Coal's Future – IGCC and Carbon Sequestration?

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Coal Gasification Topics

- IGCC cost – varies with coal type but it is greater than conventional coal
- Technical or political problems - reliability and drivers for using IGCC are unclear (e.g., CO2)
- Regulatory or market problems – incentives will be needed to get early plants built and reduce risk
- Carbon Sequestration – the issue for CO2 capture is **cost and energy use** but the technical issue is how to dispose of it

Integrated Gasification Combined Cycle

- IGCC may become the coal technology of choice
  - Low emissions
  - High efficiency
  - Best for CO_2 capture on Bituminous coal
- Key enabling technology for future coal-based power
- Ability to co-produce hydrogen adds potential for:
  - Clean transportation fuel
  - Significant reduction of green house gas emissions
- But questions remain – cost, reliability

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IGCC Environmental Attributes

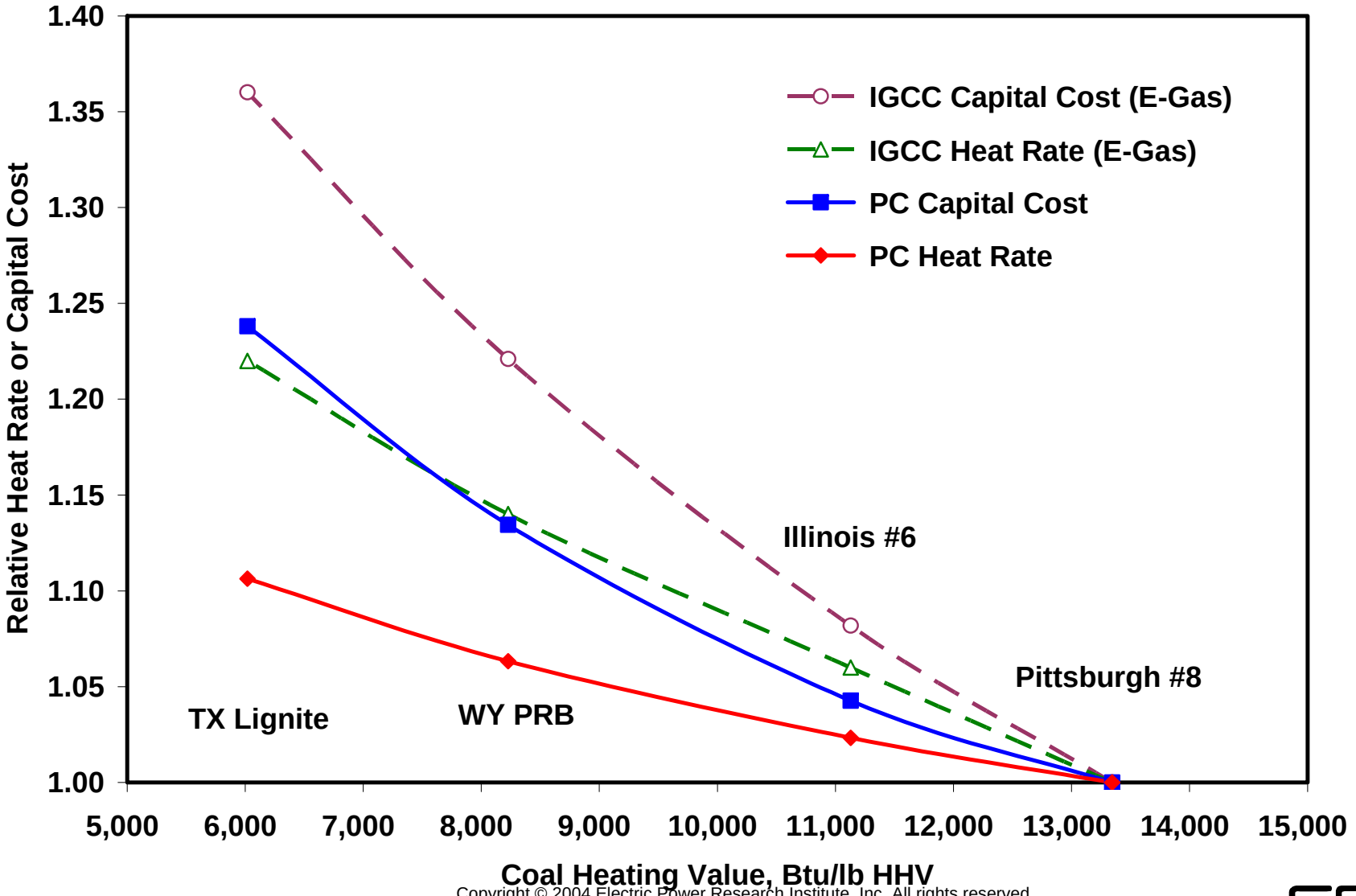
- Sulfur is removed (99.5-99.99%) from syngas
- NOx emissions are controlled by firing temperature modulation in the gas turbine with SCR possible
- Particulates are removed from the syngas by filters and water wash prior to combustion so emissions are negligible
- Current IGCC design studies plan <3ppmv each of SOx, NOx and CO
- Mercury and other HAP's removed from the syngas by absorption on activated carbon bed
- Water use is lower than conventional coal
- Byproduct slag is vitreous and inert and often salable
- CO2 under pressure takes less energy to remove

