DOE's Office of Clean Coal and Carbon Management R&D

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Office of Clean Coal and Carbon Management

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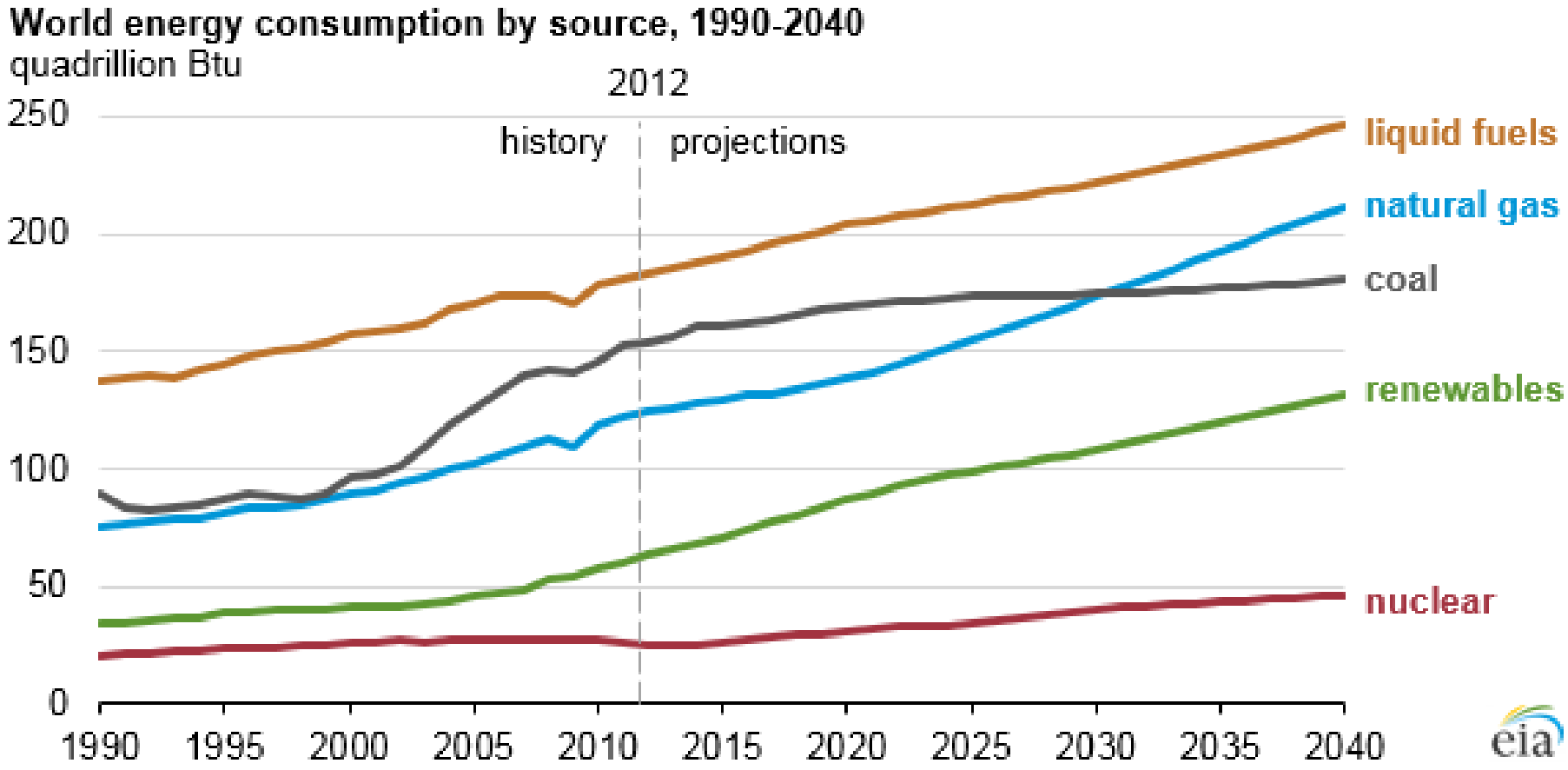
48% increase in world energy consumption by 2040, coal still needed



