



Accelerating CCUS Commercialization Through US-PRC Business Collaborations

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Growing U.S.-China Clean Technology Cooperation
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Clean Air Task Force is a non-profit organization dedicated to reducing atmospheric pollution through research, advocacy, and private sector collaboration.

MAIN OFFICE

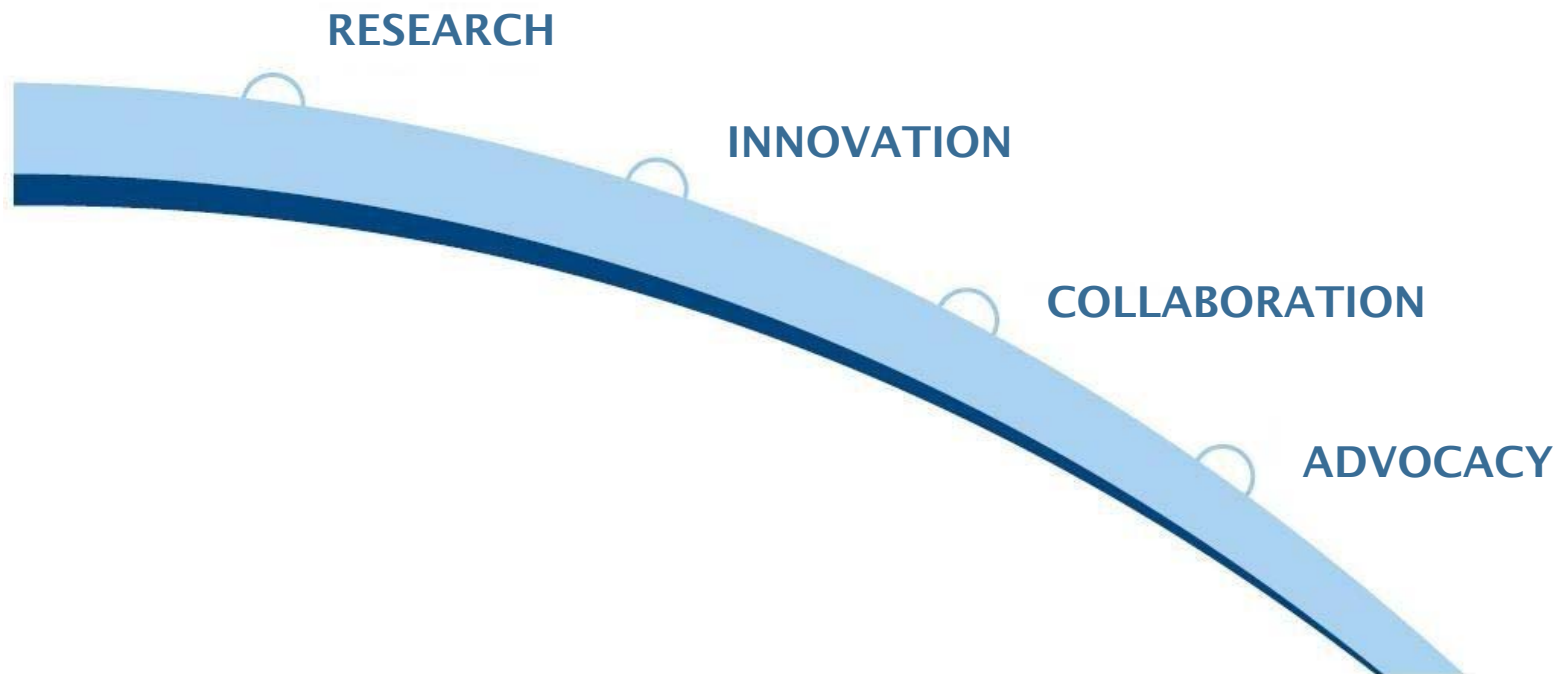
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CATF approach

- CATF works to protect the Atmosphere through...



