Carbon Sequestration leadership forum

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CSLF Technical Roadmap

Nick Otter

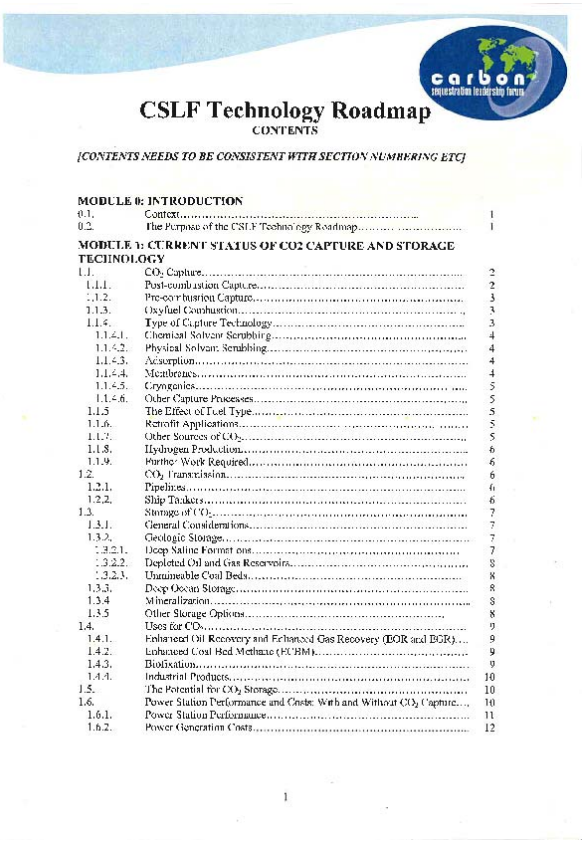
Chair

Projects Interaction and Review Team

(PIRT)

Current Position

- Nick Otter continues as PIRT chair, agreed with UK and Australia, with move to Australia as CEO of GCCSI
- Responsibility for 2008/09 revision of the 2004 TRM retained UK (and hence with Nick Otter with drafting support by GCCSI)
- Revised draft discussed in 12th March 2009 teleconference between UK and USA, France, Norway, Australia, Saudi Arabia – comments and revisions forwarded to GCCSI via the CSLF Secretariat



CSLF Technology Roadmap

CONTENTS

[CONTENTS NEEDS TO BE CONSISTENT WITH SECTION NUMBERING ETC]

1

Process (continued)

