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Update on Solar Development in Uzbekistan

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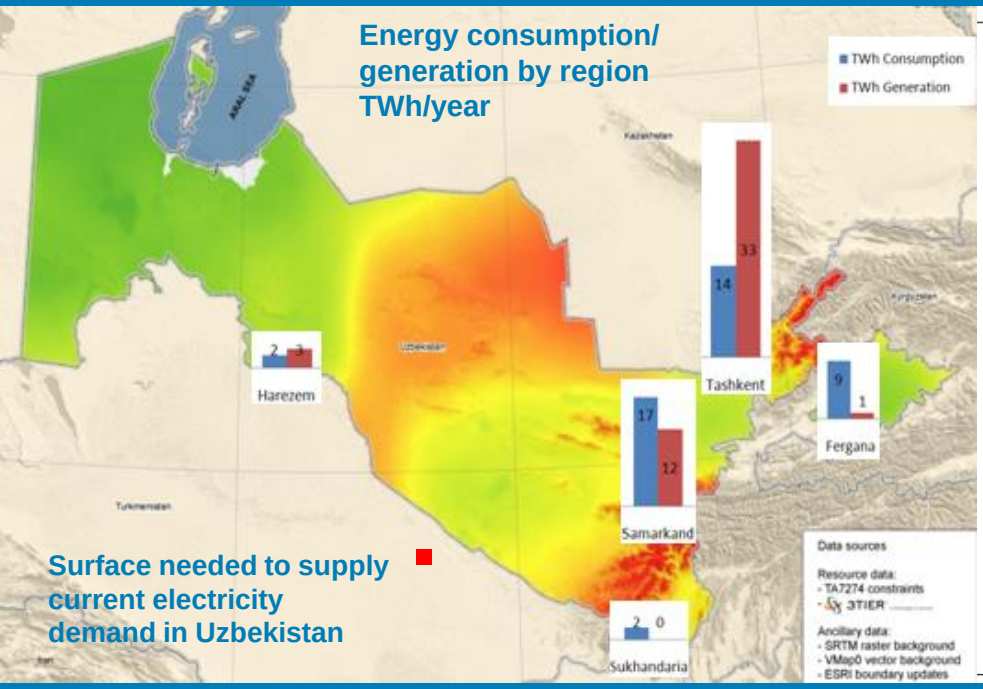
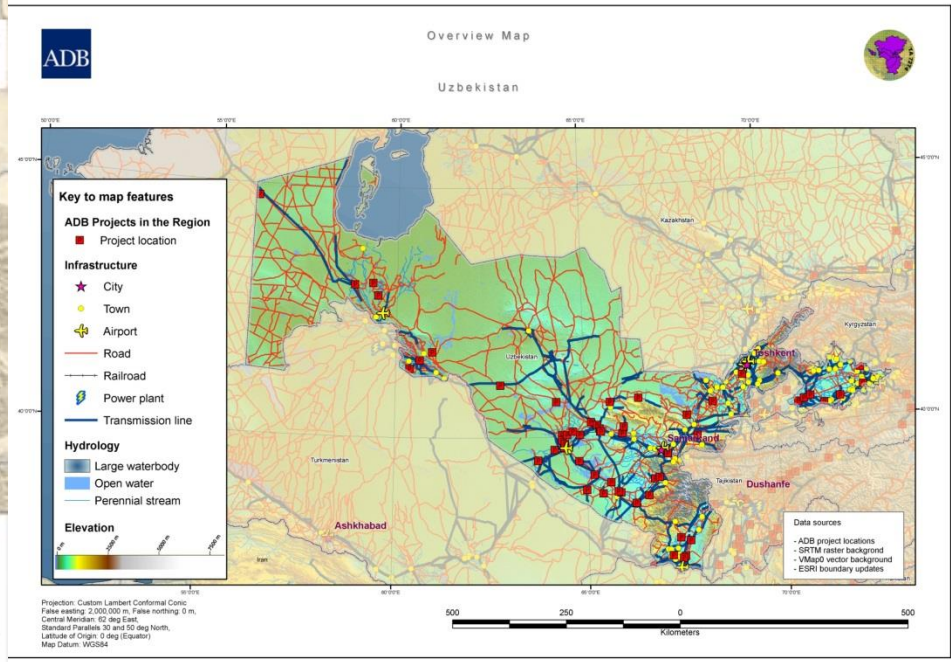
Uzbekistan Country Context





- ✓ Total installed capacity 12.6 GW (89% Fossil fuel, 11% Renewable (hydro)
- ✓ High Energy and Carbon Intensity (>6 times world average)
- ✓ Supply-Demand mismatch
- ✓ Forecasted yearly demand increase: 2-3%
- ✓ Fossil-fuel scarcity, especially natural gas (fuels 85% of installed capacity)
- ✓ Old and inefficient power generation; 20% grid losses, long distance T&D.
- ✓ Welfare Improvement and Strategy I and II (energy efficiency and RE (especially solar), and creation of high-tech industries
- ✓ Solar research capacity, solar components industry, 1 MW solar furnace

