Overview of Concentrating Solar Thermal Power

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Solar – Abundant Resource

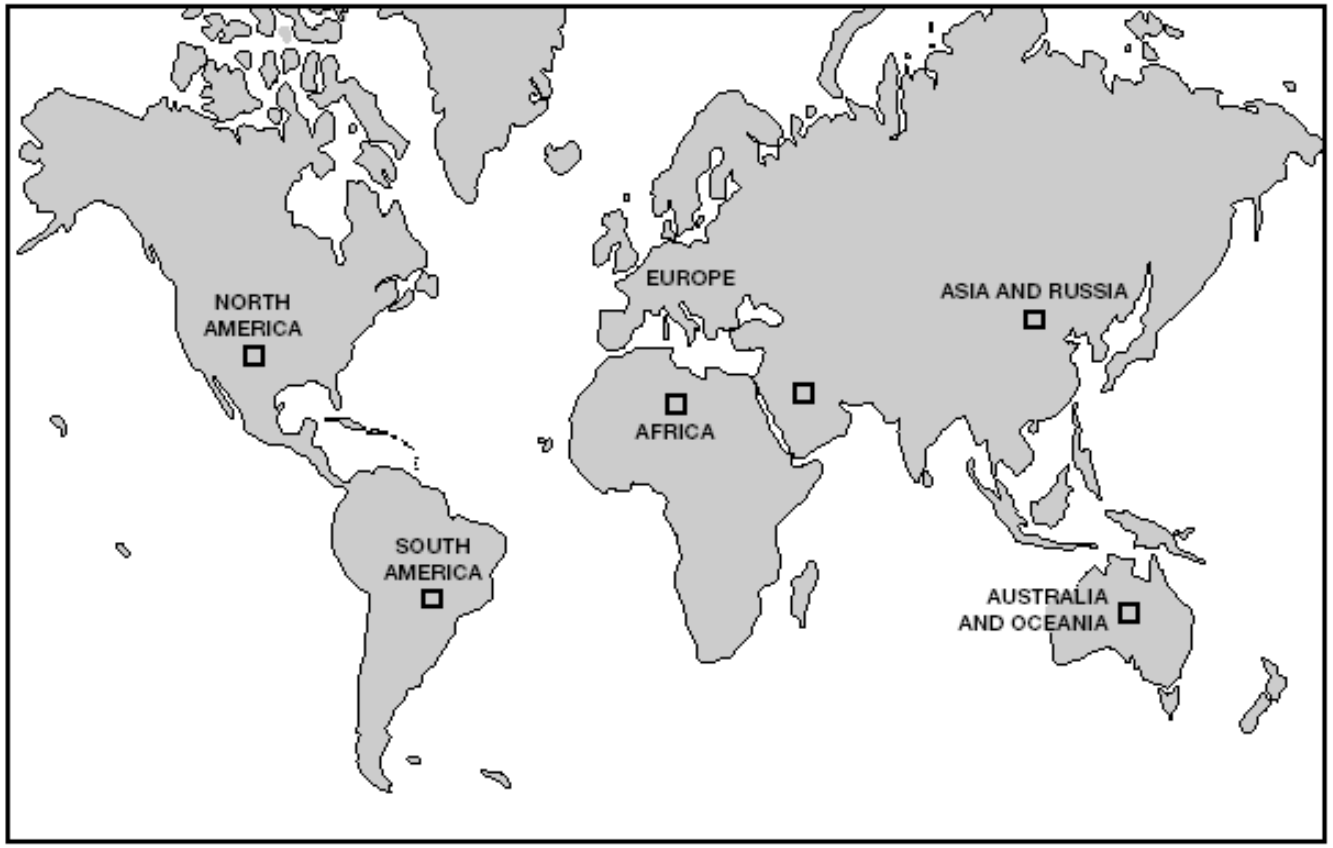


Figure 3. Solar cell land area requirements in which the six boxes (100 km on a side), located in areas of high solar radiation, can each provide 3.3 terawatts of electrical power to a total of ~20 terawatts of electrical power. Courtesy of Nate Lewis of the California Institute of Technology.

Source: R.Smalley (2005)

Renewable installed capacity and generation

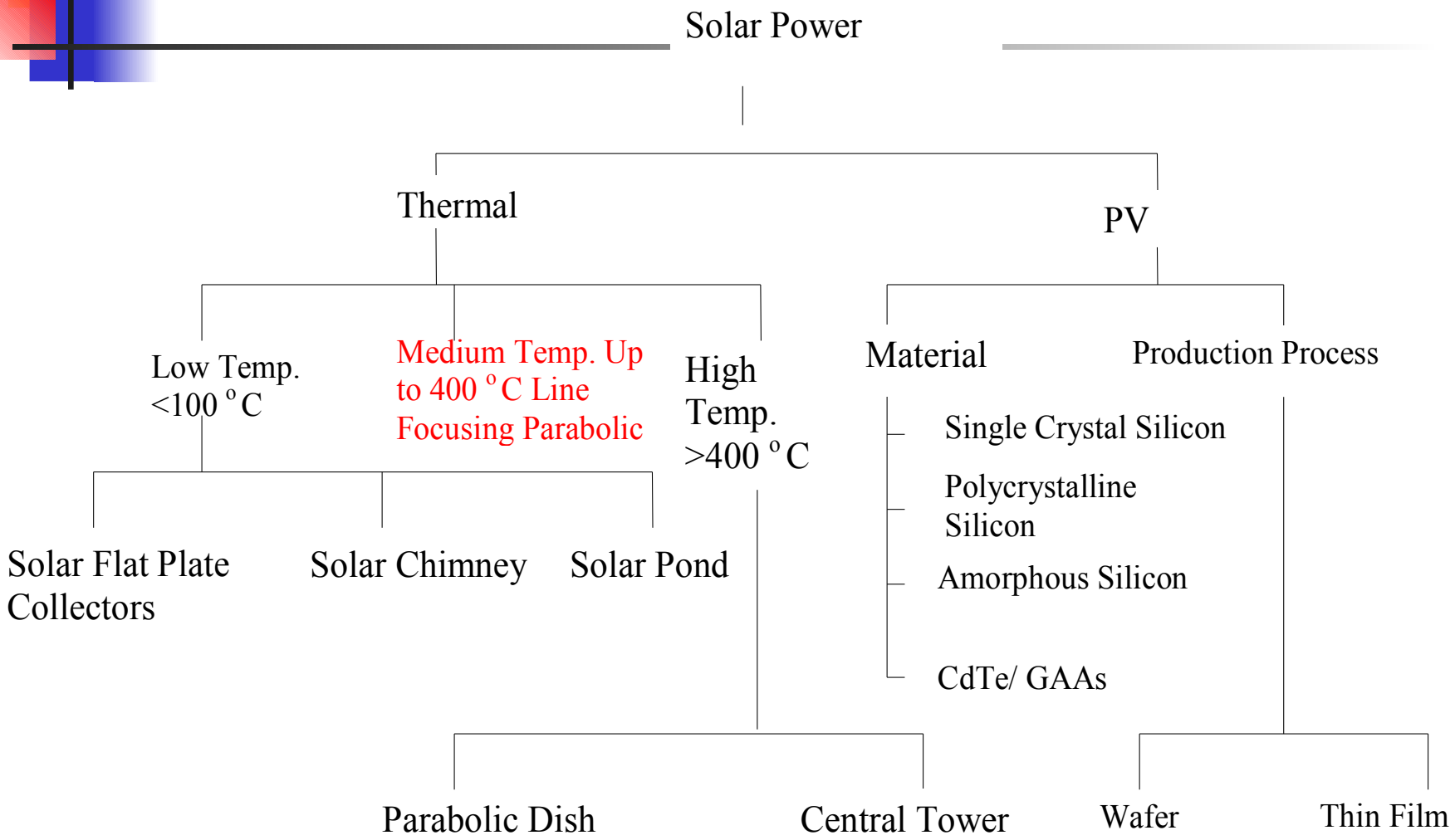
	Installed Capacity* (MW)	Estimated Capacity factor	Estimated Generation (GWh)
Wind	**7845**	**14%**	9621
Biomass Power	**606**	**70%**	3716
Biomass Gasifier	**86**	**70%**	527
Bagasse Cogeneration	**720**	**60%**	3784
Small Hydro	**2046**	**50%**	8961
Waste to Energy	**55**	**70%**	337
Solar PV	**2.74**	**20%**	5
Total	**11360**		26950

