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TECHNICAL GROUP

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CARBON CAPTURE AND STORAGE (CCS) GAP ASSESSMENT

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Note by the Secretariat

Background

At the CSLF meeting in Delhi, India, on 3-5 April 2005, the CSLF Projects Interaction and Review Team (PIRT) identified, as a key action, the completion of a comprehensive technology gap assessment and examination of CSLF project selection criteria. The gap assessment would utilize the PIRT Floating Group's expertise to identify areas in which it would be beneficial to encourage new CSLF appropriate projects and/or extend existing ones to address some important gaps. To this end a gap analysis matrix has been established, made up from the gap work done to date by the CSLF and also other relevant sources (e.g. IEA work).

This gap analysis matrix was distributed to the "Floating" Group members in order to get their feedback as to how current projects could address the issues raised and/or get suggestions for ideas for new CSLF projects. The responses will be used to help define the focus for the second "CSLF Project Workshop" to be held as a part of the next full CSLF meeting in April 2007.

Action Requested

The Technical Group is requested to discuss and consider the report of the Secretariat.

Conclusions

The Technical Group is invited to note in the Minutes of this meeting that:

"The Technical Group discussed and considered the report of the Secretariat."

	STORAGE	Will your project outcomes encompass any of these issues?	Examples;	Project to expand on the specific issues they will address under the relevant gaps and document the levels at which issues are being examined	Reference to relevant work; Publication or website
				Insert Project Name	
	Injection				
S1		Optimum well spacings and patterns	Eg so as to maximise the access to storage capacity in a given reservoir.		
S2		Optimum injection parameters	Eg to avoid geomechanical impacts, or to avoid pressure interference.		
S3		Definition of variable rock facies or rock property types for injectivity.	Eg the need to compare the injectivity of thick good reservoir quality (marine deposited sandstone) versus poorer thin bedded (fluvial channel sandstone) reservoirs.		
S4		Sustainability of high injection rates	To match the supply rates and storage volumes at regional or local basin level eg how many separate injection operations could the North Sea sustainably manage in a single reservoir sequence for the time period required?		

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S5		Formation water compression / displacement in closed or open system	Eg impacts on potentially compromising groundwater in open system or pressure build-up in closed system.		
S6		Reservoir engineering aspects	Eg Near well bore formation damage, hydrate formation, mineral precipitation, effects of impurities in CO2 stream, etc.		
	Storage Options				

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				Insert Project Name	
S7		Saline Aquifers – fluids/rock relationships and interactions	Aspects that are being focussed upon, eg – reservoir / seal continuity, mineralogical considerations, chemical reactions, accessible capacity, stochastic modelling methods, migration pathway prediction, migration pathway volumetric assessment (see trapping mechanisms), seal capacity evaluation at regional scale, injection flow path prediction, reservoir property heterogeneity, etc.		

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S8		Coal – rock properties	Aspects that are being focussed upon, eg - injectivity, swelling, capacity, adsorption, desorption, sealing potential, unmineable coal and change in storage parameters with depth, migration/escape of injected CO2 or released methane, etc.		
S9		EOR – lessons to be applied to other storage reservoirs	Aspects that are being focussed upon, eg CO2 sweep characteristics, injection flow path prediction, storage effectiveness, etc.		
S10		Depleted oil and gas fields – viability	Aspects that are being focussed upon, eg timing of availability, implication for trap and seal integrity due to production operations, ongoing use of existing materials and facilities (remediation /abandonment), etc.		

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S11		Basalts - proof of concept	Aspects that are being focussed upon eg – demonstration of injectivity, capacity methodology, sub-basalt sedimentary basins, intra-basalt sediments, sealing properties, chemical reactions, etc.		
S12		Ultra-low permeability rocks (eg organic rich shales, non-conventional reservoirs) – proof of concept	Aspects that are being focussed upon eg – injectivity, geomechanical impacts, adsorption properties, etc.		
	Trapping				
S13		Understanding physical or chemical trapping mechanisms	Eg time frames (10s to 100s years) and effectiveness of the variety of trapping processes that occur in reservoirs, eg structural, buoyancy, residual gas, adsorption, mineralisation, dissolution.		

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S14		Migration rate	Eg Quantification of migration rate of CO_2 and its impact on various trapping mechanisms (hydrodynamic, dissolution).		
	Hydrodynamics				
S15		Petroleum field development impact on hydrodynamic regime	Eg. Pressure draw down in depleting(ed) oil and gas fields – how it affects migration pathways of injected CO_2 within the basin.		
	CO_2 properties				
S16		Behaviour of CO2 under different regimes of pressure, temperature and fluid mixtures	Eg dissolution trapping processes, multi phase fluid flow, etc.		
	Assessments				
S17		Storage Capacity assessment methodologies or standards	Improved methods to accurately assess potential storage capacity at local or regional level		

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S18		Country wide or regional assessments of storage potential	Eg need to have regions "storage ready" prior to power plant construction		
S19		Innovative methods for assessments of geological storage potential	Eg improved methods / standards to assess areas where there is a paucity of direct data, both in shallow and deeper sections or where petroleum potential is poor, etc.		
S20		Geological site characterisation, methodologies, techniques and standards	Eg what approaches and standards will be acceptable to adequately characterise a site, best practice manuals, or derive rock parameters where there are no physical samples – eg geophysical remote sensing techniques to predict reservoir quality.		

