

# Solar Energy Potential in Central Asia: Case Study Pakistan

## Energy Investment Forum

Astana, Kazakhstan

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# Solar Rapid Assessment

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## 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

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- **Installed Capacity  $\approx$  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

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

- 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

# Pakistan's Renewable Energy Target

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



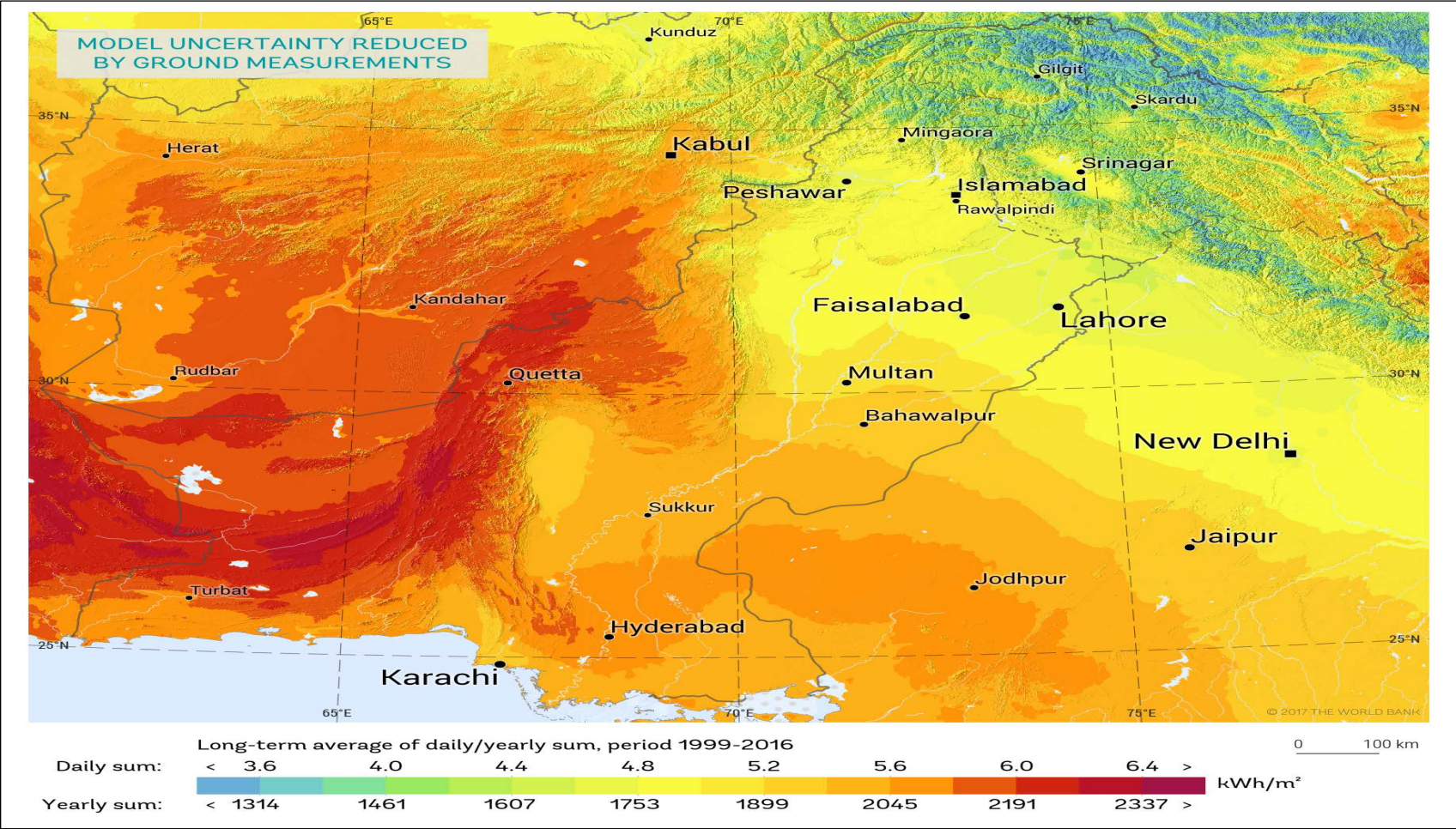
# Solar Potential in Pakistan

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- **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/m<sup>2</sup>/day covering over 90% of the country's land area.**
- **Values of just over 6.4 kWh/m<sup>2</sup>/day are reached in the southwestern region of Balochistan decreasing gradually towards the northeast of the country to 4.0 kWh/m<sup>2</sup>/day.**

