

# Electricity Generation in a Carbon Constrained World & the Role of CCS

***How do we insure the availability of technology to capture and then sequester CO<sub>2</sub> emitted from coal use?***

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# Focus of the Presentation --

**What needs to be done FIRST to best insure that technologies will be available to address CO<sub>2</sub> from future coal use**

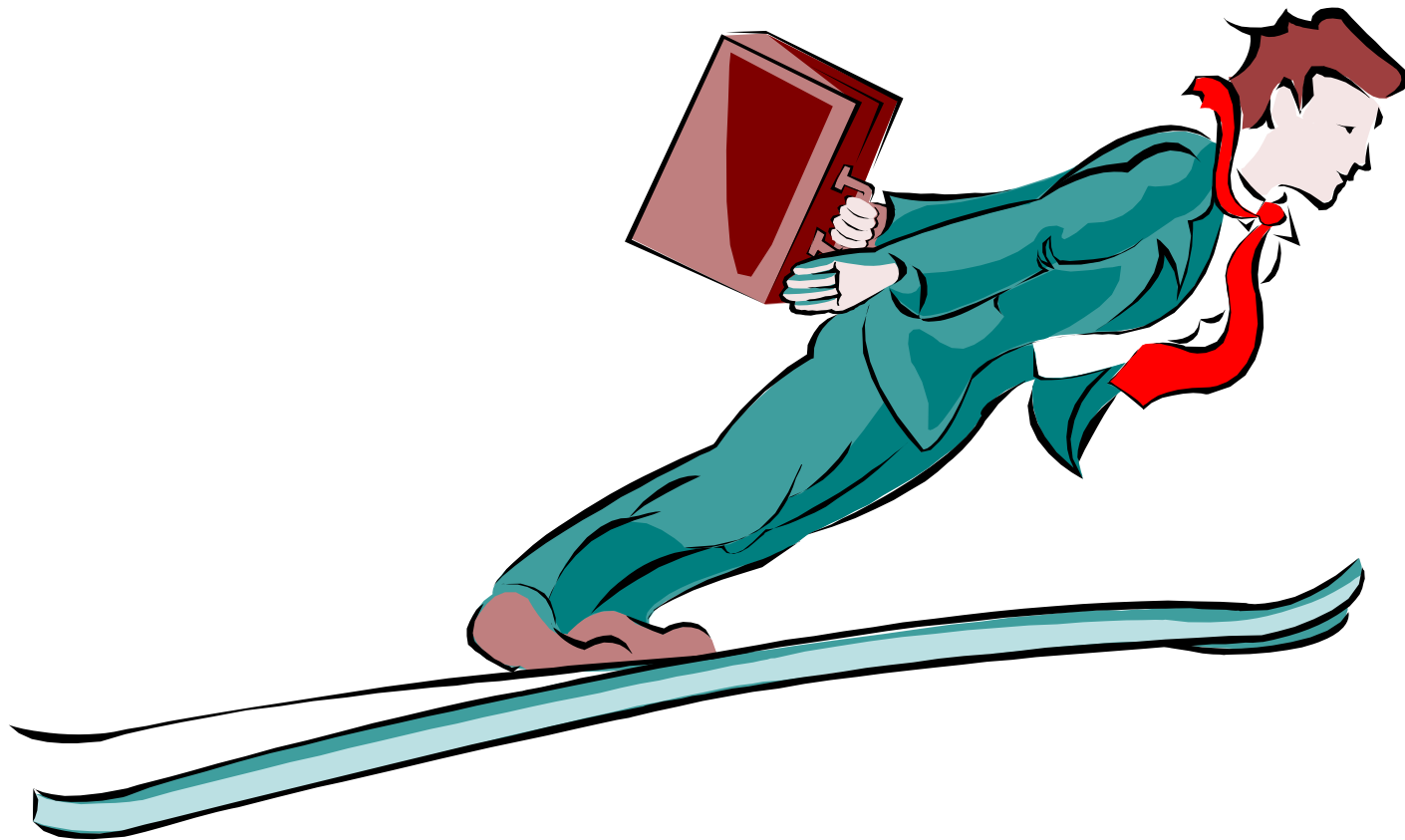
# What is CCS technology?

