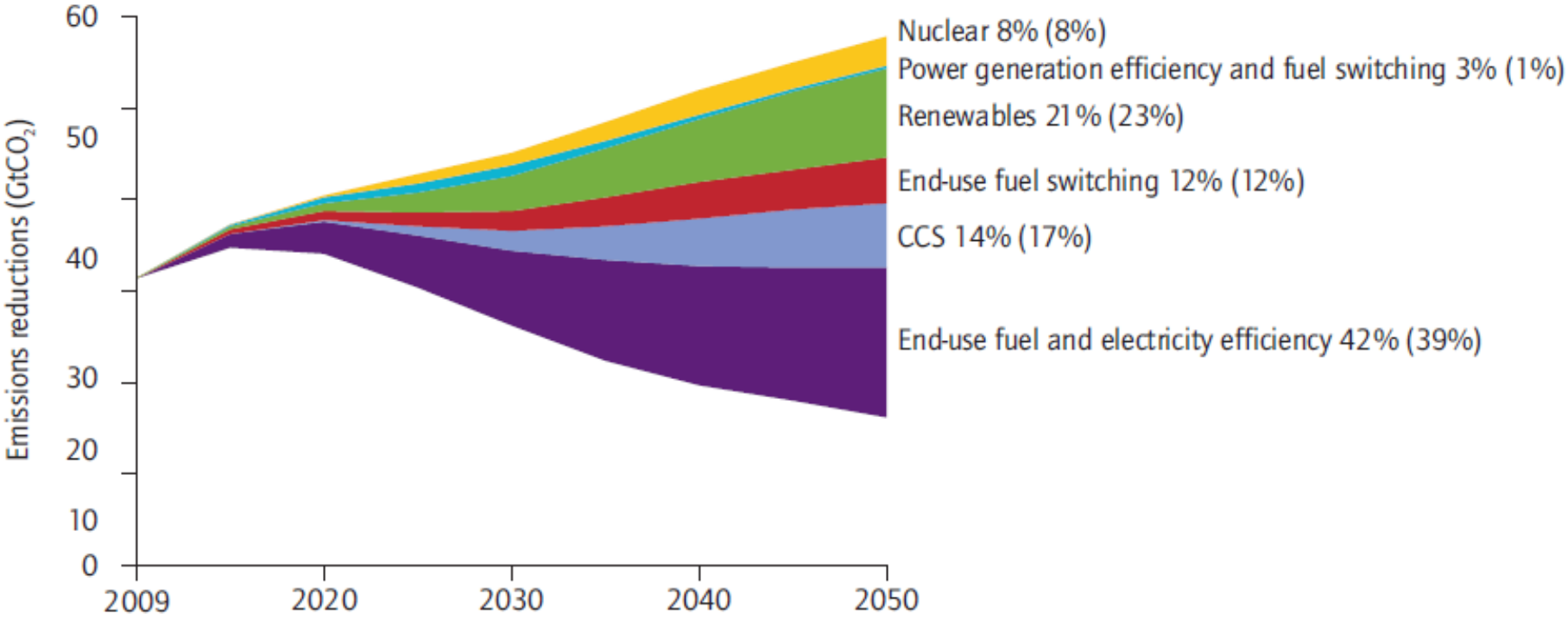

We live in a time of energy abundance
Once in a generation opportunity to build

IEA Roadmap 2013: Key Technologies for Reducing Global CO_2 Emissions



No technology is sufficient; all required to minimize cost

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Source: IEA Roadmap 2013.
Note: Numbers in brackets are shares in 2050. For example, 14% is the share of CCS in cumulative emission reductions through 2050, and 17% is the share of CCS in emission reductions in 2050, compared with the 6DS.

President's Climate Action Plan: Three overarching themes

Mitigation (emissions reduction)

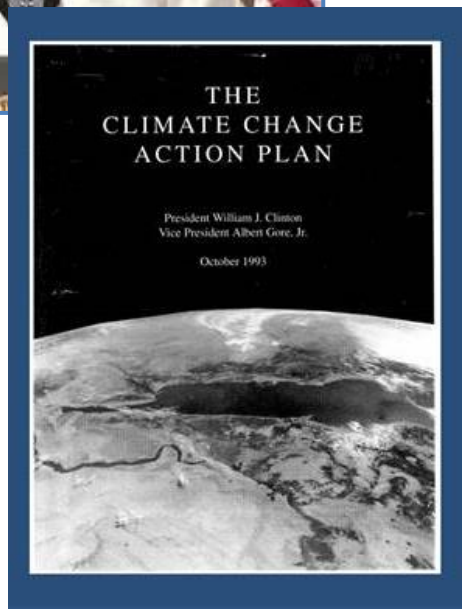
- *ALL OF THE ABOVE*
- Efficiency, Renewables, Nuclear, Gas
- Coal with CCS/CCUS

