Renewable Resources of Energy in Afghanistan
Odnawialne źródła energii w Afganistanie

dr hab. Joanna Modrzejewska-Leśniewska
Katedra Studiów Politycznych
Szkoła Główna Handlowa w Warszawie
joannamodrzejewska@poczta.onet.pl

Abstracts

One of the main problems of the contemporary Afghanistan is the lack of energy. To solve this problem is one of the main challenges for Afghanistan, as, based on the estimates of the Afghan Ministry of Energy and Water, in 2012 only 33% of Afghan population had access to electricity.

Afghanistan has sizable deposits of coal, crude oil and natural gas. Although reserves of traditional sources of energy are estimated to be at least sizable and potentially even abundant, the lack of industrial and transport infrastructure, causes that it is expected that decades will pass before those resources will be fully exploited. And it creates opportunity for a development of alternative sources of energy and among those, so called renewable resources.

Afghanistan is among the poorest countries in the world. After more than thirty years of conflict its economy is in shambles and the whole country is simply devastated. At the same time Afghanistan holds a great potential in the renewable energy resources. They are so significant, that in favorable conditions much of Afghanistan electric power generation could be based on those resources. The most obvious is a of hydroelectric power. The other, potential sources of energy in Afghanistan could be geothermal springs, solar energy and wind. The other, worth mentioning, is an issue of biomass and biogas and its use as a source of energy in Afghanistan. All those resources of renewable energy could be in the future the base of Afghanistan energetical sector.

Jednym z głównych problemów współczesnego Afganistanu jest brak energii elektrycznej. Rozwiązanie tego problemu to jedno z głównych wyzwań, gdyż jak szacuje afgańskie Ministerstwo Energii i Wody, w 2012 roku jedynie 33% afgańskiego społeczeństwa miało dostęp do elektryczności.

Afganistan ma znaczne zasoby węgla, jak również ropy naftowej i gazu ziemnego. Chociaż zasoby tradycyjnych surowców energetycznych oceniane są na wystarczające, a nawet znaczne, to brak infrastruktury wydobywczej i przesyłowej sprawia, że szacuje się, że miną dziesięciolecia zanim będzie można w pełni z nich korzystać. To stwarza możliwość rozwoju alternatywnych źródeł energii, a wśród nich energetyki opartej na odnawialnych źródłach energii.

Afganistan należy do grupy najbiedniejszych państw na świecie. Po ponad trzydziestu latach konfliktów jego gospodarka znajduje się w opłakanym stanie, a kraj jest zniszczony. Jednocześnie Afganistan dysponuje znacznym potencjałem w zakresie energetyki opartej o odnawialne źródła energii. Są one tak duże, że w sprzyjających warunkach większość energii elektrycznej na afgańskim rynku mogłaby pochodzić z tych źródeł. Najbardziej oczywistym jest hydroenergia. Innymi potencjalnymi źródłami energii w Afganistanie może być energia geotermalna, słoneczna i wiatru. Innym, wartym wymienienia jest biomasa i biogas. Wszystkie te odnawialne źródła energii mogą być podstawą sektora energetycznego w Afganistanie.

Key words:

Afghanistan; renewable resources of energy; hydroelectric power; geothermal springs; solar energy; wind energy; biomass; biogas;

Afganistan; odnawialne źródła energii; energia wodna; energia geotermalna; energia słoneczna; energia wiatrowa; biomasa; biogas;

Introduction

When there is a discussion about energy resources, usually the first which comes to mind is a crude oil, a natural gas, a coal, a lignite or a nuclear energy. All of those resources became lately controversial. But despite all the criticism and discussions they still are the chief fuels for electric power generation in the Western Countries. Despite all the promotion and programs of development, the renewable resources of energy still are rather curiosity than reality, safe the hydroelectric plants, which are an important element of modern electric power generation. There already are quite a few wind power plants, geothermal plants or several plans to use wave and tidal energy, but they still play a marginal role in the production of electricity in the Western Countries.

Therefore when there are discussions concerning the needs and prob-

lems of the extra-European countries, there is tendency to concentrate on traditional sources of electric power. But it seems wise to change this attitude. Paradoxically in the case of the underdeveloped countries, the alternative sources seem, in many cases to be better option than in the Western Countries. It is therefore sensible to look at the Afghan case from the perspective of using and developing alternate sources of electric energy.

One of the main problems of the contemporary Afghanistan is the lack of infrastructure. It never was well developed, but after more than thirty years of continuous war it is mostly destroyed and inoperative. Therefore this analysis is to a great extent theoretical. At the same time, when the situation will become more stable, the very fact that the traditional infrastructure is virtually nonexistent, could create good conditions for a development of the production of electric power from renewable resources and for the marginalisation of traditional electric power generation.

To solve the problem of energy production is one of the main challenges for contemporary Afghanistan, as, based on the estimates of the Afghan Ministry of Energy and Water, in 2012 only 33% of Afghan population had access to electricity. But there is a great disproportion in the access between larger urban areas and the countryside, where only 9% of Afghans have access to electricity. What is more important, Afghanistan in completely dependent on the import of electric energy. In 2011, electricity imports constituted almost 73% of Afghanistan's electricity production.

Tab. 1 Electricity Production and Imports (Million kWh)

Fiscal Year	2010-11	2011-2012
Total Electricity Supply	2802,8	3578,5
Imports	1866,7	2731,9
Domestic Production	936,1	846,6

Source: Oskarsson, K. *Sustainability of Energy Supplies in Afghanistan*, "Afghanistan in Transition", Civil-Military Fusion Centre, November 2012. Access (July 5, 2013) from reliefweb.int/sites/reliefweb.int/files/resources/CFC_Afghanistan_Sustainability_of_Energy_Supplies.pdf, p.3.

Traditional sources of electric power

Before the analysis of the alternative energy resources, one need to look through those more traditional. During the 1950s, 1960s, and 1970s there were several geological surveys of Afghanistan and its mineral resources.

