Research study for the Republic of Tajikistan within the framework of the project "The use of clean, renewable and / or alternative energy technologies for rural areas in Central Asia"

Summary

The aim of this study is:
a). Analysis of the level of development of renewable energy in the world and lessons learned from the implementation of large-scale renewable energy plants required for remote rural areas of the Republic of Tajikistan;
b). Estimation of access to provided energy services, through autonomous decisions (outside the network, with limited access to the network), with an emphasis on rural and remote areas of the Republic of Tajikistan in order to identify:
- Energy sources (technology, equipment), which are still used in the country, but cannot be regarded as sustainable sources of energy in accordance with national standards and approaches;
- The number of people using these energy sources;

c). An evaluation of national policy choices, best practices and business models for the provision of sustainable energy services in rural areas of the Republic of Tajikistan;

g). Identify potential locations for renewable energy in rural and remote areas of Tajikistan, close to the industrial scale use, as well as identifying areas with unreliable electricity supply system or the autonomous areas outside the main network;

d). Direct analysis for two areas of potential use of small-scale renewable energy equipment and valuation of energy production for each plant with a focus on technical and economic parameters of the proposed renewable energy for selected regions;

e). Based on a study of the potential of renewable energy sources of the country and assessments to develop a number of recommendations on the most sustainable mechanism for the application of clean energy technologies in remote areas of the Republic of Tajikistan.

Content

Section 2: Estimates suggest solutions for stand-alone (without a network connection) and network (by means of micro - and mini-networks) access to energy services with a focus on rural and remote areas and Murghab and Vanj of Gorno - Badakhshan Autonomous Oblast, the Republic of Tajikistan.

Section 3: Identify potential locations for the project development of renewable energy in rural and remote areas and Murghab and Vanj of Gorno - Badakhshan Autonomous Region;

- Analysis of the possibilities of using different generation equipment for the production of energy from renewable sources in areas of Vanj and Murghab in GBAO;
- Economic and technical information relevant to the application of technologies for the use of renewable energy sources within the area for residents of Murghab and Vanj;
- Estimate of the cost of electricity production for each type of plant.

Section 4: Recommendations for implementing the most sustainable mechanisms of renewable energy technologies in remote areas of GBAO of the Republic of Tajikistan with autonomy and network access to energy.

Introduction

In today's world, there are more and more discussions about the problem of transition to sustainable development of the community in developed, developing and underdeveloped countries or regions with their geographical, national and historical features. One of the defining parameters of the general stability of the development of any country is the energy (energy consumption, production, installed capacity, and etc.), and the practical use of alternative energy development in remote rural areas without access to sustainable sources of energy resulted in an intensive development in many countries around the world. The United Nations Environment Program says that non-traditional sources (such as wind or solar) provided 60% of the growth of the energy potential in Europe and more than 50% - in the United States. Global investment in renewable energy reached a record of 211 billion dollars, which is 32% higher than in 2009, China has invested about 50 billion dollars mainly in wind power and demonstrated the most significant growth in investing in the "green" sector, exceeding the figure of 2009 by 28%. Developing countries received 72 billion dollars for "Green" investments. According to experts, investments in renewable energy sources in North and Central America increased by 40%, the Middle East and Africa - 104% in India - 25%, and in Asia, excluding China, by 31%. According to the forecast of the World Energy Council, the share of RES in 2020 will account for 1150 - 1.45 billion tons of

standard fuel (5.6-5.8% of the total energy consumption). Today, renewable energy sources account for about 20% of global energy needs.
All countries that have a high proportion of their energy balances consisting of renewable energy, implement programs to support and promote alternative energy, which included:

-surcharges to tariffs for energy produced from renewable energy;
-exemption manufacturers of "clean" energy from the energy taxes;
-preferential taxation of profits invested in the development of alternative energy;
-acceleration due to depreciation of equipment and other reasons.

About the development of renewable energy sources, it should be noted the positive developments in India, the only country in the world which has an authoritative Ministry of alternative energy sources (MNIE). In India, the development of programs for the use of renewable energy in remote rural areas was started in the 80s. In the same period, it was going to create a network of observation and assessment of energy resources of wind and sun, the construction of demonstration plants at the expense of the state budget. To address the commercial aspects of the agency created by the Indian Renewable Energy Development (IREDA), operating at MNIE as a permanent fund for subsidies and lending to the private sector for investment facilities using renewable energy sources. As technology improved the use of RES performed valuation adjustments of technical capacity, the estimate of the economic potential of the states, conducted studies and evaluation projects on specific objects, characterized by the use of certain types of renewable energy.
In some countries, the installation of different types of renewable energy may dominate: Denmark - wind turbines, in Germany with an absolute majority of plants for biomass in second place are solar photovoltaic installation. In Iceland and the Philippines - Geothermal stations.

Ensuring energy security and environmentally balanced economic growth today are the priorities for the development of the Republic of Tajikistan, and the development of non-conventional renewable energy can become a factor in accelerating the development of remote rural areas of the country.

In Tajikistan lives 8.4 million people, including 73.5% of the population lives in rural areas, the urban population of 26.49%, the annual growth rate is 1.85%. On the 70^{th} of twentieth century, the development of the country entered a new stage. It opened the largest hydroelectric plant in Central Asia, Nurek, with capacity of 3,000 MW. This moment was a turning point in the economic and social life of Tajikistan and substantially and comprehensively influenced the modern development. Later has been built and put into operation new power capacities, thereby strengthening the energy sector and use its resources in the implementation of the country's industrialization. By 1992 the number of rural settlements, to communicate with the power grid, increased by 90% by 1965. The reserves of liquid and gaseous fossil fuels in the country are small, oil is extracted annually from 25 to 28 tons, and natural gas production stopped in 2013 due to the depletion of stocks. In 1990, the republic imported more than 2 million tons of oil and 2.1 billion m3 of natural gas. Total dependence on energy imports is as follows: 23.64% for electricity, natural gas 100%, oil and petroleum products 99.8%. At the moment, figures for oil imports declined by 30 percent and natural gas imports are virtually nonexistent. Stocks of coal fuel are available in all regions of the country, but many fields are located in remote mountainous regions, where communication infrastructures are underdeveloped.