Cost and Performance for 500 MW Power Plants

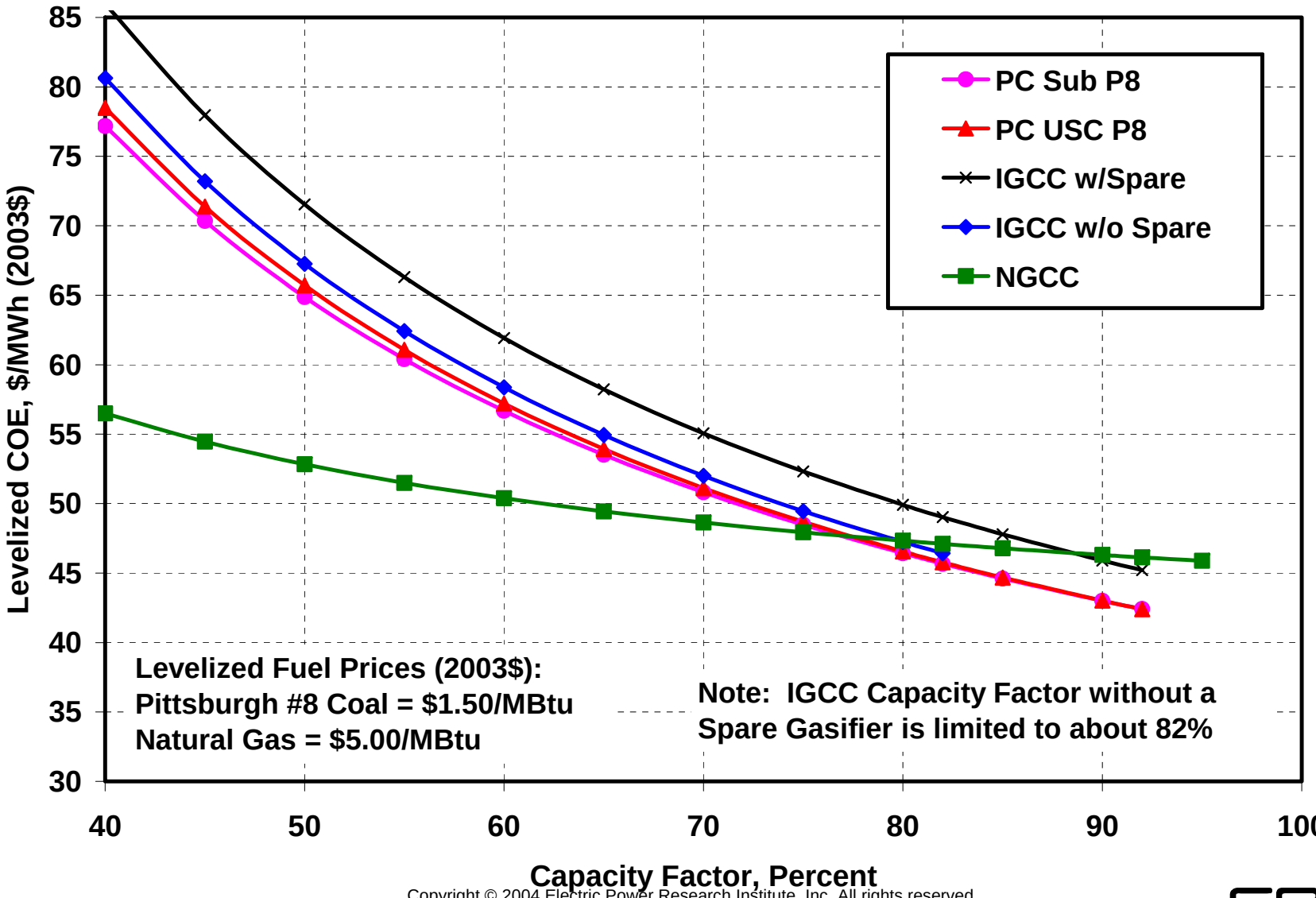
Pittsburgh #8 Bituminous Coal –for National Coal Council Report

