Utility-Scale Solar Energy Program in Afghanistan: Vision and Challenges

Eight Afghanistan Energy Study Committee Meeting

December 5, 2018

WORLD BANK GROUP

Utility-scale solar PV targets

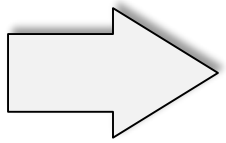
Government of the Islamic Republic of Afghanistan increasing support to solar PV

- **2015** - Renewable Energy Policy : 4500 to 5000 MW of renewable energy capacity by 2032
- **2017** - Renewable Energy Roadmap for Afghanistan : Strategies to achieve the target
- **2018** - Expression of interest targeting 2,000 MW in the Kabul, Jalalabad, Kandahar, Herat and Balkh areas

Power supply and demand

Annual total power supply	6,045 GWh	
Imported	5,067 GWh	(84 % of total)
Domestic generation	978 GWh	(16 % of total)
Total peak load	1,150 MW	

Growth rate of gross electricity demand:	
Master Plan	8.6 %
MoF	15 %

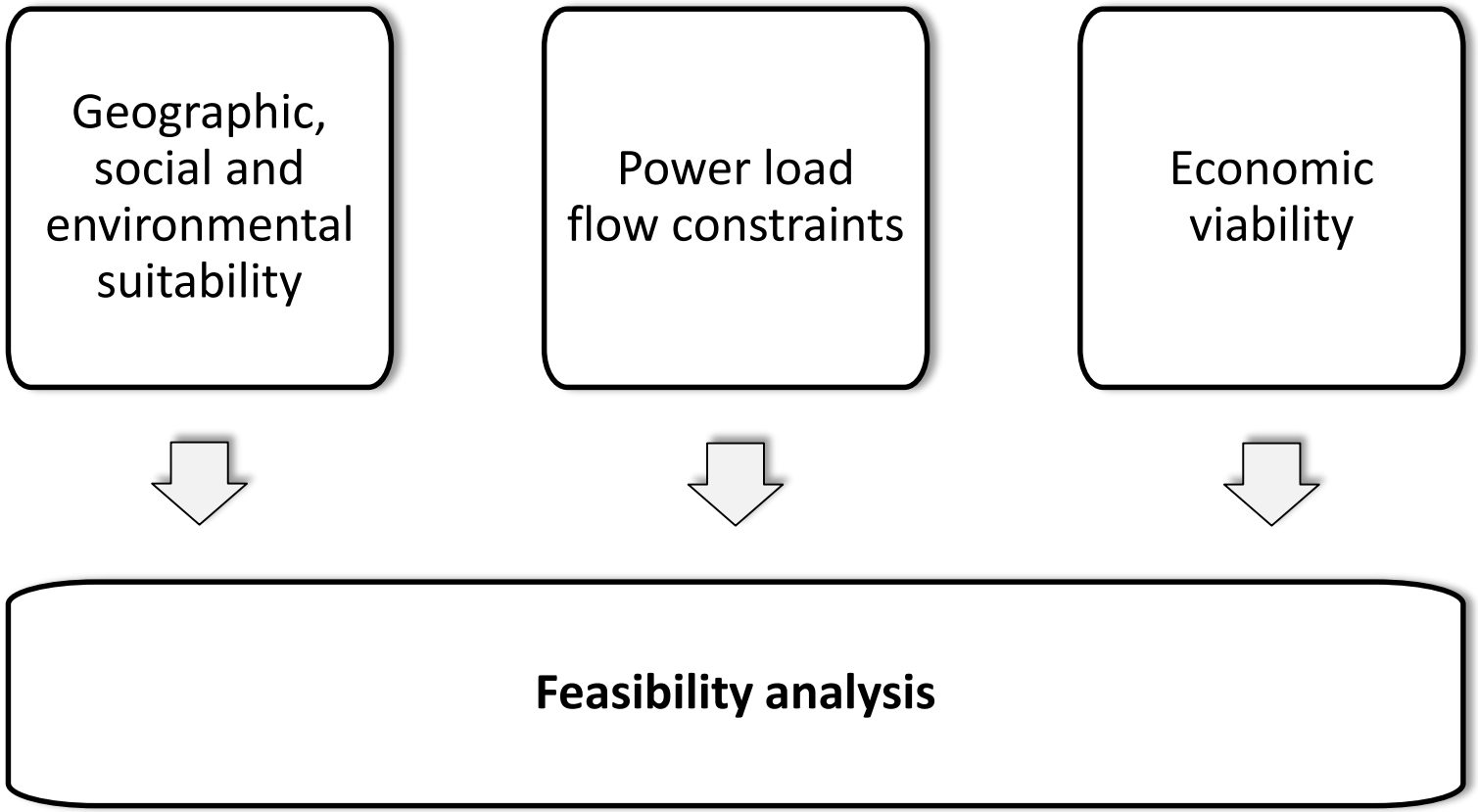


Year	Min projected peak load	Max projected peak load
2023	1,741 MW	2,313 MW
2028	2,634 MW	4,653 MW