During the 90's to the 2012's due to the limited supply of imported natural gas, as well as the scarcity and high cost of other fuels in the country was widespread transition to the use of electricity for heating and cooking. As a result, domestic consumption of the population compared with the beginning of the 90s, has increased more than four-fold - to 1 billion kWh to 4.5 billion kWh in a year. The generation of hydroelectric power plants in the country is more than 5 million kWh per day, and the average annual electricity production for 2013 was about 17.1 billion kWh. This territorial structure of energy consumption is rather uneven. Not all regions of Tajikistan now have the opportunity to satisfy their needs for normal development and the existence of volumes electro - and heat, including a significant portion of the Gorno Badakhshan Autonomous Region is located in the most complex geographical area and the climatic conditions are not covered by a centralized power supply. Power shortages in the republic account for more than 4 billion kilowatt-hours. Electricity shortages and the introduction of limits on its consumption (especially in winter) limit electric power to the population in remote areas to maximum 2.5 billion KWh. This is due to limited water and energy resources in the Nurek reservoir and other hydroelectric plants of Vakhsh cascade. In the country the rural population, consumes only 9% of the total electricity consumed in Tajikistan. In 2013, the specific energy consumption per capita amounted to: on one city dweller - 1000 kWh per year, per capita rural remote areas - 250 kWh per year (which is several times less than the specific energy consumption of residents from the developed world). Electricity shortage hinders the development of the economic sector; it affects the development of entrepreneurship and employment levels. The introduction of a limit on power consumption in autumn-winter period is detrimental to the economy of $ 200 million dollars of USA. For the agriculture of Tajikistan, there are particularly important issues regard the water supply. There is an acute problem of irrigation in arid regions of Central and

South - Western part of the country. 45% of the gross national product accounts for agricultural products. The main specialization of agriculture - farming, the successful conduct requires supplementary irrigation, especially in the summer dry period, however, hydraulic pumps used in irrigation, use only 9% of the total annual energy consumption in the country. Power supply hydraulic pumps are one of the objectives for rural electrification and part of a long-term strategy of the government for the production of agricultural products and the expansion of food exports.

With the increase in electricity production and the expansion of the network of power lines (especially low-voltage) significantly increased network losses, reaching in 2013 a value of about 16%, most of which falls on the grid in rural areas. Distribution system especially in rural areas of the country is in a state worn, damaged, and in certain localities, completely broken. As a result this energy transfer is only occasional, and at the same time, power consumption in rural areas is developing fast enough.

Currently in Tajikistan can be found sufficient number of applications, where renewable energy sources can be used efficiently. The existence of rich resources of renewable energy today in the world of advanced technology offers certain advantages to Tajikistan to increase the use of renewable energy sources. One of these applications is the off-grid electricity supply and the use of local sources of renewable energy to remote mountain settlements.

Almost all regions of Tajikistan have at least one kind of renewable resources, and in the majority - several types of renewable energy. This is a small river, having significant wind and solar resources. In some cases, their operation is more commercially attractive in comparison with the use of fossil fuel as the supply of it is expensive and unreliable.

1. Assessment of policies, best practices and business - model for support of sustainable energy services in rural areas of Tajikistan.

- Identify sources of energy (technology, equipment), which are still used in the country, but cannot be considered as sustainable sources of energy in accordance with national standards and approaches.

The number of people using these energy sources.

The growth of Tajikistan's economy predicts a significant increase in demand for energy resources (in 2018 an increase in demand for electricity is provided in the amount of 24 billion kWh. Per year), making it urgent to develop a coordinated policy in the energy sector, especially in the direction of the development of alternative energy for the remote rural areas without access to sustainable sources of energy.

Given that the insufficient supply of energy is regarded as one of the main problems of Tajikistan and access to electricity is a constant engine in development, Parliament of the Republic adopted *the following laws:*

- Law of the Republic of Tajikistan "On Energy" from November 29, 2000.

The law establishes the features of activity in the energy sector and standards compliance with established standards for the production, transportation, processing and consumption of energy resources. In order to promote and support the introduction and use of alternative and renewable energy sources, the law from June 30 2007 amended that are specified incentives to promote alternative energy sources and provide the introduction of "green" tariff for sale of electricity generated from renewable sources energy.

- **Law of the Republic of Tajikistan on January 7, 2010, "On the use of renewable energy sources",** regulates the activities in the field of renewable energy, including: - sets out the principles and objectives of the state policy in the field of renewable energy; - Identify ways of integrating renewable energy sources in the Republican power system, organizational, research design, expertise, engineering, regulatory activities aimed at increasing the use of renewable energy sources; - Provides correlation (relationship) activity in manufacturing, accounting, transportation, distribution and use of energy from renewable energy sources.

Government of the Republic of Tajikistan adopted Resolutions:

"A long-term program of building cascade of small hydropower plants 2009 - 2020" (From February 2, 2009, № 73).

The program sets out the following tasks:

-development of hydropower resources of small rivers and related infrastructure;

-development of feasibility study for construction of SHPP;

-attracting foreign and domestic investors for the construction and reconstruction of SHP;

-determination of the balance of the needs and generate electricity in remote settlements of the republic.

The program for construction of small power plants consists of three stages:

1. Short-term: - the duration of the first phase of 3 years, with implementation period 2009-2011, 66 small hydropower stations, the total installed capacity of 43,530 kW.
2. Medium-term: - the duration of the second phase of 4 years, the timing of implementation - 2012-2015, a total of 70 stations, the total installed capacity - 32850 kW.
3. Long-term: - the duration of the third phase of 5 years, the timing of the -2016-2020, only 53 stations, the total installed capacity - 26801 kW.

Government Decree of February 2, 2007 № 41 approved a program of renewable energy sources for 2007-2015, which aims to: -create, development and widespread use of advanced technologies for the production of electricity and heat from renewable energy sources; -contribution to the energy balance of the country; -assistance in improving living standards through the introduction of modern technologies of renewable energy sources; -decrease in the consumption of non-renewable energy of organic origin; -preparation of qualified personnel in the field of renewable energy; -providing social welfare and economic growth through the development of remote areas; -solving the problems of unemployment, education and environmental conservation.

Based on the foregoing, it can be concluded that the legislation of the Republic of Tajikistan recognizes the importance of the development of remote mountainous rural areas using renewable energy sources. The laws and regulations of the government are declared the need to support, as a business, scientific and technological activities in this area.
However, despite some public policy priorities, alternative renewable energy for the energy supply of the country is negligible.

This situation is primarily due to the declarative nature of the law "On the use of renewable energy sources." This law is provided for the adoption of interstate, state, branch and regional scientific and technical programs to promote the use of renewable energy in the medium and long term, however, not fixed, and effective mechanisms for achieving implementation of the declared objectives.