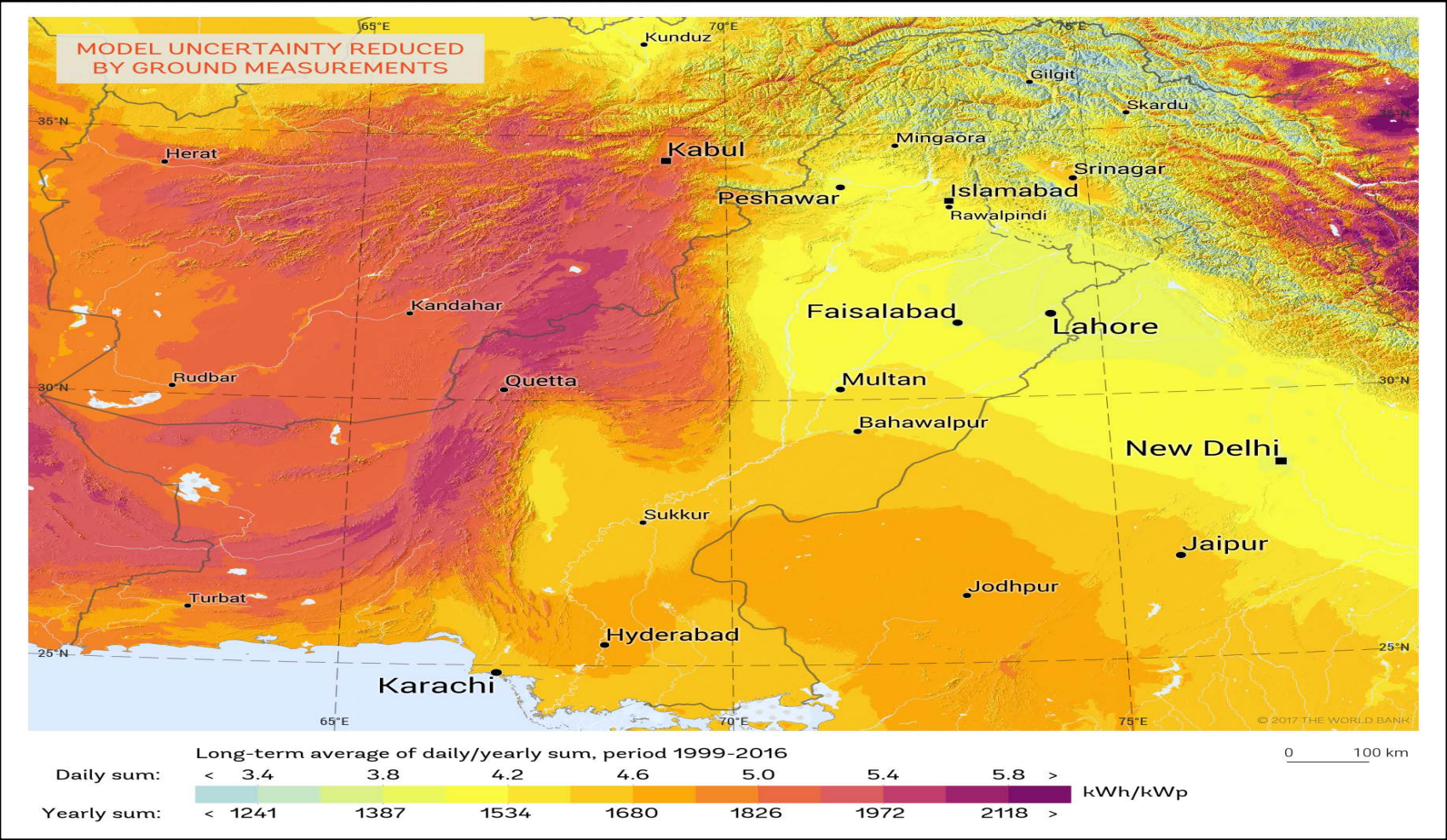


# Global Horizontal Irradiance





# 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**

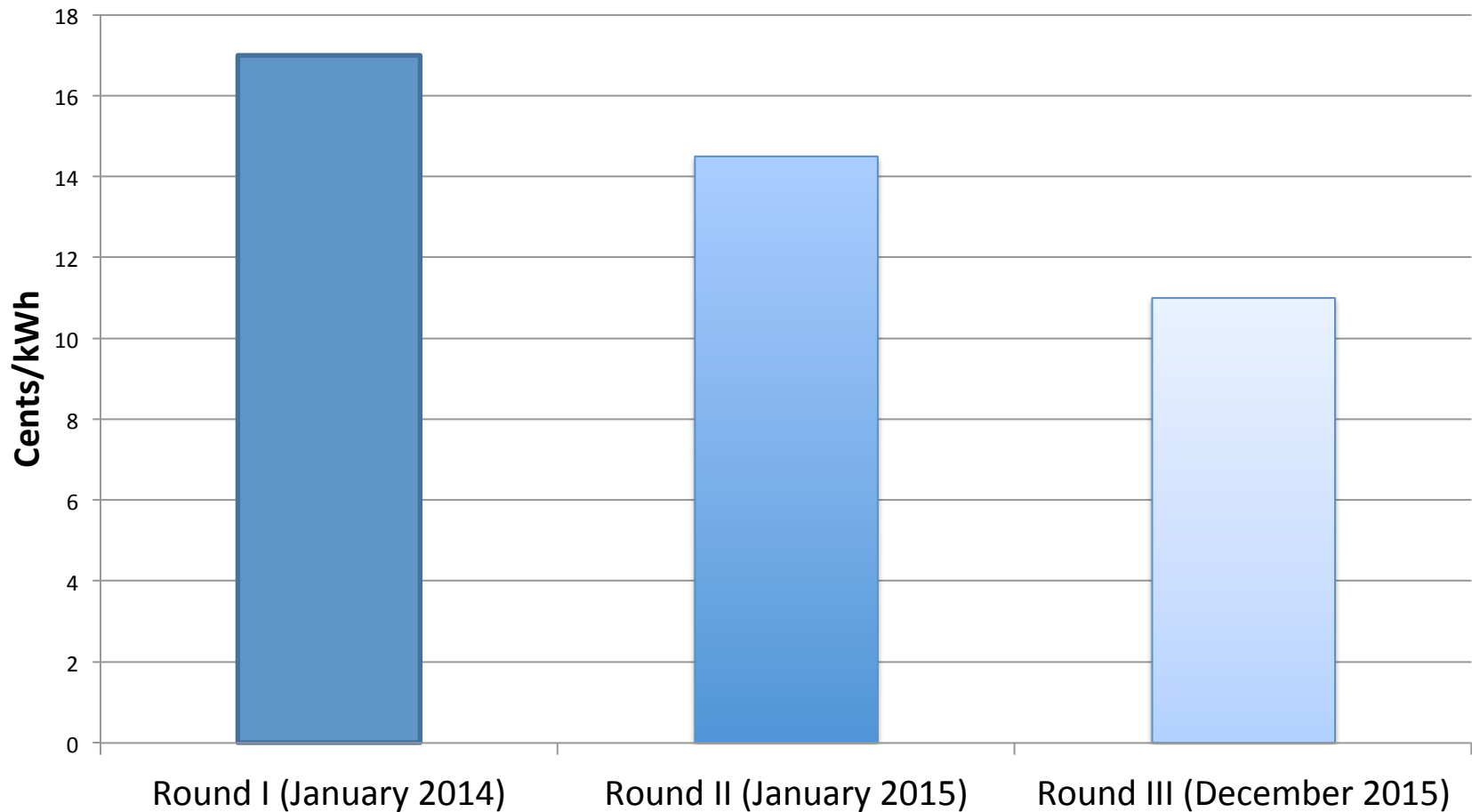


# Distributed Solar

- **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

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



# Variation in Public Sector Perspectives

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

# Possible Solutions

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

# Grid Strengthening

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- **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.



# Capacity Building

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- **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.**