*as on Jan 1, 2008

Renewables in Power

- Renewables ~ 7-8% of Capacity and 3% of generation at present
- High growth rates – Wind, PV, moderate growth – small hydro, bagasse cogen
- Integrated Energy Policy, MNRE – estimate only about 6 % of share in power generation
- Climate Change – GHG mitigation- major driver
- Need to explore Concentrated Solar Power option

Technology Options for Solar power



Solar Thermal Power Generation Technologies

Technology	Efficiency	Indian Experience	Status
Solar Flat Plate Collectors	2%	10 kW exptl unit at IITM	D
Solar Chimney	1%	No experience 50 kW Spain	D
Solar Pond	1-2%	Experience for hot water Bhuj (Israel 5 MW power)	D
Line focussing Parabolic	Peak 20% Average 11-14%	50 kW system in SEC installed Planned 35MW solar in 140 MW ISCC at Mathania	C
Paraboloid Dish	29% peak 12-18%	Demo unit 20 kW near Hyderabad 10 kW Vellore	D
Central Tower	23% peak 7-14%	No experience	D

D- Demonstration
C- Commercially available technology

The Nevada Solar One plant

Technology used - Parabolic Trough

Capacity - 64 MW

Capital investment $266 million

– Rs.1089 Crores ($1=Rs. 40.95)

Rs 17 crores/MW

21- 30 c/kWh

(Rs 8-12/kWh)

Operation since 2007

Total area – 400 acres

Data Source : www.nevadasolarone.net official plant website

PS 10 Solar Thermal Power Plant at Granada, Spain.

Solar Power Tower

Capacity - 10 MW

Capital investment

$ 56.5 million

Rs.232 Crores

(23 crores/MW)

http://en.wikipedia.org/wiki/PS10_solar_power_tower

Dish-Sterling Engine Systems

The Advanced Dish Development System is a 10 kW water pumping system developed by WG Associates for use by Native Americans in the southwest U. S.

Indicative cost estimates

- 10-150 kW
- Rs 450,000/ kW

(Rs 45 crores/ MW)

