Renewable Energy Zones and Integration in Turkmenistan

USAID Power Central Asia Program

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RES zones in Turkmenistan

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OVERVIEW OF RES ZONES

Problems in the development of RES caused by individual projects

- Optimal for the developer, not for the energy system as a whole
- Risk for investors is high, therefore, the price is higher:
  - Uncertainty in obtaining permissions to connect to the grid
  - Lack of information on energy consumption potential
  - Unknown licensing requirements
  - Unknown land grant rules
  - Unavailability of detailed wind and solar radiation measurements for resource quantification

Solution: RES zones**!**

What is a RES zone?

- High resource concentration
- High quality resource assessment
- Lower cost of grid integration
- Availability of environmental clearance
- Land permits
- Ready grid and logistics infrastructure

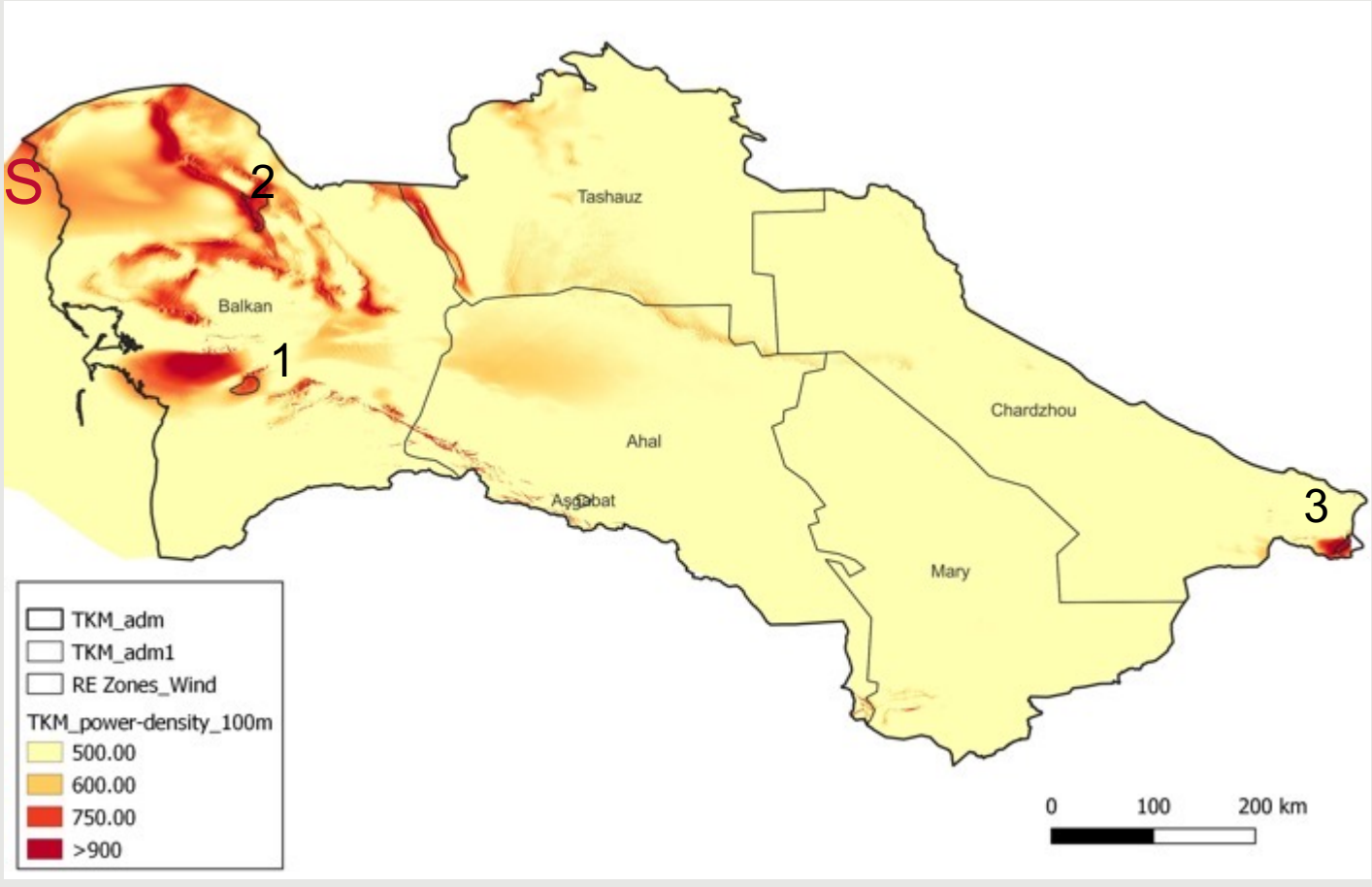
Objectives of RES zones

- Low purchasing tariff
- Low cost of grid integration
- Attracting private capital
- Increasing RES production volumes
- Minimizing the impact of renewable energy sources on the grid

Given that in the world auctions are a preferable way to purchasing renewable energy, using renewable energy zones will provide the lowest prices.

