

The Economics of Nuclear Power: Is New Nuclear Competitive?

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JULY 10, 2009 NOON PRESENTATION
Foundation for Nuclear Studies Event
House Rayburn Office Building, Room B340

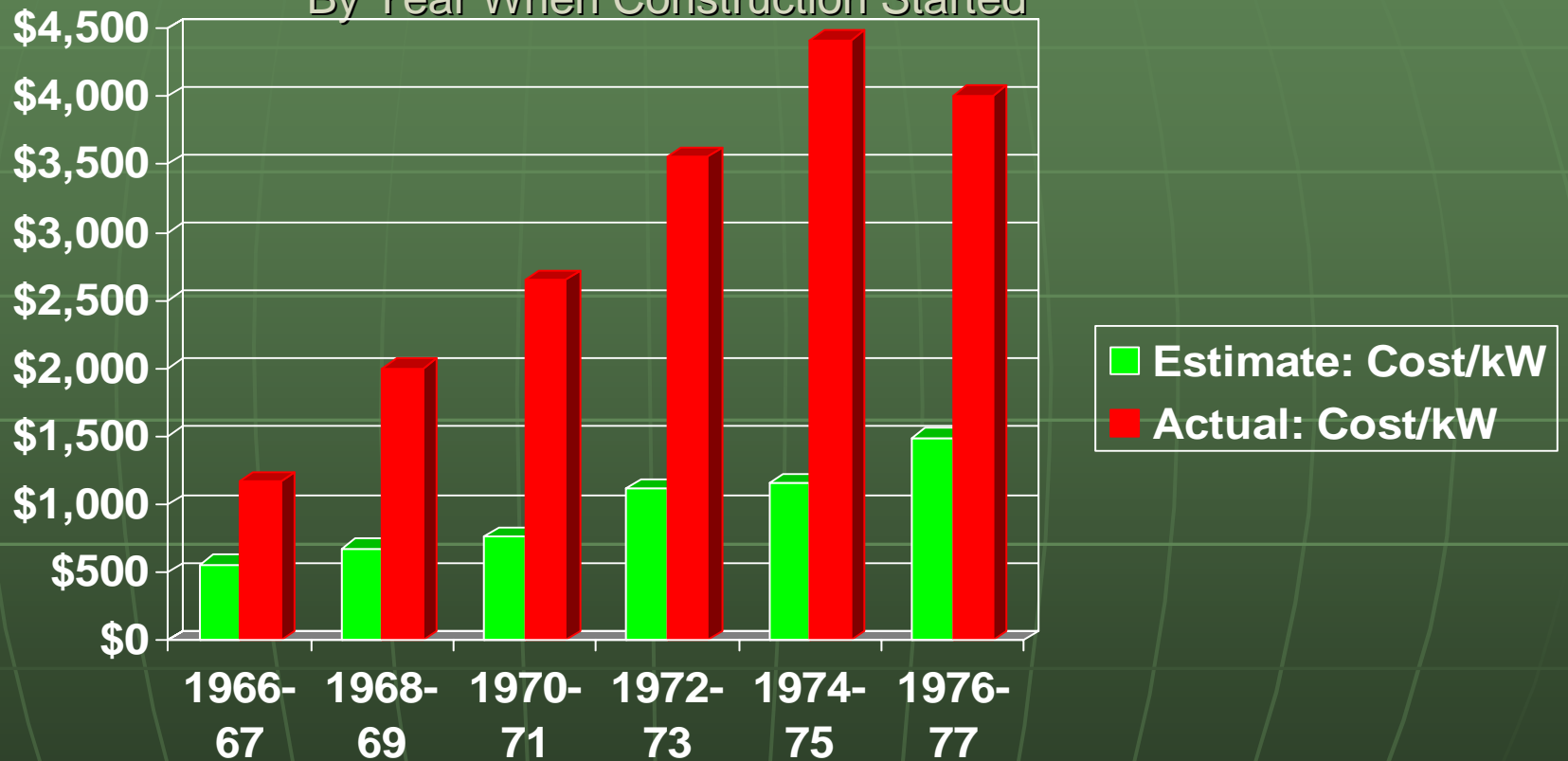
Is New Nuclear Competitive?

- By definition – if coming to Washington for subsidies you're *not* competitive
- If you're competitive you go to NY, not DC
- 2007: Six Wall Street investment banks write DOE they will not fund nuclear plants without Federal loan guarantees
- Nuclear now completely dependent on Federal backing to start a single project

Was Nuclear *EVER* Competitive?

