

Ratner, Svetlana

**Conference Paper**

## Off-Grid Renewable Energy As A Chance For Sustainable Development Of The South Of Russia

53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy", 27-31 August 2013, Palermo, Italy

**Provided in Cooperation with:**

European Regional Science Association (ERSA)

*Suggested Citation:* Ratner, Svetlana (2013) : Off-Grid Renewable Energy As A Chance For Sustainable Development Of The South Of Russia, 53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy", 27-31 August 2013, Palermo, Italy, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:

<https://hdl.handle.net/10419/123880>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

**OFF-GRID RENEWABLE ENERGY AS A CHANCE FOR SUSTAINABLE  
DEVELOPMENT OF THE SOUTH OF RUSSIA**

B. Climate Change and Environment, Sustainability Issues

**Abstract**

The problems of renewable energy sources development in Russia are complex and require long-term structural solutions in national socio-economy system. Currently, the Russian economy stays about two and half times less energy efficient and more carbon intensive than other comparable modern countries. General population on its own has not yet embraced energy efficiency as a social value. Among the main barriers to deployment of renewable energy technologies pointed out by experts are the lack of political, legislative and regulatory support, energy prices that do not reflect the costs of production, low electric power and heat tariffs, lack of information for decision makers, and preference for centralized energy supplies barriers all contribute to an inadequate investment climate for renewable energy technologies. But in some southern regions of Russia with favorable natural conditions and a comparatively low degree of economic centralization the situation is different. Good environmental conditions are very important for socio-economic development of two of those southern regions, the Krasnodar Region and the Republic of Adygea, which are currently promoted as tourist areas.

Because of rapid infrastructure and economic development, the Krasnodar region has the biggest shortage of electricity in the country. The advantage of Krasnodar Region is the relatively low level of centralization of population and economic activity in the major cities. It makes off-grid technologies a growing focus of interest.

In this paper the natural conditions for development renewable energy in Krasnodar region are studied, the potential environmental and ecological effects of renewables of different types are evaluated.

For the Russian economy at present time the problem of lack of investment and unemployment is not as important as the problem of structural imbalances. Deindustrialization characterized structural change in the former Union of Soviet Socialist

Republics during the transition to a market economy, and has transformed in early 2000 into reallocation of labor and capital to the oil&gas industry. Therefore, instead of the traditional input-output tool that estimates the number of jobs, salaries, and overall economic activity that will likely result from the renewable power project (JEDI model), we use a simplified approach, which allows us to identify the potential beneficiaries from growing demand for renewables among Russian manufacturers of power equipment.

It is demonstrated that the expected environmental effect from the biogas and heat pumps technologies implementation in the Krasnodar region is the most significant in comparison with other types of renewable energy sources.

**Key words:** Renewable Energy, Off-grid Energy Systems, Environmental Effects, Sustainable Development, Regional Economy  
**O13, Q21, Q42, Q51**

### **Introduction**

In order to ensure a secure energy supply and cope with climate change, green houses gases (GHG) emission reduction and biodiversity protection, renewable technologies development and efficiency improvements have become a growing focus worldwide. Unfortunately, this is not quite the case for Russia. The country has abundant natural energy resources such as natural gas, coal and oil and is well known for being one of the world's top energy superpowers. Raw economics has powerful backing from both the monolithic oil and gas companies and the government. That's why a lot of efforts to promote renewable power have run into resistance from the oil lobby. The renewable energy industry in Russia is represented mostly by hydroelectricity and geothermal energy as the country's most developed alternative energy sources during Soviet time (fig.1). All other kinds of renewable sources such as small hydropower plants, tidal, geothermal, wind, solar and biomass renewable sources currently make up only 1.5% of the country's electricity generation.

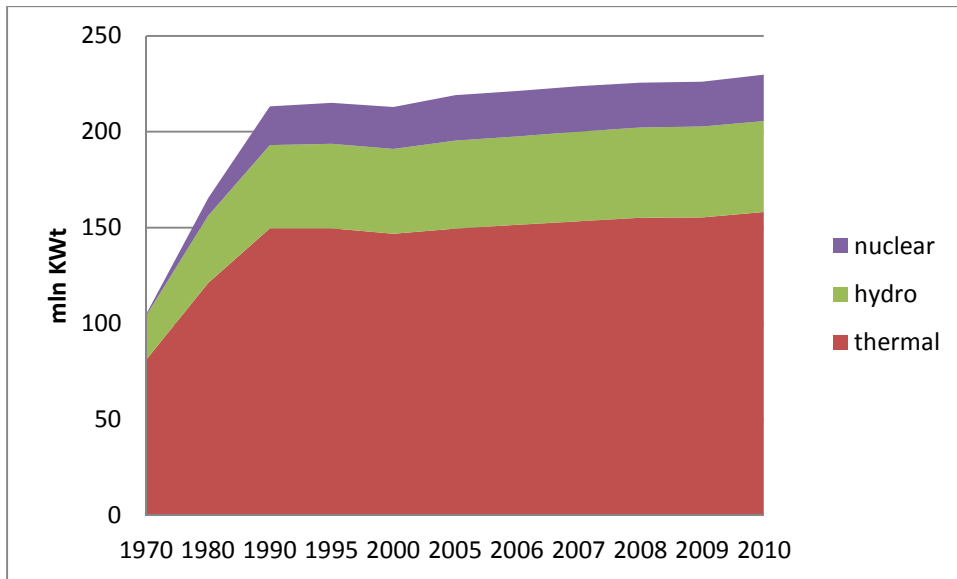


Fig.1 Russian Electricity production by sources, 2010.