- CO<sub>2</sub> capture & compression (purification)
  - Pre-combustion (gasification of coal, e.g. IGCC)
    - » Capture CO<sub>2</sub> before coal-derived gas is used
  - Post-combustion (advanced scrubbers on efficient PCs)
    - » Capture CO<sub>2</sub> in flue gas after combustion
  - Oxycombustion (combust coal with oxygen not air)
    - » Capture CO<sub>2</sub> in concentrated stream after combustion
  - Other? (e.g. partial capture & cost-effective retrofits)
- CO<sub>2</sub> transportation
- CO<sub>2</sub> injection & long-term storage
- CO<sub>2</sub> monitoring & verification

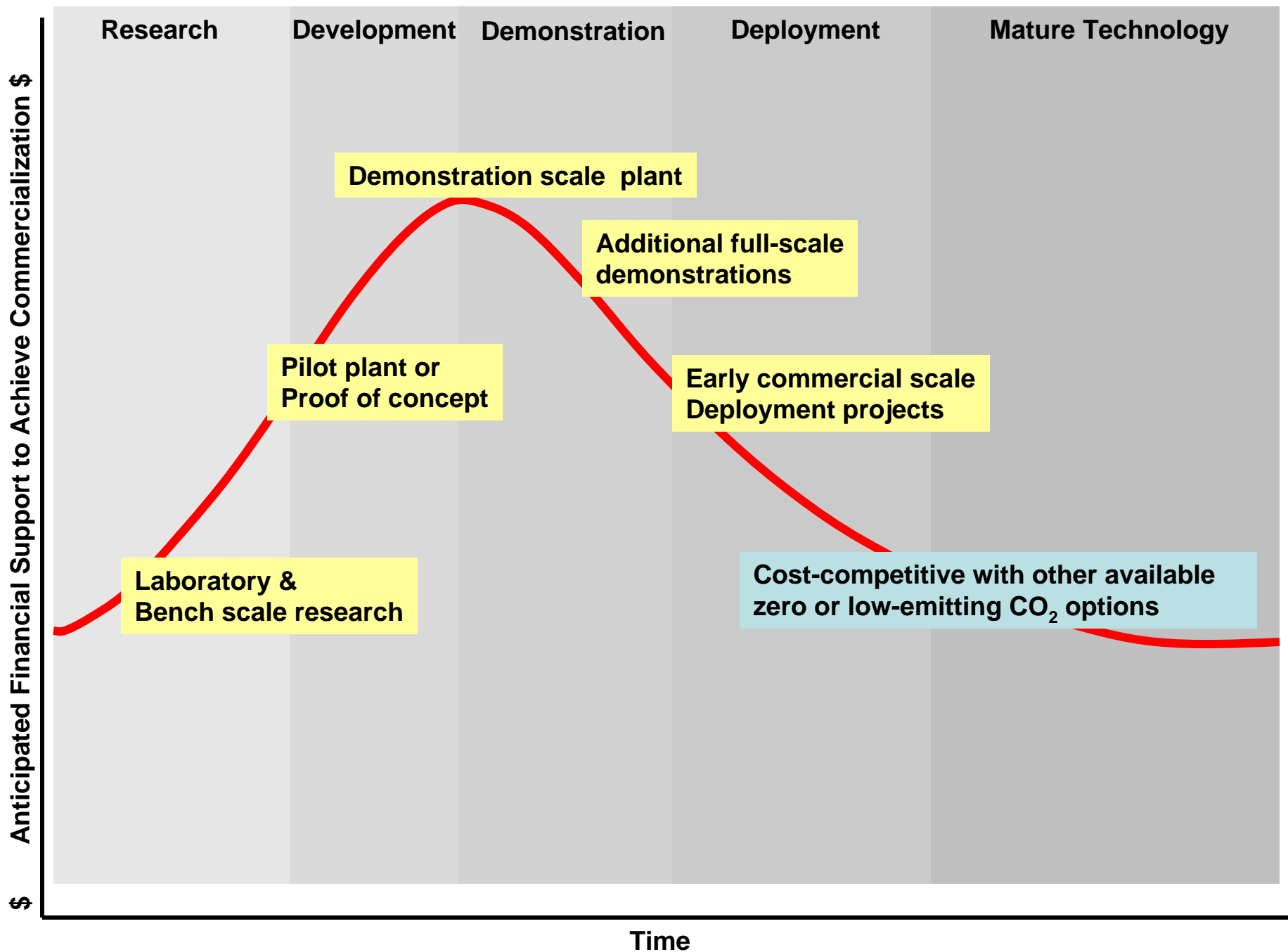
# When talking about CCS don't forget --