Adaptation and resilience

- Smart, reliable grid
- Key infrastructure investments

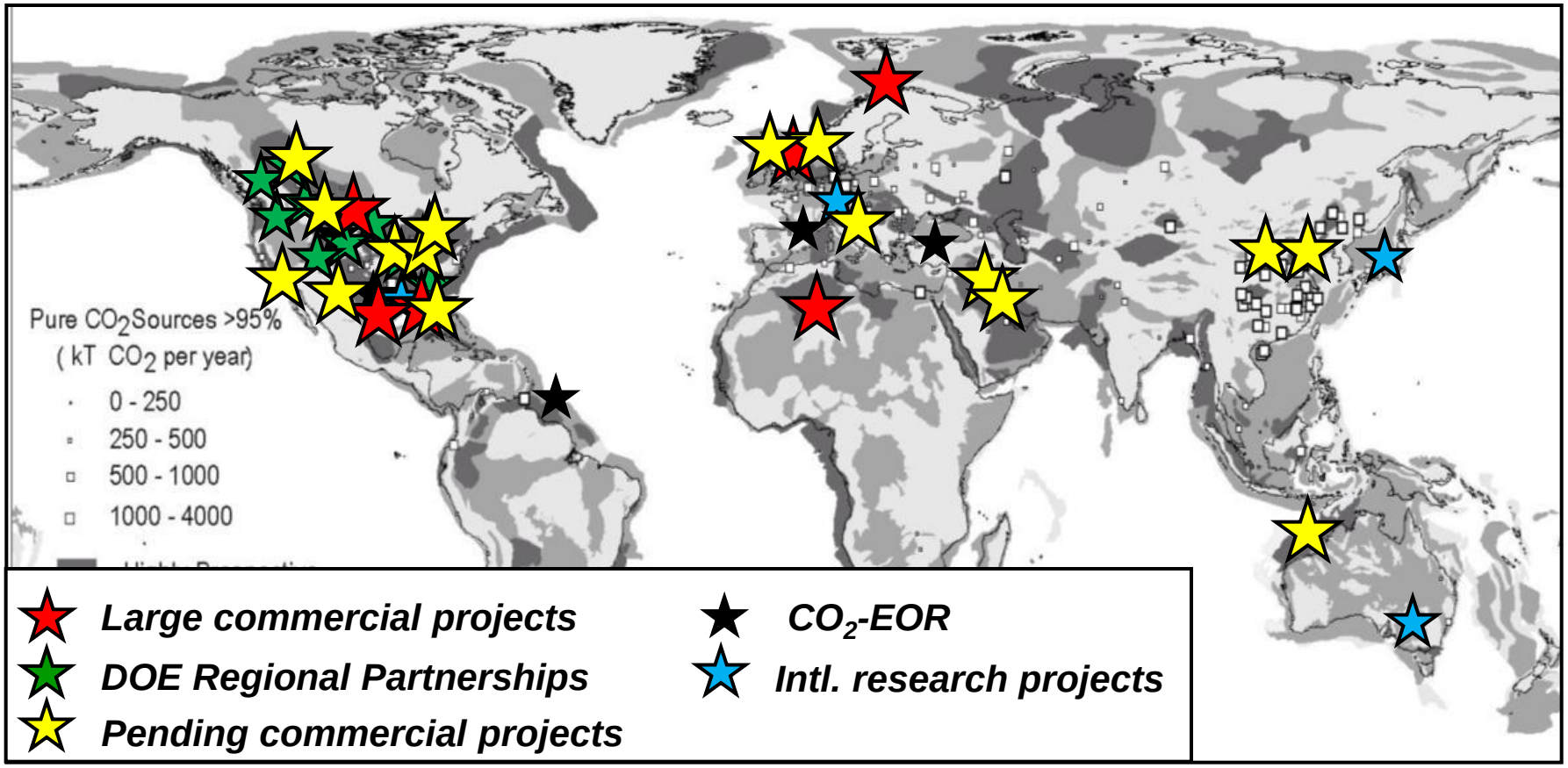
International Partnerships

- China and Asia
- Coordinated intl. efforts



Once in a generation opportunity to build