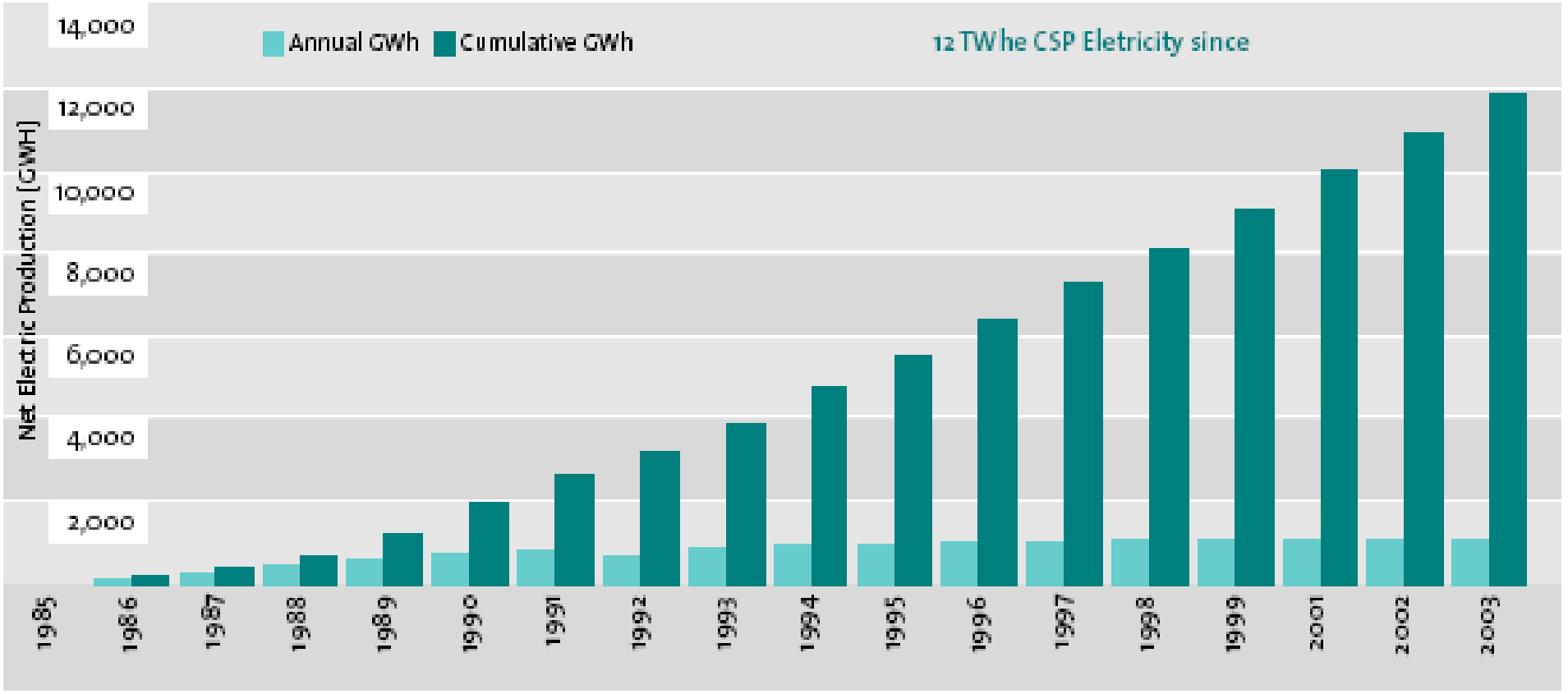
Rs 8-12/kWh

Dish Engine

150 kW Project, Albuquerque, NM

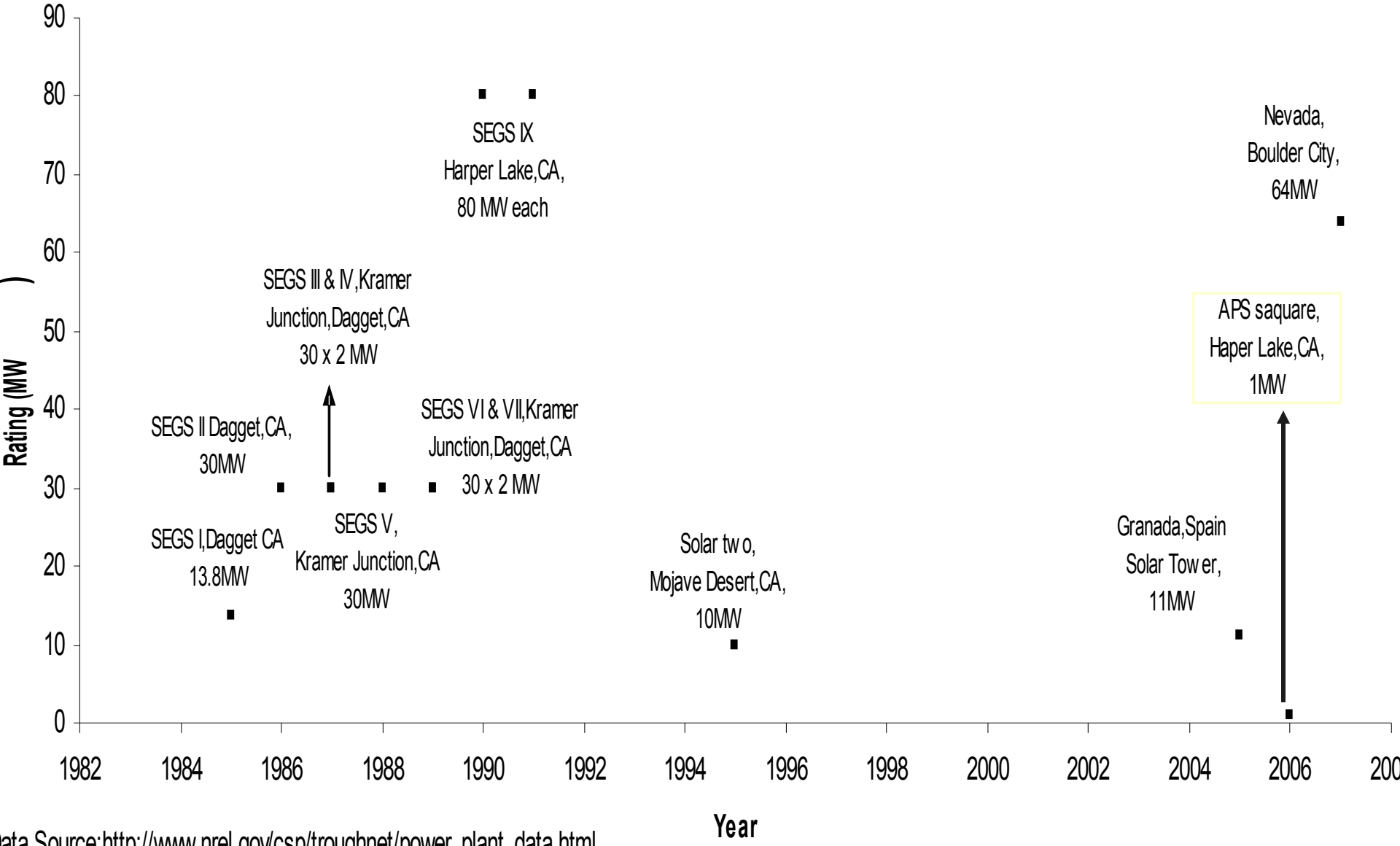
Electricity Generation from CSP

Figure 2.1: Generation of solar thermal electricity at Californian plants using parabolic trough collectors, 1985 to 2004



Source: CSP Now (2005)

Solar thermal capacities (US)