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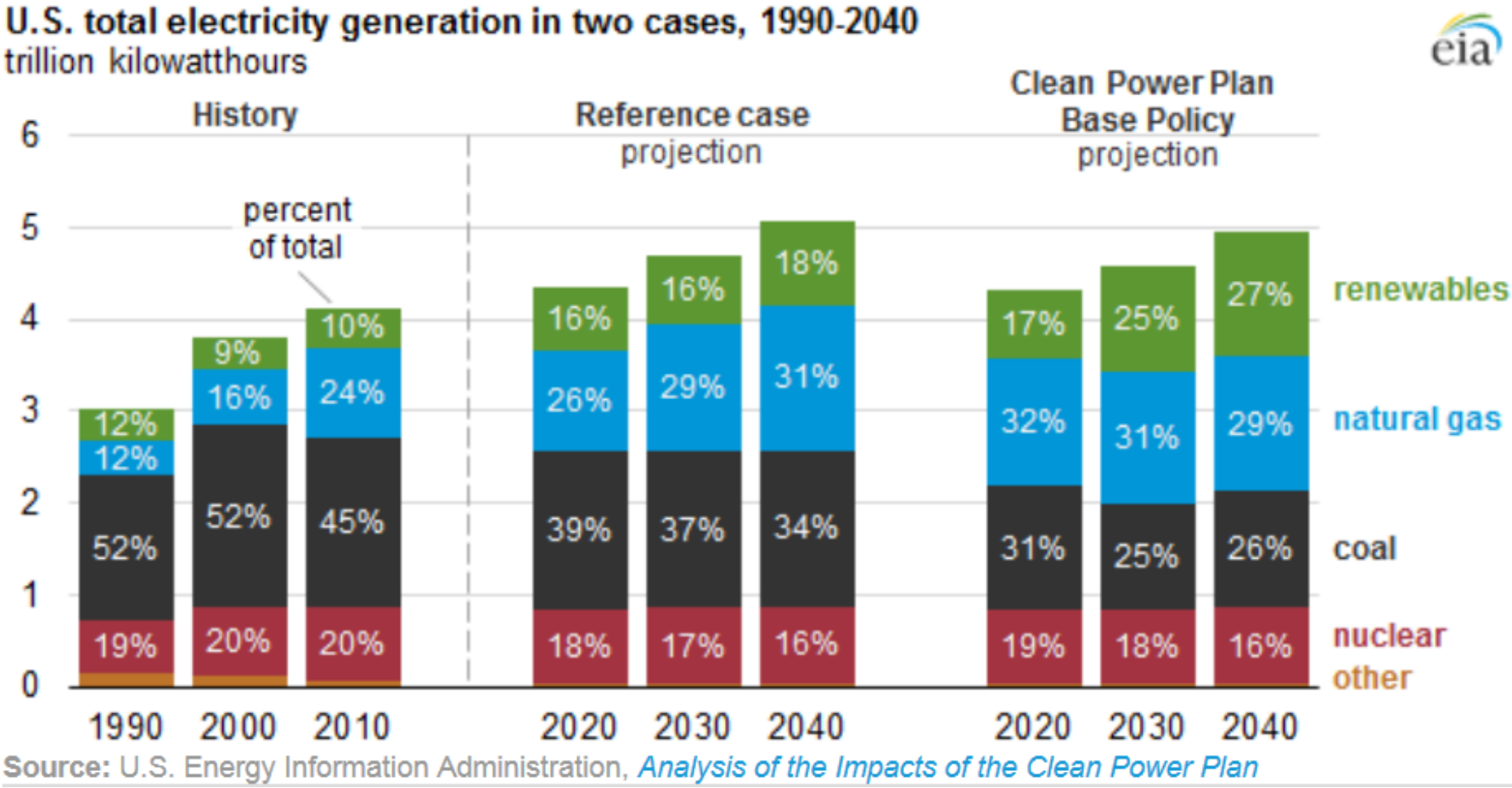
Source: U.S. Energy Information Administration, *International Energy Outlook 2016*

Electricity Trends in The US



Even with CPP, > 50% of Electricity Production from fossil sources by 2040

Role of CCS in Global Climate Mitigation

CCS provides 14% of emissions reductions through 2050 to limit global temperature increase to 2ºC.

