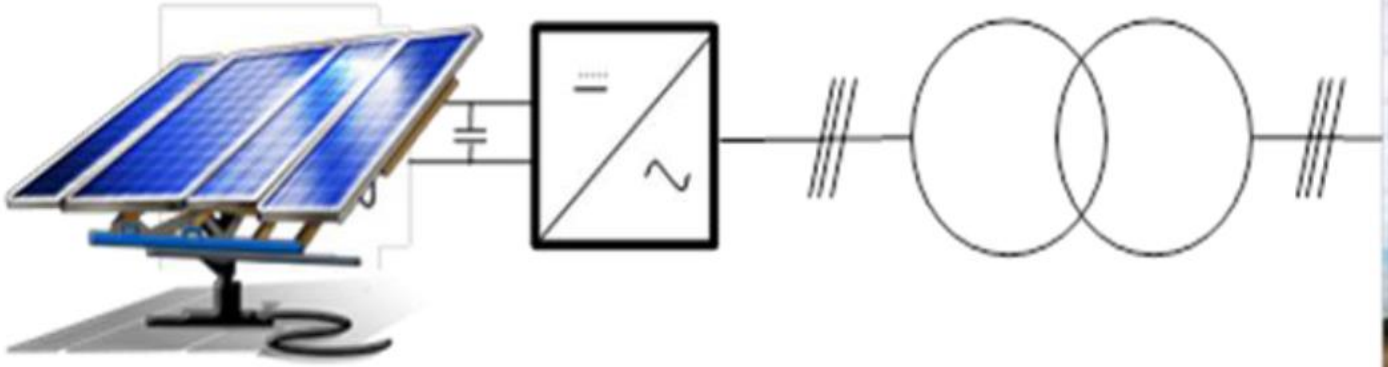
Integrating increasing shares of variable renewable energy in to Pakistan Power Grid



Major drivers:

1. Very short lead time.
2. Excellent wind and solar resources.
3. Low emissions development

Presented by:

Imran Ahmed
Program Management Specialist
USAID Pakistan

PAKISTAN POWER GENERATION MIX

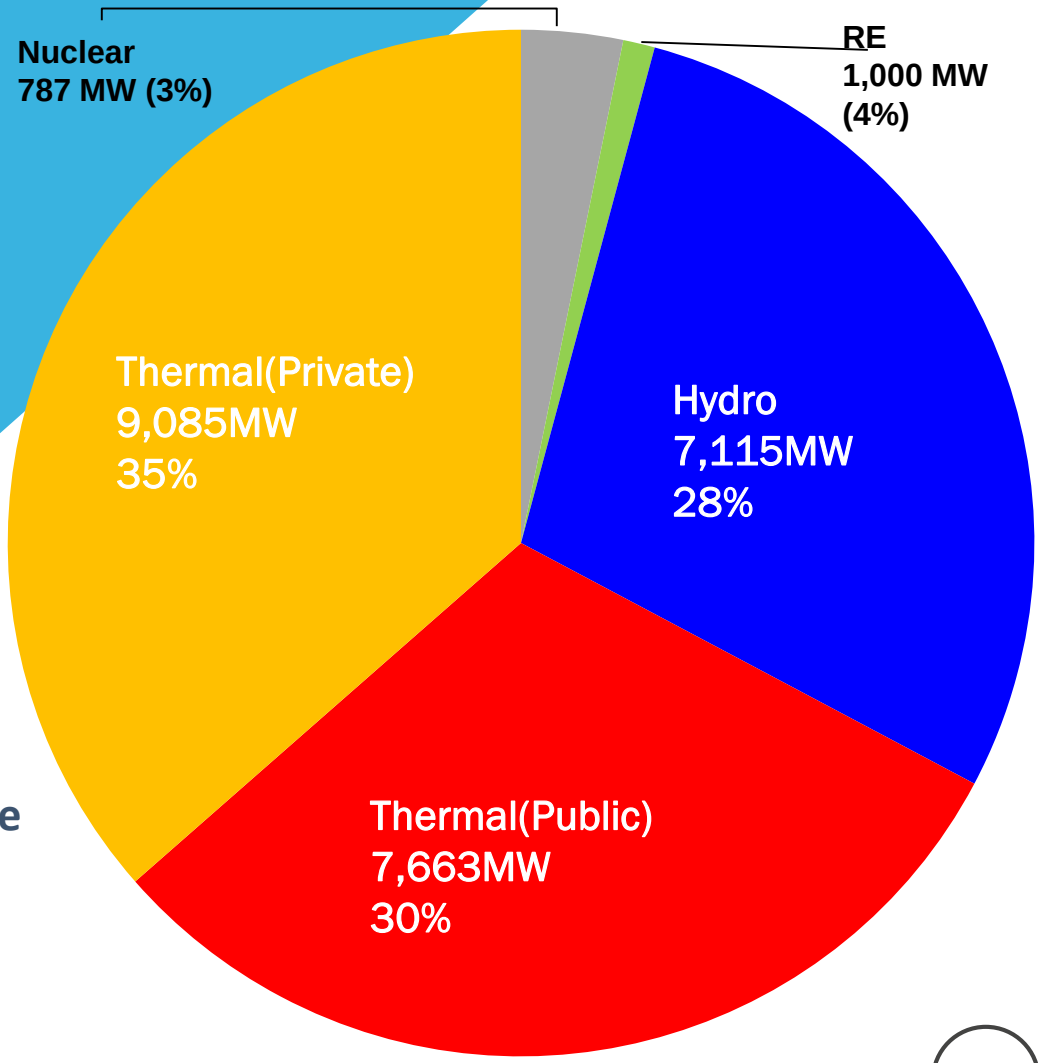
Installed capacity: 25,650 **MW**

Clean Energy Potential

Wind – 350,000 MW

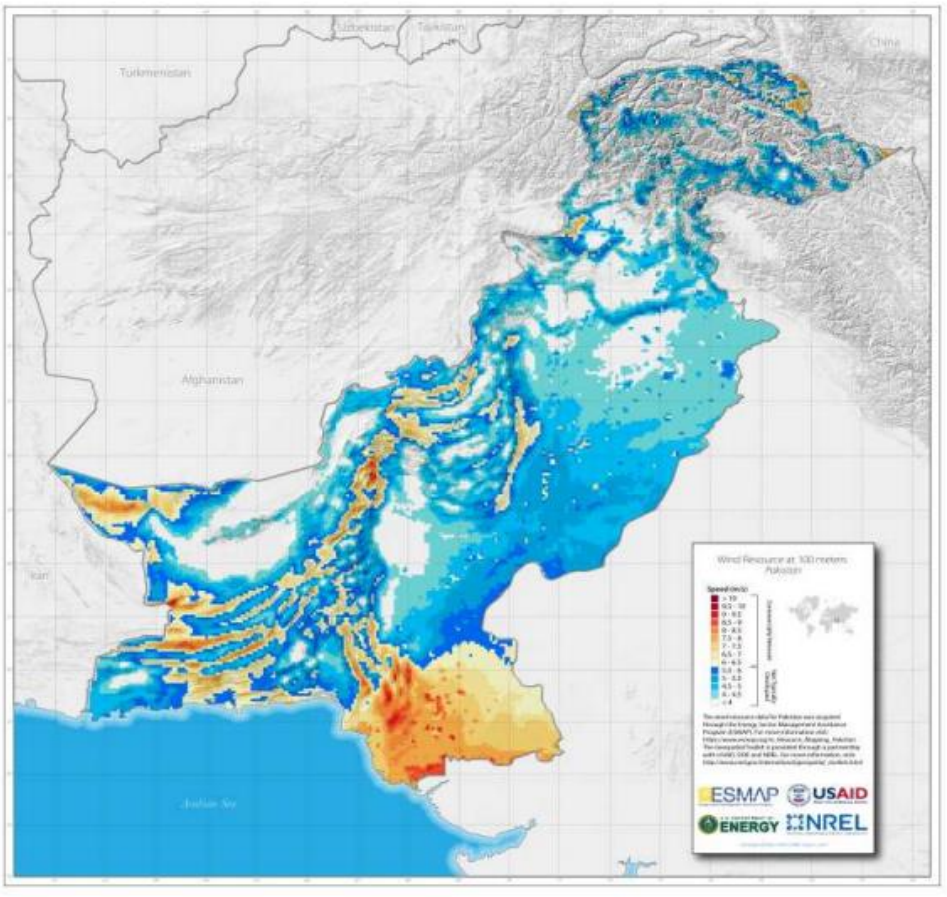