(Source: Russian Statistical Annual, 2011)

On the contrary, energy efficiency is recognized as a key factor of survival in global competition. The Russian government has recently created new policies and legislation in order to develop and implement a successful energy savings strategy. In November 2009, Federal Law No. 261 “On Saving Energy and Increasing Energy Efficiency, and on Amendments to Certain Legislative Acts of the Russian Federation,” (“Law 261-FZ”) established a framework for how Russia will direct energy efficiency reform. But the problems in this area are complex and require, for the most part, long-term structural solutions. So, the Russian economy stays about two and half times less energy efficient and more carbon intensive than other comparable modern countries (fig.2).

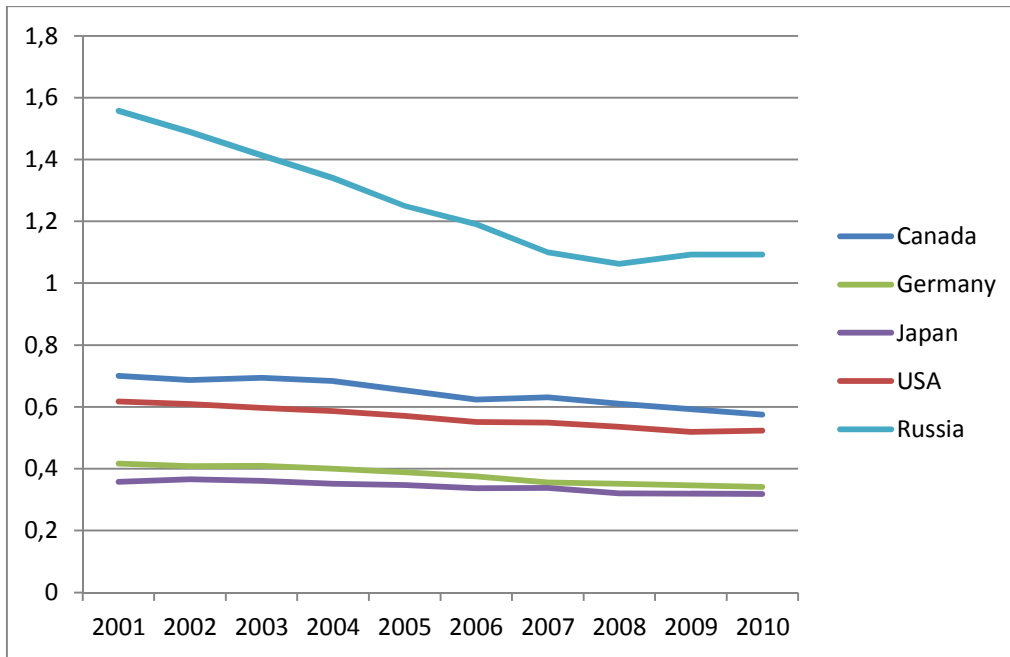


Fig. 2 Carbon intensity of some economies in the world  
 (amount of greenhouse gas emissions /GDP)  
 (Source of data: World Bank Statistical database)

Losses and leaks occur at every segment in the energy supply chain. The emission of GHG due to losses and technological processes in 2010 was more than 22% of all emissions of fossil fuels usage. Losses in electrical grids in 2010 were 10% of all electrical power consumption -more than the total consumption in the transport & communication sector alone (fig. 3). Losses in heat network are estimated in some documents as high as 25% [1].

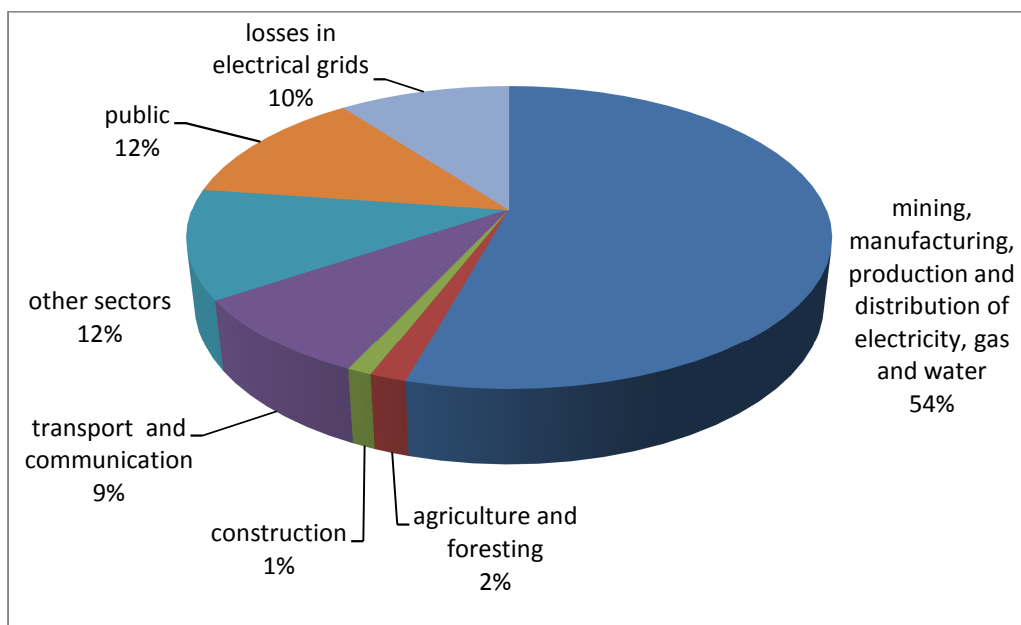


Fig.3 Electricity consumption by sectors in Russia in 2010

(Source: *Russian Statistical Annual, 2011*)

The positive changes in solving energy efficiency problems are very slow. General population on its own has not yet embraced energy efficiency as a social value. But in some southern regions of Russia with favorable natural conditions and a comparatively low degree of economic centralization the situation is different. Good environmental conditions are very important for socio-economic development of two of those southern regions, the Krasnodar Region and the Republic of Adygea, which are currently promoted as tourist areas. As it will be shown in the next parts of this paper, the most probable way of developing alternative energy and increasing energy efficiency in these regions is the introduction of distributed energy systems.