Additional capacity needed to satisfy demand

	Min Load	Max Load
2023	**590 MW**	**1,163 MW**
2028	**1,404 MW**	**3,503 MW**

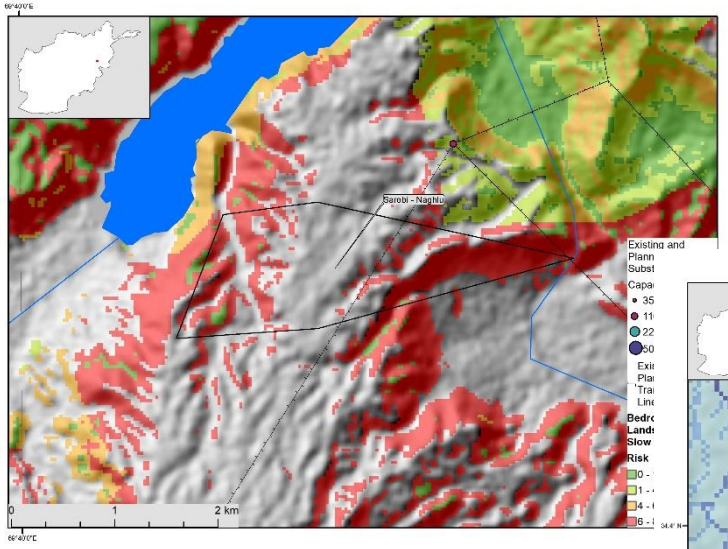
Feasibility analysis



Geographic, social and environmental suitability

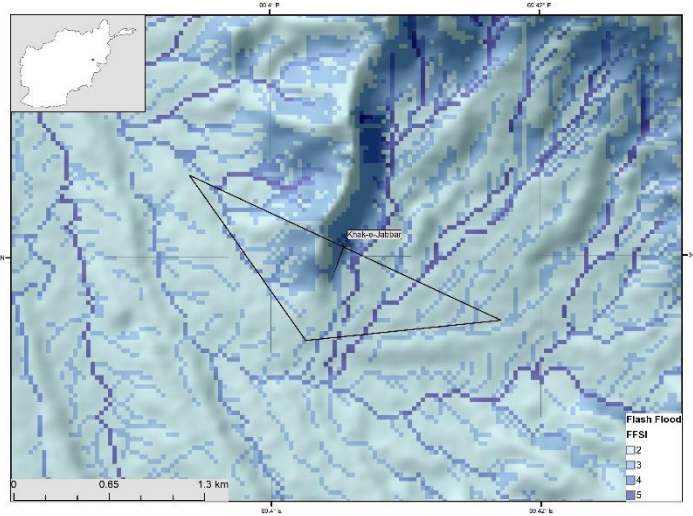
Criteria:

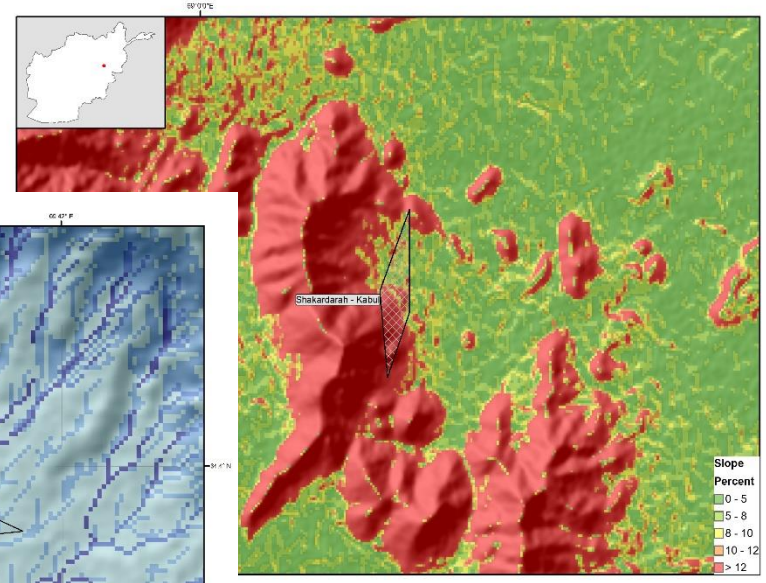
- Environment,
- Agriculture,
- Topography,
- Orography,
- Population
- Climate change and natural hazards.