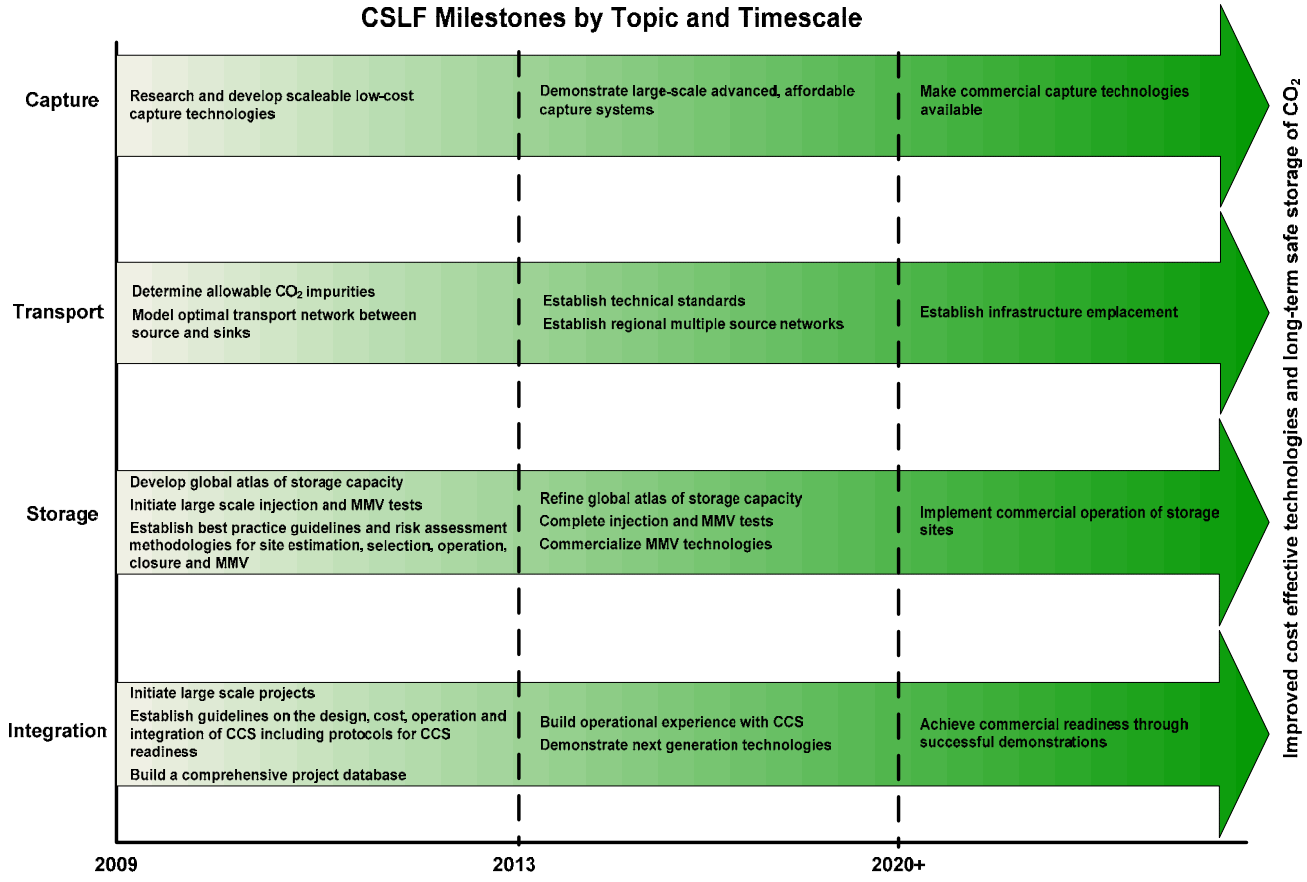
- Intermediate draft sent out in week of 23th March to PIRT and Technical Group for discussion at Oslo – 31st March/1st April 2009
- Requirement of additional comments by 17th April 2009, for full draft by end of April 2009
- Final draft by mid-May 2009 for PIRT/TG sign-off
- Presented to Policy Group for review and endorsement, June 2009
- TRM to be tabled at Ministerial Meeting in October 2009

Key Changes - Summary

- Key technology needs in capture, transport and storage
- Substantial revision on storage – technical details and gap analysis
- Updates and analysis of performance and costs of CCS options
- Review of global activities in CCS since the 2004 TRM
- Greater focus on other emitters such as industrial processes, oil and gas production – not just stationary electricity generation