### **1. Centralized energy system in Russia: economic advantages and limitations**

Russia has inherited a highly centralized energy system from the times of plan-based economy. Over the years of soviet industrialization, centralized systems have provided the potential for efficient resource allocation, and generated substantial economies of scale in the process of building and operating very reliable energy transportation and conversion plants. The population was encouraged to move from individual houses into big apartment buildings (up to more than 1,000 residents) with electricity, heat, gas, hot water and sewerage.

This trend is still vital in many regions at present. As our previous studies show, more than 22% of the regions of Russia have more than half of the population living in 1-2 big cities. According to [2], the share of households currently living in apartments is as high as 72.6%. Centralized heat plants in 1990 made up 69% of all heat plants and, while they declined a little in the last decade, were still at 59% in 2007 [1].

After the collapse of Soviet Union, most of the Russian state-owned energy assets were split among a few big public-state companies. Thus, electric energy assets, such as thermal and hydroelectric power plants, transmission lines, state-owned shares in power, research, engineering, and construction companies were transferred to the RAO UES, with the exception of any assets related to nuclear energy. In the beginning of the nineties it controlled about 70% of Russia's installed electric capacity, 96% of its high-voltage grid and over 70% of its transmission lines.

Gazprom is another big energy monopoly for the natural gas exploration and distribution system. Since 2005 the government has owned 50.02% of the company. Rosneft, Russia's largest oil producer, focuses on the exploration, production and marketing of oil and oil products and belongs to the state by 75.16%. The list of these examples can easily be continued, but what is important for our study besides the well-known role of Russian energy monopolies outside of Russia, is that they also play a great role in shaping the technological structure of the national economy and putting barriers in the way of fair competition and "green" innovations.

To demonstrate this, let's take a closer look at the national electric transmission and distribution system. Despite two attempts at restructuring of the electricity sector in 2007 and 2008 and the formation of the industry's competitive relations among new stand-alone electricity market players, organized as spin-off companies of RAO UES, the national grid system still consists of one Federal Grid Company (FGC), which operates the Unified National Electric Grid (UNEG), 12 Interregional Distribution Companies (IDC) and a number of small local grid companies (fig.4).

FGC owns power lines designed for 220 kW or higher which are of strategic importance not only for the power sector, but also for the economy of the whole country. It is controlled by the state, which owns almost 80% of the company. Almost all IDC's are united in one holding company with a very complicated corporate structure. They control different territories and actually hold monopolies in local distributional markets. Local grid companies do not play an important role and are often private.

The last level of the distribution system consists of a number of retail companies, which have a status of "guaranteed supplier", meaning that such a company is obliged to connect to any consumer who asks for it. On the other hand, a consumer doesn't have a choice at all and is induced to connect to one and only supplier. It means that the energy retail segment today is the most unreformed segment of all.

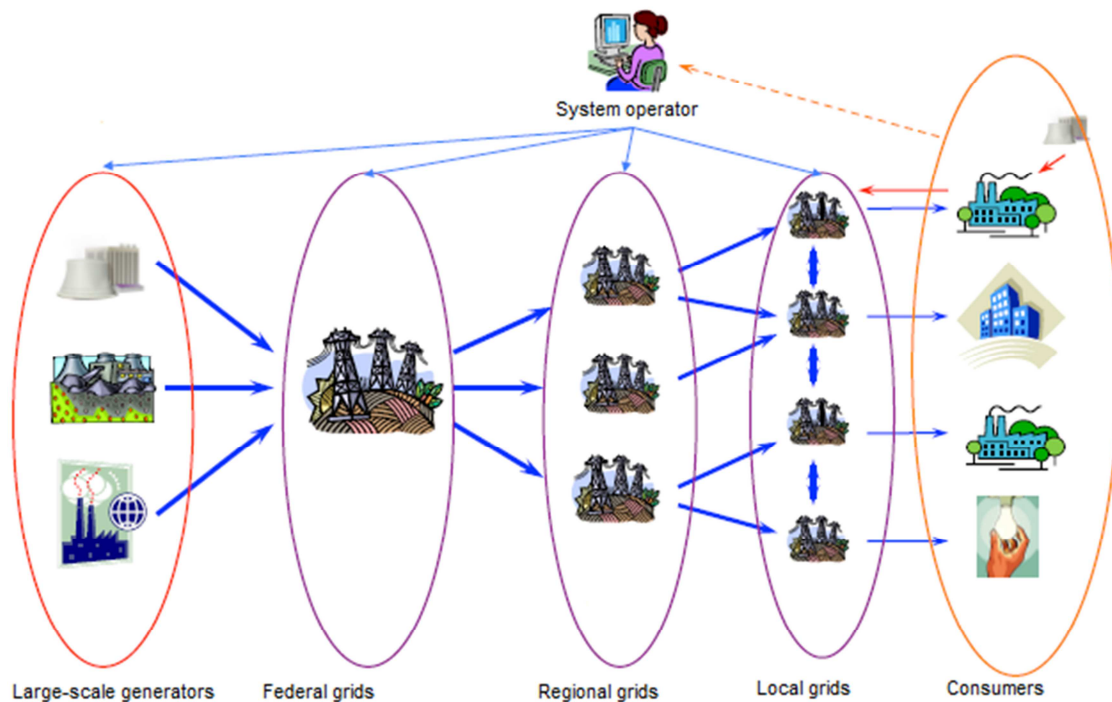


Fig.4. Technological scheme of electrical power supply in Russia

Therefore, the price for the consumer is composed of several parts. In particular in 2011 for the south of Russia the structure of electricity price was as follows: generation - 63,4%, transmission of FGC – 9,78%, transmission of IDC – 14,23%, transmission of local grid companies - 8,95% and service of “guaranteed” supplier – 3,6%. Each year prices go up, because a great portion of electricity supply and transportation equipment is approaching the end of its usable lifetime and its modernization needs a lot of investments.

