Study Launch at Promoting Renewable Energy Investments in Pakistan

June 5, 2017

Asian Development Bank
Objectives
- Study of current status of solar energy development in Pakistan
- Identification of barriers constraining growth of increased deployment of solar
- Discussion of interventions to address the barriers
- Recommendation of possible areas for investment in solar energy

Methodology
- Review of desk studies
- Interviews with solar project developers and concerned officials in the public sector
Country Context

- Installed Capacity ≈ 25,500 MW
- Demand: 5-6 GW higher than installed capacity
- Distribution and Transmission Losses: 20%
- Load Shedding: 6-8 hours in urban centers; 10-12 hours in rural areas
- Electrification Rate: 73% (90% in urban areas and 68% in rural areas)
## Country’s Power Generation Mix 2015-16

<table>
<thead>
<tr>
<th>Source</th>
<th>Installed Capacity (MW)</th>
<th>% of Installed Capacity</th>
<th>Generation (GWh)</th>
<th>% of Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydel</td>
<td>7,116</td>
<td>27.77%</td>
<td>34,272</td>
<td>29.05%</td>
</tr>
<tr>
<td>Furnace Oil/High Speed Diesel</td>
<td>5,707</td>
<td>22.27%</td>
<td>43,103</td>
<td>36.54%</td>
</tr>
<tr>
<td>Gas</td>
<td>11,023</td>
<td>43.01%</td>
<td>34,433</td>
<td>29.19%</td>
</tr>
<tr>
<td>Coal</td>
<td>150</td>
<td>0.59%</td>
<td>148</td>
<td>0.13%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>787</td>
<td>3.07%</td>
<td>4,207</td>
<td>3.57%</td>
</tr>
<tr>
<td>Wind</td>
<td>306</td>
<td>1.19%</td>
<td>786</td>
<td>0.67%</td>
</tr>
<tr>
<td>Solar</td>
<td>400</td>
<td>1.56%</td>
<td>207</td>
<td>0.18%</td>
</tr>
<tr>
<td>Others</td>
<td>139</td>
<td>0.54%</td>
<td>807</td>
<td>0.68%</td>
</tr>
<tr>
<td>Total</td>
<td>25,628</td>
<td>100%</td>
<td>117,963</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Pakistan’s power generation mix is dominated by thermal power.
- Share of renewables (excluding large hydropower above 50 MW) is less than 2%.
- Solar and wind energy has only picked up in the last few years.
- Increased deployment of renewable in the country can provide energy security, foreign exchange reserves stability and environmental benefit.

Power System Statistics 2015-16
Pakistan’s Renewable Energy Target

Adding a minimum of 9,700 MW of renewable energy capacity in the system by 2030
Solar Potential in Pakistan

- Pakistan lies in an area of one the highest solar irradiance in the world.

- There is about 2,900,000 MW of solar energy potential in the country.

- According to Pakistan Energy Book 2005-06, the amount of energy available in Balochistan is enough to meet current energy requirements of the country.

- Global Horizontal Irradiance (GHI) values over 4.5 kWh/m²/day covering over 90% of the country’s land area.

- Values of just over 6.4 kWh/m²/day are reached in the southwestern region of Balochistan decreasing gradually towards the northeast of the country to 4.0 kWh/m²/day.
Global Horizontal Irradiance

Model uncertainty reduced by ground measurements

Long-term average of daily/yearly sum, period 1999-2016

Daily sum:
- < 3.6 kWh/m²
- 4.0 kWh/m²
- 4.4 kWh/m²
- 4.8 kWh/m²
- 5.2 kWh/m²
- 5.6 kWh/m²
- 6.0 kWh/m²
- 6.4 kWh/m²

Yearly sum:
- < 1314 kWh/m²
- 1461 kWh/m²
- 1607 kWh/m²
- 1753 kWh/m²
- 1899 kWh/m²
- 2045 kWh/m²
- 2191 kWh/m²
- 2337 kWh/m²

World Bank Group ESMAP
Photovoltaic Power Potential
Grid Connected Solar Power Plants

- 28 Projects of 957 MW are at various stages of development within the framework of AEDB policies and procedures

- Additional 3,000 MW initiated by provinces

- So far 4 projects of 400 MW are operational in Cholistan, Punjab
Distributed Solar

- Net Metering initiated in Punjab and is in the process of being implemented in other provinces
- Solar power for un-electrified schools and basic health units
- Solar Home Systems for households in remote villages
- Conversion of agricultural tube wells to solar power
Declining Trend in Upfront Tariff of Solar PV Projects

Source: Various NEPRA Upfront Solar Tariff Determinations
## Barriers Constraining Increased Deployment of Solar Energy

### Private Sector vs. Public Sector

<table>
<thead>
<tr>
<th>Private Sector Perspective</th>
<th>Public Sector Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient capacity of the grid to evacuate power from incoming power projects including renewable energy</td>
<td>Intermittent nature of the resource – need about 400-500 MW of spinning reserve</td>
</tr>
<tr>
<td>Frequent revisions of tariff by the regulatory authority</td>
<td>Ability of renewables to meet electricity demand of the country</td>
</tr>
<tr>
<td>Lack of coordination between government agencies</td>
<td>High tariffs awarded to renewable energy projects</td>
</tr>
<tr>
<td>Perceived bias, among most government officials, against renewables and in favor of coal and LNG projects.</td>
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</table>
## Variation in Public Sector Perspectives