Program of the Government of the Republic of Tajikistan on the development of the hydropower industry in the country for the period 2009-2020 envisages the construction of 189 small hydropower plants. Currently, small power in the republic is represented by 310 hydropower plants (up to 30 MW), but operating only 67 of them. The rest of the 243 small hydroelectric power plants, according to the Agency for Construction and Architecture under the Government of the Republic of Tajikistan, are "built in places where the winter period of no water at all". The total power grid of Tajikistan connected only 14 small hydropower plants. As part of the project "Dissemination of renewable energy installations in mountainous areas" (with MSDSP Aga Khan Foundation, with financial support from the EU Member States) in the country, were installed more than 3,000 local, autonomous solar photovoltaic plants, solar collectors and 300 7 wind generators.
It is unknown how much the whole small hydro and solar photovoltaic installation generates electricity, and how many people use these sources of energy since the data is not available because they operate autonomously and report on them are not conducted. According to preliminary information experts, share of renewable energy (the energy of small rivers, solar, wind, etc.) in the total energy production is about 0.01%. Therefore, the use of alternative sources of renewable energy in the country today cannot be regarded as sustainable sources of energy in accordance with national standards and approaches.

The role of renewable energy in Tajikistan is insignificant due to several factors, including: high capital costs for the construction of renewable energy facilities, the lack of specific financial mechanisms of state support, low skills, and lack of reliable information on the availability and economic possibilities of renewable energy, public, business and government.

The existence today of rich resources of renewable energy in the world of advanced technology offers certain advantages to Tajikistan to increase the use of renewable energy sources in remote rural areas that do not have network access to energy.

For Tajikistan, the use of solar energy, including its derivatives - wind, water and biomass has great potential.

The energy of small rivers. The country has inexhaustible reserves of hydropower (947 rivers with a total length of 28,000 km), ranking 8th in the world in terms of specific stocks (per capita and per unit of area). The average for the territory of Tajikistan river network density is about 0.6 km / km ^{2}. The total annual potential resources of hydroelectric power in the country are about 527 billion kWh Availability of hydropower determined the direction of development of power for the republic on the path of building hydroelectric power plants.

The energy of the sun. The total duration of sunshine a year is on average 2500-3000 hours. Minimum duration of sunshine is observed in mountain stations Dehauz (2097 hours) in the upper river Zarafshan at an altitude of 2500 meters and the station "Fedchenko Glacier" at an altitude of 4169 m (2217 hours). Maximum duration of sunshine (3000 hours) is observed in the south (weather station Panj - 3029 hours), as well as on the eastern Pamir (Karakul weather station - 3166 hours). Estimates show that 60-80% of the needs of the rural population of the country for 10 months a year can be provided by solar energy. When recalculated, it accounts for about 400 thousand tons of conventional oil equivalent (toe), which is the equivalent of 460 million m3 of gas and 528 thousand tons of fuel oil.

Wind energy. The strongest winds are in the highland areas (Fedchenko Glacier, Anzob pass, and others.) and in areas where landscape favor the pressure gradient (Khujand, Faizabad, Shuroabad, Ishkashim, Murgab). The average annual wind speed in these areas reaches 3 - 6 m / sec. On the open plains and broad valleys wind speed is slightly below and is 2 - 3 m / sec in the foothills, the speed is up to 3, in closed basins in the low-lying southern areas, it does not exceed 1 - 2 m / s.

In general, renewable energy can’t satisfy the power consumption of large settlements, industrial enterprises and institutions. But the country has a good

perspective to use renewable energy in remote and environmentally disadvantaged areas and it will give environmental, social and economic impact.
Based on the above and on international experience the most relevant areas of energy development for the power supply to remote rural and mountainous settlements in Tajikistan are large-scale constructions of plants based on renewable energy sources (RES), such as small hydropower (SHP), solar photovoltaic station (SFES) and wind turbines (windmills).

2. Estimates suggest solutions for stand-alone (without a network connection) and network access (by means of micro - and mini-networks) to energy services with a focus on rural and remote areas of Murghab and Vanj of Gorno - Badakhshan Autonomous Oblast, the Republic of Tajikistan.

A significant obstacle to social and economic development of the Republic of Tajikistan is the power supply issue of the population living in distant rural areas, which is most acute in the Gorno - Badakhshan Autonomous Oblast. Therefore the areas, namely the Murghab and Vanj, were chosen to investigate the possibilities of autonomous power supply.

Gorno - Badakhshan Autonomous Oblast - is a wonderful mountain region. Worldwide, there are only two such places: Tibetan and Bolivian highlands. GBAO borders with Kyrgyzstan in the east - with China in the south and with Afghanistan in the west. The area is 64,200 square kilometers (44.9% of Tajikistan).

Tajikistan, Gorno - Badakhshan Autonomous Oblast.

The administrative center is Khorog, with a population of 29.3 thousand people. Distance from Khorog to Dushanbe is 527 km. The population of GBAO is 240 thousand people, or 3.2% of the population of Tajikistan. The average population density of the area (1 km²) is 3.4 persons. The urban population is 29.3 thousand people (13.3% of the total population of the region), the rural population - 191.3 thousand people (86.7%). There 485 localities, 20 of these are on the eastern part of the country (Murghab district).

There are also the highest ridges, powerful glaciers, and the highest situated settlement of the country (4000 m). The glaciers of this area give rise to almost all the rivers of Central Asia. Most of the field takes the Pamirs, the highest point of which is the Peak of Ismail Somoni (7495m). The region occupies 45% of the total area of Tajikistan, but only 3% of it - mainly the valley of mountain rivers - is suitable for living population.

An important characteristic of energy in the extreme climatic conditions of the Gorno-Badakhshan Autonomous Region, is the reliability of all parts of the energy supply system. Depending on this, it is not only the performance of the sectors of the economy, but also the health and life of people of the area.

The potential of electric power supply in GBAO

№	Name of hydroelectric power station	Capacity power, kW
1	Pamir HPP-1	28000
2	Khorog HPP	8700
3	Vanj HPP-1	1200
4	Vanj HPP-2	500
5	Kalayhumb HPP	1700
6	Murghab HPP	620
7	Namadgut HPP	800
8	Rushan HPP	800
	Total	42320

In the field of power generation for the year, it is in the order of 180 to 200 million KWh, the actual consumption is 150 million KWh, or annually 625 kWh/person.