In the beginning of the 21 century, there were additional surveys made by the US companies. Therefore the mineral resources of Afghanistan are pretty well known. Afghanistan has sizable deposits of coal. Those which were surveyed, are estimated for 73-100 million of metric tonnes, when those uncharted could be as large as 400 million tonnes (Shroder, Assifi, 1987, p. 116). Northern Afghanistan, especially the region between Herat and Badashkan, is the main region where there are the coal deposits could be found (Ministry of Mines and Industries of the Democratic Republic of Afghanistan, 2008, p. 64). The other area for potential coal mining is the south-eastern part of the country, along the Pakistani border. But there are technological obstacles to the development of coal mining: the lack of transport infrastructure, and this coincide with the fact that the most of the coal mining regions lay in a rugged terrain which is inaccessible without modern transport facilities. There is virtually no industrial infrastructure to utilize the coal. What is making situation even more difficult are the geologically complex structures of coal deposits, much of the coal resources occur in relatively deep and structurally deformed areas where exploitation can be both expensive and difficult (Department of the Interior, 2005, p. 1).

As for the crude oil, the geological surveys done in the beginning of the 21st century by the American companies show that there are in Afghanistan potentially six main oil-bearing areas. There are three proven oil-bearing regions: Amu Darya Basin, Afghan-Tajik Basin and Tripul Basin (near Herat); another three areas, where the occurrence of oil deposits is not proven, but highly possible, and those are: Katawaz Basin, Helmand Basin and Kushka Basin (Shahrani, 2011, p. 11). Estimates of oil reserves vary very much, from very conservative assessment of 80 million barrels (Kingston, 1990, p. 26; Malik, 2011, p. 144), up to the most optimistic, which are saying about 1 596 million cubic meters (over 10 billion barrels) of crude oil (U. S. Department of the Interior, 2006, p. 1). But even those estimates are sometimes criticised as too conservative, as when Mines Ministry spokesman declared, that just the newly discovered oilfields, between Balkh and Jawzjan provinces are estimated for 1,8 billion of barrels (Najafizada, 2010; Watkins, 2010).

In the case of the natural gas, its reserves are rather conservatively estimated for over 520 million of cubic meters. The chief areas of occurrence of the gas deposits, are similar as in the case of oil. Those surveyed reserves are found in the north of Afghanistan in the Amu Darya Basin and

Afghan-Tajik Basin (Islamic Republic of Afghanistan).

Although reserves of both, crude oil and natural gas, are estimated to be at least sizable and potentially even abundant, there is similar problem as in the case of coal. The lack of industrial and transport infrastructure, causes that it is expected that decades will pass before those resources will be fully exploited. And it creates, as it was already mentioned, opportunity for a development of alternative sources of energy and among those, so called renewable resources.

Renewable energy resources

Before we ponder on renewable energy resources, we should define those resources. The best way is to use the United States Export Council for Renewable Energy definition which states that: „The term 'renewable' is generalny applied to those energy resources and Technologies whose common characteristic is that they are non-depletable or naturally replenishable. Renewable resources include solar energy, wind, falling water, the heat of the earth (geothermal), plant materials (biomass), waves, ocean currents, temperature differences in the oceans and the energy of the tides. Renewable energy technologies produce power, heat or mechanical energy by converting those resources either to electricity or to motive power" (Armstrong, Hamrin, 2000).

In contemporary world we may observe the rise of energy production from renewable energy resources. Global demand for renewable energy was rising during 2011 and 2012, and supplyed an estimated 19% of global final energy consumption in 2011. Useful heat energy from modern renewable resources accounted for an estimated 4.1% of total final energy use, hydropower made up about 3.7%, wind, solar, geothermal and biomass are estimated 1.9% (Renewable Energy Policy Network for the 21st Century, 2013, p. 13). Among the countries, in which energy from the renewable resources represents significant segment of whole energy market, are mostly the best developed countries or the fastest developing countries. The top countries for renewable power capacity are China[1], the United States, Brazil, Canada, and Germany. The top countries for non-hydro capacity are China, the United States[2], the Germany, followed by Spain, Italy and India. By regions, the BRICS nations (Brazil, Russia, India, China and South Africa) accounted for 36% of total global renewable power capacity and almost 27% of non-hydro renewable capacity. The European Union[3] had

the most non-hydro capacity at the end of 2012, with approximately 44% of the global total (Renewable Energy Policy Network for the 21st Century, 2013, p. 13).

Afghanistan is neither among the best developed countries, nor is it among the fastest developing countries. Quite opposite in both respects, it is among the poorest countries in the world. After more than thirty years of conflict its economy is in shambles and the whole country is simply devastated. At the same time Afghanistan holds a great potential in the renewable energy resources. They are so significant, that in favorable conditions much of Afghanistan electric power generation could be based on those resources.

Hydroelectric power

The most obvious is the capability of hydroelectric plants. According to the Afghan Energy Information Center eighteen of the hydro power plants have a combined generating capacity of 263MW, as compared with fifteen thermal energy plants with a generating capacity of 88MW and thirteen sources from which energy is imported from neighbouring countries which are capable of supplying a further 296MW (Hansard, 2008).

So just from those data it is obvious that the hydroelectric power plants are important element of the energy production. The tradition of using water power to produce an electricity is in Afghanistan quite long. The first hydro power plant was build in 1910-1913 in Jabal-ul-Siraj (near Jalalabad). It produced 1 500 kW of electric power and for a long time it was the only source of an electricity for an industry which was at that time concentrated in Kabul (Ali, 1959, p. 127). During the interwar period Afghan governments started policy of modernisation and industrialisation, and the supply of electric power was one of the crucial factors in planned modernisation. Therefore ten power plants were build in Afghanistan during 1935-1951, out of this number Tyree were hydroelectric power plants: Chak Wardak (with the nominal output of 3360 kW), Pulkhumri-I (4800kW) and Kunduz-Baghlan (1200kW) (Ministry of Water and Power Preface, n.d., p. 3). After the Second World War other hydroelectric power plants were build. The last of them was erected in 1980s.