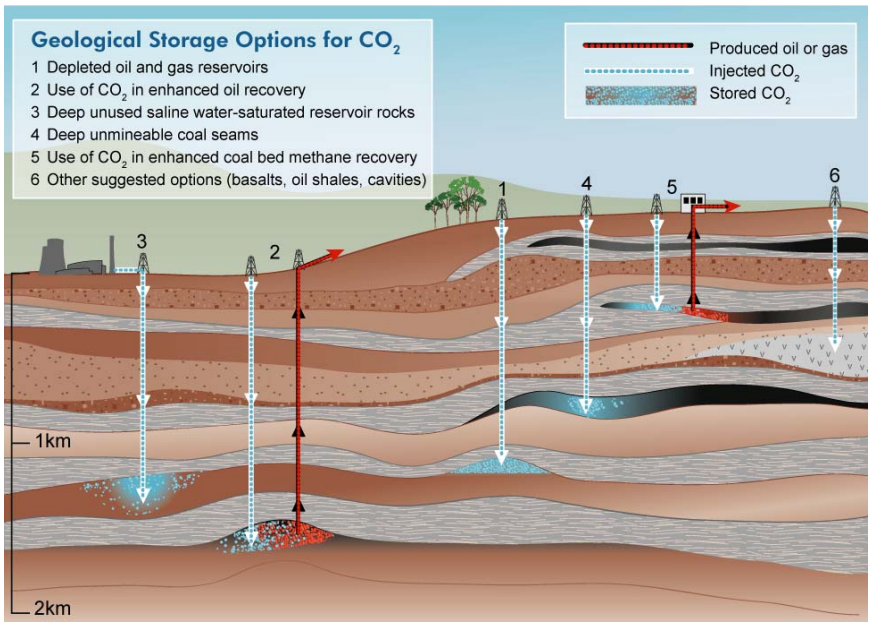
Key Changes – Key Technology Needs

- Forward-looking milestones mapped (from 2009 to 2020+)
- Technical Road Map
  - Figure 17 in document
  - developed and cross-checked/correlated with CSLF/IEA/G8 milestones
- Suggested project areas address identified gaps – set out as boxed text



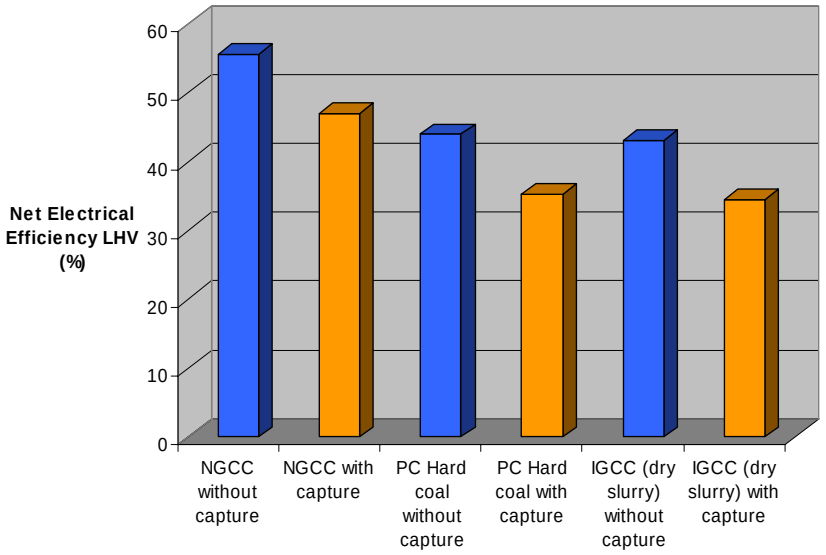
Key Changes – Revisions to Storage

- Substantial revision to storage – technical details and gap analysis
- Geological storage in section 3 expanded to provide more details on geological storage types
  - – deep saline formations, unmineable coal beds and depleted oil/gas reservoirs
- Diagrams updated to reflect greater range of storage options



Key Changes - Performance of CCS options

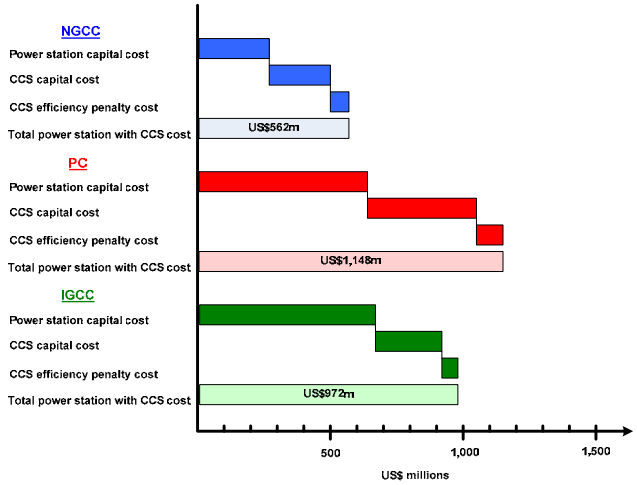
- Recent studies on performance and costs accessed
  - text and figures updated
- Notwithstanding regional factors, significant variations exist between sources
- Review team chose the most credi sources
  - but there is still a lot of work to be done in this area



Key Changes – Costs of CCS Options

- Updates and analysis of costs of CCS options
- Huge variations in estimated costs – again, credible sources mined for ranges in costs
- Component costs for capture derived to produce indicative cost bars (at left) for NGCC, PC and IGCC
- Would have been useful to include other technology types but difficult to find work from reputable sources with findings that closely correlated with the prime sources used in the analysis