At the same time, annual energy consumption in Murghab district is 0,230 kWh/person, and in Vanj is 245 kWh/person. Reasons to not provide these areas with electricity are: their distance from the unified energy system of the region and the country, small power stations and critically high depreciation of production equipment of HPP. One solution to this problem is a stand-alone power supply through the use of local renewable energy sources that are rich in these areas.

The living condition in remote areas and in the mountainous area of the sustainable energy often becomes a challenge of survival. Low reliability of power supply and the difficulties of transportation during the winter have created the conditions for the outflow of the population from mountain areas of GBAO, which are half the territory of Tajikistan. In these circumstances, by building micro power sources (RES), can be developed independent power supply, using all the resources of the mountains which are rich in these areas to attract people, and to increase the production of unique agricultural products, for a better use of recreational resources.

3. Identify potential locations for the project development of renewable energy in rural and remote areas of Murghab and Vanj of Gorno - Badakhshan Autonomous Oblast.

- Analysis of the possibility of using different generation equipment for the production of energy from renewable sources in Murghab and Vanj of GBAO;

- Economic and technical information relevant to the application of technologies for the use of renewable energy sources within the area for the residents of Murghab and Vanj;

- Estimate of the cost of electricity production for each type of plant.

GBAO, in particular, Murghab and Vanj are a typical example of remote power consumers.

The formation, development and functioning of decentralized energy facilities in Murghab district are significantly influenced by the following features of the territory:

- underdeveloped area, the predominance of small and medium-sized towns;

- the vastness of the territory causes an increase in the cost for transporting electricity, which in combination with low-density electrical loads determine the increased costs of centralized power supply;

- a combination of remote and inaccessible areas with harsh climatic conditions.

- a very low level of power consumption, eliminating the " ubiquitous "creation of large power systems;

- important transport component in the cost of fuel due to the geographical remoteness from the fuel supplier, multi-tier and limited seasonal timing of delivery of fuel;

-low technical level of the energy economy, characterized by a high degree of moral and physical wear and tear;

- A low level of reliability of electricity supply to consumers.

Murghab district is located in the eastern part of the Gorno-Badakhshan Autonomous Region. It has borders with the Osh region of Kyrgyzstan , on the east - with Xinjiang of China , on the south – with the Badakhshan province of Afghanistan . The area is 38,442.2 square kilometers. There is a population of 16.9 thousand people. Murghab covers 24% of the territory of Tajikistan, 59.4% in GBAO and is the surrounded area of the country. The region is a plateau at a height of 3500 - 4500 meters, characterized by flat, sparsely vegetated slopes, extensive and stagnant hollows, and ridges with a considerable height (maximum height of 6233 meters), glaciers and snowfields. The climatic conditions are characterized by their harshness, dry and very continental.

Tajikistan, GBAO, Murghab district

Winter is cold and consists of long periods. Summer is short and cool. Average temperatures even in the valley are negative and make ... 1.5 -5.5 degrees. The temperature during the summer, at an altitude of 3500-4200 m is in the range + 11 ... + 12 degrees, even in the month of July possibility of a significant night frosts. On some winter days the temperature drops to - 40 ... 50 .-, and in summer it can warm up to + 20 .... + 25 ° C. The frost-free period in the area lasts only 45-60 days. High mountain ranges prevent the penetration of humid air masses. rainfalls in the area are very limited and are comparable to the precipitation falls in the deserts. The average annual rate is only 60-100 mm. Due to the extensive dry, it can be observed in the rising air, jets raindrops evaporate before reaching the surface, it evaporates in the spring snow. Relative humidity in the area of Lake Karakul is only 50%.

This area is one of the harshest climatic regions of Tajikistan performance and power shortages, especially in winter, exacerbates the socio-economic situation of the region. For example, winter vacations in educational institutions of the district

are sometimes established twice throughout the country whenever it’s possible. The reason for this is the harsh climate and power failures.
Basic agricultural conditions of Murghab district territories, probably as any mountain terrain, compounded by difficulties in access, steep slopes, low temperatures and shorter growing season. Livestock mainly yak usually remains an important agricultural activity area. Because of the above difficulties, livestock products remain ineffective. Reduced livestock number is due to lack of fodder and cattle sales, a large part due to the lack of permanent income of the population. Lack of atmospheric moisture does not allow the growth of vegetation. As a result, in the district there are no forests of trees (in some places only grow handicraft plants). In general, a lack of local fuels adversely affects the energy balance in the region.

The district has a small hydro power plant “Ak-su” with capacity of 620 kW which in the summer 'generates 400 kW h of electricity because of the small flow only in the area of the river and in the winter too because of the freezing of all produced 250 kWh, i.e. 0.231 kW/person*year, which is 93% below the average power consumption of rural consumers of the republic. It is therefore important to find ways to produce the amount of electricity required for the needs and the sustainable development of the area.

At the state level, there is the problem of power supply geographically separated, and having a small amount of electricity being in remote places with the density of the electrical load from 0.5 to 70 kW per square kilometer.
In order to expand the energy supply system Murghab district government of Tajikistan is expected to implement projects for the rehabilitation of existing plant "Ak-su", bringing the power station up to 800 kW and the construction of a new hydroelectric power station "Vahdat" design capacity of 1,300 kW. In addition, the project "Dissemination of renewable energy installations in mountainous areas" (with MSDSP Aga Khan Foundation, with financial support from the EU Member States) in the area of households installed 800 local, autonomous solar photovoltaic installations.

However, as shown by a long-standing practice in the harsh mountain climatic conditions of Murghab district, especially extreme cold to 50 degrees below zero, causing the freezing of small rivers, hydropower cannot come to life accessible and cannot provide cheap source of electricity. In addition Murghab district consists of 20 scattered settlements located in 50 - 100 km apart which are not connected to the power supply system of the central district and the Gorno-Badakhshan (the distance from the administrative center of the area to the regional center is 320 km). The construction of these overhead lines, with power transmission line’s tension between 6-10 KV and with a distribution network’s capacity of 0.4 KV, coupled with the constantly rising prices for construction materials submitted for the district and the region are economically impractical. Therefore, the problem of power supply remote consumers in the long term can be solved with the help of renewable, alternative energy sources like solar and wind energy, which the region has a great potential for.

The use of stand-alone photovoltaic power plants (FES) in Murghab district, Badakhshan.