Most of the distribution companies recently started to implement the Regulatory Asset Base (RAB) model, to bring significant amounts of capital into infrastructure, but high loan rates and inflation make the final price in this case too high. In order to avoid social tension, the government tries to regulate prices for the population, which leads to an automatic increase in rates for business. In such situations grid companies are not interested at all in experimentation with new technologies in the generation sector and do not want to deal with low-scale renewable plants.

## 2. Natural conditions for development renewable energy in Krasnodar region

The Krasnodar region is located in the south-west part of the Northern Caucasus and occupies an area of 76,000 sq.km with up to 900km of coastline on the Azov and Black Seas. In the region, there live over five million people, about 47 % in the rural area. The region has



a developed electricity infrastructure based mainly on thermal fuel, with installed capacity of 1.158 GW, the largest installation being that of the Krasnodar CHP (1091 MW) fuelled by natural gas (fig.5). Because of rapid infrastructure and economic development, the region has the biggest shortage of electricity in the country. The region’s energy deficit (7,37 TWh in 2011) is supplied by the Central region.

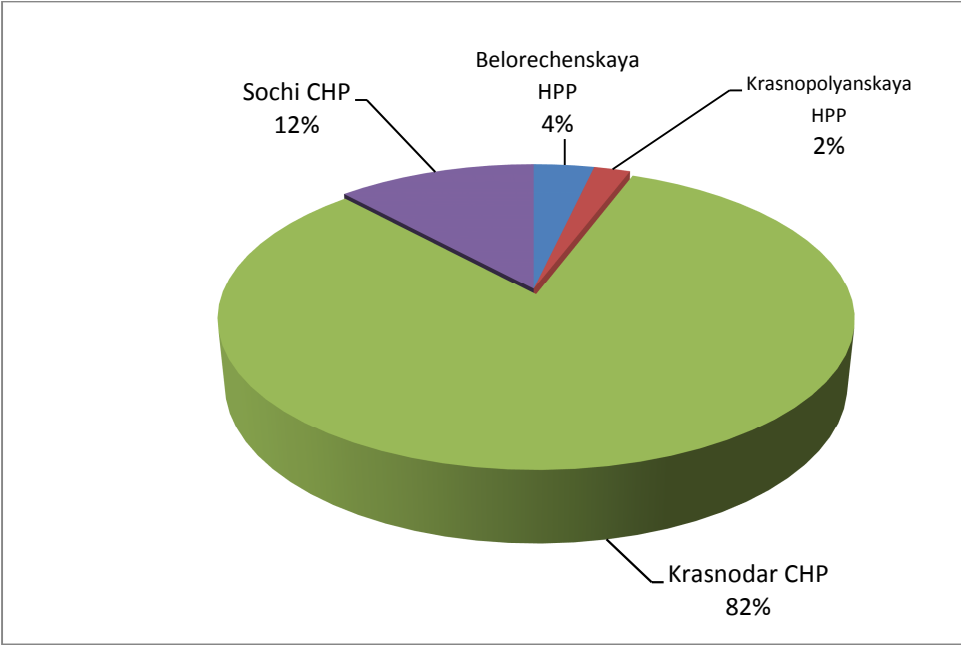


Fig.5 The structure of Krasnodar region energy system in 2012

At the same time the region has very good natural conditions for renewable energy development. The wind regime in Krasnodar Region is formed mostly under circulation processes and the landscape [3]. During winter the wind is directed mostly eastward, and in summer, southeast and south. The average wind speed in the interior parts of Krasnodar region is 4 m/sec and 5.1 - 6.4 m/sec at the coast. Wind speed increases during the cold season, with the highest winds speed is observed near port Novorossiysk (up to 8 m/sec). Some experts evaluate the potential output of wind plants in the region as 140 MW. At this time there are several wind farm projects on the Azov sea cost under development, but none of them are yet completed.

Due to its southern geographical location, Krasnodar Region gets a lot of solar energy during the year [4]. The total annual insolation varies from 2,200 to 2,400 hours; the insolation level is 3-3.5 KWh/m<sup>2</sup>/day. Thus, the installation of solar panels in the Krasnodar region is an appropriate decision for renewable energy development. Solar photovoltaic cells, however, are unable to provide a continuous supply of energy to the consumer, so it is desirable to combine them with other sources of energy. One reasonable option may be the

combination of solar photovoltaic panels with conventional solar collectors that heat water during the warm season, or more efficient vacuum solar collectors that work year-round [5]. It is estimated that the use of solar collector can cover up to 25% of the energy needed to heat water in households in the region.

As a region with highly developed agriculture, Krasnodar area also has great potential for the development of home, on-farm, community and industry biogas technology. A large number of greenhouses, livestock farms, poultry farms and granaries have a strong need both for recycling of wastes and cheap energy. More than 68% of 672,100 cattle and 65% of 1081,100 pigs in the region are grown at large-scale farms with at least 100 livestock units (this can guarantee the profitability of biogas station). In addition, increased tourist traffic on Black and Azov Seas (up to 15 million a year) causes a growing amount of waste that the now-outdated sewage disposal plants in coastal cities cannot handle, resulting in the aforementioned waste polluting the seas, which affects the ecosystem very negatively.

Krasnodar region also has a great energy potential associated with underground waters stored in 16 explored reservoirs with temperature ranges from 30<sup>0</sup>C (Labinskoe) to 110<sup>0</sup>C (Voznesenskoe) and depths of 1,600 – 1,700 meters. Since 1984 all residential and commercial buildings as well as greenhouses and farms in two towns of Krasnodar region (Labinsk, Mostovskoy) are fully heated by geothermal energy.

