



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Parabolic Trough 2007 Workshop

Welcome to NREL

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Meeting Objectives

- Provide a forum for information exchange on parabolic trough technology, markets, and related topics of interest.
- Provide an opportunity for the R&D laboratories to get feedback from industry on R&D activities.
 - DOE looking to understand how to better support current and future CSP developments



Housekeeping

- Introduction of support team
- Please sign-in
- Location of restrooms
- Phone/Internet access
- Meals & breaks
- Presentations/TroughNet
- Foreign National Data Cards
- Laboratory Tours
- You're at altitude, drink lots of water!



Agenda Review

- Markets
- Resource Assessment
- Current Technology Overview
 - Parabolic Trough
 - Thermal Energy Storage
 - Power Cycle
- Advanced Technologies
 - Molten-Salt
 - Direct Steam Generation
- Laboratory capabilities and R&D



Introductions

- Introduce self, description of products/services
- By business type & organization
- Order
 - Laboratory/DOE
 - Universities
 - Utilities
 - SEGS O&M Companies
 - Trough Technology Providers
 - Engineering
 - Developers
 - Financial
 - Other



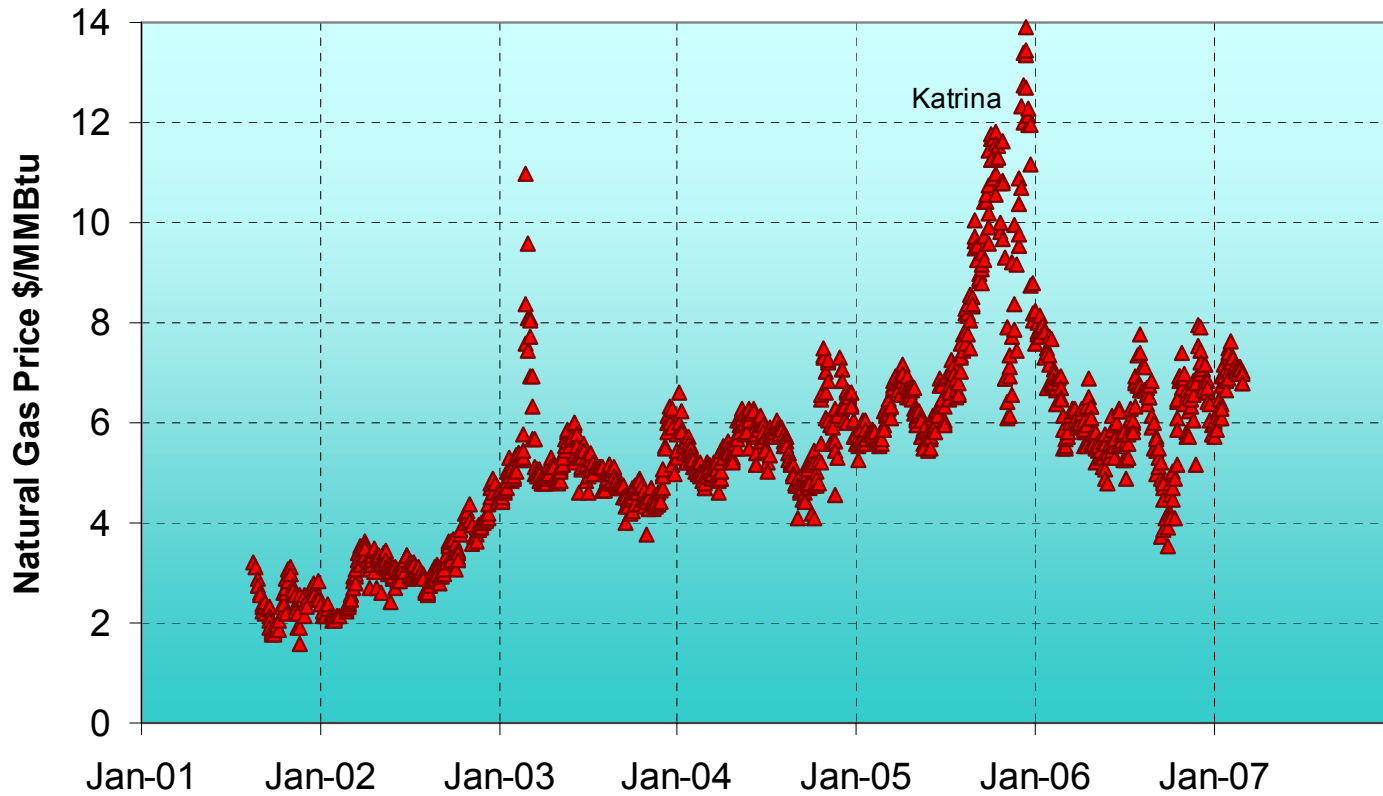
Setting the Stage

COLLECTORS, HARPER LAKE, CALIFORNIA



Natural Gas Prices

Historical data for SoCal Border
from 01/01/2001 to 03/03/2007

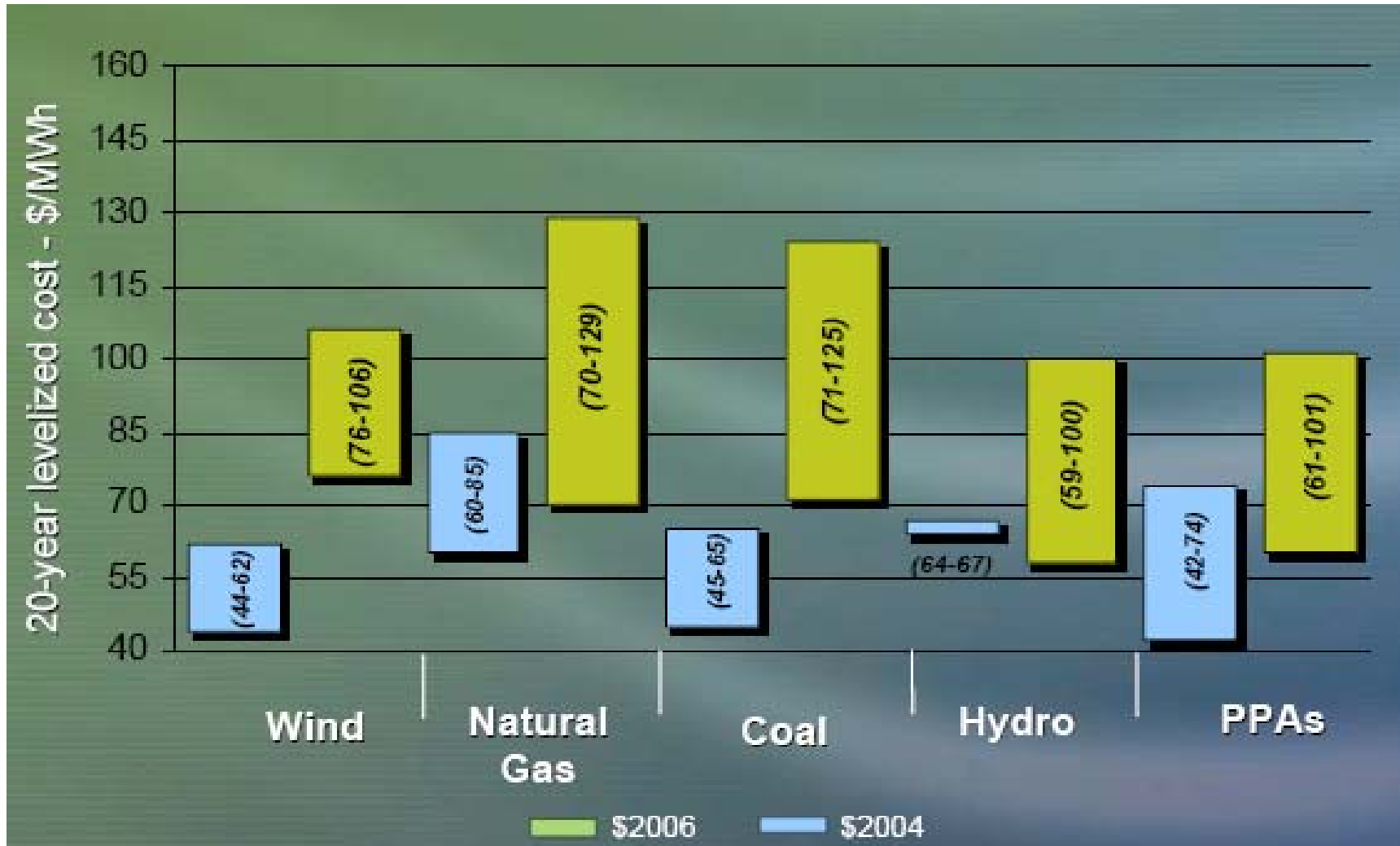


Source: ONLINE DATABASES - <http://www.energycentral.com>



Costs have increased for all technologies

