



Post-Combustion CO₂ Capture for Existing PC Boilers by Self-concentrating Absorbent

- **Funding Opportunity Number:**

DE-FOA0000131

- **Area of Interest B2:**

Solvents

- **Bench-Scale Development of Post-combustion CO₂ Capture**

2010 NETL CO₂ Capture
Technology Meeting,
Pittsburgh, PA

Sep. 13-17 , 2010

- **Principal Investigator:**

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- **Project Manager:**

Dr. Gerald Choi, Nexant, Inc.

- **DOE Project Manager:**

Mike Mosser

- **Participants:**

E-ON U.S.

Electric Power Research Institute
(EPRI)

Nexant, Inc.

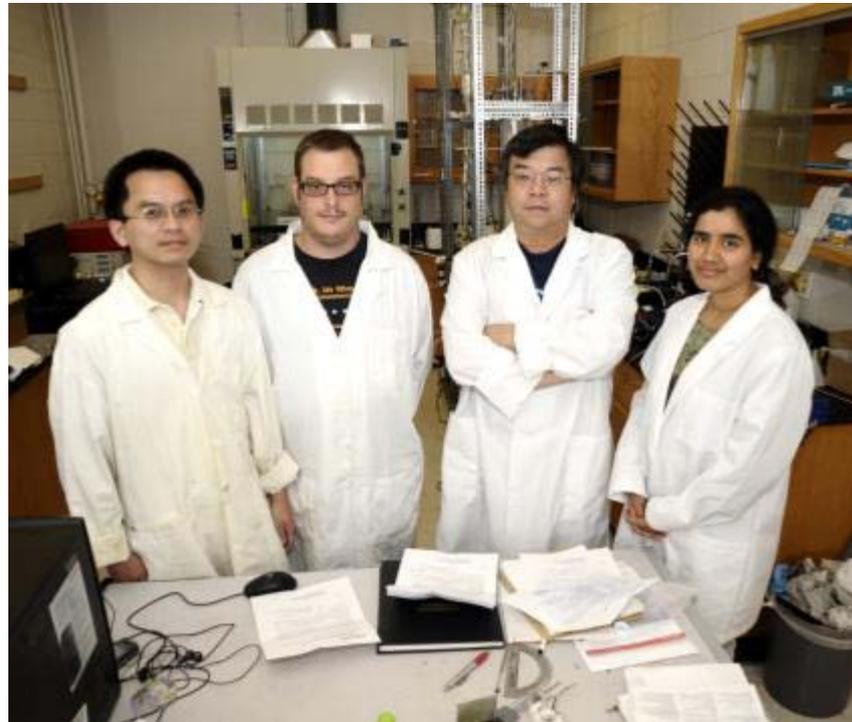
University of Kentucky

3H Company



3H Company

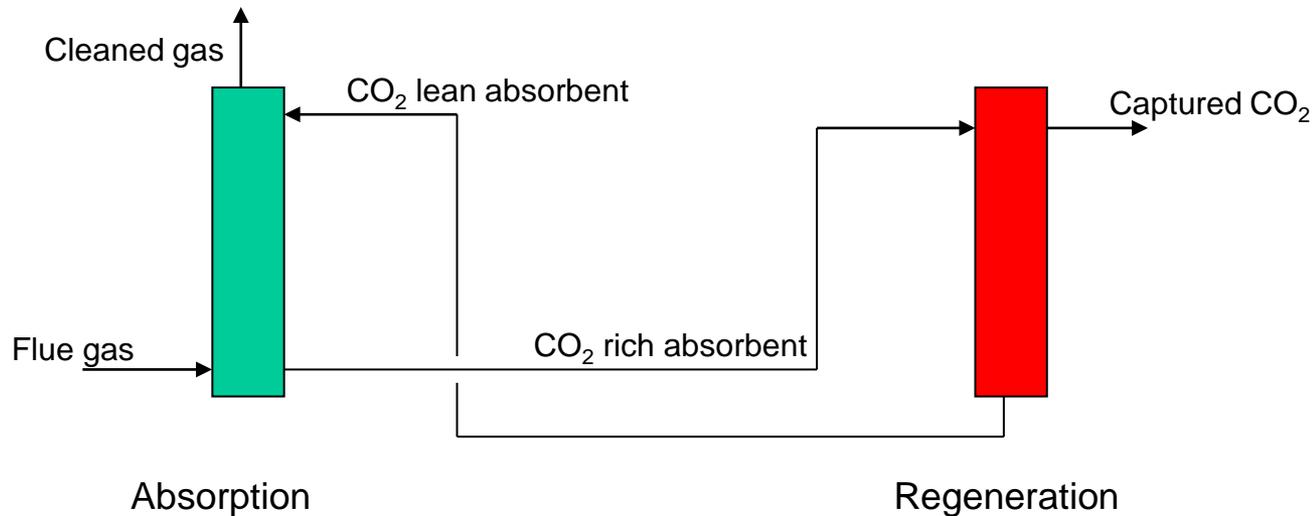
- 3 H Company is an start-up technology company, located on the campus of University of Kentucky, Lexington, KY
- The core business is research and development (R&D) of CO₂ capture technologies