- Increasing the efficiency of coal-based power plants
  - The greater the efficiency in converting coal to useful energy the less CO<sub>2</sub> emitted
    - Each 1% increase in efficiency = ~2.5% decrease in CO<sub>2</sub>
    - Increased efficiency = more energy/unit of coal
- CCS technology consumes energy or electricity
  - >energy output decreases economic impact of CCS

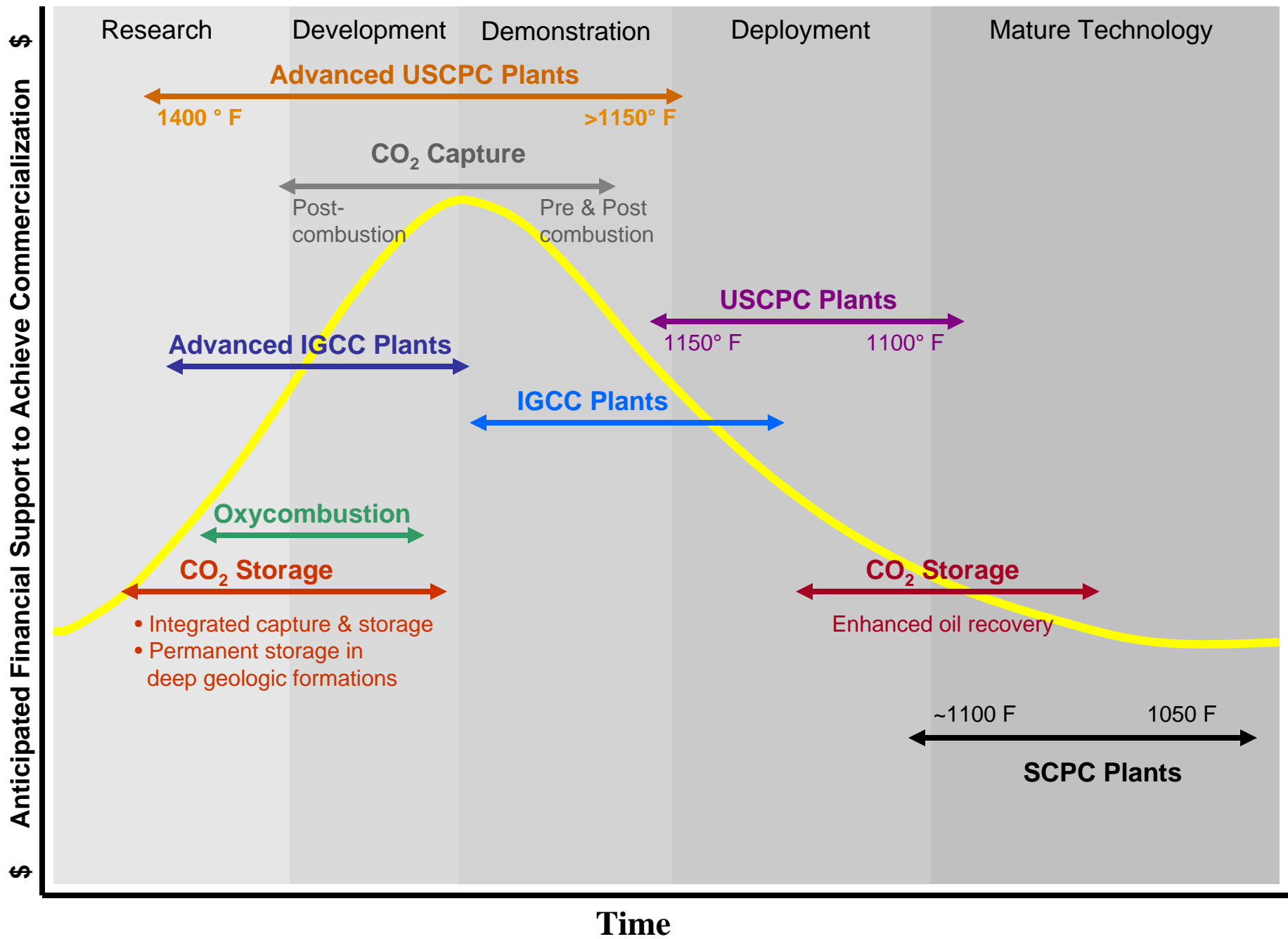
**Right Now: We are WAY in Front  
of our skis**



