 81, with best possible solar irradiation conditions in Ulyanovsk Oblast the **payback period for a subsidized system is shortened to 14.55 years** and the **equity IRR** is increased to **10.25 %.** The equity cash flow for the case is as follows:

**Figure 88 Equity Cash Flows - Residential PV with subsidies (Ulyanovsk Oblast)**




**Source: eclareon, 2020**

**Figure 89 Project Cash Flows - Residential PV with subsidies (Ulyanovsk Oblast)**

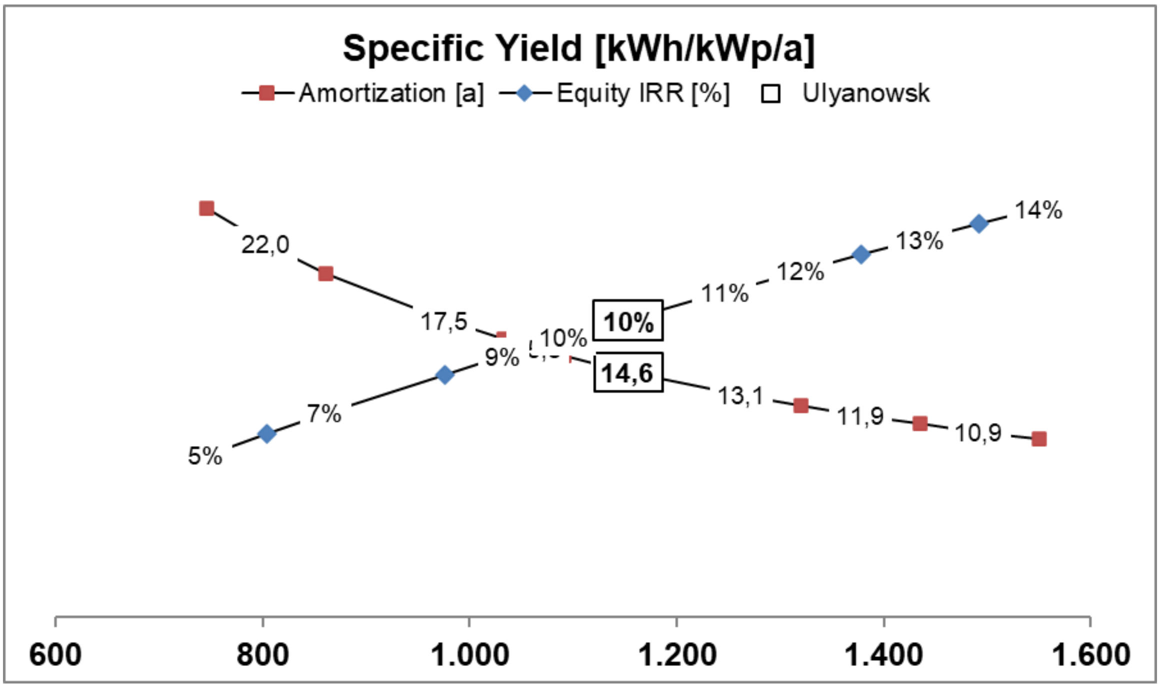



**Source: eclareon, 2020**

### Sensitivity of results for this PV Business Case

Again, the following figures show how the two key economic performance indicators for the investment, payback period (amortization) and return on equity (equity IRR) change when certain assumptions about the investment framework conditions are modified. The figures show which alterations of the individual assumptions influence the profitability of the investment particularly strongly (→ high sensitivity). This needs to be carefully observed when making the investment.

**Figure 90 Specific Yield Sensitivity - Residential PV with subsidies (Ulyanovsk Oblast)**

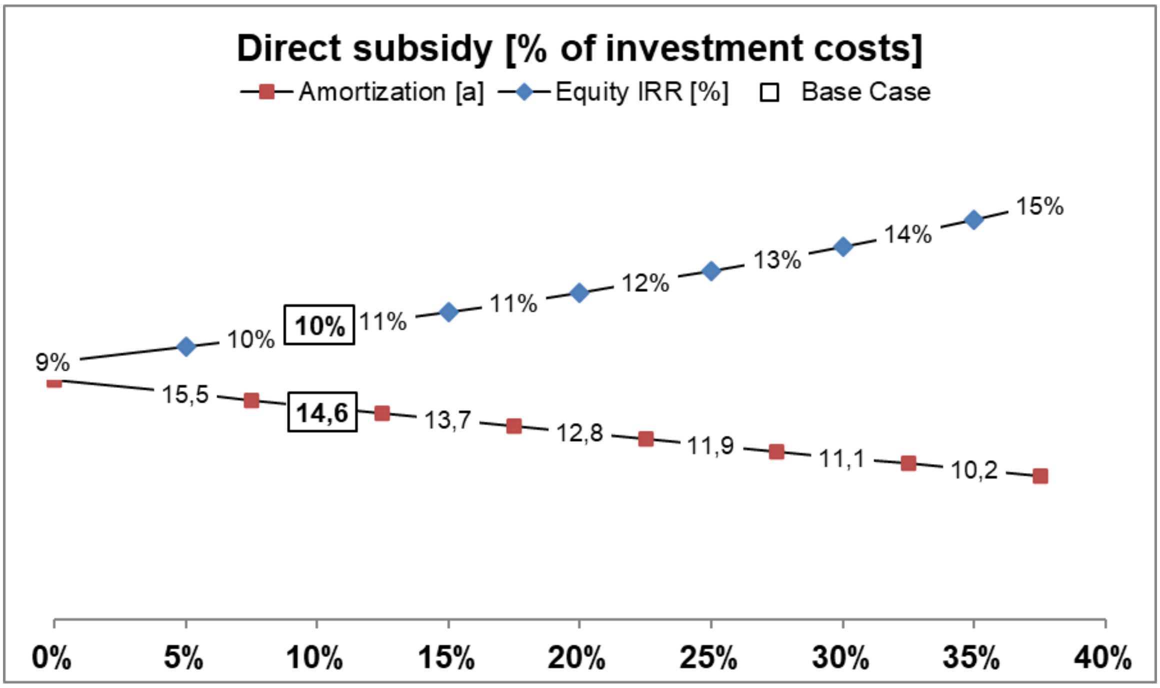



**Source: eclareon, 2020**

The business case is rather positive and could be even more positive in other regions with higher solar irradiation like Krasnodar and Bashkortostan. However, the regions also have lower grid electricity prices than Ulyanovsk.

The following sensitivity analysis shows the effect of a regional subsidy:

**Figure 91 Direct Subsidy Sensitivity - Residential PV (Ulyanovsk Oblast)**




**Source: eclareon, 2020**

The graph shows the positive impact a subsidy can have on the economic parameters of a residential PV system. Still, even though a high subsidy of 30% or more would not shorten the discounted payback period < 10 years, it would make the residential business case more attractive.

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