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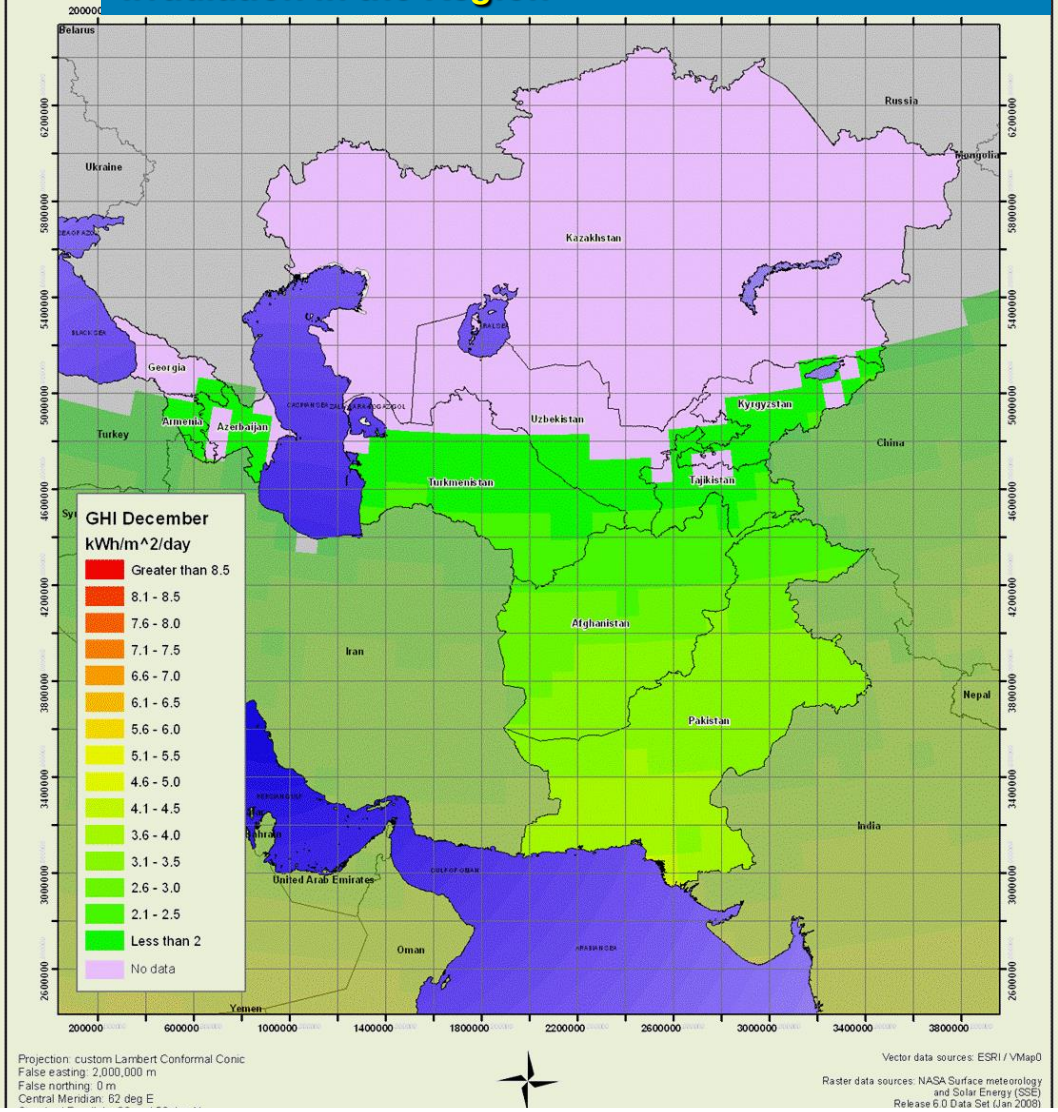
Monthly Variation of Theoretical Global Horizontal Irradiation in the Region



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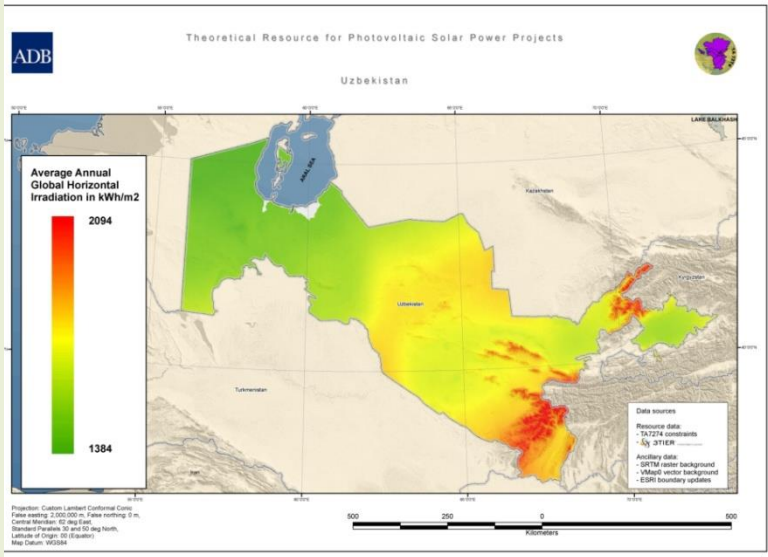
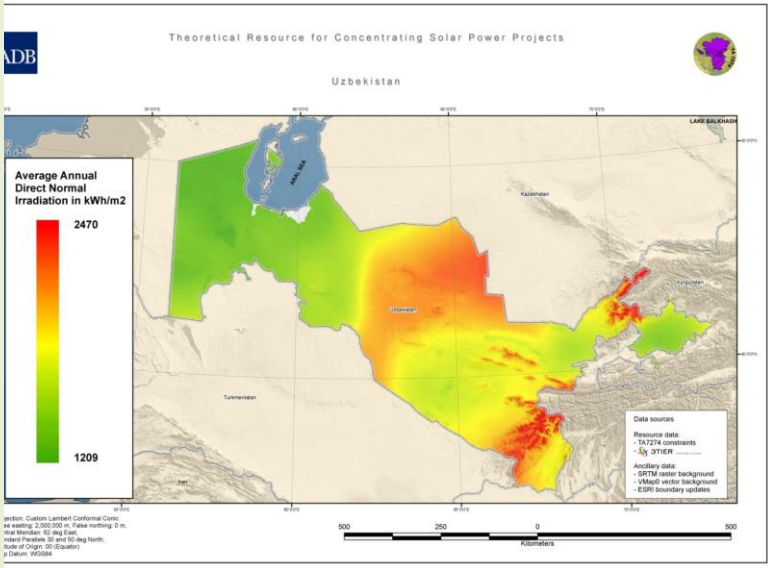
Solar PV Potential in Uzbekistan