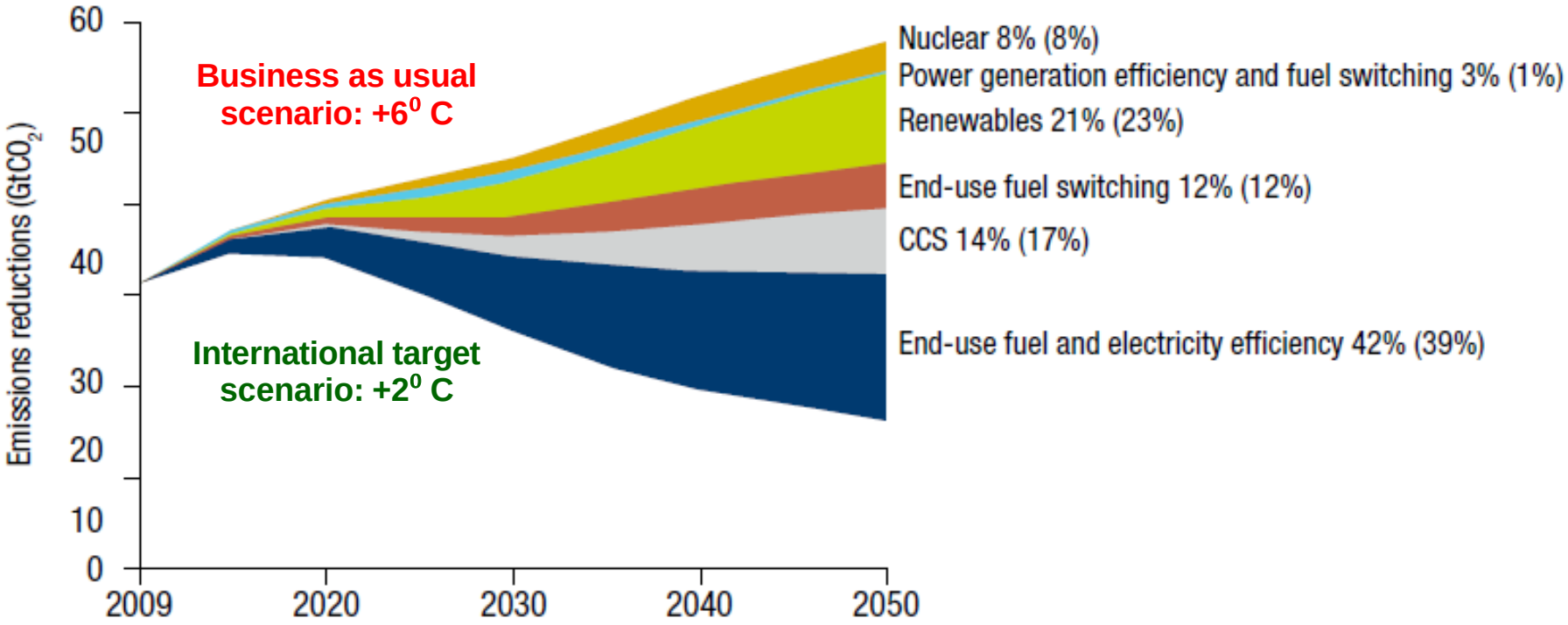


Figure source: International Energy Agency, Technology Roadmap: Carbon Capture and Storage, 2013

DOE's Clean Coal and Carbon Management Priorities

- Demos – Bring to successful operation
- Large Scale Pilots – Capture and Advanced Power Systems
- Reduce risk and uncertainty with carbon storage
- Accelerate Transformational Technologies
- Reducing water demand/use
- Materials, High performance computing, manufacturing

CCUS Demonstrations in North America

Need to go further, faster

Saskpower – Boundary Dam

Operational Oct. 1st, 2014

Shell – Quest Project

Officially opened November 2015

W.A. Parish, TX NRG/PetraNova project

Broke Ground Sept. 2014 - On time & budget for 2016

Port Arthur Refinery, TX – Air Products 2013

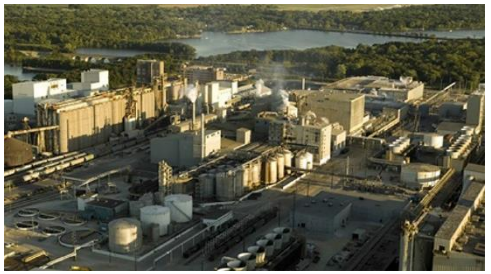
3+ million tons CO_2 stored

Knowledge Sharing Opportunities

Southern Company – Kemper Project

August 2016: Conducted initial test and produced syngas from lignite

ADM Agricultural Processing and Biofuels Plant, Decatur IL



Construction complete – Operational Jan 1 2017

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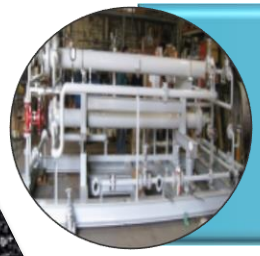
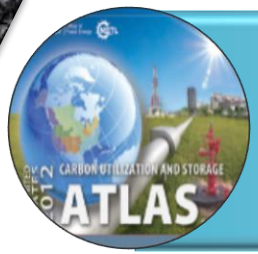
Advanced Fossil Technologies