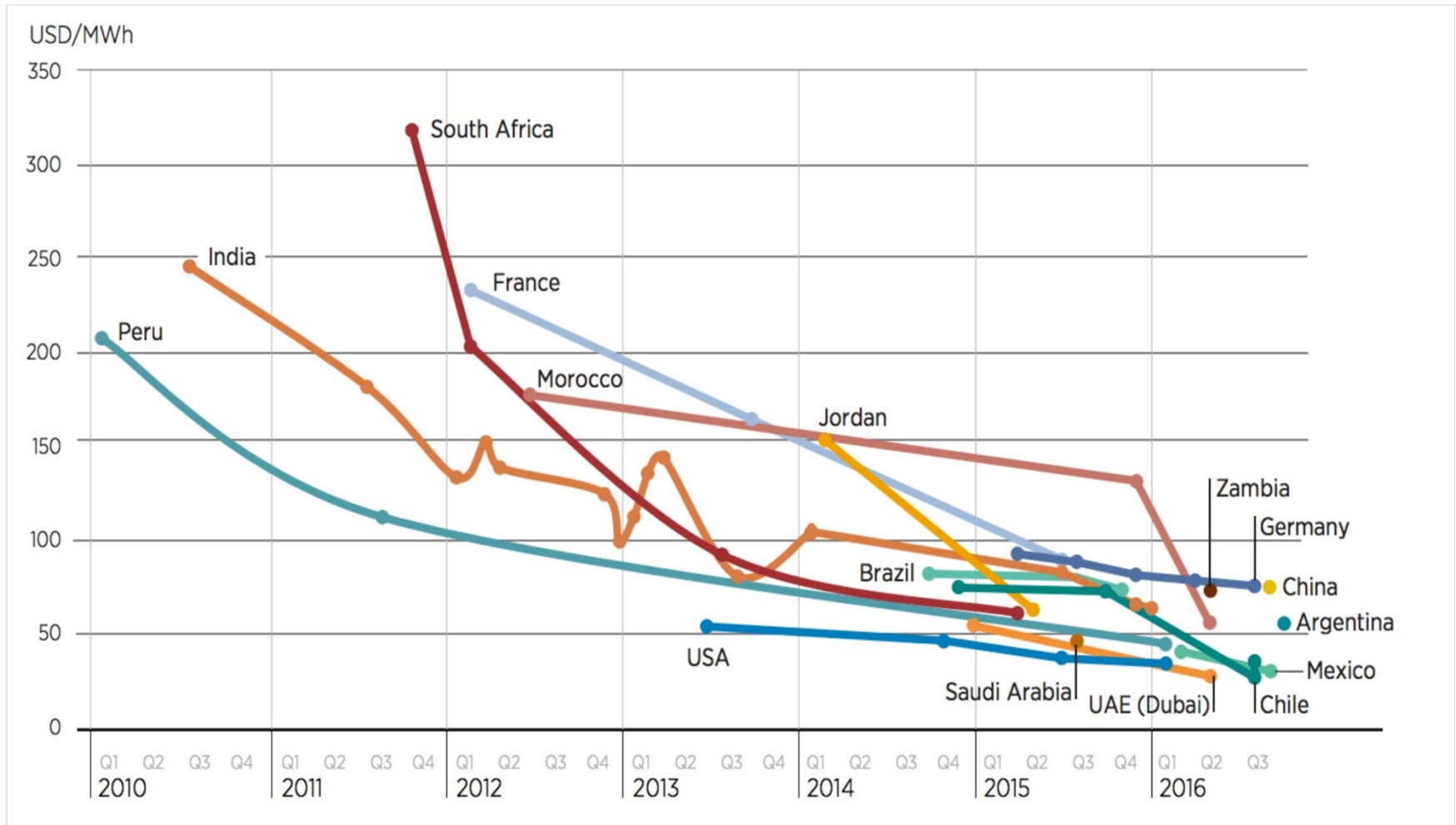


# Competitive Bidding

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- **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



# Future Technologies

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- **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>



# Concentrated Solar Plants (CSPs)



- 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.

Source:

<http://www.seia.org/policy/solar-technology/concentrating-solar-power>

# Floating Solar

- **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.**

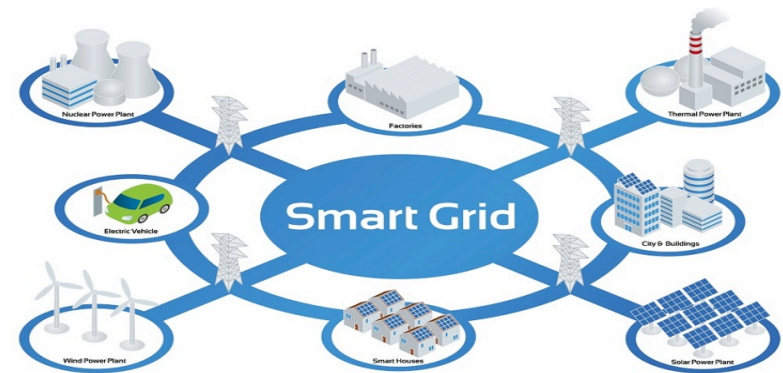


Source:

<http://reneweconomy.com.au/worlds-largest-floating-solar-pv-plant-connected-to-grid-in-china-49396/>

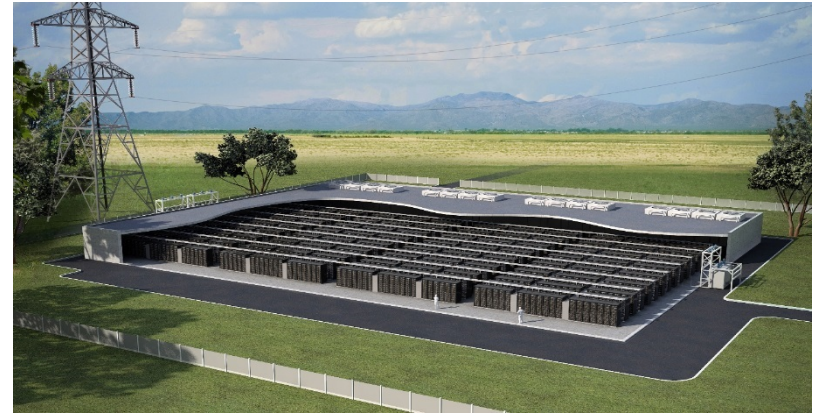
# Smart Grids

- 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.



# Energy Storage Technologies

- **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)**





# 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

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- **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.**