Nuclear Optimism Vs. Reality

Estimate v. Actual Cost/kW in 2002\$ - w/o Financing Costs
By Year When Construction Started



Source: U.S. Energy Information Administration, converted to 2002\$ by MIT Paul Joskow

Nuclear Industry Cost Credibility:

Would You Hire this Contractor Again?

Was Nuclear *EVER* Competitive?

Examples of Problems Experienced in 1970's-1980's

- Bankruptcy – Public Service Company of NH
- \$2.25 billion bond default – Washington Public Power Supply System (WPPSS)
- Completed plants cost 2 - 4 times original estimates (EIA data)
- Over \$17 billion written off 1984-93 by utilities for abandoned plants and regulatory disallowances (Schlissel, Synapse Energy)

Was Nuclear *Ever* Competitive?

“Who Stopped U.S. Nuclear Power?”



- Not environmentalists – government policies always *favored* nuclear power
- Not Three Mile Island 1979 accident – cancellations already underway *before* accident
- Utility boards stopped nuclear expansion after money could no longer be raised from Wall Street, nuclear’s actual costs, risks evident
- Cheaper coal and natural gas have ruled for last three decades



(After More Than 30 Years with No Orders)

4 Strategies for Non Competitive Industries

1. Go Out of Business (did for > 30 yrs); or
2. Change so You are More Competitive; or
3. Become the Only Choice (Monopoly); OR
4. Ask for Taxpayer Dollars for Support

Nuclear Mega-Project

- Nuclear Cost is all about the cost of building the power plant
- Mega-Project: on-site construction of multi-billion-dollar reactors – no opportunity for factory mass production declining cost curve
- Planning & Siting 2-4 Yrs followed by 5-6 Year Construction Period
- Exposed to construction cost increases & financing costs over long period

KEY TERMS

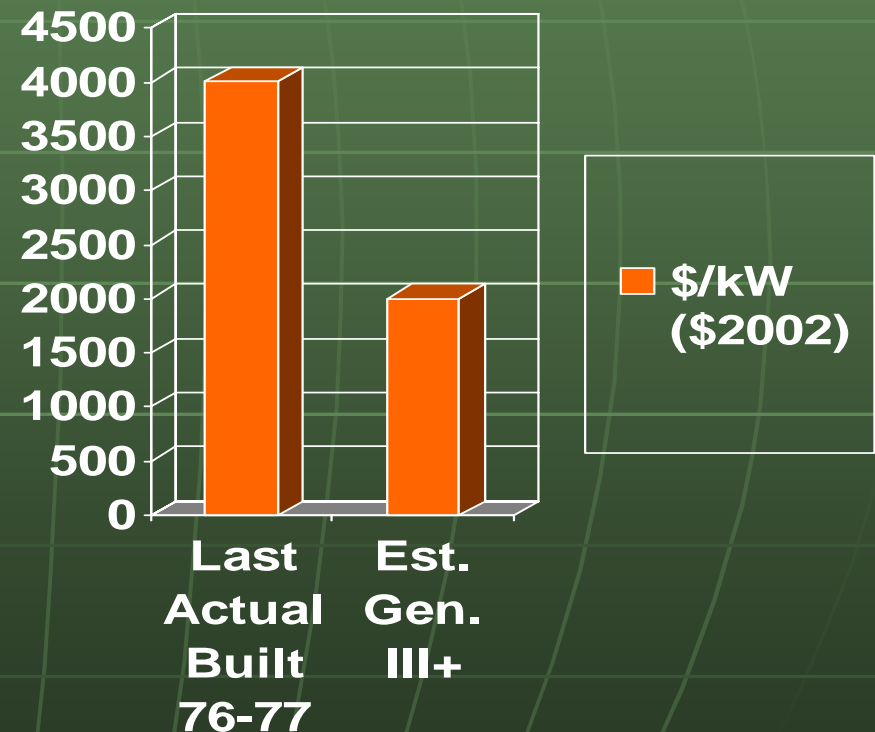
Major Costs of a Lengthy Construction Project

- “Overnight” Cost – “Brick & Mortar Costs” at *today's* prices
- “Escalation” – Next year’s “Brick & Mortar” will usually cost *more* than this year’s (do that for 10 year project)
- “Cost of Capital During Construction” – takes many years to build, so financing costs significant

Strategy #2 : “Change So You Are More Competitive” New Reactor Designs

- New Design Ideas
“Gen III+” reactors
- Less piping, wiring, pumps, valves etc.
- MIT expects new designs might CUT COSTS IN HALF compared to past
- Is this reduction in costs *enough*?

