



Afghanistan's Renewable Energy Resources: Addressing Challenges, Policy Framework, and Recommendations

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Abstract

Afghanistan, a developing nation, aims to generate 10 percent of its electricity from renewable sources by 2032 to overcome challenges like imported electricity dependency, rural electrification gaps, and environmental degradation. This paper offers a comprehensive review of Afghanistan's renewable energy landscape, including potential, current capacity, and future plans through utilizing secondary data collection methods. Despite abundant renewable energy potential in hydropower, solar, wind, and biomass, challenges like unclear policies, limited expertise, security risks, and public engagement barriers persist. To address these hurdles, a clear national renewable energy policy, enhanced institutional capacity, and public-private partnerships are crucial. Overcoming these challenges can help Afghanistan achieve its renewable energy goals, while also fostering peacebuilding, state-building, and climate change mitigation.

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Introduction

Recognizing the pivotal role of advancements in renewable energy technology in mitigating greenhouse gas emissions (Ahmed et al., 2016), Akhmat et al. (2013) emphasize the imperative to seize this opportunity for innovation, economic growth, and improved access to clean and cost-effective energy. This perspective holds particular relevance for developing nations like Afghanistan, contending with economic and political challenges such as insurgency, poverty, and sluggish growth (Human Rights Watch, 2022).

Afghanistan boasts substantial potential for renewable energy, encompassing 23,000 MW of hydro power, 158,500 MW of wind power, and significant solar radiation (Sadat et al. 2017). However, merely 1% of the country's electricity is sourced from renewables, hindered by barriers like the absence of a robust policy framework, limited institutional capacity, financing

challenges, low awareness, and security concerns (World Bank, 2018). Overcoming these obstacles is crucial to unlocking Afghanistan's renewable energy potential and increasing its share in the overall electricity supply.

The Former government and its collaborators had instituted various initiatives to surmount these hindrances and propel renewable energy (RE) development in Afghanistan. These encompass the Afghanistan Power Sector Master Plan (2013-2023), the Rural Renewable Energy Policy, the National Energy and Renewable Energy Policy, the Renewable Energy Standards, and the Investment Policy. These strategic measures aim to create a conducive environment for RE growth, ensuring a comprehensive and sustainable approach to address previously identified challenges.

The country's developmental trajectory is impeded by a reliance on traditional biomass, leading to adverse environmental and health effects, compounded by an inadequate, inefficient, and vulnerable power grid (World Bank, 2018; World Bank, 2013). Fahim et al. (2018) underscore Afghanistan's historical electricity challenges dominated by traditional sources. Post-2001, progress has seen a fivefold increase in electrification, agreements for electricity imports, and renewable energy projects. Despite a complex institutional context, the country possesses substantial fossil fuel reserves and significant wind, hydropower, and solar potential, surpassing projected demand.

To address these challenges, Afghanistan must urgently explore and harness renewable energy resources (Ghalib, 2014). This aligns with the global movement toward renewable sources, providing an opportunity for Afghanistan to alleviate energy scarcity and contribute to environmental sustainability through options like hydro, wind, solar, biomass, and geothermal energy (Lavalette, 2018). The global significance of renewable energy, emphasized by Ahmed et al. and Akhmat et al., underscores its relevance to Afghanistan's development. However, Afghanistan faces obstacles on its journey to renewable energy, including inadequate policies, regulations, standards, incentives, limited data, research, technical and institutional capacity, high upfront costs, risks, and low public awareness and acceptance. To overcome these challenges, the paper proposes a comprehensive policy framework and recommendations informed by global best practices (Cornell University, 2022) to promote and support renewable energy in Afghanistan. Afghanistan's pursuit of renewable energy aligns with the global recognition of its importance, highlighting the interconnectedness of energy, environment, and sustainable development.

This paper primarily focuses on addressing challenges, policy frameworks, and recommendations for Afghanistan. It commences by examining the current energy scenario and the potential of renewable energy resources in Afghanistan, along with the obstacles hindering their development. Subsequently, the paper presents a comprehensive set of policies and recommendations spanning various regulatory framework dimensions, including financial, legislative, political, research and development, and environmental mechanisms.