Solar – 2,900,000 MW

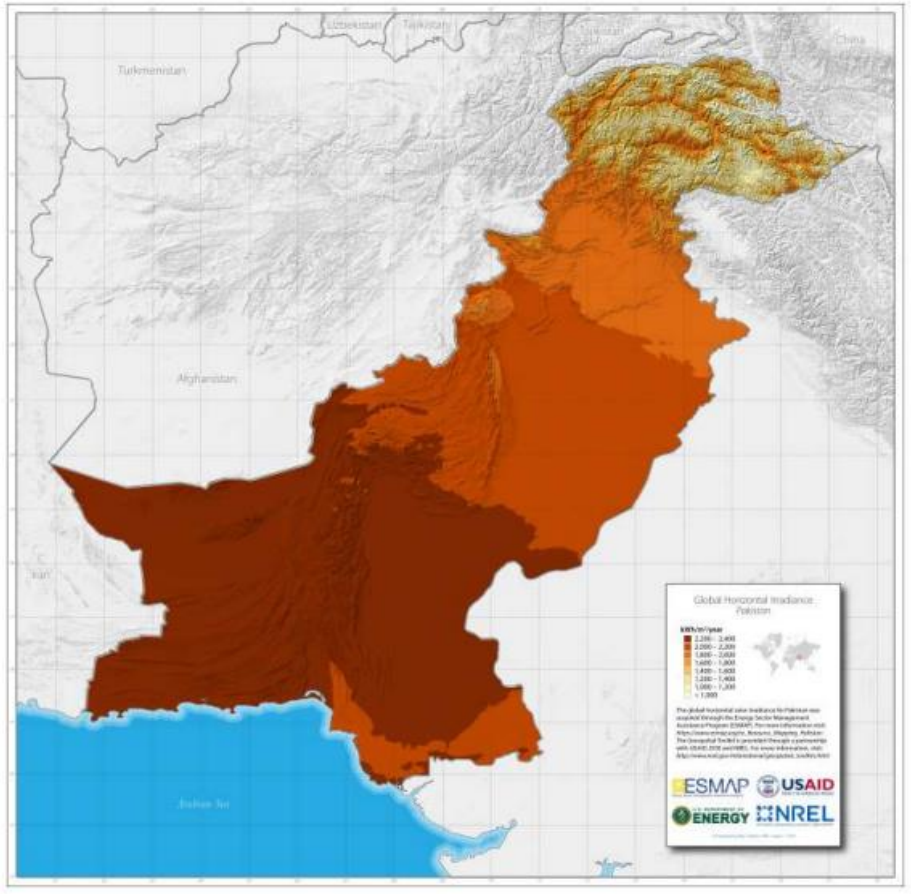
Hydropower – 60,000 MW



This offers an opportunity to make the energy generation mix more Sustainable by significantly increasing the share of renewable energy sources