Prices from Puget Sound Energy RFPs



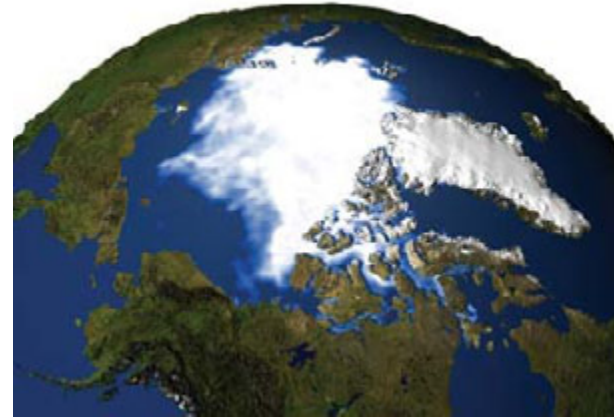


Union of
Concerned
Scientists

Climate Change Highlighting the science



Arctic sea ice in 1979



Arctic sea ice in 2003

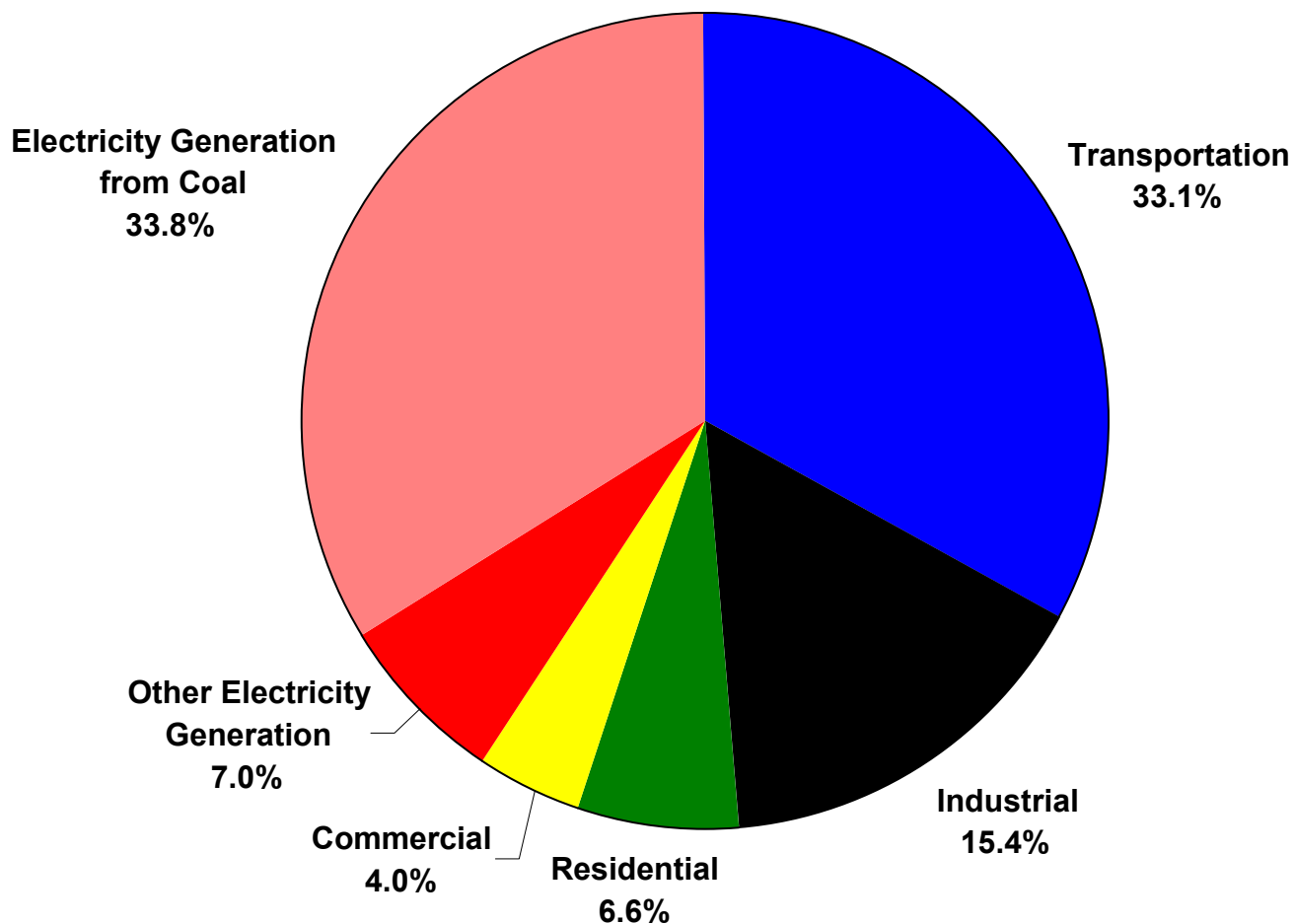
- **Powerful scientific consensus on global warming**
- **Damage already occurring**
- **Much worse lies ahead, including risk of abrupt changes**
- **Major reductions (60-80% by 2050) needed to avoid dangerous warming: CA, NM, EU, UK, New England Governors and Eastern Canadian Premiers**