Therefore, Krasnodar region has very good natural conditions for the development of all basic renewable sources. Since 2008 the issues of renewable energy and energy efficiency has been often brought up in media by Russian politicians and journalists. But besides government spending to install metering of electricity, water and heat and promotion of energy-efficient lighting technologies, not much is going on in everyday life. Among the main barriers to deployment of renewable energy technologies pointed out by experts are the lack of political, legislative and regulatory support, energy prices that do not reflect the costs of production, low electric power and heat tariffs, lack of information for decision makers, and preference for centralized energy supplies barriers all contribute to an inadequate investment climate for renewable energy technologies [6]. In such conditions, implementation of large-scale investment projects in the field of alternative energy is very difficult.

However, the advantage of Krasnodar Region is the relatively low level of centralization of population and economic activity in the major cities (tabl.1).

Table 1 - The distribution of population by city in selected regions

Region	Krasnodar region	Voronezh region	Omsky region	Novosibirsk region	Tomsky Region
Num. of cities with population 1,000,000 and more	0	0	1	1	0
Num. of cities with populations from 500,000 to 1,000,000	1	1	0	0	1
Num. of cities with populations from 250,000 to 500,000	1	0	0	0	0
Num. of cities with populations from 100,000 to 250,000	2	0	0	0	1
Num. of cities with populations from 50,000 to 100,000	11	3	0	2	0

Typically, in large cities, people live mostly in apartment buildings, where it is very difficult to do anything alone to improve energy efficiency or introduce any alternative energy technologies. But historically, in Krasnodar region more people have individual houses, which is true even for the biggest city, Krasnodar, called “Large Village”. This regional characteristic gives people more flexibility in choosing energy supply options and brings commercial effectiveness issues to the fore.

In 2010 and early 2011, end-users in all Russian regions experienced particularly high electricity price increases. This was partly due to rising gas prices and the switch of electricity transmission and distribution companies to “regulatory asset base” regulation. In order to maintain the competitiveness of domestic industry and limit the financial burden on households, the government capped increases in end-user prices at 15% for 2011. But in early 2012 they rose again, especially for business. In addition, there are cases of power failure and problems in the connection of new customers to the grid (for example, in 2008 IKEA company could not open a new store in the suburbs of Krasnodar for several months due to problems with the grid connection). All developers are faced with problems of high rates of technological connection, which goes up to 300,000 RUB (7,500 EUR) per kW. On average, not more than 30% of applications for technological connection are met on time. In these circumstances, the interest of business and the general public a cheaper, more flexible and reliable energy technologies is growing.

### **3. Evaluation of potential environmental effects of small wind systems, solar collectors, heat pumps and bio-gas stations in Krasnodar region**

Small wind energy systems, which typically generate just enough power to meet the demands of a home, farm or small business, belong to a renewables genre that continues to grow in stature. Small wind turbines (SWT) are now more reliable, quieter and safer than those introduced in past decades.

According to SolarHome data [7], one 3 - 5 kW turbine is needed to cover the full consumption of average Russian household. The cost of wind turbines of this type produced in Russia is currently ranging from 60,000 to 170,000 RUB (1,500-4,250 EUR) depending on technical specifications and warranty period. In these cases, SWT purchases seem practical only with the presence of economic incentives in grid-connected areas.

However, a different trend is observed in Krasnodar region electrification, due to growing energy shortages in summer time when thousands of tourists need extra power for cooling, cooking, hot water and entertainment. Many owners of off-grid wind systems name practicality and affordability as the main reasons for their purchase as a way to generate power and increase independence from unreliable local electricity systems. This is especially true for small tourist businesses such as mini-hotels, restaurants and stores.

Using the data from Federal Statistics Service (Table 5.22 of the book "Regions of Russia: Social and economic indicators - 2011", Table 8.3 of the book "Environmental Protection in Russia 2011") and data from the Tourism Department of Krasnodar Region Administration we can evaluate the number of potential users of SWT in the region and estimate market capacity as at least 1,760 SWT installations a year. It will allow generating at least 6.84 GW/h a year, saving 2,300 tons of equivalent fuel and decreasing more than 5,000 tons of GHG emission per year.

Another well developed and comparatively inexpensive technology for Krasnodar region is solar thermal collectors, which can be widely used to produce domestic hot water both for residential and commercial needs. Solar thermal collectors are 30% – 70% efficient in converting the sun's energy into usable heat vs. solar electric or P.V. panels which are 10% – 15% efficient in converting the sun's energy into usable electricity. Modern solar thermal water heaters are capable of providing up to 70% or more of annual hot water used.

Recently, "combi" systems have been introduced which can provide both space and water heating. Despite its commercial viability, "combi" systems have not found their way onto the Russian market yet. At the same time solar collectors of different types have already

been in use for quite some time in Krasnodar Territory. In recent years, 102 solar systems with a total collector area of 5,000 m<sup>2</sup> were built.

According to the results of our market research, the average price of vacuum solar collectors made in Russia is 40,000 – 50,000 RUB (900-1,200 EUR) depending on the amount the hot water received - 150 to 200 liters/day. The effective area of the absorbing surface of such collectors is about 2 m<sup>2</sup>. The evaluation of average consumption of water based on data from a sample survey of households in Krasnodar Region is 100-150 liters/day per 100 m<sup>2</sup> of dwelling. Then, using the above mentioned data on the number of households and mini-hotels, which are potential consumers of energy-efficient equipment and considering that lower price can attract more customers, we obtain the average estimate of market capacity of about 3,500 collectors a year.

