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## CURRENT STATUS AND FUTURE DIRECTIONS OF RENEWABLE ENERGY USE IN AFGHANISTAN

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### **Najmuddin Noorzad, PhD Student**

Department of Electrical and Electronics Engineering,  
Muğla Sıtkı Koçman University, Turkey  
Electrical Engineering, Electronics and Automation,  
“Angel Kanchev” University of Ruse, (ERASMUS<sup>+</sup>)  
Tel.: +359 877 904 195 / +90 554 165 2526  
E-mail: najmuddin.noorzad@gmail.com

### **Prof. Nicolay Mihailov, PhD, DHC**

Electrical Engineering, Electronics and Automation,  
“Angel Kanchev” University of Ruse  
Phone: +359 888 539 388  
E-mail: mihailov@uni-ruse.bg

***Abstract:** This paper reviews the existing status of renewable energy source (RES) along with assessing their potential for the contribution of energy demand in Afghanistan, and in order to make the best possible use of these resources, it examines the future prospects. Afghanistan's viable renewable energy sources are hydro, solar, wind, biomass and geothermal, which are spread over wide geographical areas throughout the country. Nowadays, the power sector of Afghanistan has mainly relied on importing electricity from the neighbor countries, which is not an optimum solution for the long-term. The most hopeful and promising source for everlasting electricity generation in Afghanistan is renewable energy (RE), which offers a wide array of opportunities. Afghanistan can produce around 318 GW of power through utilizing renewable energy resources available in the country. The rapid and high deployment of renewable energy empowers a sustainable future in Afghanistan. In addition, Afghanistan's energy sector and its economy are at crossroads of the region. This potential can be harnessed timely for the benefit of the country and entire region.*

***Keywords:** Renewable energy, Energy demand, Electricity generation, Potential, Power sector.*

## **INTRODUCTION**

### **Country Profile and Power Sector Outlook**

Afghanistan is a country located in the south-central Asia highly enriched with natural resources. The geographic location of Afghanistan is strategic and called as the heart of Asia because it connects the South Asia to Central Asia, and has surrounded by six countries (RECCA, 2015). It has a total land area of 652,230 km<sup>2</sup>. According to the (Bertelsmann Stiftung, 2018) BTI country report - Afghanistan population is 34.7 million and more than 70% of population is living in rural areas. The conflict and instability during the past decades has constrained the country's development, especially the energy infrastructure (EoI-SREP).

Afghanistan is on the verge of stability and growth, and needs reliable supply of energy sources to fuel this growth. Still, Afghanistan is among the countries, which has the lowest energy consumption in the world (195 kWh per annum) and has limited access to electricity (MEW-REP, 2015). This situation results in huge difficulties to meet the primary demands of people and delay the national development progress. Energy access is a crucial need for development progress in Afghanistan. The power supply system in Afghanistan is delivered through a combination of grid-based networks, mini-grid systems and stand-alone facilities, which are insufficient in terms geographic coverage, adequacy, flexibility, and cost of domestic supply (World Bank, RE report, 2018). It has reported on the 2013-2014 Living Conditions Survey (ALCS), while 89 % of households in the country having some kind of access to electricity, only 29.7 % are receiving their power from the grid, the remained households mostly rely on off-grid solar power-probably

solar home systems (SHS) (World Bank, RE report, 2018).

Afghanistan's total power production capacity is 1500 MW, almost 80% of which is imports. In addition, it has an off-grid installed capacity of 50 MW from renewable energy sources (MEW-REP, 2015). Grid supply highly depends on imports from neighbor countries, supplemented by electricity generated from domestic hydropower plants (HPPs). In 2015-16, the total supply from the grid-network was 4,777 GWh of which 1,007 GWh were domestic generations (Hydro 967 GWh, and Thermal 39 GWh) and the rest 3,767 GWh were imports from neighbour countries (See Fig. 1). The transmission system is disintegrate, consisting of detached grids or islands supplied by diverse power systems including different importing sources and different generating stations (World Bank, RE report, 2018).