	PC Subcritical	PC Supercritical	IGCC (E-Gas) Spare/No Spare	NGCC
Total Plant Cost, $/kW	1,230	1,290	1,350/1,250	440
Total Capital Requirement, $/kW	1,430	1,490	1,610/1,490	475
Fixed O&M, $/kW-yr	40.5	41.1	56.1/52.0	5.1
Variable O&M, $/MWh	1.7	1.6	0.9	2.1
Ave. Heat Rate, Btu/kWh (HHV)	9,300	8,690	8,630	7,200
Capacity Factor, %	80	80	80	80/40
Levelized Fuel Cost, $/MBtu	1.50	1.50	1.50	5.00
Levelized COE, $/MWh (2003$)	46.5	46.6	49.9/47.2	47.3/56.5

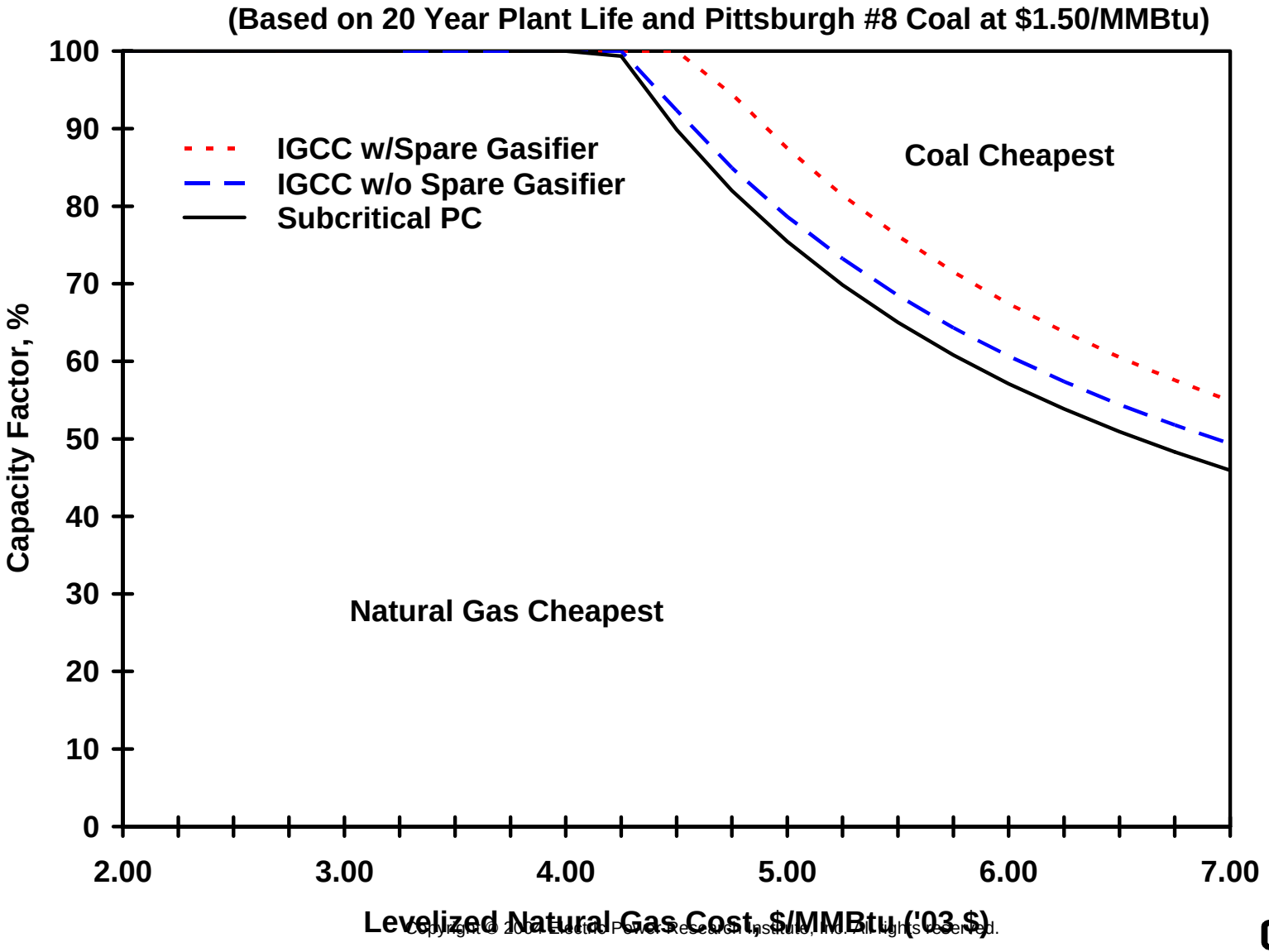
Effect of Coal Quality on PC and IGCC Plant Heat Rates and Capital Cost