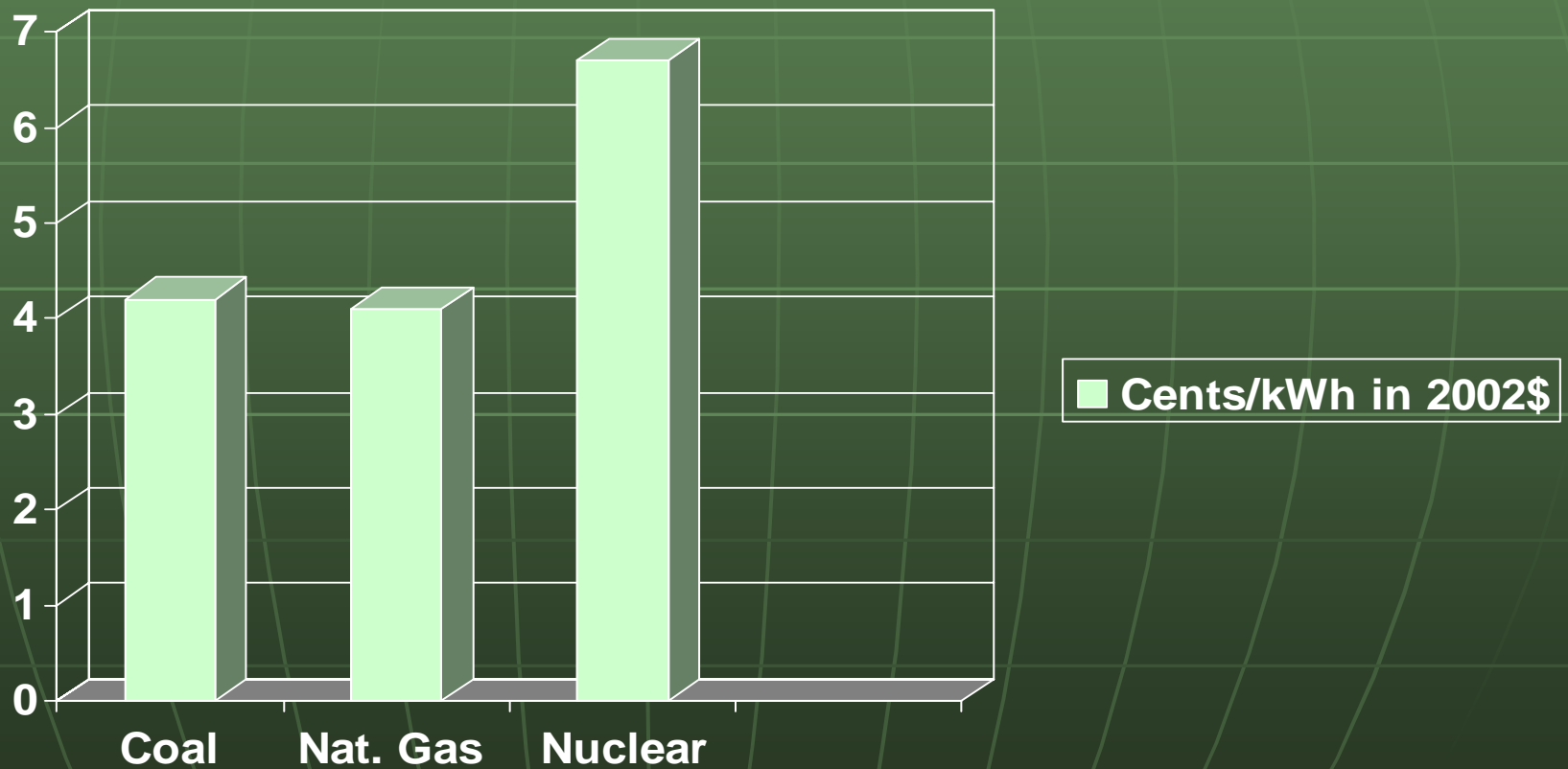
Old vs. New Designs (“Overnight” Costs w/o Financing or Escalations)



Source: MIT Estimates 2003

Will New Generation Nuclear Be Able to Compete?