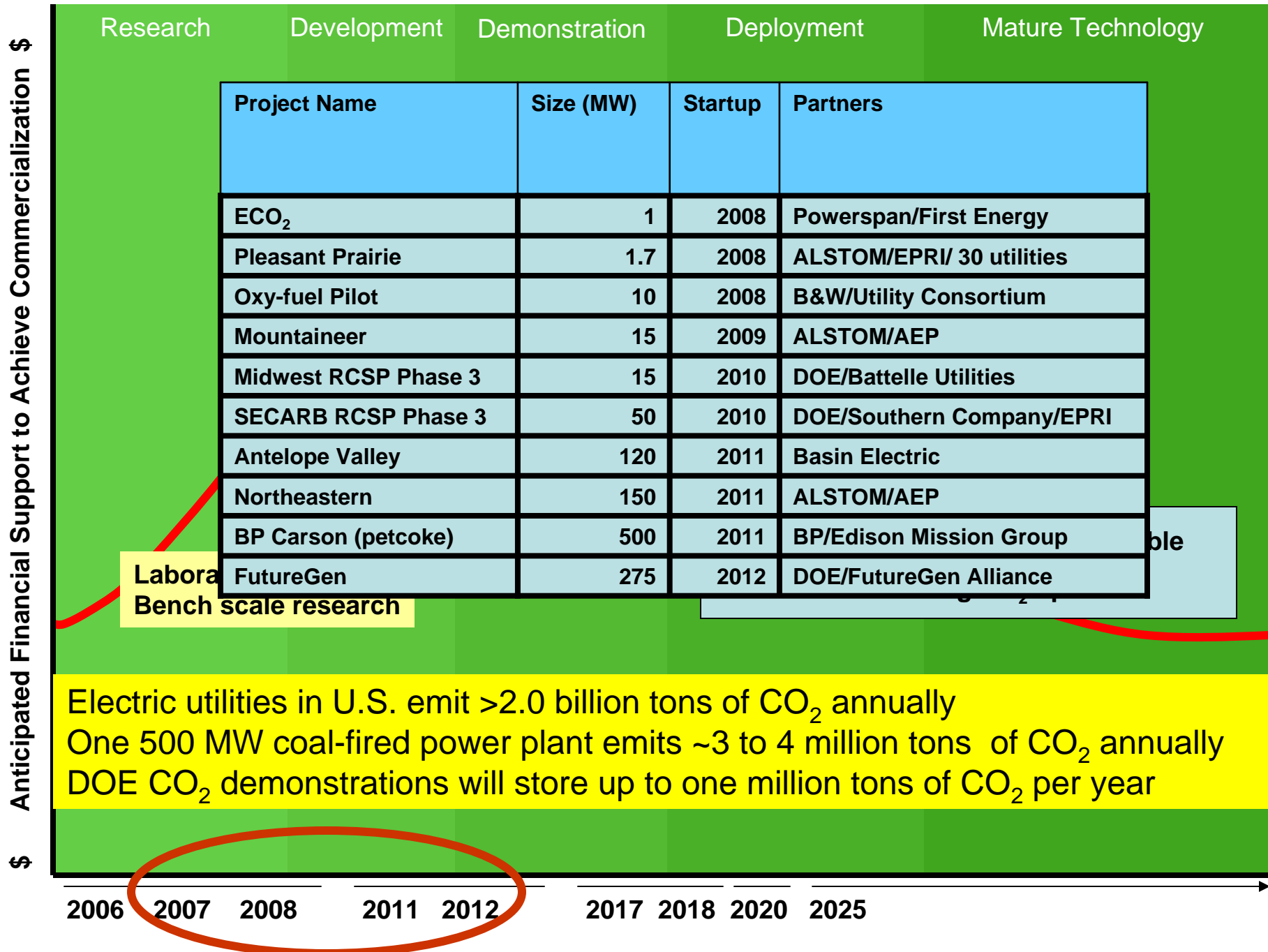
# Typical development cycle of large scale, capital intensive coal systems



# Approximate level of development of various advanced coal technologies & CO<sub>2</sub> capture and storage



# Current U.S. CO<sub>2</sub> Capture Projects



**IF CCS is the path forward to insure the continued use of coal then --**

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- **What needs to be done?**
- **How long will it take?**
- **How much will it cost?**
- **How will it be paid for?**

# What Needs to be Done?

CURC's two-part program to develop & use technology to address CO<sub>2</sub>

1. Longer term research, development and demonstration (RD&D) program
2. Near term CO<sub>2</sub> project (focuses on technology installation NOW)

