THREE EMERGING CSP DESTINATIONS: CHILE, CHINA AND UZBEKISTAN, A COMPARATIVE ANALYSIS

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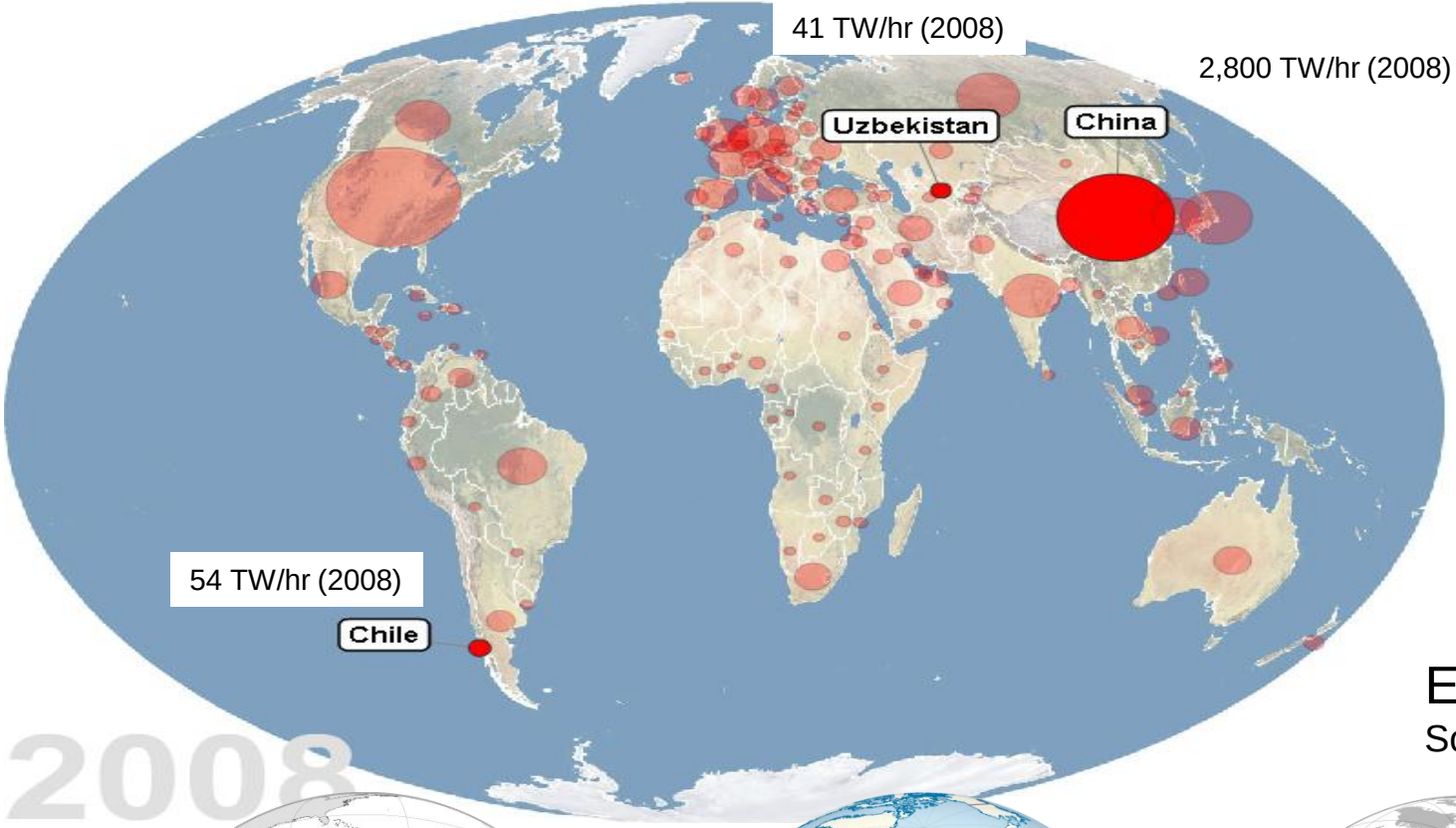
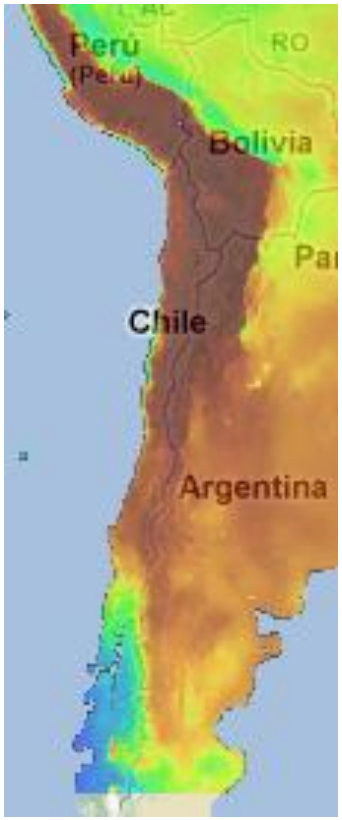
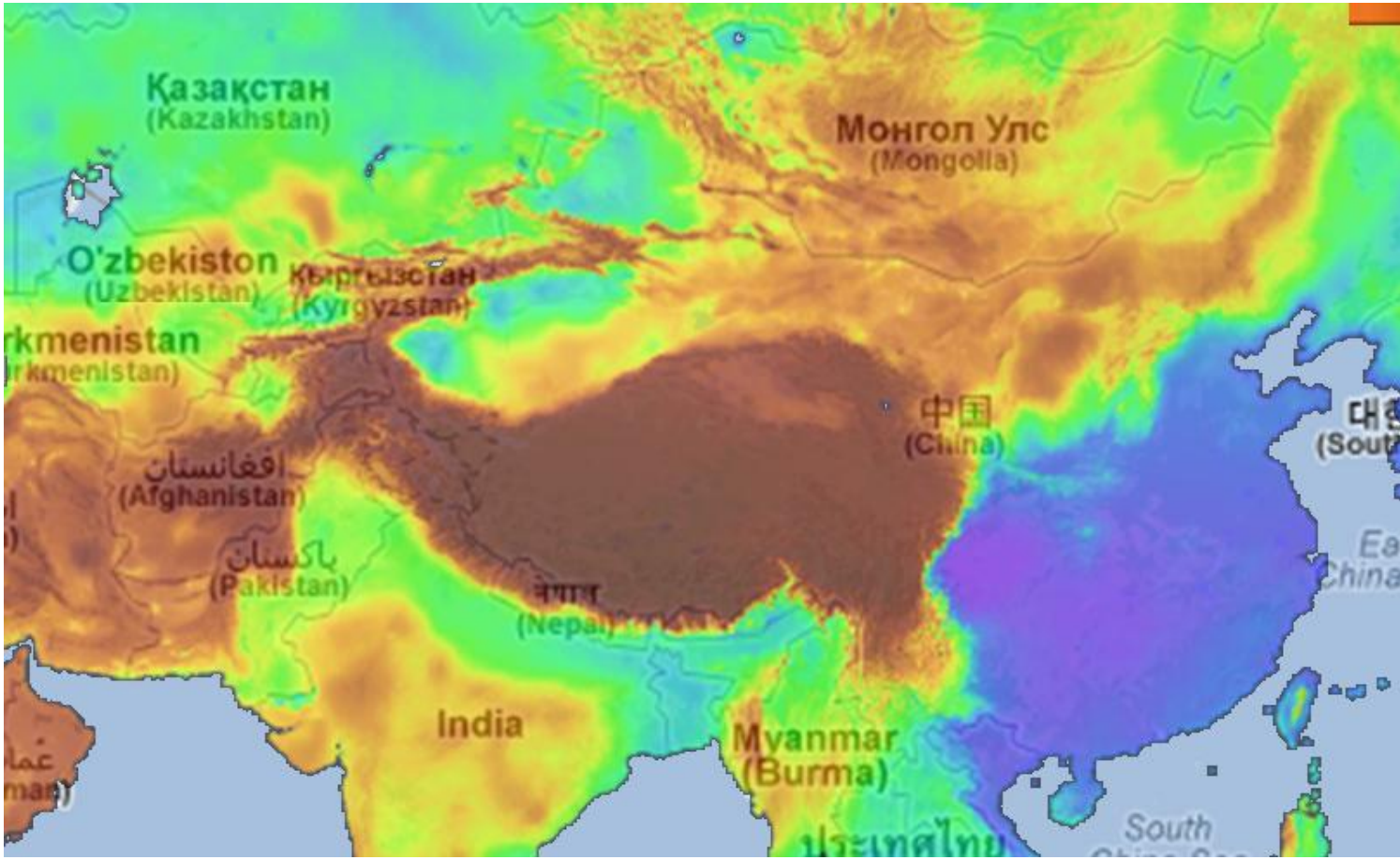
STA