Impact of Capacity Factor on Levelized COE

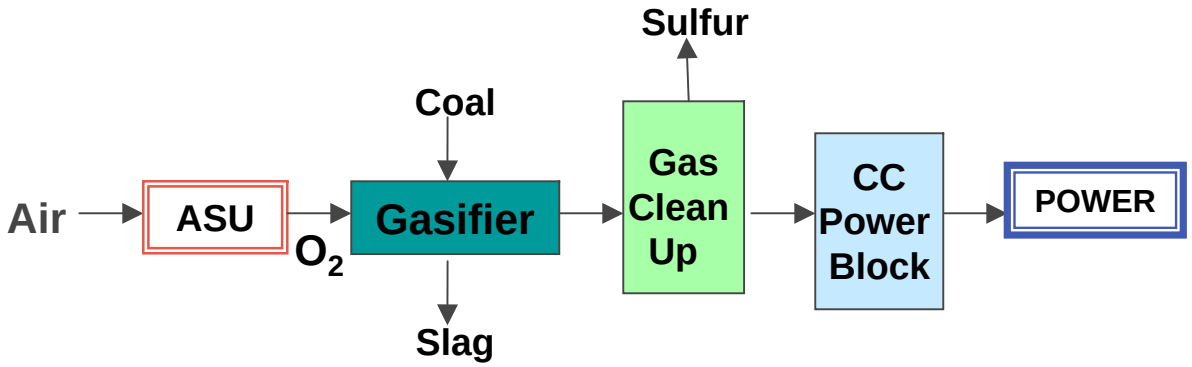


Breakeven Capacity Factor and Fuel Cost for Natural Gas vs Coal



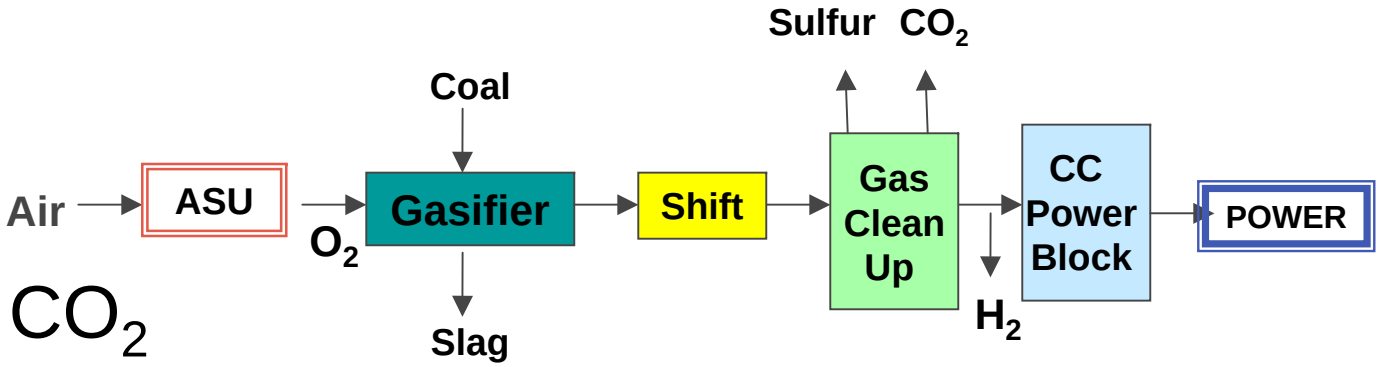
IGCC With and Without CO_2 Removal

IGCC



H_2 & CO_2

(e.g.,FutureGen)



Adds roughly 30-40% to COE to capture and compress CO2

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Coal IGCC – Status and Issues

- **Very low SO_2, NOx, and Particulate Emissions** below recent PC plants permit limits
- Global E Gas(CoP), Texaco(C-T- soon to be GE), Shell and Prenflo (Now Shell) gasifiers successfully **demonstrated at commercial size**
- **Cost is the big barrier**
- Existing single gasifier “train” **IGCC coal plants (no spare) have not yet achieved their yearly availability targets of 85%–** although on a quarterly basis the targets have been achieved. Commercial plants with spare gasifiers should achieve >90% availability.
- The **high degree of Integration used in the European IGCC plants is not recommended** for new IGCC plant designs
- IGCC is currently being **commercially used** in many plants worldwide based on the **gasification of petroleum residuals** providing power, steam and hydrogen.
- **Future advances** in air separation, gasification, gas clean up, gas turbine and fuel cell technologies **will improve efficiency and lower cost**