Advanced Energy Systems (AES)
Technologies that greatly improve plant efficiencies, reduce CO2 capture costs, increase plant availability, and maintain the highest environmental standards



Carbon Capture
R&D and scale-up technologies for capturing CO2 from new and existing industrial and power-producing plants



Carbon Storage
Safe, cost- effective, and permanent geologic storage of CO2

Cross Cutting Research
Materials, sensors, and advanced computer systems for future power plants and energy systems integrated with CCS

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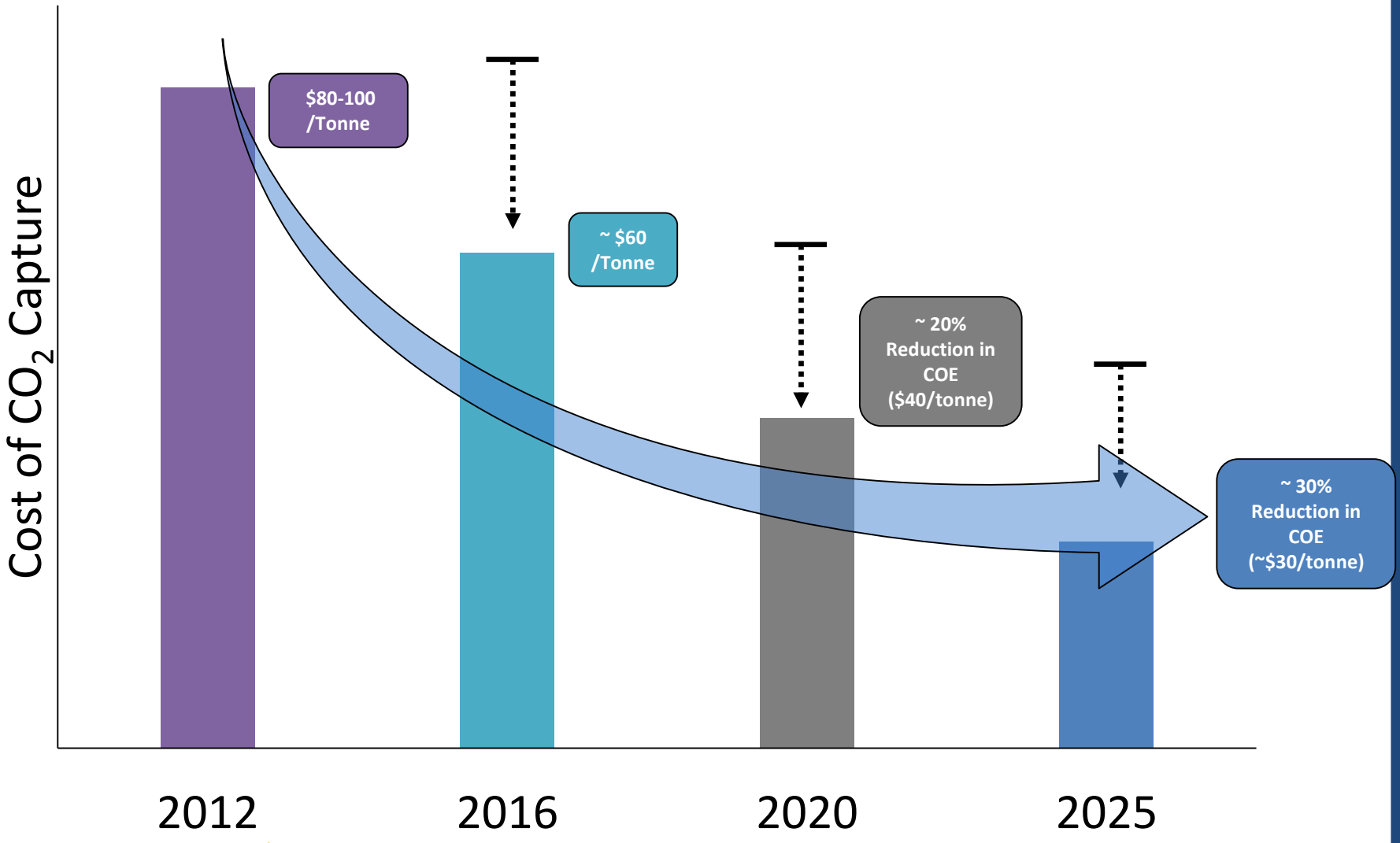
Carbon Capture and AES Goals



