Renewable Energy

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Abstract:

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Energy is a crucial input in the process of economic, social, and industrial development. As conventional energy sources are depleting day by day, utilization of alternative energy sources is the only solution. The increased power demand, depleting fossil fuel resources and growing environmental pollution have led the world to think seriously for other alternative sources of energy. Basic concepts of alternative energy resources are related to the issues of sustainability, renewability, and pollution reduction. Here we have discussed about various alternative energy resources and their usability for future demands.

Renewable Energy

Renewable energy comes from sources that are replenished naturally, such as the sun and wind. Renewable energy uses energy sources that are continually replenished by nature—the sun, the wind, water, the Earth's heat, and plants. Renewable energy technologies turn these fuels into usable forms of energy—most often electricity, but also heat, chemicals, or mechanical power. Traditional energy sources, like coal and oil, are finite and when burned, release carbon in the form of carbon dioxide and methane, two greenhouse gases that significantly contribute to the acceleration of global climate change. Renewable energy, on the other hand, either does not emit carbon or is carbon neutral, meaning it absorbs as much carbon as it emits.

Why Use Renewable Energy?

Today we primarily use fossil fuels to heat and power our homes and fuel our cars. It is convenient to use coal, oil, and natural gas for meeting our energy needs, but we have a limited supply of these fuels on the Earth. We are using them much more rapidly than they are being created. Even if we had an unlimited supply of fossil fuels, using renewable energy is better for the environment. We often call renewable energy technologies "clean" or "green" because they produce few if any pollutants. Burning fossil fuels, however, sends greenhouse gases into the atmosphere, trapping the sun's heat and contributing to global warming.

Types of renewable energy

Here are some of the most common sources of renewable energy, and some concerns about them:

Solar

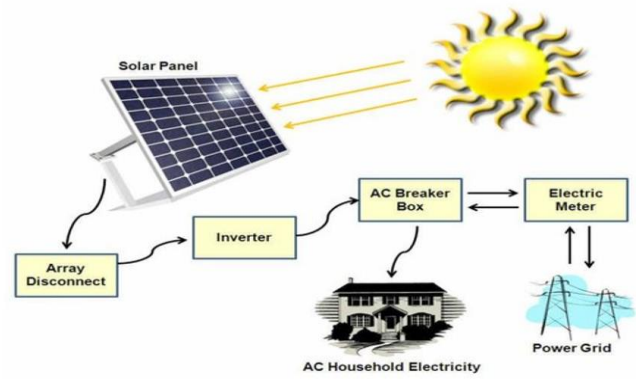
Solar Energy Solar technologies tap directly into the infinite power of the sun and use that energy to produce heat, light, and power. This can be achieved with photovoltaic solar panels or by concentrating solar-thermal power, which enables solar-generated heat to be stored until energy is needed.

Although solar energy is free, it's not always available — the sun doesn't shine at night, which often coincides with peak energy demand, For this reason, the fate of renewable energies such as solar and wind relies on the development of efficient battery storage.

How Does a Solar Panel Generate Power?

Solar panels use the photons produced by sunlight to generate direct current (DC) electricity. When the photons hit the panel, they are absorbed by the panel's semiconducting silicon material. During this process electrons separate from the atoms and move around the solar cell. This movement of the electrons is what generates Direct Current (DC) electricity. The DC electricity then flows to the systems inverter where it's converted to alternating current (AC) electricity. AC is the type of electricity needed to supply the property with power.

Wind Energy For hundreds of years, people have used windmills to harness the wind's energy. Today's wind turbines, which operate differently from windmills, are a much more efficient technology.



Wind

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Wind turbines are giant windmills with huge blades that get pushed around by the wind. As the blades rotate, they spin a generator, which creates electricity. However, environmental groups and scientists are concerned about the impact of wind turbines on local bird and bat populations.