According to the Met Office in Tajikistan, Murghab recorded the longest duration of sunshine (more than 3166 hours, the weather station Astrakhan), nearly 200 hours more than other regions of the country.

The first step in installing the FES is to determine the location. Question setting FES primarily occurs in 2300 households of Murghab, which are removed from power transmission lines (PTL). The calculation for the economic feasibility of installing FES is directly proportional to the distance from the power lines. Establish independent FES in individual households as an alternative transmission lines for remote settlements area, are more economically profitable than the last build.

The second step when installing the PVS is to determine the required number of photovoltaic modules (FEM) in the system for one household. To do this, you must know the energy consumption of the house, the nominal power module and the coefficient of insolation for a particular area. The best indicator that determines the power consumption of the house is the average daily electricity consumption in kW. Indicators such as the installed capacity of the facility or the rated power of electrical equipment are not suitable, because it does not reflect the specificity of the object in terms of the extent of its operation, and the calculation based on them can be serious to miss, "according to experts advice.

Insolation factor characterizes the efficiency of the unit for a certain period of time. It is calculated on the basis of statistical observations and take into account the effect of sunshine and cloudy days, the seasonal duration of daylight, reducing the efficiency of the PEM at dusk and dawn. Insolation coefficient for each area can be found on the map of solar insolation, published in specialized publications or websites.

The third stage - the power calculation with the FES projected needs. It is enough to solve a simple arithmetic problem from several factors: for example, the average power consumption of the object - 2000kW, the rated power of the PV module (FEM) - 160W during operation of the facility - all year round, the annual average rate of solar insolation on the basis of the worst weather conditions the same - 4.

First we need to calculate the average daily energy production for one FEM:

-160W (rated power of FEM) multiplied by 4 (sun insolation factor) 160W x 4 = 640W, that is, a daily average energy yield of one FEM accounts for 640W.

What follows, identify the required number of solar modules for one household:

-The daily average consuming capacity installed for one household is 2000 W, which is classified into the amount of daily average manufacture of energy for one FEM, which is 640W or 2000W: 640W=3modules. Therefore, the number of sun modules for one household accounts for 3 units, and for 2300 households in Murghab, which are removed from the power lines, the required number of solar modules is 2300(households) x 3(module units) = 6900 units.

The fourth stage is the determination of the number of batteries (AB). Stand-alone solar systems use special battery - helium, closed-end, sealed, maintenance-free, with a service life of 10-15 years. "For the calculation of the total capacity or number of batteries in the autonomous solar system, it should be guided by the fact that the depth of discharge should not exceed 50%. For our example, the total capacity will be:

1) 2000 + 50% = 3000 W;

2) 3000 W / 12 = 250 A.

Thus, the total capacity of the batteries with a voltage of 12 V will be 250 Ah. If we opt for the battery capacity of 200 Ah, they make the required number of 250 Ah / 200 A * h = 1.25 - 2 pcs. And even large round up will not be superfluous, since the additional capacity will reduce the depth of discharge in each of the batteries, and therefore increase their life. Another element of the solar system is the charge controller (SC). Despite the fact that its value is less than 1% of the total cost of the system, it plays a key role in the efficient operation of PVS. It protects the battery from overcharging and deep discharges, thereby extending battery life. The use of "intelligent" control not only prolongs the life of the battery, but also allows more efficient use of the energy obtained from the solar module to charge it. Increase the efficiency of the order of 15-20%. The last "link" in the solar power plant is an inverter. This element converts the DC voltage supplied from the rechargeable battery into AC voltage supplied to the electric grid object. Power inverter required for a particular autonomous object is defined as the total power consumption of all electrical appliances that are in it.

Importantly, during the design process of the FES, the key role is played by the "energy audit" system power facility, that is, our house. It is important to assess the functioning of virtually every unit of power in terms of its energy efficiency. Like the experience of the company "Solyar HF" (Department of solar power PAO "Quasar" Ukraine), the cost of the solar system after the "energy audit" may be reduced up to 30%. Taking into account the total cost of an autonomous solar system (about $ 5-7 thousand.), This is a very tangible saving.

Installing the stand-alone photovoltaic plant (FES), which will allow to provide uninterrupted electricity to households in the Murghab district, today will cost $ 5-7 thousand. Such amount for residents of Murghab is unattainable due to their limited income, and solves the problem of electricity supply and improves living conditions of people living in remote, especially in harsh environments as it remains the task of national importance.

Wind energy. Today in some industrialized countries, the installed capacity of wind power plants (wind turbines) achieves significant values. For example, the United States has more than 1.5 million. KW wind turbines, wind turbines in Denmark produces about 3 ° / consuming countries on energy; large installed capacity of wind turbines in Sweden, the Netherlands, the UK and Germany. According to the report "Prospects for the global wind energy", prepared jointly by Greenpeace and the International Mission of wind energy (GWEC), the annual growth of this industry is over 11,000 MW of new capacity. Unit capacity of wind turbines increased in the last 30 years from 20 kW to 3,000 kW for production vehicles and up to 5 MW pilot wind-energy installations (wind turbines). The cost of a unit of installed capacity of wind turbines in the same period decreased from $ 5,000 to $ 600 per kilowatt.

Estimated wind speed for large wind turbines is usually taken at the level of 11-15 m / s. Generally, as a rule of thumb, the greater the power unit, the greater the wind speed it calculated. However, due to the variability of the wind speed, most of the time the wind turbine produces less power. It is believed that if the average wind speed at a given location is at least 5-7 m / s, with an equivalent number of hours per year, which is generated when the rated power is at least 2000, it is a favorable place for installation of large wind turbines and wind farms even.

In developing countries, interest in the wind turbine is mainly connected with the autonomous units of small capacity, which can be used in villages remote from centralized power systems. Such systems already compete with diesel engines running on fuel. However, in some cases, the volatility of wind speed causes a wind turbine installed in parallel with the battery, or to reserve its installation on fossil fuel. Naturally, this increases the cost of installation and operation, so the spread of such plants is small.

Murghab district of GBAO seems to share a variety of renewable energy resources, very promising in order to smooth idle and peak bursts in energy production. Maximum wind speeds accounted for the cold season (January-May) is 4.3 - 6.1 m/sec and coincides with the seasonal peak power consumption. Winter is a maximum out of phase with the average annual solar insolation factor, ie wind and solar power complement each other. This creates favorable conditions for sharing in the context of reducing the overall level of intensity of the wind in the summer day, high solar insolation is beneficial for the efficient use of solar energy, because it is in the daytime, and as a rule of thumb, there is an increased demand for energy on the behalf of the consumer.