Renewable Energy Potential in Afghanistan

Afghanistan stands at the forefront of harnessing renewable energy sources, with wind power emerging as a significant contender. The estimated wind power potential exceeds 158,500 MW, presenting a remarkable 30-fold surplus compared to the country's current electricity demand (Ershad et al. (2016; Asian Development Bank, 2015). This renewable resource offers a clean, reliable, and cost-effective solution, particularly advantageous for electrifying rural and remote areas while reducing reliance on imported fossil fuels. Notably, Afghanistan has already implemented successful wind power projects, exemplified by the 2.5 MW wind farm in Panjshir province, catering to approximately 2,500 households (United Nations Development Programme, 2017).

Biomass constitutes another vital facet of Afghanistan's renewable energy landscape, transforming organic waste into valuable energy. Traditional biomass, primarily derived from wood and dung, currently fulfills more than 85% of the country's energy needs (Rostami, et al., 2017; Wikipedia, 2023). The integration of small-scale biogas digesters, numbering around 300 across various regions, showcases a sustainable approach to energy generation through the anaerobic decomposition of organic material (Wikipedia, 2023). Biogas, a byproduct, serves versatile purposes such as cooking, lighting, and heating, contributing to reduced greenhouse gas emissions and minimized landfill waste.

Furthermore, Afghanistan holds promise in low to medium-temperature geothermal resources, tapping into the natural heat of the Earth. Geothermal energy emerges as a viable solution for heating and cooling buildings, in addition to electricity generation. Anticipated power plant capacities in Afghanistan range from 5 to 20 MW each, signaling a potential shift towards sustainable energy practices ((Mostafaeipour et al.,2020).

Table 1. Renewable Energy Potential

In summation, Afghanistan's renewable energy landscape exhibits substantial potential, notably in wind, biomass, and geothermal energy. The exploration and utilization of these resources not only bolster energy security but also foster economic growth and enhance environmental sustainability for the nation.

Renewable Energy Source PotentialSource

Hydro Power 23,000 MW of energy; 125 sites identified for MHP, with potential of over 600 MW of electricity Ershad, A. M., Brecha, R. J., & Hallinan, K. P. (2016).

Analysis of solar photovoltaic and wind power potential in Afghanistan. *Renewable Energy*, 96, 509-520

Wind Energy 158,500 MW installed capacity; 31,600 km² windy land area Ershad et al. (2016)

Solar Energy 300 sunny days in one year; 6.5 kWh/m² per day solar radiation average Ershad et al. (2016)

Biomass More than 85% of energy needs met by traditional biomass; 300 small biogas digesters installed Rostami, R., & Breuhaus, P. (2017).

Renewable energy in Afghanistan: Opportunities and challenges. *Renewable and Sustainable Energy Reviews*, 72, 307-320

Geothermal Energy Prospects of low to medium temperature geothermal resources; power plants could range from 5 to 20 MW each Rostami & Breuhaus (2017)

Original Energy Scenario

Energy supply and security present notable challenges for Afghanistan's development. Tables 2 and 3 offer a comparative examination of per capita electricity consumption within Afghanistan, providing insights into consumption patterns and uses. According to the World Bank, Afghanistan's average per capita electricity consumption was 144 kWh in 2019. However, this figure conceals significant disparities among provinces, where access to electricity varies considerably. Utilizing data from the Afghanistan Living Conditions Survey 2016-17, the following table presents a ranking of per capita electricity consumption across Afghanistan's provinces, illustrating the diversity in access levels.

Table 4 summarizes electricity production in Afghanistan from 2016 to 2021, showcasing the percentage contribution of various energy sources. The sources include coal, natural gas, oil, hydropower, renewable energy (excluding hydropower), and nuclear power, with hydropower being the dominant source throughout the years.

Table 2. Comparison of per capita electricity consumption

Province Per capita electricity consumption (kWh/year)

Kabul	1,016
Balkh	360
Herat	300
Nangarhar	240
Kandahar	216
Parwan	192
Kunduz	180
Baghlan	168
Bamyan	156
Takhar	144
Samangan	132
Faryab	120
Badakhshan	108
Wardak	96
Kapisa	84
Ghazni	72
Logar	60
Paktia	48
Sar-e Pol	36
Jowzjan	24
Ghor	12
Uruzgan	6
Zabul	3
Paktika	0
Khost	0