WIND AND SOLAR POTENTIAL



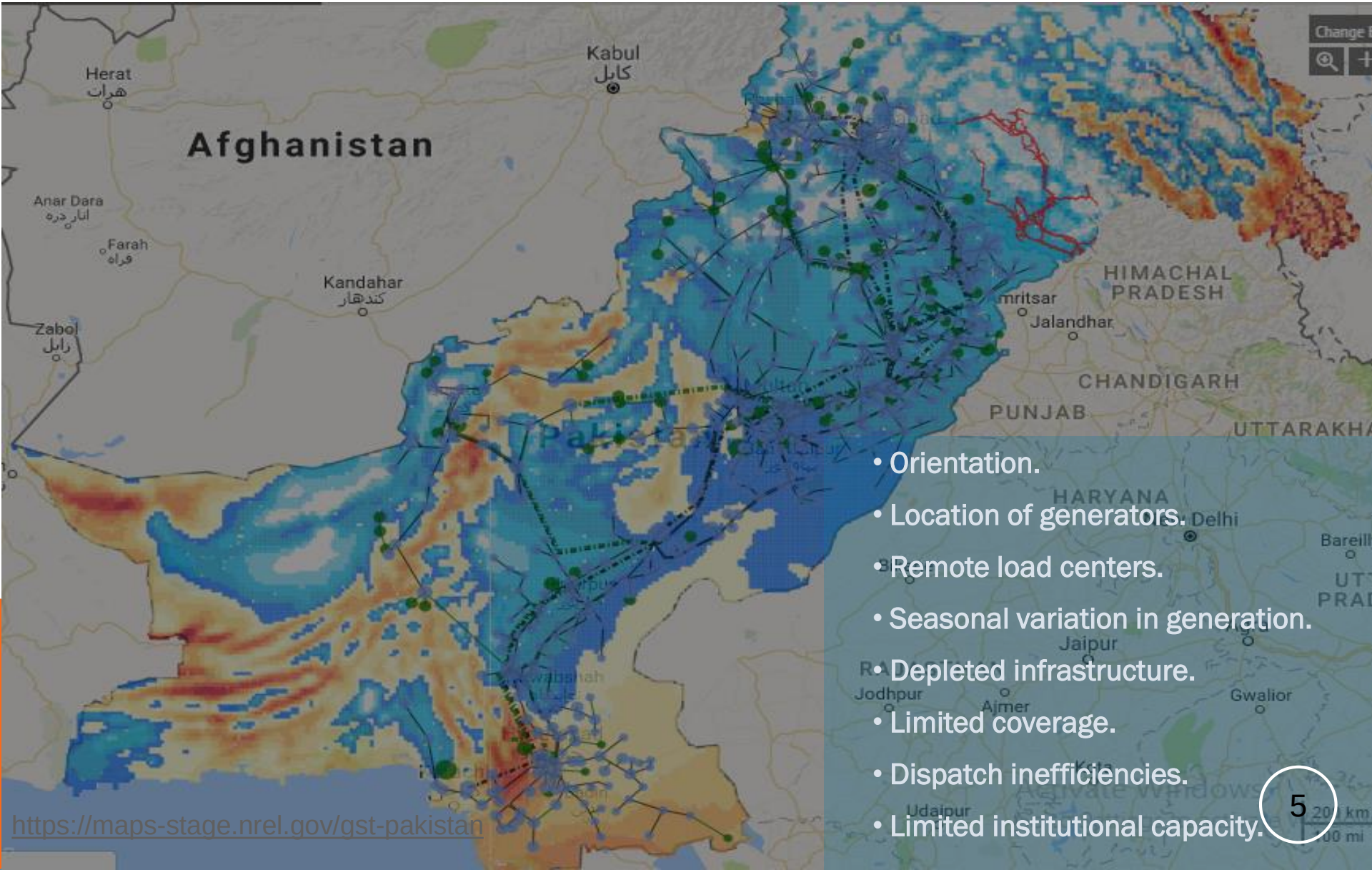


https://maps-stage.nrel.gov/gst-pakistan

RE INTEGRATION - BUILDING BLOCKS

- Strategic Energy Planning: Goals; Policy actions; Resource allocation; etc.
- Smart Incentives: Accelerated Depreciation; Tax credits/ rebates; Import duties; sovereign guarantees; Return on investments; etc.
- Procurement methods: Cost Plus; Upfront FITs; Reverse Auctions; etc.
- Renewable Energy Zones: Technical and economic considerations
- Finance: Direct subsidies; Interest rates; Loan guarantees; Private capital; etc.
- **Grid Integration: Grid connections; operational impediments**

PAKISTAN POWER GRID - CHALLENGES



- Orientation.
- Location of generators.
- Remote load centers.
- Seasonal variation in generation.
- Depleted infrastructure.
- Limited coverage.
- Dispatch inefficiencies.
- Limited institutional capacity.

https://maps-stage.nrel.gov/gst-pakistan

ADDITIONAL CHALLENGES POSED BY RE INTEGRATION

- **As the amount of Renewable Energy in the electricity grid increases, new challenges emerge.**

- **Initially built for traditional power sources, the grid is not yet to handle variability at generation level**

- **The RE integration requires grid enhancements and modifications including:**
  - addition / allocation of spinning / contingency reserves;
  - reactive power compensation arrangements;
  - grid code modification and enforcements;
  - optimal dispatch orders; and,
  - best practice management.

MAJOR CONSIDERATIONS: RE GRID INTEGRATION STUDY

- **What capacity of RE can be integrated in short-term without grid expansions?**

  2 GW+ of wind and PV generation can be integrated at defined locations without any major grid upgrades.

- **What grid reinforcements are required for medium terms RE integration?**

  Around 10 GW of wind and PV generation can integrated at defined locations by strengthening grid at 500kV, 220kV and 132kV level.

- **What is the financial impact of integrating variable RE into the power system?**

  Wind and PV integration will reduce the financial loss of Pakistan Power system.

- **What modifications are required in the grid code?**

  Study recommends some modifications to transmission grid code of Pakistan.

- **What are the impacts of the variability of wind and PV?**

  There will be increased spinning reserve requirement.

WIND – SOLAR HYBRID PROJECTS

- **Increased capacity factor – 45% plus in hybrid mode**
- **Reduced variability–wind and solar complement each other**
- **Optimal utilization of resources**
- **Work within the allocated transmission capacity**
- **Short gestation period (<year)**

Increased renewable share without grid reinforcements

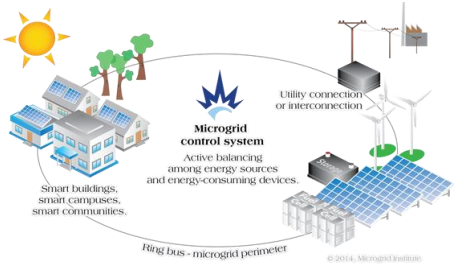
SYSTEM STABILITY SERVICES

Storage: Ancillary; Generation; Transmission; Distribution Services

Micro-grids: Peak load shaving; Voltage regulation; Loss Control

Volt-Var Optimization: Voltage and Frequency controls

Smart Technologies: GIS; SCADA; CIS; Real time analysis



FINANCING GRID INFRASTRUCTURE

Transmission slot is the responsibility of power purchaser – NTDC/DISCO

Lack of public sector funding delay the projects

Donors are providing funds for construction of transmission system

GOP may consider operationalizing Private Transmission Policy

THANK YOU

Questions?