IChemE Energy Centre

The Future of CCS

An IChemE Energy Centre Green Paper

The world's population is expected to exceed nine billion by 2050, a figure that will undoubtedly increase demand for energy. Currently fossil fuels provide more than 85% of the world's energy. Despite significant global efforts to shift to renewable energy generation, renewable sources only accounted for 2% of the global energy supply in 2014. It is therefore logical to assume that fossil fuels will remain an indispensable part of the world's energy landscape until at least the end of this century.

In signing the Paris Agreement the world reached a decision to limit global warming to 2°C, with the ambition of capping this at 1.5°C. To do this atmospheric CO_2 concentrations must be stabilised. This means that we must act now to decarbonise our electricity production; and carbon capture and storage (CCS) is a readily deployable technology solution to achieve this.

To meet the world's global warming limit, it is expected that we need to store 120-160 Gigatonnes of carbon dioxide ($GtCO_2$) from now until 2050. Globally there is a theoretical storage capacity of approximately 11,000 Gt of CO_2 with 1,000 $GtCO_2$ provided by oil and gas reservoirs, 9,000-10,000 GtCO2 provided by deep saline aquifers and a significant potential capacity in unminable coal seams. If we choose to sequester 120-160 $GtCO_2$ by 2050 there is more than enough storage capacity to do so, and enough for our CCS needs to be met well beyond the next century.

Translating major research findings to the market often takes many years, and developing a systematic procedure for the acceleration of the transition of academic research to pilot- and demonstration-scales is essential for CCS.

Key areas for discussion

Power sector and flexible CCS	Negative emissions technologies
Industrial CCS	CO_2 transport
The role of new sorbent materials	CO_2 storage, utilisation and conversion

It is vital that the near-term (2030) targets do not prohibit medium (2050) or long-term plans. Roadmaps must employ a whole-systems approach incorporating existing power sources, green energy sources, industrial plants, and carbon capture, transport and de-risked storage infrastructure. The balance of the components will evolve as the process of decarbonisation takes place across many decades.

Climate change is estimated to cause enormous direct costs due to changing weather patterns and crop yields. These global financial losses will vastly exceed the costs of implementing CCS. The deployment of CO_2 capture, transport and storage infrastructure will support the creation of new, high skills STEM jobs, directly contributing to the health of the global economy.

To limit global warming to the 1.5°C degree limit CCS deployment must be progressed as an urgent priority, this will require proactive support from governments around the world. We have the ability to deploy CCS technology today, and in so doing, take a major step forwards to the least-cost mitigation of dangerous climate change.

Priorities for CCS

1. **Creation of a computational framework to understand the dynamic interplay between scientific and technological advancements**, their impacts on the power markets, and the broader socio-economic consequences of deploying CCS.

2. **Development of a methodology to rapidly screen new solvents and sorbents** for CO_2 capture based on molecular level information, and provide process level cost and performance information.

3. **Appropriate benchmarks must be identified and universally adopted** for the successful development of new processes for CCS. We recommend the use of the Cansolv technology as a new standard against which progress with sorbent development should be compared.

4. **CO_2 storage infrastructure must be de-risked around the world** via exploration and characterisation of suitable geological structures. This is more urgent than the development of new capture technologies.

5. **CO_2 utilisation via Enhanced Oil Recovery (EOR) is mature**, and has the potential to provide a near-term, market-driven pull for the deployment of CO_2 transport infrastructure. However, EOR is not a panacea and can lead to the net emission of CO_2.

6. **The environmental impact of products derived from CO_2 will be very small** compared to the level of CO_2 that is needed to be stored as part of climate change mitigation. However, using CO_2 can reduce the environmental footprint of existing chemical processes.

7. **The impact of CCS must focus on the £/MWh, rather than efficiency** improvements at the cost of increased CAPEX. Materials with accelerated rates of heat and mass transfer are essential.

8. **The cost of power generation or industrial processes must be decoupled from CO_2 capture and the CO_2 transport infrastructure**. Initial project costs are significantly inflated relative to the potential for the subsequent cost reduction once infrastructure costs are shared.

9. **The role of electricity markets in the development of CCS technologies needs to be carefully evaluated**, with particular attention paid to the way in which CCS power plants will interact with the electricity markets.

10. **It is vital that meeting near-term targets does not come at the expense of long-term targets.** Meeting the Paris Agreement depends on using bioenergy with CCS (BECCS), this cannot be implemented without a mature and established CCS industry.

To meet targets outlined in the Paris Agreement funds must be made available to support the research needs of CCS. It is imperative that funding for CCS is progressed towards deployment.

Acknowledgements

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