# Two Methods to Reduce Coal's Carbon Footprint

- **CO<sub>2</sub> Emissions Reductions thru Efficiency:**
  - Can be achieved by **increasing the efficiency** of a plant so less coal is used to produce the same amount of electrical output
  - Higher Efficiency = Lower Emissions
- **CO<sub>2</sub> Emissions Reductions thru Carbon Capture and Storage (CCS):**
  - Can be achieved in the future by developing **CO<sub>2</sub> capture** technology to retrofit existing units or integrate into new units

# The Longer-term RD&D Program

- ❑ Developed with EPRI, in cooperation with the DOE; focuses on technology Research, Development and Demonstration, defining technology goals and timelines
- ❑ Roadmap defines a path for future advanced, highly efficient (+50% efficiency) combustion-based plants and integrated gasification combined cycle plants (IGCC) to be highly competitive, to provide the industry with power generation options and to cost less than either technology costs today.
- ❑ **Problem:** Relies upon annual federal appropriations; R&D funding is marginally adequate. Demonstration funding is completely inadequate. At current rate of funding, the RD&D goals of the Roadmap cannot be met in a timely fashion.

# Summary of CURC/EPRI Long-Term R D &D Program

1. Achieve emission reductions an “order of magnitude greater” than today’s best technology – SO<sub>2</sub>, NO<sub>x</sub>, PM, H<sub>2</sub> and CO<sub>2</sub>
2. Energy conversion efficiency at coal fueled power plants of ~50% (today 35%)
3. Advanced coal utilization power plants capable of capturing 90+% CO<sub>2</sub>
4. Long-term, safe and permanent storage of CO<sub>2</sub>
5. Affordable electricity

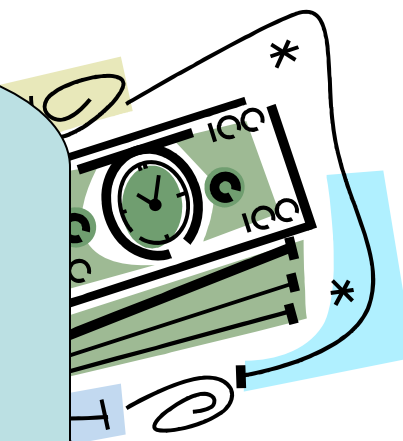
# The Near Term CO<sub>2</sub> Project Features

- ❑ Near term program relies upon tax incentives not annual appropriations
- ❑ Incentives for actions to reduce CO<sub>2</sub> NOW with focus limited to existing units, pioneer IGCC & advanced combustion systems and CCS “early adopters”
- ❑ CO<sub>2</sub> impacts: ~140 million TPY of CO<sub>2</sub>; 3 billion tons over program life; many billions of TPY after FOAK projects
- ❑ Maintains options (existing units, new IGCC & advanced PC)

# Summary of Near Term Recommendations

1. Increase the efficiency of existing units and new advanced clean coal units
2. Support “early adopters” who plan to demonstrate carbon capture & storage (CCS) projects
3. Adopt legislation to create a predictable framework for CO<sub>2</sub> long term transport & storage (questions about risk & liability)

# What's needed to achieve the two-part plan?



**Total gov't funding required -- ~\$24 billion:**

- \$17 billion for long-term RD&D program
- \$10 billion federal government
- \$ 7 billion private sector & other

**\$30+ billion for near-term CO<sub>2</sub> projects**

- \$14 billion federal tax incentives
- \$16+ billion from industry

How much  
do we need?