Conventional Solvent-Based CO₂ Capture Process is Very Energy Intensive

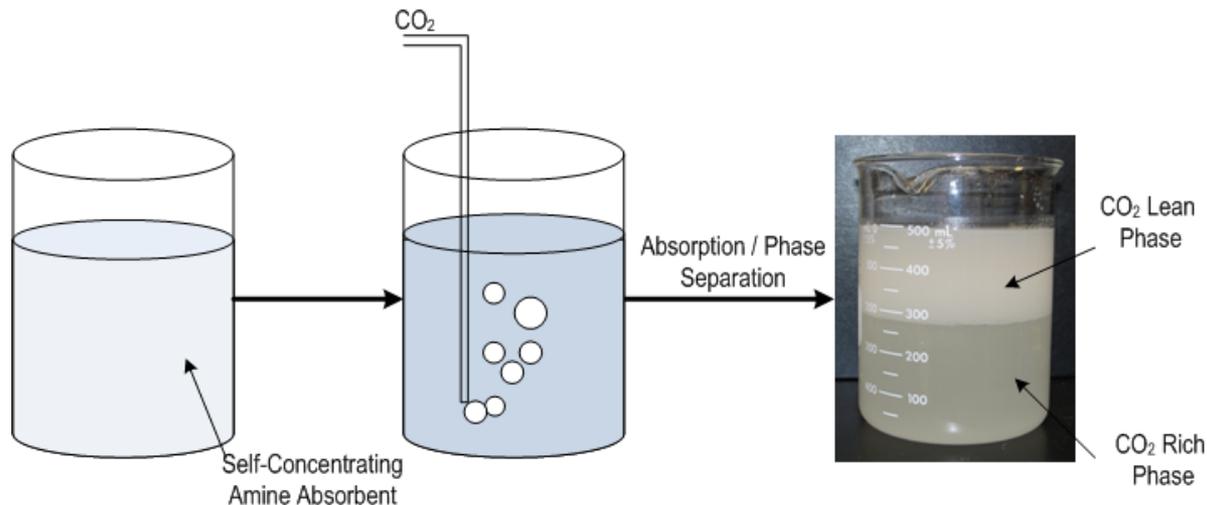
- Energy components: heat of reaction, sensible heat and vaporization heat
- Significant energy savings can be achieved with reduced solvent recirculation, and heat loss