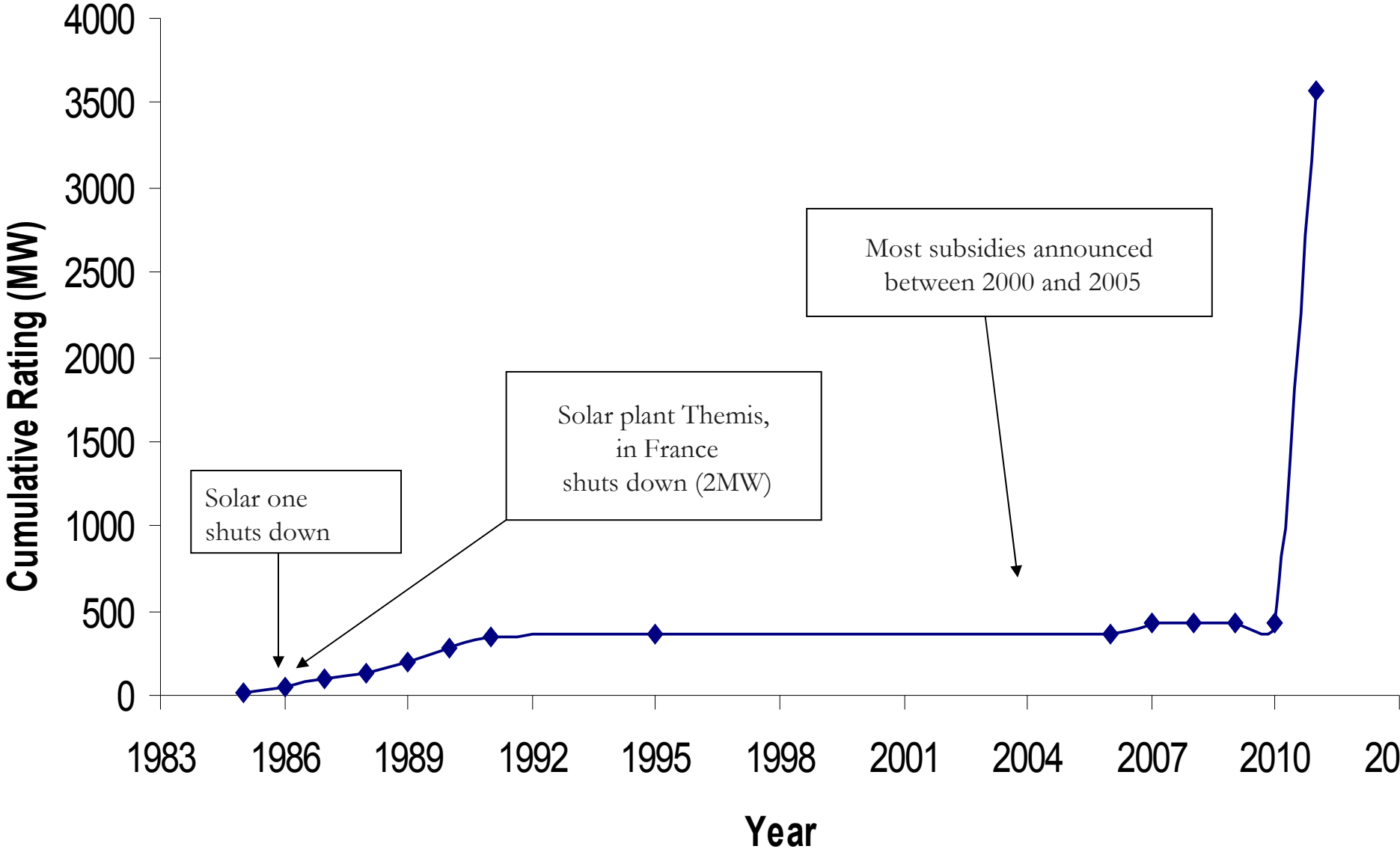


ata Source:http://www.nrel.gov/csp/troughnet/power_plant_data.html

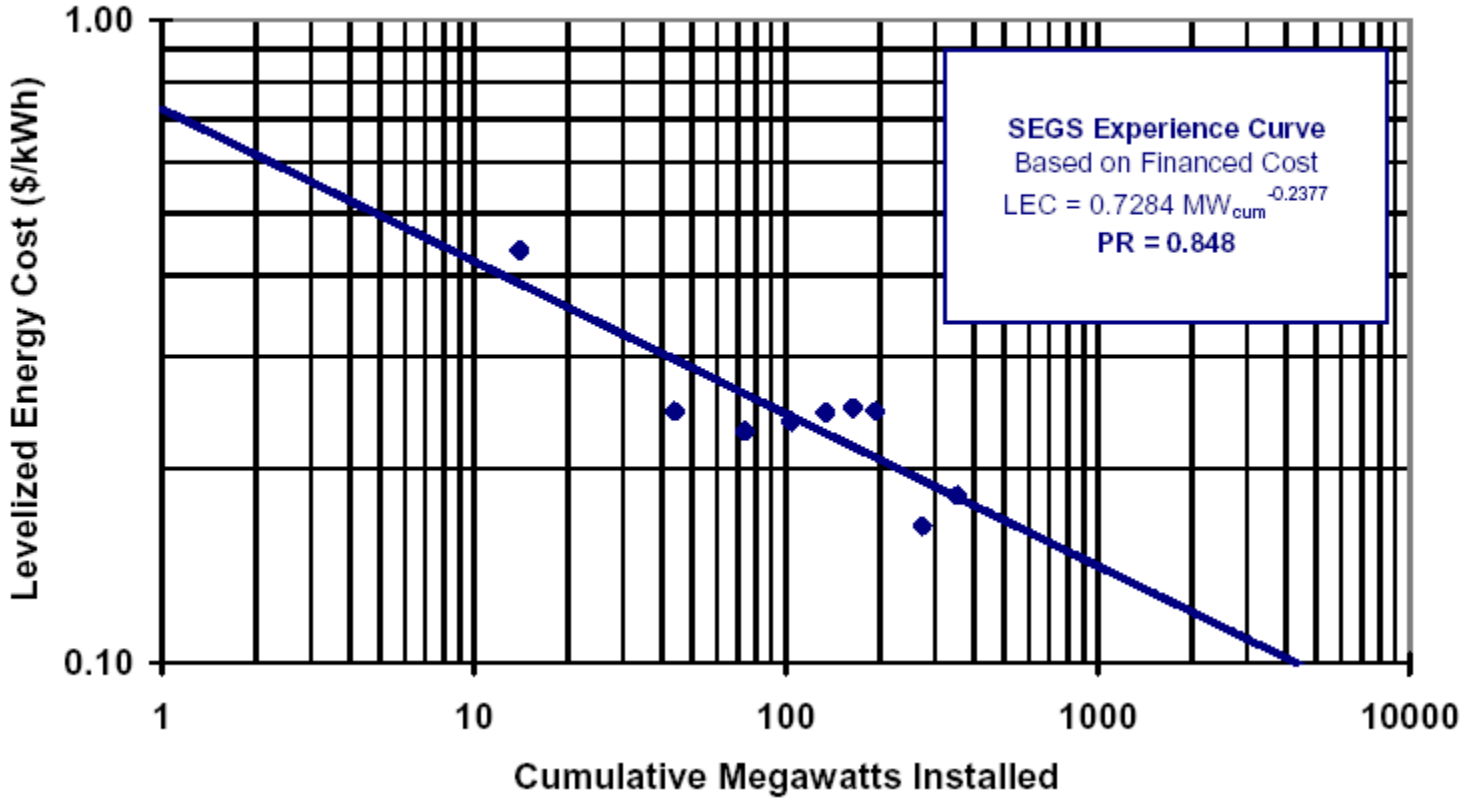
List of Solar Thermal Plants (Announced)

- Ivanpah Solar, USA California, 500 MW + 400 MW optional extension, power tower design
- Mojave Solar Park, USA California, 553 MW, parabolic trough design
- Pisgah, USA California near Pisgah north of I-40, 500 MW, dish design
- Unnamed, USA Florida, 300 MW, Fresnel reflector design
- Imperial Valley, USA California, 300 MW, dish design
- Solana solar power plant, USA Arizona southwest of Phoenix, 280 MW, parabolic trough design
- Beacon Solar Energy Project, USA California, 250 MW, parabolic trough design
- Negev Desert, Israel, 250 MW, design will be known after tender
- Carrizo Solar Farm, USA California near San Luis Obispo, 177 MW, Fresnel reflector design
- Upington, South Africa, 100 MW, power tower design
- Shams, Abu Dhabi Madinat Zayad, 100 MW, parabolic through design
- Yazd Plant, Iran, 67 MW steam input for hybrid gas plant, technology unknown.
- Barstow, USA California, 59 MW with heat storage and back-up, parabolic trough design
- Victorville 2 Hybrid Power Project, 50 MW steam input for hybrid gas plant, parabolic trough design
- Kuraymat Plant, Egypt, 40 MW steam input for a gas powered plant, parabolic trough design
- Hassi R'mel, Algeria, 25 MW steam input for gas powered plant, parabolic trough design
- Cloncurry solar power station, Australia, 10 MW with heat storage, power tower design
- Sopogy, Hawaii, 1 MW, Micro CSP design