- 100% charitable funding ensures independence

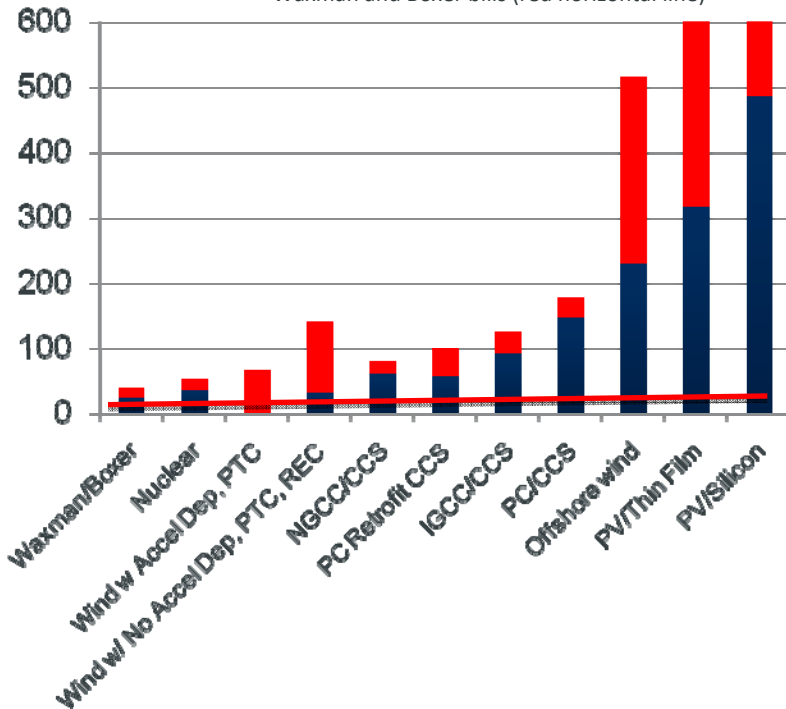
Discussion Outline

- **Needed: Decarbonized Coal**
- Key CCUS Technologies and Opportunities
- CATF Facilitation of CCUS Projects

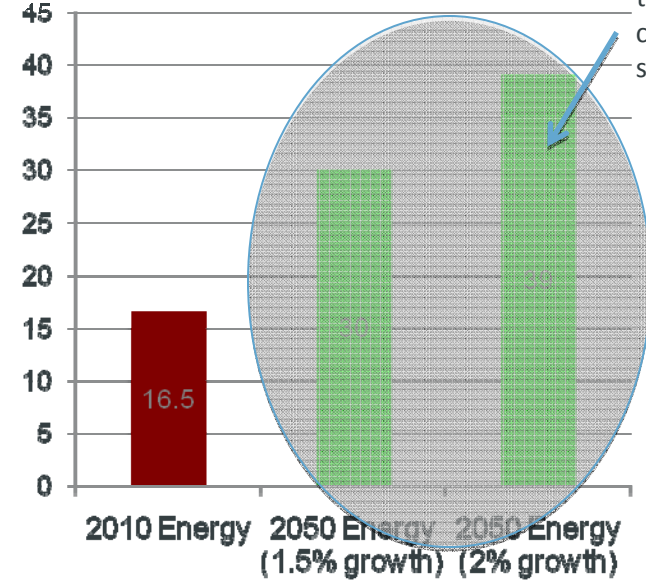
The Climate/Energy Challenge

- Significant reductions in global and US energy greenhouse gas emissions will require massive change in technology.
- We are not on such a pathway, and even if carbon prices rise rapidly it will not get us there.

High and low carbon prices (\$/ton CO2) needed to incent low/zero carbon energy sources instead of natural gas vs carbon prices projected from Waxman and Boxer bills (red horizontal line)

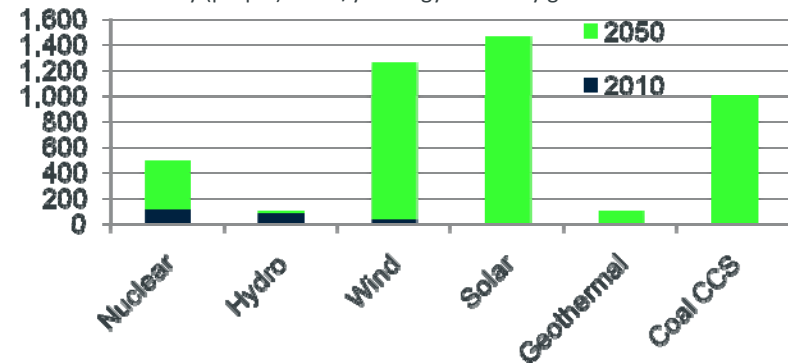


Global energy demand: present, and future (Terawatts)