Tab. 2 Hydroelectric power plants in Afghanistan

Hydro Power plant	Year of Erection	Ivesting country supporting the investemnt
Chak Wardak	1940	
Pulkhumri-I	1941	
Kunduz-Baghlan	1942	
Faizabad	1984	Indie
Baharak	1986	Indie
Pulikhumri-I	1960	Germany
Pulikhumri-II	1964	ZSRR
Khanabad	1950	Germany
Chalwarcha	1936	Germany
Naghlu	1967	USSR
Mahiper	1967	Germany
Sarobi	1957	Germany
Charikar	1973	China
Jabel Seraj	1920	US/UK/Germany
Chak Wardak	1940	Germany
Ghorband	1975	India
Darunta	1964	USSR
Assadabad	1983	Germany
Filko	1950	Germany
Baba-Wali	1936	Germany
Kajaki	1975	USA
Grishk	1945	USA

Source: Afghan Energy Information Center (AEIC, 2004), Securing Afghanistan's Future: Accomplishments and the Strategic Path Forward, Power Sector, Annex 3: Afghanistan Generation Installed Capacity, Annex 3, January 2004, p. 38-39, Access (July 7, 2013) from www.afghaneic.org/Presentations/Securing%20Afghanistan's%20Future2.pdf

The Soviet intervention, later the civil war and the rule of Taleban cause great damage to those objects. Some of them were turned off, the rest is only partially operational. According to the situation from 2003, situation was as follows:

Faizabad Micro Hydro station – in 2003 all three turbines were non-functional, due to lack of spare parts. The government of India[4] was prepared to provide parts. The plant would require about US$ 400,000 for

rehabilitation (AEIC, 2004, p. 22). Baharak Micro Hydro station – in 2003 it was not operational due to lack of spare parts. Ahgha-Khan Network has agreed to reconstruct this facility (AEIC, 2004, p. 22). Pulikhumri I Hydro electric plant – in 2003 it was damaged and the cost for rehabilitation was estimated at US$ 1.8 million (AEIC, 2004, p. 22). Pulikhumri II Hydro electric plant – in 2003 only one (of three) turbine was operational. The other two turbines require servicing and spare parts. Rehabilitation cost of this plant is about US$ 1.2 million (AEIC, 2004, p. 22). Khanabad Hydro electric plant – in 2003 it was not producing electricity and destruction was complete. The estimated cost ofor rehabilitation was US$ 3 million (AEIC, 2004, p. 23). Chalwarcha Micro Hydro plant – in 2003 it was non-operational for the last ten years. US$ 200,000 was required for rehabilitation (AEIC, 2004, p. 27). Naghlu Hydro Electric plant – in 2003 it was producing about 50MW (it has a capacity of 100MW), mainly due to low water level. In 2003, due to deterioration, non availability of spare parts, and lack of servicing, it was a opinion that the plant may stop producing at any time (AEIC, 2004, p. 29). Mahiper Hydro Electric plant – in 2003 this plant was operational but lacks spares. Strategic spare parts were estimated to cost about US$ 1.2 million (AEIC, 2004, p. 29). Sarobi Hydro Electric plant – in 2003 it was operating at 70% of the nominal capacity due to lack of maintenance and spare parts. Strategic spare parts were estimated to cost about US$ 1.1 million (AEIC, 2004, p. 30). Charikar Micro Hydro plant – in 2003 the plant was operating at 60% of its capacity because of lack of spares. The estimated cost for rehabilitation was US$ 80,000 (AEIC, 2004, p. 30). Jabul Seraj Hydro Electric plant – in 2003 the plant was operating at 30% of its rated output due to depreciation. The antique desing of the plant may make rehabilitation unfeasible. Replacement of turbines and generators was recommended, at an estimated cost of US$ 4 million (AEIC, 2004, p. 30). Chak-Wardak Hydro Power plant – in 2003 it was operating at 500kW instead of 3.3MW due to damage. Repaire of the turbines was not possible because of their age. The cost estimated for replacing this plant was US$ 4 million (AEIC, 2004, p. 30). Ghorband Micro Hydro plant – in 2003 the plant was functional, providing power to Ghorband district. The plant requires a small amount of spares (AEIC, 2004, p. 30). Darunta Hydro Electric Power plant – in 2003 two (of three) turbines were operating. The production was 4MW instead of 11.55MW. All three turbines required servicing and spare parts (AEIC, 2004, p. 33). Assadabad Micro Hydro plant – in 2003 one (of two) turbines was functioning and the other was awaiting spare part. The cost of rehabilitation was estimated US$ 300,000

((AEIC, 2004, p. 33-34). Filko Hydro Electric plant – this plant was built as two turbines. In 2003 one of the turbines was missing and the second one was demaged beyond repair. Both turbines and other parts would need to be replaced at an estimated cost of US$ 1.6 million (AEIC, 2004, p. 35). Babe Wali Micro Electric plant – needs to be rebuild at an estimated cost of US$ 0.75 million (AEIC, 2004, p. 35). Kajaki Hydro Electric Plant – it needed service because the plant has not been serviced since 1979 (AEIC, 2004, p. 35). Grishk Hydro Electric plant – in 2003 the plant was heavily damaged and of antiue design. Replacement was required at a cost of US$ 3 million (AEIC, 2004, p. 35). So most of the plants needed and still needs refurbishment and modernisation. The total costs of necessary repairs, spare parts and modernisation are estimated for circa 23 million USD.