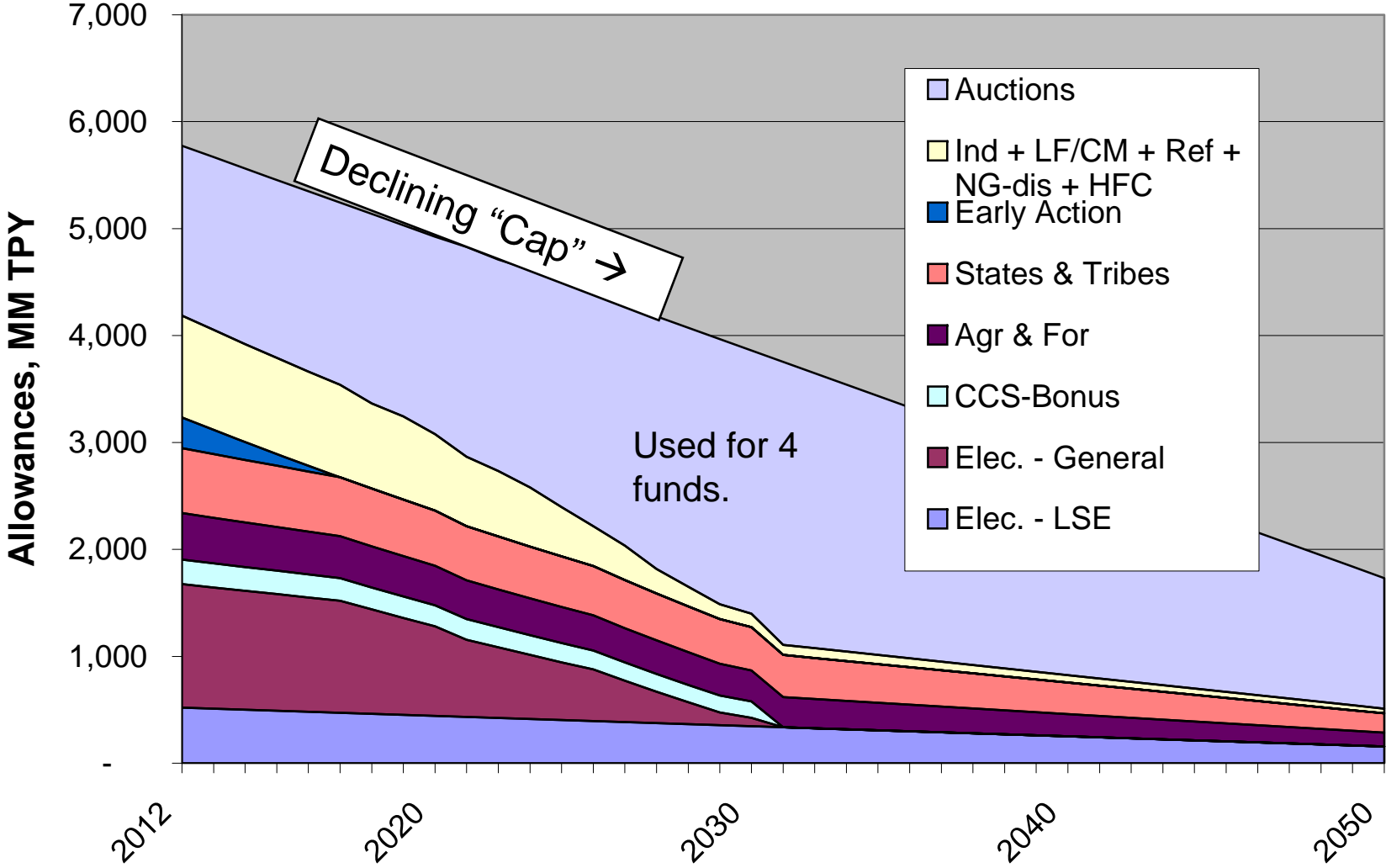
How much money  
is needed?

Long-term RD&D Now thru 2025	DOE and/or other	Long-term RD&D ~\$17 B
Near-term CO <sub>2</sub> Now thru 2023	Near-term CO <sub>2</sub> Industry projects with tax incentives	Near-term CO <sub>2</sub> ~\$14 B (gov't only)

