



Solar PV Power Developments in Pakistan

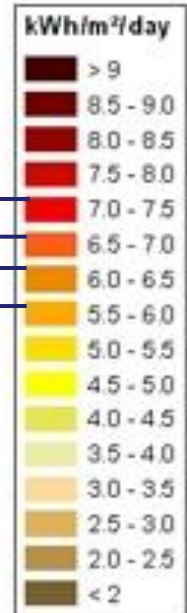
AEDB

07 November 2018

SOLAR MAP OF PAKISTAN

- Average irradiance varies between 5.5-7.5 kWh/m²/day
- Average Annual Sunny days varies between 185-290
- Estimated Theoretical Potential is around 2.9 million MW, spread all over Pakistan
- Projects ranging 1-50 MW can be installed distributed all over Pakistan near national grid and load centers.

Pakistan Direct Normal Solar Radiation Annual



April 2006

Model estimates of monthly average daily total radiation using inputs derived from satellite and surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone sampled at a 40km resolution.

1990-94

SOLAR RESOURCE MAPPING

- Resource mapping for solar being carried with the assistance of Energy Sector Management Assistance Program (ESMAP) of the World Bank

- 9 Data Stations were installed in different locations in Pakistan to collect solar resource data
- Solar Resource Map updated based on 2 years on-ground data and long-term satellite based data
- Solar Atlas for Pakistan was launched in March 2017

- Solar GIS Tool got developed through National Renewable Energy Laboratory (NREL), USA

- The tool comprise layers for solar resource map, land use, infrastructure, grid availability etc.
- Provides pre-feasibility details for setting solar PV power project at a particular site

- ❖ Below link provides GIS based wind and solar resource maps with other details i.e. grid network, transportation network, land use, other infrastructure

(<https://maps.nrel.gov/gst-pakistan>)

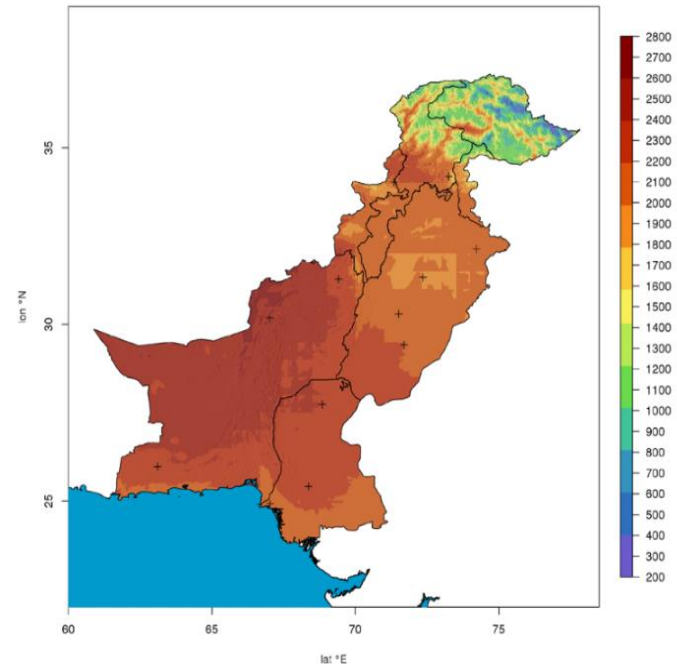


Figure 8: Multi-year mean (2000-2012) of annual Direct Normal Irradiance (DNI) for Pakistan in kWh/m²

ESMAP Solar Resource Mapping of Pakistan

PHOTOVOLTAIC POWER POTENTIAL PAKISTAN

DESCRIPTION

This map provides an estimate of solar photovoltaic (PV) power generation potential. It represents the average daily/yearly sum of electricity production from a 1 kW peak grid-connected solar PV power plant for a period of recent 18 years (1999-2016).

The PV system configuration, considered in this calculation, includes ground-based, free-standing structures with crystalline silicon PV modules mounted at a fixed position, with optimum tilt to maximize yearly energy yield. The optimum tilt ranges from 20° to 35°, facing towards the equator. Use of high efficiency inverters is assumed. The solar electricity calculation is based on high-resolution data and PV modeling software developed and operated by Solargis. The calculation takes into account solar radiation, air temperature, and terrain, to simulate the energy conversion and losses in the PV modules and other components of a PV power plant. The cumulative effect of losses due to dirt, snow and ice on the PV modules, and the losses from cables, inverters and transformers, is 9%. The power plant availability is considered to be 100%.

