The Integrated Test Center – Carbon (ITC)

Accelerating the Development and Commercialization of Carbon Utilization Technologies

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Industry Background

- Introduction of new technologies can be challenging in providing consistently reliable and affordable electricity to consumers
- Industry is understandable cautious when introducing new technologies into scaled production
- The ITC will share the risk and provide for the testing of a broader spectrum of technologies
Overview of the ITC

• An international post-combustion advanced technology test center
• Integrated into a Wyoming-based coal-fired power plant
• For the demonstration and perfection of integrated CO2 capture and utilization technologies
• And host to an international, multi-million dollar prize competition (in development); http://www.xprize.org/prizes/future-prizes/carbon
Advantages of Energy Test Centers, Specifically the ITC

- Facilitates concurrent testing and development of multiple technologies
  - Not wedded to one technology or approach
  - Provides an apples to apples comparison of how a variety of technologies perform
- Reflects the real world - a primary concern among energy producers is the accuracy of performance predictions extrapolated from labs and applied to the real world
- Addresses “stack risk” – goal is the ITC’s approach would be permitted up front, reducing the burden of receiving a permit for every test technology
- Reduces deployment costs - ease and reduction of interconnection costs (design and connect to a standardized connection)
- Promotes experimentation, innovation, and collaboration – with multiple technologies comes natural collaboration including that between operators and energy producers
- Enables cost-effective scale-up – linking of slipstreams (e.g., 10 x 2 MW slipstreams)
The new Integrated Test Center will complement and build upon the successful approaches of the existing U.S. government-supported National Carbon Center (NGCC) and post combustion carbon center (PC4).

- To accelerate development of unconventional carbon capture technologies that break through the current capital and parasitic load burdens.
- And utilize CO2 to create value out of what is currently a waste product.
- By adding unconventional carbon capture technologies and CO2 utilization to the technology acceleration platform, the Integrated Test Center will be the world’s first end-to-end carbon solution accelerator.

Leveraging existing support of carbon capture…

…By catalyzing the technology’s development in conjunction with the beneficial utilization of CO2
ITC’s Aim

• The ITC’s Aim is to host new technologies focused on augmenting virtually any and every element of the electric generation plant from pre-combustion to combustion to post combustion R&D

• The cornerstone of the ITC will be the International Carbon Utilization Center (ICUC), the first end-to-end carbon solution accelerator that accelerates the development of unconventional carbon capture technologies, as well as the utilization of the captured CO2 to create value

• Ability to test multiple technologies across a spectrum of integrated energy platforms

• Provide multiple technologies with multiple integrated platforms

• Will combine existing technologies and infrastructure with new ones to create interlinked, hybridized approaches

• Allows for the entrance and exit of various technologies
Emerging Industry Snapshots
Carbon Utilization Beyond EOR

Carbon Capture & Recycling Industry Overview
A Review and Analysis of Technologies and Organizations that Recycle Industrial Carbon Dioxide Emissions Into Beneficial New Products.

Emerging Carbon Capture Technologies Overview
A Review of New Post-Combustion Technologies and Processes that Capture Industrial Carbon Dioxide Emissions at Power Plants.

136 (and counting) Carbon Utilization Entities

> 90 Emerging Carbon Capture Approaches
Carbon Recycling Approach #1

**Biological** (37)

A biological organism rapidly absorbs CO2 to produce a product
Carbon Recycling Approach # 2

Chemical/catalytic (63)

A catalyst breaks the carbon-oxygen bond, then combines the carbon with other elements to produce a product.
Carbon Recycling Approach #3

Mineralization (23)

CO2 is locked into solid structures that can then be incorporated into products.
> 90 Emerging Carbon Capture Technologies

In Six Different Categories

- Solvents
- Enzyme Based Systems
- Physical Sorbents
- Precipitated Calcium Carbonate Ionic Liquids
- Gas Separation Membranes
- Metal Organic Frameworks (MOFs)
The Carbon XPRIZE

Prizes Have a Long Record of Success

1714
The Longitude Act of 1714

1791
Chemical Engineering Prize
French Academy

1927
The Orteig Prize
(Charles Lindbergh)

1992
The Golden Carrot Prize

2004
Progressive Automotive X PRIZE

2010
The Ansari X PRIZE
Centralized Test Centers Have Proven Prize Success

Goal: inspire solutions to speed the pace of cleaning up seawater surface oil

*Held at the U.S. government's one-of-a-kind OHMSETT marine spill test center on a high-security military base in New Jersey*

38 teams competed from four nations
2x recovery rate improvement required
4x recovery rate achieved in 2011
Envisioned First Tenant of the ITC

Carbon X PRIZE

$10 million to the team that captures CO2 & creates the highest valued products

Turn CO2 from a “cost” to a “profit” center
Proposed Carbon XPRIZE Selection Process

- Hundreds of applicants
- 20 Chosen
- 3 + 2 = 5
- 6 mo Set-up
- X Prize
- 12 mo operations
- 2 years
- 6 mo
- 2 years
Canadian Majors Co-sponsor Carbon XPRIZE...
…and Build Their Own “Sister” Test Center in Alberta
Summary

- Fully researched test center approach
- Comprehensive platform to catalyze emerging carbon capture and utilization technologies
- Test Center Integrated into a Wyoming-based coal-fired power plant
- Carbon XPRIZE validated and co-sponsored by eight (and counting) large Canadian energy companies
- Sister test center to be built in Alberta with support of Canadian gov’t

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