Magnetohydrodynamics Power Generation Workshop

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IEA CCS Roadmap 2013: Key Technologies for Reducing Global CO₂ Emissions

Lower Cost Carbon Capture is Required to Meet GHG Goal

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.
DOE Office of Fossil Energy Clean Coal Program
DOE/FE’s Clean Coal and CCS Mission

Success of the demos
• Serial # 1 in operation 2013-2018
• A deep and rich set of public learning

R&D – Making CCS technology widely adopted
• Intrinsic Capture of CO2 e.g. Advanced combustion
• Dramatic reductions in size, reliability, and cost
• Ensure storage is safe and permanent

New mode: delivering solutions
Integrated Fossil Energy Solutions

Advanced Combustion
- Pressurized
- O₂ membrane
- Chemical looping
- USC Materials

Advanced Energy Systems
- Gasification
- Turbines
- Supercritical CO₂
- Direct Power Extraction

Advanced CO₂ Capture and Compression
- Solvents
- Sorbents
- Membranes
- Hybrid
- Process Intensification
- Cryogenic Capture

Efficiencies > 45%
↓ Capital Cost by 50%
$10 - $40/tonne CO₂ Captured
Near-zero GHGs
Near-zero criteria pollutants
Near-zero water usage

5 MWE Oxycombustion Pilot

5 MWE Oxycombustion Pilot

Advanced Turbines

CO₂ Storage
- Carbon Utilization (EOR)
- Infrastructure (RCSPs)
- Geological Storage
- Monitoring, Verification and Accounting

U.S. DEPARTMENT OF ENERGY
Fossil Energy
A technology pipeline for affordable CCS

We need more 2\textsuperscript{nd} generation pilots!
### Why Take a Fresh Look at MHD? What has changed in 25 years

<table>
<thead>
<tr>
<th>Legacy MHD program</th>
<th>Today</th>
<th>Comments</th>
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<tbody>
<tr>
<td>No CO₂ capture</td>
<td>CO₂ Capture</td>
<td>Oxy-fuel combustion developed for capture enables MHD.</td>
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<tr>
<td>Large demos</td>
<td>Simulation &amp; validation</td>
<td>Validated models for different generator concepts, not demos.</td>
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<td>Pre-heated air</td>
<td>Efficient oxygen production</td>
<td>ASU power requirements have dropped 40% since 1990.</td>
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<td>SOx and NOx control</td>
<td>Capture GPU</td>
<td>No emissions! Use oxy-fuel gas processing unit (GPU).</td>
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<tr>
<td>Magnets &lt; 6 Tesla</td>
<td>Magnets &gt; 6 Tesla</td>
<td>Advanced magnets exist today.</td>
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<tr>
<td>Analog electronics</td>
<td>Solid-state inverters/control</td>
<td>Electrode arcing could be controlled with digital devices.</td>
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<tr>
<td>Linear generator</td>
<td>Radial, Linear, others</td>
<td>Simulations can compare multiple geometries.</td>
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<td>Conventional manufacturing</td>
<td>Advanced manufacturing</td>
<td>New channel construction approaches.</td>
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<td>Seeded flows</td>
<td>New goal: injected plasma</td>
<td>Aspirational – use nanosecond pulse discharge to ionize gas?</td>
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Why This Workshop is Important

• Get current status of technology
• Understand some overarching issues
• Identify synergies with current program e.g. O2 separation, simulation tools
• Fuel Collaboration – need to bring best minds together
Next Steps: Crawl/Walk/Run

• SOTA - Summarize what was learn at workshop
• Assess potential to meet efficiency and CCS goals
• Develop a program plan with path forward.