International community is clearly supporting a restoration of a hydroelectric power plants[5] (Flak, 2012; German Cooperation with Afghanistan, 2013a), but the progress is rather slow, because of continuous destability of the situation and the Taleban threat, and becaouse of a widespread corruption. Because the demand for an electricity in Afghanistan is so enormous and a reconstruction of large power plants is so slow emerged an alternative, the development of the system of small hydro power plants which would satisfy local demands even at the single villages level. It is important project when one remembers how inaccessible some of those hamlets are. The very terrain makes preferable a decentralised system of energy supply. The special role in this case is palyed by a variety of a Non Governemental Organistaions (NGO-s), which are working on the local level and whose human and financial potential is sufficient for such micro investemnts. One example of such activity is International Assistance Mission which is impelmenting the Renewable Energy Sources in Afghanistan Project (RESAP). RESAP received a flood of applications for install hydro-power plants – around 300th every year. Due to limited resources (personnel and funding) RESAP can implement 10-15 power station per year. For expamle, in 2011, RESAP helped install hydro-power plants in 16 villages, supplying a total of 1,793 families with electricity for lighting and small appliances (International Assistance Mission, 2011, p. 11).

Surely the construction, reconstruction and modernization of hydro power plants is a move in right direction as Afghanistan has a great potential in this respect. Several rivers are specially convenient for the production of an electricity, such as: Amu Darya, Bartang River, Wakhan River, Panj River, Hari River, Helmand River, Kabul River, Kushk River,

Panjshir River and Jarhun. The most valuable as a source of energy is of course Amu Darya which counts for 50% of all hydrological resources of Afghanistan. The hydroenergetic potential of this River alone is estimated for 37 billion kilowatts. The potential of another large Afghan river, Hari is estimated for 21 billion kilowatts of energy (Poya, 2010). According to the United nations estimates, Afghanistan could produce in hydroelectric power plants as much as 24 thousands megawatts of electricity, when it produces right now not even 200 megawatts (United States Institute of Peace, 2012).

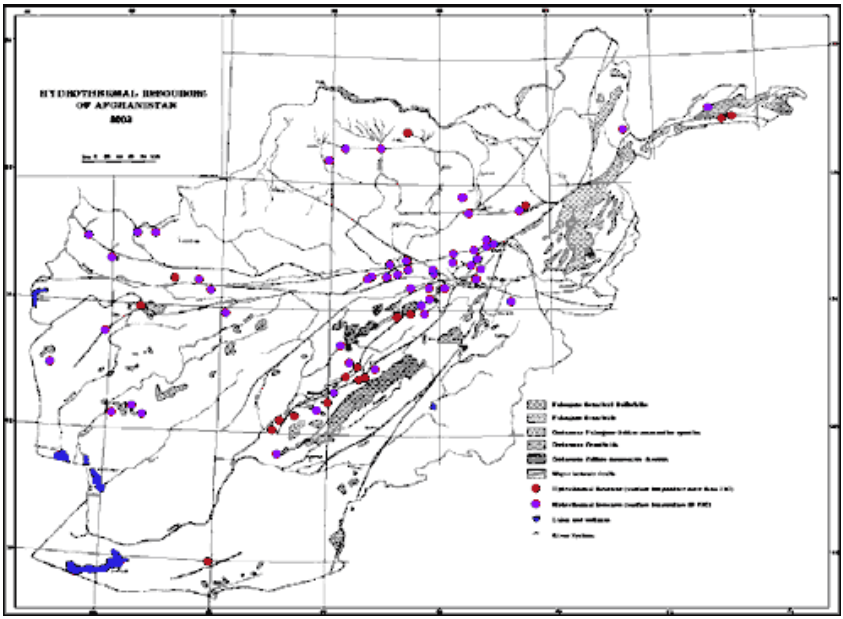
Geothermal springs

The other, potential source of energy in Afghanistan could be geothermal springs. But its reserves are not studied in any detail, although for centuries they were used for therapeutic purposes. Modern use of mineral thermal springs goes back to 1940s, when the infrastructure o some thermal springs were developed for therapeutic purposes. However, soon this development was abandoned, but in 1974 the Obe spring in Heart was renovated and bathrooms were built in Pole-khumri and Hairatan towns. Most of the hot springs around Afghnistan are still undeveloped, but local people continue to use them (Saba, Najaf, Musazai, Taraki, 2004, p. 7).

The first studies were made in 1964 by a soviet geologists. But they were mosty interested in chemical composition of the water not in their energetic potential and possibility of use in this respect. The second study of those springs was done in 1969-1970, but this time also geologists were interested in their chemical composition. Therefore the geothermal energetic potential of Afghanistan is assessed from the geological structure not from the detailed and systematic field studies (Saba, Najaf, Musazai, Taraki, 2004, p. 7-8).

In Afghanistan, active geothermal systems are generalny located in the main axis areas of the Hindu Kush, which runs along the Herat fault system, all the way from Heart in the westernmost part of the country, up to the Wakhan corridor in the Afghan Pamirs. There are many low to medium temperature geothermal resources all over the country. These geothermal fields can be found in the following areas: Harirud-Badakhshan and Helmand-Arghandab (Rodrigues, Tamás, 2012, p. 288).

Map 1 Resources of surface thermal waters of the temperature over 20° C



Source: Saba D.S., Najaf M.E., Musazai A.M., Taraki S.A., *Geothermal Energy In Afghanistan: Prospects and Potential*, Center on International Cooperation, New York University, New York & Research Institute for Economic Development and Social Policy, Kabul, February 2004, p. 9.

Solar energy

Another source of renewable energy in Afghanistan is the solar energy. Afghanistan has significant solar resource, averaging 300 days (in Kandahar pronince it is 320 days) of sunshine per year . This solar radiation is estimated to average 6.5 kWh per square meter per day (Ashraf, 2009, p. 20). Inducements to use this source of energy flow, among others, from the Afghan Energy information Center, which encourages people to use it for heating water. Such a solar water-heater can provide 140-180 liters of hot-water per day at temperature of 60-75°C (AEICa). At the same time critical voices are exclaimed that although Afghanistan can produce thousands of megawatts of solar power there has not been much interest from the government so far. As Sharifullah Mohammadi, head of solar

power company Zularistan, said: "Afghanistan has possibility of creating solar parks with the capacity to produce 150 MW of energy, but nothin is being done in this area" (Jhanmal, 2013).