Must all be carbon free to achieve climate stabilization

Amount of US carbon free capacity (Gigawatts) needed to reduce CO2 by 80% by 2050 (green) versus amount we have today (purple) at 3%/yr energy efficiency gains



The Climate/Coal Challenge

Coal will remain a significant source of GHG ...

- IEA, DOE EIA, PRC NDRC, and others project that coal will continue to be a key source of energy for years (particularly in China, India, US).
- Coal-fired power generation accounts for about 40 percent of man-made CO₂ emissions from energy use.
- Global warming cannot be seriously addressed without substantial reductions in CO₂ emissions from coal power within the next two decades.

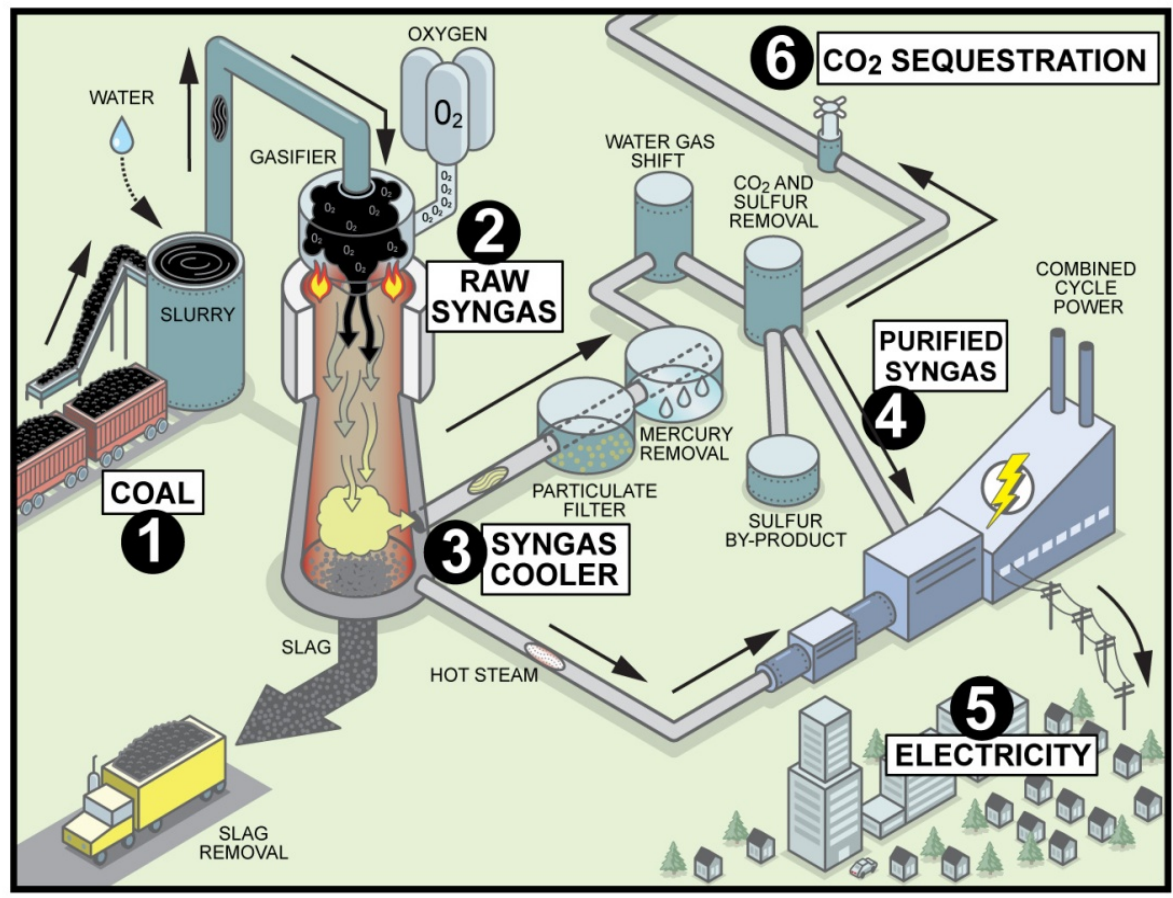
... Unless we deploy CCUS technologies.