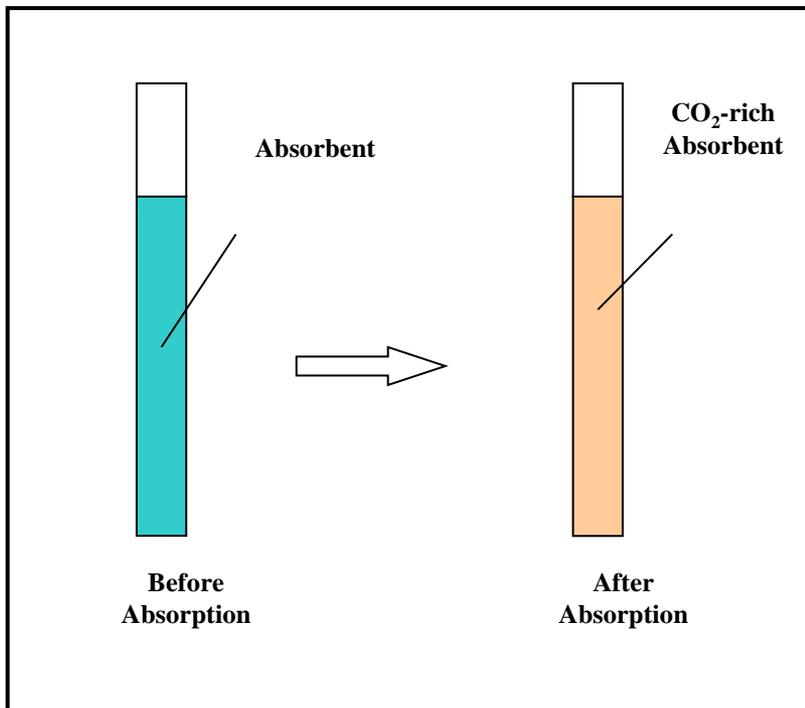
3H “Self-Concentrating” CO₂ Capture Process

- The absorbent after absorbing CO₂ splits into two phases, CO₂ rich phase and CO₂ lean phase. After separating the two phases, CO₂ rich phase is sent to regeneration. After regeneration, the regenerated CO₂ rich phase combines with CO₂ lean phase to form absorbent to complete the cycle.
- Process demonstrated in the laboratory for specific absorbent/solvent pairs in bench scale vessel and scaled-model packed column.