MIT Study 2003
The Future of Nuclear Power
Base Case



MIT: Still “much more costly than coal and gas”

MIT Study 2003

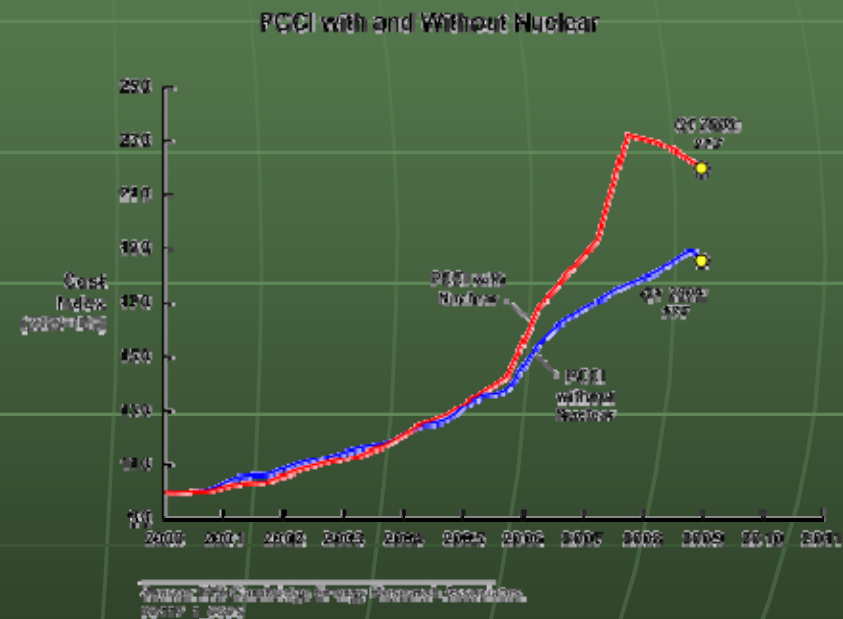
“The Future of Nuclear Power”

- “Today, nuclear power is not an economically competitive choice.”
- Needed to compete: *even lower* construction costs – 25% lower, down to only \$1,500/kW Overnight
- Results promoted as positive to nuclear because report said nuclear *might* be competitive – *if* its costs could go *down*

Nuclear Needed *Lower* Construction Costs BUT Power Plant Construction Costs More than Doubled

- Driven by rapidly expanding economies e.g. China, India, Brazil
- MIT New Nuclear 2002\$ = \$2,000/kW "Overnight" Cost
- New Nuclear 2007\$ > \$4,000/kW "Overnight" cost (Florida Power & Light estimates)

Power Capital Costs Index 00-09 Q1



Source: Cambridge Energy
Research Assoc. Press Release
Jun 23, 2009

Example of New Nuclear “All-In” Cost to Build “Low Cost” Case

- “Overnight” Cost: \$ 3,596/kW
- Escalations in Costs: \$ 2,637/KW
- Cost of Capital: \$ 2,625/kW
- “All-In” Costs \$ 8,858/kW

Total Cost for 2,234 MW 2-Unit New Nuclear Facility
\$19.8 Billion

Wall Street assessment:

“Nuclear’s ‘bet the farm’ risk” – Moody’s

Putting Numbers in Perspective

- 2 Reactor New Facility: \$19.8 Billion
- 100 New Nuclear Reactors: \$1 TRILLION
- Is this the best use of a Trillion dollars?
- What could a Trillion dollars achieve if spent on *other* energy solutions?

Paying off The Nuclear Plant

- \$19.8 Billion Cost (\$8,858/kW)
- Capital Recovery Factor = 14.57%/Yr
- $\$8,858/\text{kW} \times .1457 = \$1,290/\text{kW}/\text{Yr}$
- $\$1,290/\text{kW}/\text{Yr}$ for 7,446 kWh per yr =

$\$.17/\text{kWh}$

This is just the Capital Cost

Total Costs of Nuclear Generation “Low Cost” Case

■ Capital Recovery Cost	\$.17/kWh
■ O&M, Property Taxes	\$.03/kWh
■ Decomm/Waste	\$.02/kWh
■ Fuel Cycle Costs	<u>\$.03/kWh</u>
TOTAL (\$/kWh)	\$.25/kWh