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S21		Protocols for evaluation of potential sterilisation of existing resources	Eg impact on groundwater, petroleum production or coal mining		
	Leakage				
S22		Flux rates of modern and ancient systems	Eg analogue studies both as seepage at surface and leakage within the subsurface migration system		
S23		Quantification and modelling of potential subsurface leakage impacts	Eg what leakage is acceptable (in both volume and time) out of the primary storage formation relative to timing and volume of potential final escape to the atmosphere.		
S24		Existing facilities and materials	Eg Risks of leakage from abandoned wells caused by material and cement degradation.		
	Economics				

	STORAGE	Will your project outcomes encompass any of these issues?	Examples;	Project to expand on the specific issues they will address under the relevant gaps and document the levels at which issues are being examined	Reference to relevant work; Publication or website
				Insert Project Name	
S25		Costs of storage	Eg impacts on costs of source sink matching, hub development, reservoir parameters, economies of scale, "smart" well design, etc.		
	Software				
S26		Parameters for modelling fluid and rock interactions	Eg improved algorithms specifically for CO_2 behaviour either physically or chemically, or long time periods required		
S27		Improvements in software for basin wide geological, reservoir engineering and hydrodynamic model	Eg most software is only fully functional at local field level, not basin scale – heterogeneity issues (see Sustainability of the high injection rates)		
S28		Integration in single software system of geological, reservoir engineering and hydrodynamic aspects	Eg – allow for single predictive software system rather than "bolting" together different systems and results.		
	Risk				

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S29		Risk assessment models	Eg Development, verification and quantification, and grow with experience base		
	Public Outreach				
S30		Procedures and approaches for communicating the impacts of geological storage to the general public	Eg Education programs		

	CAPTURE	Will your project outcomes encompass any of these issues?	Examples;	Project to expand on the specific issues they will address under the relevant gaps and document the levels at which issues are being examined	Reference to relevant work ; Publication or website
				Insert Project Name	
	Post-Combustion				
C1		Improved solvent systems	Less energy-intensive, reduced degradation, reduced corrosion, improved operability, new solvent types		
C2		Advanced capture systems	Membranes, solid sorbents, physical separation techniques, bio-minetic approaches		
C3		Power plant concepts to integrate CO2 capture	process optimization, heat integration, capture readiness		
C4		CO2 capture pilot plant	Demonstration and/or testing key components or integrated systems on a scale of MWs to tens of MWs		
C5		Fully integrated demonstration plant	Demonstration of long-term operational availability, reliability, technical and environmental performance on a commercial scale using relevant fuels (e.g., coal)		
	Pre-Combustion				
C6		Hydrogen-rich turbines	Develop, validate and demonstrate optimised-low emission hydrogen-rich combustion technology for gas turbines including basic tools and data (CFD codes and kinetics)		

	CAPTURE	Will your project outcomes encompass any of these issues?	Examples;	Project to expand on the specific issues they will address under the relevant gaps and document the levels at which issues are being examined	Reference to relevant work ; Publication or website
				Insert Project Name	
C7		Improved air separation processes	high temperature ceramic membranes		
C8		Improved water-gas shift	Improved catalysts		
C9		Improved H2/CO2 separation	Improved solvents, membranes		
C10		Power plant concepts to integrate CO2 capture	Combined shift and separation, hot gas clean-up technology, process optimization, heat integration		
C11		Polygeneration optimization	Co-production of H2, methanol, ethanol, synthetic fuels, etc. in combination with electricity		
C12		Fully integrated demonstration plant	Demonstration of long-term operational availability, reliability, technical and environmental performance on a commercial scale using relevant fuels (e.g., coal)		
	Oxyfuel Combustion				
C13		Boiler design	Optimize, CFB-type units, PC without external recirculation		
C14		Improved air separation processes	Ceramic membranes, polymeric membranes, others		

	CAPTURE	Will your project outcomes encompass any of these issues?	Examples;	Project to expand on the specific issues they will address under the relevant gaps and document the levels at which issues are being examined	Reference to relevant work ; Publication or website
				Insert Project Name	
C15		Oxy-fuel gas turbines	Develop, design and demonstrate components, modules and engines		
C16		Combustion science	investigation of combustion chemistry, heat transfer and kinetics to improve design, scale-up		
C17		Power plant concepts to integrate CO2 capture	process optimization, heat integration, integration of ASU with process		
C18		CO2 capture pilot plant	Demonstration and/or testing key components or integrated systems on a scale of MWs to tens of MWs		
C19		Fully integrated demonstration plant	Demonstration of long-term operational availability, reliability, technical and environmental performance on a commercial scale using relevant fuels (e.g., coal)		
	Industrial applications				
C20		Capture from non-power industrial processes	Steel, cement, refineries, etc.		