According to experts, building power lines in scattered and remote settlements of Murghab is uneconomical. Therefore, the power supply of the Murghab along with FES may play an important role for wind energy installations (wind turbines), that will solve the problems of supplying isolated settlements in the region. Wind speed permit. So, according to Gidromettsenra Republic (station Astrakhan), it is on average, 4.1 m/s. However, in Murghab winter there are hurricane winds.

That is the conclusion drawn by researchers from Physico-Technical Institute. SU Umarov Tajik Academy of Sciences on the conference - "Renewable energy sources in Tajikistan: Current State and Prospects for Development".
Below is a table of the average wind speed at Murghab district in 2010.

days	M o n th s											
	1	2	3	4	5	6	7	8	9	10	11	12
1	0	8	4	4	6	4	4	0	6	0	0	0
2	0	4	0	10	8	10	4	0	6	0	0	0
3	0	10	0	4	6	6	4	0	4	0	8	0
4	0	10	0	8	8	6	4	4	4	0	4	8
5	0	6	6	4	4	2	4	6	0	0	4	0
6	0	6	0	2	2	6	4	4	4	0	0	0
7	10	12	0	10	2	4	4	4	2	0	0	0
8	10	4	0	12	2	2	4	0	2	0	0	0
9	8	8	0	6	4	2	0	4	0	0	0	0
10	0	2	0	6	0	4	4	4	0	4	0	0
11	0	4	8	10	4	6	4	4	4	6	0	0
12	0	4	10	12	4	4	6	0	4	4	0	0
13	0	6	6	8	4	4	4	6	8	0	0	0
14	6	0	2	6	6	8	6	6	4	8	0	0
15	12	0	4	6	8	4	4	6	2	6	0	0

16	8	0	2	8	4	6	0	6	10	2	0	2
17	12	0	2	8	8	2	0	6	6	0	0	2
18	12	0	6	0	8	8	6	2	6	2	0	4
19	8	0	6	6	6	2	4	6	6	2	0	0
20	10	8	12	0	4	2	6	0	0	4	2	0
21	4	4	12	6	8	8	4	6	0	12	10	4
22	0	0	4	6	10	8	4	0	0	6	8	4
23	4	6	8	6	10	2	2	6	6	6	0	4
24	4	6	4	4	4	8	8	2	4	0	0	0
25	4	2	6	6	6	6	2	4	4	0	0	0
26	4	2	6	6	8	4	2	2	8	0	0	0
27	4	6	12	2	8	6	4	2	8	0	0	0
28	0	0	6	4	6	6	4	0	8	4	0	0
29	10		6	6	4	10	0	4	8	4	0	0
30	2		4	8	4	8	0	2	6	8	0	0
31	0		4		6		4	2		8		2
In total No. of months	4.3	4.2	4.5	6.1	5.5	5.3	3.5	3.2	4.3	2.8	1.2	1.0

In Murghab development of wind turbines it is mainly connected with the autonomous units of small capacity, which can be used in villages remote from centralized power systems. Here, all the settlements are removed from the power lines and do not have access to electricity. Human settlements are located on the open steppe areas without trees and here the wind turbines would be useful as well as possible. For a small village with a population of 300 people, where power consumption is 180 kW wind turbine capacity must be 200 kW. The cost of such an installation of wind turbines to the cost of energy storage systems will be 250 thousand dollars. They must be placed on an open area near the village. This is an approximate scheme for the application of VES, not connected to power lines settlements with fewer inhabitants.

The use of wind energy along remote decentralized settlements in Murghab also creates favorable conditions for meteorological stations, lighthouses, border posts, receiving electricity from autonomous diesel plants. Such plants today are competitive and are used in many developing countries to improve the electricity supply in remote mountain areas. Because of the remoteness and poor transport links, fuel costs in the region increased by 150-200% or more. Under these conditions, the use of wind turbines can increase the economy of expensive diesel fuel.

Since the presence of prevailing winds having the highest concentration of energy allows to have wind turbines compact, Murghab district is particularly suitable for the construction of wind farms with the greatest distribution of the network settings of the unit capacity from 100 to 500 kW. The unit cost of wind turbine capacity of 500 kW is now about $ 1,200 / kW and has a tendency to decrease. Under favorable characteristics of the wind turbine cost of electricity will be 10-17 cents per 1 kWh.

It could be a new sector of business development and opens up prospects for economic development of the region, in particular the growth of the mining sector for which the area has a great potential.

However, the small wind turbine unit in Murghab may have a problem with the network infrastructure, as the cost of power lines and switchgear for connection to the grid may be too large. In this case, they must be rationally used as a stand-alone wind energy plant.

Low-power wind turbines in Murghab were created to address the problems of energy supply in remote and isolated settlements that are not supplied with electricity and virtually no other economically viable alternatives than the construction of wind power plants;

Small hydro-electric stations. The most accessible and cheapest source of electricity, especially in mountainous Badakhshan. The hydropower potential of Badakhshan in the Pyanj River Basin is defined in the 150 billion kWh. Hydroelectric complex of Panj river on the partitioning scheme adopted at the level of energy use described as follows: Barshorskaya (300 thousand kW), Anderobskaya (650 thousand kW), Pishskaya (320 thousand kW), Khorog (250 thousand kW), Rushan (3000,0tys. kW), Yazgulem (850 thousand kW), Granite Gate (2100,0tys.kVt), Shirgovatskaya (190.0 thousand kW), Hostavskaya (1200,0 thousand kW). This potential will improve the socio-cultural level of life of the inhabitants region, reduce production costs, improve reliability and quality of power supply on the basis of local resources, and reduce human impact on the environment. However to date none of these stations of Panj River Basin are built.

If the traditional way of development of hydropower potential is the construction of large plants that require large capital investments and long construction period, the non-traditional solution to this problem for the GBAO it is the construction of small and micro hydropower plants on the rivers and streams. The power of such stations can range from a few hundred watts to megawatts. Their massive construction will improve living conditions, increase the use of agricultural land and recreational potential of the mountain areas, and improve the impact of investments in the energy sector, given that the period of construction of small and micro hydropower plants ranged from one month to three years, depending on the specific hydrological conditions and capacity.

Small hydroelectric stations are easy to combine with traditional food production and small-scale production. Those sources of energy for the agricultural consumers in remote areas in Vanj are particularly interesting.