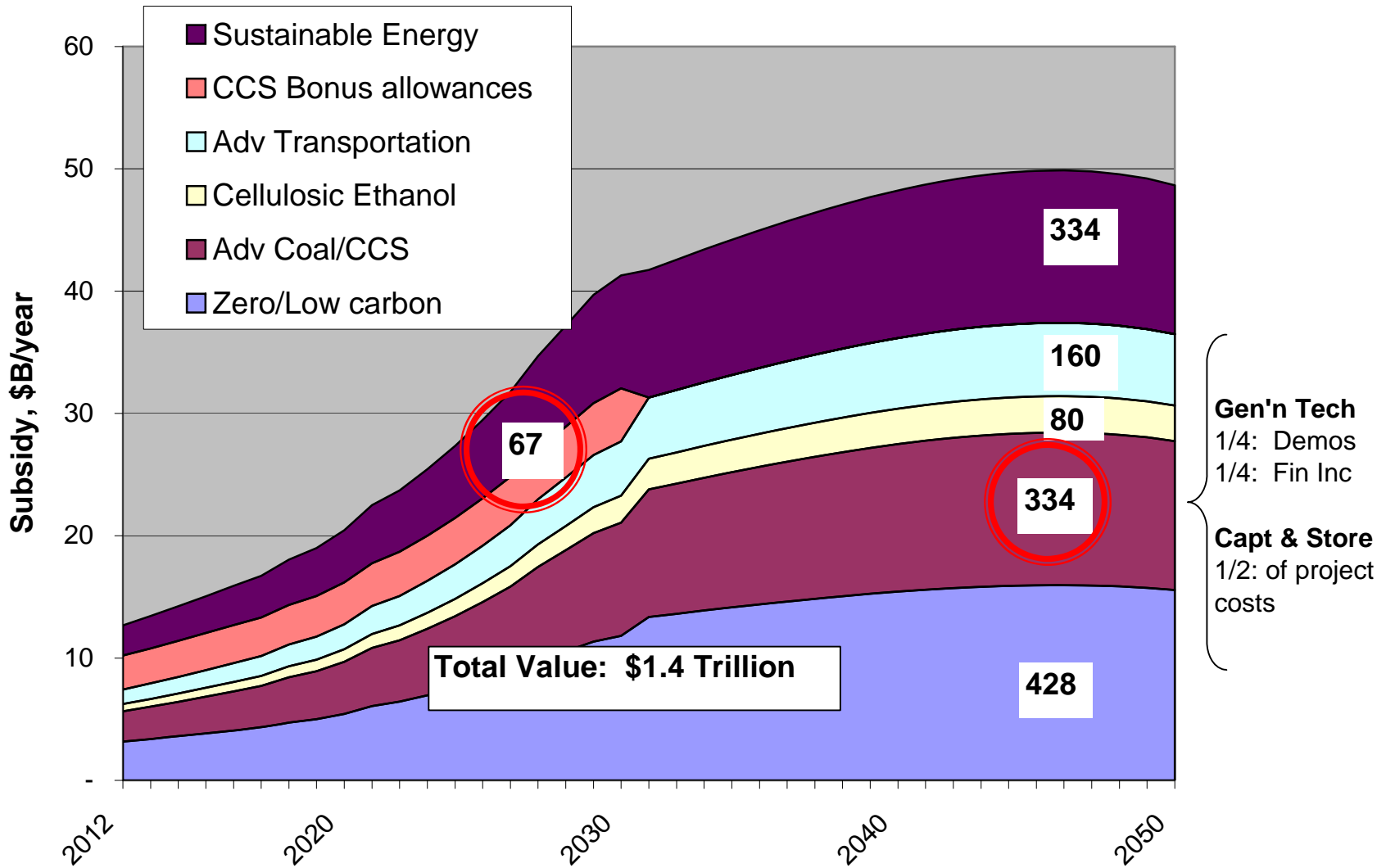
# Lieberman-Warner (S.2191) Climate Change Proposal

- The principle incentive provisions related to coal-based systems are contained in the “Bonus Allowance” provisions (Section 3601-3604), and the Advanced Coal and Sequestration Technology Incentives (Section 4403) of the bill