<table>
<thead>
<tr>
<th>Government Agency</th>
<th>Identified Barrier(s)</th>
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<tbody>
<tr>
<td>Alternate Energy Development Board (AEDB)</td>
<td>Inadequate capacity of the grid and system operator to integrate variable renewable energy into the system</td>
</tr>
<tr>
<td>National Transmission and Despatch Company (NTDC)</td>
<td>Vulnerability of renewable energy to large fluctuations affecting grid reliability and security&lt;br&gt;Insufficient financial resources to undertake the required grid reinforcement</td>
</tr>
<tr>
<td>Central Power Purchase Agency-Guarantee (CPPA-G), Planning Commission</td>
<td>High upfront tariffs awarded to solar and wind projects driving up generation costs</td>
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Possible Solutions

- Grid Strengthening
- Capacity Building
- Competitive Bidding
- Implementing Future Technologies
Grid Strengthening

- Carry out major system reinforcements, including additional transmission lines and transformers.
  - i. Reinforcement of 220 kV system in Lal Suhanra region and extension of 500kV network in Jhimpir.
  - ii. 132kV system reinforcements for numerous dispersed and embedded renewable generators.
- Leverage private investment through the recently introduced “Transmission Line Investment Policy of 2015”.
- Build capabilities of the system operator to integrate renewable energy
  - i. Improved forecasting capabilities
  - ii. Criteria for contingencies, and its response to up/down ramps in generation as well as weather disturbances
  - iii. Response options such as electricity storage and transmission to distant load centers.
Competitive Bidding

• Establish a one-window facility for developers throughout the implementation process.

• Standardize processing time for government agencies and departments to reduce the turnaround time

• Work on improving administrative capacities of the relevant federal and provincial agencies both in terms of sectoral knowledge and sufficiency of human resources to execute renewable energy projects

• Improve energy planning in Pakistan to optimize available generation sources and to meet demand in the most cost-effective and sustainable manner.
Implementing auction schemes can alleviate concerns of the federal government regarding high solar energy costs and tariffs.

NEPRA, in March 2015, announced competitive bidding tariff for solar projects. AEDB has initiated work on developing framework for competitive bidding.

The framework should be based on the lessons learnt from the past policies in the country for the IPPs, as well as from the experience of international renewable energy market.

Design of the auction should be such that it disincentivizes bidders from underbidding.
Evolution of Utility-Scale Solar PV Auction Prices around the world

Source: IRENA, 2017a
Future Technologies

- Hybrid Plants
- Concentrated Solar Power
- Floating Solar
- Smart Grids
- Energy Storage Technologies
- Solar Powered Irrigation Pumps
- Pay-As-You-Go System
Hybrid Plants

- Combining Photovoltaic (PV) with wind turbines, large hydro, and/or diesel generators can address the weather-reliant issues of intermittent renewables.

- Hybrid projects benefit by increasing the aggregate system output and by sharing the transmission capacity.

- Hybrid plants are also ideal for installation in remote areas, electrifying complete regions with high efficiency.

Source: http://www.ecmag.com/section/green-building/hybrid-power
Competitive Bidding

- Compared to PV systems, CSPs allow the use of solar power to be used for baseload generation as well as for peak power generation.

- With improvements in technology and industry experience, CSP bid prices have started declining. The installed costs of a concentrated solar plant is expected to decline by 33% by 2025.

- CSP projects in Balochistan and/or south of Punjab can be beneficial for Pakistan given the grid constraints and the flexible dispatch profile CSP offers.

Setting up floating solar plants in reservoirs of hydro plants, such as Tarbela, Mangla and Ghazi Barotha, can improve its water storage capacity and amp up the energy production.

Globally, Japan has taken lead in the installation of this technology. Other countries including India, Australia, UK and Brazil have followed suit.

Solar plants can also be built atop irrigation canals enabling efficient and cheap land use and reduced water evaporation from the channels underneath.

Smart grids provide real-time data on system operation which can be used for improving reliability of the grid as well as for increasing system security.

- It allows for more sophisticated information from transmission and distribution systems as any fluctuation of voltage can be addressed before it leads to an outage.

- Smart grid technology should be implemented incrementally.
Combining battery storage with renewable energy can support the output of these plants by responding quickly to any output fluctuations.

In 2015, 250 MW of utility-scale electricity storage (excluding pumped hydro and lead-acid batteries) were installed worldwide, up from 160 MW in 2014 (IRENA, 2016)

Decline in capital costs will continue in the next five years, with the strongest declines in lead acid batteries, lithium-ion energy applications, sodium and long-duration flywheels (Lazard’s Levelized Cost of Storage Analysis 2.0)
Competitive Bidding
Solar for Water Pumping

• 1.08 million tube-wells and lift pumps are currently in operation in the country but the number of solar powered tube-wells and pumps are limited to few thousands.

• Inefficient use of electricity by diesel powered water pumps is a concern across the country, as majority of the farmers do not pay for electricity for pumping water.

• Conversion of diesel powered pumps on to solar can yield economic and environmental benefits
ADB’s Involvement in the Sector

- ADB has been the largest development assistance provider in the energy sector, providing almost $8 billion in assistance to the sector.

- Under its Multi-Tranche Financing Facility (MFF), ADB is assisting NTDC in strengthening Pakistan’s power transmission system and improving operations and management of NTDC and CPPA-G.

- ADB is also financing installation of Advanced Metering Infrastructure (AMI) in IESCO and LESCO.

- Late last year, ADB approved Access to Clean Energy Result Based Lending (RBL) facility in 2016 for financing off-grid solar and micro-hydro to provide power for public schools, community centers, and basic health units in Punjab and KPK.