Electricity use

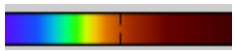
Source: IEA (gapminder)





Chile DNI

China and Uzbekistan DNI



700 2000 3300

KWh/m^{2}year

Source: 3Tiers

Comparison

Topic	Chile	China	Uzbekistan
Population (million)	16(1)	1,347(5)	30(9)
Teritory ($10^3 km^2$)	756	9,641	447
GDP (PPP) (2011 billion USD)	300(2)	11,299(6)	95(10)
GDP (PPP) per capita (2011, USD)	17,380(3)	8,382(7)	3,302(11)
Installed capacity (GW)	13 /4 (SING)(4)	990(8)	12(12)
Based on	Coal /Hydro	Coal	Gas
Economy	Market	Market-Planified	Market-Planified
Electricity sector	Private	Public/Private	Public

Sources: (1) National Institute of Statistics, Chile; (2) & (3) Central Bank of Chile; (4) Central Energía, Chile; (5) Chinese Government Statistics; (6) & (7) International Monetary Fund; (8) EIA; (9) Uzbek Government Statistics; (10) & (11) International Monetary Fund; (12) Uzbekenergo

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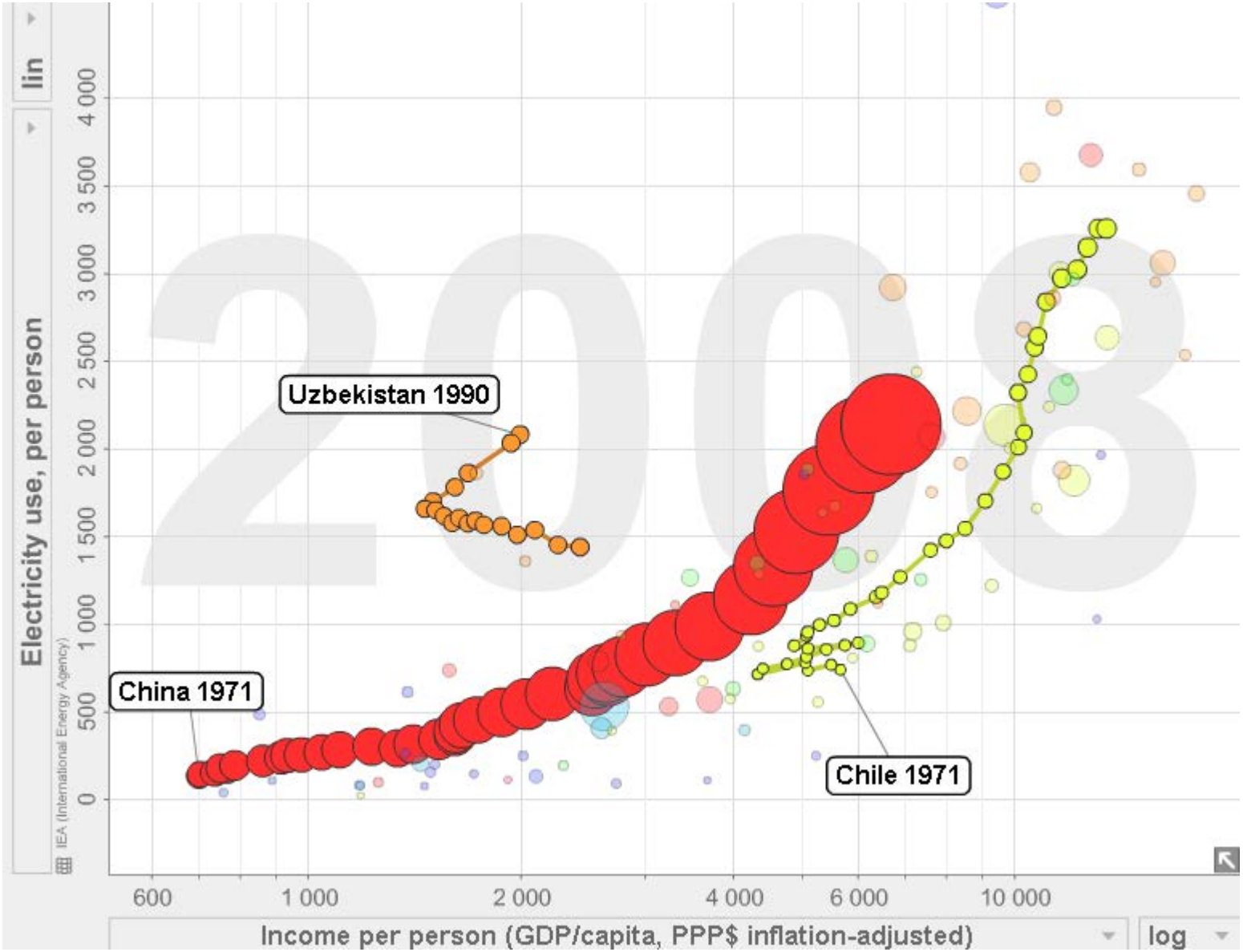
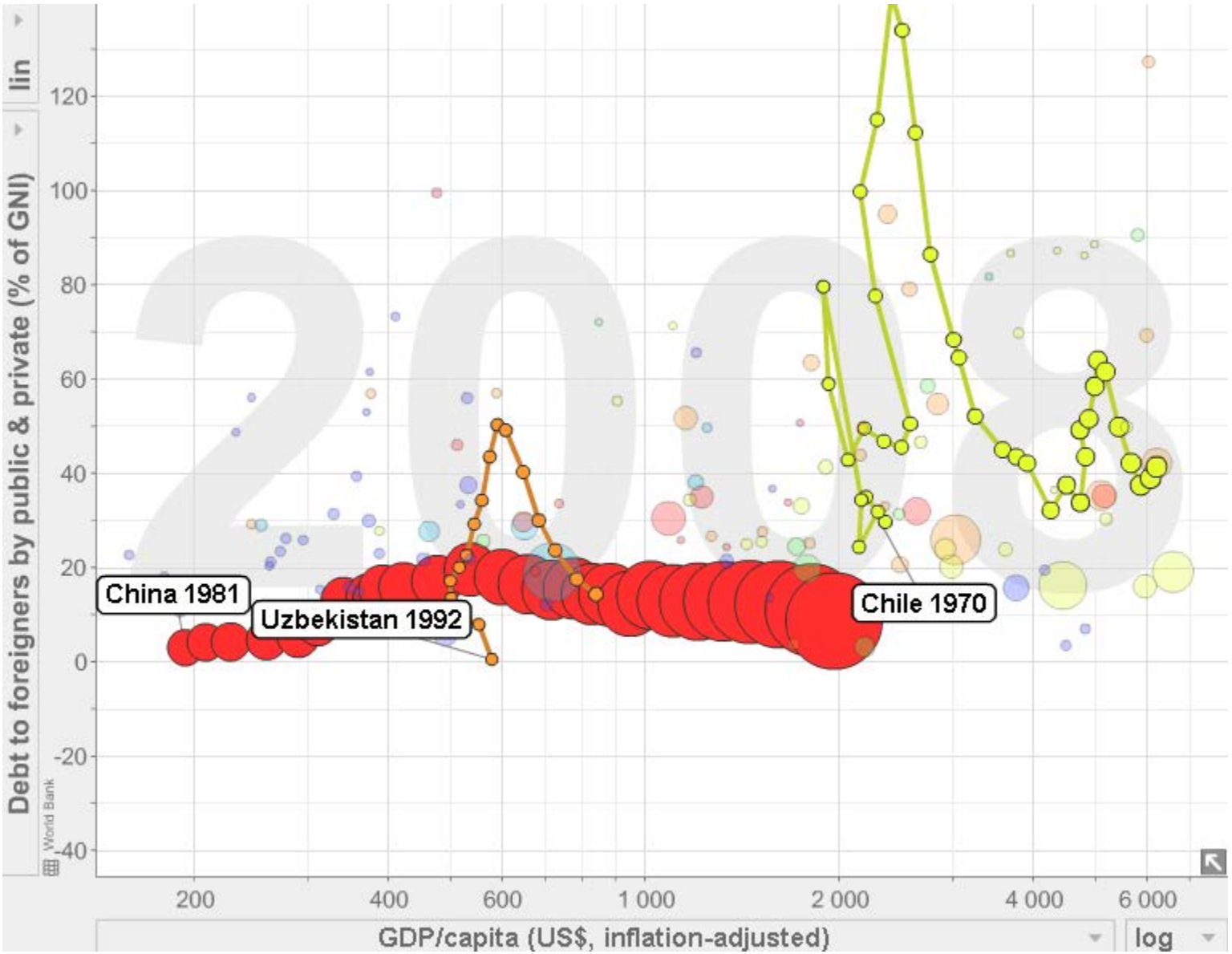