Union of
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Coal plants a large part of the problem

Sources of U.S. Energy Related CO₂ Emissions: 2004



Source: EPA 2006



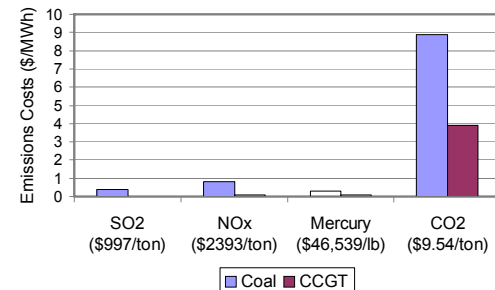
Currently a Major Resurgence in Coal

Coal's Resurgence

- High natural gas prices driving new coal rush and higher carbon emissions
- 159 new plants proposed
- No plans to capture and store CO₂
- Locks us in for decades to highest-carbon energy, with huge environmental AND financial risk
- IOUs believe they can pass costs on to ratepayers

Push Back on Coal

- Growing public support for GHG reductions
- Pressure from investors
- Ratepayers shouldn't bear the risk of these imprudently incurred costs
- Grandfathering of new coal plants is not likely.
- Many utilities are starting to include an assumed CO₂ cost





Carbon Sequestration

IPCC Special Report 2002

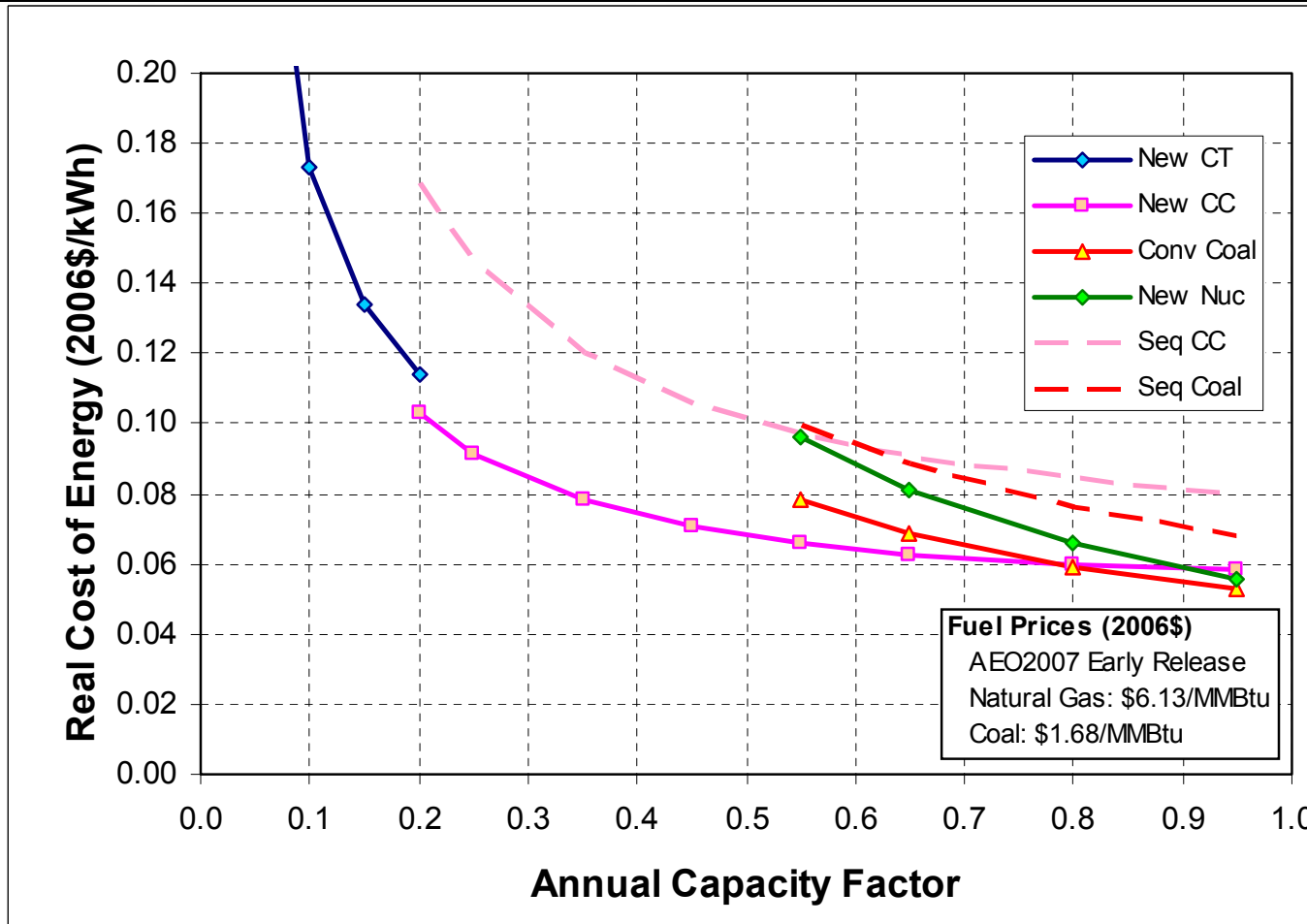
US\$2002	Pulverized Coal	Natural Gas CC	Integrated Coal Gasification CC
Cost of Electricity w/o CCS (\$/kWh)	0.043–0.052	0.031–0.050	0.041–0.061
Carbon Capture & Sequestration			
- Increased fuel requirements	24-40%	11-22%	14-25%
- CO2 Avoided	81-88%	83-88%	81-91%
- Cost of Carbon Capture (\$/kWh)	0.019–0.047	0.012–0.029	0.010–0.032
- Mitigation Cost (\$/tCO2 avoided)	30–71	38–91	14–53
Cost of Electricity w/ CCS (\$/kWh)	0.063–0.099	0.043–0.077	0.055–0.091
Potential value of EOR (\$/kWh)	0.014–0.018	0.006–0.007	0.013-0.015