The US and international community have deployed over a dozen large CCS projects



Key unit of innovation – global engines of discovery

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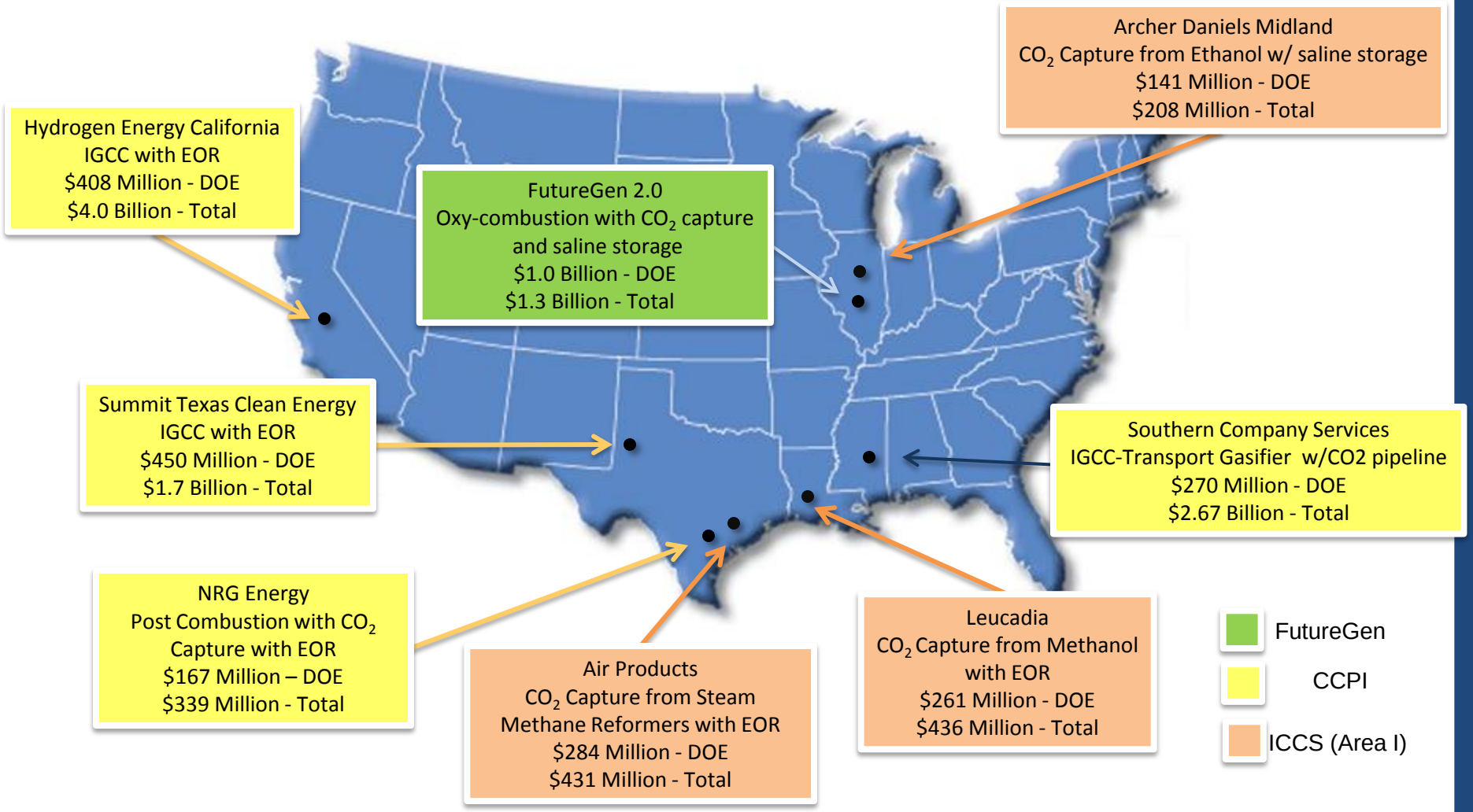
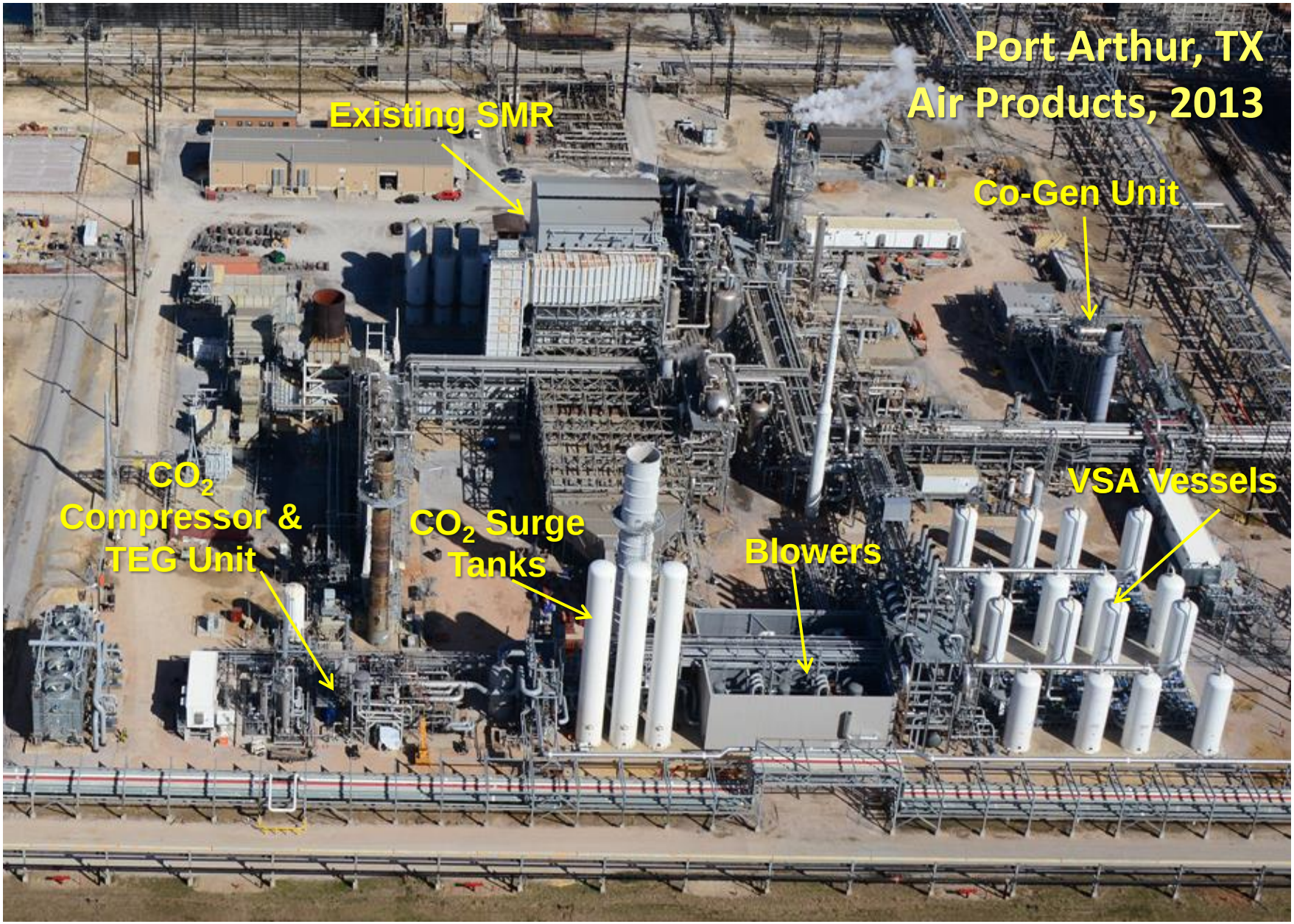
DOE CCUS Demonstration Projects

