

# **Sixth Annual Conference on Carbon Capture & Sequestration**

*Expediting Deployment of Industrial Scale Systems*

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**What We Have Found and What Should Be Future Priorities:  
Need to Engage CCS Community in Synfuels Activities**

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# WHAT WE HAVE FOUND

- Historically bulk of CCS activity focused on electric power
- New challenge to CCS community—coal synfuels
- Drivers: high oil/NG prices, supply security concerns
- Rapidly growing US interest:
  - Air Force goal: 100,000 B/D of domestically produced synthetic jet fuel by 2016 (*~ 1/2 of expected Air Force jet fuel demand*)
  - New bill being debated: Bunning/Obama Coal-to-Liquid Fuel Promotion Act of 2007—S. 155 (*12 sponsors*) & H.R. 370 (*29 sponsors*)
  - Strong political support in coal-rich states
- China situation:
  - Scant domestic oil/gas but substantial coal
  - Many coal-to-MethOH, coal-to-DME plants being built...F-T liquids plants are under consideration
  - Extensive experience gasifying coal to make chemicals...transition to making synfuels via gasification likely to be much easier than transition to coal IGCC power (*inhibited by low-cost steam power in China*)

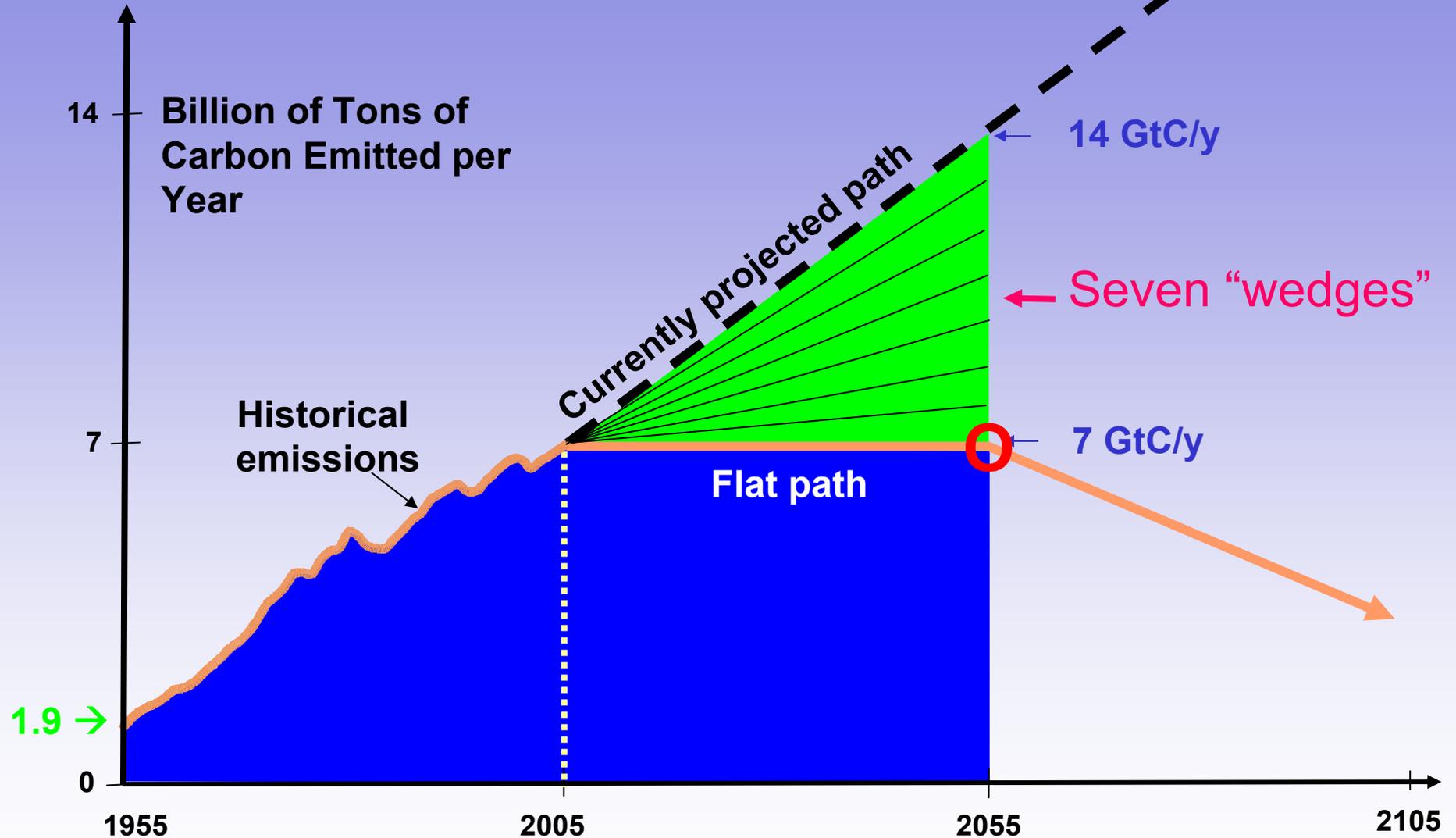
# **BENEFITS OFFERED BY COAL SYNFUELS**

- Secure and abundant potential supplies of fluid fuels
- Prospectively competitive at oil prices ~ \$50/barrel

# RISKS POSED BY COAL SYNFUELS

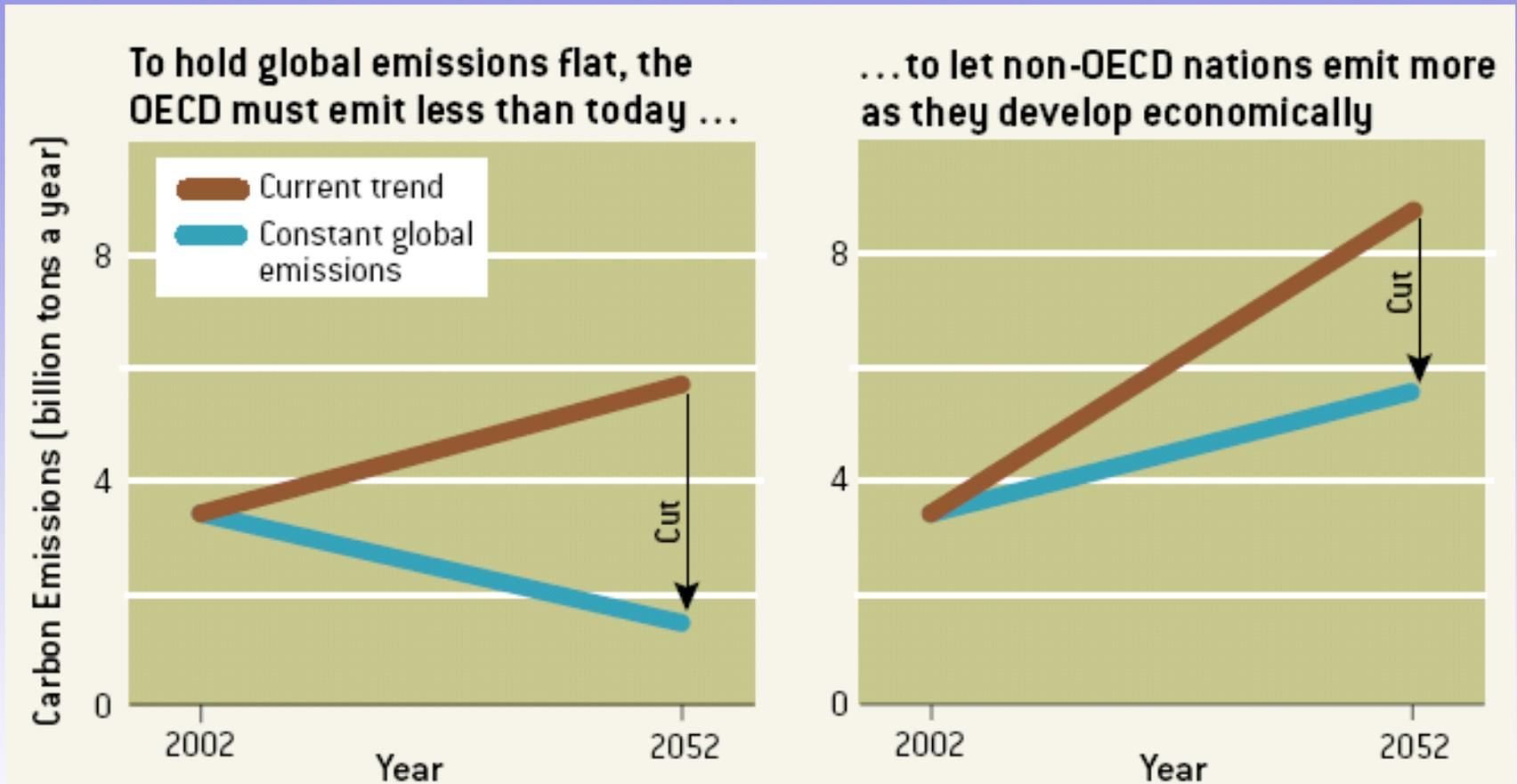
- Coal synfuels made w/o CCS → well-to-wheels GHG emission rate ~ 2X that for crude-oil-derived HC fuels displaced
- Most CO<sub>2</sub> emissions other than from tailpipes of synfuel-burning vehicles are in relatively pure streams → much lower capture costs than for coal power plants
- Even with CCS, GHG emission rate is ~ that for displaced HC fuels
- Coal's abundance → for CTL with CCS a long-term persistence of the current GHG emission rate for transport fuels
- Not good enough—especially in industrialized countries—if society decides to stabilize atmosphere at “safe” CO<sub>2</sub> level