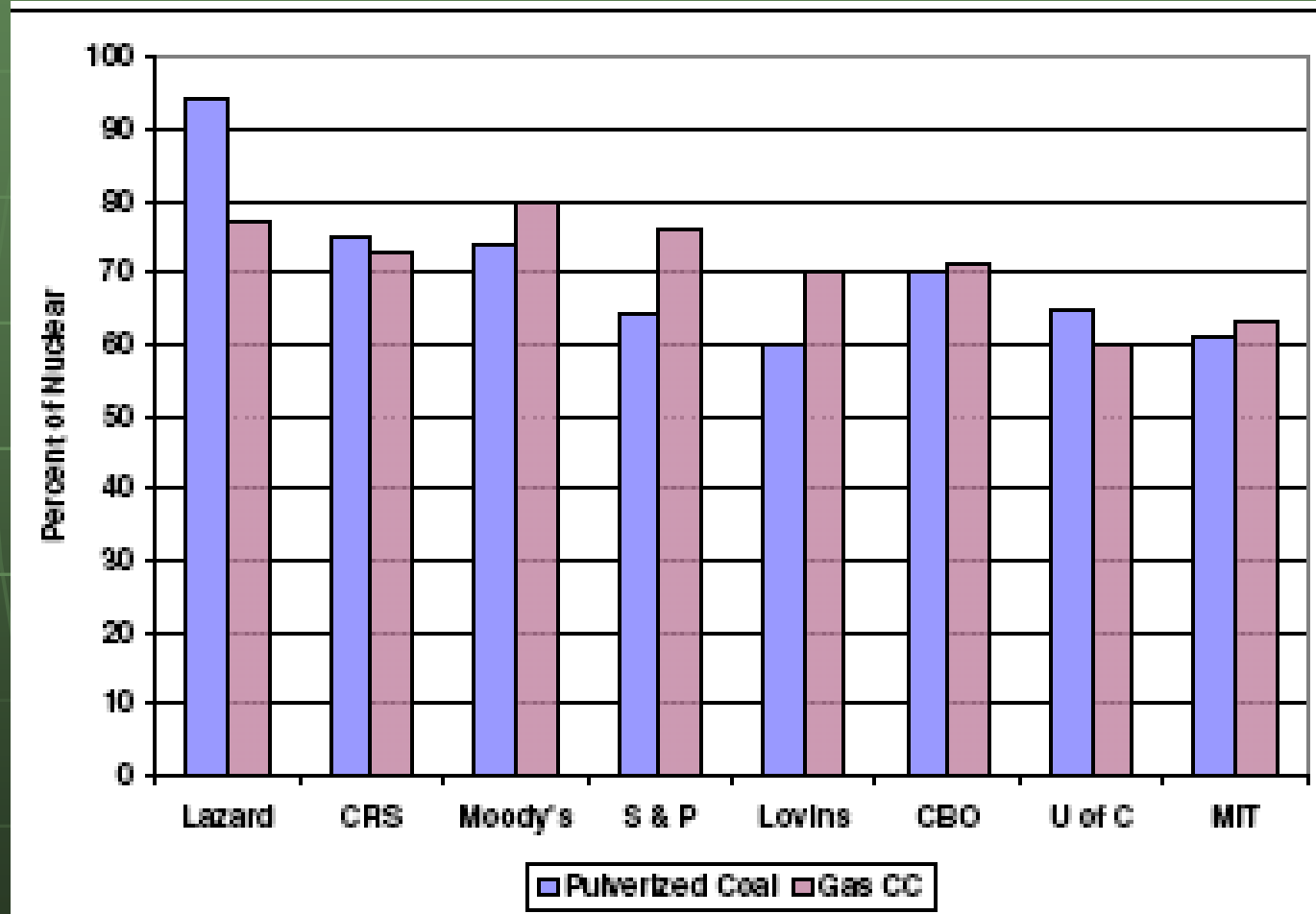
1st Yr of Operation (2018\$); 2008\$ approx. \$.18/kWh

Very High Costs/kWh

Will Customers Willingly Pay This Much?

