

# Utility Perspectives on Carbon Capture and Storage

California Carbon Capture and Storage Review Panel

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June 2, 2010

# Important Factors to be Considered in CCS Future Planning

The collage consists of four panels:

- Top Left:** A line graph titled "Springville AZ, One Day at 10 Second Resolution" showing power output (kW) fluctuating between 2000 and 4000. Next to it is a photograph of a large industrial pipe.
- Top Right:** A cross-sectional diagram of the ground showing various layers and wells. Labels include: "Accumulation in water of deep, stably stratified lake", "Wetlands", "Lake", "Water table", "Vadose zone", "Accumulation in topographic depression", "Abandoned well", "Shallow groundwater well", "Off gas from well", "Accumulation in basement", "Oil well", "CO<sub>2</sub> injection well", "CO<sub>2</sub> direct to air", "Casing corrosion", "CO<sub>2</sub> in low permeability environment", and "Caprock".
- Bottom Left:** An aerial photograph of the Edwardsport IGCC plant. Text overlay reads: "Edwardsport IGCC", "The project's scale and complexity has added approximately \$530 million to the previously approved \$2.35 billion cost.", and "Monday, Apr 19, 2010".
- Bottom Right:** A map of the United States with a large orange question mark over the central and southern regions. A large dollar sign (\$) is positioned to the left of the map.

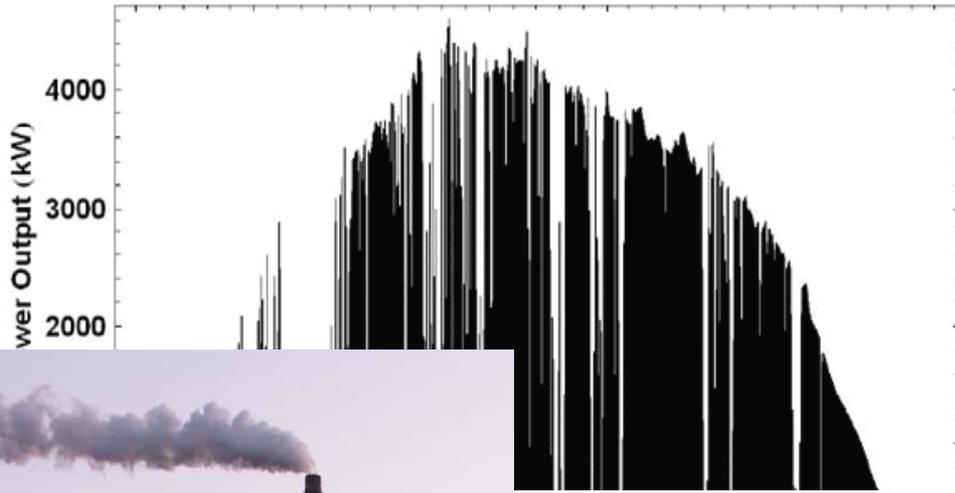
The Technology

The Vulnerabilities

The Costs

The Financing

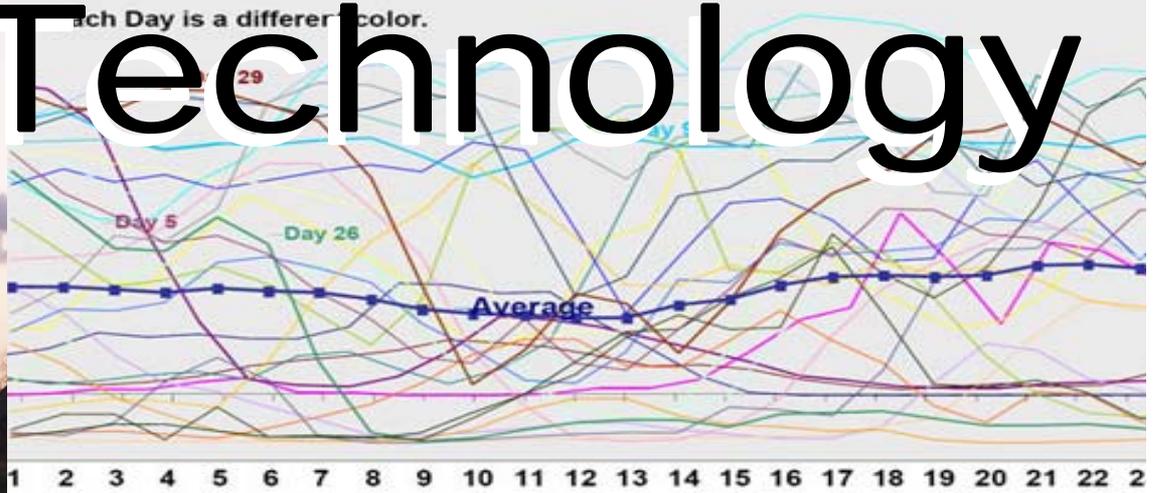
Springerville AZ, One Day at 10 Second Resolution