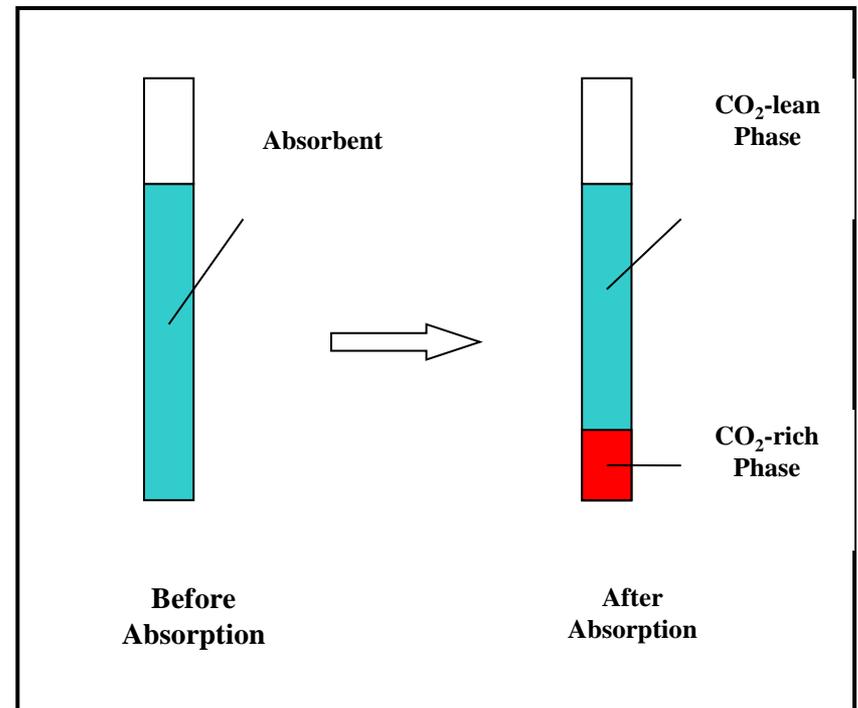




The difference between 3H and a Conventional MEA CO₂ Capture process



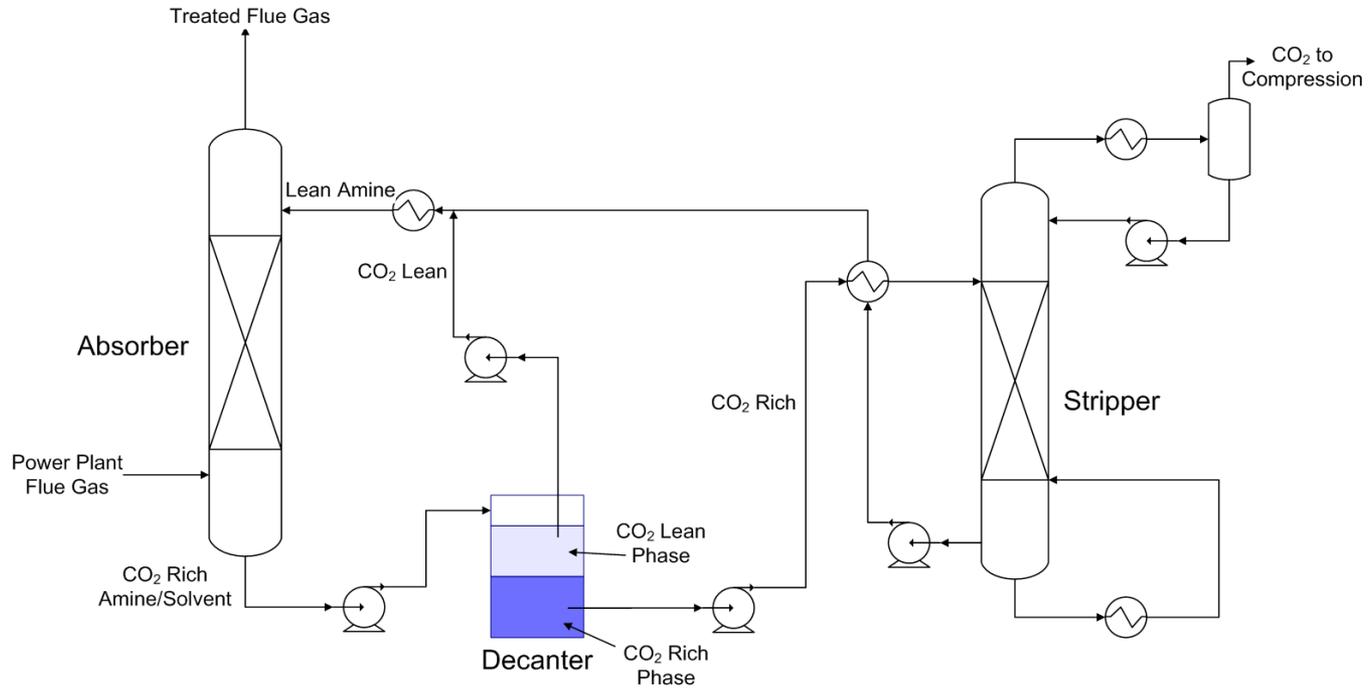
Benchmark MEA Absorption



Self-Concentrating Absorption



Conceptual Flow Scheme of a 3H ‘Self-Concentrating’ process

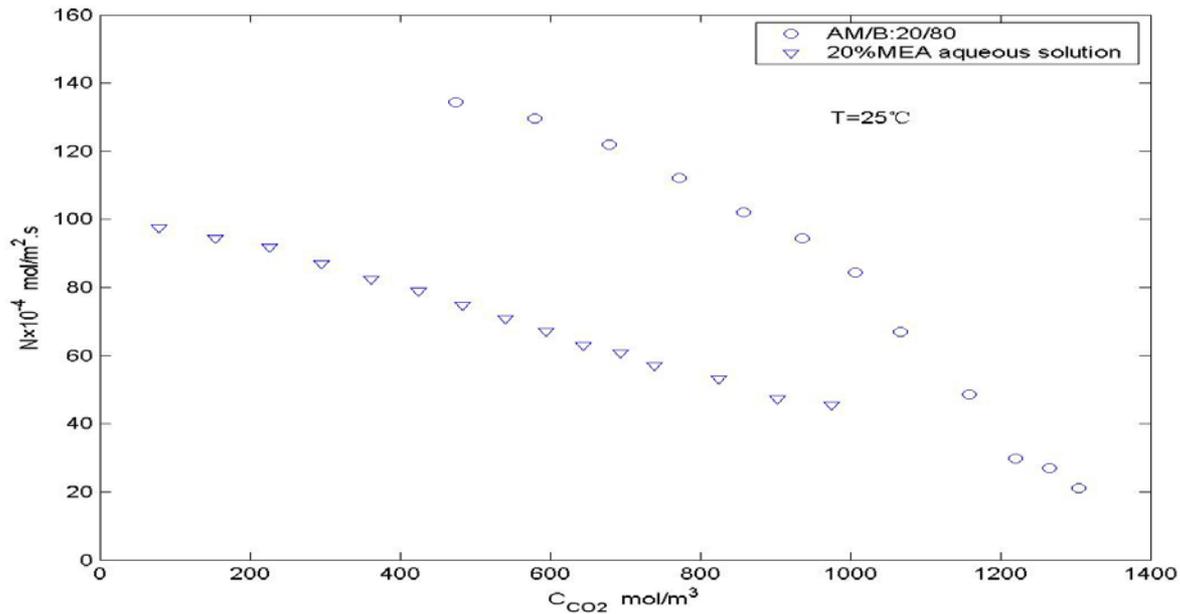


3H's Patents

- U.S. Patent No. 6,969,418, (11/2005)
- U.S. Patent No. 7,541,011, (06/2009)
- U.S. Patent No. 7,718,151, (06/2010)
- 5 pending patents



Preliminary Laboratory Results (CO₂ Absorption Rate)



[Conditions: 25 °C; P_{CO₂} at 1 atm.; liquid agitation speed of 60 rpm; liquid volume=900 ml]