Water heating in Russia takes about 12% of total household energy use, which is comparable to the amount of energy consumed by all electrical devices and lighting [5]. Therefore, energy savings achieved through the use of a solar collector can be equated to the energy saving achieved by using the same number SWT of middle power. That gives us an estimation of environmental effect of saving 4,600 tons of equivalent fuel and decreasing more than 10,000 tons GHG emission per year.

For space heating and cooling purposes in Krasnodar Region the use of heat pumps is advisable. Heat pumps can use a variety of low-grade heat sources so that they can work almost anywhere, not only in areas with geothermal sources. Since heat pumps produce essential economic effect only in large enough houses (more than 100 m<sup>2</sup>), we consider individual owners of hotels and real estate developers in urban areas as the main potential group of consumers. Some owners of new homes in rural areas may also join the target group. In order to estimate a percentage of large new houses in the rural area (>100 m<sup>2</sup>) we've conducted a sample survey of 100 new houses in the city of Krasnodar, Leningradskaya village and city of Tuapse. According to our results, the share of houses with floor space of more than 100 m<sup>2</sup> can be estimated as at least 25%. Then using statistic data "Regions of Russia. Socio-economic indicators – 2011" we can estimate an average number of heat pump installations as 15,542 a year. The cost of equipment and installation of heat pumps for a house with area of 100 m<sup>2</sup> an average is about 300,000 RUB (7,300 EUR).

In order to estimate the potential energy savings we will use the fact that energy consumption for heating is 77% of the total power consumption of the home. Then the reduction of energy consumption for heating by two-thirds leads to an overall reduction in

energy consumption by more than 50%. So it can reduce energy consumption by 9,533 tons equivalent fuel a year and reduce emissions by 20,800 tons of GHG per year.

Speaking about the potential environmental effects of biogas plants, it should be noted in the first place that the problems with the quality of water in the whole of Russia and Krasnodar Region in particular are very vexing. The water quality of open sources such as lakes, rivers and adjacent seas has been declining significantly in Krasnodar region due to increasing human activity. While water pollution from industrial sources has diminished because of the decline in manufacturing, municipal and agricultural wastes increasingly threaten key water supply sources (fig. 6-7).

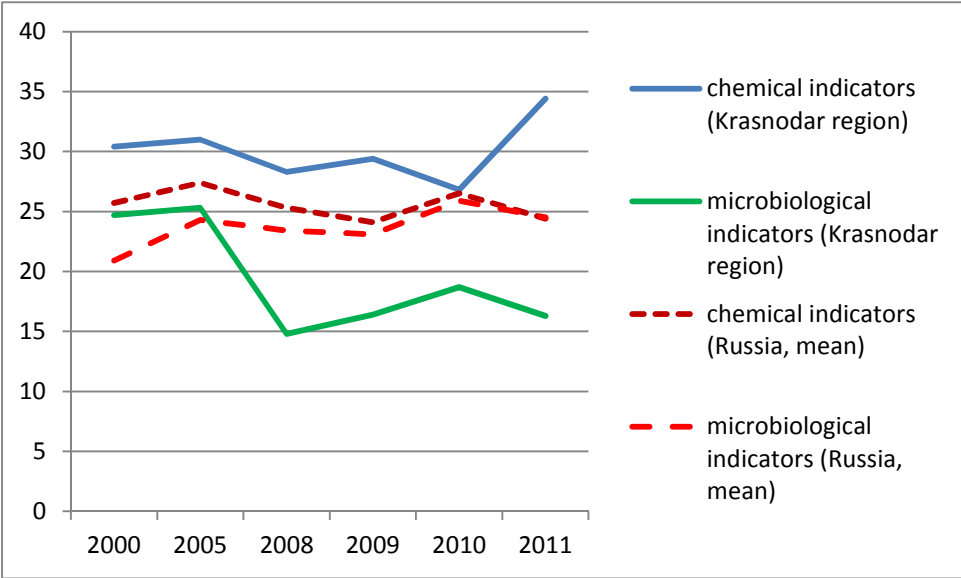


Fig. 6 Proportion of water samples (%), which do not meet sanitary standards (waters of II category, recreation resources)

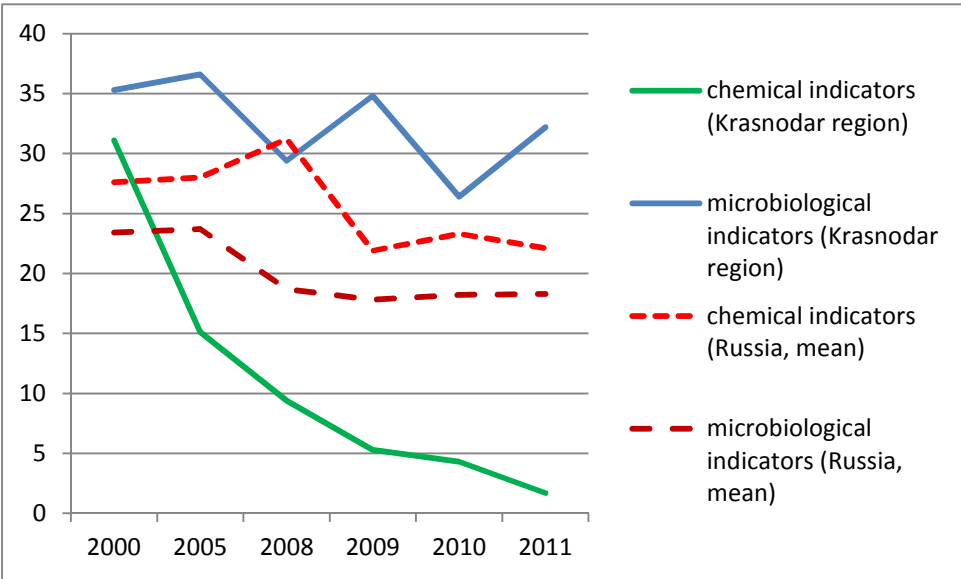


Fig.7. Proportion of water samples (%), which do not meet sanitary standards (waters of I category, drinking water sources)

In Russian statistics that are open to the public there is no accurate data on the impact of specific industries in specific regions of the environment. Therefore, in order to assess the damage to water quality caused by animal husbandry in the Krasnodar region, we used correlation and regression analysis. As it is shown on fig.8, there is a fairly strong correlation ( $r=0,75$ ) between the amount of bio-waste and the volume of wastewater discharged into the river Kuban (the main artery of the region).