Focus – Large-scale commercial demonstration of CCUS integrated with coal power generation and industrial sources.

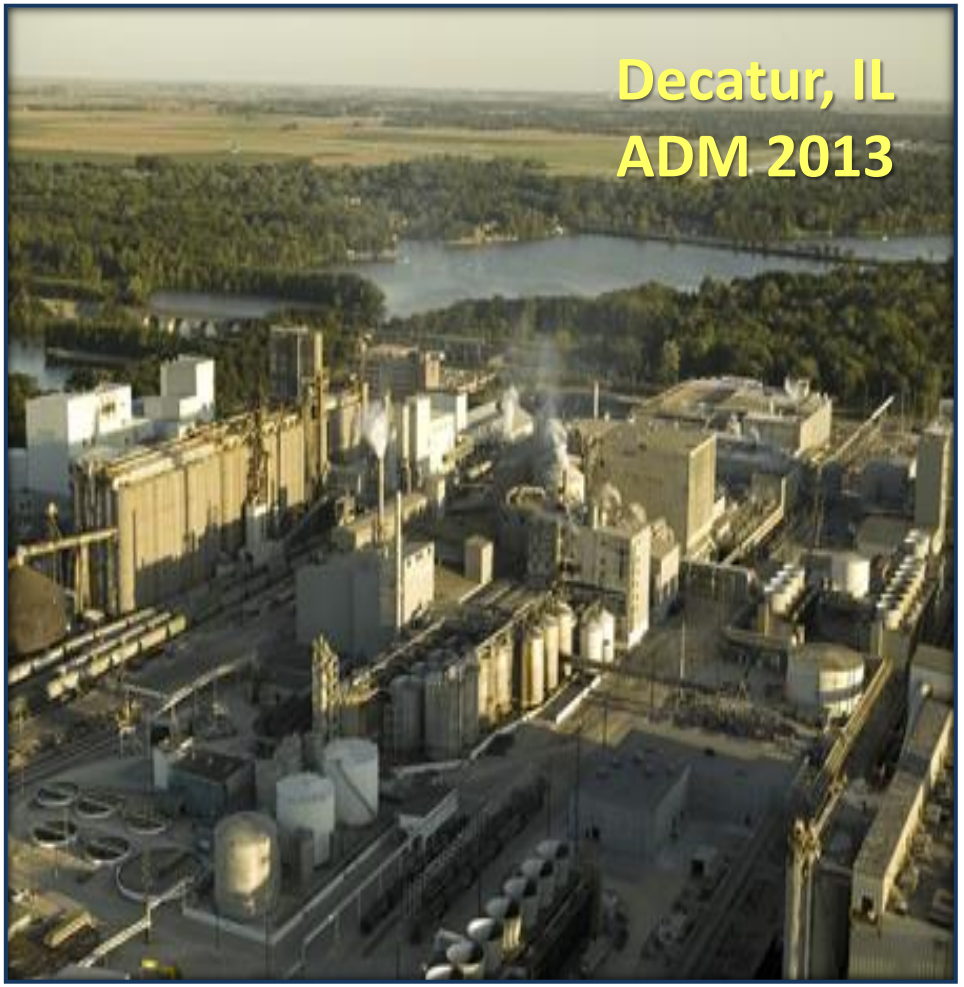



Kemper County, MS
Southern Co., 2010
OxBlue™
Construction Camera Service


Kemper County, MS
Southern Co., 2013


Port Arthur, TX
Air Products, 2013
Existing SMR
Co-Gen Unit
CO_2 Compressor & TEG Unit
CO_2 Surge Tanks
Blowers
VSA Vessels

A Dehydration/ compression facility location