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Much Progress on Carbon Storage, But Uncertainties Remain

- **If cost issues lie with capture, risk issues lie with storage**
  - **Questions about scale up, liability, performance**

- **Current program reflects progress made**
  - **Emphasis on key areas (e.g., geomechanics)**
  - **Emphasis on integration (e.g., NRAP)**
  - **Operational aspects (BEST)**
  - **Large-scale deployment**

	Then CCS Program Initiated (1997)	**Now** Progress to Date	**Future** CCS Broad Commercial Deployment
Storage R&D	• Little known	• Knowledge gained and tools being developed and tested	• "Commercial toolbox" developed
Infrastructure/Field Tests	• Little known; Sleipner project initiated	• Increased visibility; Knowledge gained and lessons learned	• Potential realized; Frameworks in place for market deployment

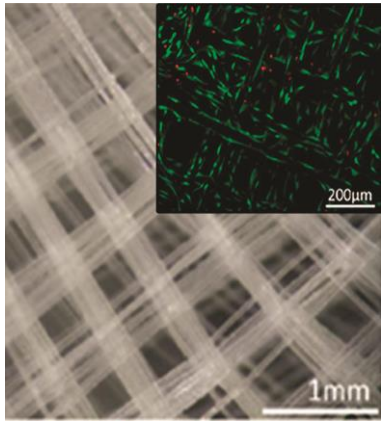
CCS is Also Critical for Industrial Sources

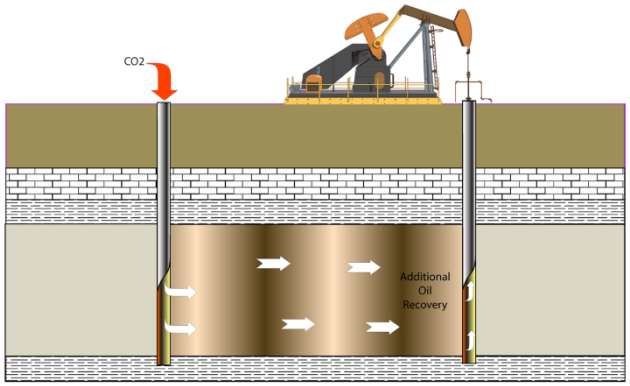
- Globally, industry accounts for 40% of energy-related CO_2 emissions -- mostly in developing countries
- Many industrial facilities are large point sources
- In some plants, CO_2 is already being captured in order to produce the desired product (e.g., H_2/Ammonia), and additional capture cost is minimal
- CO_2 concentration in treated stream may be high or nearly pure
- Often located near potential storage sites

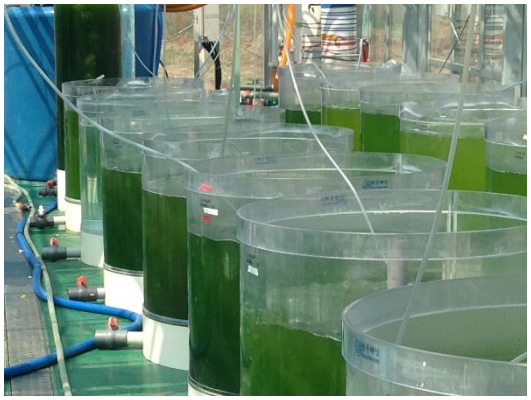
Hanson Permanente Cement Kiln, Los Altos, CA, 2008

Future Opportunities

- “Mission Innovation”
- Manufacturing/Modularization
- Materials
- High-Performance Computing
- CO2 Utilization?
- “Negative emissions” – BECCS and other concepts?







Mission Innovation

- 20 heads of state
- Countries represent 85-90 % of global R&D investment
- Each country supporting a doubling of its R&D investment over the next five years
- Complemented by a private sector initiative

Summary

- CCS is necessary and required to meet climate goals
- Program efforts are focused on:
  - Delivering large-scale CCS projects to maximum scientific and technical benefit
  - Support a diverse clean coal research program likely to bring to market large improvements in cost, efficiency, and performance
  - Find solutions to maximize carbon efficiency and offset costs of CCS
- Partnerships are imperative: public-private, international, local-state-federal

Questions