Projection of Solar Thermal Power Output after 2008
Global

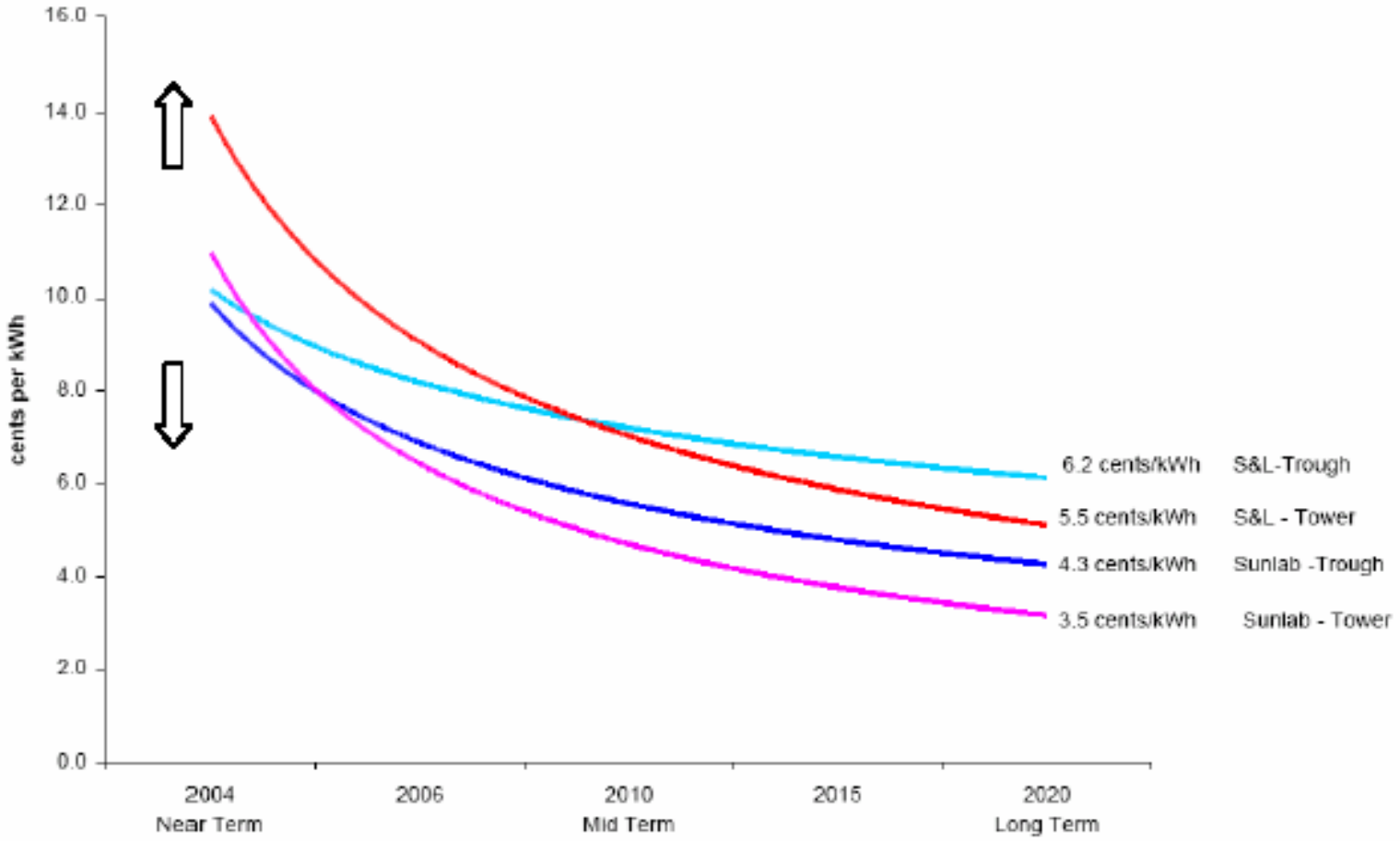


Cost Projections



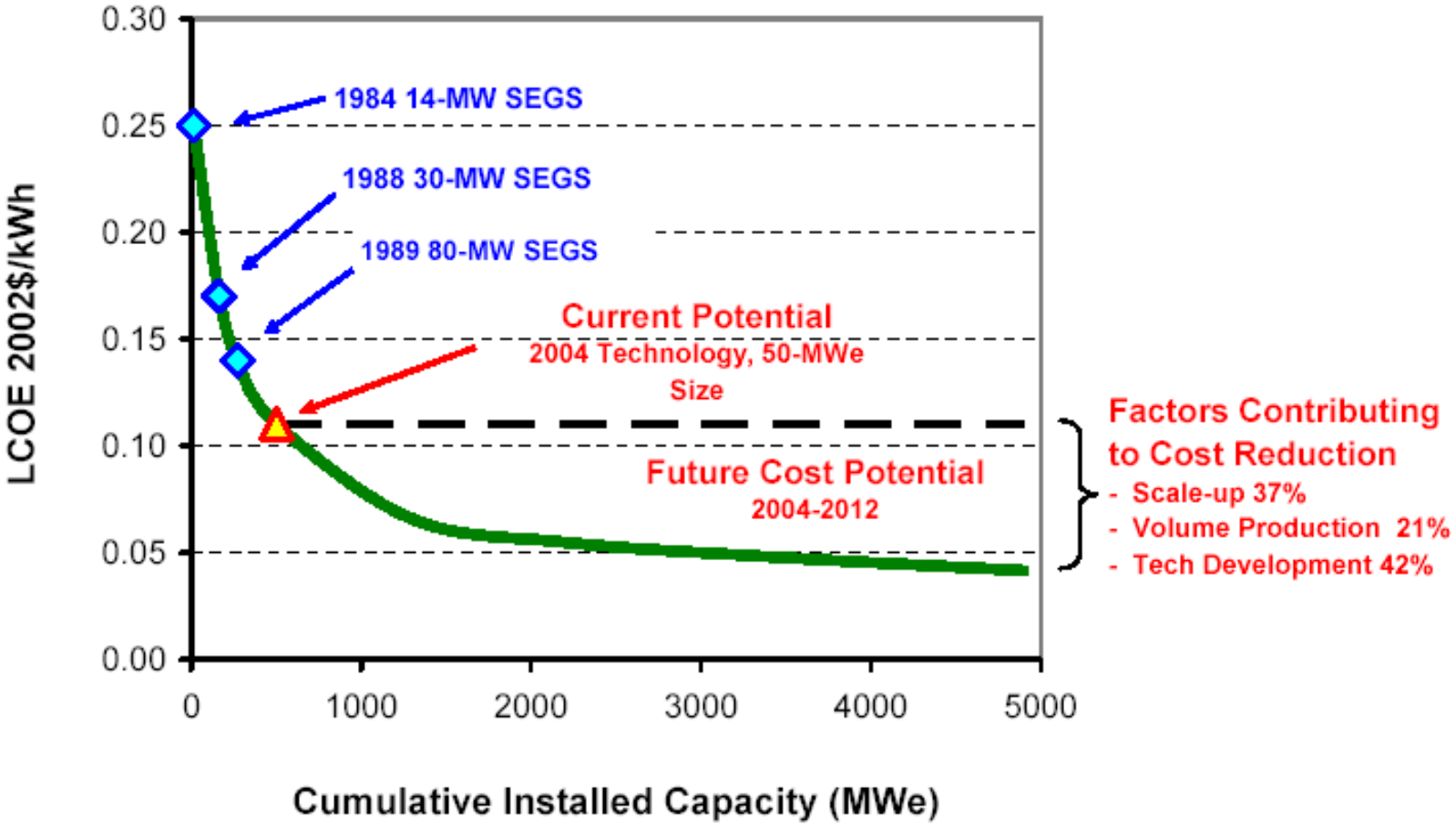
http://www.nrel.gov/docs/fy99osti/26649.pdf (1999)