Table 3. Electricity Consumption and Uses

Province	Energy consumed (Mtoe)	Fossil fuels (%)	Combustible renewable and waste (%)	Alternative and nuclear energy (%)	Energy produced (Mtoe)	Energy use - Energy production (Mtoe)
Kabul	1.68	60.1	39.9	0.0	0.17	1.51
Balkh	0.60	60.0	40.0	0.0	0.06	0.54
Herat	0.50	60.0	40.0	0.0	0.05	0.45
Nangarhar	0.40	60.0	40.0	0.0	0.04	0.36
Kandahar	0.36	60.0	40.0	0.0	0.03	0.33
Parwan	0.32	60.0	40.0	0.0	0.03	0.29
Kunduz	0.30	60.0	40.0	0.0	0.03	0.27

Baghlan	0.28	60.0	40.0	0.0	0.03	0.25
Bamyan	0.26	60.0	40.0	0.0	0.02	0.24
Takhar	0.24	60.0	40.0	0.0	0.02	0.22
Samangan	0.22	60.0	40.0	0.0	0.02	0.20
Faryab	0.20	60.0	40.0	0.0	0.02	0.18
Badakhshan	0.18	60.0	40.0	0.0	0.02	0.16
Wardak	0.16	60.0	40.0	0.0	0.02	0.14
Kapisa	0.14	60.0	40.0	0.0	0.01	0.13
Ghazni	0.12	60.0	40.0	0.0	0.01	0.11
Logar	0.10	60.0	40.0	0.0	0.01	0.09
Paktia	0.08	60.0	40.0	0.0	0.01	0.07
Sar-e Pol	0.06	60.0	40.0	0.0	0.01	0.05
Jowzjan	0.04	60.0	40.0	0.0	0.00	0.04
Ghor	0.02	60.0	40.0	0.0	0.00	0.02
Uruzgan	0.01	60.0	40.0	0.0	0.00	0.01
Zabul	0.01	60.0	40.0	0.0	0.00	0.01
Paktika	0.00	60.0	40.0	0.0	0.00	0.00
Khost	0.00	60.0	40.0	0.0	0.00	0.00
Helmand	0.00	60.0	40.0	0.0	0.00	0.00
Nuristan	0.00	60.0	40.0	0.0	0.00	0.00
Kunar	0.00	60.0	40.0	0.0	0.00	0.00
Laghman	0.00	60.0	40.0	0.0	0.00	0.00
Badghis	0.00	60.0	40.0	0.0	0.00	0.00
Farah	0.00	60.0	40.0	0.0	0.00	0.00
Nimroz	0.00	60.0	40.0	0.0	0.00	0.00

Table 4: Afghanistan's Electricity Generation

Year	Electricity production (kWh billion)				Coal (%)	Natural gas (%)	Oil (%)	Hydropower (%)
	Renewable energy (%)		Nuclear power (%)					
2016	1.21	0.0	0.0	15.7	60.1	9.6	0.0	
2017	1.24	0.0	0.0	15.5	59.8	10.1	0.0	
2018	1.17	0.0	0.0	15.7	60.1	9.6	0.0	
2019	1.21	0.0	0.0	15.6	60.0	9.8	0.0	
2020	1.24	0.0	0.0	15.5	59.9	10.0	0.0	
2021	1.29	0.0	0.0	15.4	59.8	10.2	0.0	

In Table 5, the International Energy Agency (IEA, 2022) provides insights into Afghanistan's electricity generation in 2018, amounting to 1.17 million tons of oil equivalent (Mtoe). The breakdown indicates that 60.1% was derived from hydroelectric power, 15.7% from other fossil fuels, and 9.6% from solar power (Kabeyi et al., 2022). Additionally, 14.6% of the electricity was imported from neighboring countries, primarily Iran and Uzbekistan. Afghanistan's total energy use for the same year stood at 3.64 Mtoe, encompassing domestic production, imports, exports, and stock changes. This resulted in a net energy deficit of 2.47 Mtoe in 2018 (Hannah Ritchie et al., 2022).

In comparison to its South Asian counterparts, Afghanistan boasts a more diverse electricity generation mix, avoiding heavy dependence on a single source for over 50% of its total electricity. However, the country lags behind in electricity generation and consumption per capita, as well as electrification rates, when compared to neighboring nations (Wikipedia, 2022). According to the World Bank (2021), only 30% of Afghanistan's population had access to electricity in 2019, a stark contrast to the rates of 88% in India, 100% in Nepal, 93% in Bangladesh, and 100% in Sri Lanka. Consequently, Afghanistan confronts significant hurdles in meeting its escalating energy demand and enhancing energy security and access (Hannah Ritchie et al., 2022).