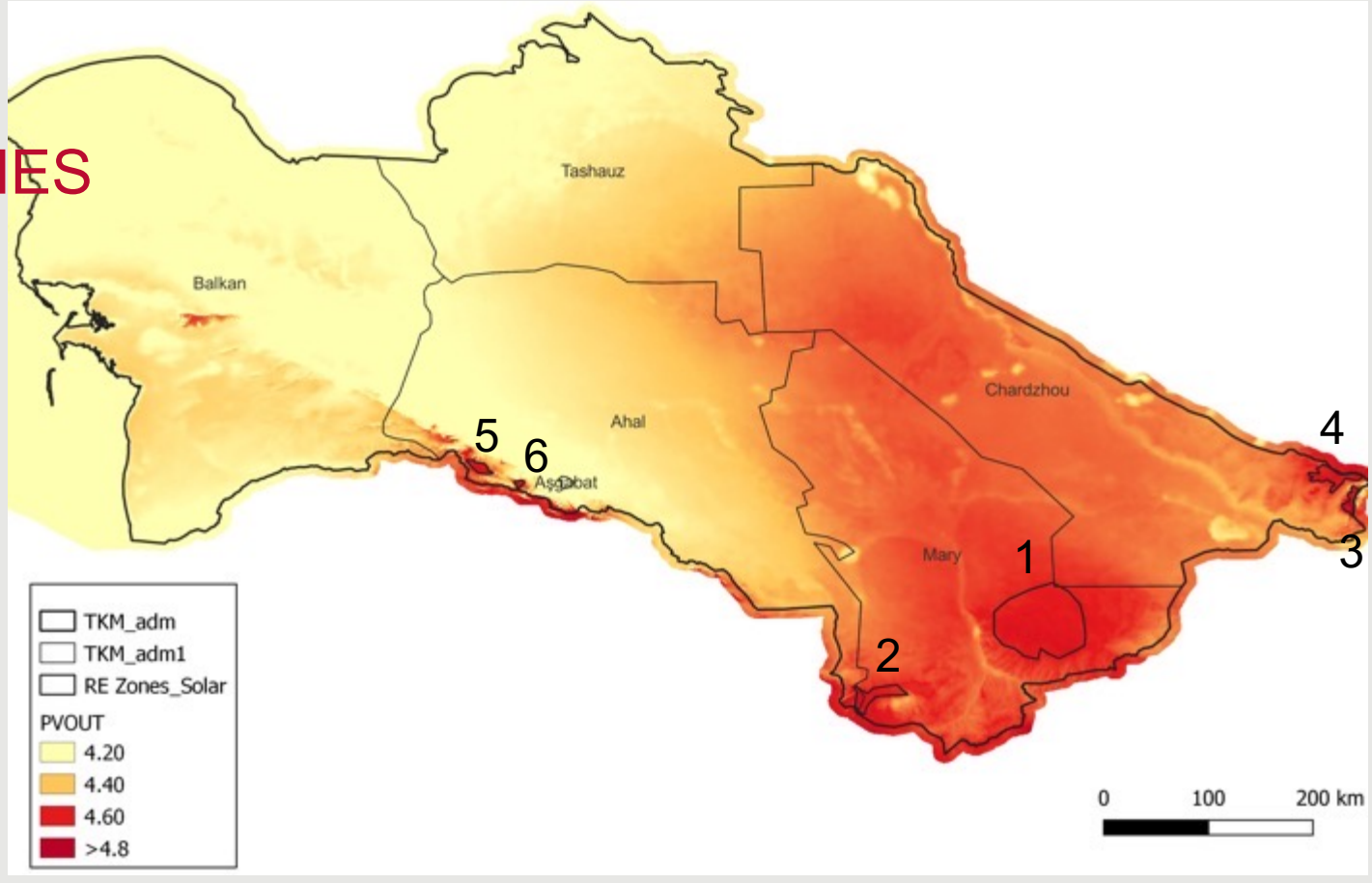
DEFINED WIND ZONES

- 3 wind zones defined
- Threshold: WPD (wind power density) ~500 W/m2, wind speed ~7+ m/s; CF (capacity factor) ~50%



DEFINED SOLAR ZONES

- 6 zones determined



STATISTICS BY ZONE

Assumptions for pre-defined RES zones:

- Completely based on wind and solar resources. Data obtained from the Global Wind and Solar Atlas developed by ESMAP (Energy Sector Management Assistance Programme)
- The following parameters were not taken into account: distance to transmission, distance to energy center, landscape, environmentally sensitive areas, land purpose and others. These may be reviewed under the guidance of the local team as part of the next phase
- The MW potential in the tables is the maximum capacity value of the power plant

WIND			
Zone No.	Area (km2)	Average WPD (W/m2)	MW potential
1	336	722.51	1,680
2	524	864.62	2,623
3	128	1,053.92	641

SOLAR			
Zone No.	Area (km2)	PVOUT (PV power generation) average per day (kWh / kW peak)	MW potential
1	5,521	4.61	331,295
2	635	4.63	38,110
3	218	4.70	13,085
4	550	4.62	33,010
5	184	4.62	11,062
6	52	4.64	3,127

FINANCIAL MODELING AND SENSITIVITY ANALYSIS

Sensitivity analysis begins by defining standard values and calculates the levelized cost of electricity (LCOE) for all possible combinations of two parameters—total investment cost (TIC) and return on equity (ROE).