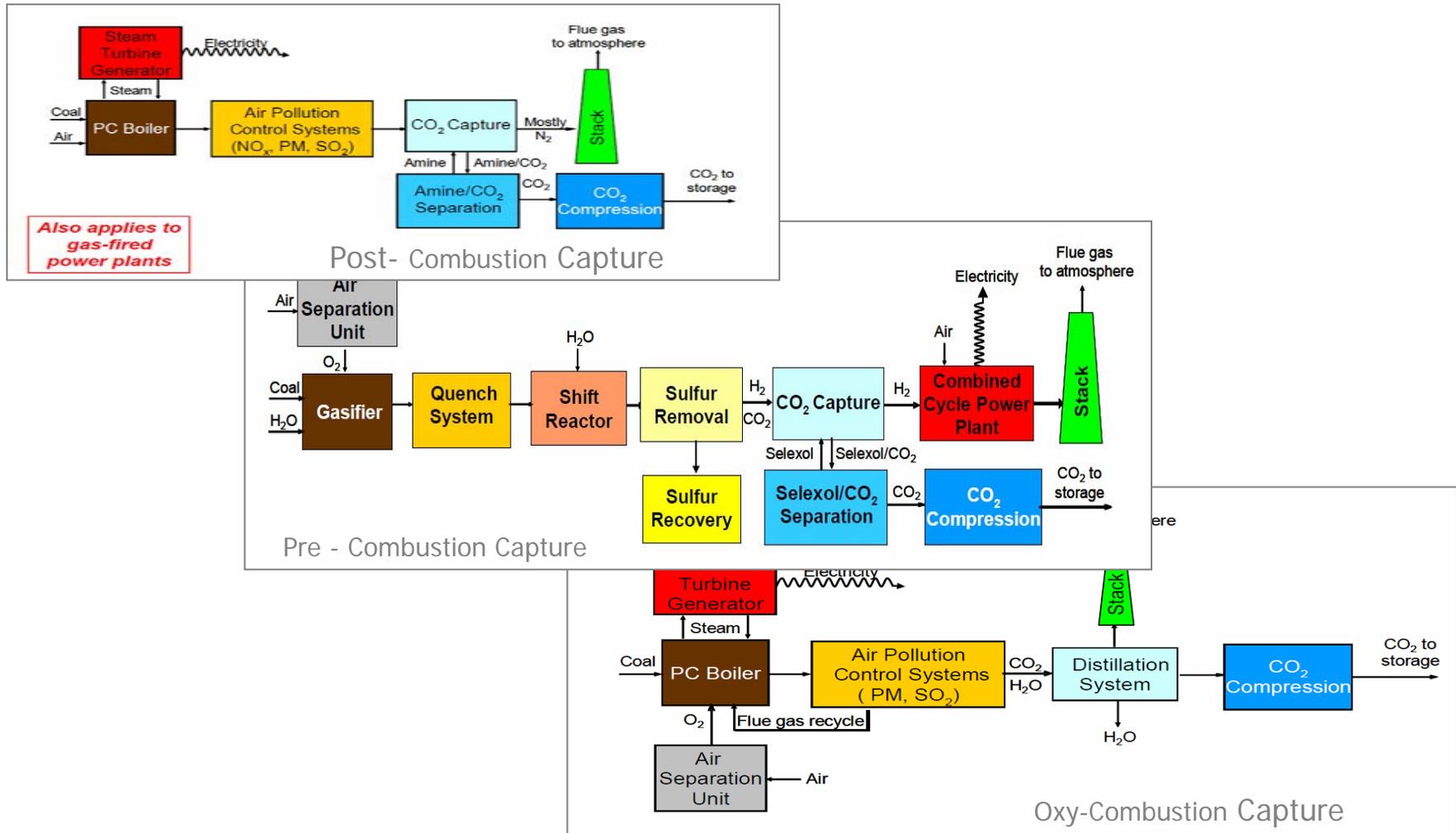
Increasing levels of intermittent resources will require increasing levels of ramping resources or storage