Landslide

Flood



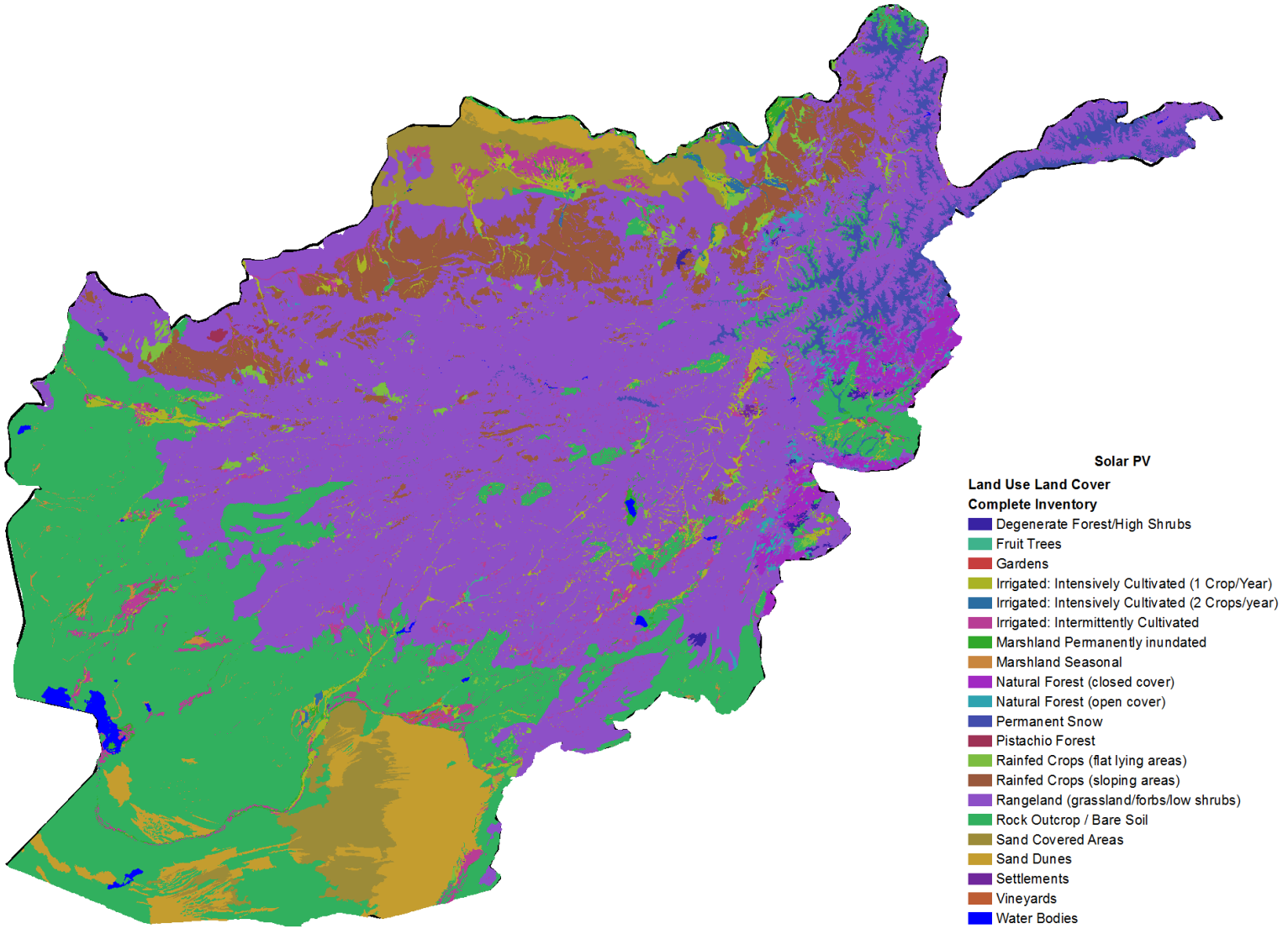


Slope

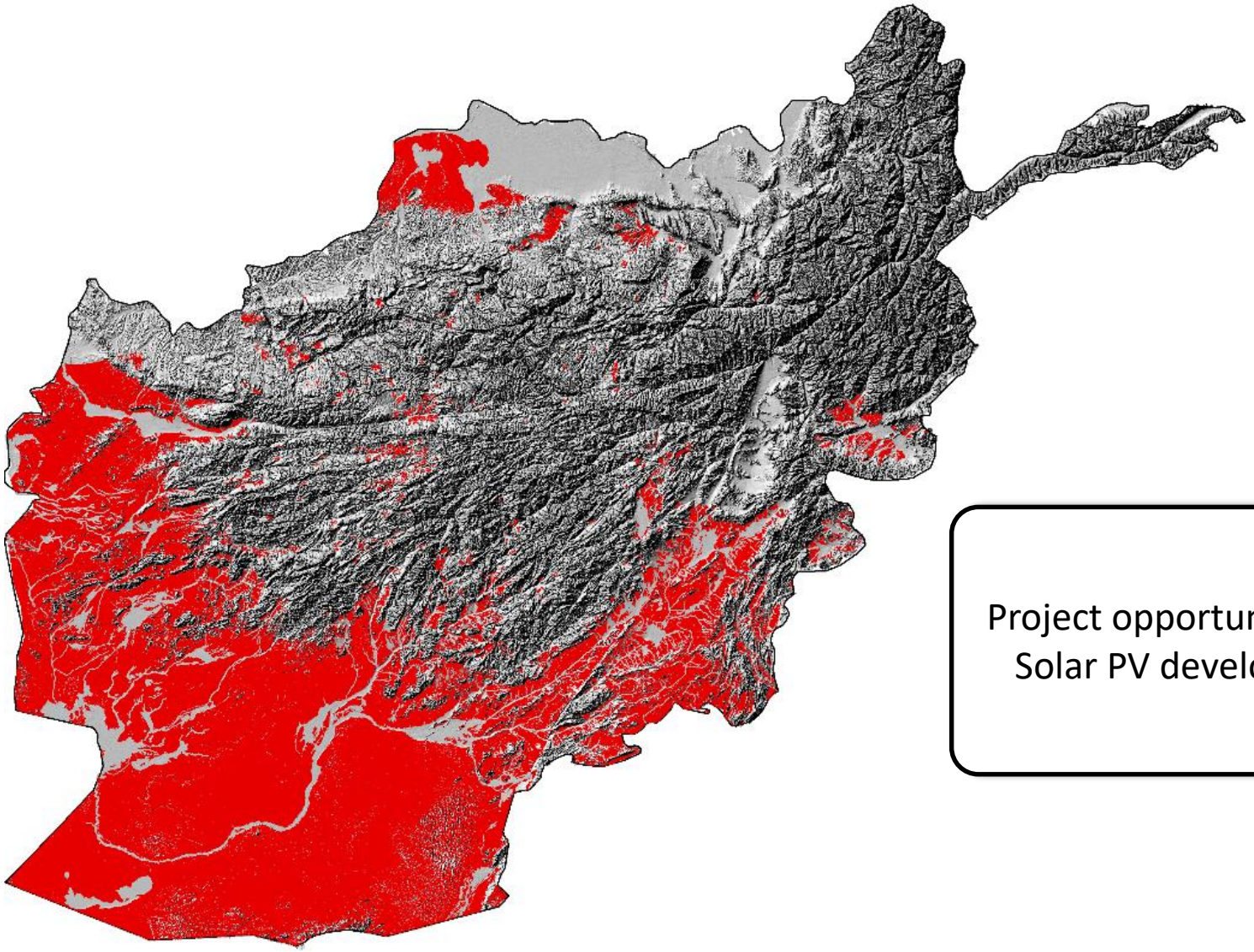
Proximity to water body	Presence of cultural heritage site	Protected areas
Proximity to roads	Human footprint	Risk of landslides
Proximity to grid infrastructure	Population density	Risk of earthquake
Proximity to protected areas	Altitude	Risk of floods
Proximity to airfields	Slope and terrain features	Solar radiation
Proximity to airports	Land use and land cover	

Criteria for Land Use and Land Cover

	Land Use Land Cover Class
Included	Rangeland (grassland/forbs/low shrubs)
Included	Rock Outcrop / Bare Soil
Included	Permanent Snow
Included	Sand Dunes
Included	Sand Covered Areas
Excluded	Irrigated: Intermittently Cultivated
Excluded	Irrigated: Intensively Cultivated (1 Crop/Year)
Excluded	Rainfed Crops (sloping areas)
Excluded	Marshland Permanently inundated
Excluded	Fruit Trees
Excluded	Rainfed Crops (flat lying areas)
Excluded	Settlements
Excluded	Natural Forest (closed cover)
Excluded	Natural Forest (open cover)
Excluded	Irrigated: Intensively Cultivated (2 Crops/year)
Excluded	Degenerate Forest/High Shrubs
Excluded	Water Bodies
Excluded	Marshland Seasonal
Excluded	Vineyards
Excluded	Pistachio Forest
Excluded	Gardens