Natural Gas Price: 2.8-4.4 US\$/GJ (LHV)

Coal Price: 1.0-1.5 US\$/GJ



Conventional Energy Prices (Black & Veatch)





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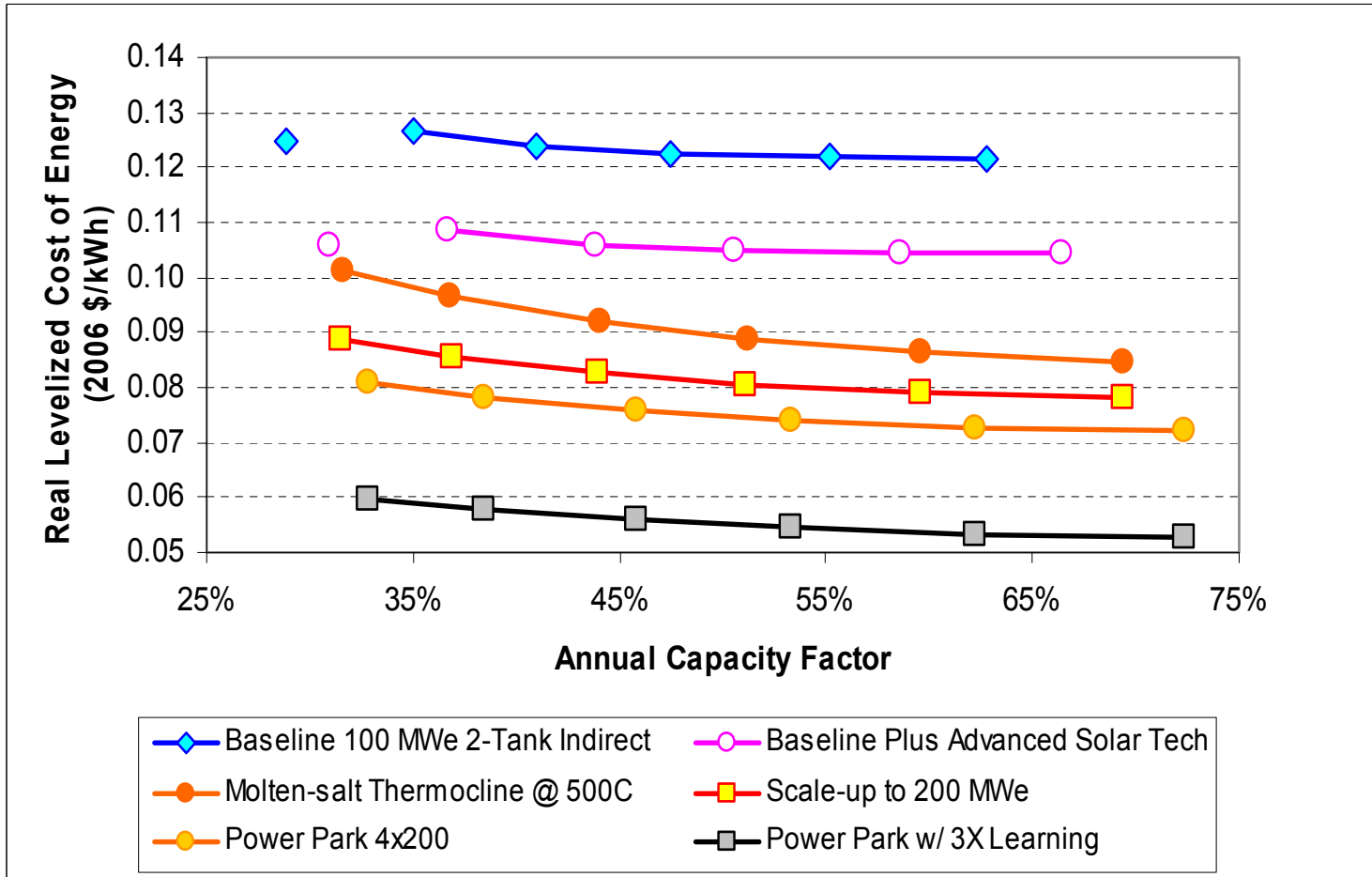
Parabolic Trough Technology