Sources: IEA and IMF World Economic Outlook, Gapminder



Sources: IEA and IMF World Economic Outlook and World Bank, Global Development Finance. Gapminder

Drivers

	Chile	China	Uzbekistan
Energy cost/price	Yes (100 USD/MW)	No	No but interest on NG exports
Off taker	Yes	Yes	Yes
Increasing demand	Yes	Yes	No
Need to install or replace capacity	Yes	Yes	Yes
Good solar resource	Yes (DNI 3,000 KWh/year)	Yes (DNI 1,800-2,200 KWh/year)	Yes (DNI 1,800-2,200 KWh/year)
Social and environmental pressure	High	Medium	Medium
Interest local industry development	High	High	High
Investment/debt capacity	High	High	Medium
Existing technical capacity	Medium	High/Medium	Medium/Low

Barriers

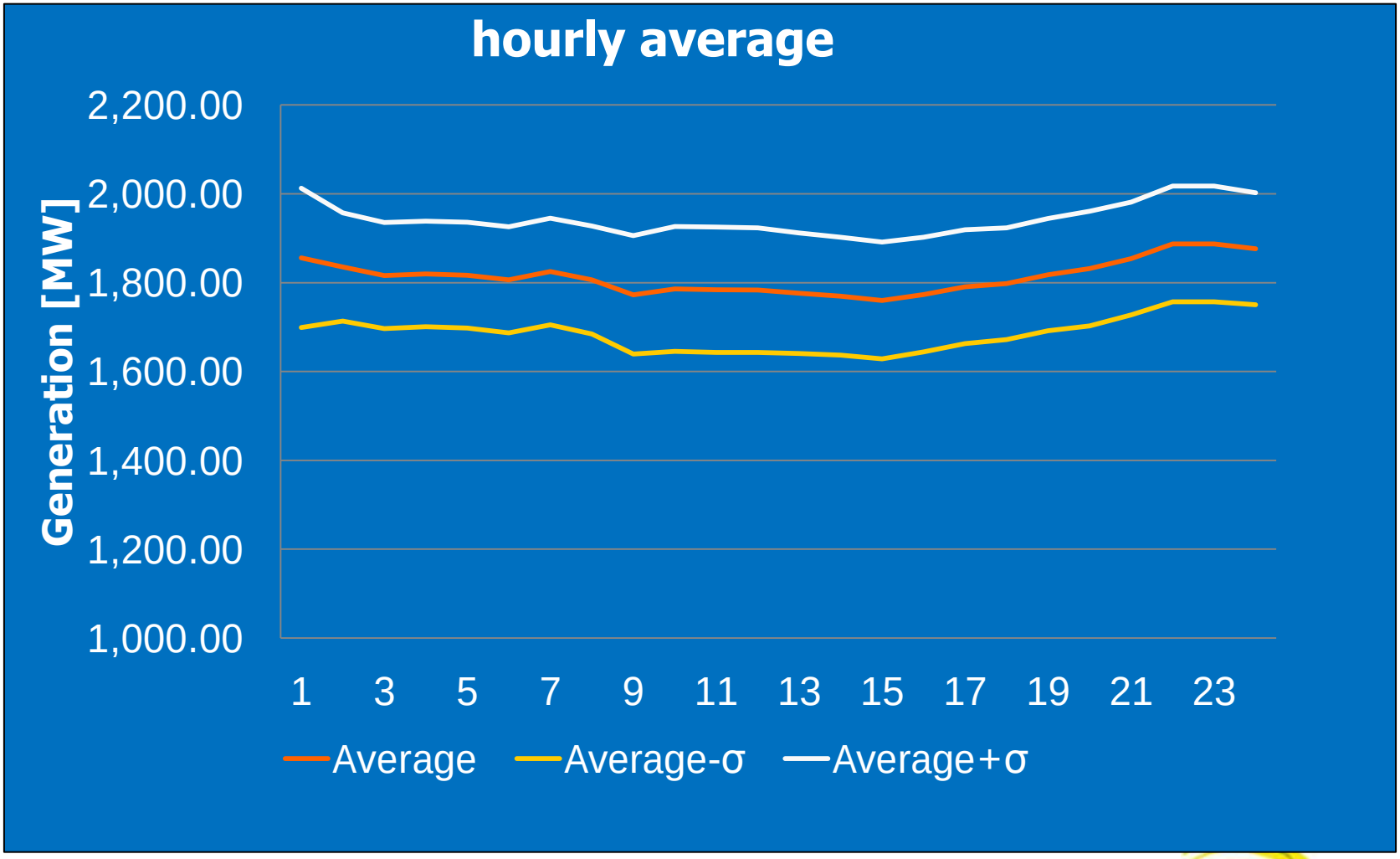
	Chile	China	Uzbekistan
Lack of knowledge of the technology	Medium	Medium/Low	Medium/High
Lack of water	High	Medium	Medium
Extreme meteorology	Medium	High	Medium
Lack of specific regulation	Medium	Medium	High
Lack of indigenous industry	Medium	Medium/Low	High
Financing	Medium	Medium	Medium