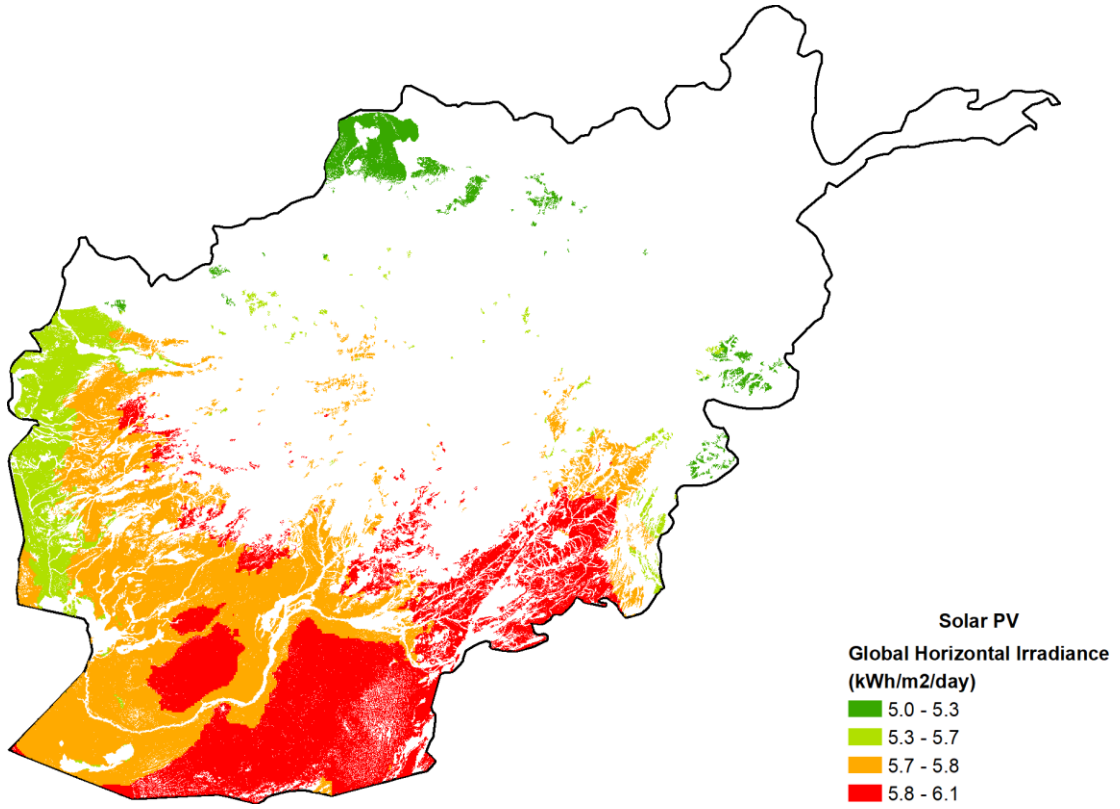
All viable land by applying exclusion criteria



Project opportunity areas
Solar PV development

Red areas: land suitable
for solar PV development

Solar PV – Global Horizontal Irradiance



Afghanistan has excellent solar resources and large land-areas where solar can be deployed.

Long-term yearly average of daily totals of global horizontal irradiation (GHI) in kWh/m^2

Output from the global solar model SolarGIS derived from satellite digital images and atmospheric datasets

Period: from 1994/1999/2007 (depending on the region) to 2015

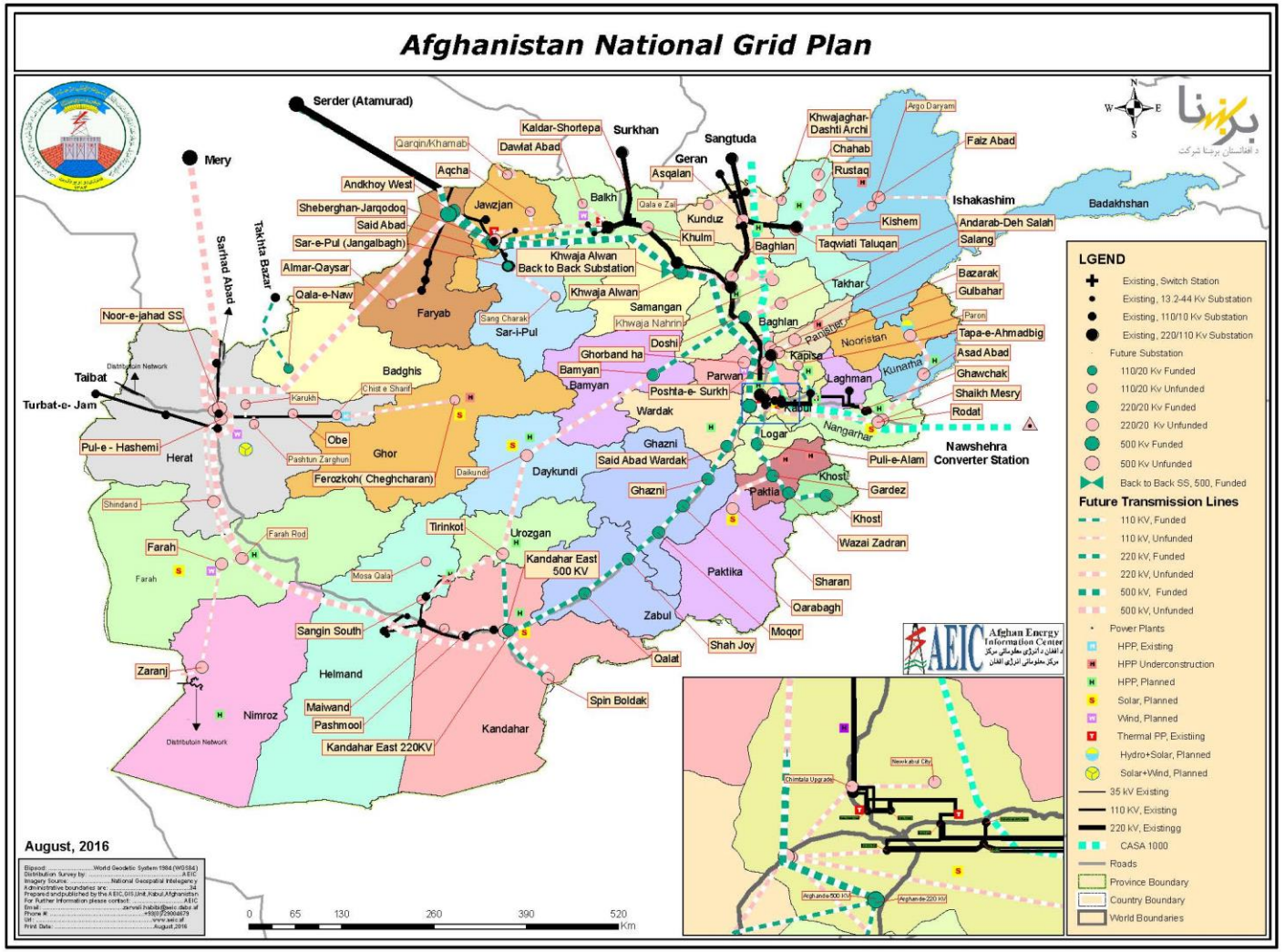
Spatial resolution: 30 arc-sec (900 m)