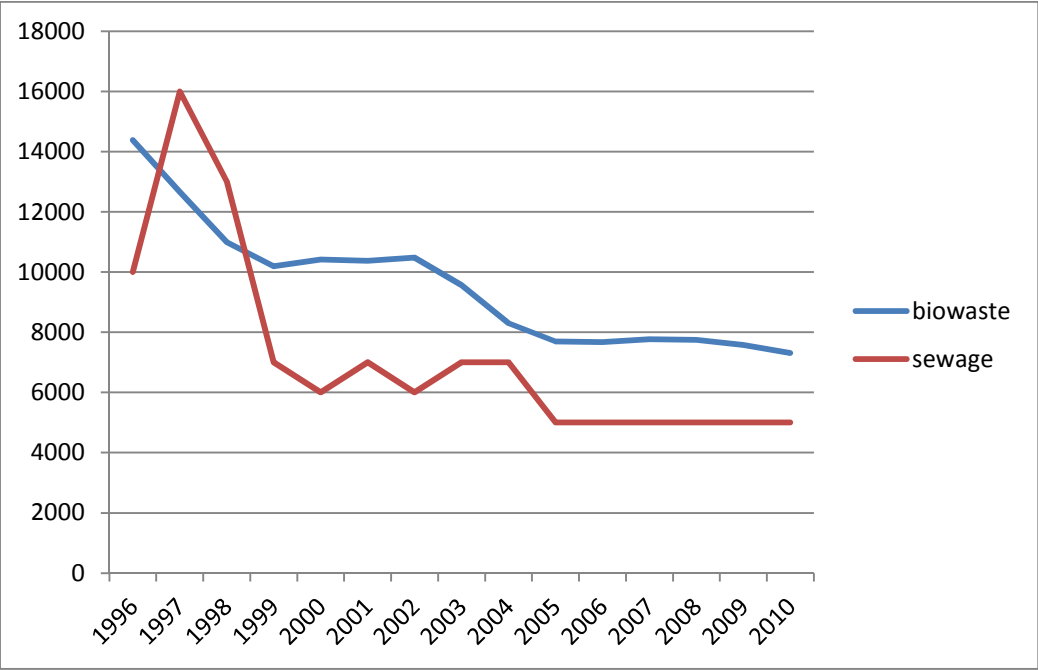


Fig. 8. The amount of bio-waste (tons) and the volume of wastewater (100,000 m<sup>3</sup>) discharged into the river Kuban

The obtained model of linear regression  $Y=1,174 \times X - 3931,16$ ; Y- the volume of wastewater, X - the amount of bio-waste (fig.9) allows us to estimate the decrease in waste water as 0,3 billion m<sup>3</sup> as a result of the implementation of bio-gas technology. It can also give additional clean energy at a rate of about 5,4 GWh per year and reduce GHG emissions by 20,700 tons per year.

<i>Regression Statistics</i>						
Multiple R	0,7502928					
R Square	0,5629393					
Adjusted R Squ	0,5293192					
Standard Error	2252,64					
Observations	15					
<b>ANOVA</b>						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	1	84966303,02	84966303	16,744151	0,001272162	
Residual	13	65967030,31	5074386,95			
Total	14	150933333,3				
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-3931,157	2797,669138	-1,4051544	0,1834196	-9975,153894	2112,839541
X Variable 1	1,1736768	0,286824964	4,0919618	0,0012722	0,554029132	1,793324454

Fig.9 Linear regression results (Y- the volume of wastewater in river Kuban,  
X - amount of bio-waste)

Thus the expected environmental effect from the implementation of biogas and heat pumps technology in the Krasnodar region is the most significant in comparison with other types of renewable energy sources.

#### **4. Evaluation of potential economic effects of renewables in Krasnodar region**

Estimating the economic development impacts of new energy power plants usually allows policy and decision makers to assess impacts not just on the energy supply, but also on the state-level jobs and economic growth [8]. In many countries the possibility for economic development from renewables has been particularly salient in rural areas where new investment, earnings growth, and employment opportunities have, in many cases, otherwise trended downward for some time. The injection of investment in wind, solar and other kinds of power plants triggers several rounds of spending that will result in an overall increase in output, employment, and income in the economy. This economic relationship between suppliers and producers, and producers and consumers is embedded in the multipliers [9].

For the Russian economy at present time the problem of lack of investment and unemployment is not as important as the problem of structural imbalances. Deindustrialization characterized structural change in the former Union of Soviet Socialist Republics during the transition to a market economy, and has transformed in early 2000 into reallocation of labor and capital to the oil&gas industry. (Currently most sectors of the



engineering industry only survive thanks to orders from large oil and gas companies. Therefore, instead of the traditional input-output tool that estimates the number of jobs, salaries, and overall economic activity that will likely result from the renewable power project (JEDI model), we use a simplified approach, which allows us to identify the potential beneficiaries from growing demand for renewables among Russian manufacturers of power equipment.