- Widespread deployment of **carbon capture, utilization, and sequestration (CCUS)** technology is essential to stabilizing the global climate.

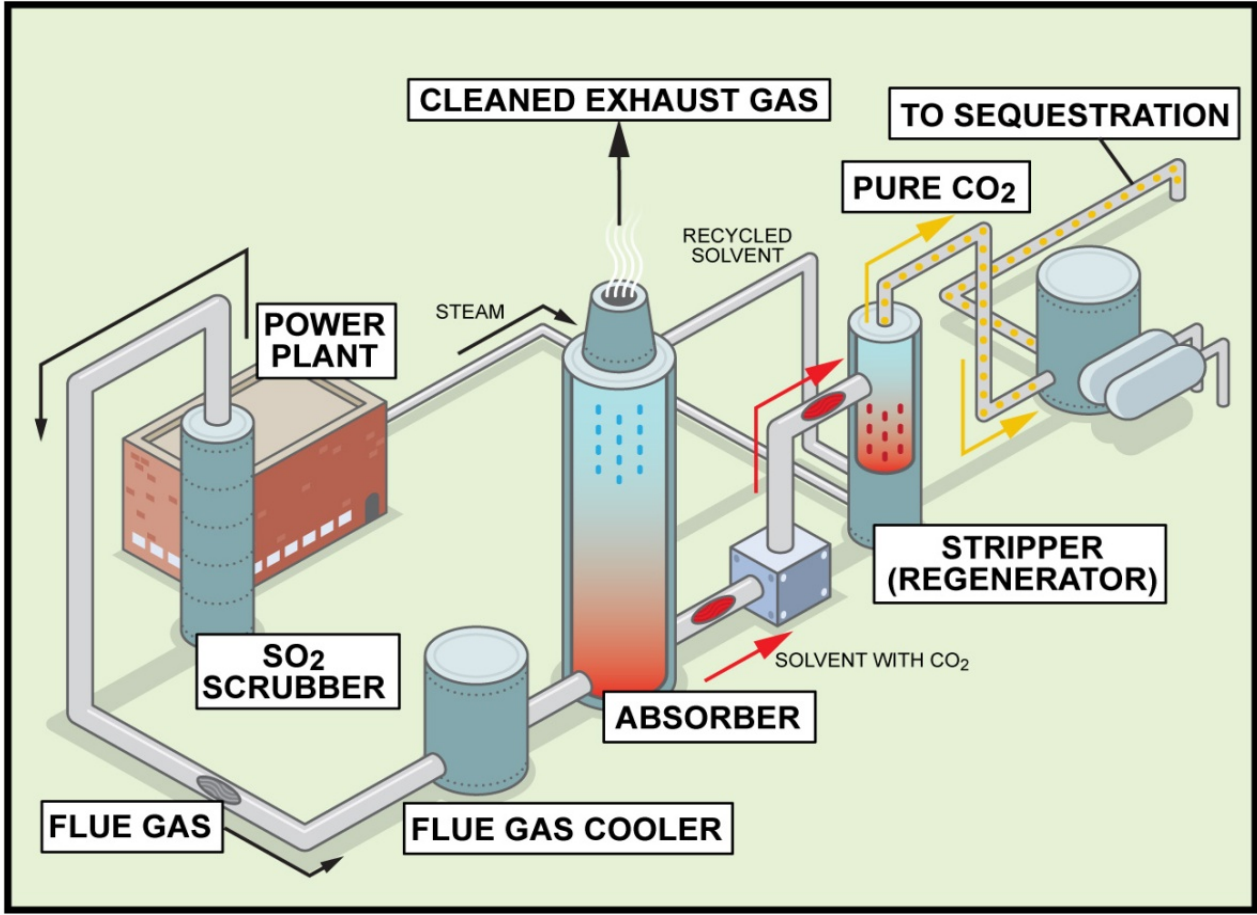
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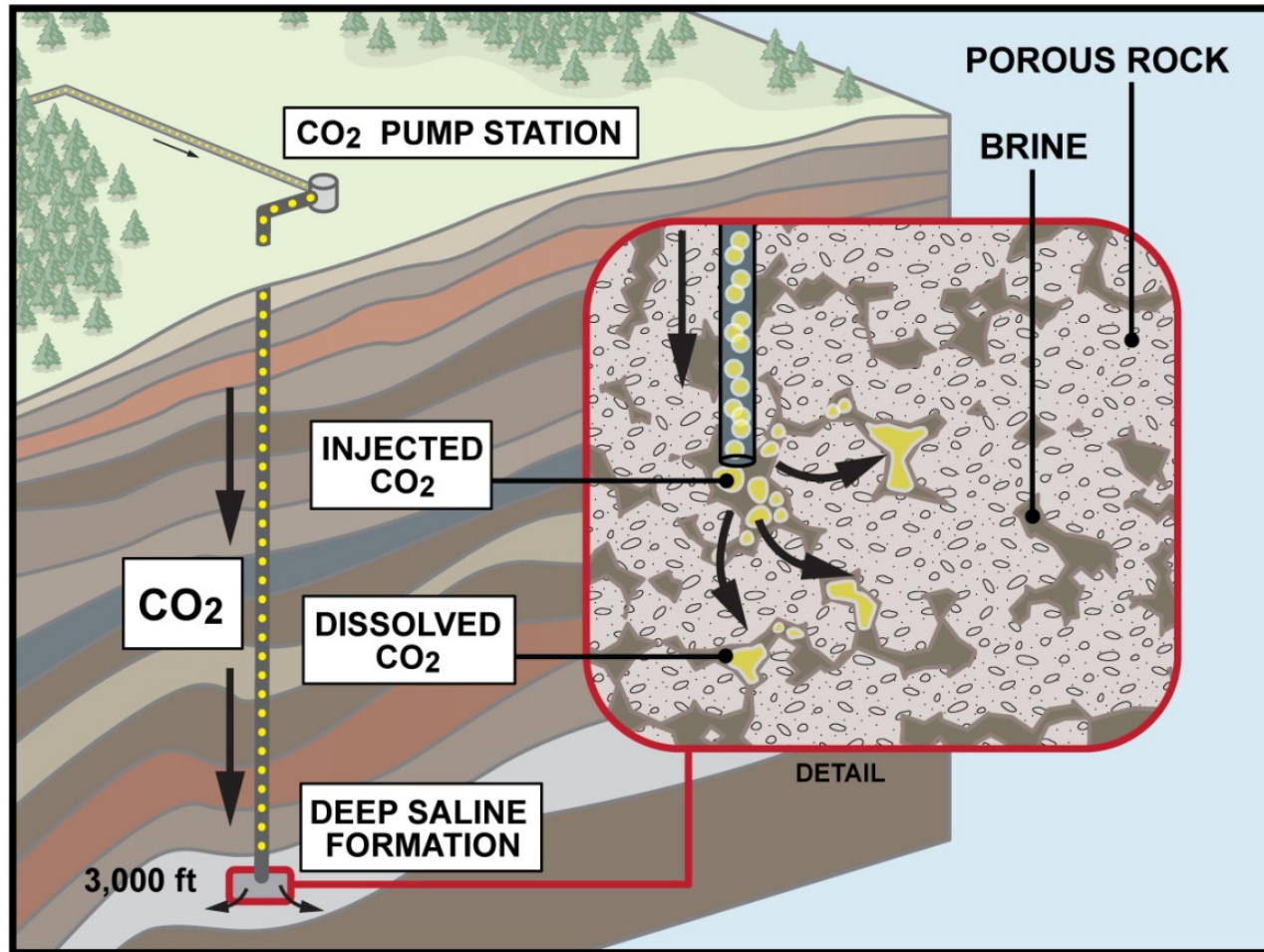
Advanced Coal Gasification