Power flow analysis

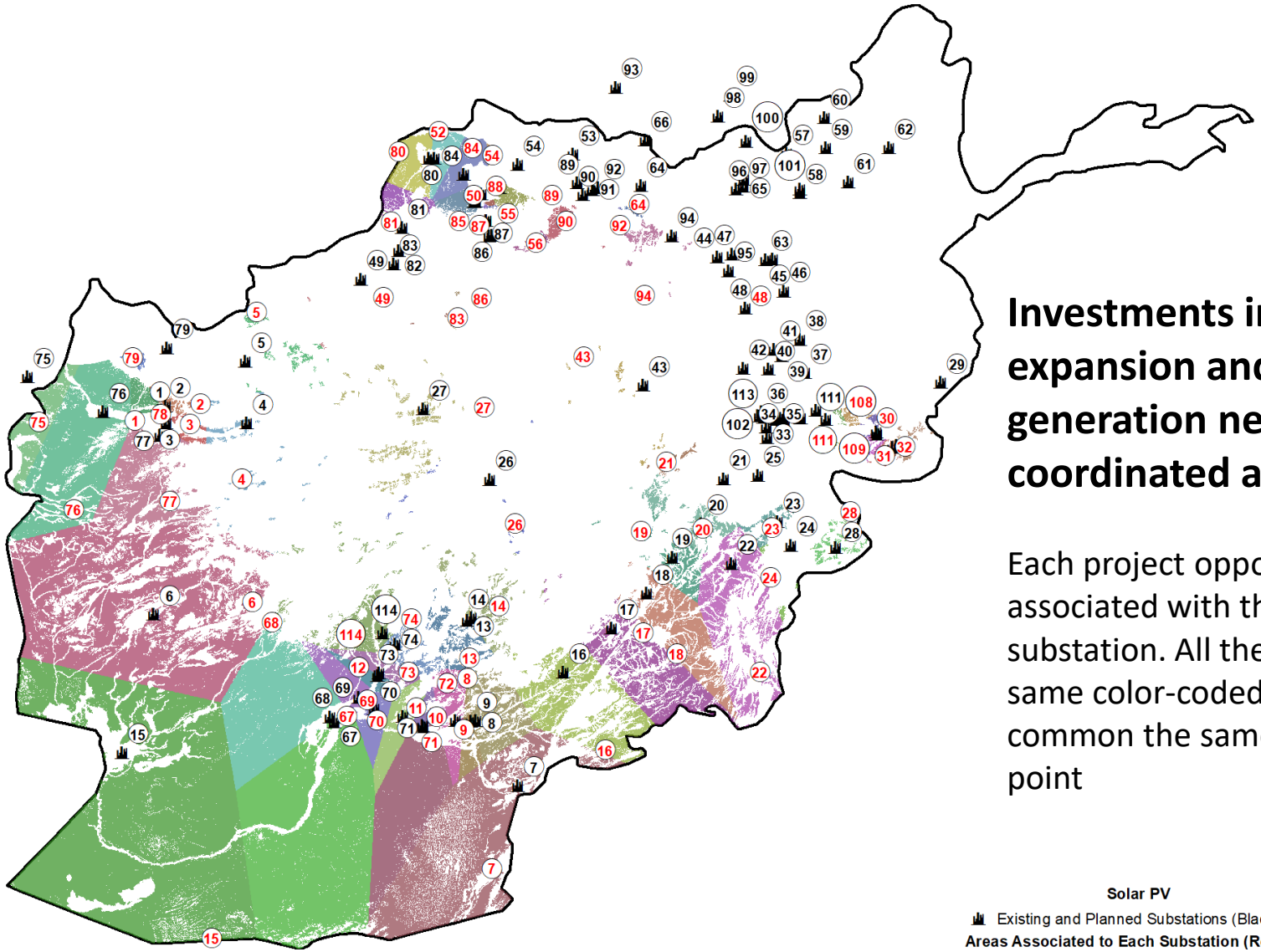
Assess new source impacts on the transmission system