In a wind turbine, a spinning drive shaft is connected to a gearbox that increases the speed of the rotation by a factor of 100 — which in turn spins a generator. Therefore, the gears end up spinning much faster than the blades being pushed by the wind. Once these gears reach a fast enough speed, they can power a generator that produces electricity.

The United States is home to one of the largest and fastest growing wind markets in the world. To stay competitive in this sector, the Energy Department invests in wind research and development projects, both on land and offshore, to advance technology innovations, create job opportunities and boost economic growth.

Fig1

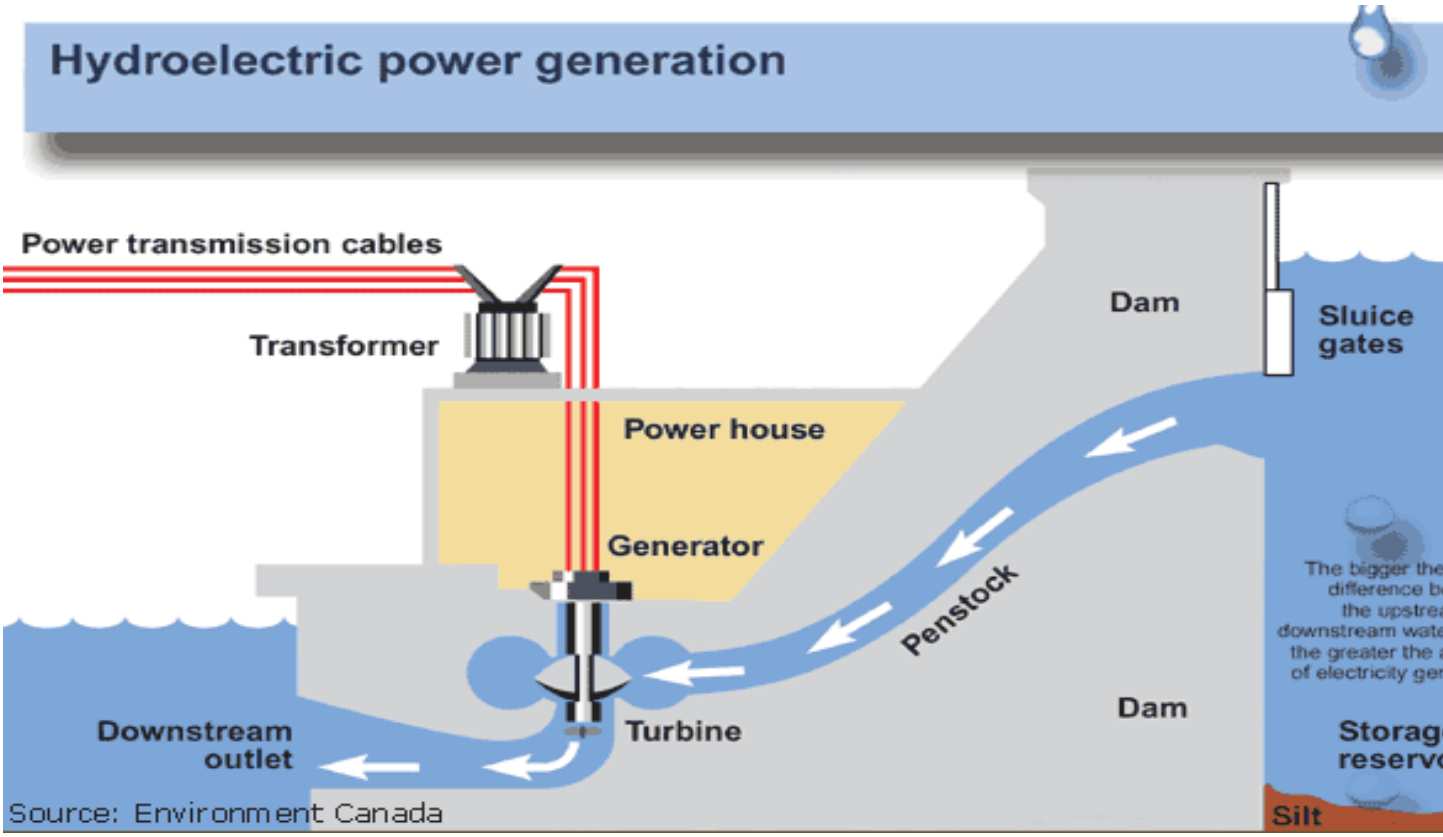
Most powerful, tallest, largest and with highest 24-hour production