The above LCOE calculation uses a combination of international costs (TIC & O&M – operation and maintenance) and standard regional values (financial parameters)

LCOE parameters by country	Standard values	Sensitivity Analysis Values
Cost of investment for SPP	600$/kW	10% increase
Cost of investment for WPP	1400 $/kW	10% increase
Inflation	2%	-
O&M fixed rate (solar/wind)	0/32 $/kW-year	-
O&M variable rate (solar only)	0.0022 $/kW	-
Income tax rate for RES project	18%	-
Interest rate	6.00%	-
% of loan	70%	-
Loan period	15 years	-
Depreciation	Linear over 12.5 years	-
Expected return on equity	10.00%	20% increase
Depreciable capital CAPEX solar/wind	66.7%/83.2%	-

LEVELIZED COST OF ELECTRICITY (LCOE) FOR SOLAR

- The top solar zone is highlighted **in bold**

Baseline Scenario: Total Investment Cost (TIC) =$600, Return on Equity (ROE) =10%

Scenario 4: Total Investment Cost (TIC) =$660, Return on Equity (ROE) =12%

Zone	LCOE, TIC=600, ROE=0.1	LCOE, TIC=600, ROE=0.12	LCOE, TIC=660, ROE=0.1	LCOE, TIC=660, ROE=0.12
Zone 1	$ 0.0374	$ 0.0403	$ 0.0408	$ 0.0440
Zone 2	$ 0.0373	$ 0.0401	$ 0.0407	$ 0.0439
Zone **3**	**$ 0.0367**	**$ 0.0396**	**$ 0.0401**	**$ 0.0433**
Zone 4	$ 0.0373	$ 0.0402	$ 0.0407	$ 0.0439
Zone 5	$ 0.0373	$ 0.0402	$ 0.0407	$ 0.0439
Zone 6	$ 0.0371	$ 0.0400	$ 0.0406	$ 0.0438