# GLOBAL WEDGES STRATEGY



After Pacala and Socolow (2004)...Stable emissions needed until 2050

# OECD AND NON-OECD SHARES



Source: Socolow and Pacala, *Scientific American*, September 2006, p.56

# WHAT TO DO ABOUT COAL SYNFUELS

- Very controversial—some ask, *why even go there?*
- First priority: No incentives for coal synfuels projects that don't do CCS—consistent with *MIT Coal Study* recommendation regarding clean coal technology projects
  - Not an especially bitter pill to swallow because capture cost is low
  - Which implies low plant-gate cost of CO<sub>2</sub>
  - Early projects sited near CO<sub>2</sub> EOR opportunities can often offset capture costs with CO<sub>2</sub> sales revenues—CO<sub>2</sub> from one barrel of synfuels can support ~ 2 barrels of incremental crude oil
  - But policy needed to make CCS worthwhile (*more on this later*)
- Second priority: Reduce demand for transport fuels via efficiency improvements, hybrid vehicles (*including, hopefully, plug-in hybrids*)
- Third priority: Evolve to synfuels production with reduced GHG emission rates by coprocessing biomass and coal with CCS to make synfuels

# CCS FOR BIOMASS

- If CCS works for coal, it should also be considered for biomass
- CCS for biomass would change its status as a carbon mitigation option from “carbon neutral” to “carbon-negative” as a result of geological storage of photosynthetic CO<sub>2</sub>
- A significant market value for CO<sub>2</sub> emissions (*~ \$30/t CO<sub>2</sub>*) can make even expensive biomass attractive as feedstock for energy conversion
- Attractive approach: coprocess biomass with coal to make useful energy exploiting simultaneously:
  - Economies of scale of coal energy conversion
  - Low cost of coal as feedstock
  - Negative emissions potential of biomass when photosynthetic CO<sub>2</sub> is stored underground along with coal-derived CO<sub>2</sub>