GHI (kWh/m2 per year)

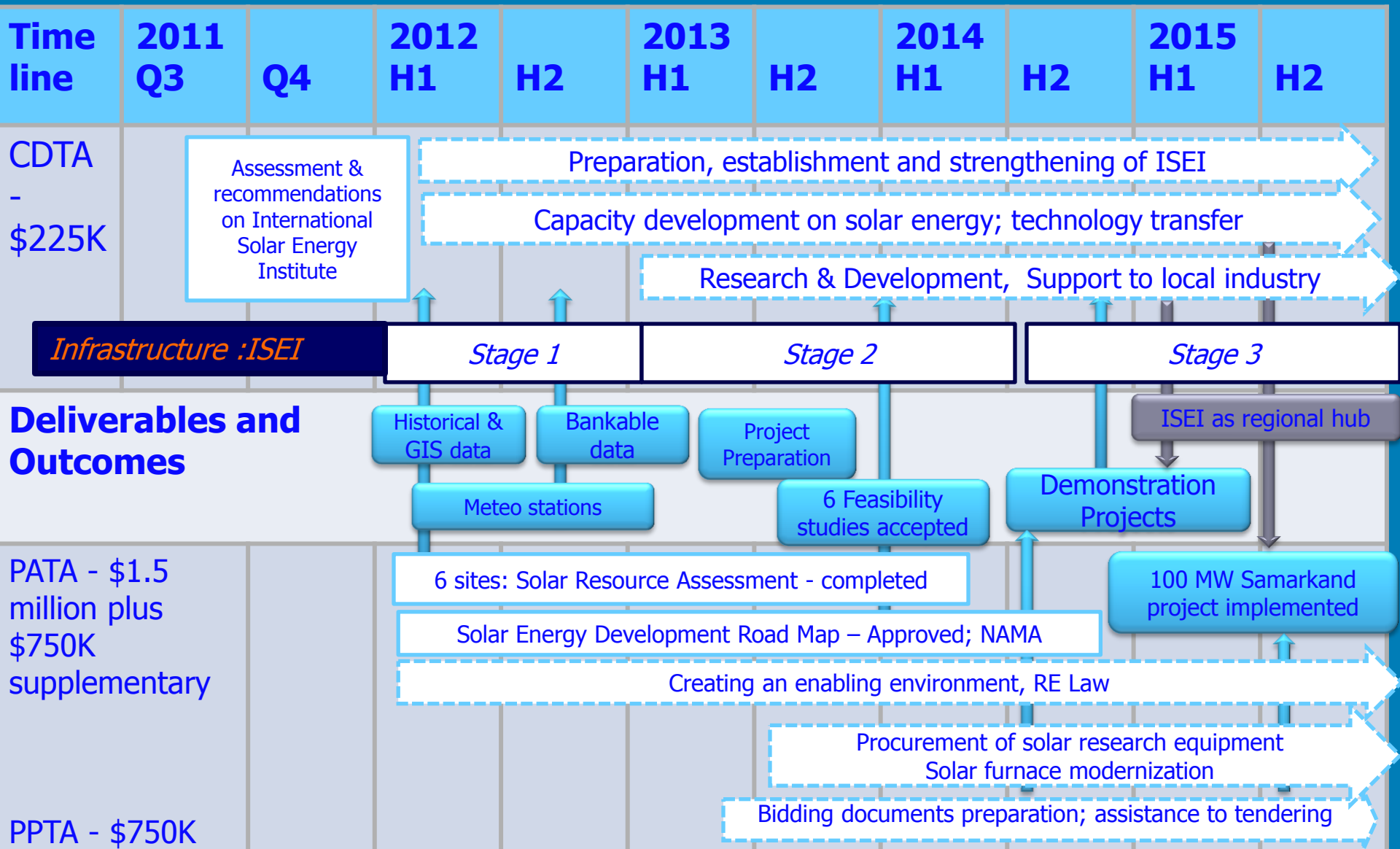


CSP Potential in Uzbekistan

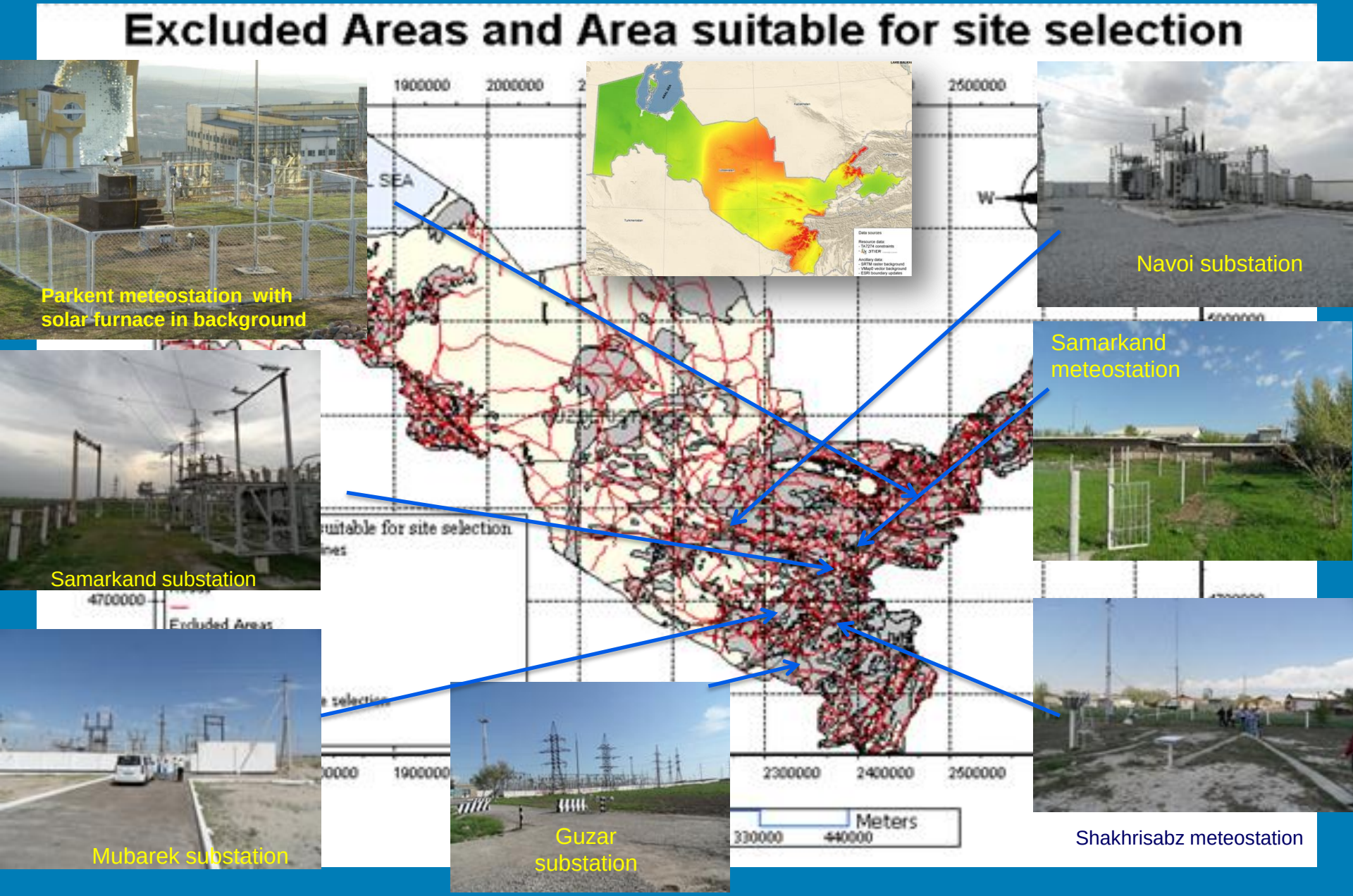
DNI (kWh/m2 per year)



ADB Assistance to Uzbekistan Solar Energy Development - Synergy, Outcomes and Status



Six sites evaluated under TA 8008



Annual long-term mean from satellite data (14 years)
with 4th ground adjustment (after 12 months)

Months used for ground adjustment of the satellite data: *February 2013 to January 2014*

Ground adjusted satellite data (6 months)	**GHI** *kWh/m²a*	**DNI** *kWh/m²a*	**DHI** *kWh/m²a*	**Ta** *°C*	**rH** *%*	**BP** *hPa*	**WS** *m/s*	**WD** *°N*	**rain** *mm*
Dagbid, Samarkand	**1699** ± 51	**2012** ± 96	**565** ± 11	14.4	43	935	5	200	64
Parkent, Tashkent	**1622** ± 48	**1753** ± 78	**601** ± 19	11.6	49	885	5	211	127
Karmana, Navoi	**1722** ± 43	**1922** ± 95	**593** ± 17	15.4	38	972	6	199	68
Guzar, Kashkadarya	**1735** ± 37	**1805** ± 94	**643** ± 27	15.2	37	952	6	207	111
Sherabad, Surkhandarya	**1810** ± 46	**1948** ± 83	**639** ± 7	16.7	32	964	5	190	75
Pap, Namangan	**1687** ± 34	**1711** ± 68	**675** ± 10	16.9	43	957	4	152	50

- **6 Automatic Weather Stations installed** and **operative**
- **>13 years** of site specific **satellite data** acquired,
  4 updates with ground measurement adjustments performed
- Strongly differing irradiation values from publicly available sources and also between single adjustments
- Solar resource assessment yields **expected long-term mean irradiation** values for the selected 6 sites in Uzbekistan:
  - GHI: 1650 – 1845 kWh/m²a,
  - DNI: 1790 – 2000 kWh/m²a