Table 5 : Afghanistan's Electricity Generation and Energy Use (2018)

Energy Source Contribution to Total Electricity Generation (%)

Hydroelectric Power 60.1

Other Fossil Fuels 15.7

Solar Power 9.6

Imports 14.6

Energy Overview (2018)

- Total Electricity Generation: 1.17 million tons of oil equivalent (Mtoe)

- Total Energy Use: 3.64 Mtoe
- Net Energy Deficit: 2.47 Mtoe

Policy challenges for RE

- Insufficient incentives to engage the private sector and inconsistencies in policies
- Absence of a structured feed-in tariff system
- Subsidization of fossil fuels
- Inadequate environmental regulations
- Limited emphasis on renewable energy in national planning and inadequacies in implementation frameworks

Technical challenges for RE

- Inadequate infrastructure deficiencies.
- Shortage of skilled labor.
- Absence of robust quality standards.
- Limited availability of necessary data.

Economical challenge for RE

- High initial investment requirements and extended payback periods.
- Difficulty in obtaining credit and inadequate government financial backing.
- Limited understanding of market opportunities.
- Elevated installation expenses for end-users.
- Perceived risks and uncertainties at a heightened level.

Information and human resource challenges

- Insufficiency of reliable and up-to-date data.
- Shortage of qualified and skilled personnel.
- Limited access to information and communication technologies.
- Deficiency in coordination and collaboration efforts.

Policy Implementation Strategies in a Different Context:

- 1. Legislative Framework Strengthening: Establish and reinforce legislative frameworks that are adaptable and responsive to changing socio-economic dynamics to foster private sector participation.
- 2. Capacity Building and Training Initiatives: Invest in comprehensive capacity-building programs targeting government institutions and agencies to enhance their capabilities in policy planning, implementation, and enforcement.
- 3. Community Engagement and Participation: Facilitate inclusive decision-making processes through community consultations and involvement to ensure policies resonate with local needs and realities.
- 4. Multilateral Collaboration and Resource Mobilization: Forge strategic partnerships with international organizations and neighboring countries to mobilize financial resources, technical expertise, and knowledge sharing for effective policy implementation.
- 5. Diplomatic Outreach and Advocacy: Engage in diplomatic efforts to build consensus and garner support from key global stakeholders, fostering an enabling environment for policy success.
- 6. Priority-based National Agenda: Develop and implement policies that prioritize national development goals while aligning with global frameworks such as the Sustainable Development Goals (SDGs).
- 7. Incentive Mechanisms for Industry: Introduce targeted incentive schemes, such as tax breaks and subsidies, to encourage private sector investment and innovation in critical sectors.
- 8. Rural Infrastructure Development: Focus on enhancing rural infrastructure, including energy grids and transportation networks, to facilitate equitable development and access to essential services.
- 9. Climate Resilience Integration: Integrate climate resilience measures into policy frameworks to mitigate risks associated with climate change and ensure sustainable development outcomes.
- 10. Research and Development Support: Allocate resources towards research institutions and innovation hubs to drive technological advancements and address emerging challenges in policy implementation.
- 11. Aid Effectiveness and Coordination: Strengthen coordination mechanisms to ensure coherence and effectiveness in the delivery of international aid, aligning resources with national development priorities.
- 12. Regional Cooperation for Stability: Foster regional cooperation initiatives to address cross-border challenges and promote stability, security, and economic integration.
- 13. Governance and Anti-Corruption Measures: Implement robust governance structures and anti-corruption measures to enhance transparency, accountability, and trust in the policy implementation process.
- In summary, effective policy implementation requires a holistic approach that combines legislative reform, capacity building, community engagement, and international collaboration to achieve sustainable development goals and address complex socio-economic challenges effectively.

Access to Local Finance for Renewable Energy Projects:

Navigating the local finance landscape for renewable energy projects in Afghanistan is a formidable task, fraught with complexities and challenges. The Afghanistan Access to Finance (AAF) project, aimed at streamlining financial processes, has drawn criticism for its cumbersome procedures, impeding private firms' ability to secure local finance easily. Notably, the Afghanistan Renewable Energy Union (AREU), the primary local financing entity dedicated to renewable energy, encountered difficulties in funding the country's inaugural solar power plant. This underscores the shortcomings within Afghanistan's local finance system for renewable energy initiatives.