CHILE

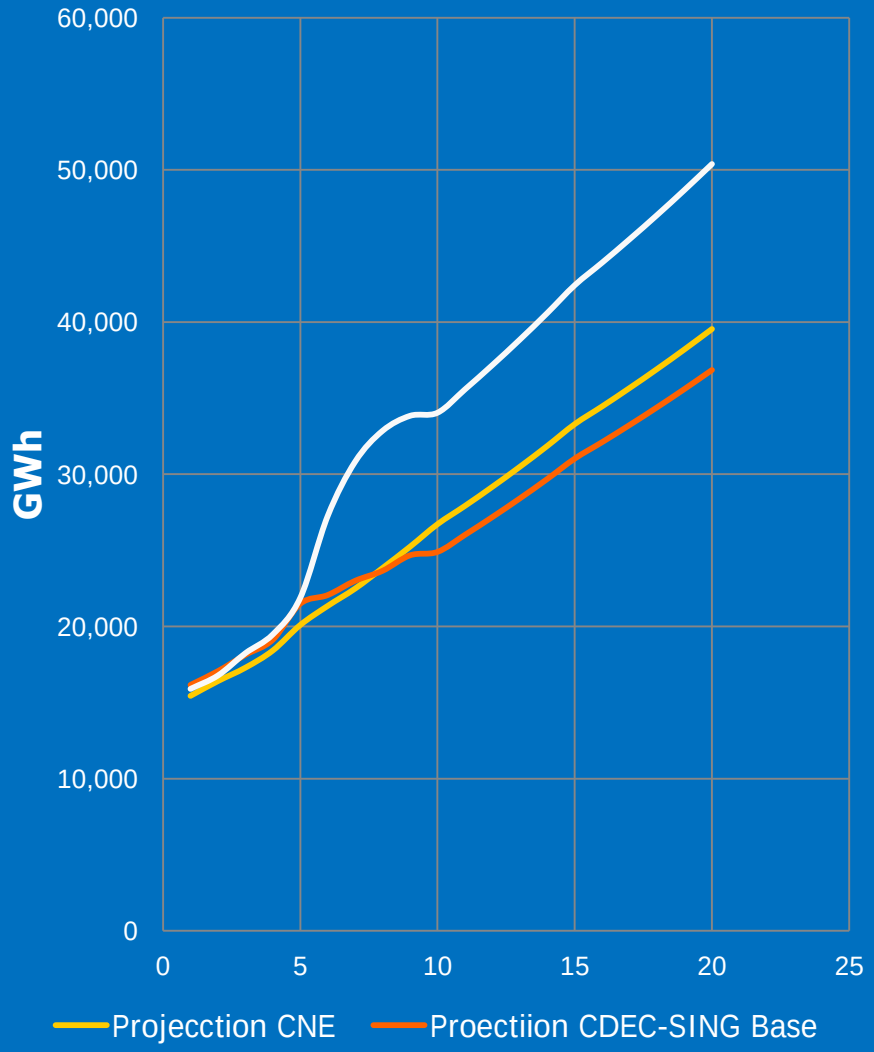
ATACAMATEC-Support for large scale solar power in northern Chile

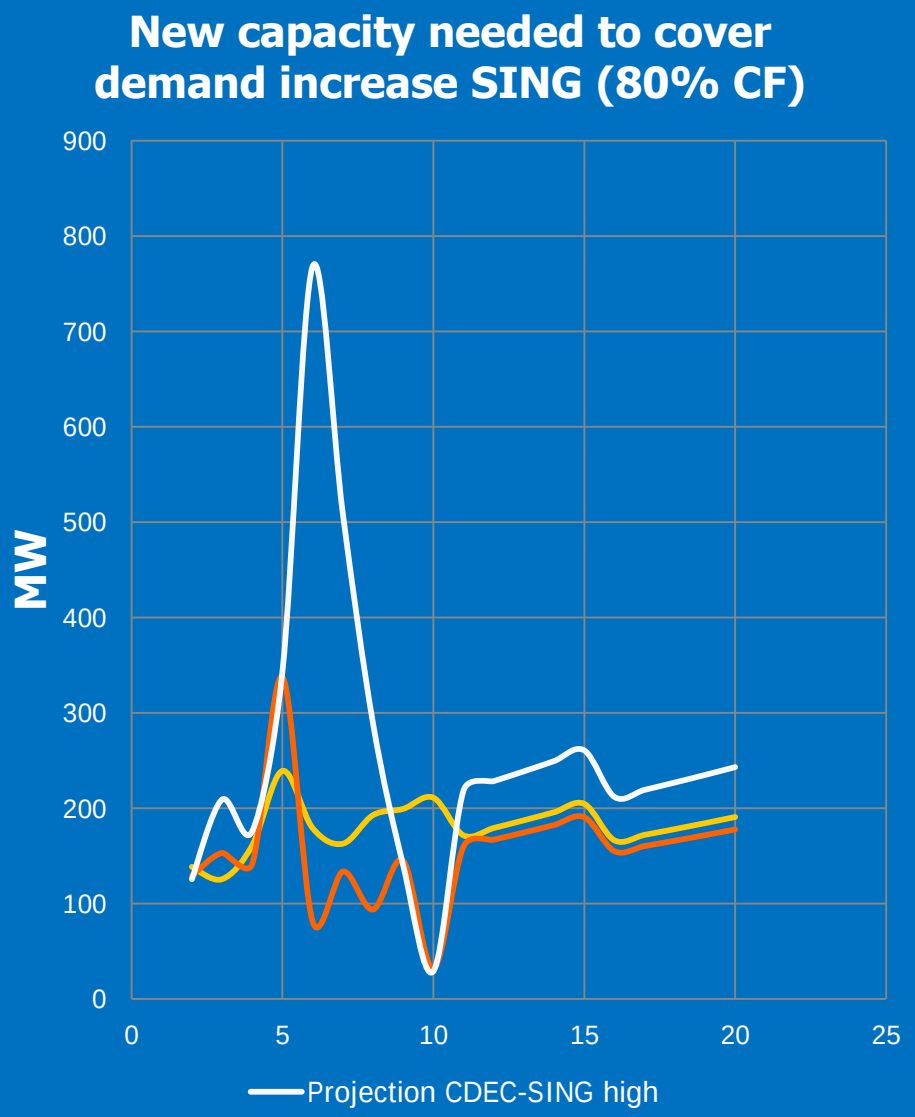
- Support on ***public biding*** for the first CSP plant in Chile.
- ***Gap analysis*** of the current regulatory framework and proposals
- Propose appropriate ***financial mechanisms***.
- ***Analyze pipeline*** of existing and potential solar projects
- Select and carry on ***feasibility studies*** of selected projects and technologies