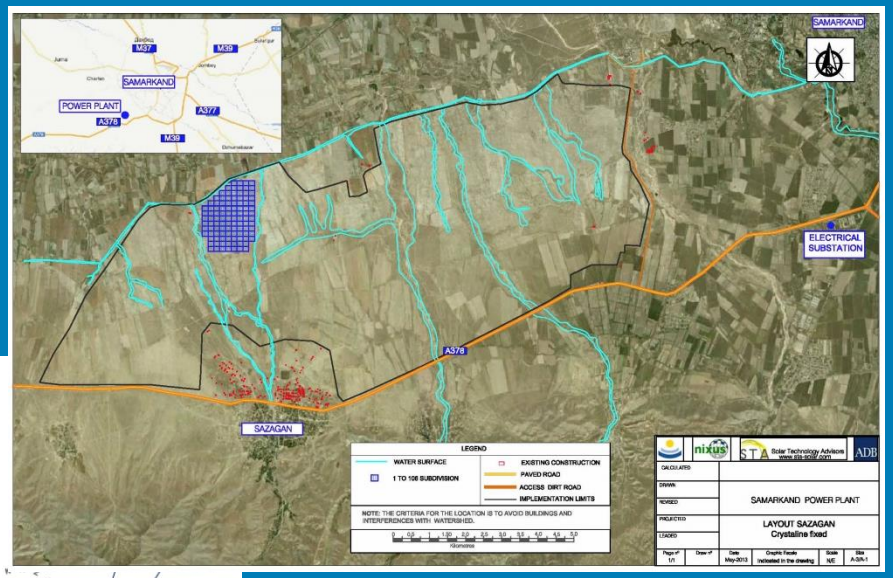
Samarkand Project

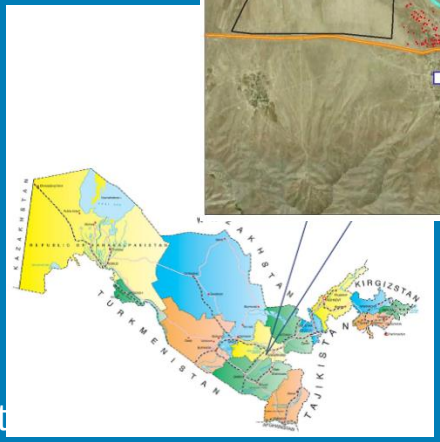
IMPACT: Improved energy security in Uzbekistan

OUTCOME: Increased renewable energy generation in Uzbekistan

OUTPUTS:

- ✓ 100 MW grid-connected crystalline PV fixed tilt power plant
- ✓ Institutional capacity building on solar energy
- ✓ Project management and supervision support





Location: Samarkand Province, Pastdargom and Nurabod districts, 13 km southwest of Samarkand City

EXPECTED RESULTS

- ✓ **100 MWe** grid-connected solar PV plant
- ✓ About **88,000 tCO_2** emissions avoided per year
- ✓ At least **159 GWh** of solar power generated per year

STATUS OF IMPLEMENTATION

- ✓ Project Implementation Consultant mobilization expected in July 2015
- ✓ Design-Build-Operate contract procurement at evaluation stage. Contract award expected Q4 2015

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Solar Projects in the Approved Roadmap

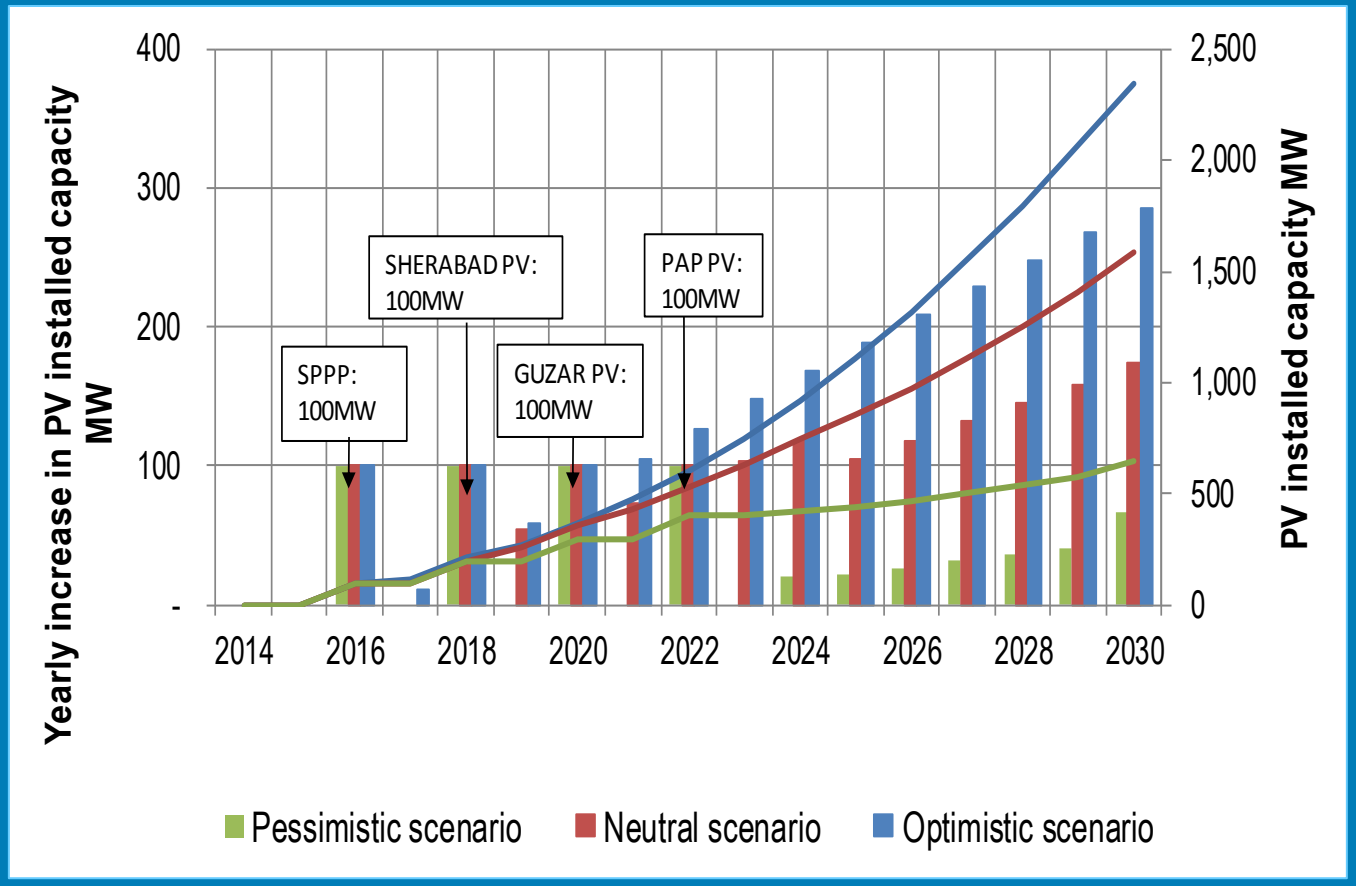
PV Projects:

1. Samarkand: 100MW PV-fixed
2. Sherabad: 100MW PV-1axis
3. Guzar: 100MW PV-1axis
4. Pap, Namangan: 100MW PV-fixed

CSP Projects:

1. Kibray: 10MW CSP
2. Karmana: 130MW ISCC

PV Technology in Solar Roadmap



Installed PV capacity according to Roadmap:

- Optimistic: 2,350 MW
- Neutral: 1,600 MW
- Pessimistic: 650 MW

Assumptions:
Neutral: Uzbekistan's renewable energy plus conventional= 100% of Conservative Scenario of consumption in 2030
Optimistic: Installed PV capacity reaches the 15% of installed capacity (Grid stability)
Pessimistic: Uzbekistan's renewable energy plus conventional 95% = of Conservative Scenario of consumption in 2030
PV/CSP (Power) = 5 (Following IEA world forecast)
Quadratic growth

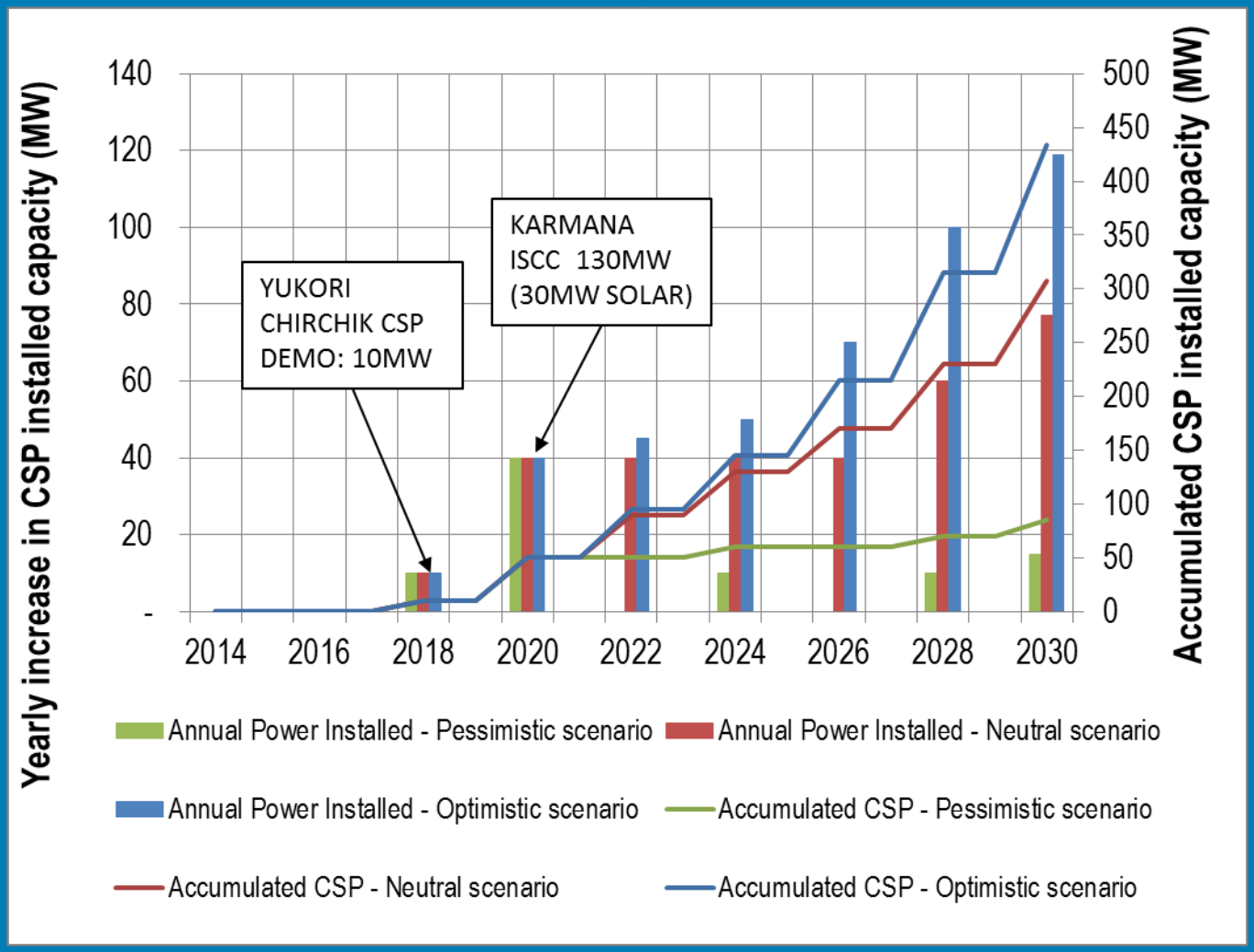
Proposed PV Plants

	SHERABAD		GUZAR		PAP	
	Fixed	1 axis	Fixed	1 axis	Fixed	1 axis
GHI (kWh/m2*year)	1810		1738		1682	
Energy (GWh)	172	222	163	214	159	206
CAPEX (M USD)	177	206	171	196	165	191
OPEX (M USD/year)	1.4	2	1.4	2	1.4	2
Energy / Costs (GWh/ M USD)	19.3	20.4	18.6	20.5	18.7	20.1
Land use (ha)	195	280	195	280	195	280
Specific land usage (MWh/ha·year)	882	792	836	765	815	735
Specific water usage (MWh/m3)	34	44	27	36	17	22