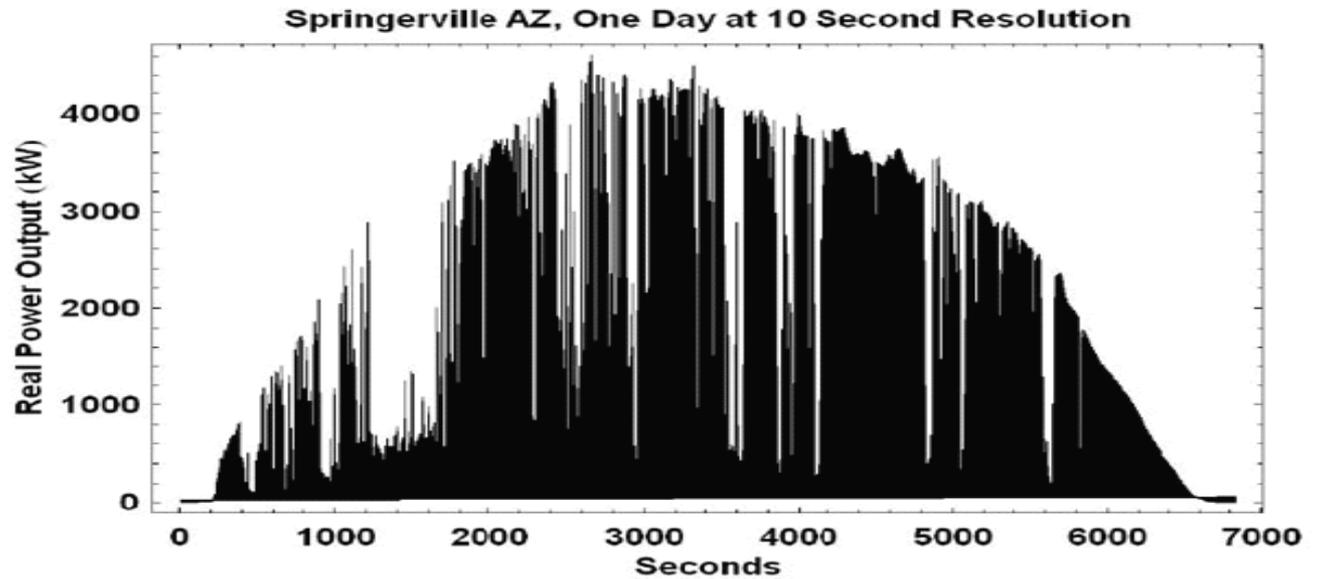
# The Technology



# Predominant CCS Technologies are Steady-State

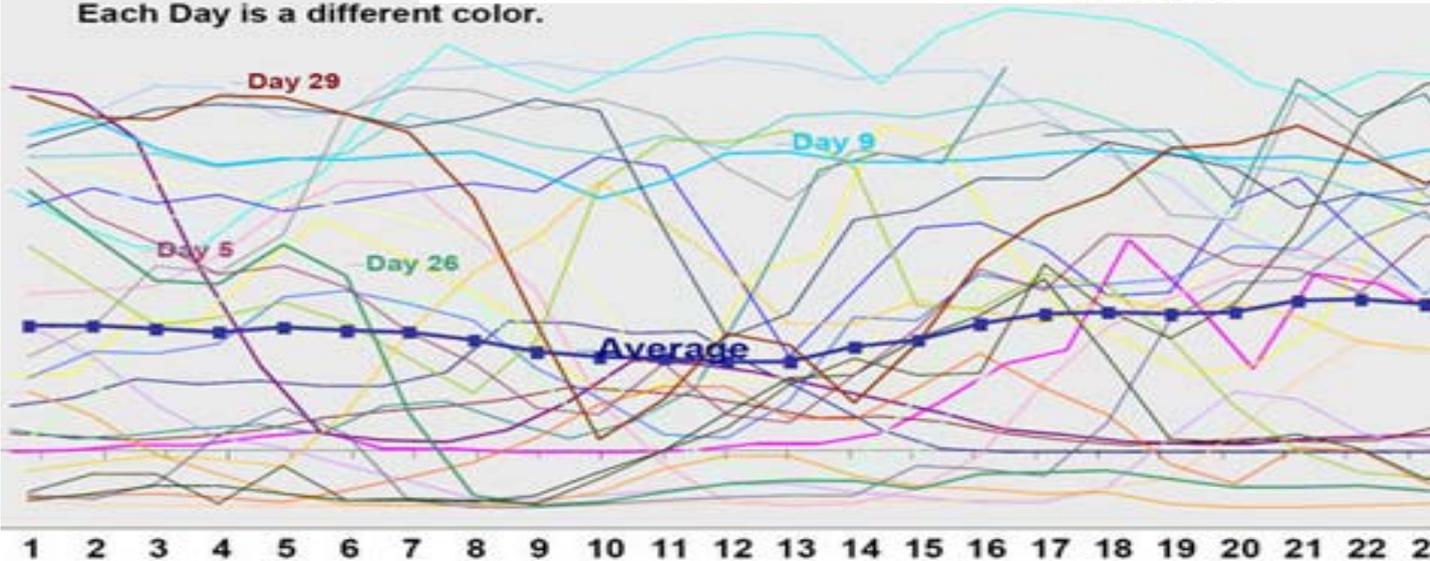


# Renewable Technologies are Intermittent

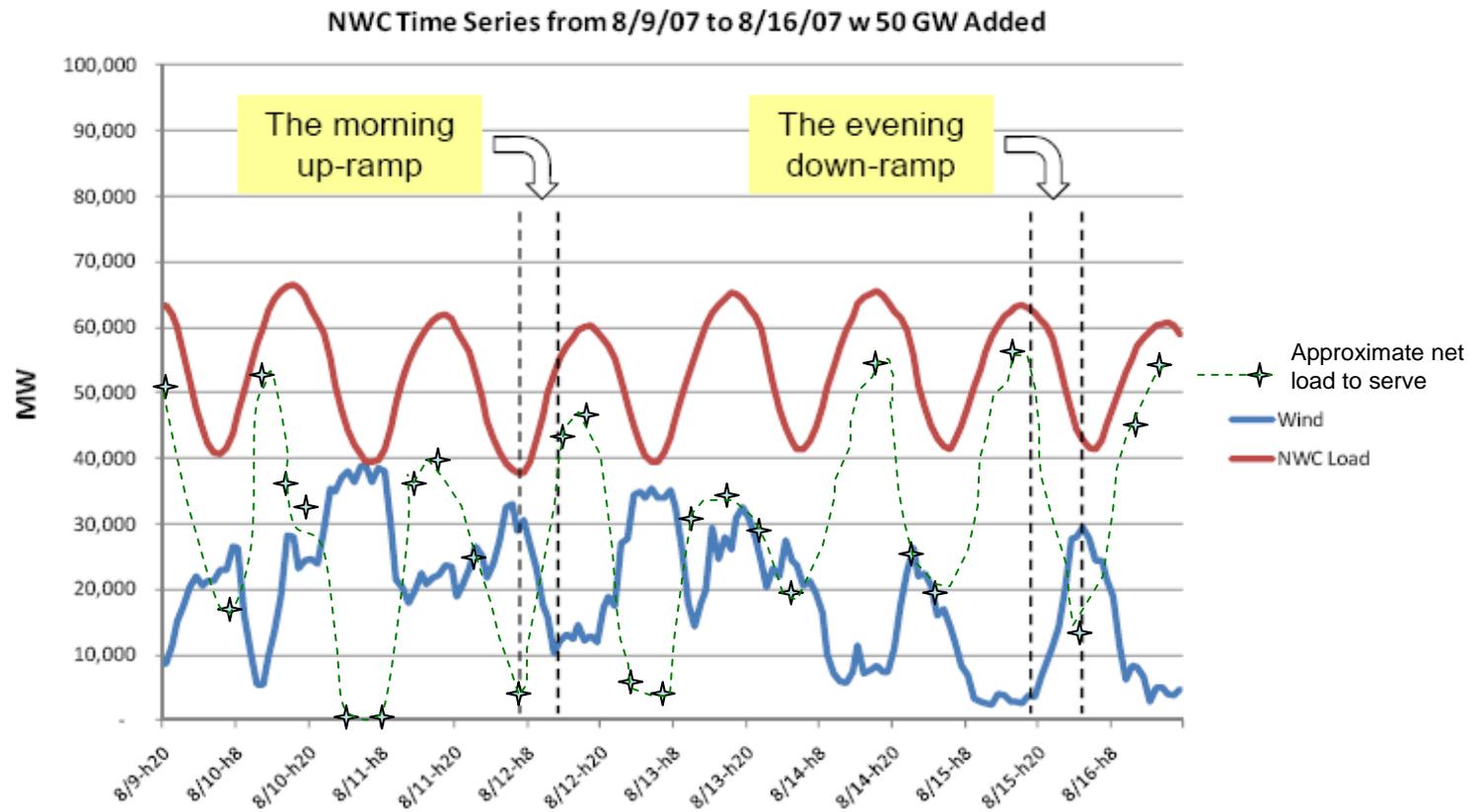


## CAISO Wind Graph

Each Day is a different color.