LEVELIZED COST OF ELECTRICITY (LCOE) FOR WIND

Baseline Scenario: Total Investment Cost (TIC) = $1,400, Return on Equity (ROE) = 10%

Scenario 4: Total Investment Cost (TIC) =$1,540, Return on Equity (ROE) =12%

- The top solar zone is highlighted **in bold**

Zone	LCOE, TIC=1400, ROE=0.1	LCOE, TIC=1400, ROE=0.12	LCOE, TIC=1540, ROE=0.1	LCOE, TIC=1540, ROE=0.12
Zone 1	$ 0.0380	$ 0.0402	$ 0.0410	$ 0.0435
Zone 2	**$ 0.0352**	**$ 0.0373**	**$ 0.0380**	**$ 0.0402**
Zone 3	$ 0.0367	$ 0.0388	$ 0.0396	$ 0.0419

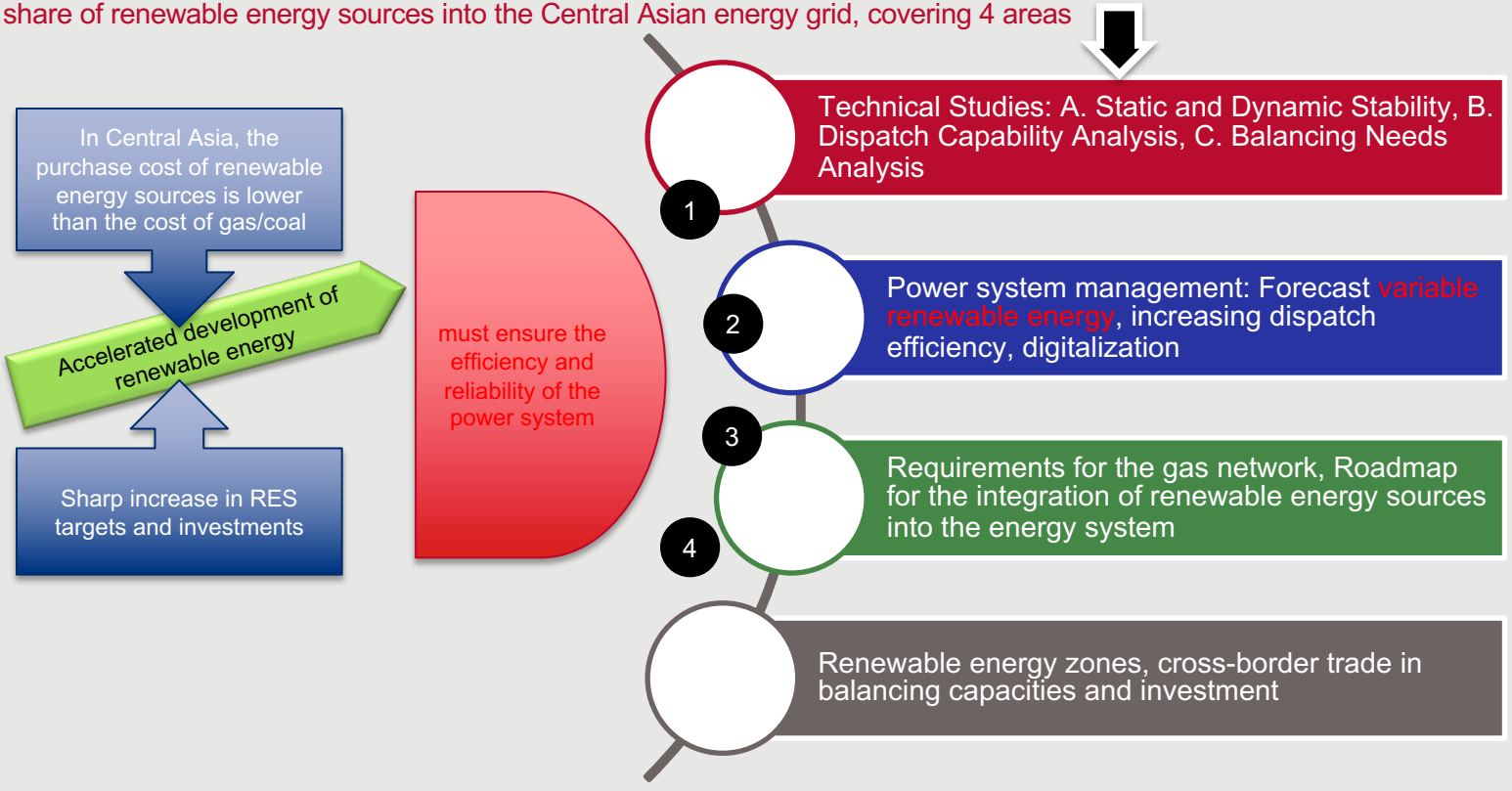
NEXT STEPS

- Create a team of local experts
- With the support of local experts obtain country-specific data regarding:
- distance to transmission, distance to power center, landscape, environmentally sensitive areas
- Obtain country-specific data regarding input parameters for the financial model
- Adjust zone boundaries and rankings based on the above country-relevant data.