New Nuclear Still Loses Against Coal and Natural Gas

Coal & Natural Gas Costs as % of Nuclear Cost

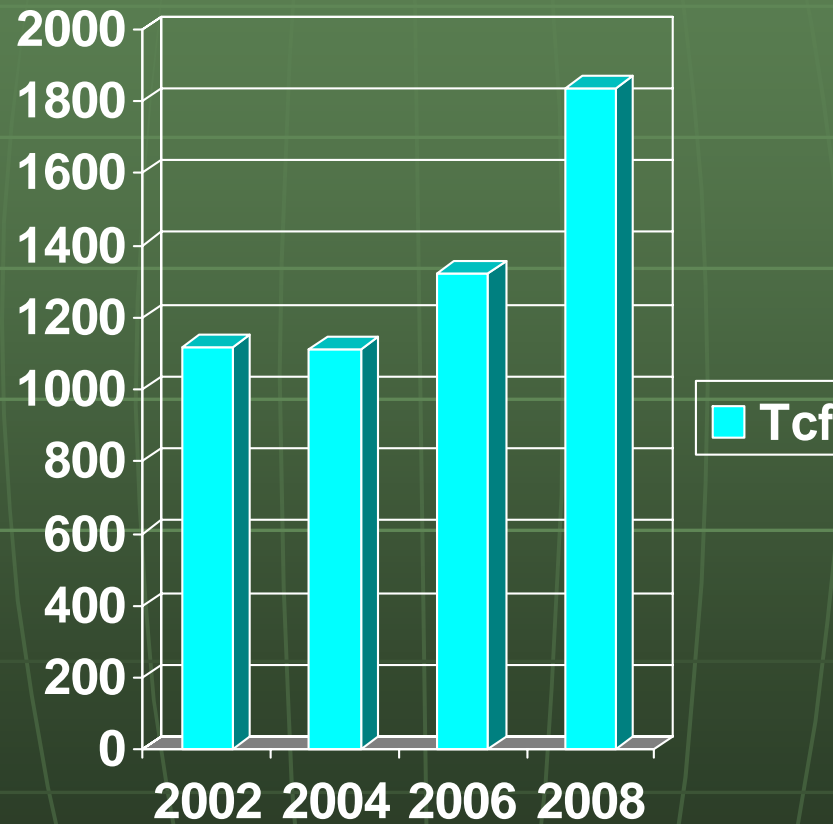


Source: Cooper, Mark "The Economics of Nuclear Reactors: Renaissance or Relapse", June 2009

Strategy #3: “Become the Only Choice (Monopoly)” (2003 Thinking)

- Global warming may eliminate coal as competitor
- U.S. natural gas supplies seemed limited and volatile in cost
- If coal and natural gas are out – “what else *but* new nuclear power?”
- Limited experience with energy efficiency, Smart Grid, renewable sources

“Game Changer” - U.S. Natural Gas Supply Greater than Expected



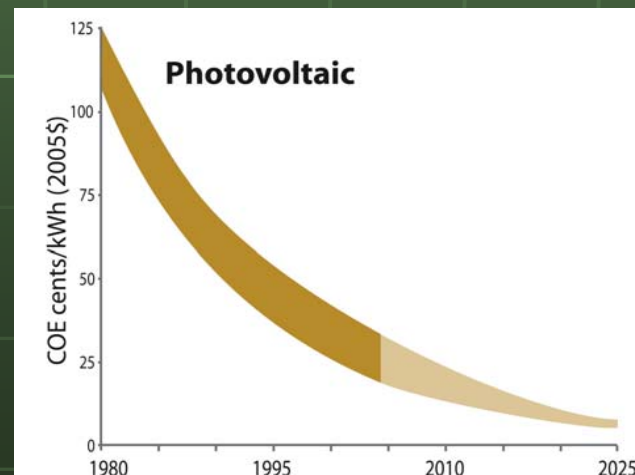
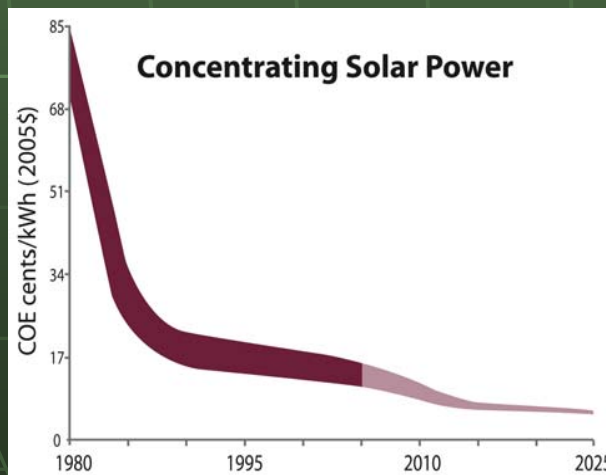
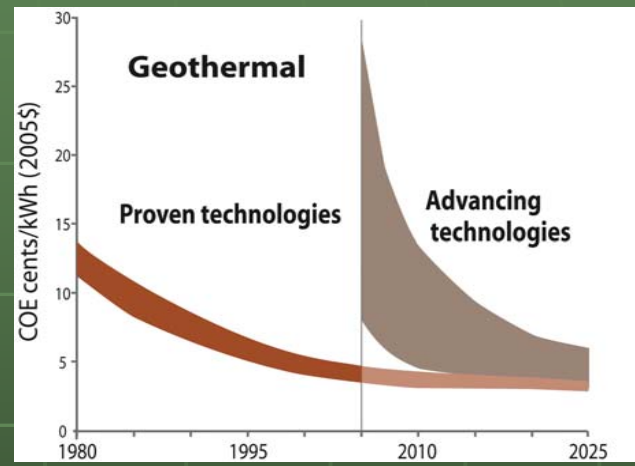
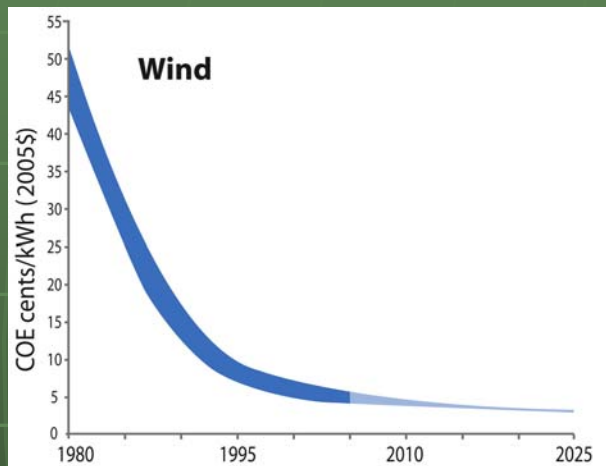
Source: Potential Gas Committee/CO School of Mines