B Pipeline route
C Injection well site
D Verification well site
E Geophone well



CO_2 Pipe to Injection Well

Compression Facility

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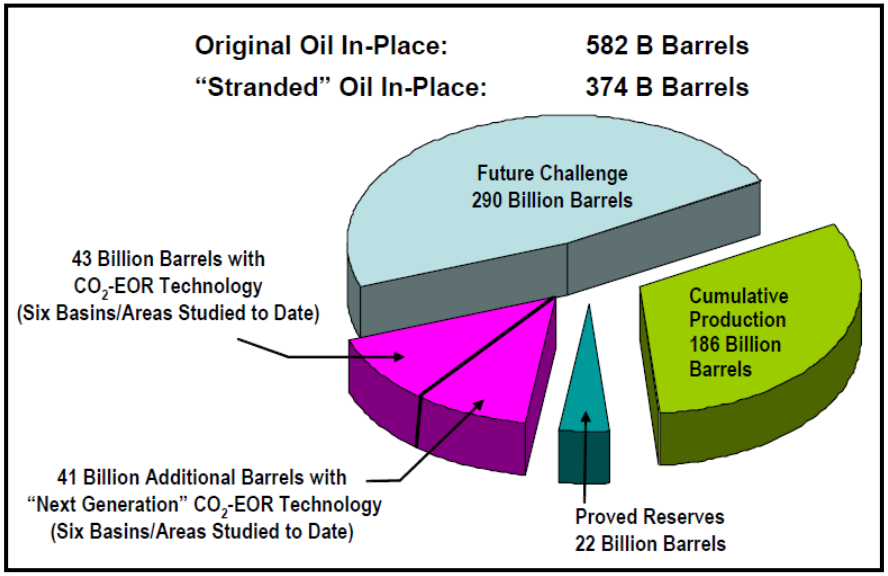
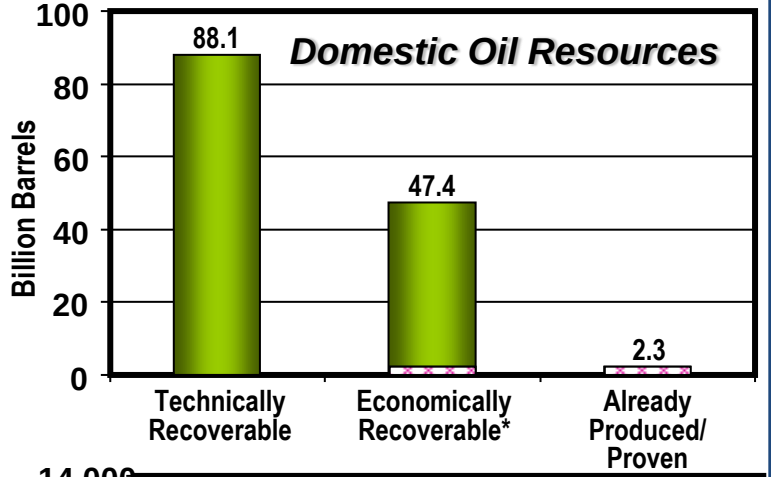
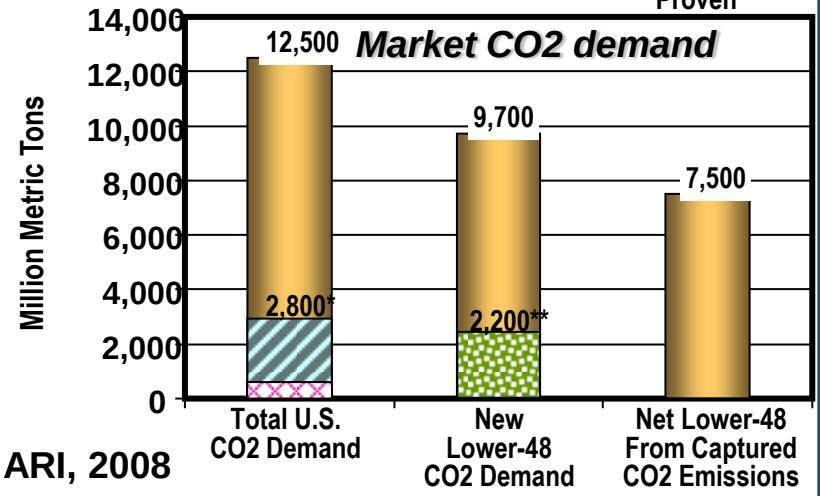
In the near term, EOR is a critical bridging step that brings near-term benefits to the US