Plant	Location	Project Start	Commissioning	CAPEX (million USD)	OPEX (million USD)	Production P50 (GWH/year)
100 MW Sherabad PV* (1-axis tracking)	Sherabad, Sukhandarya	2019	2021	206	1 (year 1) 2 (years 2-25)	222
100 MW Guzar PV (1-axis tracking)	Guzar, Kashkadarya			196	1 (year 1) 2 (years 2-25)	214
100 MW Namangan PV* (fixed tilt)	Pap, Namangam	2017	2019	165	0.8 (year 1) 1.4 (years 2-25)	159

*** Included in Annex № 3 to the Decree of the President of Uzbekistan dated « 4 » March 2015 г. № UP- 4707 List of new priority projects with participation of foreign investments and loans**

CSP Technology in Solar Roadmap



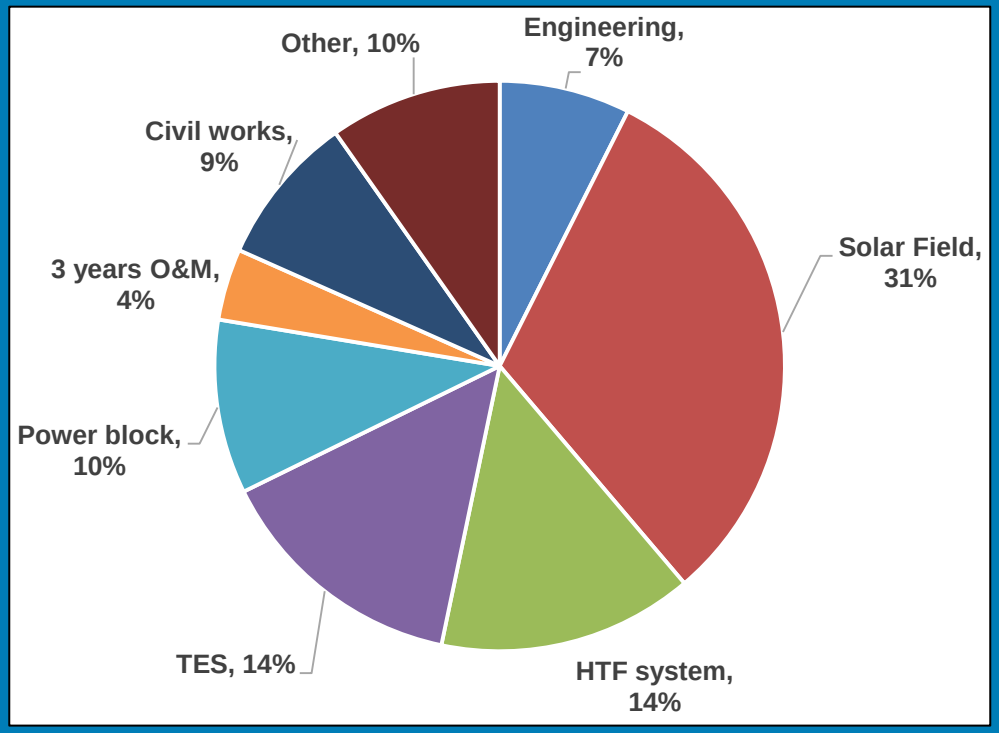
Installed CSP capacity according to Roadmap:

- Optimistic: 430MW
- Neutral: 300 MW
- Pessimistic: 80MW

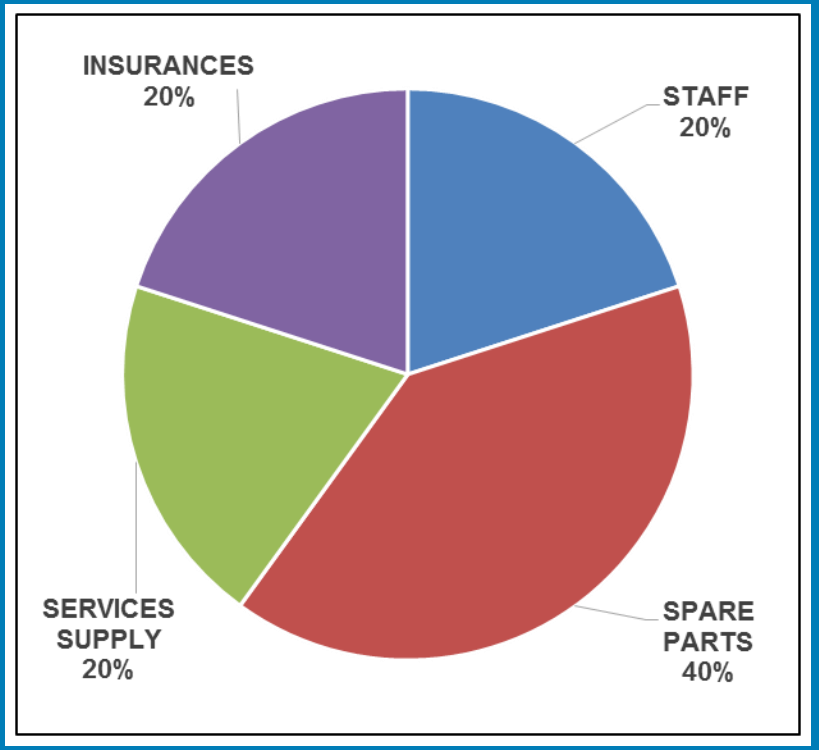
Assumptions:
Neutral: Uzbekistan's renewable energy plus conventional= 100% of Conservative Scenario of consumption in 2030
Optimistic: Installed PV capacity reaches the 15% of installed capacity (Grid stability)
Pessimistic: Uzbekistan's renewable energy plus conventional 95% = of Conservative Scenario of consumption in 2030
PV/CSP (Power) = 5 (Following IEA world forecast); Quadratic growth