Performance and cost measures	New NGCC plant			New PC plant			New IGCC plant		
	Range		Rep.	Range		Rep.	Range		Rep.
	Low	High	value	Low	High	value	Low	High	value
Emission rate without capture ($kgCO_2/kWh$)	0.344	0.379	0.367	0.736	0.811	0.762	0.682	0.846	0.773
Emission rate with capture ($kgCO_2/kWh$)	0.040	0.066	0.052	0.092	0.145	0.112	0.065	0.152	0.108
Percentage CO_2 reduction per kWh (%)	83	88	86	81	88	85	81	91	86
Plant efficiency with capture, LHV basis (%)	47	50	48	30	35	33	31	40	35
Capture energy requirement (% increase input/ kWh)	11	22	16	24	40	31	14	25	19
Total capital requirement without capture (US$/kW)	515	724	568	1161	1486	1286	1169	1565	1326
Total capital requirement with capture (US$/kW)	909	1261	998	1894	2578	2096	1414	2270	1825
Percent increase in capital cost with capture (%)	64	100	76	44	74	63	19	66	37
COE without capture (US$/kWh)	0.031	0.050	0.037	0.043	0.052	0.046	0.041	0.061	0.047
COE with capture only (US$/kWh)	0.043	0.072	0.054	0.062	0.086	0.073	0.054	0.079	0.062
Increase in COE with capture (US$/kWh)	0.012	0.024	0.017	0.018	0.034	0.027	0.009	0.022	0.016
Percent increase in COE with capture (%)	37	69	46	42	66	57	20	55	33
Cost of net CO_2 captured (US$/t$CO_2$)	37	74	53	29	51	41	13	37	23
Capture cost confidence level (see Table 3.6)	moderate			moderate			moderate		



Updates Needed – Costs of CCS Options

Performance and cost measures	New NGCC plant			New PC plant			New IGCC plant		
	Range		Rep.	Range		Rep.	Range		Rep.
	Low	High	value	Low	High	value	Low	High	value
Emission rate without capture ($kgCO_2/kWh$)	0.344 - 0.379		0.367	0.736 - 0.811		0.762	0.682 - 0.846		0.773
Emission rate with capture ($kgCO_2/kWh$)	0.040 - 0.066		0.052	0.092 - 0.145		0.112	0.065 - 0.152		0.108
Percentage CO_2 reduction per kWh (%)	83 - 88		86	81 - 88		85	81 - 91		86
Plant efficiency with capture, LHV basis (%)	47 - 50		48	30 - 35		33	31 - 40		35
Capture energy requirement (% increase input/ kWh)	11 - 22		16	24 - 40		31	14 - 25		19
Total capital requirement without capture (US$/kW)	515 - 724		568	1161 - 1486		1286	1169 - 1565		1326
Total capital requirement with capture (US$/kW)	909 - 1261		998	1894 - 2578		2096	1414 - 2270		1825
Percent increase in capital cost with capture (%)	64 - 100		76	44 - 74		63	19 - 66		37
COE without capture (US$/kWh)	0.031 - 0.050		0.037	0.043 - 0.052		0.046	0.041 - 0.061		0.047
COE with capture only (US$/kWh)	0.043 - 0.072		0.054	0.062 - 0.086		0.073	0.054 - 0.079		0.062
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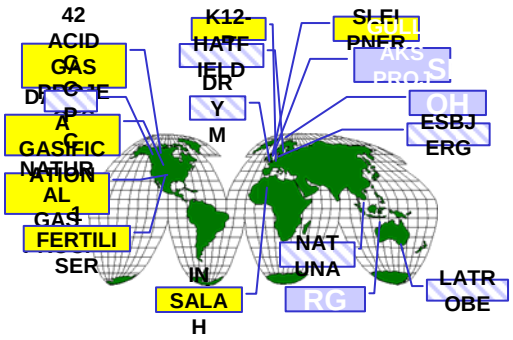
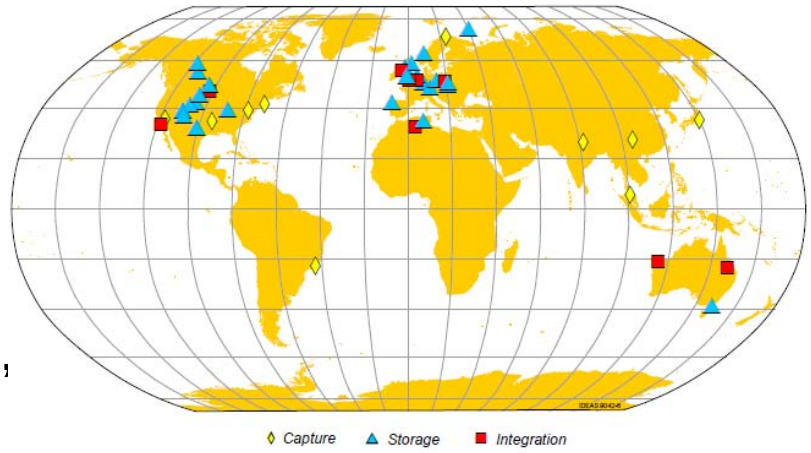
Percent increase in COE with capture (%)	37 - 69		46	42 - 66		57	20 - 55		33
Cost of net CO_2 captured (US/tCO_2$)	37 - 74		53	29 - 51		41	13 - 37		23
Capture cost confidence level (see Table 3.6)	moderate			moderate			moderate		