The underlying solar resource database is calculated from the atmospheric and satellite data with a 30-minute time step, and a spatial resolution of 250 m. The uncertainty of the solar resource data has been reduced by regional model adaptation based on ground measurements collected at one solar meteorological stations in Pakistan, commissioned by The World Bank over the years 2014 to 2017.

DATA SOURCES

This map was prepared by Solargis for Alternative Energy Development Board (AEDB), Ministry of Water and Power, Government of Pakistan. The solar resource data, used for calculating this map, is obtained from the World Bank via their Global Solar Atlas, following a solar resource mapping project carried out in Pakistan in collaboration with AEDB. The project was funded by the Energy Sector Management Assistance Program (ESMAP), and the solar resource data is provided by Solargis under the contract to the World Bank. Users of this data should refer to the Global Solar Atlas website for further information, including terms of use and data copyright details.

Solar PV power potential © 2017 Solargis • Administrative boundaries © 2017 AEDB • GeoNames.org • Data and Maps for ArcGIS © 2014 ESRI • Shuttle Radar Topography Mission, version 2 © 2000–2006 SRTM Mission Team • Cartography © 2017 Solargis

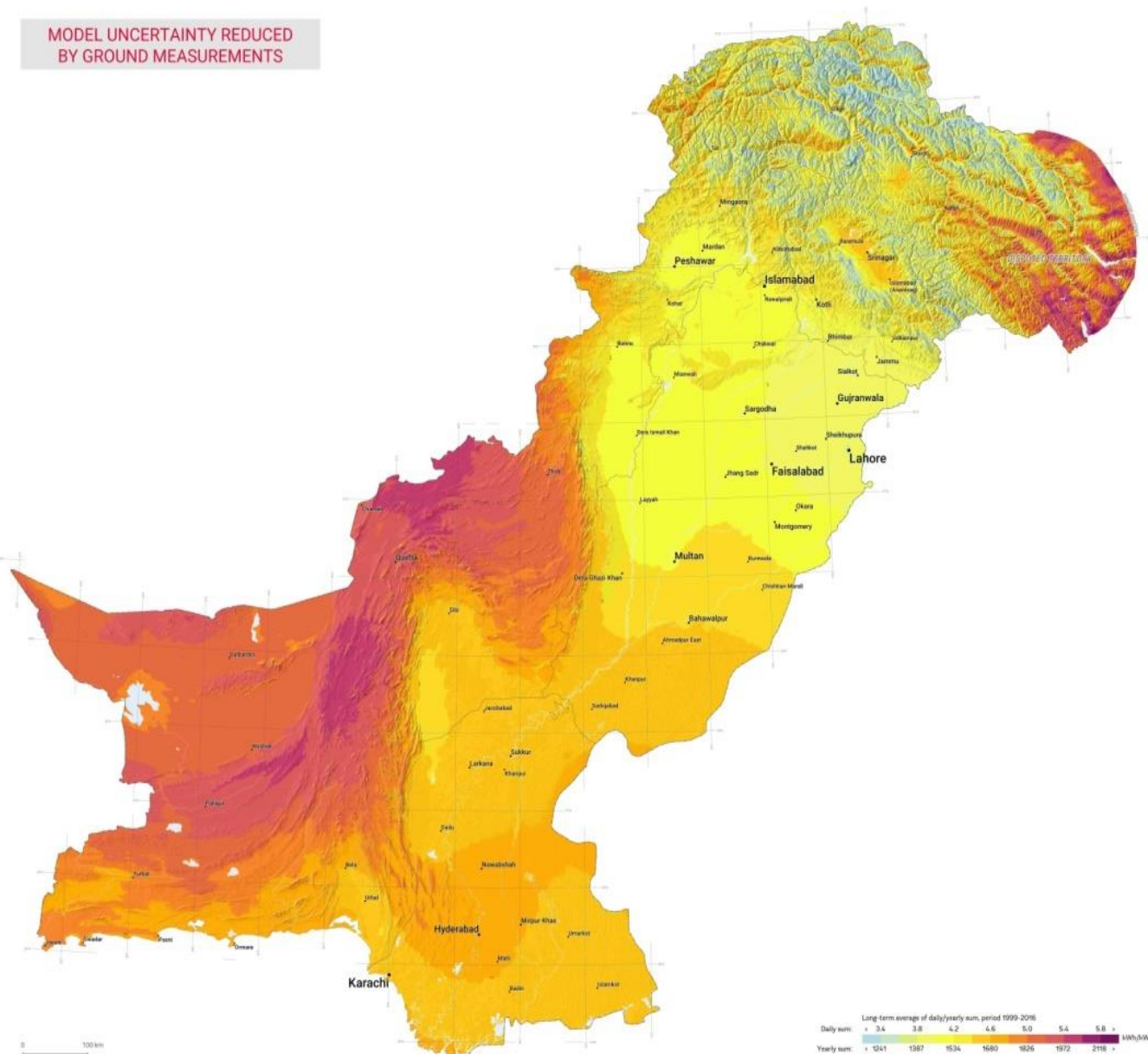
DISCLAIMER

Considering the nature of climate fluctuations, interannual and long term changes, as well as the uncertainty of measurements and applied methods, Solargis does not take any responsibility whatsoever, and does not give any warranty on the accuracy of the data that were used to produce this map. Solargis has done its utmost to make an assessment of climate conditions and performance of solar power systems based on the best available data, software and knowledge. It is recommended that this map be used as a guideline, rather than an instrument to build the solar power systems.

The boundaries, colours, denominations, and other information shown in this map do not imply any judgment on the part of Solargis concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Solargis database version: 2.1 • Map issue date: 2017-05-09

MODEL UNCERTAINTY REDUCED
BY GROUND MEASUREMENTS



SOLARGIS

Renewable Energy Policy 2006 (Salient Features)

- Determines scope and the role of different stakeholders throughout project cycle.
- Lays down Procedures, Roadmap, Engaging Mechanism for the development of RE projects
- Provides for two modes of Project Development;
 - Solicited projects
 - Unsolicited projects