Unfortunately, many types of power equipment are not produced in Russia: wind turbines and all necessary components to them, some types of solar panels and collectors. But in the sector of small wind turbines the situation is different. By the end of 2011, some 330 companies in 26 countries manufacture, or plan to manufacture, small wind turbines, according to the latest report released by the World Wind Energy Association (WWEA). Of these companies, 43 (or 13%) are based in the Russian Federation in different regions - Moscow, St. Petersburg, Novosibirsk, Omsk, Tomsk, Yaroslavskiy region, Nizhny Novgorod, Rostov region, Ekaterinburg and a few towns in the Moscow region, but none of them in Krasnodar region.

On the other hand there are at least 2 well-known Russian solar cells manufacturers – former military firm “Saturn” and its spin-off company “Solar Wind”, located in Krasnodar. Around them has gradually formed a cluster of small, innovative companies operating in the sector of solar energy. In Krasnodar alone there are more than 20 small service companies which deliver and install solar energy equipment, including solar collectors. According to the information in the local media, Krasnodar solar thermal system supplier Yuzhgeoteplo is planning to build a new solar collector factory. In addition to Yuzhgeoteplo, there is only one other major collector manufacturer: the military company NPO Mashinostroyeniya in Moscow.

Most energy equipment for biogas plants used today in Russia are made in Germany or Denmark. However, for their installation and successful use some adapted Russian technologies are necessary. Therefore, at the present time in Russia there is quite a number of innovative service companies involved in the development and implementation of biogas projects. Some of them like “Kubanbiogas” and “Chernomorskaya Energy Company” are located in Krasnodar region. But their projects are carried out in other regions due to the lack of competent and experienced advisors and consultants in the home region, as well as lack of reliable and up-to-date information for good investment decisions.

This kind of eco-innovation can be widely diffused only by a change in consumption and production patterns in agriculture. To do this, the province is providing for the

implementation of two demonstration projects: a small-scale one in Chernomorskaya village, initiated by local authorities and a large-scale one in a suburb of Krasnodar, initiated by LLC "Klaas-Kuban". The company "Klaas" supports the development of alternative energy and is ready to buy "green energy" from the first commercial plant in the province with a capacity of 650 KW through conversion of animal waste. This plant already planned for 2014. Both projects have been created for demonstration, training and research in the field of alternative energy. The education programs in this area are very important, since a poorly educated society is susceptible to all kinds of "negative information" concerning potential investments and commercial effects, local conditions and human health.

For further development and implementation of bio-gas technologies, the financial barriers seem to be the most difficult to overcome. Bio-gas plants are costly and require involvements of banks or other credit institutions [10]. Therefore, elaboration of various financing schemes for bio-gas plants construction and development become of special urgency.

The important fact is that all abovementioned companies, which can benefit from a rise in demand for alternative energy sources, are innovative small and mid-sized companies. This means that not only positive structural shifts can be achieved, but also improvements to the competitive environment and strengthening of social infrastructure. It is very well accepted that Small and Medium Enterprises (SMEs) play major roles in most developed economies both in terms of the economy itself and also social insurance. They help bring flexibility and resilience to the economy, particularly in times of crisis, and they can also be an engine of innovation growth. Russian economy lacks a broad base of mid-sized companies. In recent years, the sector has grown considerably, but it still makes up only 25% of the economy, so there is still a lot of room for further growth.

## **5. Summary**

Significant dependence of both the Russian economy and the state budget on the oil and gas industry and a very high level of centralization of the energy distribution system are the major obstacles to the widespread adoption of renewable energy technologies in practice, even in regions of the country where it is commercially reasonable. But in some energy deficient regions with comparatively low level of centralization of both population and economical activities off-grid renewable technologies are the objects of growing interests. For

Krasnodar region the environmental effects of renewables are much more important than the economical effects due to tourism-focused ways of development.

The expected environmental effect from the biogas and heat pumps technology implementation in the Krasnodar region is the most significant in comparison with other types of renewable energy sources. The promotion of these technologies includes improvement of education in the field of energy efficiency and renewable energy as well as elaboration of various financing schemes for bio-gas plants construction and development.

### References

1. *Semikashev V.V.* The use of heat energy in Russian civilian sector // The problems of forecasting, 2010, Vol.4, pp.73-86 (in Russian)
2. Russian Statistics Annual, 2011. [www.gks.ru](http://www.gks.ru)
3. *Ganaga S.V., Kudryashov U.I., Nicolaev V.G.* National cadaster of wind energy resources of Russia// Low Energy, 2008, №3 (in Russian)
4. *Taysaeva V.T., Malyh V.T., Mazaev L.R.* Eco-village with renewable energy systems// Low Energy, 2009, №1-2. (in Russian)
5. *Vasilyev G.P.* Geothermal pump systems and their effectiveness in Russia // Low Energy, 2008, №3. (in Russian)
6. [http://www.unece.org/energy/se/enef\\_dev\\_renew\\_en\\_sec.html](http://www.unece.org/energy/se/enef_dev_renew_en_sec.html)
7. [www.solarhome.ru](http://www.solarhome.ru)
8. *Goldberg, M., Sinclair, K., Milligan, M.* (March 2004). "Job and Economic Development Impact (JEDI) Model: A User-Friendly Tool to Calculate Economic Impacts from Wind Projects." Prepared for the 2004 Global WINDPOWER Conference, March 2004. NREL/CP-500-35953. Golden, CO: National Renewable Energy Laboratory, 12 pp. <http://www.nrel.gov/docs/fy04osti/35953.pdf>
9. *Lantz, E., Tegen, S.* (July 2008). "Variables Affecting Economic Development of Wind Energy." Prepared for WINDPOWER 2008, June 2008. NREL/CP-500-43506. Golden, CO: National Renewable Energy Laboratory, 30 pp. <http://www.nrel.gov/docs/fy08osti/43506.pdf>
10. *Ratner S.V., Dira D.V.* Tax incentives of alternative energy development in Europe // Finances and credit, №8(488), 2012, pp.21-27 (in Russian)