Demand SING 2012



Demand forecast SING





2012-2021 SING New power plants program

Generation matrix 2011

Primary source	[MW]	[%]
Coal	1,933	52.6
Diesel	171	4.6
Fuel Oil Nro. 6	179	4.9
Natural Gas	1,375	37.4
Hidro	15	0.4
Total	**3,671**	**100.0**

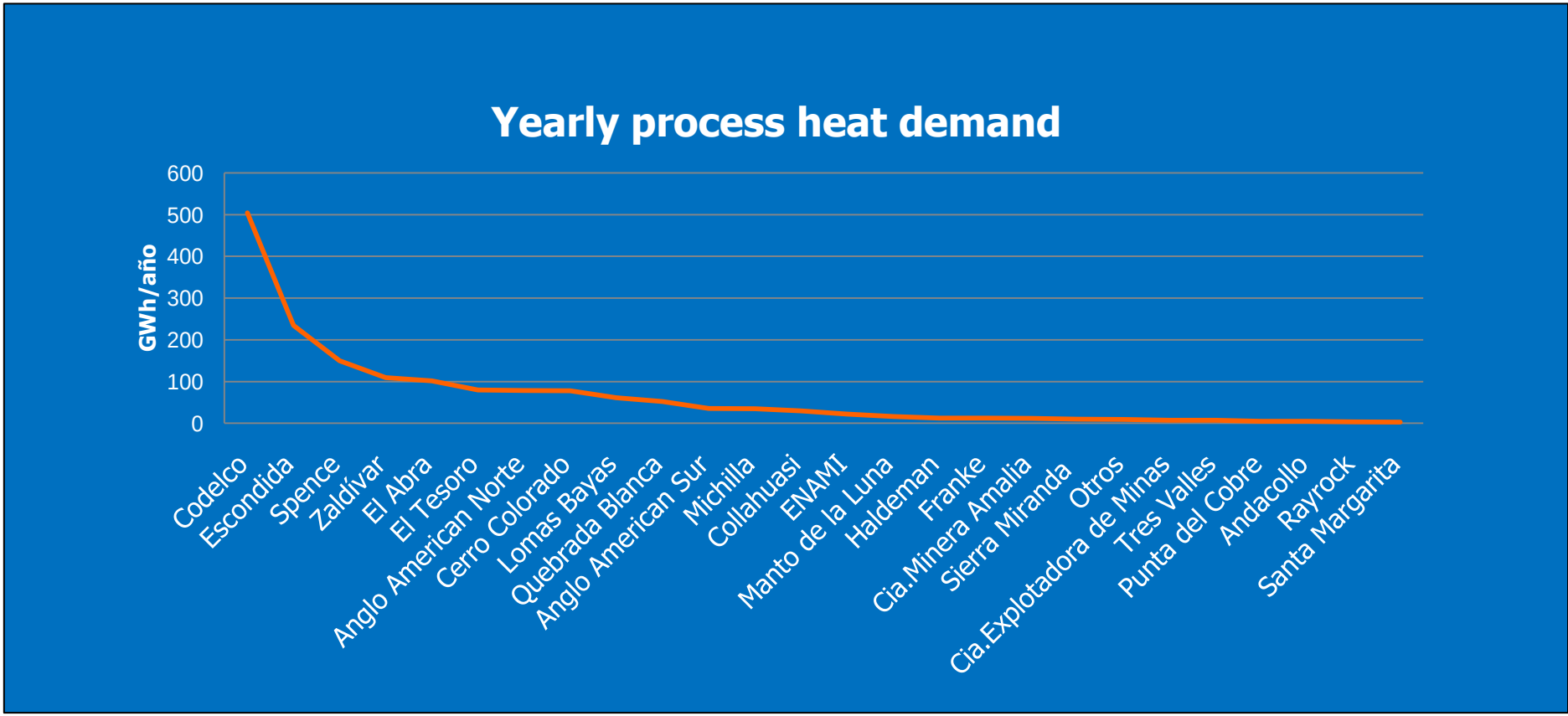
Plan 2011

Primary Source	[MW]	[%]
Residual heat	17	0.7
Coal	1,600	69.2
Diesel	5	0.2
Wind	240	10.4
Geothermal	200	8.7
Solar	250	10.8
Total general	**2,312**	**100.0**

Matriz de Generación al 2021

Primary Source	[MW]	[%]
Residual heat	17	0.3
Coal	3,533	59.0
Diesel	175	2.9
Wind	240	4.0
Fuel Oil Nro. 6	179	3.0
Natural Gas	1,375	23.0
Geothermal	200	3.3
Hidro	15	0.2
Solar	250	4.2
Total general	**5,983**	**100.0**

Process heat, an opportunity



200 GWh/year <> 70 MW_{th}

Other applications

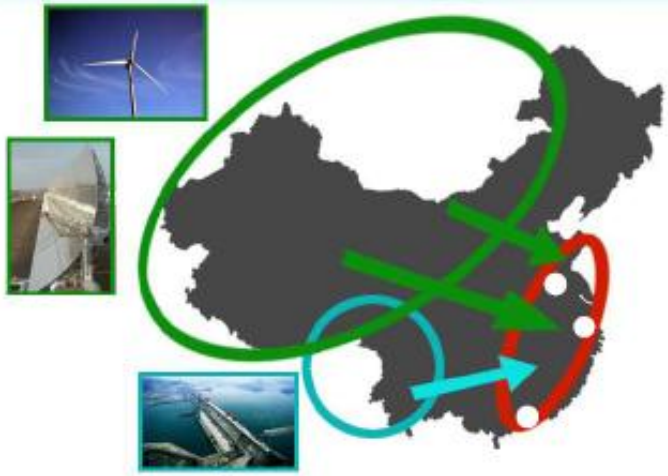
- Water:
  - desalinization
  - pumping

In the North of Chile
Water
is equivalent to
Energy

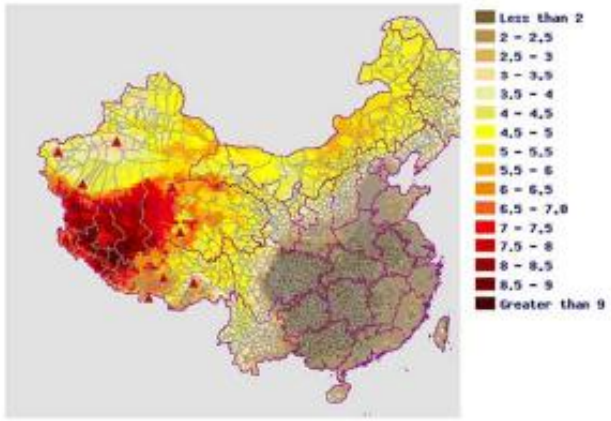
CHINA

People's Republic of China: Concentrating Solar Thermal Power Development

- ***Roadmap*** for CSP development in Qinghai, Gansu and China
- ***Support to implement*** Dahan 1 MW pilot solar tower
- ***Feasibility study*** of a 50 MW power plant in Gansu
- ***Capacity building***