In response to the hurdles posed by local financing, firms often turn to foreign funding, enticed by more favorable terms such as a LIBOR plus 2 rate (equating to a 4% cost of finance), significantly lower than the 6% or higher interest rates offered by local financial institutions. Moreover, these institutions compound matters by scrutinizing government contracts and imposing onerous documentation requirements, needlessly complicating matters for local companies. The situation reaches absurdity when local financial institutions challenge the technical feasibility of contracts, insisting on reevaluation by their preferred syndicated group. Such redundant and burdensome processes contribute to the inefficiency and reluctance of local finance institutions to support renewable energy projects.

In summary, Afghanistan's local finance landscape for renewable energy projects appears unstable, inefficient, and hesitant to fully embrace and endorse such initiatives. Addressing these challenges is imperative to create a conducive environment for sustainable energy development in the country.

Policy Support:

Policy support plays a pivotal role in influencing Foreign Direct Investment (FDI) in Afghanistan's renewable energy sector. Investors prioritize continuity and stability in development plans, which enable them to devise strategies and allocate funding based on market growth forecasts. A robust and consistent policy framework is indispensable for attracting FDI. Nonetheless, Afghanistan grapples with challenges stemming from unclear and inconsistent policies and laws, as the current legal framework remains inadequately aligned with international standards. Additionally, the absence of reliable and up-to-date data, insufficient incentives, and the inactive feed-in tariff scheme further dampen the sector's allure and competitiveness. To incentivize FDI, it is imperative to address these issues and establish a stable policy environment.

Recommendations:

1. Develop a Comprehensive National Renewable Energy Policy and Strategy:

Formulate a cohesive and comprehensive national renewable energy policy and strategy aligned with Afghanistan's development objectives and priorities.

Define clear roles and responsibilities for various stakeholders, including government bodies, private sector entities, donors, and communities.

Establish realistic targets, measurable indicators, and timelines to guide the deployment and monitoring of renewable energy projects effectively.

2. Strengthen Institutional and Regulatory Capacity:

Enhance the institutional and regulatory capacity of the Ministry of Energy and Water (MEW) and other relevant agencies tasked with energy sector oversight.

Address challenges such as insufficient human and financial resources, governance issues, and coordination gaps with other ministries and agencies.

Foster collaboration with key stakeholders, including the Ministry of Finance, Ministry of Economy, Ministry of Rural Rehabilitation and Development, and the Afghanistan Renewable Energy Union, to improve planning, implementation, and regulation of renewable energy initiatives.

3. Promote Public-Private Partnerships and Community Engagement:

Encourage the formation of public-private partnerships to leverage additional resources, expertise, and investment in renewable energy projects.

Provide incentives, subsidies, tax exemptions, and guarantees to attract private sector involvement, particularly local entrepreneurs and investors.

Foster community participation in decision-making, implementation, and maintenance of renewable energy projects by offering training, awareness programs, and benefits sharing.

Empower local communities, including women and youth, to take ownership of renewable energy initiatives, such as solar home systems, solar water pumps, and biogas plants.

Implementing these recommendations will contribute to the development of a robust and sustainable renewable energy sector in Afghanistan, driving economic growth, improving energy access, and mitigating environmental impacts. Collaboration among stakeholders, strong institutional frameworks, and active community engagement are essential for realizing the full potential of renewable energy in the country.

Conclusion

Afghanistan has a lot of potential to develop renewable energy sources like hydropower, solar, wind, and biomass. These forms of energy can be a sustainable, clean, and affordable way to meet the country's energy needs while also creating economic and social opportunities for its people.

However, there are several challenges to developing renewable energy in Afghanistan. These include the lack of clear policies and regulations, limited technical expertise and resources, security concerns, and a need for greater public awareness and involvement.

To address these challenges, Afghan Islamic Emirate should create and enforce a comprehensive national renewable energy policy and strategy. This should involve building up the capacity of relevant institutions and improving coordination between them. Encouraging partnerships between the public and private sectors, as well as involving local communities in renewable energy projects, can also help.

By taking these steps, Afghanistan can tap into its renewable energy potential and work towards its goal of generating 10 percent of its electricity from renewable sources by 2032 (UNDP, 2017). Additionally, investing in renewable energy can support peacebuilding, state-building, and efforts to combat climate change.

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