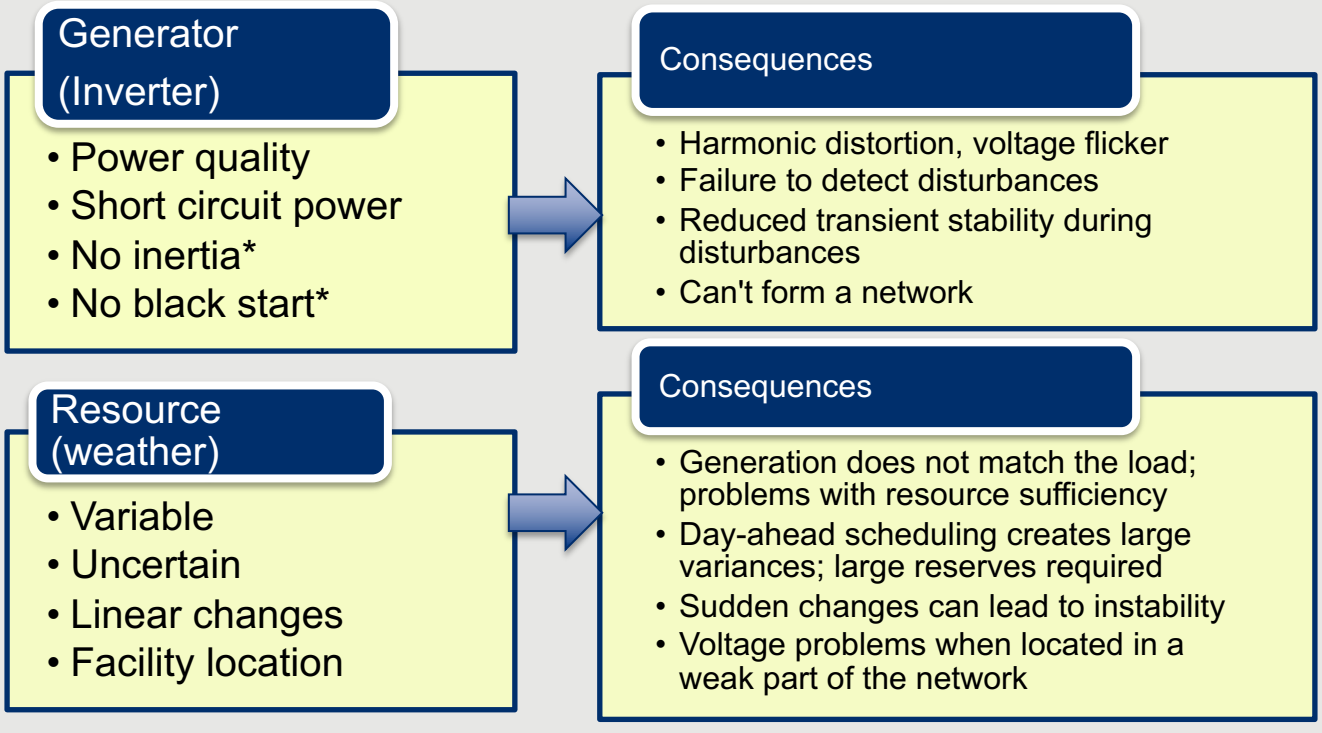
RES integration

A NEW APPROACH TO INCREASING THE SHARE OF RES

The USAID's Power the Future project provides technical assistance for the integration of a higher share of renewable energy sources into the Central Asian energy grid, covering 4 areas



TECHNICAL IMPACT OF RES ON THE ENERGY SYSTEM



WHAT DOES RES INTEGRATION INTO THE ENERGY SYSTEM MEAN??

Managing connectivity and operational issues

Regarding connection

- Intersystem connections: power quality, P/Q regulation, voltage dip regulation
- Substation power
- Transmission capacity from substations to consumers, from RES-based power plants to substations

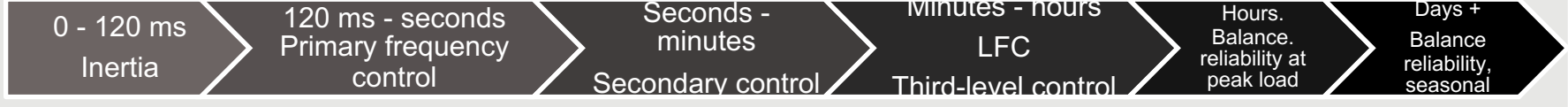
Regarding management

- Balancing at all time periods
- Static and dynamic stability
- Balancing capability and reserves

Studying the impact of renewable energy sources on the system

- Project studies
  - Assessment of intersystem connections
  - Static and dynamic stability
- Analysis of the system-wide impact of renewable energy sources
  - Static and dynamic stability
  - Dispatching, modeling of production costs
  - Balancing capability and the need for reserves

Balancing at different time intervals



Opportunities for Turkmenistan to export balancing generation

UNUSED OPPORTUNITIES

- The region is experiencing significant growth in renewable energy sources, requiring balancing capability that is already in short supply.
- Turkmenistan has significant potential for untapped balancing capability and opportunities for its growth.
- Using its existing generation mix and associated energy infrastructure, Turkmenistan can generate flexible electricity that can be sold at a higher price.
- This will increase the income Turkmenistan receives from each cubic meter of gas.
- The PCA will help examine in detail the opportunities, costs and benefits for Turkmenistan to produce and export this flexible generation as an additional service to existing exports.

SUPPORT BY PCA IN USING BALANCING CAPACITIES

- **Potential market:** Existing and future needs of neighboring countries.
- **Interconnections:** Transmission and cross-border connections, their current capacity and possible modernization.
- **Balancing capability of generation:** Study of generation and energy system in order to determine the balancing capacity and operational profile of the complex of generating enterprises in Turkmenistan by technology, power plants and transmission systems after meeting the needs within the country.
- **Gas supply:** Flexibility of Turkmen gas supplies to national power plants to ensure that the offered generation balancing capability services match the country's gas reserves and equitably cover national needs.
- **Strengthening the power grid:** Localizing and determining the scope of the upcoming national grid modernization in order to increase the balancing capability of electricity exports and value-added income.
- **Expansion of gas infrastructure:** Determining the scope of possible modernization of the national gas transportation infrastructure to increase the balancing capability of generating capacities.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