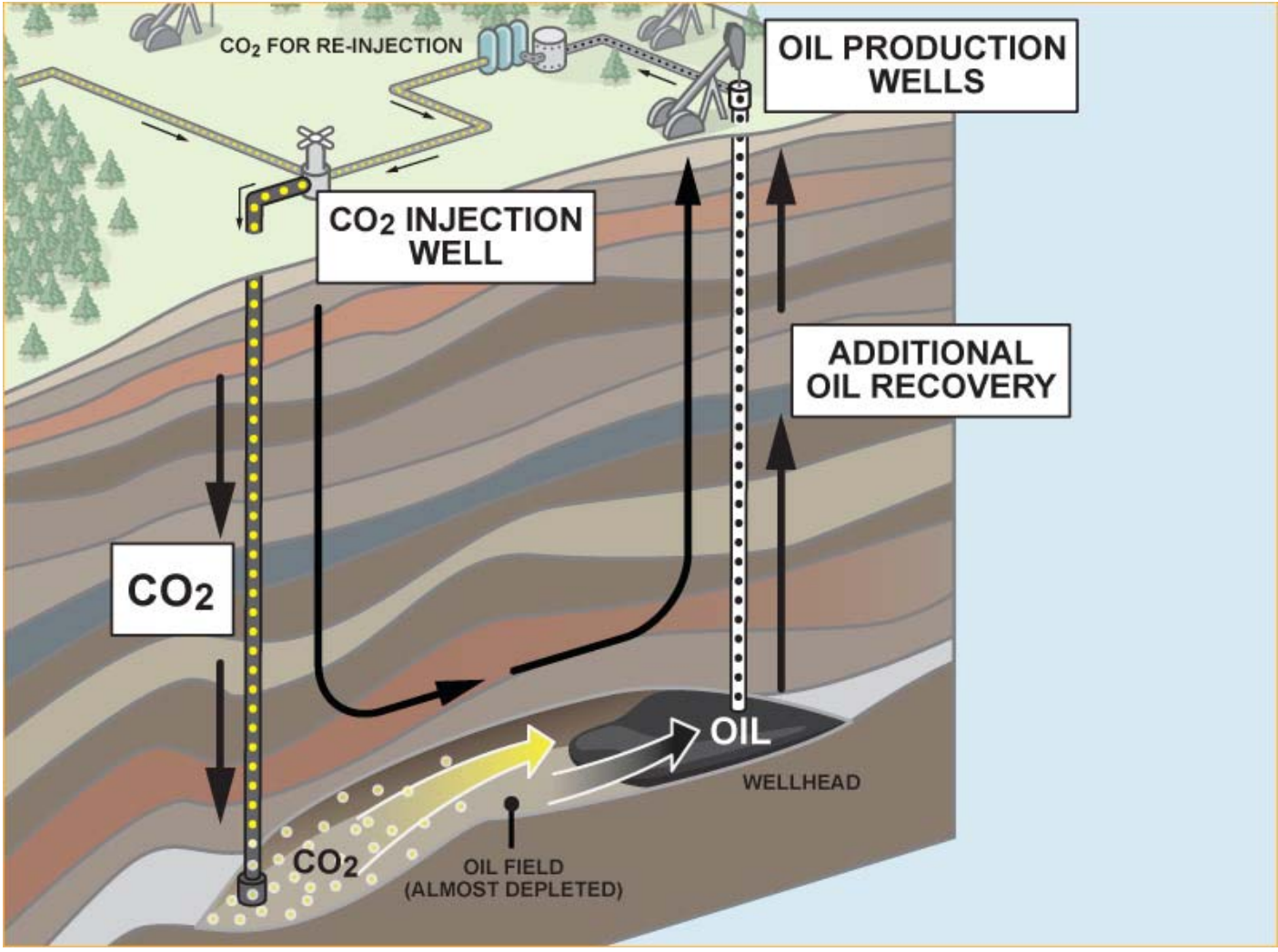
Post-Combustion Capture



Geological Carbon Sequestration



Enhanced Oil Recovery



China is a highly capable CCUS partner

- GreenGen IGCC
- TPRI and ECUST gasification systems
- Shanghai PCC (120,000T CO₂/year)
- Potential TPRI/Huaneng PCC scale-up to 1.0 million tons/year
- Shenhua DCL - 100K tons/year pilot, expand to 2.9 million tons/year
- Shenhua chemicals - several at pre-feasibility stage
- ENN Group Underground Coal Gasification
- CO₂ EOR – Jilin field?
- Ammonia plant CO₂ aggregation/EOR – exploration stage