GE Wind Energy's Haliade-X is the most powerful wind turbine in the world, at 12MW. It also is the tallest, with a hub height of 150 m and a tip height of 260m. It also has the largest rotor of 220 m and largest swept area at 38000 m It also holds the record for the highest production in 24 hours, at 312 MWh.

Manufacturer	Model	Power rating (MW)	Type
MHI-Vestas	V164-9.5	9.5	Offshore
Siemens Gamesa	SG 8.0-167 DD	8	Offshore
Enercon	E-126 7.580	7.5	Onshore
GE Wind Energy	Haliade-X	13	Offshore

Hydropower

Hydropower, or hydro energy, is a form of renewable energy that uses the water stored in dams, as well as flowing in rivers to create electricity in hydropower plants. The falling water rotates blades of a turbine, which then spins a generator that converts the mechanical energy of the spinning turbine into electrical energy. Pumped storage is another method of hydropower that involves pumping water into a dam at a higher altitude during off-peak periods and then releasing it to transfer energy to the electricity grid when there is high demand. Hydroelectric power is a significant component of electricity production worldwide. Large dams and reservoirs, however, come with environmental concerns of their own, as these large-scale pieces of infrastructure drastically change water flow and affect local ecosystems.



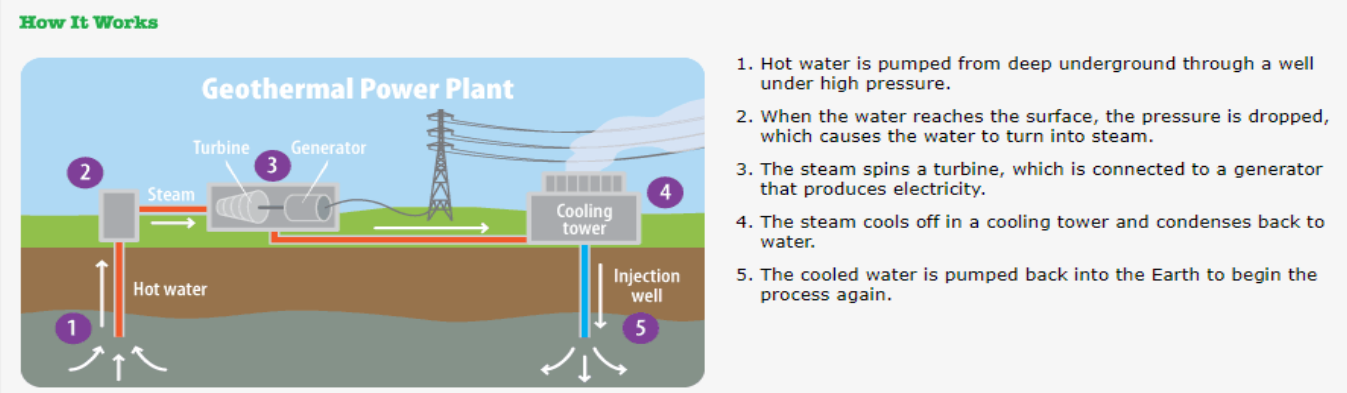
(Credit: Environment Canada)