- Check that the system can support new source
- Identify best point of interconnection based on grid strength
- Test load demand of the network
- Determine energy to be curtailed from other generation sources
- Compare the PV plant energy price to cost of supply and cost of unserved demand

Segmented transmission system: Separate power flow analysis for each grid island



Solar PV – Areas associated to each substation



Investments in grid expansion and solar generation need to be coordinated and sequenced.

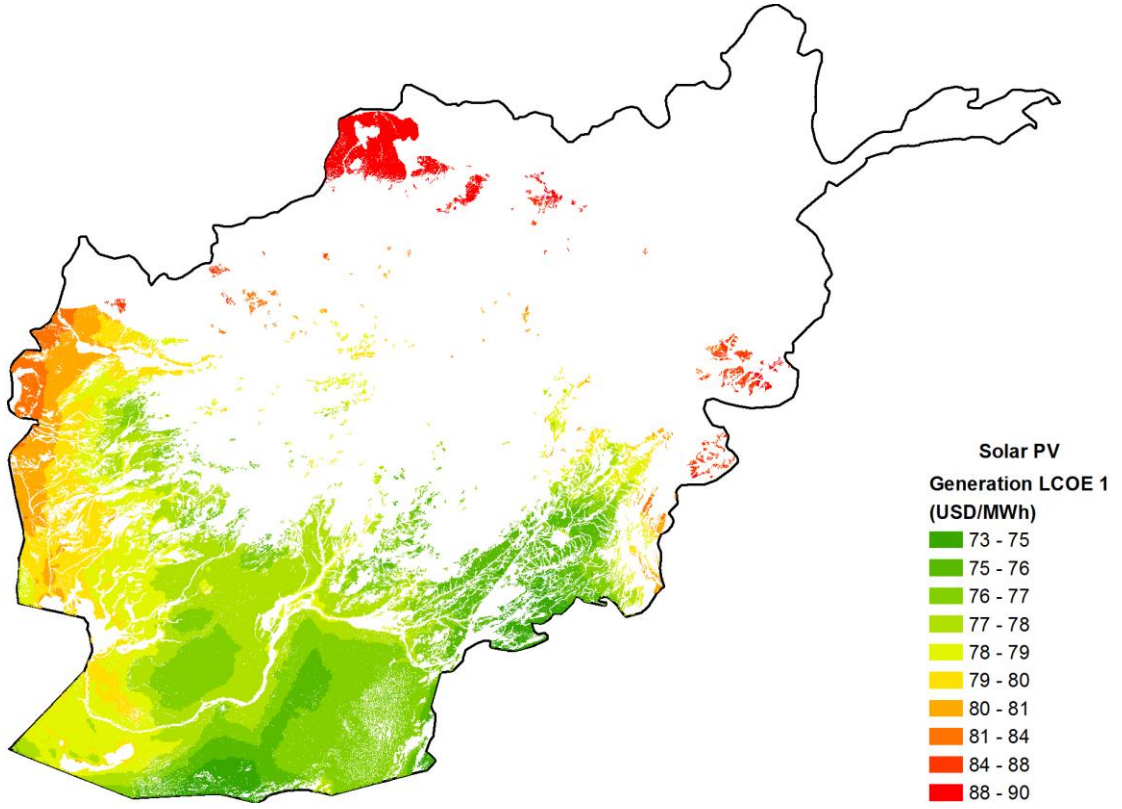
Each project opportunity areas is associated with the closest substation. All the points within the same color-coded area have in common the same interconnection point

Solar PV

Existing and Planned Substations (Black IDs)

Areas Associated to Each Substation (Red IDs)

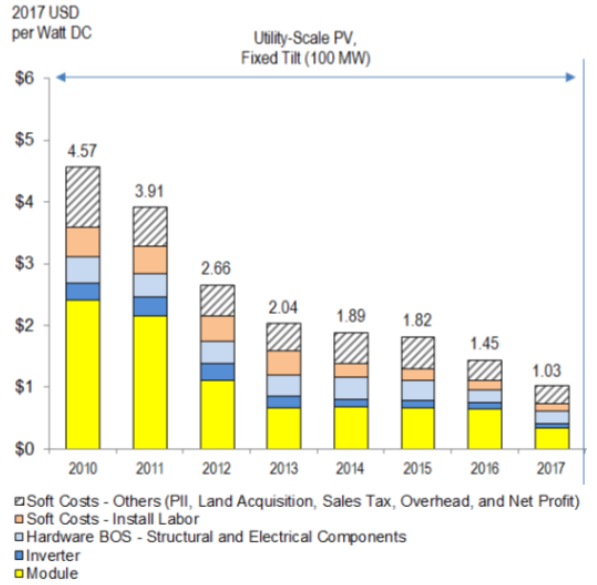
Solar PV – Generation LCOE



Capital costs = 1,030 [USD/kW]
Fixed O&M = 15,000 [USD/MW/y]
Variable O&M = 0

Average levelized cost of electricity (in USD/MWh) for the generation component.

