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## Energy saving, implementation of solar energy and other renewable energy sources for energy supply in rural areas of Russia

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### Abstract

The project of large-scale stage-by-stage implementation of energy systems based on solar energy and other renewable energy sources (RES) in rural settlements of Russia has been worked out. Research was made based on the analysis of regional, climatic, social, economical and technical factors, proposed complex approach to energy supply of rural buildings and predictive estimates. Priorities, sequence of actions and the values of interstage and final indicators have been defined. The issues of RES implementations and measures on energy saving over vast, mainly poorly populated, rural territories have been considered.

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### 1. Conditions for large-scale implementation of complex energy systems based on RES

#### 1.1. Condition of energy supply in Russia rural settlements

The energetics of agriculture have some specific features: dispersed of rural consumers, small unit capacity, great length of electrical, thermal, and gas networks, large sparsely populated territories where the agricultural production is carried out but which have no centralized energy supply. These features impose additional requirements for energy supply systems; substantial transition line wear off and low quality of supply, failures and power losses in lines. The agriculture possesses the greatest potential for disclosing RES advantages with the simultaneous decision of the most acute problems of rural energy supply.

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The major part of rural settlements in our country is located in thinly populated and remote areas and the problem of their low power provision level is vitally important. This problem affects substantially the living conditions of rural population, demographic situation, as well as the maintaining and development of agricultural production on these territories.

A substantial part of localities in Russia has no access to power supply grids and are powered from petrol- or diesel-generators. Every year, 6 to 8 m t. fuels and lubricants (diesel fuel, gasoline, fuel oil, lubricant oil) and 25 to 30 m t. coal are imported to the regions of Far North, Far East and Siberia where power supply is stand-alone based. Due to transportation cost rise the price of fuels in the regions mentioned above is two or even three times higher compared with that of producer. More than half of territories' budgets has to be spent on fuels and their transportation. In some cases lack of fuel endangers human lives, and the governmental bodies have to solve the problem with the help of EMERCOM of Russia.

According to the agricultural census data, less than 35% of large and medium agricultural enterprises have an access to the centralized gas supply system and only 20% of them are connected to centralized heating systems. If even the gasification program is going to be completely implemented, the former indicator will grow not more than by 10%.

Accelerating power rates, transmission lines wear out and high prices for capacity connections make the power supply problem urgent also for rural settlements located in densely populated areas with centralized power.

In areas with centralized power supply under-power may occur, for example, due to a certain limit established in the course of installation of transformer substation having a specific rating and subsequent power uniform distribution in accordance with the number of sectors or due to a flexible power tariff (when the price per power unit is several times higher for capacities exceeding a certain established threshold level). It is vitally important to install power generation capacities at the "end points" of extended local power distribution lines of 6kV to 10kV. Power interruptions for consumers connected to such power lines may take many hours which aggravate the damage to customers not compensated by utilities [1].

### *1.2. Condition of RES use in Russia rural settlements*

The condition of RES use in Russia is as follows: single, individual installations, the lack of standard installations and systems.

Issues of state support belong to the most important and undeveloped as far as the implementation of renewable energy sources on rural territories of Russia is concerned. The existing general concepts do not take into account, to a sufficient extent, all components of economic efficiency, neither the advantages of renewable energy sources nor the drawbacks of competing power technologies, as well as all possibilities of RES efficiency improvement. A wide range of development specific features of both rural settlements and renewable energy technologies makes it impossible application to apply economical solutions of other countries as they are.

Rural settlements present the best starting platform to launch a large-scale implementation of RES in Russia and may serve the driver that will bring this branch of power industry on the level of EU countries and USA. Rural areas provide the maximum possible variety of local conditions and the highest possible effectiveness of solar energy and other RES practical application. The major problems of rural territories in terms of the large power networks development run into advantages as far as the implementation of RES-based integrated energy systems is concerned. Low per-unit capacity of power installations and their scattering over large remote areas provide the maximum implementation efficiency of these systems reducing the payback period and proving the expediency of their use. Moreover, these systems provide the opportunity to maintain the up-to-date level of power availability in rural settlements, and their implementation is, under most circumstances, the only option to achieve this goal. At the same time these are exactly rural areas that are most sensitive in terms of environmental requirements that have to be met while implementing power equipment.

For rural settlements, buildings and territories of environmentally dedicated villages, where the natural environmental conditions are stable and on a satisfactory level, the trend of substantial increase of power generation from systems based on RES is clear.

For the most regions of Russia the introduction of stand-alone and complex energy supply systems using renewable energy is the most expedient. Generally, integrated systems based on different kinds of RES shall be able

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