- **Many 10's of billions producible just US; 100's of billions worldwide**
- **Required to finance first set of projects; required to drive down costs through deployment**
- **Additional domestic supply, revenues; reduced imports**





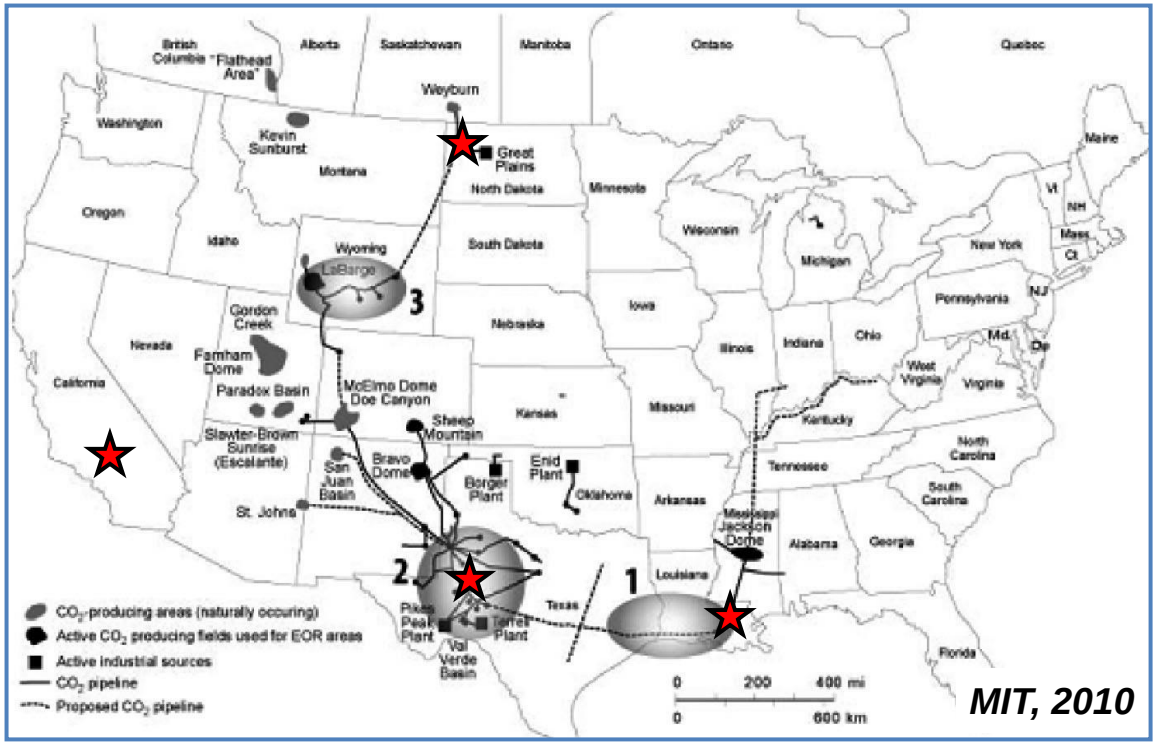


ARI, 2008

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

Emergent networks of EOR-anchored projects: Anchors for additional development

- **Permian basin; Gulf Coast; California; N. Dakota/ Saskatchewan**
- **Central Alberta Basin**
- **Scotland/Central N. Sea**
- **Ordos basin**