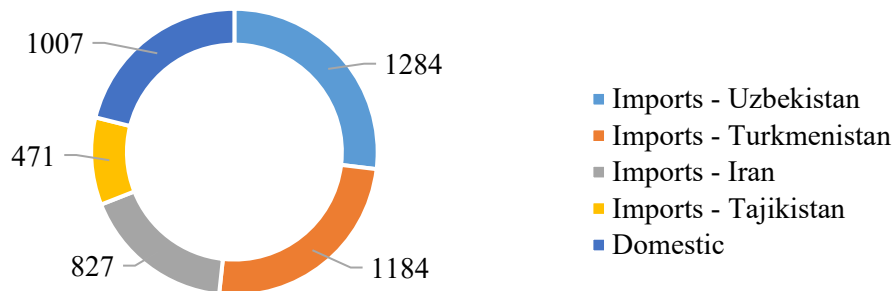


Fig. 1. Grid electricity supply of Afghanistan (GWh), 2015-2016

Lack of access to reliable, affordable and secure energy has limited the economic, social and educational opportunities, especially for those who are poor and live in rural areas (EoI-SREP). The solution is to diversify the power supply particularly by using renewable energy sources in order to ensure a sustainable future (Rostami, R. et al., 2017). The objective of this paper is to review the potential viability and future prospects of renewable energy use as part of the electricity supply in Afghanistan.

## EXPOSITION

### Renewable Energy Outlook in Afghanistan

Fortunately, Afghanistan enjoys an abundance of Renewable Energy Sources (RES), it is only beginning to exploit them, specially the provinces and remote areas that are unlikely to be supplied by a centralized grid has enormous Renewable Energy (RE) potential. The exploitation of these resources could help to alleviate future energy supply gaps at a level cost that are both financially and economically attractive. Now it is the time for Afghanistan to rebuild its energy sector within focusing on sustainable energy for its population (Rostami, R. et al., 2017).

The evidences show that from a theoretical standpoint, there is a noticeable potential of RES in Afghanistan and it can produce about 318 GW of power utilizing available RES in the country through diversified RES (Hydro, Solar, Wind, Biomass and Geothermal). This section briefly assesses the available theoretical potential of above-mentioned types of renewable energy sources in the country.

### Hydropower

The most widely used form of RE in Afghanistan is known as hydropower. The main portion of domestic electricity generation is comprised of large hydropower plants operating inside the country (Ludin, G. A., et al., 2016). Afghanistan with its mountainous terrain, annual average rainfall of 300 mm, stream catchment area of 677900 km<sup>2</sup>, and with extensive river system has major hydro resources (Rostami, R. et al., 2017). Total theoretical potential of hydroelectric capacity is estimated 23,000 MW (where 300 MW is operating), and technically the feasible

capacity to tap is claimed more than 5,000 MW (World Bank, RE report, 2018; Ludin, G. A., et al., 2016).

### Solar energy

Afghanistan is a “sunbelt” country having great solar resource that make the major portion of RE potential in the country. “Most of Afghanistan lies between a latitude of 30 and 38 degrees north and 60 to 72 degrees east” (World Bank, RE report, 2018). With 300 days of sunshine each year, average estimated solar radiation of (6.5 kWh /m<sup>2</sup> /day) and feasible area the total capacity of solar power is estimated 222,000 MW. The 10 km resolution annual map of solar radiation relevant for photovoltaic technology was evaluated by national renewable energy laboratory (NREL) as shown in Fig. 2.

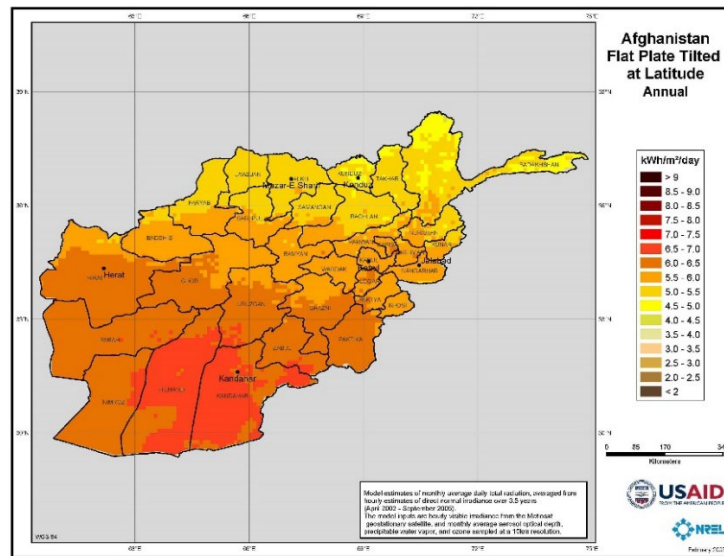


Fig. 2. Annual solar irradiance map of Afghanistan (Fichtner. PSMP, 2013)

### Wind energy

Afghanistan also has considerable wind resources, which hugely localized with the areas of maximum potential located in the western and southwestern regions. The total theoretical potential is predicted about 158000 MW (with 5 MW/km<sup>2</sup>), and the total feasible potential is 66726 MW (Ludin, G. A., et al., 2016).