There are some actions undertaken to introduce solar panels, but there is no countrywide, centralized plan in this respect. Those are mostly an isolated, local initiatives, such as the actions of the U.S Agency for International Development which recently installed a 25 kilowatt-hour solar electricity system on top of the Muqur District Center building in Badghis province, or the Solar Home Lighting System programme which was concluded in 2007, and which in effect brought electricity to a hundred villages, and this meant electrification of 5200 homesteads (Ashraf. 2009). Further projects include solar street lights for bazaars, solar hot water heating systems for clinics and various public facilities in Heart and Badghis (New Solar Panels Installed In Badghis Province, 2011). Kandahar University will install a total of 900 solar panels on the 36 solar pallets that the university had previously received from a private US company and it is expected to provide enough electricity to fully upport the campus (Kandahar University – Afghanistan's Pioneer In Renewable Energy, 2013). New Zealand companies (NetCon Ltd and Sustainable Energy Service International) were awarded the contract to build 1.05 megawatt solar plant, which will be the largest in Afghanistan. The contract will cost US$ 15million (Wilson, 2012). The UAE will be built eight isolated villages with Solar Home System with appliances. The project will benefit 600 households (Haider, 2012). But taking into account the natural conditions of Afghanistan the solar energy could be one of the more important sources of energy and electricity for individual homesteads.

It is important to notice that the Afghans themselves are conscious of the importance of this source of energy. There is for example a native company – Afghan Solar Ltd. which on its on-line site wrote that it „… is a leading solar company engaged in the design, supply and maintain solar power applications" (Afghan Solar Ltd.). This company offers: panels, batteries, charge controllers, inverters, water pumps, street lights, cables, DC lights, and LED lights (Afghan Solar Ltd.). A commercial of an another company says: "Choose Zularistan solar system, and we all can reach a secure future for the people in Afghanistan together" (Zularistan). What is important, there are in Afghanistan local companies producing solar panels and other appliances. In September 2012 Afghan Shams Solar Energy Co. advertised on its on-line page its products: "Our Kabul

factory is proudly manufacturing Starlight Solar Stoves. From pressing the parabolic panels to carefully crafting the stove's stands, we are proud to be producing this 100% Afghan made product. We have recently improved our reflective surface, with it now reflecting up to 95% of the sun's rays. This then means more energy to cook with and therefore greater savings for you, our valued customers!" (Afghan Shams Solar Energy Co.)

The Kandahar University recently established an energy department, the only department of its kind in thr country, to focuse on optimising Kandahar's solar energy potential (Kandahar University – Afghanistan's Pioneer In Renewable Energy, 2013). As was said by Navy Lt. Jason Gabbard, one of the American military engaged in the project: „With clean and reliable energy just around the corner, Kandahar University shines as a beacon of hope for the future of renewable energy in Kandahar and maybe someday, all of Afghanistan" (Sada-e Azadi, 2013).

Wind energy

The other, worth mentioning, source of renewable power, is wind. By some estimates, Afghanistan has enough wind potential to meet even one-third of the country's future energy needs. The use of a wind as a source of an electric power seem to be more complicated, than in the case of a solar energy. There is a sand and dust factor, to be taken into consideration. It causes damage to the rotors, so the maintenance cost are on average much higher than in other countries. Still the wind resources in Afghanistan show promise. Most of these wind resources are in the west and north, but certain well-known wind corridors are located closer to the Kabul in Parwan and Kabul provinces (USAID, 2011a). The lowland areas in the south and west have around 120 windy days per year, with average velocity of four meters per second (AEICb).

As in the case of other renewable energy resources, Afghanistan needs outside help also in this respect. In the beginning of 2013 the German government has pledged to provide financial aid for the establishment of wind power plans in Afghanistan. This will mark Afghanistan's first ever installment of wind power supply (Germany To Fund Wind Power Plans In Afghanistan, 2013).

As for concrete projects, there is a plan of building of 945 wind turbines on the outskirts of Herat[6]. One of the studies revealed that this part of country has ideal conditions for the wind turbines (Life Support

and Sustainable Living Program). United States Agency for International Development and United States National Renewable Energy Laboratory have identified approximately 158,000 megawatts of untapped potential wind (Energy That Never Run Out, 2012).

As in the case of solar energy, also in this case there are a local and foreign initiatives. There is for example a case of a local initiative of Khalifa Muhammad Rahim Rasool from Balkh Province who for last nine years is producing wind pumps which are acco,modated to local needs. His wind pumps have 20 blades, stand 20 meters high and can be build in a week by three or four workers. They can pump 20 liters of water per minute out of a 30 metre-deep well. Rasool is not the only one now, who produces such pumps, there is a number of local producers who are building such pumps (Rahimi, 2012). But there are also on Afghan market some foreign companies, such as Indian Exide Industries, which is present in Afghanistan since 2002. This company offers, for example 400-watt rooftop wind power generation systems, coupled with bigger installations of 1,000 watts and 3,200 watts, targeted at high-worth or institutional customers (Bose, 2004). Another example is the largest small-scale wind installation built by the New Zealand experts. This wind farm consists of ten turbines and produces 75kW of electricity for governmental buildings in the Panjshir Valley (Afghanistan's First Wind Farm Wins NZ Award, 2008).

Biomass and biogas

Finally there is an issue of biomass and biogas and its use as a source of energy in Afghanistan. Biomass is biological material derived from living, or recently living oranisms. It most often refers to plants or plant-derived materials (What is Biomass?). The most obvious sources of biomass is trees. Woodfuel cab be derived from conventional forestry practice, from surgery operations and from management of gardens or parks.

In the case of Afghanistan the use of wood as a source of biomass is not so obvious. Traditionally wood was used as a burning material at homesteads but not as a source of energy on a larger scale. What is more, the access to firewood was always problematic, as a wooden areas are irregularly dispersed and they were intensively exploited even in the 19th century, especially near Kabul. In the period between 1890 and 1908, the wood supplies of the region were almost exhausted, and the workshops faced a fuel shortage. The situation was so critical that in 1908 two avenues

of poplars lining the city streets were felled for government use. The police were ordered to protect the trees of the region and to fire on anyone seen cutting them for their own use, pack animals were muzzled to keep them from nibbling at the green branches, and a modest refosteration program was hurriedly set in motion. But these haphazard mrasures did little to alleviate the immediate situation (Thornton, Thornton, 1910, p. 54; Martin, 1907, p. 265).