Unlike Murghab, the Vanj climate is tropical and sub-tropical lowlands. Vanj cut by high ridges, deep gorges, which are flowing fast, impassable rivers, mountains, high, rocky, covered with eternal snows and glaciers.

Tajikistan, Badakhshan, Vanj.

In Vanj, suitable economical hydropower resources are already used in small and medium-sized rivers where 5 micro hydropower stations were built with capacity of 100-1200 kW, providing 40% of the needs of the population. Small power, between 500 kW and 1200kW, located within the district center and small hydroelectric power station in the village Teharv (300 kW) are connected to a local 75-kilometer overhead line 10 - 6 / 0,4 kV, which connects 40 settlements. Currently, the area is not covered by centralized power around 50 settlements and separate objects. The area is isolated from the main power supply region and the country, electricity is supplied only three or four hours a day.

The natural conditions specific to Vanj can provide power generation by small hydropower plants, fully meeting the needs of the area's economy, which is focused on agricultural production, agro-processing and further development of the building materials industry.

In Vanj there are more than 22 small rivers and streams with a total length of 300 km. The locations suitable for placing small hydropower plants are in the following rivers: Vanchob (2 areas, and with maximum capacity of 60 thousand kW) Pshiharv (1, 500 kW), Panchshanbeabad (1, 100 kW), Boone (1, 200 kW), Sed (1, 200 kW), Shirgovad (1,200 kW), Sitarg (1, 100 kW), Yazgulem (1, 100 kW).

The program for the construction of small hydropower plants cascade 2009 -2020. "(Resolution of the Government of the Republic of Tajikistan on February 2, 2009, № 73) provides for the use of the river as part of the development of the area, but financial restrictions make the construction of micro hydropower plants on the rivers of the above problematic and resources of small rivers remain untapped.

Studies in GBAO say that only three main components of renewable water (no dams), the wind, and in a rational measure, the sun, can be for one hundred percent, secured areas of energy, particularly its outlying areas.

For small settlements in remote areas of the region, below are suggested some simple, affordable energy projects:

- Projects of small and micro hydropower program "alternative energy";
- Low power for small hydroelectric natural flows in rivers (the depth of 0.15 m and above, at a flow rate of 50 l / s and a capacity of 1 to 1000kV and above) or artificial river parallel chutes.

It would be better to draw attention to the possibility damless HPP, which can be built on small rivers and streams even. For example, according to press reports, China - the world leader in the number of small and micro hydropower plants, has more than 100 000 stations, and Russian technology produced turbines for hydroelectric such such as Kadzhisaysky electrical plant in Kyrgyzstan, which made the trial a micro hydropower plant with capacity of 1.5 kW installation on small streams with sufficient pressure and prepared their serial production. Micro hydropower plants weighing 90 kg, can be quickly installed in place, it is reliable and easy to maintain. Therefore, increasing the number of damless HPP on small rivers in Vanj can be useful to meet the energy needs of towns and villages.

Such work has already commenced in GBAO, for electricity settlements in the mountainous area is easy to arrange the use of micro hydro sleeve, which can be installed on site for 2-3 months. For example, in the village of Van - Van (river Garmodara) the locals have established a micro hydropower plant with capacity of 100 kW. Here, the price of electricity for end consumers is not more than 2 cents per kilowatt-hour.

The cost of construction of small hydropower plants is on average $ 500 to 2,000 per kilowatt of installed capacity with a payback period of 2 to 12 years depending on the specific conditions. Hydrological and morphometric characteristics of mountainous areas of Tajikistan, for example GBAO or Vanj, allow the use of all types produced in Russia and the CIS micro hydro and equipment for small hydropower plants.

The main technical characteristics of hydraulic units for small hydroelectric power plants

Hydraulic units with propeller turbines

Parameters	***Type of hydraulic unit***				
	GA1	***GA8***	***GA13***	***Pr15***	***AP30***
Power kW	100-330	150-1800	50-200	to 130.0	to 150.0
Pressure, m	3,5-9,0	6,0-22,0	2.0-5.0	2,0-12,0	4,0-18,0
Flow rate, m^3/s	2,3-6,2	2,5-11,0	2,3-5,0	0,44-1,5	0,38-1,1
Rotational speed of the turbine rotor, min^{-1}	200-360	300-600	190-300	600; 750; 1000	750; 1000;
Rated voltage,	400	400; 6000; 10000	400	230/400	230/400
Rated frequency, Hz	50				

Delivery, mass characteristics and the value of 1 kW of installed capacity hydroelectric generators for small hydropower plants

#	***Name***	***Weight, kg***								
		GA-1	***GA-13***	***GA-8***	***GA-2***	***GA-4***	***GA-9***	***GA-11***	***GA-5***	***GA-10***
1	Turbine propeller with impeller	3980	3720	7000	---	---	---	---	---	---

2	Turbine with radial-axial impeller	---	---	---	1300	1350	3300	4400	-	-
3	Turbine bucket with impeller	-	---	-	-	-	-	-	2200	5000
4	Corner multiplier	1430	---	-	-	-	-	-	-	-
5	Anti accelerating device	1850		1850	175	175	370	370	-	-
6	Generator (depending on power)	1320 2600	350 1300	2600 3400	2000 2600	1500 2400	3000 13000	5000 28000	2500 3900	10000 25000
7	The automatic control system (ACS)	100	100	100	100	100	120	200	100	200
8	Knee and suction tube	-	---	3100	400	400	600	700	-	-
9	Cost of 1 kW of installed capacity	for aggregate capacity of about 100-300 kW 28500-13500 rubles.		for aggregate capacity of about 200-500 kW27200-13000 rubles.	power unit for 200-500 kW18300-10300 rubles.		for aggregate capacity of about 1000 kW 9,000-10,000 rubles		power unit for 200-500 kW17200-10200 rubles.	

The installed capacity of hydroelectric power station can range from tens of watts to 1 MW, the flow rate of the watercourse is 0.6 m/s, and the water pressure, if required, from three meters. Small hydropower plants can be equipped with generators of different capacities and pick up for each object, the optimal combination of price and performance. The advantage of small and micro-hydropower plants is that they do not require the continuous presence of staff and can operate in automatic mode.

Small hydropower plants do not require ultra-high capital investments. According to consulting company AEnergy.ru, the price per kilowatt of installed capacity in the construction of mini-hydropower plants up to 5 MW costs about twice cheaper than a small diesel power plant of similar capacity. Cost of electricity generated at this station is 11-20 times lower than with a small diesel power station. A modern small hydro is quite easy to operate and have a relatively high efficiency - over 80%.