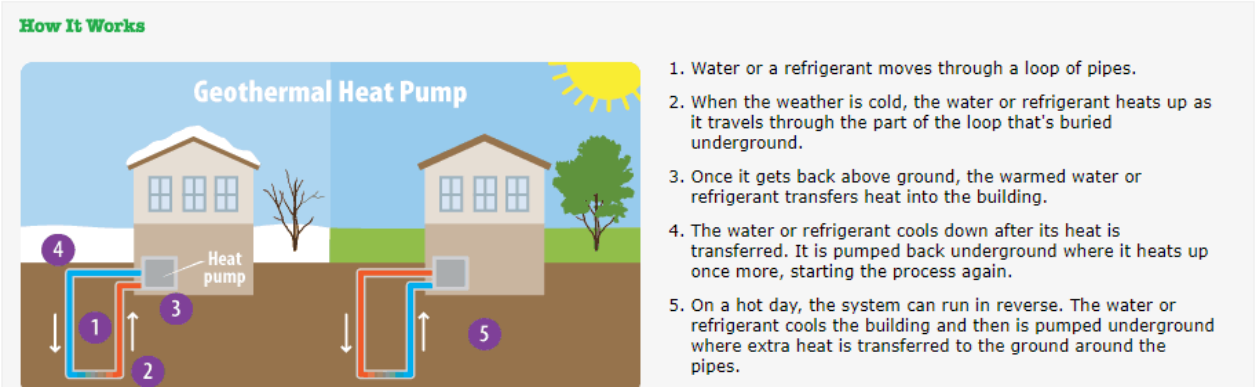
The Three Gorges Dam in Hubei, China, has the world's largest instantaneous generating capacity (22,500 MW), with the Itaipu Dam in Paraguay/Brazil in second place (14,000 MW). Despite the large difference in installed capacity, these two power stations generate nearly equal amounts of electrical energy during the course of an entire year - Itaipu 103 TWh in 2016 and Three Gorges 98.8 TWh in 2014, because the Three Gorges experiences six months per year when there is very little water available to generate power, while the Paraná River that feeds the Itaipu has a much lower seasonal variance in flow. Energy output of the Three Gorges reaches 125 TWh in years of high feed availability.

Geothermal

Geothermal energy is heat derived below the earth's surface which can be harnessed to generate clean, renewable energy. This vital, clean energy resource supplies renewable power around the clock and emits little or no greenhouse gases -- all while requiring a small environmental footprint to develop. Geothermal energy is a renewable "green" source of energy because the heat of the Earth is practically unlimited and, mostly, environmentally friendly.

Geothermal resources are reservoirs of hot water that exist at varying temperatures and depths below the Earth's surface. Mile-or-more-deep wells can be drilled into underground reservoirs to tap steam and very hot water that can be brought to the surface for use in a variety of applications, including electricity generation, direct use, and heating and cooling. In the United States, most geothermal reservoirs are located in the western states.





Renewable energy in Afghanistan

Afghanistan has a good solar resource that can be harnessed for electricity generation and for thermal applications. The country enjoys particularly long sunny days with high irradiation, ranging from 4.5 - 7 kWh/m²/day. Technologies that convert solar energy into electric energy and usable heat are classified into two types:

Solar and wind energy resources of Afghanistan are excellent for applications such as water pumping, water heating, and power generation through centralized schemes, miniguides, and stand-alone systems. Afghanistan is a “sunbelt country” similar to latitude equal parts of the United States.

Solar resource characteristics Afghanistan receives on average about 5.3 kWh per square meter of horizontal surface on a clear day with a standard deviation of 0.42 kWh. This corresponds to an average

annual Global Horizontal Irradiance (GHI) of 1,935 kWh/m². National average seasonal maximum and minimum GHI are 7.84 kWh/m2/day and 2.38 kWh/m²/day. Annual GHI for Herat and Balkh provinces are 1,726 kWh/m2 and 1,967 kWh/m², respectively. Figure 1 show resource map of GHI for Afghanistan