The level of forestation, despite the actions undertaken to alleviate this problem, not only did not rise, but even diminished. According to reports prepared by the international organizations, during 1977-2002 was observed the process of deforestation. In the eastern part of the country (where most of the vegetation occurs) disappeared 50-80% of forests (Forest Department, 2010, p. 6).

This process was caused by several factors: long conflict, the extensive use of firewood, illegal woodcutting and export of the illegally acquired wood[7]. In effect right now only some 1,3-2,1% of the country is covered by woods and forests. And this is one of the lowest in the world forestation index (United Nations Environment Programme in Afghanistan, 2009, p. 6). Despite that the wood is still used as a firewood in homesteads, and according to "The Economist" it could lead to the complete deforestation of Afghanistan (Bare Mountains, Poor People, 2001).

There is potentially an alternative to wood, it is the poppy straw. But this rises certain problems, also moral ones. In theory it is good alternative. Afghanistan is the largest opium producer in the world. In 2012 the area of the poppy cultivation was as large as 154,000 hectares (United Nations Office on Drugs and Crime, 2012, p. 11). Its by-product is a poppy straw. There is no data as to the amount of poppy straw produced In Afghanistan each year. Quite probably the farmers, cultivating opium poppy are using its straw as a fire material, but surely they did not use it for produce of biomass and biogas. What is more the state, nor NGO-s or international institutions could postulate the use of poppy straw as a source for biomass production, as it would mean a kind of legalization of opium poppy cultivation.

There is also another reason why biomass and biogas are not viewed as useful option of energy production. As Abdul Rahman Ashraf, well known scholar and Afghanistan ambassador in Berlin, stressed: "Biofuels raise competition with agricultural land use and water resources for irrigation" (Ashraf, 2009, p. 25).

Conclusion

Summing up, the fact that the renewable resources of energy could potentially have an enormous significance for Afghanistan, is evident from the fact that foreign powers such as the US and Germany are willing to support investments in this field. Only during 2009-2011 just the USAID was committed to building the capacity of the Afghan government to provide its people with renewable energy. The Afghan Clean Energy Project (ACEP) aims to foster energy independence and development through increased use of renewable energy technologie. In effect of ACEP they accomplishments: electrified two health clinics with 5kW soplar power systems, installed solar systems totalling 20kW to electrify three schools, installed 367 solar streetlights in eleven provinces, wrote Afghanistan's first solar implementation guidelaine and technical specification and trained 498 people (including 37 women) on various topics connected with renewable energy (USAID, 2011b). What is more within ACEP the Americans played a significant part in creating Renewable Energy Laboratory (KURE Lab) at Kabul University, as a part of the Faculty of Engineering. The KURE Lab is intended to serve as a multipurpose facility for renewable energy education, research, component testing, and evaluation for engineers (USAID, 2011c). The Germans on the other hand are engaged in a trainings connected with the use of renewable energy sources. The foundations have now been laid for the first training centre for renewable energy technology. Here technicians will learn how to maintain the hydro and solar power plants (German Cooperation with Afghanistan, 2013b).

Therefore in favorable conditions, the use of Afghanistan's reserves of renewable energy may, as Martin Wright editor of Green Futures wrote, make Afghanistan a "promising haven of renewable energy" (Wright, 2012).

References:

Afghan Energy Information Center (AEIC , 2004, January), Securing Afghanistan's Future: Accomplishments and the Strategic Path Forward, Power Sector, Annex 3: Afghanistan Generation Installed Capacity, Annex 3. Access (July 7, 2013) from www.afghaneic.org/Presentations/Securing%20Afghanistan's%20Future2.pdf

Afghan Energy Information Center (AEICa), Solar Energy. Access (July 20, 2013) from www.afghaneic.org/solar.php

Afghan Energy Information Center (AEICb), Wind Energy. Access (July 20, 2013) from www.afghaneic.org/wind.php

Afghan Shams Solar Energy Co., 100% Afghan Made, September 4, 2012. Access (July 20, 2013) from afghanstarlight.com

Afghan Solar Ltd. Access (July 20, 2013) from www.afghansolar.com

Afghanistan Forest Information and Data. Pozyskano () z rainforest.mongabay.com?deforestation/2000/Afghanistan.htm

Afghanistan's First Wind Farm Wins NZ Award, (2008, December 12), *Scoop Business*. Access (July 26, 2013) from www.scoop.co.nz/stories/BU0812/S00276.htm

Ali, M. (1959). *Afghanistan (The Mohammedzai Period)*. Kabul: Khan Mohammed Ali Khan.

Armstrong ,J., Hamrin, J. (2000). The Renewable Energy Policy Manual, United States Export Council for Renewable Energy, Washington. Access (July 6, 2013) from www.oas.org/dsd/publications/Unit/oea79e/oea79e.pdf

Ashraf, A. R. (2009, November 10 and 11), Energy Sector Afghanistan. Importance of Renewable Energy for Afghanistan, International Conference on "Renewable Energy in Central Asia: Creating Economic Sustainabiliyu to Solve Socio-Economic Challenges", Dushanbe, Tajikistan, Access (July 16, 2013) from carnegieendowment.org/files/Presentation_-%20Ashraf.pdf

Bare Mountains, Poor People (2001, November 1st), *The Economist*. Access (July 26, 2013) from www.economist.com/node/842516

Bose, P.R. (2004, October 20). Exide To Power Afghanistan With Its Wind, Solar Energy. *The Hindu. Business Line*, Access (July 26, 2013) from www.thehindubusinessline.in/2004/10/20/stories/2004102002840100.htm

Chan, L. (2007, November 1), The Lost Forests of Afghanistan, *UBC Reports*, 53 (11). Pozyskano () z www.publicaffairs.ubc.ca/ubcreports/2007/07nov01/afghanistan.html;

