CSP considerations and issues I

Potentially available in very large quantity

Little direct production of carbon dioxide or criteria air pollutants (SOx, NOx, etc.)
  • Power tower and parabolic-trough technologies may employ gas backup for stabilization of output and for providing peaking capacity value

Potential ecological impacts from habitat preemption
  • Large land area required

Public perception:
  • Power plants - cautiously supportive (concerns regarding land use, aesthetics and ecological impacts)
  • New transmission needed from remote resource areas - possible public resistance
CSP considerations and issues II

Investment risk:
• High capital cost (currently $4000 - 5000/kW)
• Short development and construction lead time
• Advanced development of longer-lead time transmission will be needed to access suitable resource areas

Low fuel price risk
Diurnally intermittent and seasonally variable output
• Probably less forecast error than windpower
• Parabolic trough and power tower systems can include thermal storage and gas backup to stabilize output
• Reduces or eliminates regulation and load-following costs

Northwest perspective:
• Poor seasonal load-resource coincidence for most of region
• New transmission in new corridors needed to access resource
• Price competition from California & SW utilities

Power Tower
Field of heliostats (tracking mirrors) focus radiation on central tower-mounted receiver
Molten salt heat transfer fluid transfers energy to salt/water boiler, steam drives conventional steam turbine generator
Molten salt thermal storage and supplemental natural gas boiler firing may be provided.
~ 20 MW unit capacity

North American Development
10 MW Solar One pilot project (1982 -1988), Barstow, CA
10 MW Solar Two pilot project (molten salt heat transfer fluid & thermal storage) (1998 -1999), Barstow, CA.
Power sales agreements for 6 projects totalling 1145 MW in CA
Dish/Engine

Heat-driven engine/generator (usually Stirling) at focal point of mirrored dish.
Highly modular (25kW/unit); opportunities for economies of production.
Scalable to arrays of several hundred megawatts, or more.
North American Development
150 kW (6 dish) pilot plant in operation
Power sales contract w/SDGE for 300 MW (12,000 dish) plant in the Imperial Valley, CA
Power sales contract w/ SCE for 500 MW (20,000) dish plant in the Mojave Desert, CA

Parabolic-trough

Mirrored parabolic troughs or linear Fresnel lenses focus radiation on a linear oil-filled receiver
Oil heat transfer fluid transfers energy in an oil/water boiler; steam drives conventional steam turbine generator
Oil thermal storage and supplemental natural gas boiler firing may be provided.
1 - 200 MW unit capacity

North American Development:
SEGS I - X (354 MW total) in service in California since late 1980s
64 MW Nevada Solar One in service in 2007
5 MW Kimberlina Linear Fresnel Reflector plant in service 2008 (CA)
Power sales agreements for 4 projects totalling 1180 MW in CA & AZ
Power sales agreements for 177 MW Carrizo Plains Fresnel Reflector project
Parabolic trough selected for further analysis

Each technology is likely ultimately to play a commercial role
Parabolic-trough technology is commercially proven with an extensive operating record

Cost:
- Dish Stirling cost estimates somewhat higher than Power Tower or Parabolic Trough, but are very preliminary and may benefit from economies of production
- Power Tower and Parabolic trough costs are roughly in the same range, but parabolic trough costs are firmer, based on commercial-scale construction and extended (20 years) of operation.

CSP technologies use direct normal radiation
Best sites are in the desert Southwest.
We assumed development in the White River Valley of Nevada

6.5 - 7.5 kWh/m/day
~ 100 mi south of Thirtymile substation of proposed Southwest Intertie Project

Central NV CSP to S. Idaho, Oregon & Washington
Derivation of CSP capital cost assumption

Cost announced

Overnight capital cost (2006$/kW)

2002 2003 2004 2005 2006 2007 2008 2009 2010

Proposed overnight cost assumption for 2010 service $4700/kW

Closed long-term financing of Nevada Solar One on completion

Wkg Draft CSP

All CSP Trough Near-term

Nevada Solar One

Construction costs over the long-term

Year of Construction Contract (2006$/kW)


Year of Service

Costs flatten in 2008 - 2009

2015 > Costs decline at approximate B&V & NREL long-term rate

Combined effects of general construction cost decline, economies of scale & addition of storage

Historical project cost estimates

NREL 2006 Long-term Trough

NREL 2006A Long-term Trough

B&V 2007 Long-term Trough

Proposed Long-term

December 18, 2008
CSP Plant assumptions

Configuration:
- 200 MW parabolic trough power plant
- Natural gas backup (10,000 Btu/kWh HR) and 6 hours storage
- 40% capacity factor

Development and construction cost (overnight):
- $4700/kW (2010 service)
- $4100/kW (2015 service)

Operating costs:
- Fixed O&M - $60.00/kW/yr
- Variable O&M - $1.00/MWh
- System Integration - None (Storage & backup NG used for stabilization)

Schedule and cash flow
- Development - 24 mo; 2% of overnight cost
- Preparation - 8 mo (4 mo overlap w/development); 20% of overnight cost
- Construction - 24 mo; 78% of overnight cost

Earliest service for project available to the Northwest ~ 2015
- Prerequisite: Construction of transmission

Transmission assumptions

- Incremental transmission system cost fully allocated to CSP energy transfer (no network reliability credit).
- Transfer capacity provided for 100% of project output.
- Transfer cost based on expected capacity factor (~40%)
- Estimates based on line miles and substations proposed for B2H, appropriate Gateway, SWIP North segments.
- Assumed additional 100 mi lateral + receiving substation w/transformation from White River Valley to SWIP Thirtymile sub.
- Lines assumed to be single-circuit 500kV AC w/1500 MW transfer capacity
- Line and substation unit costs are as recommended by Bonneville Nov 2008.
- ROW, communication, EPC, owner's cost and O&M cost percentages are from MSTI proposal.
- Losses are from 2006 NTAC Canada-Northwest-California study
CSP plant cost elements

- Levelized lifecycle 2006$/MWh
- NV CSP in 2015 (30% ITC)
- NV CSP in 2015 (No ITC)

- CO2 (Bingaman-Spector cap)
- Transmission & Losses
- System Integration
- Variable Fuel
- Variable O&M
- Fixed Fuel*
- Fixed O&M
- Capital

* Fixed fuel cost would be about $25/MWh if pipeline capacity to provide firm peaking capacity were secured.

Effect of historical and forecast cost trends

- Levelized Energy Cost ($/MWh)
- Year of Service
- Nevada CSP to PNW (No ITC)
- Nevada CSP to PNW (w/ITC)

December 18, 2008