- Different tariff options;
 - Cost-plus / Negotiated tariff
 - Upfront Tariff
 - Competitive Bidding

Renewable Energy Policy 2006 (Salient Features)

- Options for Grid Connected Solar PV Projects as per Regulatory Regime
 - IPP Based Commercial Projects
 - PPP Based Projects
 - Net Metering
 - Wheeling of electricity
 - Grid Spill Over
 - Banking of Electricity
- Incentives as per RE Policy
 - Grid provision is the responsibility of the power purchaser
 - Fiscal and Financial Incentives
 - Carbon Credits through CDM Facility

INCENTIVES OFFERED: (By Government of Pakistan)

- ❖ No customs duty or sales tax on import of equipment
- ❖ No Income Tax / withholding tax / turnover tax
- ❖ Repatriation of Equity along with dividends freely allowed
- ❖ Convertibility of PKR into USD
- ❖ Non-Muslims and non-residents exempted from payment of Zakat on dividends
- ❖ Mandatory purchase of electricity by power purchaser
- ❖ 15-17% ROE
- ❖ Government's Sovereign Guarantee
- ❖ Mandatory purchase of electricity from RE projects

SOLAR ON-GRID POWER DEVELOPMENTS SO FAR

- RE Resource mapping (including Solar) being carried out by Energy Sector Management Assistance Program (ESMAP) of the World Bank
- NEPRA has announced amendment in Grid Code for solar PV power projects
- Standard Project Security Documents (EPA, IA) have been approved by the ECC.
- Quality standards to restrict the import of sub-standard solar equipment being introduced
- AEDB is offering Federal Govt. Guarantee to projects initiated under provincial Lols, provided they obtain a tripartite LoS (AEDB, Prov. Govt. and IPP)
 - RE Policy 2006 has been amended to this effect
- Framework regulations for introduction of net-metering using solar, wind etc. developed and provided to NEPRA for implementation

ON-GRID COMMERCIAL SOLAR POWER PROJECTS

CURRENT STATUS

- Solar power projects are being developed through private sector investors on IPP mode.
- **23 Solar Power Projects (892.52 MW)** are at various stages of development.
 - Six (06) Solar Power Projects (430 MW) achieved COD and are operational
 - Four (04) Solar Power Projects (41.52 MW) in process of achieving Financial Closing
 - Sixteen (13) Solar Power Projects (421 MW) are in different stages of development and are expected to be completed by 2019 / 2020.
- Provincial Governments have also issued LOIs for wind power projects (Sindh: 24 LOIs for 1500 MW; Punjab: 11 LOIs for 1413 MW; KPK: 5 LOIs for 204 MW; Balochistan: 3 LOIs for 150 MW)
- **Competitive Bidding to be carried out for new solar power projects**