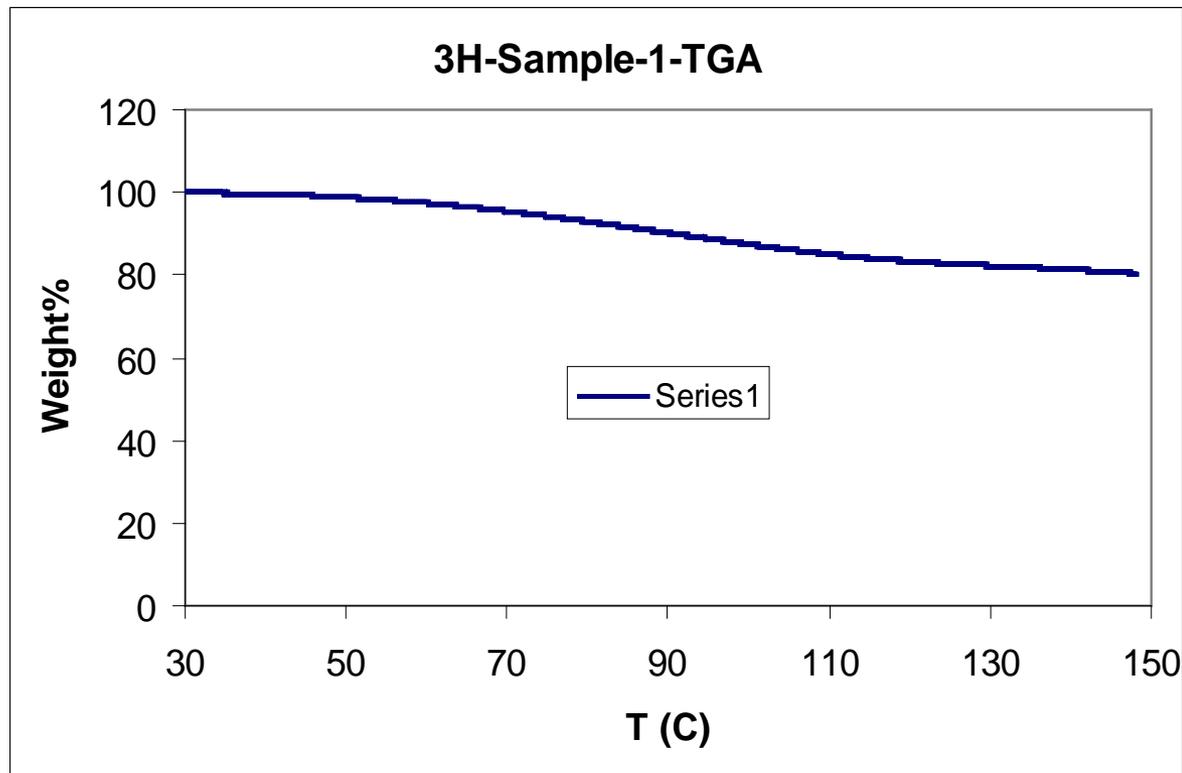


Preliminary Laboratory Results (Heat of Regeneration)

- **Benchmark MEA absorbent (30% aqueous solution)**
- **1934 Btu/lb of CO₂**
- **3H Technology**
- **Absorbent 1**
587 Btu/lb of CO₂ (or 30% of Btu/lb of MEA)
- **Absorbent 2**
287 Btu/lb of CO₂ (or 15% of the Btu/lb of MEA)



TGA Result for Concentrated CO₂ Rich Phase





Preliminary Laboratory Results (Regeneration at Lower Temperature)

**Benchmark MEA
absorbent (30% aqueous
solution)**

**Self-concentrating
absorbent**

- 120 °C

- 90 °C



Preliminary Laboratory Results (CO₂ Loading Capacity)

Absorbent

CO₂ Loading Capacity

- Self-Concentrating Absorbent 0.27g CO₂/g absorbent
 - Benchmark MEA 0.036g CO₂/g absorbent (20 % MEA)
- The CO₂ loading capacity was measured at 25°C and 1 atm (99.9 % CO₂). The CO₂ loading capacity for benchmark MEA absorbent was taken from literature. The results show that the CO₂ loading capacity by the self-concentrating solvent is 7.5 times higher than that by Benchmark MEA absorbent.



Objectives of the Current DOE Funding Opportunity

- Experimentally and analytically confirm the techno-economic feasibility of the 'Self-Concentration' CO₂ Capture Process
- Develop an engineering design to construct and operate a slip-stream demonstration facility at one of E-ON's power plants in the U.S. as the next stage of technology development



Two-Phase R&D Approach

- Phase I is to focus on continuing laboratory screening experiments to identify different absorbent/solvent combinations that can exhibit the ‘self-concentrating’ CO₂ absorption effect, and conduct fundamental absorption/regeneration rates, physical and chemical property measurements to allow its process design and techno-economic feasibility to be evaluated.
- Phase II is to focus on conducting experiments to demonstrate the process under dynamic column testing conditions and to develop a process design package for a slip stream testing facility at a E-ON site.