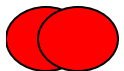
# S. 2191 Allowance Distribution



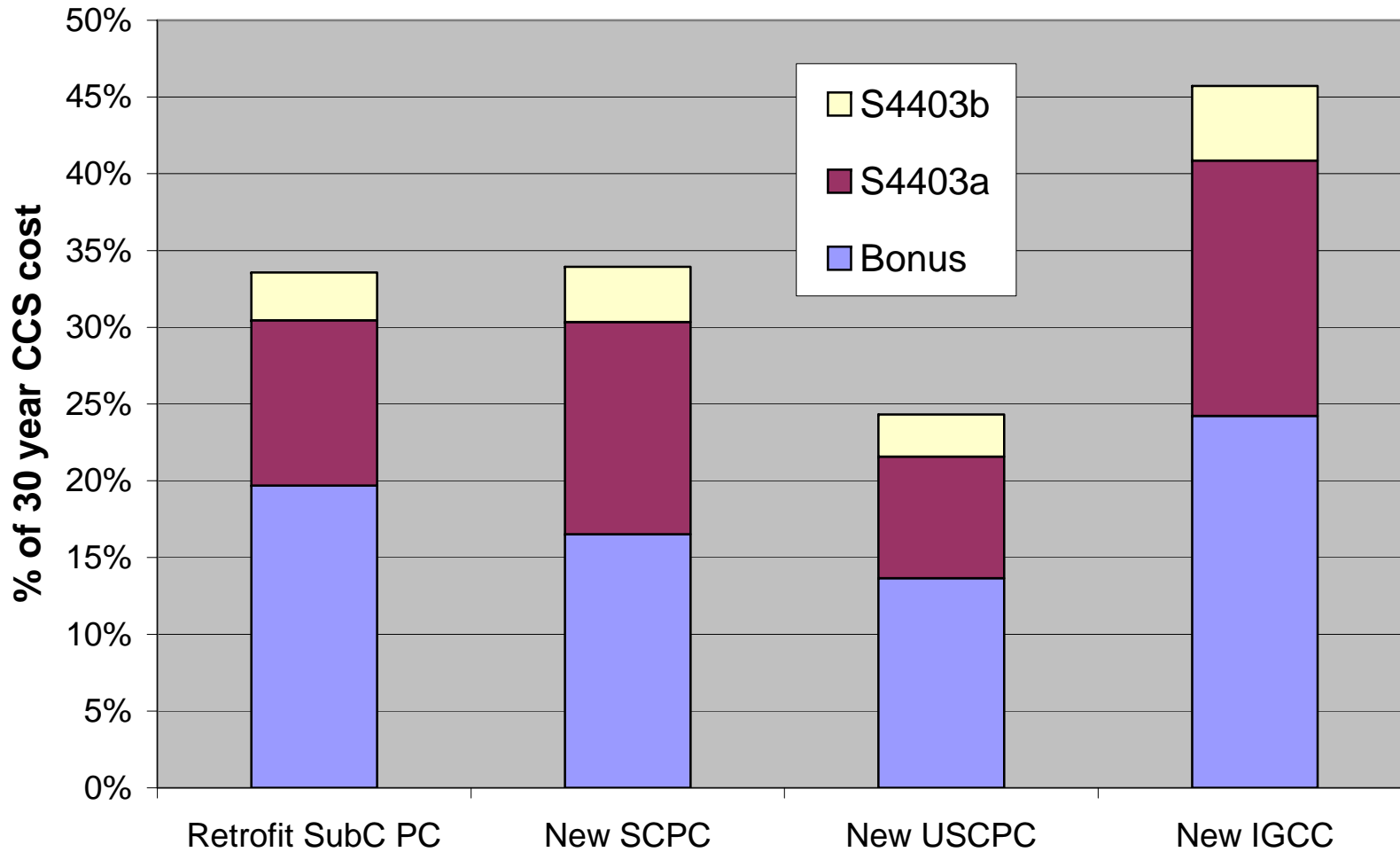
# S. 2191 Technology Subsidies



These are **approximate \$ values**, based on Bingaman "safety valve" prices.



# Example CCS subsidies are modest



These values reflect initial estimate, now under member review.



# Does S.2191 Address Issues Identified in the CURC Near Term CO<sub>2</sub> Program?

- To take advantage of these incentives the *technology must be available* to meet the stated qualifying criteria
  - Technology is not available that meets qualifying criteria, or
  - Technology is not available at reasonable cost and associated risks, or
  - No demonstrations underway or completed to permanently store large amounts (>one million tons) of CO<sub>2</sub> annually
  - Not sufficient funding to compete with purchased offsets
  - Infrastructure changes are needed immediately

# Does S.2191 Address Issues Identified in the CURC Near Term CO<sub>2</sub> Program?

- Funding may reduce cost impacts but does not accelerate technology improvements
- When faced with CO<sub>2</sub> reductions -- immature coal technology vs. less costly & proven alternatives (natural gas or offsets) & the winner is ... .?
- Programs do NOT currently exist to mature (demonstrate/deploy) current technology (e.g. IGCC or advanced coal combustion)
- Given uncertainty of climate change regulatory legislation, opposition to coal plant construction (without CCS) few, if any, coal projects will be initiated
- Nothing is built, technology does not advance for next 5 to 10 years

# Areas of agreement

- With the Pew Center --
  - Need for technology solutions
  - Financial incentives required (incremental costs only?)
  - Scope of program (\$\$ and # of plants or MWs)
  - Sources of funding
    - Generators/coal producers
    - Governments (federal & state via taxpayers)
    - Ratepayers

# Areas of agreement

- With the Regulatory Assistance Project --
  - Need for an accelerated CCS program that encompasses all aspects of CCS technology
  - Importance of federal/state cooperation
  - Assignment of risks to address a global issue
  - Recognition that unless “we get it right” there will be “a dash to gas”
  - Where’s the “beef”; how do we pay for CCS?

## One last note of caution –

- Do not assume that passage of climate change legislation will enhance the likelihood of technology development
- If the technology solution is to be viable, time, focus and money are required