The small power plants allow you to save natural landscape, the environment, not only during operation, but also during the construction process. Small hydropower plants' work does not adversely affect water quality. In the rivers, the fishes are maintained. In the context of a combined schedule of project documentation development, equipment manufacturing, construction and installation of small hydropower plants with installed capacity of about 500 kW were put into operation within 15-18 months. Construction costs recouped 3.5-5 years.

General advantages and disadvantages of the known types of mini-hydro and pico-hydro are as follows:

Advantages of micro-hydro:

- Generation of electricity comes from renewable sources, more stable than sunlight and wind;
- Proximity to the end consumer, the energy losses in the transportation are minimal or absent;
- Low cost of electricity, taking into account the zero cost of the original fuel;
- The complete absence of any emissions, and minimal impact on the water basins;
- Access to full power from small hydro power plants takes less time than in the case with generators on petroleum products;
- Away from central energy networks, only small hydropower plants are able to provide uninterrupted electricity to consumers, as they do not depend on a regular fuel supply.

Cons of small hydropower plants:

- Bed of small rivers and streams often dry in summer and freeze in winter;
- The performance of mini-hydro connected to the pressure of the water and its quantity. To fully provide electricity, it may require the creation of a dam above the bed of the reservoir - it is necessary to comply with the law;
- Construction of a full-fledged small hydroelectric power plant, albeit capable of properly supplying electric energy throughout the year, does not come cheap.

4. Recommendations for the implementation of the most sustainable mechanisms of renewable energy technologies in remote areas of the Republic of Tajikistan with the autonomy and network access to energy.

The large number of dispersed consumers whose electricity supply may be only independent energy sources, problems related to the current decentralized system of power supply need to be addressed as well as topical issues of development and optimization of the power supply to isolated consumers. Thus, the optimization of decentralized energy systems from the districts of GBAO, with high demands for reliable sources of energy and transport are very urgent tasks. An obvious way to improve energy efficiency of such zones is to maximize the use of alternative and local energy, for which, the implementation is impossible without a comprehensive analysis of alternatives for energy development with an assessment of their technical and economic efficiency.

Analysis of the energy supply in Tajikistan showed that the country has enough power plants (mainly hydraulics). Due to the low water flow in winter, electricity generation decreased by almost 60% and the bed of small rivers and streams often dry in summer and freeze in winter. Therefore, today, one of the main challenges for the energy sector of Tajikistan is considered to be the severe shortage of electricity, especially among consumers remote from centralized power supply.

Besides determining factors in the power industry of the Republic, along with the problems of power generation, it becomes more a problem about its delivery to consumers. Most scattered small towns in Tajikistan, regional centers, towns, business outlets and production facilities, which account for the predominant part of the population, cause very extensive construction of power transmission lines (300 - 400 km), which in turn become impractical. As a result, there is a region with a plurality of decentralized consumer, distribution lines and the construction of multiple electric powers exceeds the optimum range. It increases the cost of operation of the distribution network, impairs operation, and results in large power losses.

In summary, it should be noted that Tajikistan faces an important challenge; to ensure the production growth of electrical energy. This task can be a done in a variety of ways, the most important of them is the use of renewable energy sources.

For the Republic of Tajikistan, the use of renewable energy sources has the following values:

- A country rich in resources, renewable sources of energy, namely, hydraulic, solar and wind;

- A characteristic feature of Tajikistan is the large number of small energy consumers located far away from the sources of energy and their distribution centers - these are villages, farms and other small farms. Construction of power lines or gas to such customers is economically unprofitable;

- Non-traditional energy sources used in remote areas of the country for independent power plants, mainly replace electricity and coal and wood, which are subsidized by the budget. Thus, the use of renewable energy sources will significantly reduce state subsidies;

- The use of renewable energy sources ensures environmental safety for individual cities and towns affected by environmental problems, as well as places of public recreation.

- The organization of domestic production of cheap high-quality wind, solar and hydro units of kilowatt class of the country's material and human resources, based on the acquisition of licenses from the best manufacturers of such equipment, since the establishment of local production of wind, hydro, solar and other power plants licensed best producers using renewable energy sources will allow to reduce the cost of installations in the country and create jobs;

Given this, it is necessary to work in the following areas:

- Analysis of decentralized republic consumers, and determine the most appropriate and promising areas to ensure their needs, and to address the economic, social and environmental situation in the region where they are located;

- Assess the potential of renewable energy in the regions;

- Establish the most promising use of energy renewables for promising regions of the republic and carrying out zoning of the republic on the regions favorable for the comprehensive utilization of renewable energy sources;

- Identify the main solutions to the problems related to power supply of consumers on the basis of decentralized autonomous micro energy systems based on renewable energy;

- To attract the scientific - research centers for the development and submission procedures for the selection of micro energy parameters systems based on renewable energy, as well as the basic principles for the design of power systems for renewable energy;

- The example of the Murghab district undertaking micro energy systems rationale for the selection based on renewable energy sources for electricity in remote rural settlements;

- Identify the main economic indicators for micro energy systems selected based on renewable energy sources and to justify the economic feasibility in using micro energy systems based on RES in the Murghab district;

- Provision of legal entities and individuals that use renewable energy for their own power supply, with a ready access to renewable energy resources by simplifying procedures for the transfer of rights for the use of necessary natural resources;

- Tax incentives, the establishment of additional grounds for granting an investment tax credit, the provision of subsidies to legal entities (except for subsidies to state (municipal) institutions), individual entrepreneurs, individuals engaged in the production and sale of renewable energy devices and the use of renewable energy for power supply of consumers, in accordance with the legislation of the Republic of Tajikistan.

The aim of further research is to conduct comprehensive needs of climate research in Tajikistan in order to determine the exact data on renewable energy resources and the introduction of alternative technologies based on them, as well as the project development related to the development of efficient electricity sector, based on reducing environmental impacts, and raising the social and economic status of the country.

As mentioned above, the development of renewable energy due to the increase in employment opportunities, especially in rural areas where unemployment is highest. Renewable energy technologies generally use less imported goods and services than conventional energy technologies, so their use directly stimulate an increase in employment in the area where they are used, thus increasing the economic development of remote areas and villages. Creating new jobs and renewable energy technology to some extent can strengthen social stability and reduce the outflow of population from underdeveloped regions of the country.