



IEA Greenhouse Gas R&D Programme



Regulatory Perspective on Modelling

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Regulation needs modelling

- IPCC GHG Inventory Guidelines
- London and OSPAR Marine Treaties
- EU CCS Directive
- US EPA draft Rule



IPCC Guidelines for GHG Inventories



- Apr 2006
- Vol 2 Energy, Chp 5 - *CO₂ Transport, Injection and Geological Storage*
- Each site will have different characteristics
- **Methodology**

Site characterisation – inc leakage pathways



Assessment of risk of leakage – modelling of CO₂ movement



Monitoring – use results to validate/update modelling



Reporting – inc CO₂ inj and emissions from storage site

- For appropriately selected and managed sites, supports **zero leakage** assumption unless monitoring indicates otherwise



IPCC Guidelines for GHG – cont.



- Geological model of site – site characterisation
- Numerical Modelling – to predict the movement and distribution of the CO₂ – short-term and long-term
- Use models to design monitoring plan
- Sensitivity analysis and uncertainty estimates
- History match against monitoring results
- Important principle - Post-injection monitoring, linked to modelling, may be reduced or discontinued once CO₂ stabilises at its predicted long-term distribution



London Convention and Protocol



- Marine Treaty - Global agreement regulating disposal of wastes and other matter at sea
- Convention 1972 (85 countries), Protocol 1996 – ratified March 2006 (35 countries)
- Uncertainty over whether it prohibited some CCS project configurations

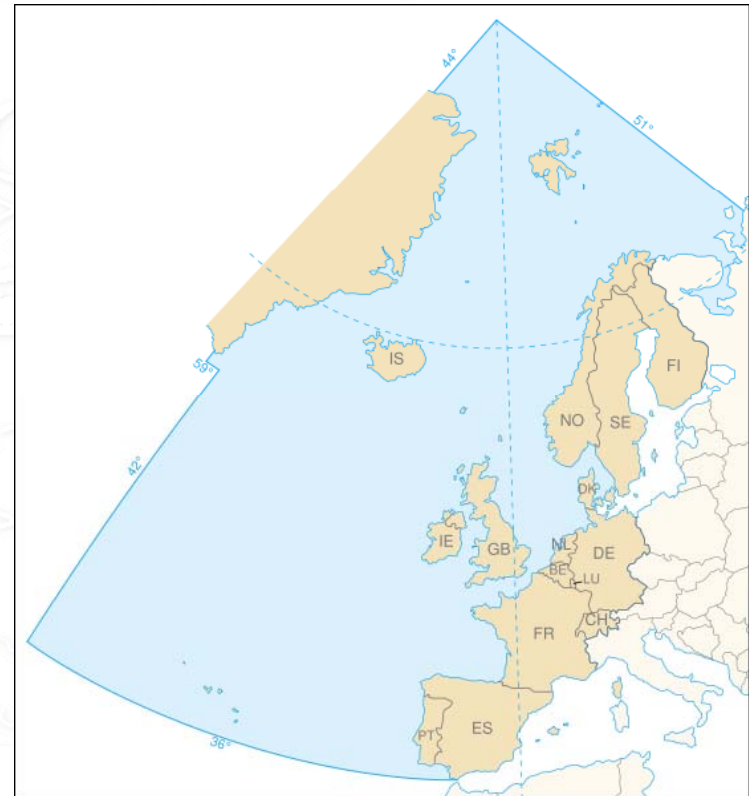
CCS work

- Assessed by LC Scientific Group
- 2006 - Risk Assessment Framework for CO₂
- To allow prohibited CCS Configurations - **amendment adopted** at 28th Consultative Meeting, 2 Nov 2006 - came into force 10 Feb 2007 **to allow disposal in geological formations**
- With 'CO₂ Specific Guidelines' to be used by regulators for guidance



OSPAR

- Marine Treaty for NE Atlantic
- 15 nations and EC
- Prohibited some CCS configurations
- Considered CCS and CO₂ impacts on seas
- To allow prohibited CCS configurations - **OSPAR amendments** (to Annexes II and III) for CO₂ storage **adopted June 2007** - but need ratification by 7 Parties
- **OSPAR Decision** – requirement to use Guidelines when permitting.
- **OSPAR Guidelines** for Risk Assessment and Management of Storage of CO₂ in Geological Formations – includes the Framework for Risk Assessment and Management (FRAM)
- Decision - Storage in water column prohibited





London and OSPAR Guidelines for Risk Assessment and Management

- **Scope** – scenarios, boundaries
- **Site selection and characterisation** – physical, geological, chemical, biological – using geological modelling
- **Exposure assessment** – characterisation CO₂ stream, leakage pathways - characterisation and movement of the CO₂ stream within formations
- **Effects assessment** – sensitivity of species, communities, habitats, other users
- **Risk characterisation** – integrates exposure and effects - environmental impact, likelihood
- **Risk management** and permitting requirements – incl. monitoring, mitigation plans



EU CCS Directive

Enabling regulatory framework to ensure environmentally sound CCS (proposed 23 Jan 2008)

- Follows IPCC GHG Guidelines and OSPAR
- Objective is permanent storage
- Storage permit only if “no significant risk of leakage”
- Emphasis on site selection and characterisation (details in Annex 1), risk assessment, monitoring plans (details in Annex 2)
- Permit application to include characterisation of site and security
- The draft has been agreed/finalised on 16th December 2008, due for issue within next 2 months



EU CCS Directive – Annex 1 Site Characterisation

1. Data collection
2. Static Simulation
 - 3-d geological earth model, including caprock and hydraulically connected areas, geological structure, geomechanical, geochemical, flow properties of reservoir, overburden and surrounding formations, fracture systems. Uncertainties with each parameter assessed with range of scenarios for each and calculating confidence limits.
3. Dynamic simulation
 - security characterisation (ie performance assessment) based on dynamic modelling, including “efficacy of coupled process modelling”, reactive processes, over short-term and long-term (decades-millennia), to provide information on range of characteristics including pressure, temperature, plume extent, trapping mechanisms, etc. Sensitivity characterisation.
4. Risk assessment



US EPA proposed draft rule for CO₂ injection wells for geological sequestration

- III.A.1 Geological siting requirements (characterisation) – detailed geological assessment
- III.A.2 Define Area of Review – using computational multiphase fluid flow models for CO₂ and mobilised substances movement, and pressure. Use to develop monitoring plans.
- Informed by EPA Modelling workshop Houston, April 2005.
- Status - public consultation ended on 24 Dec 2008, EPA aiming to have a final rule published in late 2010 / early 2011.



Conclusion

- Modelling of geological formations and CO₂ behaviour is central to the regulation of geological storage and to the ability for regulators to make assessments and decisions on granting permits.



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- General - www.ieagreen.org.uk
- CCS - www.co2captureandstorage.info