Cost Reductions



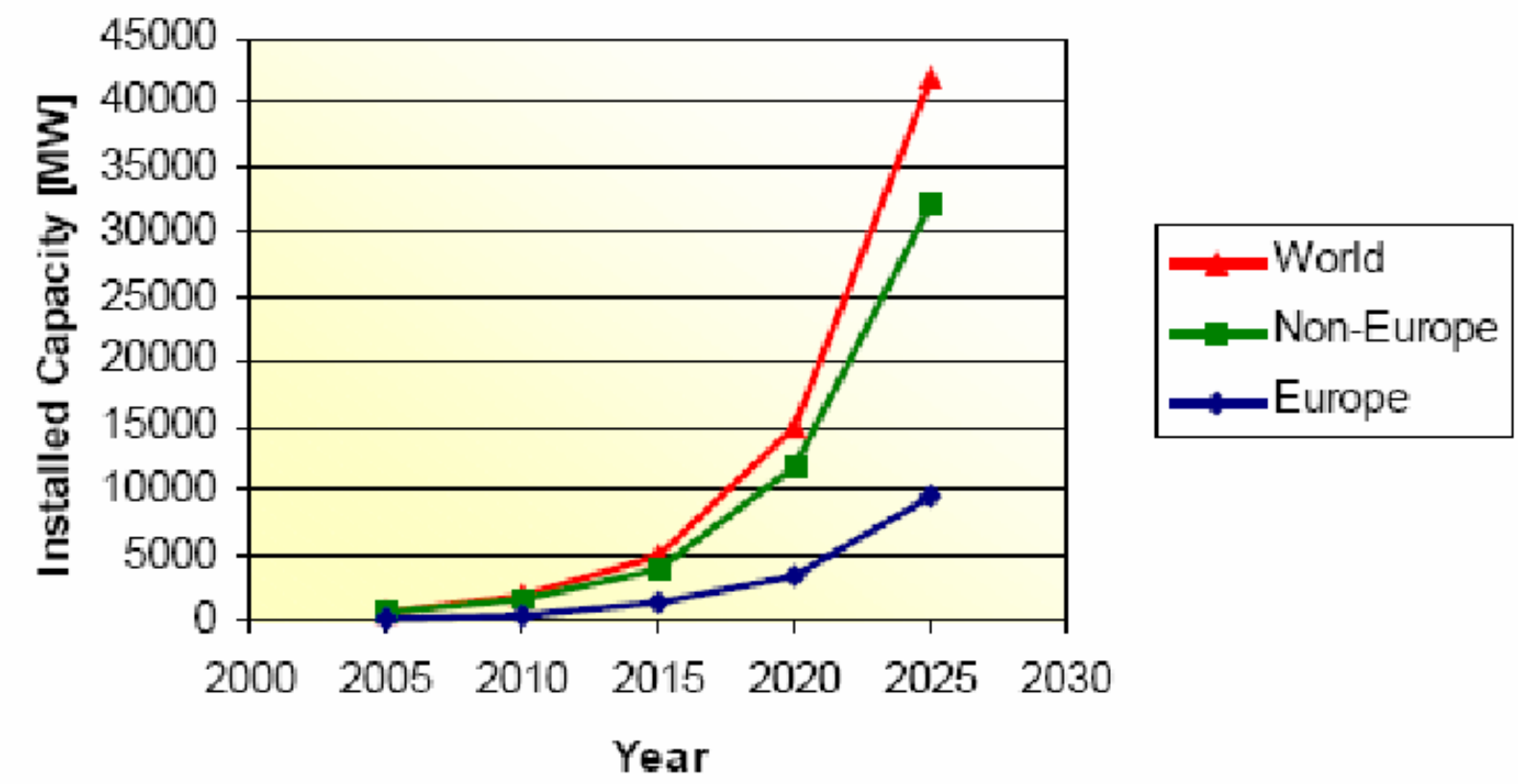
Sargent & Lundy, 2003

Cost Reductions



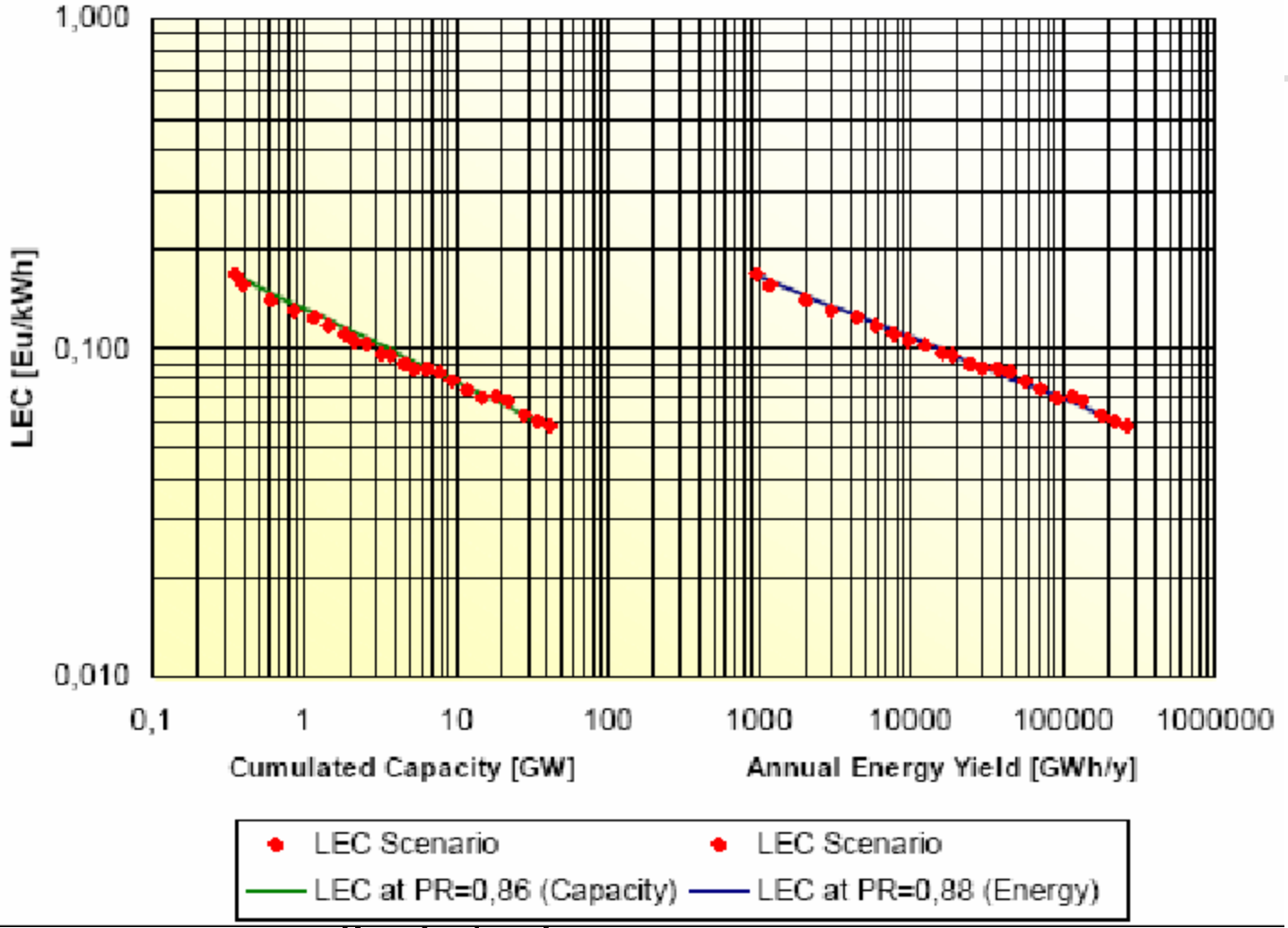
Source: DOE/GO-102007-2400

CSP Scenario

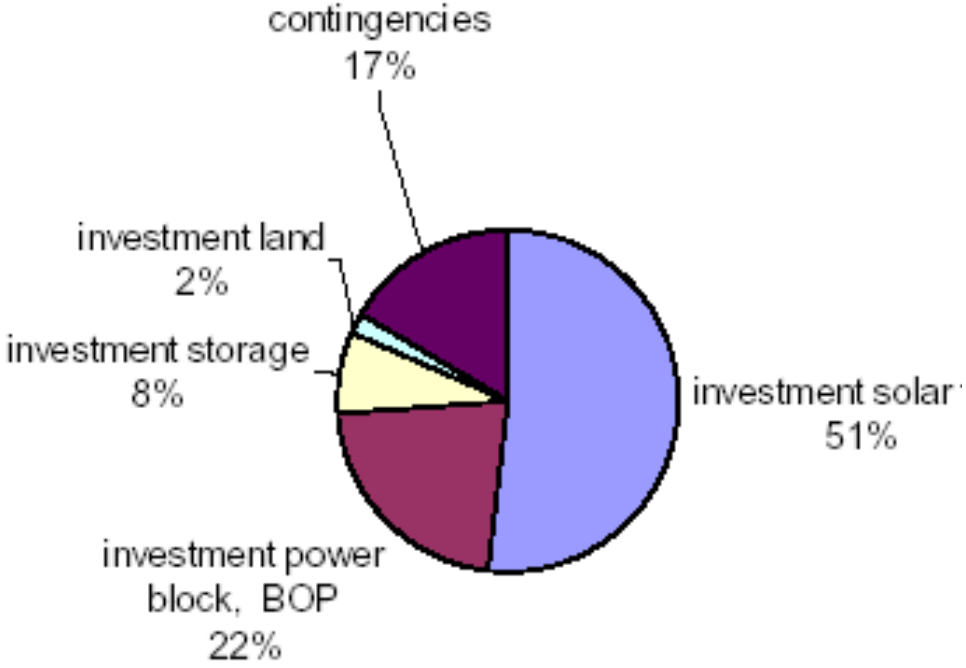


www.dlr.de/socrates

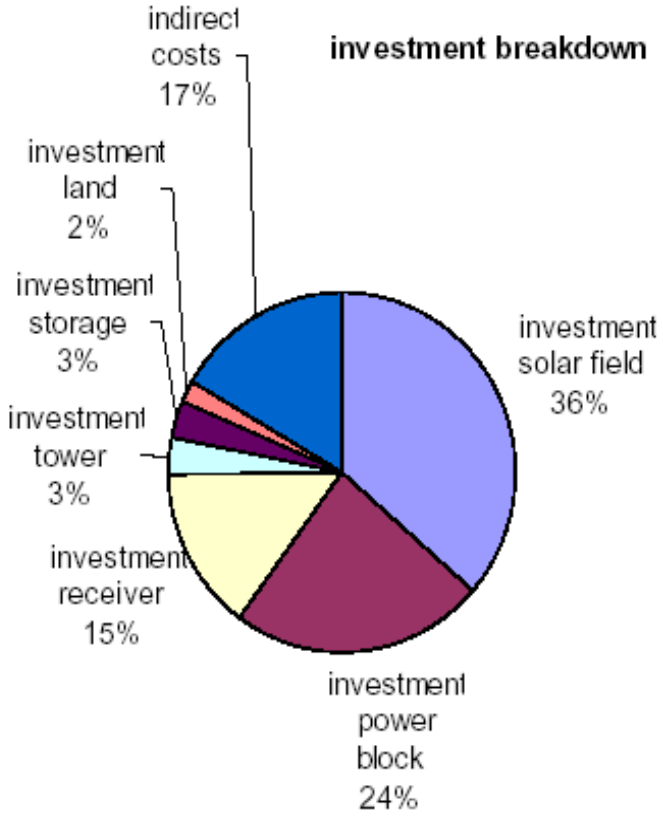
CSP Learning Curve Effects



Approximate breakup of capital cost -CSP



Trough



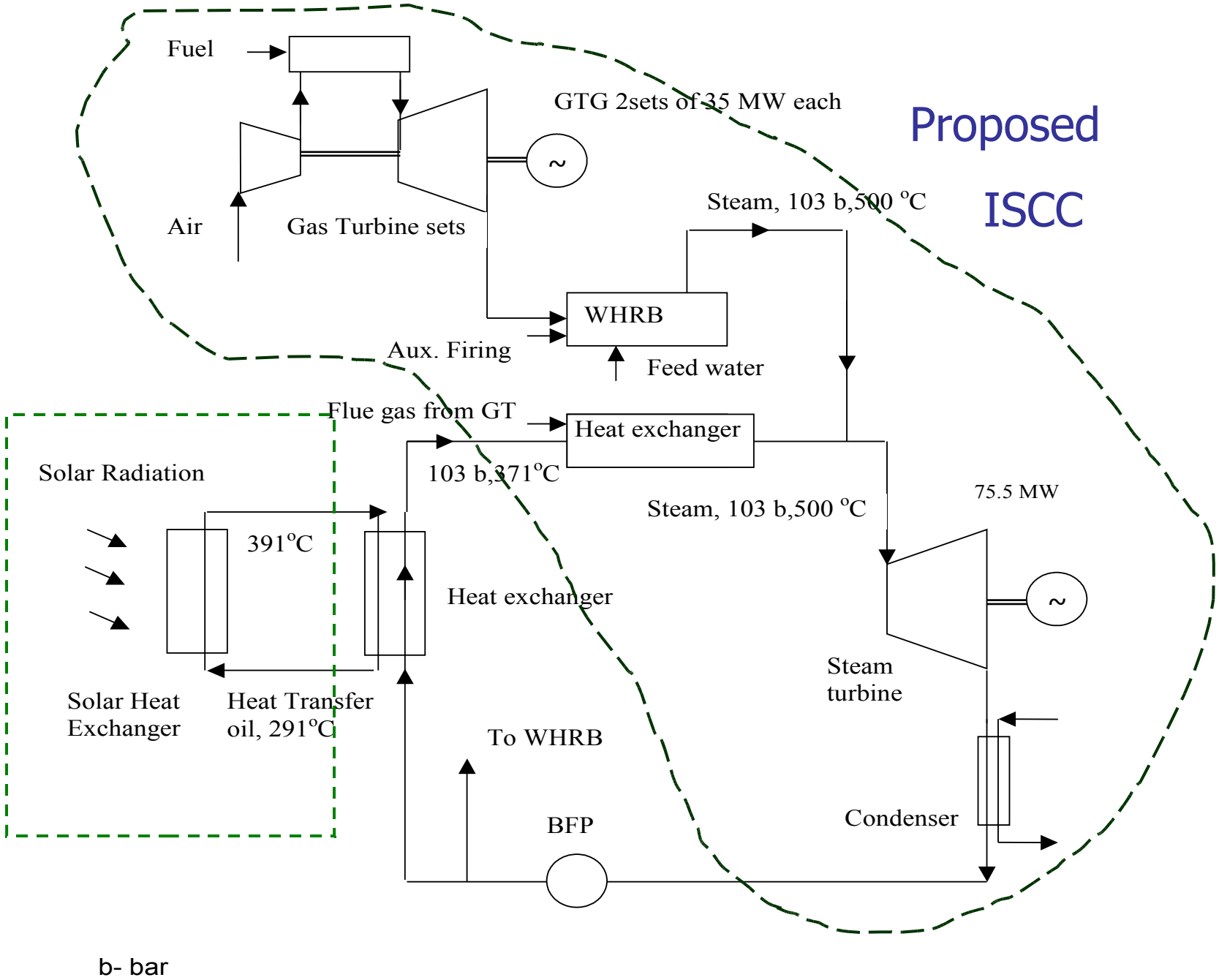
Solar Tower

Industry Partner/Technology Provider	Solar Technology	O&M Operator	Consulting	Developer	Engineering	Models & Tools	EPC
Black & Veatch			X		Power Plant		
Flabeg	Mirrors						
FPL Energy		SEGS III - IX		Power			
Solucar	Collector			Power/ IPH	Solar Field Power Plant		
Lauren							NVS1
Kearney and Associates			X				
Nexant			X		Storage ISCCS	Piping Flow	
Sargent & Lundy			X		Power Plant		