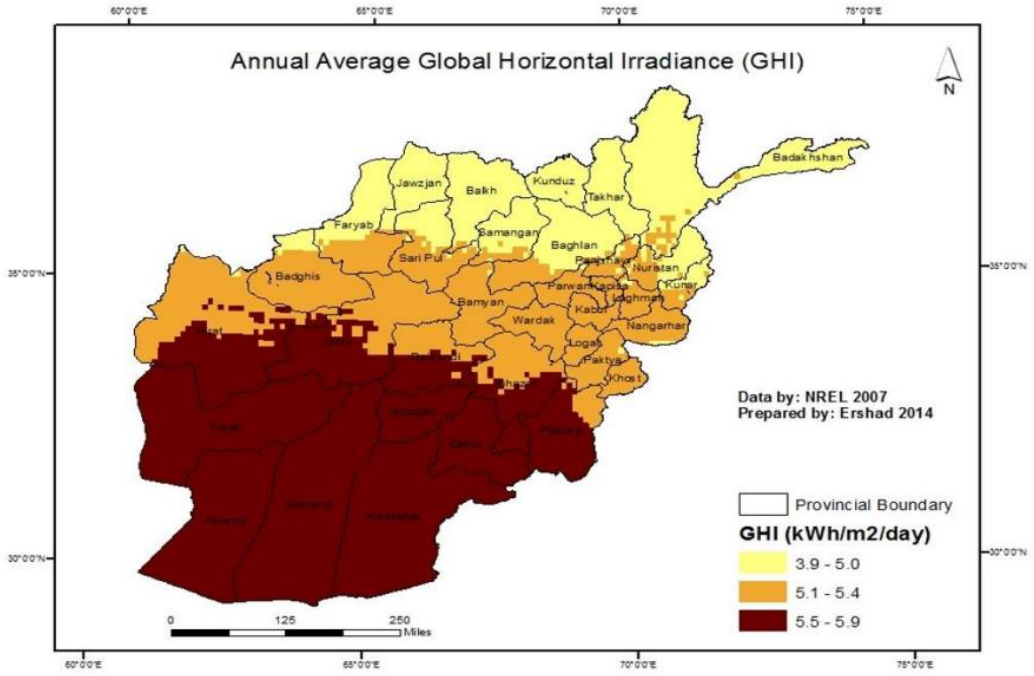


Figure 1: Annual Average Global Horizontal Irradiance (GHI) in Afghanistan

In the meantime, maximum theoretical potential of wind power is estimated to be 158 GW mainly from Herat province in the west and Balkh and Parwan provinces in the north out of which only about 1000 MW of installed capacity is economically feasible. Although it is unclear how much in KW of wind power is installed in Afghanistan due to lack of any industry reporting mechanism, it is estimated that total installed capacity of wind power is about 300 kW with the largest wind power system of 100 kW in the mountainous province of Panjshir.

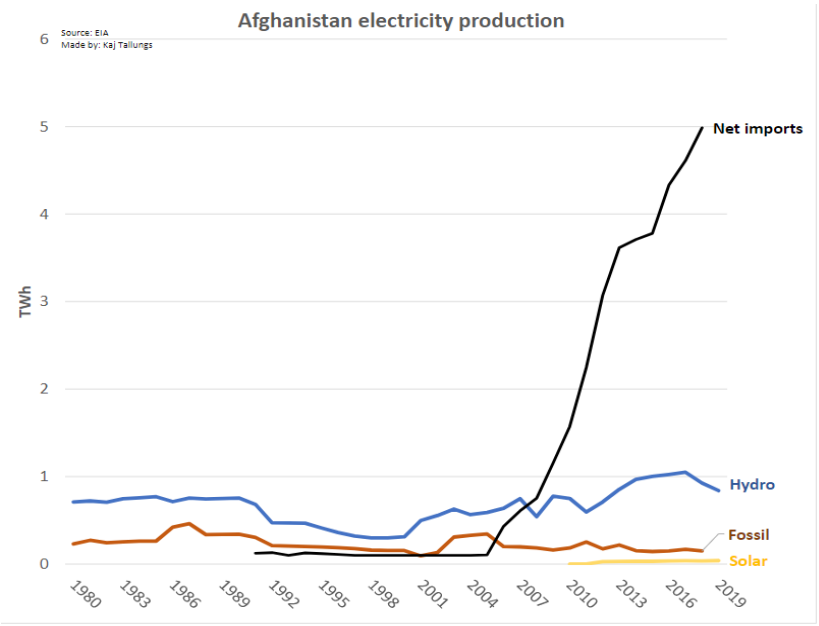
Afghanistan's first wind farm in Panjshir Province