	Monitoring	Will your project outcomes encompass any of these issues?	Examples;	Project to expand on the specific issues they will address under the relevant gaps and document the levels at which issues are being examined	Reference to relevant work; Publication or website
				Insert Project Name	
	Well bore Integrity				
M1		functionality and resolution of available logging tools	identification of logging tools that have applicability to the monitoring of CO2 storage sites		
M2		Improved interpretation of cased hole logs	to determine potential activity outside the casing or identification of problems with cement bonding		
M3		Improved wellbore monitoring techniques	to allow interpretation of activity outside the casing, but in the immediate wellbore area		
M4		physical or chemical changes to cement			
	Identification of faults and fractures				
M5		use of seismic	regarding identification of open fractures that might be intersected by an expanding CO_2 plume		
M6		non-seismic geophysical techniques	improvements in resolution		

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	Well bore Integrity				
M7		Improved recognition and interpretation of the nature of faults and fractures	with seismic, non-seismic or the combination of techniques		
	Leaks in the subsurface				
M8		sesimic, resolution	improved vertical resolution		
M9		seismic, cost reduction	reduced costs for survey and data interpretation		
M10		evaluation of permanent or semi-permanent sampling points in an observation well	to determine leakage into overlying zones		
	Surface and near-surface leaks				
M11		detecting CO_2 seeps into subaqueous settings	Improved methods, particularly dissolved CO_2		
M12		Remote sensing of CO2 flux	develop techniques that can measure low flux increases		
M13		use of vegetational changes by hyperspectral surveys changes to identify gas levels in the vadose zone	determine optimal times for surveys in different climatic zones, a better understanding of the influence of soil type		

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	Well bore Integrity				
M14		Improved remote sensing to identify souces of CO2	to allow identification of increased CO_2 fluxes at surface that might be from deeper sources		
	Guideline Development				
M15		determination of effective pre-injection surveys	to provide guidance in the determination of hydrodynamic isolation of the proposed injection zone		
M16		Improved integration of monitoring techniques	results of the application of these techniques		
M17		Identify thresholds of leakage that can be measured	implications of these on formulating regulation of sites		

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				Project X	
	Injection				
S3		Definition of variable rock facies or rock property types for injectivity.	Eg the need to compare the injectivity of thick good reservoir quality (marine deposited sandstone) versus poorer thin bedded (fluvial channel sandstone) reservoirs.	**Examining the interaction of up dip migration of CO2 in an estuarine fine graned system to a fine to coarse grained fluvial system.**	**See : Geo-engineering Assessment of a Potential Storage Site for Carbon Dioxide – A Case Study, Southeast Queensland Australia; Sayers, J., Marsh, C., Scott, A., Cinar, Y., Bradshaw, J., Hennig, A., Barclay, S. and Daniel, R.: AAPG Environmental Geosciences Journal 2006.**
	Assessments				
S23		Storage Capacity assessment methodologies or standards	Improved methods to accurately assess potential storage capacity at local or regional level	**Examining methodologies for improved coal storage capacity assessment at a regional level and development of a risk approach to capacity estimates.**	**See : Australia's CO2 geological storage potential: a comparison of saline formations and coal related storage options. 2004 - Bradshaw, J. and Bradshaw, B.E., Abstract 13th International Conference on Coal Research, Shanghai, China (October, 2004).**

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				Project X	
	Post-Combustion				
C1		Improved solvent systems	Less energy-intensive, reduced degradation, reduced corrosion, improved operability, new solvent types	**Development of selection methodology for CO2 aborbents and validation of results in pilot plant**	**Selection and Pilot Plant Tests of New Absorbents for Post Combustion Carbon Dioxide Capture, Ralf Notz, Norbert Asprion, Iven Clausen, Hans Hasse, paper presented at Distillation & Absorption, September 2006, London, UK**
	Pre-Combustion				
C6		Hydrogen-rich turbines	Develop, validate and demonstrate optimised-low emission hydrogen-rich combustion technology for gas turbines including basic tools and data (CFD codes and kinetics)	**Provide high pressure hydrogen reaction schemes through experiments, facilitate the use of these in commercial computer codes /type CFD). Premixed prototypes to be built and etsted-computer code validation.**	**See: ZEP WG1 technical report. Also: Myhrvold, Tore; Ströhle, Jochen Evaluation of detailed chemistry effects on the prediction of turbulent reacting hydrogen jet flames. I: Proceedings : ECCOMAS Thematic Conference on Computational Combustion. ECCOMAS, 2005**