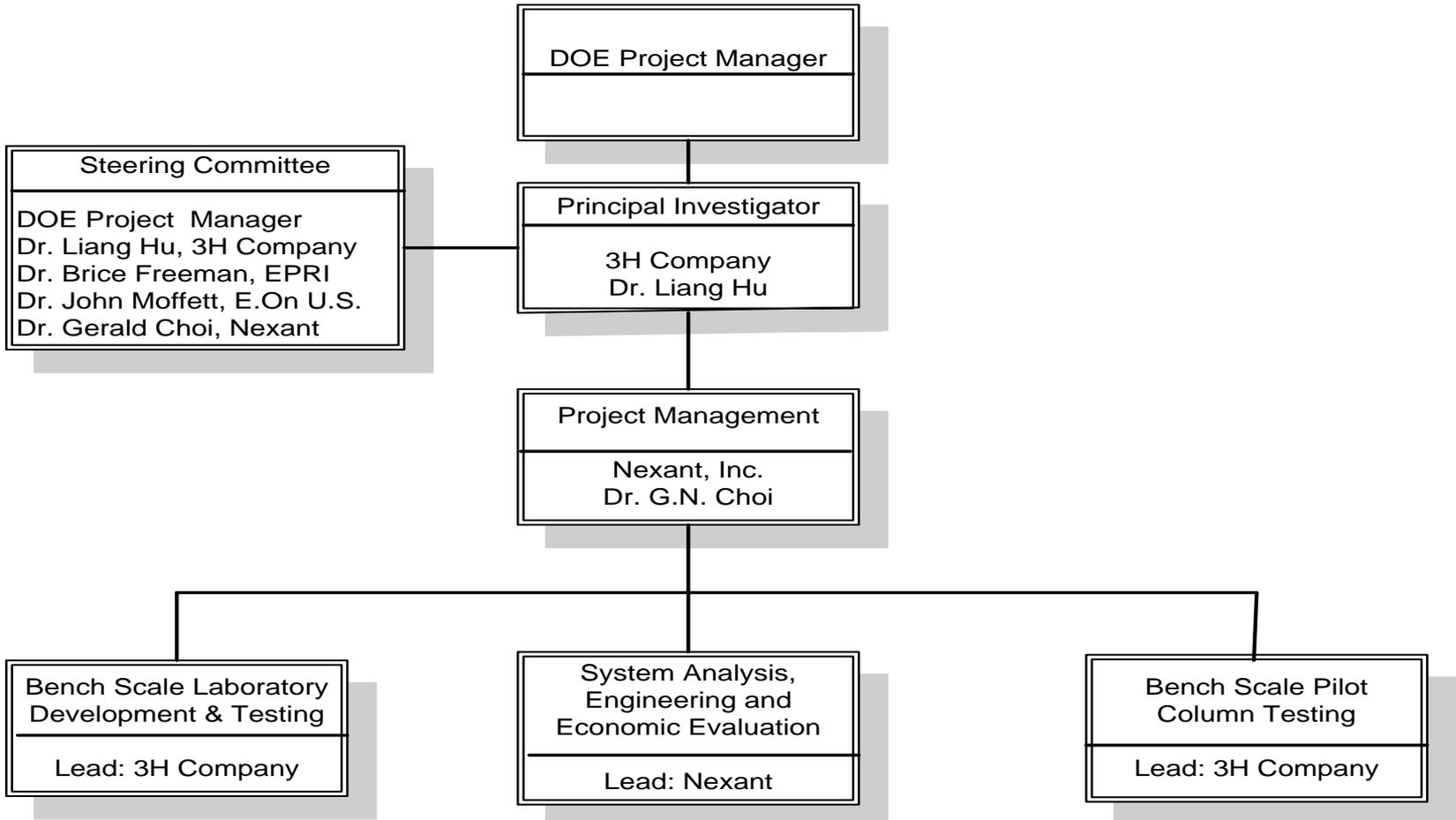


Teaming Arrangement

- 3H Company – patent owner and developer of the Phase Transitional Absorption CO₂ capture technology
- Electric Power Research Institute (EPRI) – research arm of electric utility industry
- E.On U.S. – a U.S. subsidiary of E.ON, an electric utility company headquartered in Germany
- University of Kentucky (Advanced Science and Technology Commercialization Center) – the institution where 3H also has its research own laboratory
- Nexant, Inc. – a global energy consulting company



Project Organization





Program Funding Supports

- DOE
- Energy Power Research Institute (EPRI)
- E-ON U.S.



THANK YOU!

Dr. Gerald Choi, Nexant, Inc.

Mr. Brice Freeman, EPRI

Mr. John Moffert, E-ON/US

Mr. Mike Mosser, Andy Aurelio and Tim Fout,

DOE NETL

and

DOE NETL for the funding support