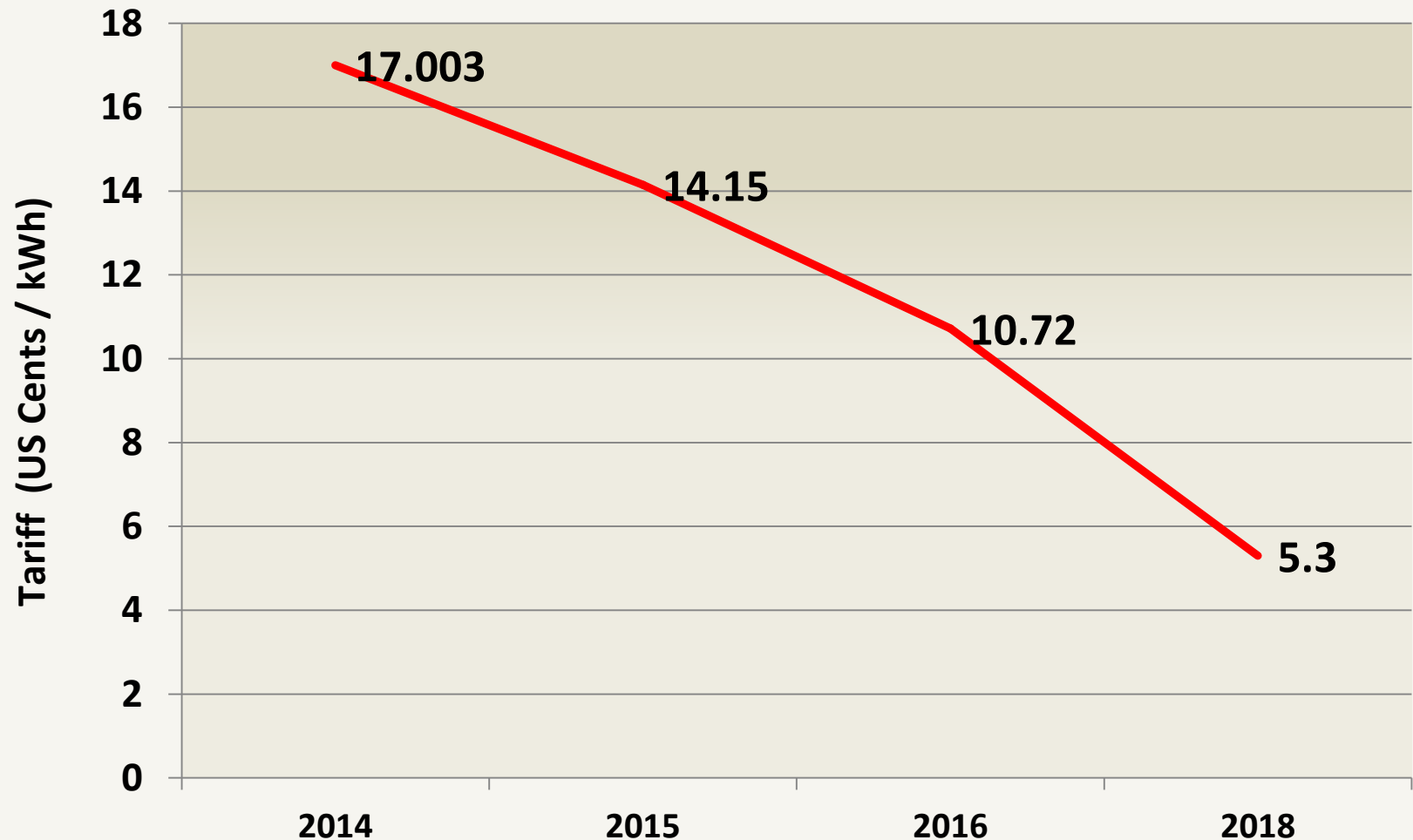
100 MW Solar Power Project by M/s QA Solar Pvt. Ltd.



3x100 MW Solar Power Projects by M/s Zonergy



STATUS OF SOLAR PV (Solar Power Tariffs)



A vertical strip of six images is located on the left side of the slide. From top to bottom, the images are: a close-up of a sun with rays, a flowing river with rocks, a wind farm at sunset, a forest with a stream, a boat on a river, and a large solar panel array.