# CCS Will Likely Need to Operate Flexibly: Anti-correlation of Wind with Load Creates a Ramping Challenge (e.g., 50GW of wind in Northwest Central US)



# Integration Requirements of Steady-State CCS may Exacerbate an Already Known Integration Need

## Requirements for Integration of Renewables



Wind Generation

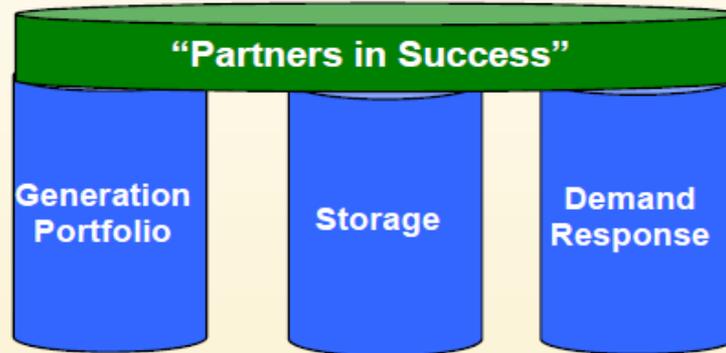


Solar Generation

Resources Required for Renewables Integration



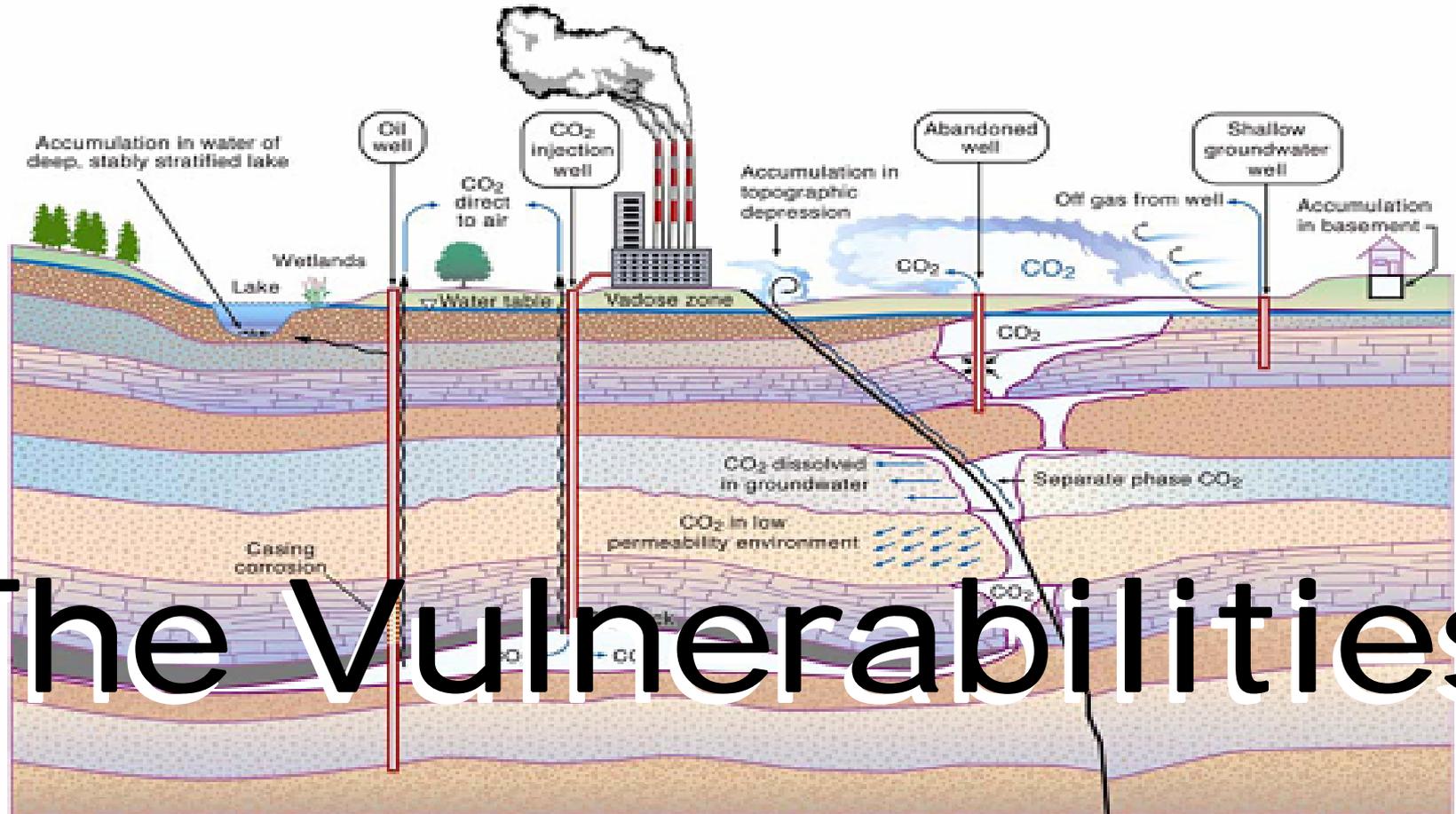
Hydro Generation



Quick Start Units  
Fast Ramping  
Wider Operating Range (lower  $P_{min}$ )  
Regulation capability