10 MW Kibray District CSP Power Plant

CAPEX: 62 * 10^6 USD

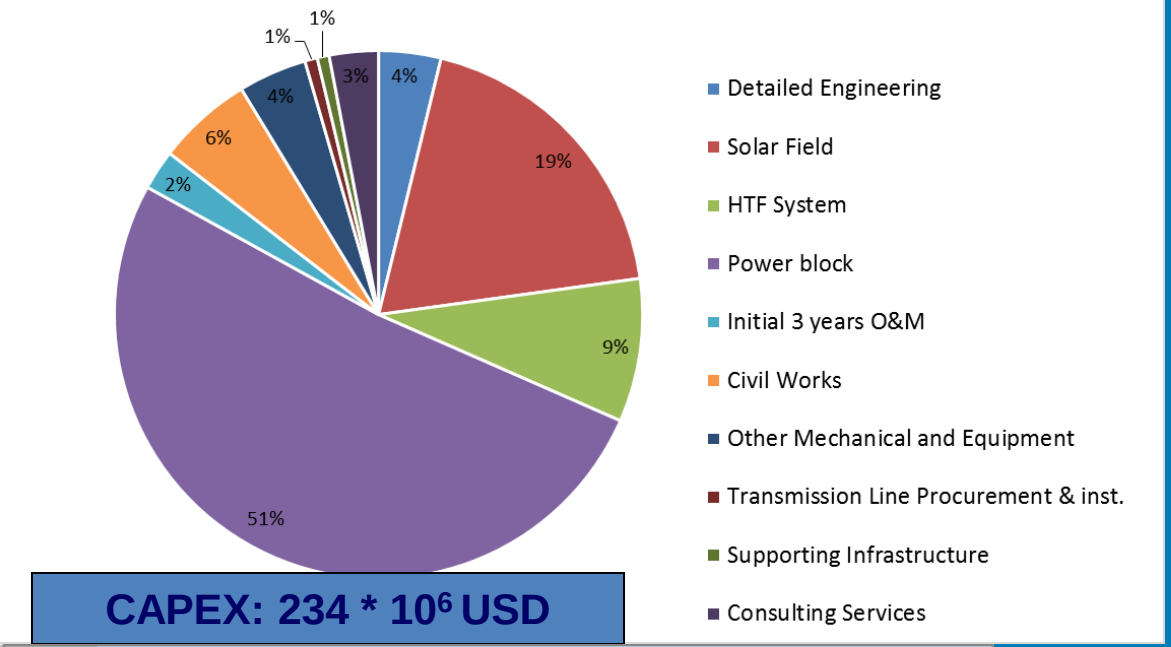


OPEX (1): 0.5 * 10^6 USD

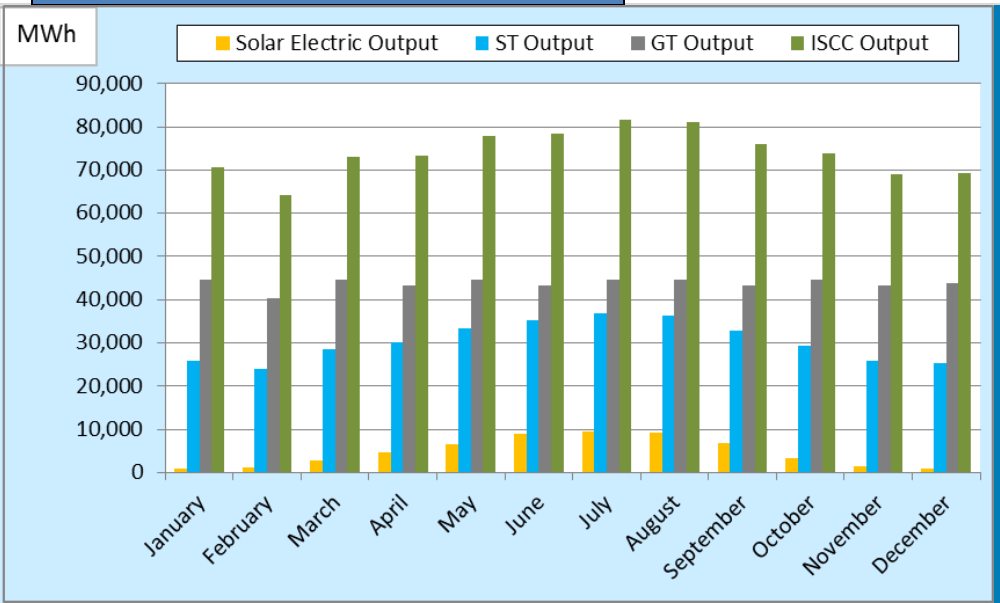


(1) OPEX do not include gas consumption for maintenance purposes (anti-freezing)

Navoi - 130 MW ISCC Power Plant



CAPEX: 234 * 10^6 USD



	Impact
Land occupation	80 ha
Water consumption	350,000 m^3/year
CO_2 emissions avoided (kTon/year) (9) (0.5Ton/MWh)	28.25 kTon/year
Type of land occupied	Wasteland
New grid construction needed (distance to the substation)	0.2 km (220kV, line) 15 km (220 kV, substation),
Access road (km)	0.2 km

- ADB President Takehiko Nakao visits Uzbekistan Solar Furnace Parkent District, Uzbekistan, 22 November 2013

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