Energy That Never Run Out (2012, 13 September), *Sada-e Azadi.* Access (July 25, 2013) from www.sada-e-azadi.net/index.php/en/topics/features/6714-energy-that-never-run-out?googleb0t=true

Flak, A. (2012, January 9). Electricity Only Reaches One In Three Afghans, *Reuters*. Access (July 10, 2013) from http://www.reuters.com/article/2012/01/09/us-afghanistan-power-idUSTRE8080C920120109

Forest Department, Food and Agriculture Organization of the United Nations (2010). Global Forest Resources Assessment 2010. Country Reports: Af-

ghanistan, FRA2010/001, Rome. Access (July 27, 2013) from www.fao.org/docrep/013/al437e.pdf

German Cooperation with Afghanistan, Hydroelectric Power Generation (2013a, January) Deutsche Gesellschaft fűr Internationale Zusammenarbeit GmbH, Bonn. Access (July 10, 2013) from www.ez-afghanistan.de/fileadmin/content/fact-sheets/english/2013-kraftwerk_e-RZ.pdf

German Cooperation with Afghanistan, Energy as a Key to Development (2013b, January) Deutsche Gesellschaft fűr Internationale Zusammenarbeit GmbH, Bonn. Access (July 10, 2013) from www.ez-afghanistan.de/fileadmin/content/fact-sheets/english/2013-energie-allgemein-e_RZ.pdf

Germany To Fund Wind Power Plans In Afghanistan (2013, January 10). *Wadsam*. Access (July 20, 2013) from www.wadsam.com/germany-to-fund-wind-power-plans-in-afghanistan-7868/

Gurevich, N. M.,(1963). *Voprosy ekonomiki Afganistana*. Moskva: Izdatelstvo Akademii Nauk SSSR,

Haider, H. (2012, 18 January). UAE to Set Up Clean Energy Project in Afghanistan, *Khaleej Times*. Access (July 17, 2013) from www.khaleejtimes.com/displayarticle.asp?xfile=/data/theuae/2012/January/theuae_January454.xml&section=theuae

Hansard (House of Commons Daily Debates) Archive (2008). Parliamentary Business, International Development, Afghanistan: Power Station, 26 November. Access (July 7, 2013) from www.publications.parliament.uk/pa/cm200708/cmhansrd/cm081126/text/81126w0067.htm

International Assistance Mission (2011). 2011 Annual Report. Access (July 10, 2013) from www.iam-afghanistan.org/sites/default/files/2011%20Annual%20Report.pdf

Islamic Republic of Afghanistan, Ministry of Mines, A Brief History of Natural Gas in Afghanistan. Access (n.d) from http://mom.gov.af/en/page/4750

Islamic Republic of Afghanistan, Ministry of Energy & Water (2007, April 15). Power Sector Strategy for the Afghanistan National Strategy. Pozyskano () z http://www.carecprogram.org/uploads/docs/AFG-Power-Sector-Strategy-en.pdf

Jhanmal, Z. (2013, 17 January). Solar Expert See Strong Potential in Afghanistan. *Tolonews*. Access (July 20, 2013) from tolonews.com/en/afghanistan/9102-solar-experts-see-strong-potential-in-afghanistan

Kandahar University – Afghanistan's Pioneer In Renewable Energy (2013, 13 May), *News2WOWU*, Access (July 17, 2013) from www.qsnews2wow-u.

com/latest/kandahar-university-afganistans-pioneer-renewable-anaergy/

Kingston, J. (1990). *The Undiscovered Oil and Gas In Afghanistan.*Santa Barbara: Department of the Interior, U.S. Geology Survey. Access (July 5, 2013) from http://pubs.usgs.gov/of/1990/0401/report.pdf;

Life Support and Sustainable Living Program, Wind Power for Herat, Afghanistan. Access (July 25, 2013) from www.ccot-lifesupport.org/wind%20power%20for%20herat.html

Malik, N. (2011). *Overview and Prospects for Energy Resource in Afghanistan: Measures for Improvement and Sustainable Development. The Journal of Energy and Development* 35 (1), pp.141-164.

Martin, F.A. (1907). *Under the Absolute Amir.* London, New York: Harper & brothers.

Ministry of Mines and Industries of the Democratic Republic of Afghanistan, Afghanistan Geological Survey (2008). *Geology and Mineral Resources of Afghanistan*, Book 2, *Mineral Resources of Afghanistan.* British Geological Survey, Report Series Published by British Geological Survey

Ministry of Water and Power Preface. Access (July 7, 2013) from

www.afghaneic.org/Presentations/English%20version%20Presentation.pdf.

Najafizada, E. (2010, August 15). Afghanistan Says It Locates 1.8 Billion-Barrel Oilfield in Nation's North. *Bloomberg.com.* Access (July 6, 2013) from http://www.bloomberg.com/news/2010-08-15/afghanistan-discovers-1-8-billion-barrel-oilfield-in-north-ministry-says.html

New Solar Panels Installed In Badghis Province (2011, January 24). *dvids*, Access (July 17, 2013) from www.dvidshub.net/news/64132/new-solar-panels-installed-badghis-province#.UapLkdJM_xA

Oil Field Discovered in Afghanistan, (2010, August 16). *The Independent*, Pozyskano () z http://www.independent.co.uk/news/world/asia/oil-field-discovered-in-afghanistan-2053829.html

Oskarsson, K. (2012, November). Sustainability of Energy Supplies in Afghanistan. *Afghanistan in Transition*, Civil-Military Fusion Centre, Access (July 5, 2013) from reliefweb.int/sites/reliefweb.int/files/resources/CFC_Afghanistan_Sustainability_of_Energy_Supplies.pdf

Poya, S. (2010, August 10). Afghanistan's Energy Potential, *New Eastern Outlook*. Access (July 12, 2013) from http://www.journal-neo.com/node/1002

Rahimi, R. (2012, July 3). The Innovators: Second Wind For Farmers, *Afghanistan Today*. Access (July 25, 2013) from www.afghanistan-today.org/article/?id=241

Renewable Energy Policy Network for the 21st Century (2013). *Renewables 2013. Global Status Report,* Paris. Access (July 6, 2013) from www.ren21.net/Portals/0/documents/Resources/GSR/2013/GSR2013_lowres.pdf

Rodrigues, A.R., Barbarics, T. (2012). Foreign Military Bases with Renewable Energy Sources, Hadmérnök, VII Evfolyam 1 szám – 2012. Március. Access (July 14, 2013) from hadmernok.hu/2012_1_rodriguez_barbarics.pdf

Saba, D.S.,Najaf, M.E., Musazai A.M., S.A. Tarak, S.A. (2004, February). *Geothermal Energy In Afghanistan: Prospects and Potential, Center on International Cooperation*, New York University, New York & Research Institute for Economic Development and Social Policy, Kabul.