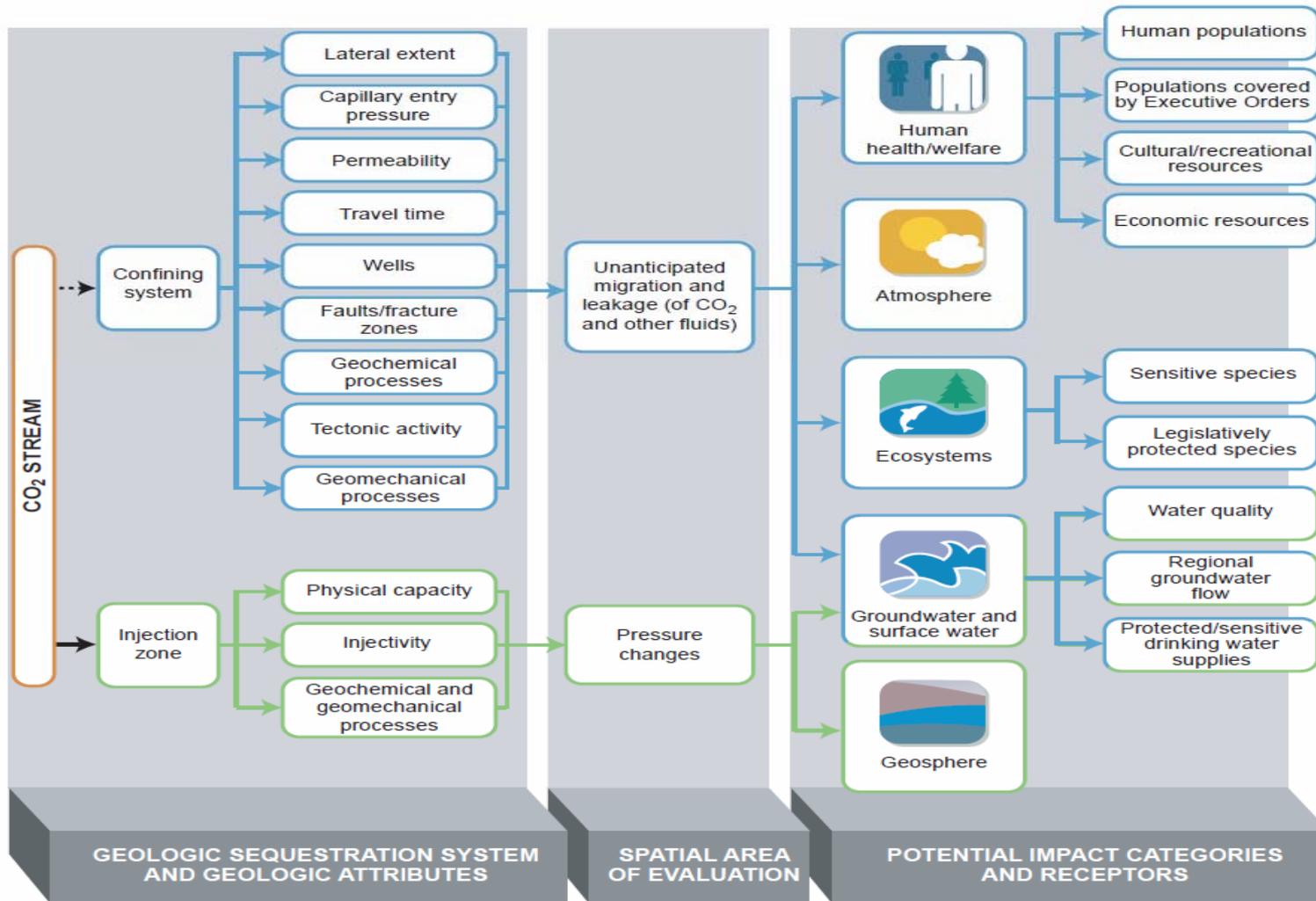
Shift Energy from off-peak to on-peak  
Mitigate Over Generation  
Voltage Support  
Regulation capability

Price sensitive load  
Responsive to ISO dispatches  
Frequency Responsive  
Responsive to Wind Generation Production



# The Vulnerabilities

# Methods Exist to Identify, Assess, and Value – Much Work and Experience is Still Ahead



[http://www.epa.gov/climatechange/emissions/downloads/VEF-Technical\\_Document\\_072408.pdf](http://www.epa.gov/climatechange/emissions/downloads/VEF-Technical_Document_072408.pdf)

# As with Other Technologies, Initial Deployments Bear the Costs of Unknown Risks and Consequences

Gathering and dispersing increasing amounts of technical, behavioral and experience data will expedite risk assessment, contingency planning, and valuation

## **RISK MANAGEMENT TOOL**

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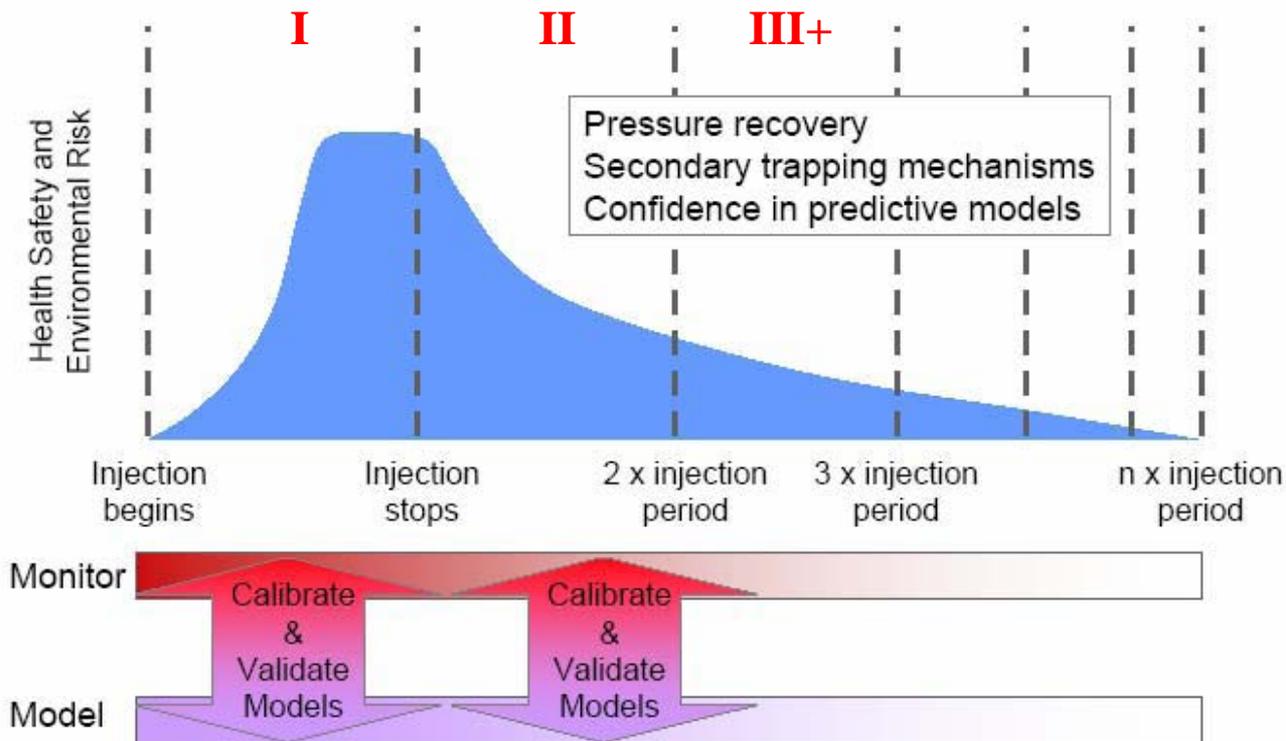
The table below summarizes the risks identified shows a mechanism to be used to document, assess, and track the mitigating actions taken for risks identified and managed throughout the life of the project.