Gobitec, clean energy supply from dessert areas.
Source: Own elaboration



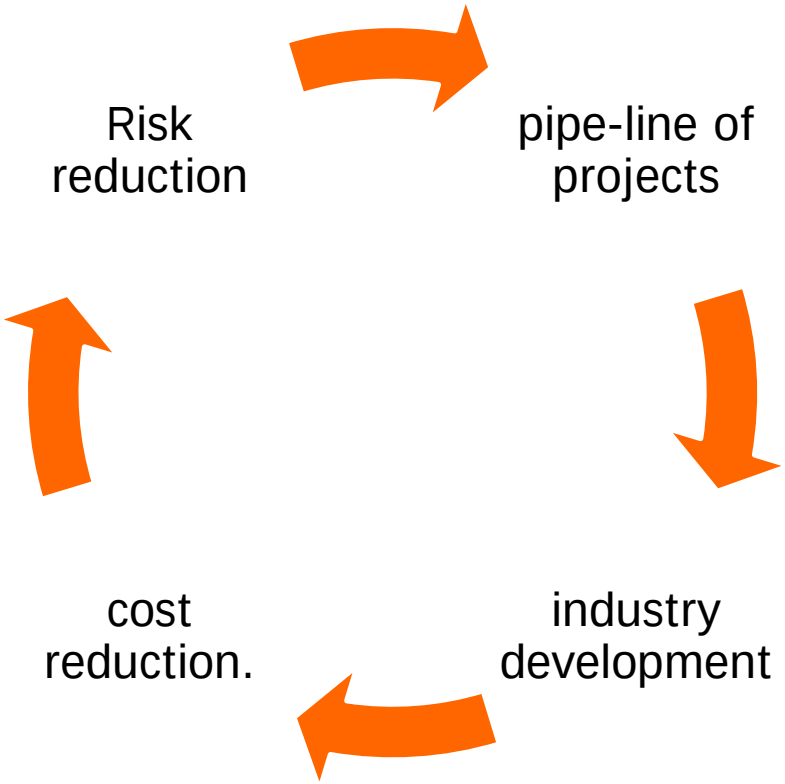
Direct Solar Radiation Map in China (kWh/m²/day). Source: swera

Reasons to develop CSP

- Availability of primary resource
- It can be used as a firm source of power to supply base-load demand and peak
- It has a high share of locally produced components,
- It is a source of local high, medium and low qualification jobs for construction and Operation and Maintenance (O&M)
- and it has potential for cost reduction.

Reason to develop in P.R.C.

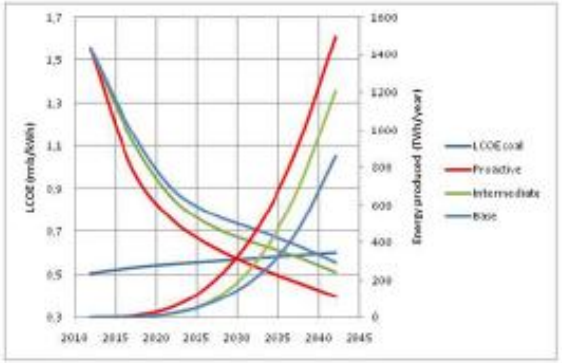
- Solar resource
- Manufacturing and development capabilities (wind-PV)
- Challenges



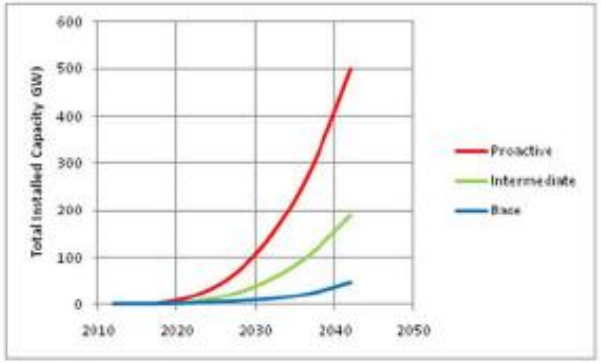
Impact on Gansu and Qinghai (2040) optimistic scenario

	Gansu	Quinghai
Export energy (TWh/year)	65	174
Land required (km^2)	850	2,200
% of total land	0.3 %	0.3%
% suitable land	2%	2%
Income (billion CNY)	30	80
Employment	42,000	110,000

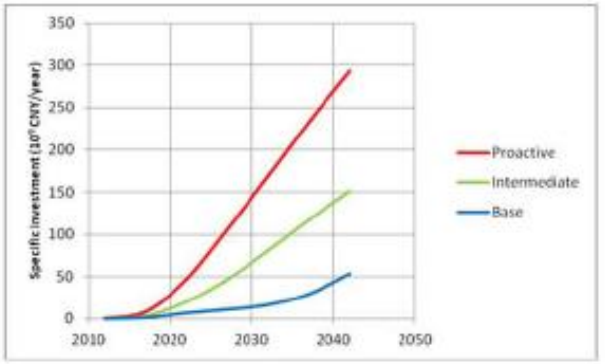
Source: Ummel (2010) and own ellaboration



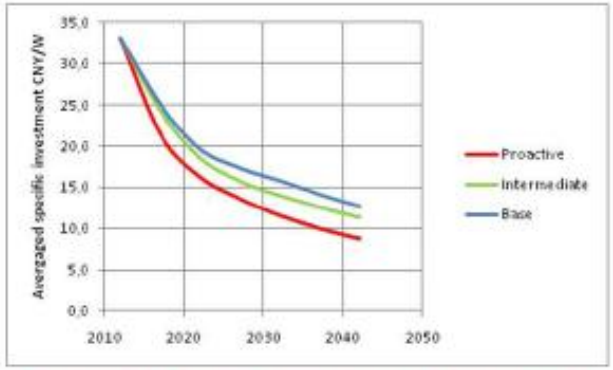
C.S.P. LCOE and energy output forecasted for three scenario: proactive, intermediate and base in P.R.C. and LCOE forecasted evolution for supercritical coal fired plants. Source: Own elaboration



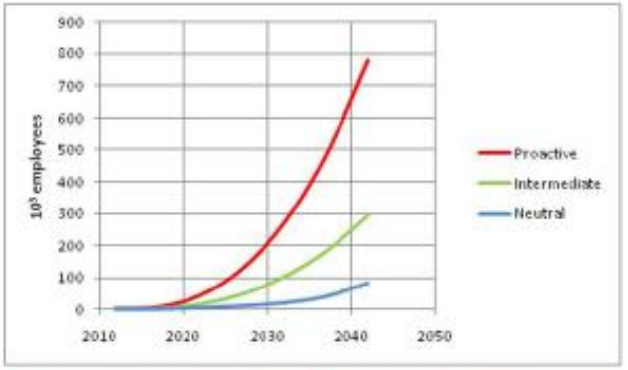
Total installed capacity for proactive, neutral and base scenario. Source: Own elaboration