Opportunity for govt. fast-tracking and co-development

Ground work for pipeline networks; fast followers; CO2 utilities

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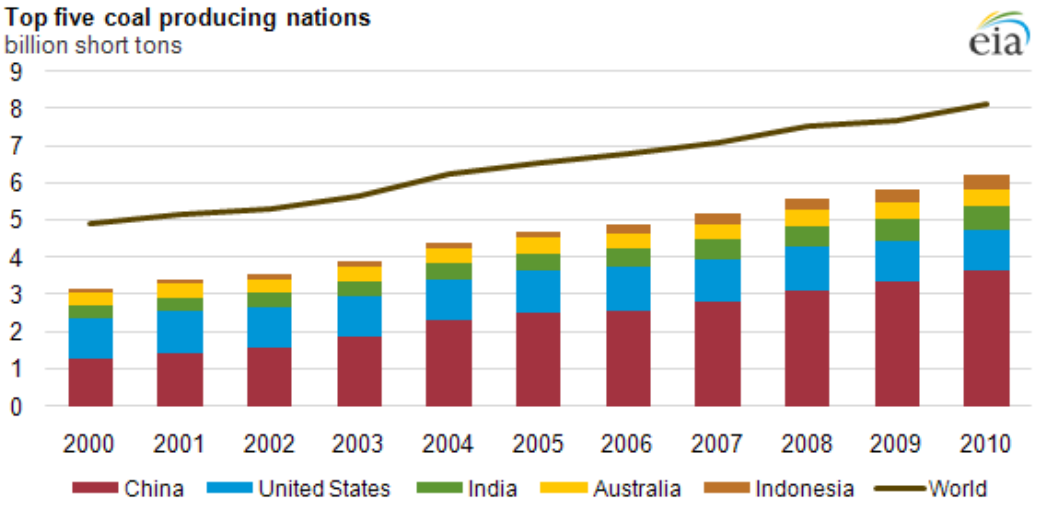
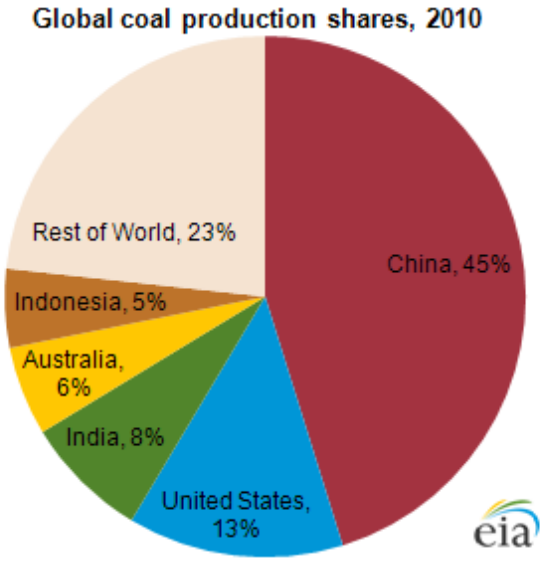
China: necessary and equal partner

- **Global leader and driver**
  - In coal use, production, & imports
  - In CO2 emissions
  - In boiler and gasifier construction
  - In renewable loading and production
- **Technically advanced**
  - Gasification technology and use
  - USC-PC; developing A-USC cycles
  - Advanced modeling & simulation
- **Global economic powerhouse**





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Changing landscape for CCUS is China

- **Environmental focus**
  - High political and economic costs
  - Beginning to affect investors
- **Policy Changes**
  - Bilateral agreements (e.g., CCWG)
  - NDRC primacy
  - Shaking up SOEs
- **Technology progress**
  - GreenGen operational: capture facility in construction
  - Progress on Post- and Oxy-combustion

Once in a generation opportunity to build

US-China key bi-lateral cleantech platforms

Strategic New and Economic Dialogue

Climate Change Working Group

US-China CERC (key R&D platform)