<b>Item</b>	<b>Category</b>	<b>Describe Risk</b>	<b>Probability of Occurrence (H/M/L)</b>	<b>Impact (H/M/L)</b>	<b>Mitigation Measures</b>	<b>Contingency Measures</b>
1						
2						
3						

# The Move from *Expected* to *Experienced* will Shape Commercial Solutions for Risk Management



Quantitative Assessment of Long Term Liability and Risk Management Strategies



Source: Sally M. Benson, Stanford University  
<http://pangea.stanford.edu/research/bensonlab/presentations/Is%20CCS%20Ready%20for%20Prime%20Time.pdf>

# The Costs

## Edwardsport IGCC

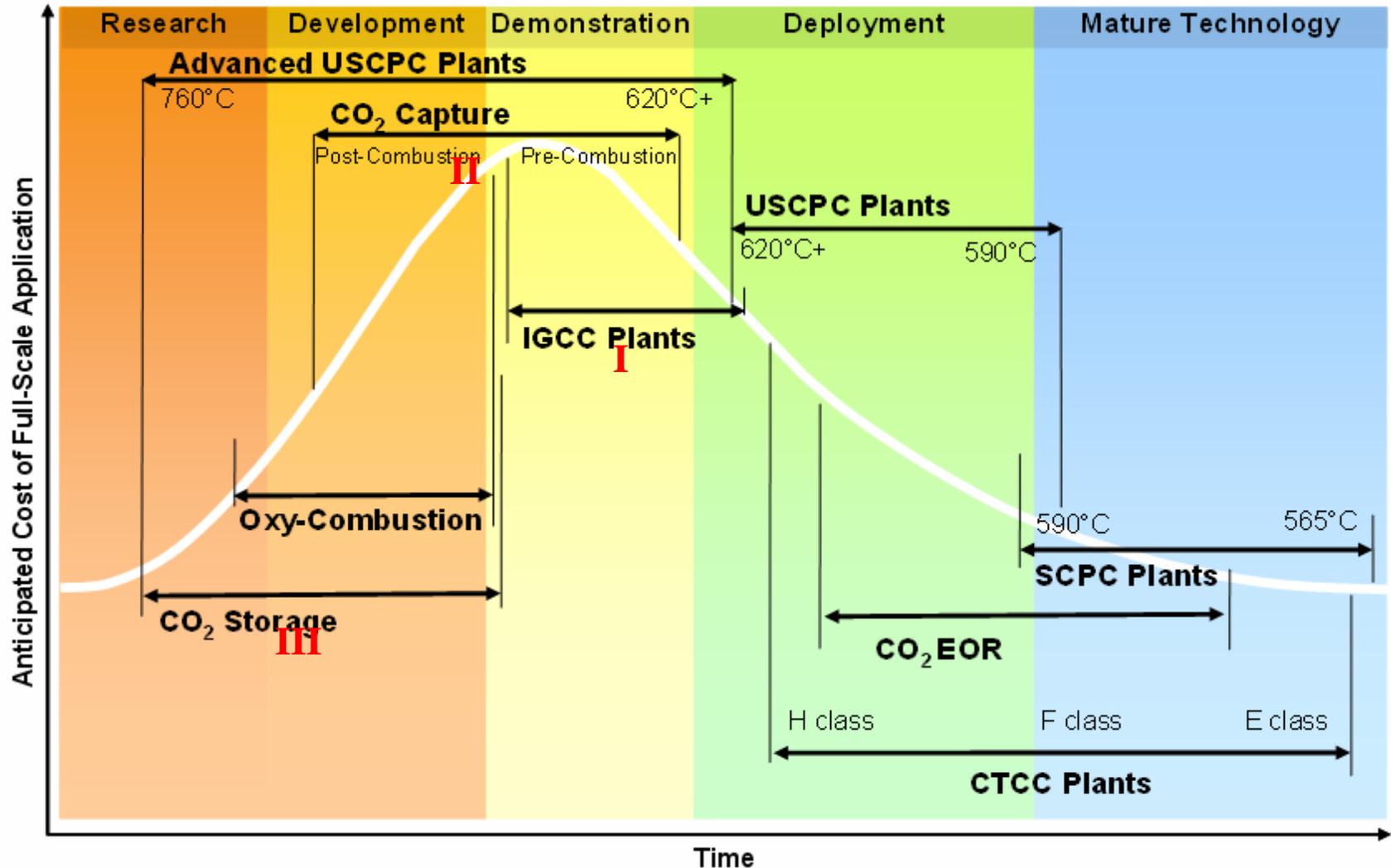
*Latest example of IGCC technology costs*

\$2.88B, 618 MW = \$4,660/kw  
(if CCS added, estimated \$4.2B)

“Based on a customer's bill today, the project will result in an overall average 19 percent rate increase phased into rates by 2013.”