Yearly needed investment for proactive, neutral and base scenario. Source: Own elaboration



Forecasted Evolution of averaged specific investment in P.R.C. Source: own elaboration

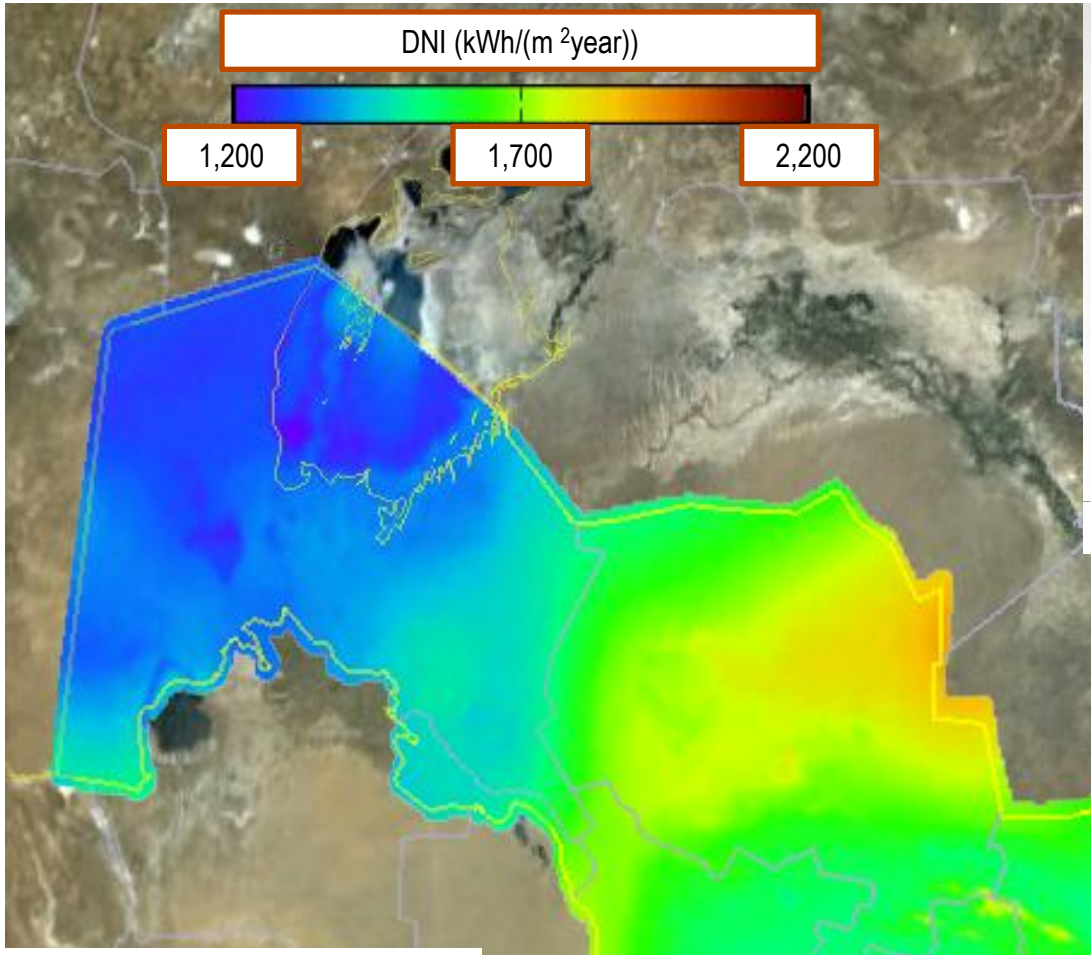


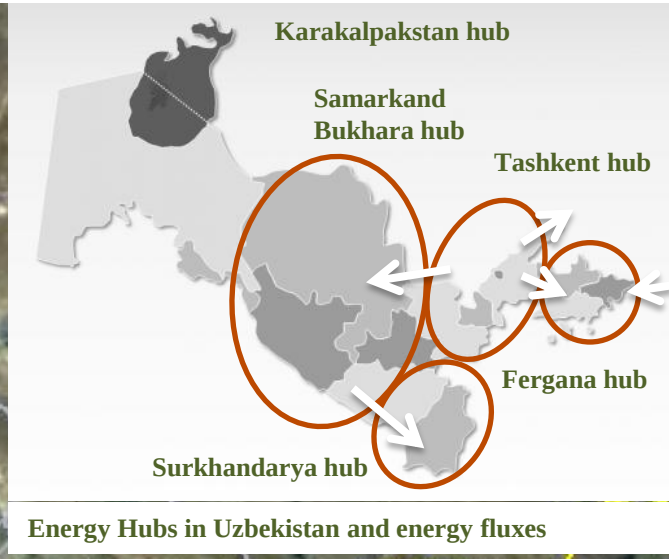
Forecasted evolution of direct employment, comprising construction, supply chain and O&M in P.R.C. Source: own elaboration

UZBEKISTAN

Concentrating Solar Power Development in Uzbekistan

- Creating an enabling environment
  - ***Solar roadmap***
- ***Solar resource assesment***
  - Six meteorological stations
  - Satellite data correlation
- ***Project preparation***
  - Selection of projects (Demo and pilot)
  - Feasibility study