- Coal + CCUS*
- Efficient buildings
- Efficient Vehicles
- IP protections

***Fossil Energy Protocol & Oil and Gas Industrial Forum**

**** fossil focus***

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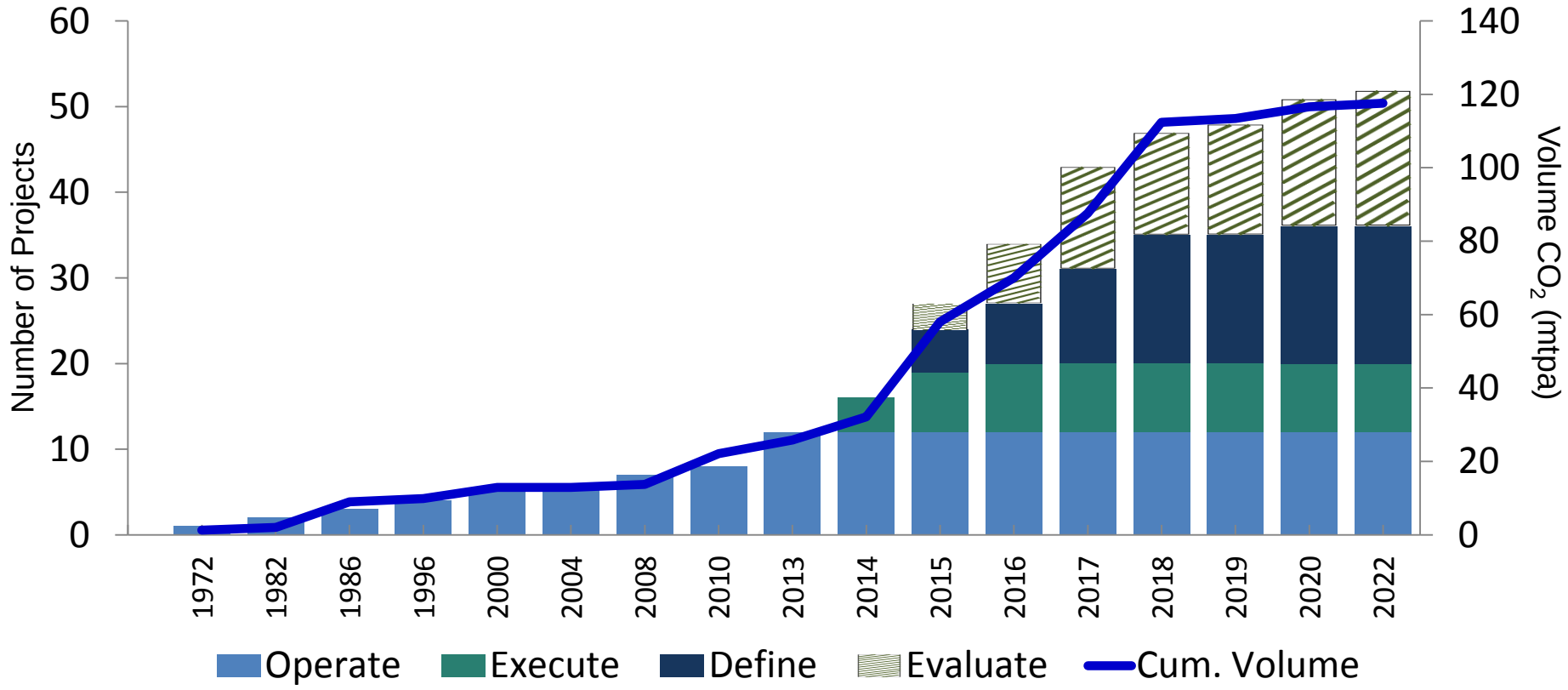
Large Scale Integrated Projects World Wide



Data from Global CCS Institute

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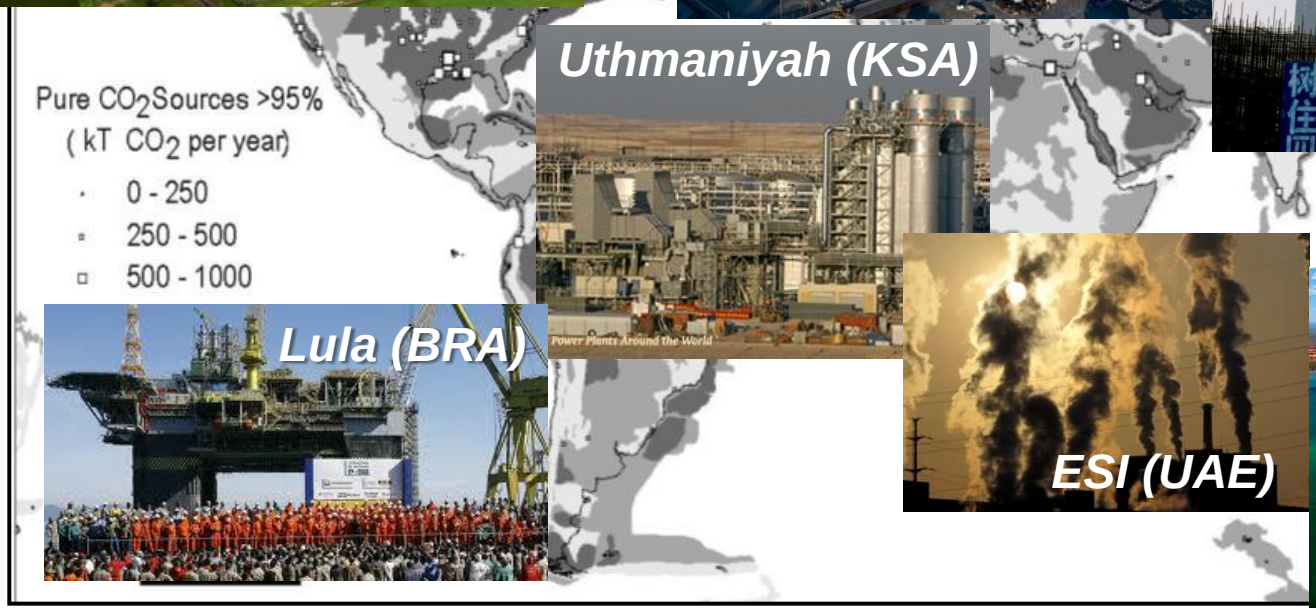
Global challenge ⇒ global progress: new global solutions still required



We just need more projects and more information