Supporting Development of 2nd and 3rd Generation CCS Technologies

Trygve Riis, Norway
at
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From the Exploratory Committee

- ”Efforts should be taken to better understand the role of 2nd and 3rd generation technologies for CCS deployment, and policies and approaches identified among individual CSLF member countries that can stimulate 2nd and 3rd generation CCS project proposals to improve the outlook for successful Large Scale Integrated Project deployment in the 2020 to 2030 timeframe. Development of these technologies will benefit from the CCS Pilot Scale Testing Network, which is in the process of being stood up. ”

What is 2nd and 3rd generation capture technologies?

From the CSLF Technology Roadmap 2013:

- 2nd generation technologies are systems generally based on 1st generation concepts and equipment with modifications to reduce the energy penalty and CCS costs (e.g. better capture solvents, higher efficiency boilers, better integration) – this may also involve some step-changes to the 'technology blocks'.
- 3rd generation technologies are novel technologies and process options that are distinct from 1st generation technology options and are currently far from commercialisation yet may offer substantial gains when developed.

Targets for 2nd and 3rd generation capture technologies (from CSLF TRM 2013)

- For energy penalty, normalized capital cost, and normalized operational and maintenance (O&M) costs (fixed and non-fuel variable costs) compared to 1st generation technologies for power generation and industrial applications:
  - 2nd generation:
    - Towards 2030: 30% reduction
  - 3rd generation:
    - Beyond 2030: 50% reduction

Energy penalty = [Power output (state-of-the-art plant w/o CCS) - Power output(state-of-the-art plant w/CCS)) / Energy input (state-of-the-art plant w/o CCS]

Normalized cost = [Cost (state-of-the-art plant w/CCS) – cost (state-of-the-art plant w/o CCS)) / Cost (state-of-the-art plant w/o CCS]

Possible actions

Action	Description	Responsible	Deadline
1	Map Identify 2nd and 3rd generation technologies under consideration in CSLF member countries, and identify technologies that may mature in the 2020 –2030 timeframe and their development plans.	Technical Group	
2	Use existing networks, e.g. the CCS Testing Centre Network, ECCSEL and other networks, to map potential for testing 2nd and 3rd generation technologies.	CCS Test Centre Network/Technical Group	
3	Map initiatives and funding mechanisms for 2nd and 3rd generation technologies in CSLF member countries	Policy Group	
4	Prepare a Policy document on how to achieve an accelerated implementation of 2nd and 3rd generation CO_2 capture technologies.	Policy Group	

Notes

Action	Note
1	Good staring points are Technology update from DOE/NETL Advanced Carbon Dioxide Capture R&D Program, report from UK Advanced Power generation Technology Forum, IEA Greenhouse Gas R&D Program reports, CLIMIT projects and reports from SINTEF on behalf of CSLF and TCM. Possibly many others. Food for Technical Group delegates
2	Presently, the information is readily available for a limited number of test facilities (e.g. NCCC, CanmetENERGY and TCM). There be be other facilities capable of testing pilot scale (1 - 5 MW_{th}) 2^{nd} generation technologies. CCS Test Centre Network is willing to contribute by mapping potential at member facilities and in associated networks
3	US DOE/NETL Advanced Carbon Dioxide Capture R&D Program, Norwegian CLIMIT and UK Innovation Fund for Carbon Capture Projects are examples that should be summarized for the benefit of CSLF members. There must be others. Food for Policy Group delegates

Examples of and the challenges facing 2nd and 3rd generation capture technologies

	Possible 2nd and 3rd generation technology options	Implementation challenges
IGCC with pre-combustion decarbonisation	• Membrane separation of oxygen and syngas • Turbines for hydrogen-rich gas with low NO_x	• Degree of integration of large IGCC plants versus flexibility • Operational availability with coal in base load • Lack of commercial guarantees
Oxy-combustion	• New and more efficient air separation, e.g. membranes • Optimized boiler systems • Oxy-combustion turbines • Chemical looping combustion (CLC) - reactor systems and oxygen carriers • High pressure combustion – reactor systems to enhance efficiency.	• Unit size and capacity combined with energy demand for ASU • Peak temperatures versus flue-gas re-circulation • NO_x formation • Optimisation of overall compressor work (ASU and CO_2 purification unit (CPU) require compression work) • Lack of commercial guarantees
Post-combustion capture	• New solvents (e.g. amino acids, enzyme-accelerated carbonates) • 2nd & 3rd generation amines requiring less energy for regeneration • 2nd & 3rd generation process designs and equipment for new and conventional solvents • Solid sorbent technologies • Membrane technologies • Hydrates • Cryogenic technologies	• Scale and integration of complete systems for flue gas cleaning • Slippage of solvent to the surrounding air (possible health, safety & environmental (HS&E) issues) • Carry-over of solvent into the CO_2 stream • Flue gas contaminants • Energy penalty • Water balance (make-up water)

Comments?

Thank you!

CCS Test Centre Network

- Contract signed May 8, 2014 between
  - E.ON Technologies GmbH, Tyskland
  - Southern Company Services, Inc/National Carbon Capture Center, USA
  - Saskatchewan Power Corporation, Canada
  - ENEL Ingegneria e Ricerca S.p.A., Italia
  - Technology Centre Mongstad

- Contact with:
  - Korea Electric Power Company, Korea
  - ENEA (Italian National agency for new technologies, Energy and sustainable economic development), Italia
  - ECCSEL – European Carbon Dioxide Capture and Storage Laboratory Infrastructure