DISTRIBUTED GENERATION (NET-METERING AND OFF-GRID)

Distributed Generation (Key Areas)

- A. Net Metering through Solar and Wind Systems**
- B. Direct Sale/Purchase of Electricity (B2B PPAs)**
- C. Wheeling Arrangement**
- D. Off-Grid Lighting Solutions – IFC-Lighting
Asia/Pakistan**
- E. Solar Water Pumping**

STATUS OF DISTRIBUTED GENERATION



Net Metering

- NEPRA approved Regulations on September 1, 2015 to put into effect Net Metering for solar and wind generation of up to 1MW.
- 699 customers of cumulative 15.20 MW have been issued Generation License for Net Metering as of November 05, 2018.
- Addition of 3000-4000 MW of net metering based installations is envisaged in next 3-4 years.

Direct EPA

- Private sector companies are offering installation of solar PV systems under B2B EPAs
- 7 companies are active; 5 projects of 3.8 MW capacity are already installed and a number of more are at planning and design phase

Wheeling

- Private sector companies are showing interest; regulatory and security package is being devised

State Bank of Pakistan Financing Facility

- State Bank of Pakistan announced Financing Scheme for new installed net metering based RE systems (*between 4kW-1000kW capacity*) at 6% flat interest in 2016
- The scheme is valid till June 30, 2019
- Under this scheme, refinancing is provided for 100% of the financing by the banks/DFIs
- Terms of Financing
 - Financing Period 10 Years
 - Rate of Refinance 2% fixed
 - Bank's/DFI's Spread 4% fixed
 - End User's Rate 6% fixed
- Loan with interest is to be repaid in monthly/quarterly installments
- SBP is under discussion with Bank/DFIs for further improvements in the Scheme

IFC – Lighting Asia / Pakistan Program

Lighting Asia/Pakistan aims at:

- Helping address the lighting needs of consumers
- Give access to low-cost, high-quality, safe, reliable, and cleaner lighting products.
- Target: enable 1.5 million people have access to modern energy services for lighting and associated services.
 - The Framework Includes:
 - Quality Assurance
 - Market Intelligence
 - Business-to-Business Connections
 - Consumer Awareness

IFC – Lighting Asia / Pakistan Program

Partners

- IFC, AEDB, Micro-financing Institutes, international manufacturers and local distribution companies
- Establishing range of channels: microfinance institutions, retail shops, and own franchise network.

Progress

- Lighting Pakistan has reached the following milestones since its inception:
 - 150, 000 products sold
 - 750,000 people reached
 - Six manufacturing associates found local distributors



Future Planned Addition of Wind & Solar Power

Based on the power demand projections, the following capacity addition from wind and solar was mentioned in Generation Plan;

Sr. No.	Resource	Capacity (MW)	Expected Completion
1	Solar - QA Solar Park	600	Jun-2020
2	Wind Solar	1200 600	June-2021
3	Wind & Solar	300	June-2022
4	Wind & Solar	500	June-2023
5	Wind & Solar	450	June-2024
	Wind & Solar	900	Jun-2025
		4550	

The revised Generation Plan only includes the following;

- | | | |
|--------------------------------|---------|-----------|
| 1. QA Solar Park | 600 MW | Jun, 2020 |
| 2. Solar (Competitive Bidding) | 600 MW | Jun, 2021 |
| 3. Wind (Competitive Bidding) | 1224 MW | Jun, 2021 |

Future Way Out

- ❖ Fixing share of Renewables in the energy mix of Pakistan
- ❖ Better State of Art System Integration of Renewables at On Grid and Off Grid Levels
- ❖ Maintaining the confidence of Investors
- ❖ For every energy planning in this country, the projects be viewed in the perspective of Sustainability and Energy Security.
- ❖ Upfront tariff for Wind-Solar Grid Hybrid projects be announced
- ❖ All future wind projects should have solar component
- ❖ Bilateral contracts (wheeling) using RE generation

Future Way Out

- ❖ Village electrification (not possible through grid extension) though solar, wind and small hydel based generation in standalone and hybrid mode – Provincial Govts / DISCOs in collaboration with AEDB
- ❖ NTDC may suggest grid points / areas (from grid stability / technical point of view) for development of new wind / solar projects on solicited mode

A vertical strip of five images is located on the left side of the slide. From top to bottom, they show: a close-up of a solar panel with a bright reflection; a fast-flowing river with white water rapids; a row of wind turbines against a sunset sky; a lush green forest with a path; and a close-up of a solar panel with a bright reflection.

Thank you.

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