Competition To New Nuclear Strong & Viable

- U.S. natural gas – enormous new deposits, less than $\frac{1}{2}$ the CO² emissions of coal
- Wind – adds 23,521 MW since 2003, low cost energy
- Geothermal & Biomass— low cost, 24/7 power
- Solar thermal/natural gas hybrid plants – 24/7 power, costs lower than new nuclear
- Energy efficiency, Smart Grid – new future for electric utilities
- Utility scale energy storage – goes mainstream, now commercially available

Renewable Energy Cost Trends

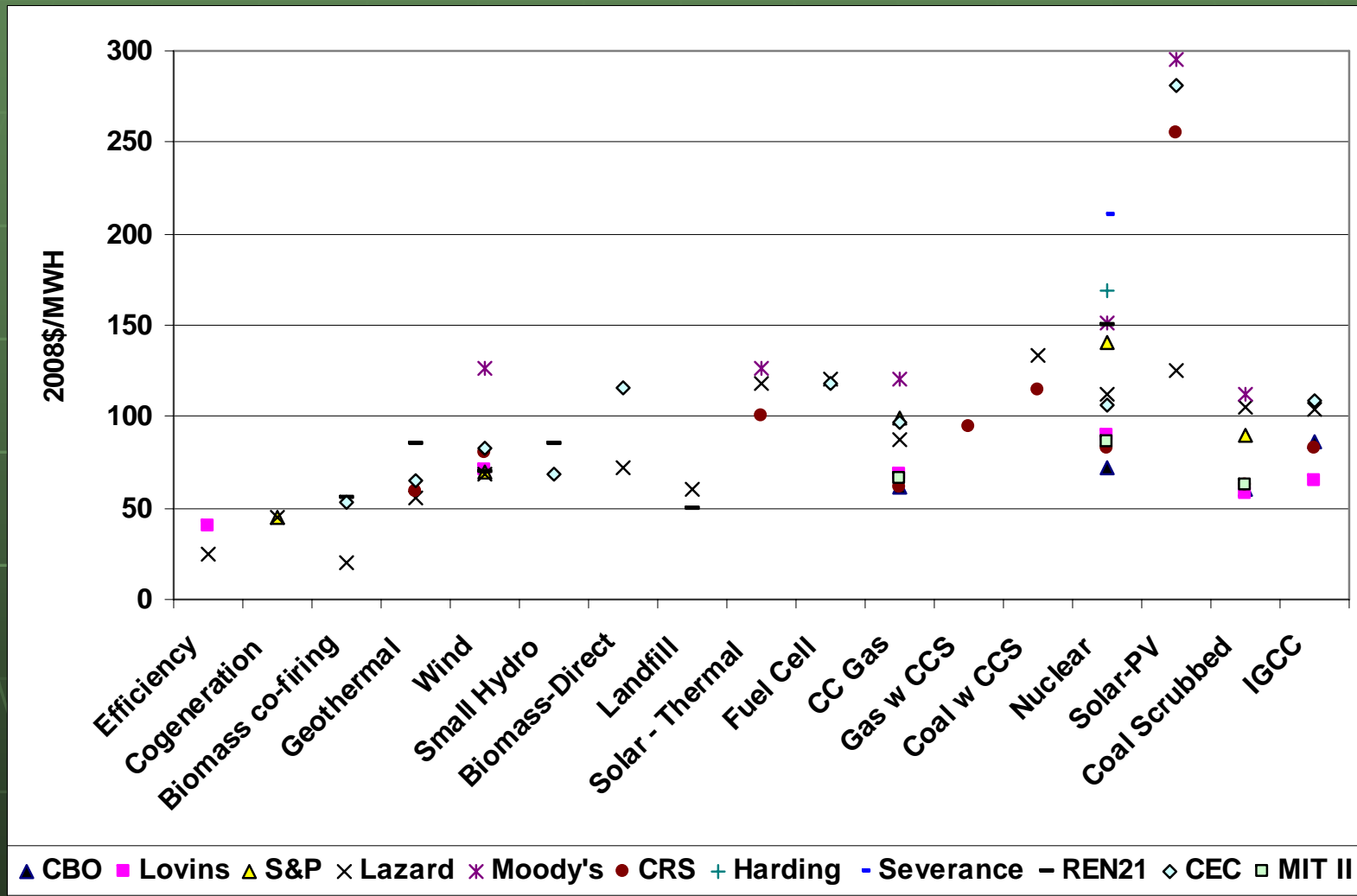
Advantage of FACTORY MADE Mass Production Cost Curves
– Renewable Portfolio Standards Achieve Desired Goal –