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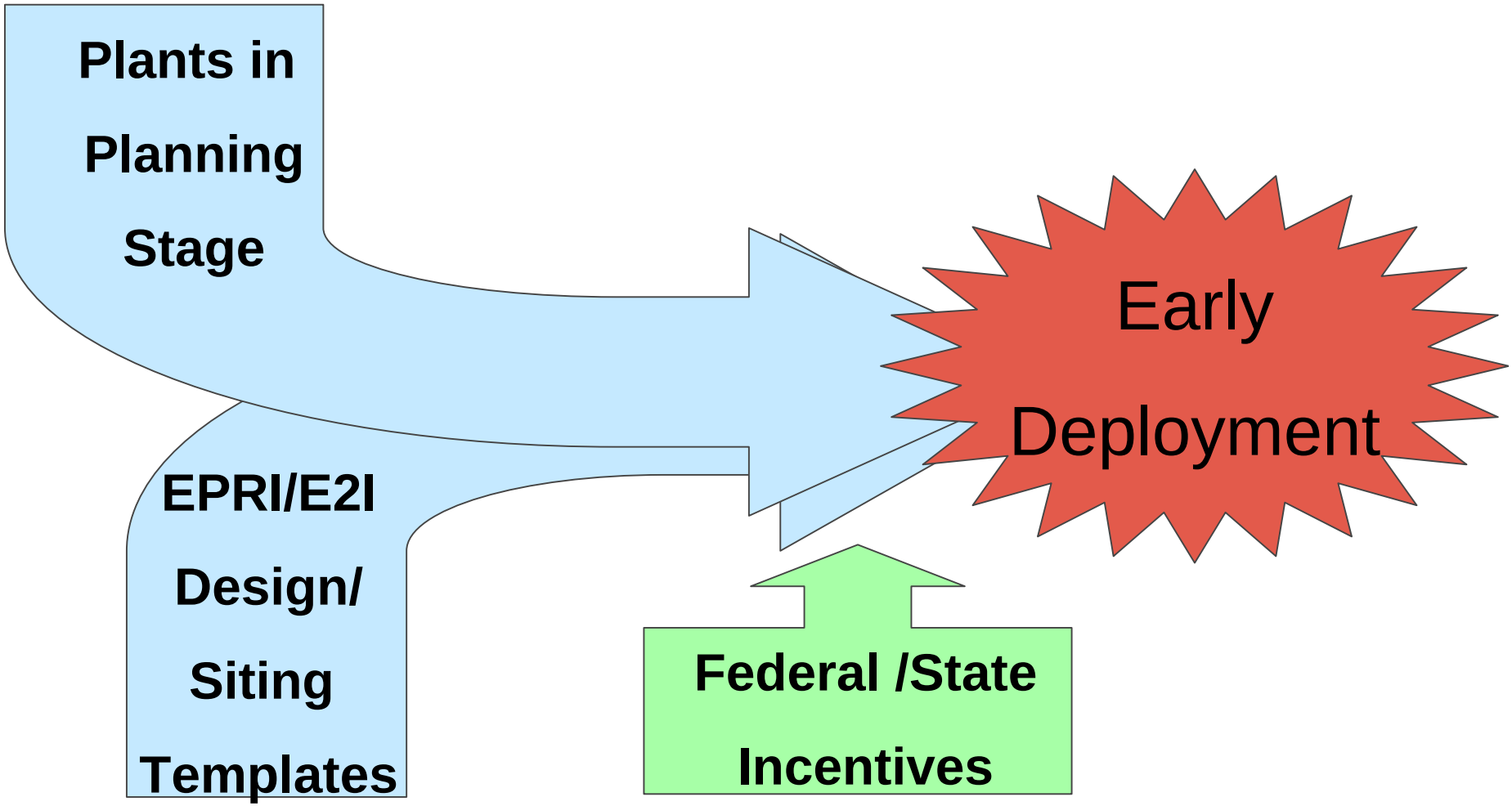
New IGCC Deployment Efforts

- Current efforts are underway to reduce the risk and financing costs
- Several Groups are discussing incentives for IGCC use
  - Gasification Technologies Council
  - Harvard
  - IGCC Coalition
  - Coal Utilization Research Council
- DOE Office of Policy is analyzing risk and looking to aim incentives use federal funds for highest impact
- EPRI and E2I's new collaborative effort **"CoalFleet for Tomorrow"** (includes CO2 consideration)

EPRI/E2I CoalFleet for Tomorrow Advanced Coal Plant Partnership

- Kickoff workshop with 70 attendees April 13-14
  - Sense of urgency
  - Window of new coal opportunity 2008-12 …will it be more of the same?
  - **There is no "silver bullet" technology**
- Organizing Committee formed
- First Phase of work in 1 year
- Three elements of work
  1. **Analysis of incentives, finances, technology impact, and risk (aimed at deployment)**
  2. **Design templates (by fuel, region, type of company)**
  3. **R&D gaps and acceleration needs**