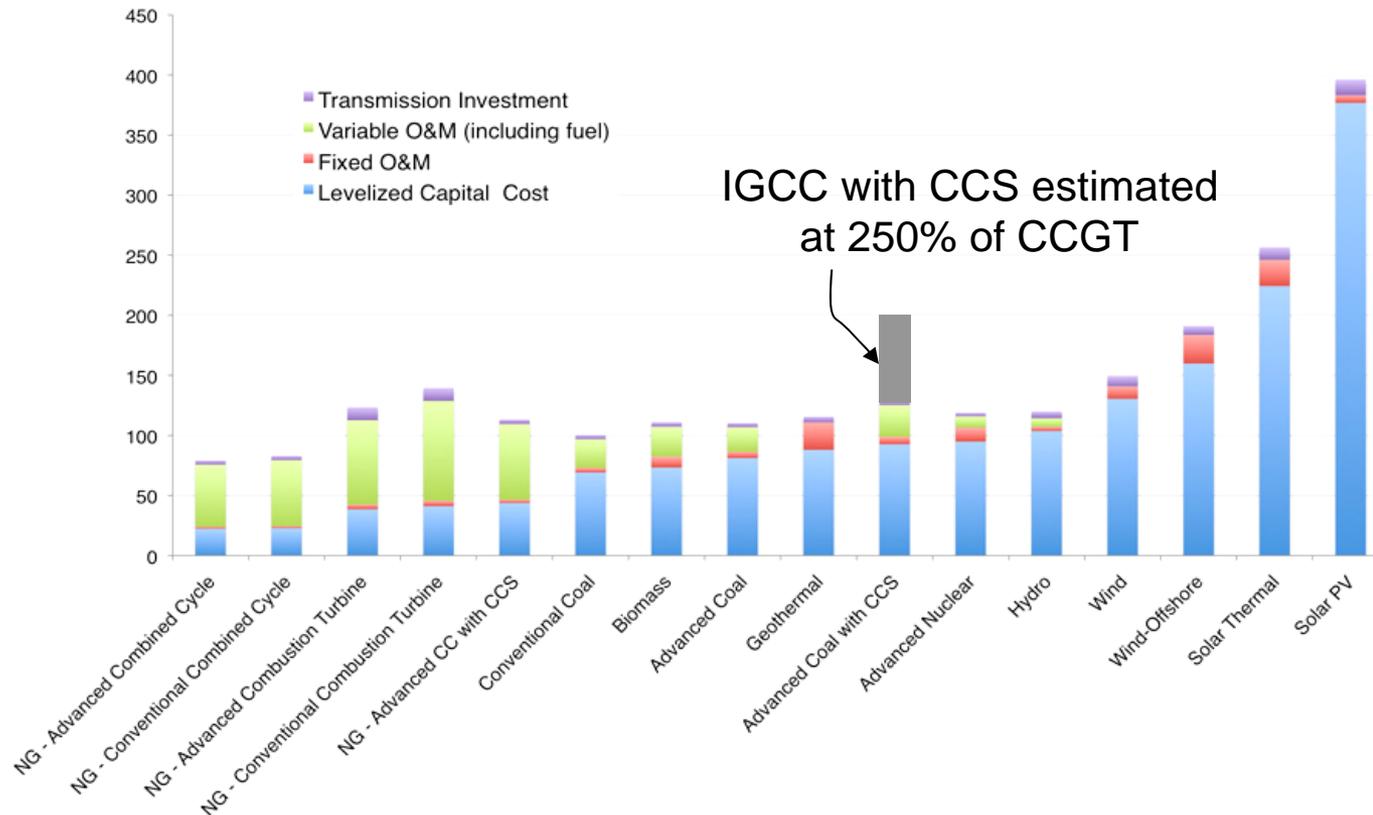
Duke Press release April 16, 2010

# Costs are Likely to Rise for CCS Plants



# Above Market Costs are Likely to be Significant

Estimated Levelized Cost of New Electricity Generating Technologies in 2016  
(\$2008/megawatt hour)

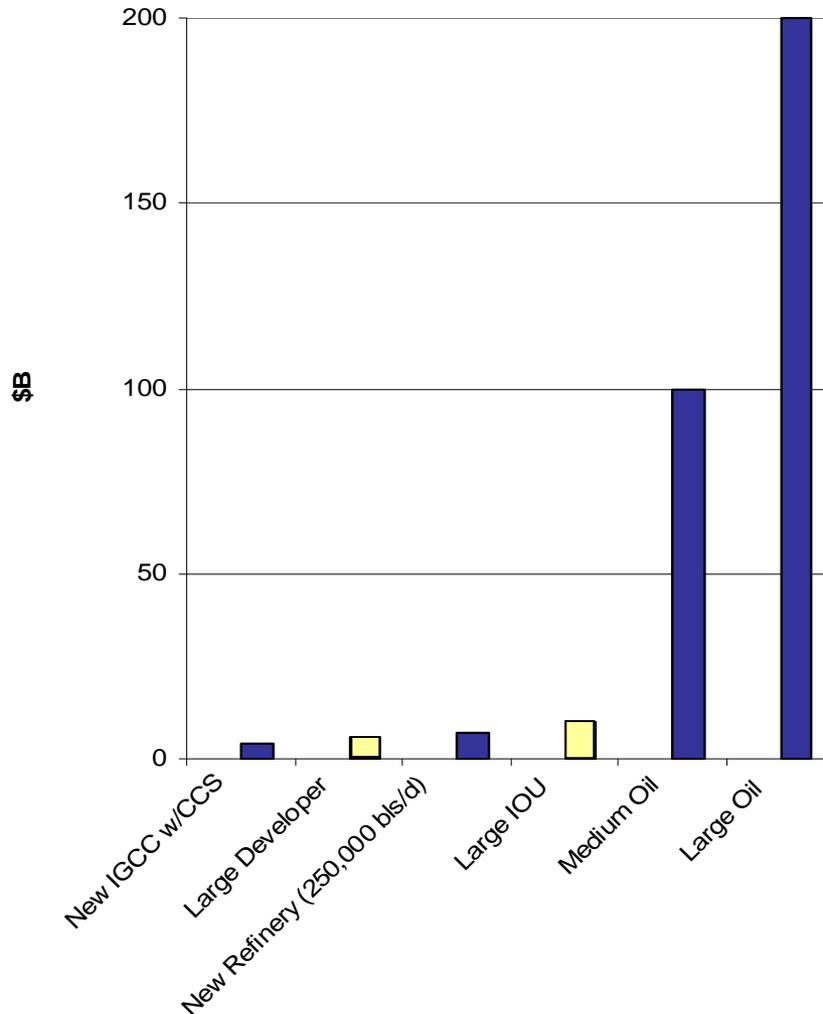


Source: Energy Information Administration, Annual Energy Outlook 2010, [http://www.eia.doe.gov/oiat/aeo/electricity\\_generation.html](http://www.eia.doe.gov/oiat/aeo/electricity_generation.html)