Schott	Receiver						
Solargenix	Collector	APS, NVS1		Power/ IPH	Solar Field		
Solar Millennium	Collector		X	Power	Solar Field, Storage		
Solel	Collector, Receiver			Power/ IPH	Solar Field		
Sunray Energy		SEGS I - II					

http://www.nrel.gov/csp/troughnet/industry_partners.html

Objective of Workshop

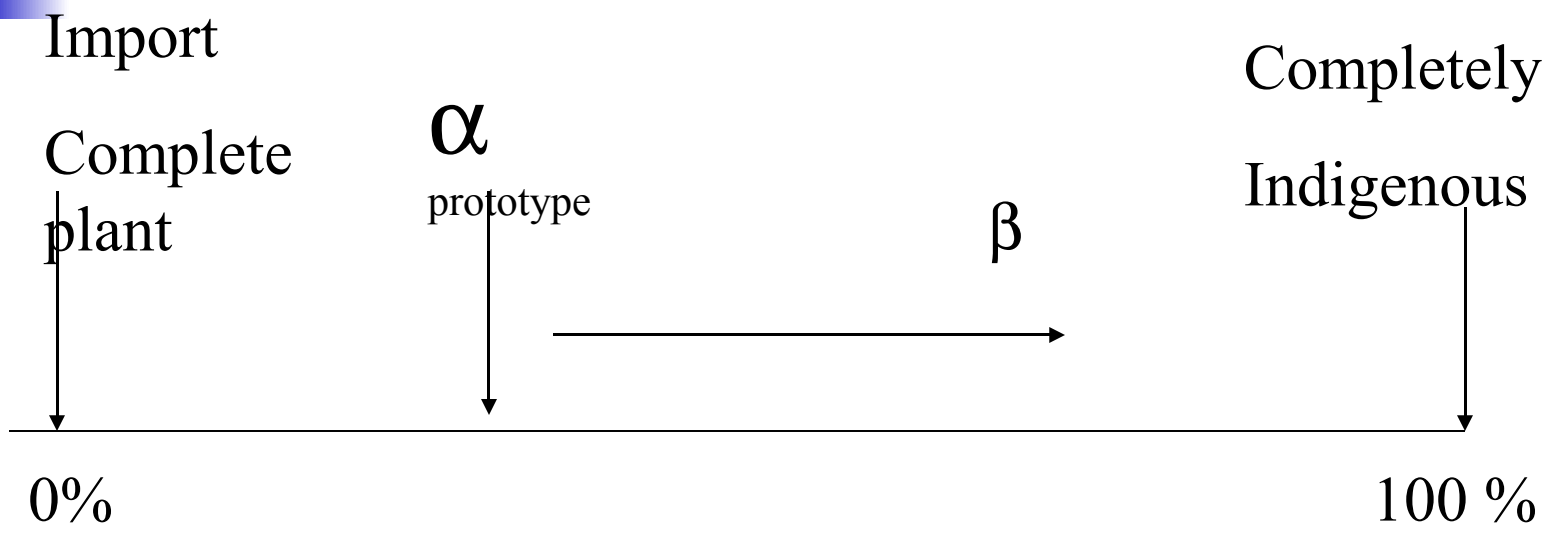
- Decide National Strategy for Concentrated Solar Power (CSP)
- Develop a consortium based approach for MW scale (CSP) in India
- Identify steps involved and action plan for a prototype plant and Testing facility


Proposed
ISCC
Fuel
GTG 2sets of 35 MW each
Air
Gas Turbine sets
Steam, 103 b,500 °C
WHRB
Aux. Firing
Feed water
Flue gas from GT
Heat exchanger
Solar Radiation
103 b,371°C
Steam, 103 b,500 °C
75.5 MW
391°C
Heat exchanger
Solar Heat Exchanger
Heat Transfer oil, 291°C
Steam turbine
To WHRB
Condenser
BFP
b- bar

Technology components

- Solar field – Technology type, temperature
- Receiver
- Storage
- Power plant systems – Working fluid – power plant cycle
- Hybrid/ Solar only
- Rating

Strategy



National Testing facility – Facilitate technology development

Workshop output

- Identification of potential consortium partners
- Capability/ Strength/ Gaps
- Action plan and Timeline

  Detailed proposal for prototype and testing facility, report outlining cost reduction strategy

Issues / Concerns

- Intellectual Property Rights
- Location
- Competition and Collaboration
- Funding and Benefit Sharing
- Access to Technology (for α prototype)
- Management of consortium and facility
- Monitoring and Review

References

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Thank you