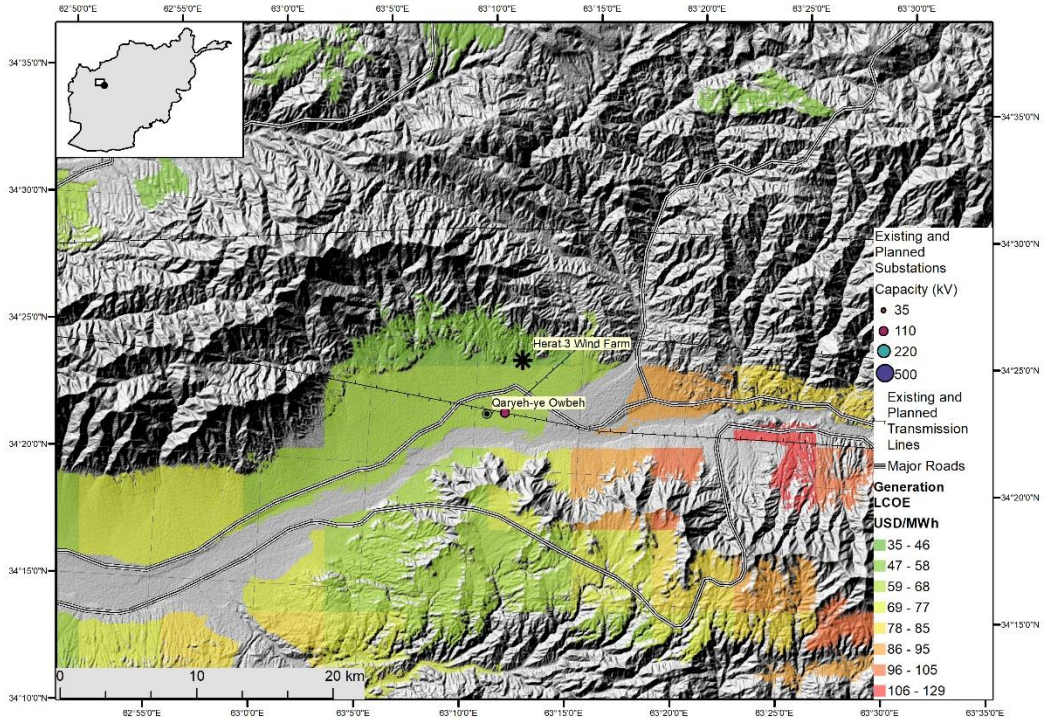
Values estimated using the location, capacity factor and efficiencies specific to the technology



Economic viability

- Access road
- Generation
- Interconnection
- Discount rate
- Capacity factor

Levelized Cost of Electricity (USD/MWh) : Average cost of every unit of electricity generated over the lifetime of the project



Levelized Cost of Electricity

Economic analysis

Import tariffs

Export possibilities

Local Cost of Electricity – including investment in grid

Barriers

Technical

- Limited geographic coverage of the grid
- Lack of grid synchronization
- Parallel and coordinated investments in grid assets

Regulatory

- Designing concession keeping in mind domestic needs, export possibilities, and energy security.
- Land rights and ownership issues
- Potentially conflicting permitting process between statutory and customary rules
- Lack of commercial financial institutions operating within the country

Commercial

- Need for insurance or guarantees against commercial risks
- Gaps in the legal and regulatory framework may result in negotiated PPA for each project
- Credit-worthiness of the off-taker
- Regional market for off-take of solar generation

Recommendations

- Technical feasibility and economic viability analyses to identify potential areas and realistic regional distribution of installed solar capacity. Solar generation plan.
- Update the demand forecast following results of Afghanistan Energy Study.
- **One-stop shop: Reinforce coordination mechanisms in charge of planning and managing the solar program. Coordination with transmission planning in much needed. Consider creation of a solar agency.**
- Full definition of procedures for sector regulation, tariff setting, and interaction of the GoIRA and DABS with the private sector.
- Financial security for private sector involvement must be enhanced by contracts and guarantees to compensate for limitations in the legal framework.
- Implement a pilot project of modest scale before setting a final target for domestic generation.
- **Identify potential target sites for priority development and confirm potential market – including options for domestic consumption and export, optimal capacity and detailed cost estimates. Field survey of the priority sites should follow.**

Thank you