US-PRC Partnerships Can Accelerate CCUS Deployment

- Energy companies in China and US have enormous experience and expertise working with coal, and are similarly motivated to develop technologies and techniques that will preserve a role for coal in a carbon-constrained world.
- China is the center of the coal gasification “universe” (~80 GW thermal today), and its companies can develop CCS projects quickly (1/3 to 1/5 the US time) and at substantially less cost.
- US is the world leader in geologic sequestration: it injects 30 million tons of CO₂ each year for enhanced oil recovery and is undertaking large-scale saline aquifer CO₂ injection projects.
- Investments by one country can reduce the cost of a technology worldwide, increasing the likelihood that CCUS will be widely deployed in time to help avert the worst consequences of climate change.

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CATF's Coal Transition Project

- **Project Facilitation-** “Steel in the Ground” aimed at building commercial coal plants with CCS. Some projects include enhanced oil recovery (“EOR”) using CO₂.
- **Policy-** Develop and advocate for policies to rapidly commercial CCS.
- **RD&D-** Identify CCS technology RD&D needs and advocate for effective RD&D programs, funding (also explore potential US/China R&D cooperation).
- **CCS Industry-** Develop initial CCS industry at regional level that can grow to national/international scale.
- **International-** Develop international business collaboration on low carbon coal & gas technology, especially in Asia.

Overview of CATF US/Asia CCUS Work

- CATF launched its international advanced coal technology/CCS business-to-business effort in 2007.
- CATF co-founded two related organizations to promote our work in Asia: the Asia Clean Coal Initiative (established 2007) and the Asia Clean Energy Innovation Initiative (established 2009)
- Result: several partnerships between innovative US/PRC energy companies, in which CCUS projects are being explored.
- Partnerships are changing attitudes!
- Potential partnerships are being explored in India

ACCI

Asia Clean Coal Initiative



Premise

- Stabilizing global climate requires decarbonized coal.
- International business-to-business collaboration will reduce advanced fossil and CCS costs and accelerate deployment timelines.

Results

- Strong commercial interest
- Many JVs/MOUs

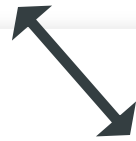


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Asia Clean Energy Innovation Initiative

Launched in 2009 to apply ACCI's B2B-focused approach to renewables and advanced nuclear, in addition to low-carbon coal.





TPRI

THERMAL POWER RESEARCH INSTITUTE



Future Fuels



CHINA project – partnerships facilitated

JV Agreements	Scope of Agreement
ZEEP - ENN Group	Deployment of P&W Rocketdyne gasification system.
Southern Company/KBR – Dongguan Tiaming Electric Power Company	Deployment of TRIG gasifier.
Duke Energy – ENN Group	Joint work on a range of climate technologies including UCG, CCS, solar, and algae biofuels; ENN investment in Duke solar-PV projects.
BrightSource - TPRI	Solar-thermal technology development and application in China.
Duke Energy – China Huaneng Power/TPRI	Advanced coal generation, CCS including post combustion capture, GCS/EOR, and renewable energy – including wind, biomass and solar.
Future Fuels - Thermal Power Research Institute (TPRI)	North American licensee for TPRI gasifiers, application of TPRI-designed gasifier at proposed IGCC projects in US and EU.
Others parties under discussion include CNOOC, GreatPoint Energy, General Compression, etc.	

Summary

- US/China B2B advanced coal technology/clean energy tech partnerships are gaining momentum
- Opportunities exist to develop and deploy CCUS in both countries through such partnerships.
- Priority should be placed on B2B partnership facilitation of operational CCUS project development in both countries.

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