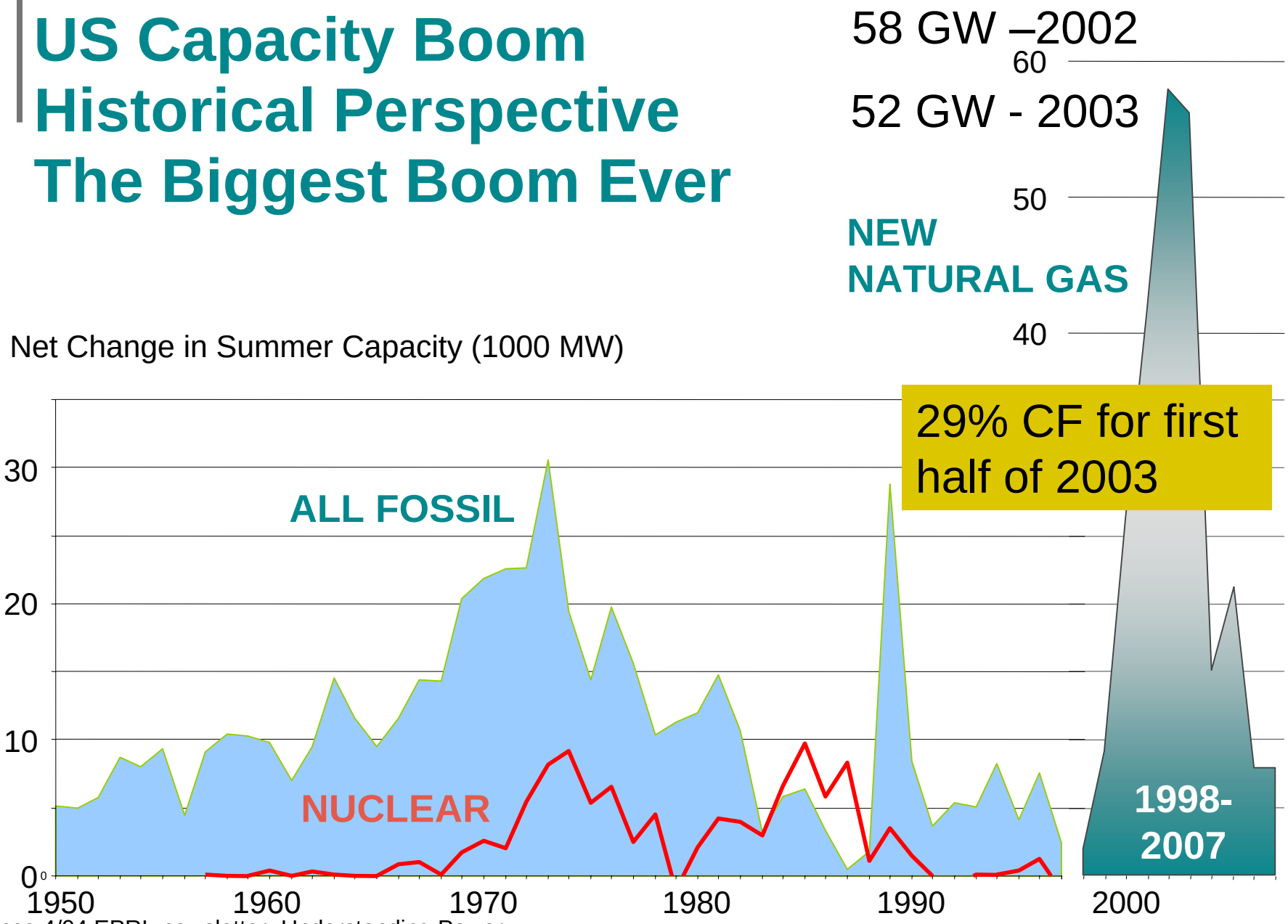
CoalFleet for Tomorrow
- A Partnership to Secure Americas Energy Future



IGCC – Summary and Conclusions

- **The driver for coal is low fuel cost, and not capacity needs in many areas since new natural gas capacity has been built (but it is not always running due to fuel cost.)**
- **IGCC is more expensive and less reliable today than conventional coal firing**
- **Environmental advantages are clear and costs should come down as new plants are built and improved designs become standard**
- **To get early plants "on the ground" incentives are being debated at the federal level, and federal/state "covenants" to share risk have been proposed**

US Capacity Boom
Historical Perspective
The Biggest Boom Ever



Reference 4/04 EPRI newsletter- Understanding Power & Fuel Markets

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Natural Gas and Power Reliability: A Vital Concern

- Even with a reduction in planned additions, gas-fired capacity continues to grow
- It will be difficult to maintain even existing levels of production with conventional resources
- Supplies will have to increase by 8 trillion cubic ft/yr to meet post-2010 projections
- Most US Hydrogen is made from natural gas
- LNG, coal bed methane, North Slope gas, deep offshore gas and Canadian gas is not enough

Reference EPRI Report 1008328 Gas Supply: Outlook for Critical New Sources to Meet Growing Gas Requirements 1/04

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