Afghanistan unfortunately has not yet taken advantage of its vast resources of renewable energies such as solar radiation and wind on a scale large enough to meet a significant fraction of its electricity demand. Two of the most promising provinces for renewable energy deployment are Balkh and Herat provinces. Annual average global horizontal solar radiation in Herat and Balkh are 1,726 kWh/m^2 and 1,967 kWh/m^2, respectively. Fixed axis solar power plants tilted at angles equal to the latitudes achieve 14% and 17% annual net capacity factors including modest losses in Balkh and Herat respectively. Typical global capacity factors of solar power plants are in the range of 10% to 20%.

Afghanistan's renewable energy potential is estimated to be over 300,000 MW, consisting of solar (222,849 MW), wind (66,726 MW), hydro (23,310 MW) and biomass (4,000 MW). Geothermal needs more detailed assessments to ascertain realizable potential. Table 1 provides a summary of the total potential for RE resources in different provinces in Afghanistan. RE technical resource maps for Afgh

S. No.	Province/ Capital	RE resource technical potential					
		Solar (MW)	Wind (MW)	Hydro (MW) (River basin)	Biomass- Electrical Energy Production potential (MWhr/ year)		
					MSW	Animal Manure	Crop Residue
1	Kabul (Kabul)	432	41	1,941 (Kabul)	126,884	69,089	465,372
2	Kapisa (Mahmud-e-Raqi)	183	81		13,848	171,438	442,103
3	Parwan (Charikar)	548	127		20,287	160,281	565,369
4	Wardak (Meydan Shahr)	1,043	18		18,231	84,917	529,715
5	Lowgar (Pol-e Alam)	451	-		11,984	72,713	842,423
6	Ghazni (Ghazni)	5,802	48		37,542	227,860	1,343,574
7	Paktia (Gardez)	5,042	99		13,291	144,569	475,755
8	Khost (Khost)	364			17,563	367,769	376,509
9	Nangarhar (Jalalabad)	1,687	146		46,124	626,687	1,749,774
10	Konar (Asadabad)	447	81		13,773	313,913	449,026
11	Laghman (Mehtar Lam)	842	255		13,622	269,201	654,148
12	Nuristan (Nuristan)	888	-		4,526	156,503	93,491
13	Badakhshan (Faizabad)	3,736	331		29,029	452,658	598,604
14	Bamian (Bamian)	1,863	24		13,667	143,149	286,562
15	Takhar (Taloqan)	2,543	1,199	20,137 (Panj-Amu)	29,990	269,732	1,524,344
16	Baghlan (Pol-e Khomri)	1,536	208		27,742	296,943	1,442,236
17	Kunduz (Kunduz)	1,279	7		30,636	388,437	1,863,114
18	Samangan (Aybak)	2,912	266	760 (Northern)	11,846	53,134	416,541
19	Balkh (Mazar-e-Shariff)	2,900	786		39,993	196,478	1,731,926
20	Jowzjan (Sheberghan)	2,230	43		16,449	75,809	906,725
21	Sar-i Pol (Sar-i Pol)	4,131	182		17,086	124,985	616,743
22	Faryab (Maymana)	4,679	252		30,450	182,703	1,350,830
23	Badghis (Qaleh-ye Now)	5,328	191	202 (Harirod-Murghab)	15,157	148,016	577,837
24	Herat (Herat)	28,539	18,473		28,250	382,275	2,013,776
25	Farah (Farah)	27,137	30,677		15,495	162,717	375,425
26	Ghowr (Chaghcharan)	10,539	84		21,109	232,387	406,450
27	Helmand (Lashkar Gah)	33,282	936	270 (Helmand)	57,174	424,513	1,732,510
28	Nimruz (Zaranj)	22,618	10,725		5,030	47,449	299,114
29	Kandahar (Kandahar)	31,079	117		36,973	406,866	1,111,055
30	Zabol (Qalat)	9,464	816		9,292	70,405	261,469
31	Uruzgan (Tarin Kowt)	6,530	495		10,712	159,410	584,592
32	Daikondi (Nili)	1,911	-		14,085	209,599	194,405
33	Panjshir (Bazarak)	510	-	-	16,863	237,601	616,076
34	Paktika (Sharan)	374	18		4,693	37,076	185,815
Total		222,849	66,726	23,310	819,396	7,367,282	27,083,408