# Few Companies Can Support \$4B Plants

Capital Costs/Market Capitalization



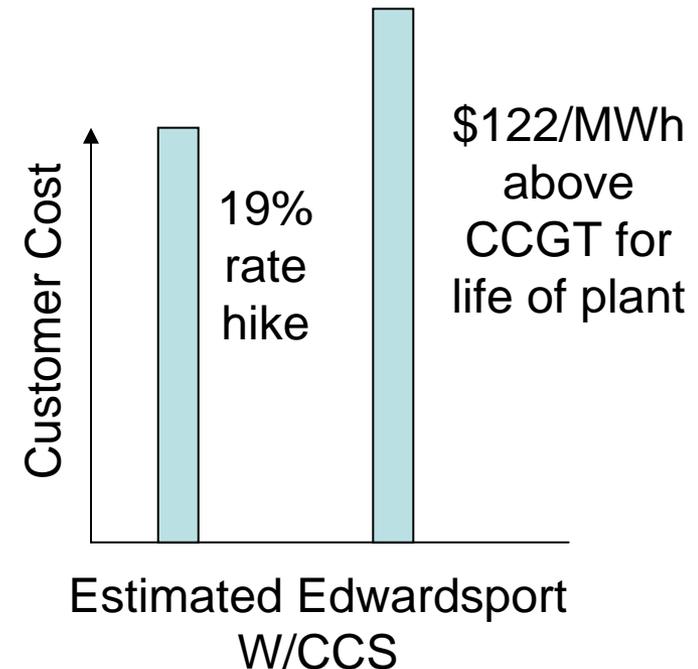
Marathon Refinery, La



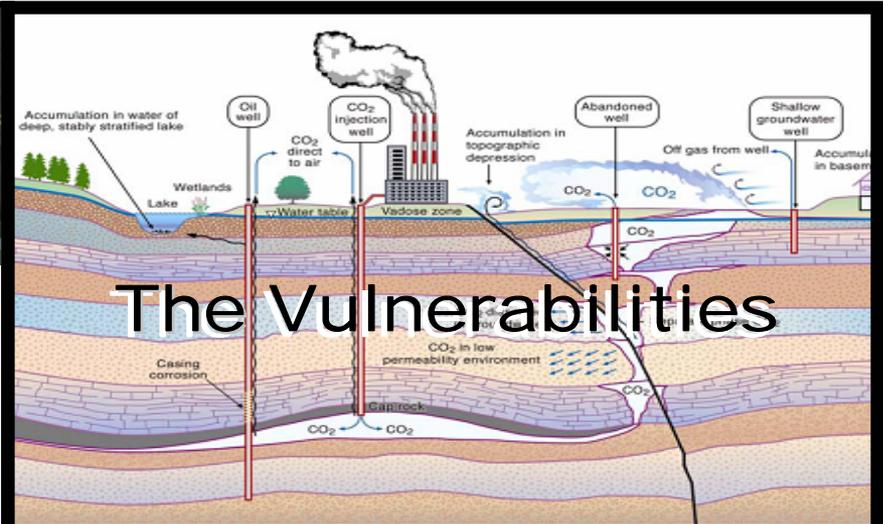
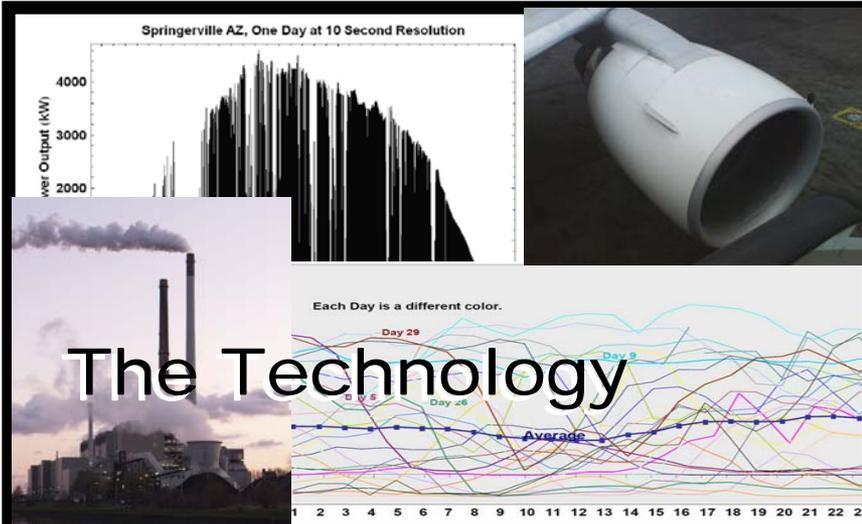
Edwardsport construction, In

# Above Market Costs Require Fair Solutions

- CCS Plants are 250% above CCGT costs on an all-in basis
- Ways for CCS Plants to Cover Costs
  - Buy down CAPEX (\$1-2B subsidy)
  - Sell the power at significantly above market
- Some sources of CAPEX Subsidies
  - Worldwide sources – GCCSI-like organizations (few and far between)
  - Federal subsidies – DOE, ARRA
  - State subsidies
- No single IOU balance sheet can support these sorts of subsidies



# Future Factors to Consider



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