Source: NREL Energy Analysis Office (www.nrel.gov/analysis/docs/cost_curves_2005.ppt)

Levelized cost of energy in constant 2005\$

Comparative Costs of Power Latest Studies



Source: Mark Cooper, Sr. Fellow for Economic Analysis, Institute for Energy and the Environment, Vermont Law School, July 2009

When Can We Stop Subsidies?

- **Wind** Production Tax Credit (PTC) – **Expires 2013**
- **Other Renewables** PTC – **Expire 2014**
- **Solar** Tax Credits – **Expire 2017**
- **Nuclear** – When *can* it stand on its own??

Strategy #4: “Ask for Taxpayer Dollars for Support”



Nuclear Power Subsidies From Taxpayers

1. Loan Guarantees – Public *Covers Losses*
2. Per Kwh Production Tax Credits – through 2029
3. Subsidies for fuel cycle i.e. enrichment; mine and reprocessing cleanups
4. Billions for R&D
5. Taxpayers responsible for nuclear waste – *“back to square one”* – still no solution after billions wasted on failed Yucca Mountain
6. Industry pays only 1/10 of a cent per kWh for nuclear waste, actual costs likely 6 times higher (Source: analysis of Moody’s Data)
7. Inadequate reserves for decommissioning/ends as public burden

French “Example”

- Socialist/Nationalized Utility
- Government Adopted & Supported
- Areva in cash flow crunch, on Standard & Poors credit watch, asking French taxpayers for billions
- Electricite de France (EdF) raided by European Union officials investigating price fixing in electricity markets

Jerry Taylor (Cato Institute): “How do France, India, China, and Russia build cost-effective nuclear power plants? *They don't.* Government officials in those countries, not private investors, decide what is built. Either these governments build expensive plants and shove them down the market's throat - or they build shoddy plants and hope for the best.” *“Nuclear Energy: Risky Business”, October 22, 2008*

Prudent Path for Utilities Now

- Adopt “least cost” strategies - \$500 energy saving rebate could save \$10,000 new power plant construction
- With economy and demand uncertain, use shorter-lead-time plants – can wait longer to commit. 2 years to build a natural gas or wind turbine, solar project instead of needing to start 10 years ahead of time for nuclear project
- Use natural gas load-following and peak plants) to cheaply guarantee capacity so lights stay on (kW)
- Use others (e.g. wind, solar PV) to generate energy (kWh) and cut fossil fuel use by traditional power plants
- Share resources across country – natural gas, transmission