- 354MWe SEGS plants continue in daily operation
- First new projects in 15 years are coming on line
- Growth in industrial players
- New trough technology is improved



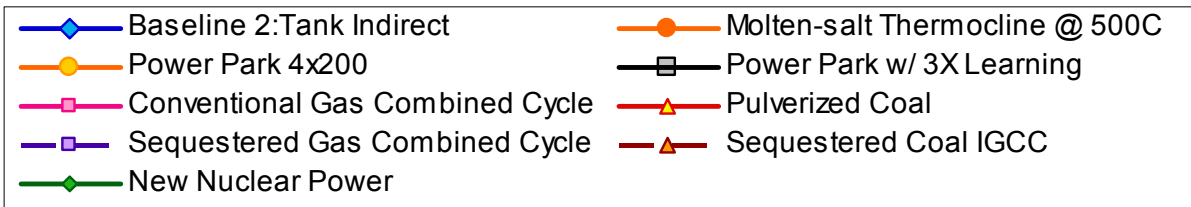
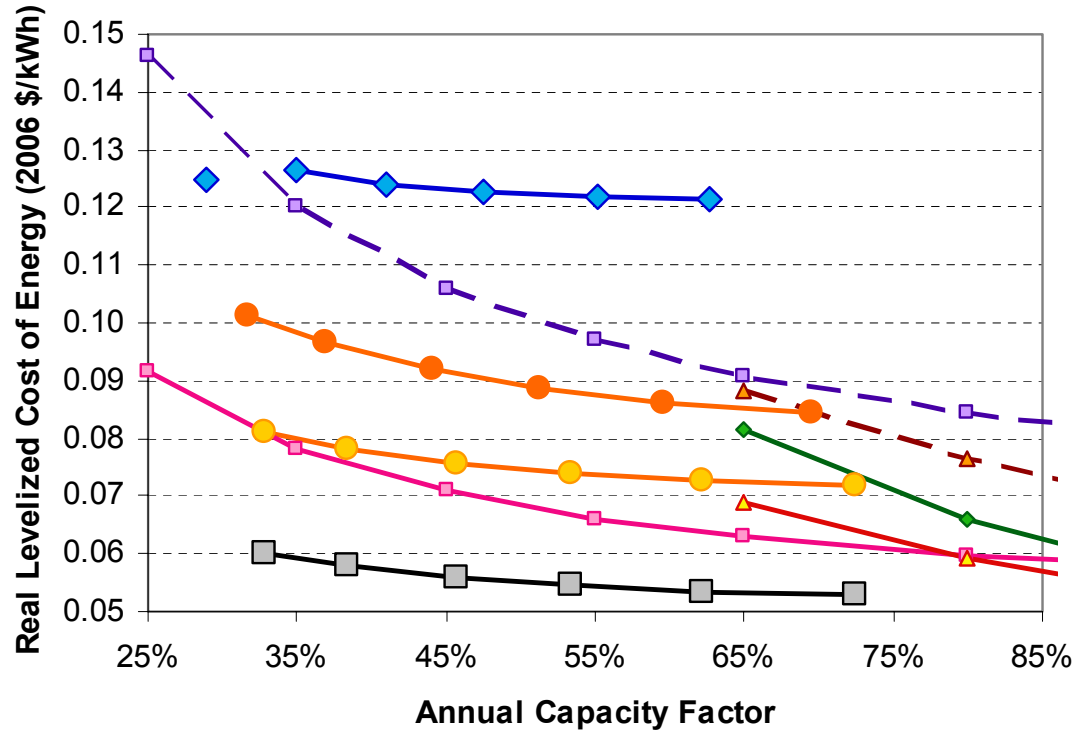


Parabolic Trough Potential Cost Reductions





How Does CSP Stack Up?





- **Markets**
 - **Value of CSP Power for U.S. Utilities**
 - **Tackling Climate Change in the U.S. with Renewables**
 - **CSP Project Developments**