Energy Hubs in Uzbekistan and energy fluxes

Direct Normal Irradiation (DNI).
Source: ·own elaboration from 3 Tier data

CSP technology yearly energy output and needed land

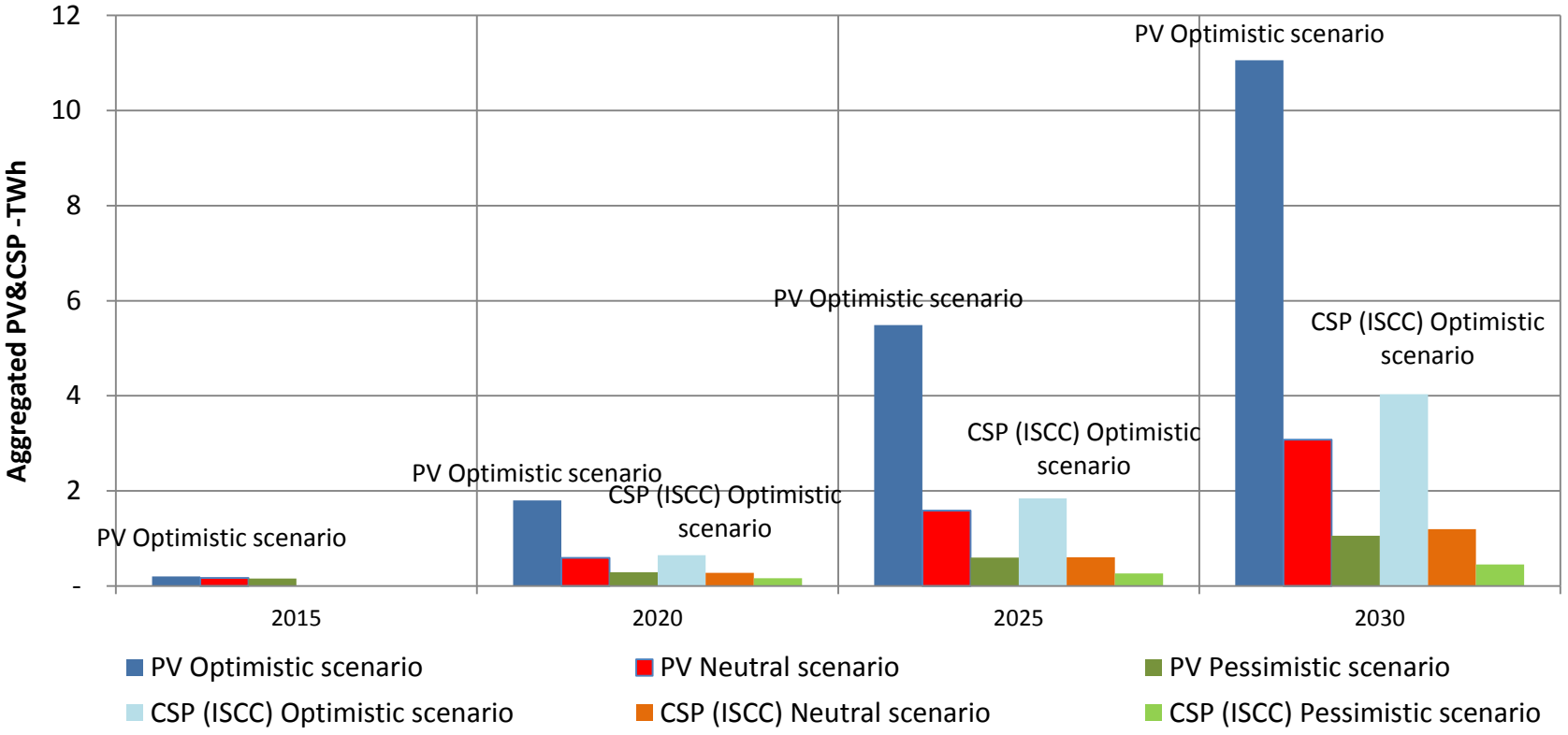
- **Optimistic scenario**
  4 TWh/year, 120 Km^2
- **Neutral scenario**
  1 TWh/year, 35 Km^2
- **Pessimistic scenario**
  0.4 TWh/year, 13 Km^2

PV tecnology yearly energy output and needed land:

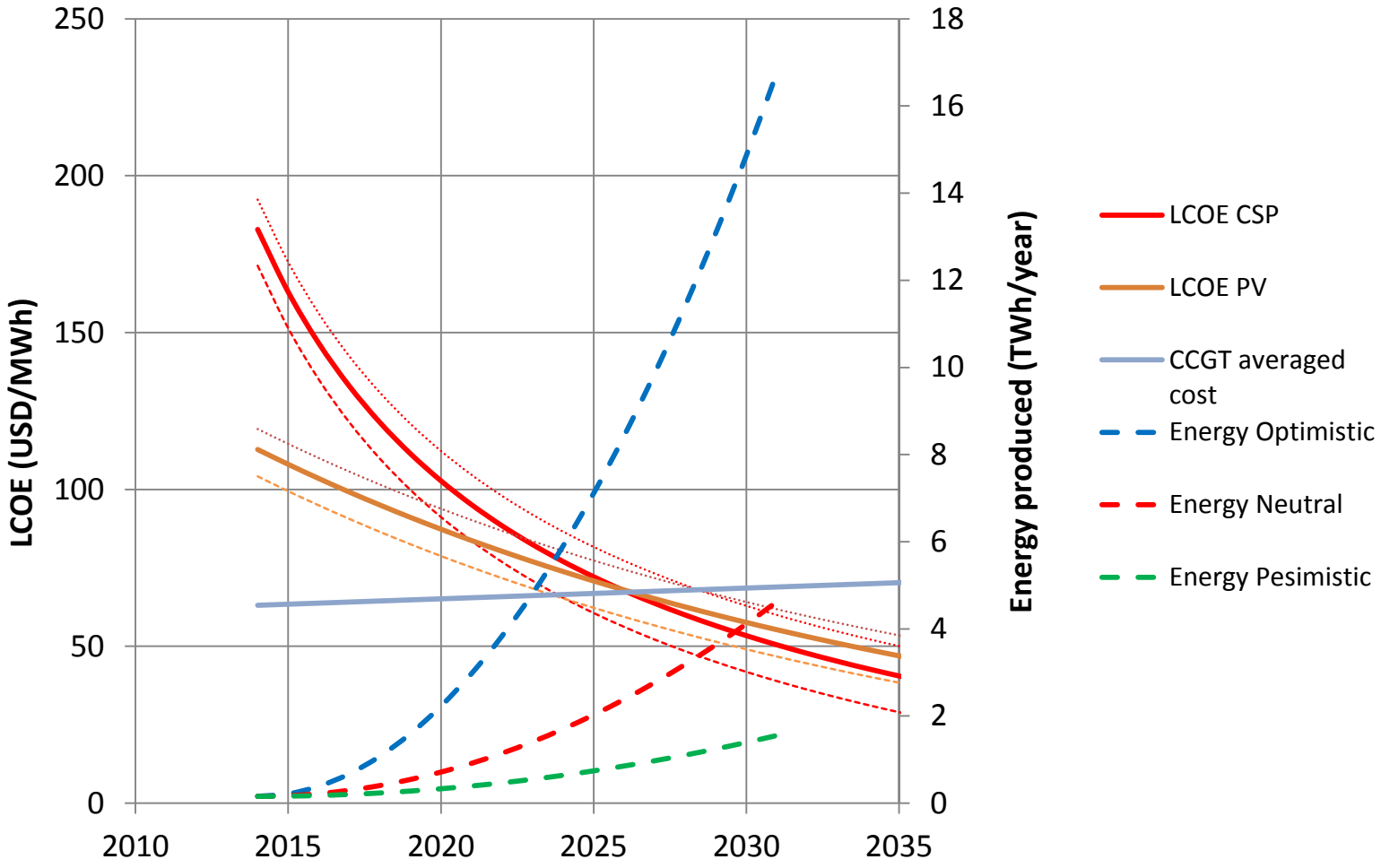
- **Optimistic scenario**
  12 TWh/year, 190 **Km^2**
- **Neutral scenario**
  3 TWh/year, 50 Km^2
- **Pessimistic scenario**
  1 TWh/year, 20 Km^2

Solar Energy - Hypothesis

Aggregated energy (TWh) for PV and CSP in 2015, 2020, 2025 and 2030



Forecast


LCOE (USD/MWh)
Energy produced (TWh/year)
250
200
150
100
50
0
18
16
14
12
10
8
6
4
2
0
2010
2015
2020
2025
2030
2035
LCOE CSP
LCOE PV
CCGT averaged cost
Energy Optimistic
Energy Neutral
Energy Pesimistic

Future activities

- Solar resource evaluation
- Feasibility analysis
- Local capacity building
  - Industry
  - Knowledge

Three countries, three approaches, three opportunities

Solar Technology Advisors a PSA spin off company

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