Table 1. Afghanistan wind power potential (RED, Database, 2015)

Wind Power Class	Resource Potential	Wind Power (W/m <sup>2</sup> )	Wind Speed (m/s)	Land Area (km <sup>2</sup> )	Windy Land (%)	Wind Power Potential (MW)
1	Poor	0 - 200	0 - 5.4	-	-	-
2	Marginal	200 - 300	5.4 - 6.1	-	-	-
3	Moderate	300 - 400	6.1 - 6.8	-	-	-
4	Good	400 - 500	6.8 - 7.3	15193	2.4	75970
5	Excellent	500 - 600	7.3 - 7.7	6633	1	33160
6	Outstanding	600 - 800	7.7 - 8.5	6615	1	33100
7	Superb	> 800	> 8.5	3169	0.5	15800
<b>Total</b>				<b>31610</b>	<b>4.9</b>	<b>158030</b>

Based on the data, there are around (120 windy-days/year) in the lowland areas in the west and south zones (Rostami, R. et al., 2017). Almost 12 % of Afghanistan's land area has "Class 3" or better wind resource (See Table 1).

### Biomass

Biomass energy has excellent potential (4000 MW) for electricity production in Afghanistan. The largest portion of households' primary energy consumption in Afghanistan massively rely on solid biomass that the efficiency of conversion is very low (Rostami, R. et al., 2017). The share of power generation potential from biomass resources each (crop residue, animal manure and municipal solid waste) is shown in Fig. 3. (RED, Database, 2015).

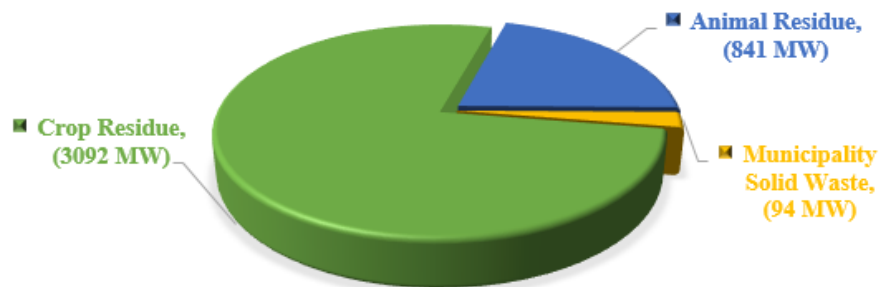


Fig. 3. Afghanistan biomass resource potential (MW)

### Geothermal energy

Geothermal energy has a certain potential (3,000 - 3,500 MW) to afford cover part of power demand in Afghanistan (MEW-REP, 2015). The active geothermal systems are localized along the Hindu Kush Mountains but to exploit these resources certain conditions have to be met in terms of depth and technology, however it is not expected that geothermal power generation will have a significant part on the power generation in Afghanistan within the next 20 years.

### Prospects of Renewable Energy use in Afghanistan

The massive need for energy resources has always been a major concern in human life and an effort to access an inexhaustible energy source is one of the longstanding desires of human. Fortunately, Afghanistan has a substantial potential of endless energy type which are RES such as hydro, solar, wind, biomass and geothermal.

The use of these resources will not only meet the growing energy demand, but also create many opportunities and having different benefits:

- Eco-friendly (they are clean; less global warming)
- Reliability and resilience (sustainable, reduce energy dependency, improving energy security, diversify the energy supply, empowering of people in the countryside)
- Socio-economic benefits (leads to to employment & job creation, boosts productivity, poverty alleviation, improved public health, better education & communication services, improve human development indicators)

Access to energy and energy security are two fundamental requirements for the economic and social growth of Afghan communities. With its tremendous potential in Afghanistan, the renewable energy source can be used successfully to meet these two requirements. Therefore, the development of the RE sector is a high priority of the Afghan Government and all its supportive partners (ABD-RER2032, 2017). Moreover, in some areas having significant RE potential, it may be more appropriate to served by local renewables than to provide grid-based supply with subsidized tariffs that do not meet the service costs of local renewable energy sources (Ludin, G. A., et al., 2016).

The latest and most comprehensive electricity demand forecast in Afghanistan has been developed as part of the Power Sector Master Plan (PSMP). Afghanistan's RE policy sets a target of 4,500 to 5,000 MW of RE capacity to deploy by 2032, this corresponds to 95% of the total energy mix of 5,000 to 6,000 MW in line with the targets of PSMP (MEW-REP, 2015).