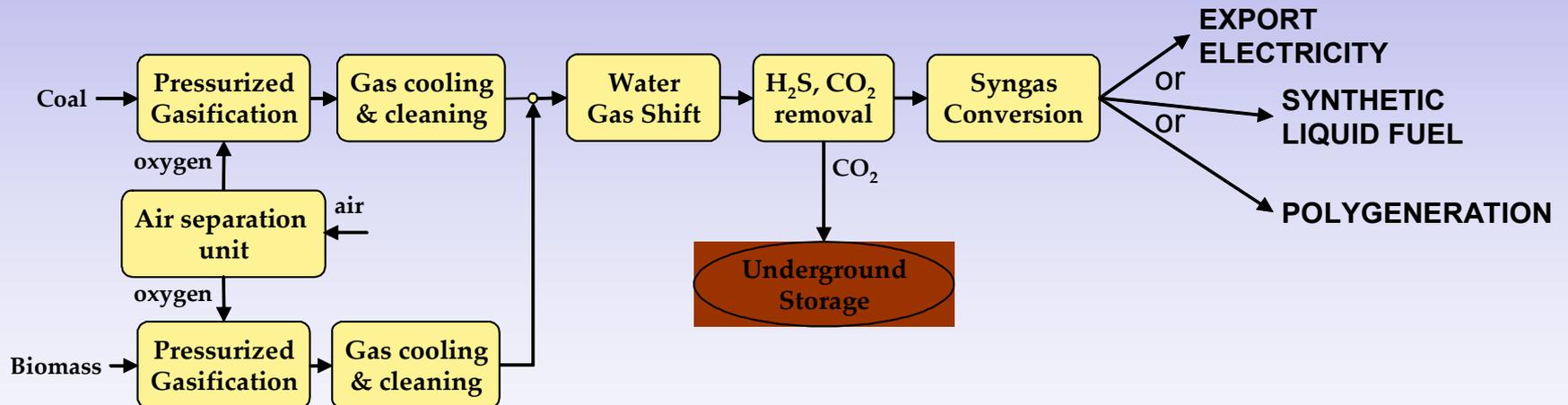
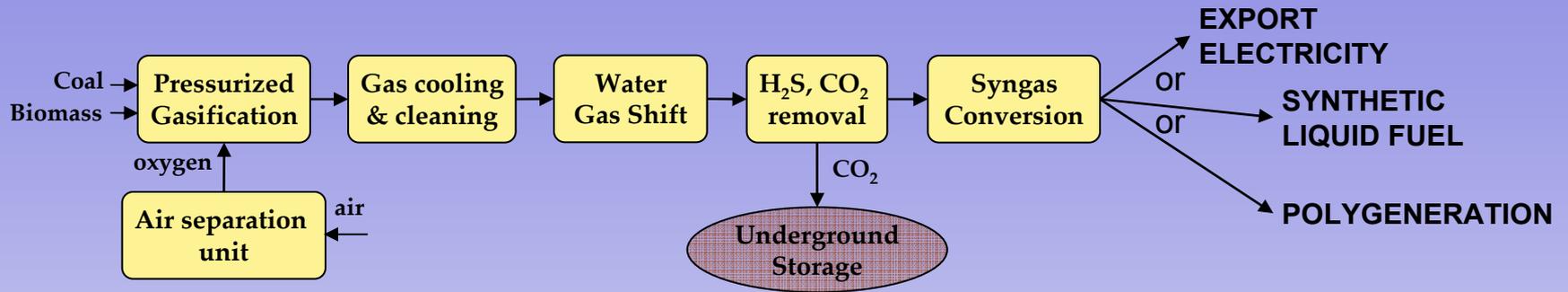
# ENERGY FROM COAL/BIOMASS WITH CCS COMPARED TO CONVENTIONAL BIOFUELS

- EthOH subsidy (*51 ¢/gallon*) has driven up corn prices
  - Street demonstrations in Mexico from rising tortilla prices
  - Higher meat prices/“pain” for livestock producers
- Shift to biomass/coal coprocessing would shift most biomass supplies off agricultural lands:
  - $< \frac{1}{4}$  of potential US biomass supply identified in USDOE/USDA “Billion Tons” study would be energy crops
  - Most supplies would be crop/forest industry residues, municipal wastes
- Shift from corn EthOH to cellulosic EthOH would also shift most biomass supplies off agricultural lands
- But transition from corn EthOH to cellulosic EthOH will be slow:
  - “Producing cellulosic ethanol is clearly more difficult than we thought in the 1990s.” Dan Reicher, former DOE Asst. Secretary for EE/RE (*NYT*, 17 April 2007)
- And zero GHG emitting synfuels produced from coal/biomass with CCS would require  $< \frac{1}{2}$  as much biomass as cellulosic EthOH

# WHAT SHOULD BE FUTURE PRIORITIES

- Diversification of biomass R,D,&D portfolio needed to embrace thermochemical conversion (*especially via gasification*) as well as biochemical conversion
- This was a major recommendation of *1997 PCAST Energy R&D Panel Report* to President Clinton
- Advice was not heeded...instead we got “EthOH lock-in,” the economy-wide consequences of which are now manifestly non-trivial
- In pursuing biomass gasification-based energy, emphasis on coal/biomass coprocessing with CCS is warranted

# GASIFICATION ENERGY FROM COAL + BIOMASS



# DEPLOYMENT POLICY FOR SYN-FUELS IN CARBON-CONSTRAINED WORLD

- Policy needed that enables market (*not government*) to pick winners and punish losers
- One possibility:
  - Elimination of current winner-picking subsidies
  - Introduction of low carbon standard for fuels like that introduced in California via executive order by Governor Schwarzenegger in January 2007