Sada-e Azadi, (2013, 21 January). Kandahar University To Be National 'Model' In Renewable Energy, *Afghan-review.* Access (July 17, 2013) from www.afghan-review.com/index.php/education/item/202-kandahar-university-to-be-national-model-in-renewable-energy

Shahrani, W. (2011, 26 October). *Outlook for the Mining Industry In Afghanistan*, Mining Investors' Forum for Afghanistan, Brussels, Access (July 5, 2013) from http://mom.gov.af/Content/files/Minister's%20Presentation%20in%20Brussel%20on%20Outlook%20for%20the%20Mining%20Industry%20in%20Afghanistan,%20Oct%202011.pdf

Shroder, Jr, J.F., Assifi, A.T., (1987). Afghan Resources and Soviet Exploitation. in: Klass R. (ed.), Afghanistan. The Great Game Revisited (ss. 97-134). New York: Freedom House.

Thornton, E., and Thornton, A. (1910). *Leaves from an Afghan Scrapbook.* London: John Murray.

United Nations Environment Programme in Afghanistan (2009, January). *Laying the Foundations for Sustainable Development*. Access (July 27, 2013) from www.unep.org/pdf/UNEP_in_Afghanistan.pdf

United Nations Office on Drugs and Crime (2012). *Afghanistan Opium Survey, 2012*. Access (July 28, 2013) from www.unodc.org/documents/crop-monitoring/Afghanistan/Afghanistan_OS_2012_FINAL_web.pdf

United States Institute of Peace, International Network for Economics and Conflict, (2012, August 13). *Could Afghanistan's Water Woes Undermine Peace?*Access (July 12, 2013) from http://inec.usip.org/blog/2012/aug/13/water-and-energy-planning-afghanistan-mitigating-security-threats-through-sustainab

U. S. Department of the Interior, U.S. Geological Survey, (2006). *Assessment of Undiscovered Petroleum Resources of Northern Afghanistan, 2006*, March,

Fact Sheet 2006-3031. Access (July 5, 2013) from http://pubs.usgs.gov/fs/2006/3031/pdf/FS-3031.pdf

U.S. Department of the Interior, U.S. Geological Survey, (2005, June). *Assessing the Coal Resources of Afghanistan*, Fact Sheet 2005-3073. Access (July 5, 2013) from http://escweb.wr.usgs.gov/share/mooney/USGS%20coal%20assessment.pdf

USAID (2011a, December 26*). The Future is Blowing in the Wind*. Access (July 20, 2013) from afghanistan.usaid.gov/USAID/Article/2521/The_Future_is_Blowing_in_the_Wind

USAID (2011b, June). *Fact Sheet: Afghan Clean Energy Project (ACEP)*. Access (July 20, 2013) from afghanistan.usaid.gov/en/USAID/Activity/152/Afghan_Clean_Energy_Project_ACEP

USAID (2011c, 4 May). *Establishment of Renewable Energy Laboratory AT Kabul University* . Access (July 20, 2013) from Afganistan.usaid/gov/en/USAID/Article/2233/Establishment_of_Renewable_Energy_Laboratory_at_Kabul-University

Watkins, E. (2010, August 18). Afghanistan Claims 1.8 Billion bbl Oil Field Find, *Penny Energy*. Access (July 6, 2013) from http://www.pennenergy.com/index/petroleum/display/6576660494/articles/oil-gas-journal/exploration-development-2/reserves/2010/08/afghanistan-claims.html

Wilson, I. (2012, August 2). New Zealand to Provide Backing for Afghanistan Solar Project, *Bloomberg.com*. Access (July 17, 2013) from www.bloomberg.com/news/2012-08-02/new-zealand-to-provide-backing-for-afghanistan-solar-project.html

What is Biomass?. Access (July 27, 2013) from www.biomassenergycentre.org.uk/portal/page?_pageid=76,15049&_dad=portal&_schema=PORTAL

Wright, M.(2012, July 6), Inside Afghanistan's Hydropower Revolution", *The Guardian*. Access (July 29, 2013) from http://www.guardian.co.uk/environment/2012/jul/06/inside-afghanistans-hydropower-revolution

Zularistan. Access (July 20, 2013) from www.afghan-solar.com/en/company/index.html

(Endnotes)

1 In China wind power generation increased more than generation from coal and passed nuclear power output for the first time.

2 The United States addend more capacity from wind power than any other technology, and all renewables made up about half of total electric capacity additions during the year.

3 In the European Union, renewables accounted for almost 70% of additions to electric capacity in 2012, mostly form solar and wind power.

4 This plant was built with Indian technical and economical co-operation in 1984.

5 Energy producing section of Afghan economy receives yearly from external sources c. 200 millions USD of assistence.

6 This city, with a population of 350,000, is unable to maintain a constant supply of power. They must rely on imported power from Iran and use diesel generators.

7 For example, in the 1970s, the Badghis and Takhar provinces of northern Afghanistan were covered with pistachio forests. These forests were almost completely lost in three decades because of breakdown of state institutions and many trees were uprooted or depleted by Soviet military forces. Many trees were cutting and illegally exported to neighbouring countries.