Renewable Energy Development in Afghanistan" (September 2015- June 2017)



Energy access and energy security are two key requisites for the socio-economic growth of Afghan societies. Renewable energy resource with their enormous potential in Afghanistan, can successfully be harnessed to meet these two requirements.

Conclusion

As you can see there are number of different alternative energy sources that are more than capable to replace currently dominant fossil fuels, of course given enough money for their further development. The main advantage of these alternative energy sources is that they are ecologically acceptable energy sources, that unlike fossil fuels do not release large quantities of CO2 and other harmful greenhouse gases into the atmosphere, causing global warming and climate change. This is really the advantage that should mean faster development of different alternative energy technologies because world will otherwise lose the battle against climate change. Even politics has become aware of this fact, and world looks ready to embrace new rules that should reduce current emission levels. To succeed in this world will need to stop relying on fossil fuels to satisfy its energy demand, and will have to focus on alternative energy sources, especially renewable energy sources, and make them more effective.

Resources:

EPA web archive/ a student's guide to global climate change

*Journal of Renewable Energy/*Volume 2017 |Article ID 5723152

IT Power Consulting/ ITP INDIA /AFG: Renewable Energy Development in Afghanistan" (September 2015-June 2017). Page 21

GeothermalGenius

Encyclopedia of engineering Geology

Energy Efficiency and Renewable Energy /DOE/GO-102001-110

Ghulam M Feda's Bio

Ghulam M Feda earned his master's degree in electrical and computer engineering from the University of Cincinnati, along with a BSEE from Kabul University, Faculty of Engineering. With more than 35 years of engineering experience, he has primarily held leadership roles in industrial R&D projects, focusing on optimizing organizational efficiency. Notably, his significant contributions have been within Owens Illinois, a global glass technology company headquartered in Ohio. Furthermore, he has provided guidance by serving on advisory boards for various state colleges and universities. Presently, he stands as the visionary founder and president/CEO of Afghan Education for a Better Tomorrow, an organization spearheading the development and delivery of educational resources to the conflict-affected regions of Afghanistan.

Engineer Feda has been honored with a patent award in "Glass Technology" and a Congressional award for his work in implementing innovative energy efficiency projects.

He also holds a certification as a Lean Six Sigma Black Belt (LSSBB).

Mr. Feda is passionate about projects that utilize technology to transform education, especially tele-education, to foster deeper learning in underserved and under-resourced communities, particularly in regions with significant needs.

Apart from his professional pursuits, Mr. Feda is an avid traveler and has authored several articles on the architectural techniques of ancient civilizations, as well as topics related to Afghan history and culture. Besides, he has been a guest on several TV shows, where he shares his scientific and historical knowledge with others.

Moreover, Engineer Feda is deeply involved with several other non-profit organizations. He holds an active membership with the Society of Afghan Engineers (SAE) and holds positions as a board member for both International Orphan Care and Immigrant Integration and Empowerment. Additionally, he is the visionary founder of the Afghanistan Relief Alliance, an organization dedicated to providing crucial relief supplies to the most vulnerable and poverty-stricken families in disaster-stricken areas of Afghanistan.