- Costs and technical details for NGCC, PC and IGCC are based on 2005 IPCC report with data from 2002
- Good scope for updating these values, particularly as the IPCC data was assembled from various sources
- Drafting team is working with US contributors (and others) on getting more up-to-date information

Key Changes – Global Activities Since 2004

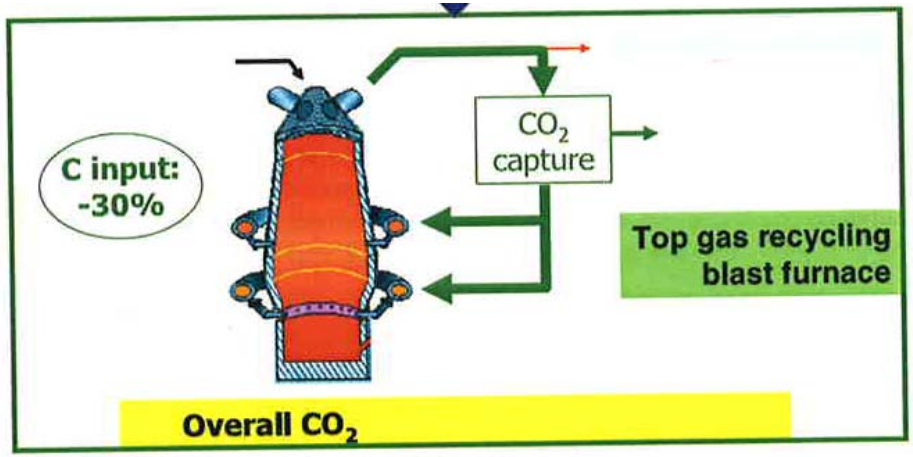
- The 2004 TRM showed project locations for (then) current and proposed projects
- Different emphasis for 2009 TRM – maps revised to show increase in activity levels between 2004 and 2008
- Project lists consolidated, additional projects provided by PIRT members, url references attached to project to allow for "live" navigation





Key Changes – Other Large Emitters

- More inclusive references to other industries and processes
- The steel industry in particular is acknowledged because of global activities that are taking place
- The European based ULCOS (Ultra low CO_2 Steelmaking) has CCS as an important component for the industry to move towards a low carbon future



Key Messages

- Key focus needs to be where true knowledge gaps exist rather than gaps due to inertia
- A need to harmonise with other bodies in this area – IEA, GCCSI etc to achieve a common outcome
- Importance of integration – CCS to be considered as a complete package ..... not as a set of independent, discrete elements
- Integration/demonstration message has been expanded in the `*suggested project areas*` and the `*Roadmap*` table
- Compliance and consistency with IEA TRM for CCS and co-ordination action between IEA, CSLF and GCCSI

Acknowledgements

Contributions by

- CSLF members
  - Especially contributions and involvement from Australia, France, USA and UK

Co-ordination by

- CSLF Secretariat

Supporting work by

- Global CCS Institute