According to the database of RE projects has prepared by Ministry of Energy and Water (MEW), over 5000 RE projects comprising solar, wind and micro hydro plants (MHP) have been completed or under construction. The total installed capacity of completed projects is 55 MW (See Fig. 4), and recently MEW has been invited private sector to invest on another 30 renewable energy projects totalling capacity upto 100 MW (ABD-RER2032, 2017; MEW-REP, 2015).

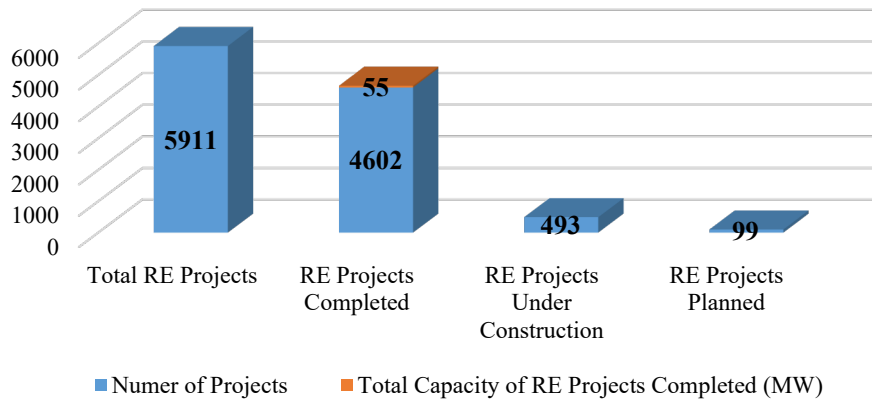


Fig. 4. Status of renewable energy projects in Afghanistan

Indeed, the large hydro plants are only one aspect of hydropower resources in Afghanistan. There are 13 hydropower plants (HPPs) with a total installed capacity of around 300 MW operating in the country. The two largest power plants are Naghlu and Mahipar HPPs at installed capacity of 100 MW and 66 MW respectively (World Bank, RE report, 2018).

Along with hydroelectric, solar energy in the form of SHS through PV panels have also proliferated across the country for lighting purposes (ABD-RER2032, 2017). The total installed capacity of solar photo-voltaics are about 13 MW, and the largest solar power plant in Afghanistan is a 1 MW solar PV system in the central Bamyan province that provides electricity via a minigrid for near villages (Ershad, A. M., 2017).

Sixteen wind-monitoring stations have settled in different parts of Afghanistan. A few number of small wind turbine systems (<50kW) have been installed in different locations of the country. The first ever wind power plant having capacity 100 kW (battery backup system) has been installed in Panjsher province (ABD-RER2032, 2017). In addition, the first-ever hybrid (solar & wind) 2 MW power plant project was put in service on September 2017 at the industrial park in western Herat province of Afghanistan. Through these, the 5320 solar PV boards would produce 1700 KW (1.7 MW), while remaining 300 KW will produce by three wind turbines (DABS).

The future prospect of RE in Afghanistan is very promising, especially in the case of solar, wind and hydro energy. To date, the use and exploitation of renewable energy source is minimal relative to its potential in Afghanistan. One of the initiatives that has identified and emphasising by the Government of Afghanistan is to invest and capitalize on its wealth of RES. Therefore, it is expected that the national RE market will grow rapid and remarkably in the coming decade and beyond.

### Risks and Barriers

While there are plenty of ongoing support for successful deployment RE in the Afghanistan, still some key obstacles could prohibit the full development this sector.

To classify the issues there will be five major categories including:

1. Security and political instability
2. Technical and human capacity
3. Economic and Financial risks
4. Organizational and Institutional risks
5. Lack of powerful policy and gaps in the regulatory frameworks

## **CONCLUSIONS**

Renewable energy plays an important role in meeting the future expected power demands of both urban and rural areas. Afghanistan is well endowed with high levels of RES. The current level of using RE and modern technology is low in Afghanistan. The development and utilization of RE seeks more attention and should be given a higher priority in the country. As a matter of urgency, all stakeholders in the energy sector should rise up and work hand in hand to emphasize more on RES to produce electricity and solve the power crisis problem in Afghanistan.

In this paper, the current scenarios of RES in Afghanistan is shown very clearly and coherently. The compendium of this article shows that there is a great opportunity for Afghanistan to meet its overall energy demand by utilizing properly its available renewables. If it could make the best possible use of its available RE potential then it is feasible to extract the load-shedding problem from the country. As a result, this is the high time to look forward and deal with the fields of renewable energy to generate power rather than to rely on importing electricity from neighbors countries. Well managing of renewable energy resources can make the economy of Afghanistan great.

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