

# Report of Task Force on Application of UNFC-2009 to Injection Projects

Karin Ask

Task Force on UNFC-2009 and Injection Projects

# Task Force on UNFC-2009 and Injection Projects

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# Outline of the presentation

- Survey on possible application of UNFC-2009 to injection projects such as CO<sub>2</sub> storage projects - Summary of results and comments received
- High-level mapping comparing UNFC-2009 with other proposed classifications for CO<sub>2</sub> storage projects
- Draft proposal for classification of injection projects and possible application of UNFC-2009
- High level case study based on Global CCS Institutes project overview

# Survey on possible application of UNFC-2009 to injection projects such as CO<sub>2</sub> storage projects

- Questionnaire prepared by the Task Force
- Distributed to a group of known stake holders
- Less than 25% responded despite extended dead line

**Survey on possible application of the UNFC-2009 to Injection Projects**

Your name:

Company/organization:

1. Are you/your company/organisation currently involved in or considering any carbon storage opportunities or other injection projects?

Yes ☐ No ☐

If yes, do you currently use any system for measuring project maturity when evaluating these opportunities?

Yes ☐ No ☐

If not, do you believe such a system would help you in your decision process?

Yes ☐ No ☐

2. Are you familiar with the UNFC2009 classification system for extraction projects?

☐ Yes, detailed knowledge ☐ Yes, some knowledge ☐ No

If yes, do you believe that the UNFC2009 framework could be a model for developing a classification also for injection projects such as carbon storage projects?

☐ Yes ☐ No ☐ Have no opinion

Any comments:

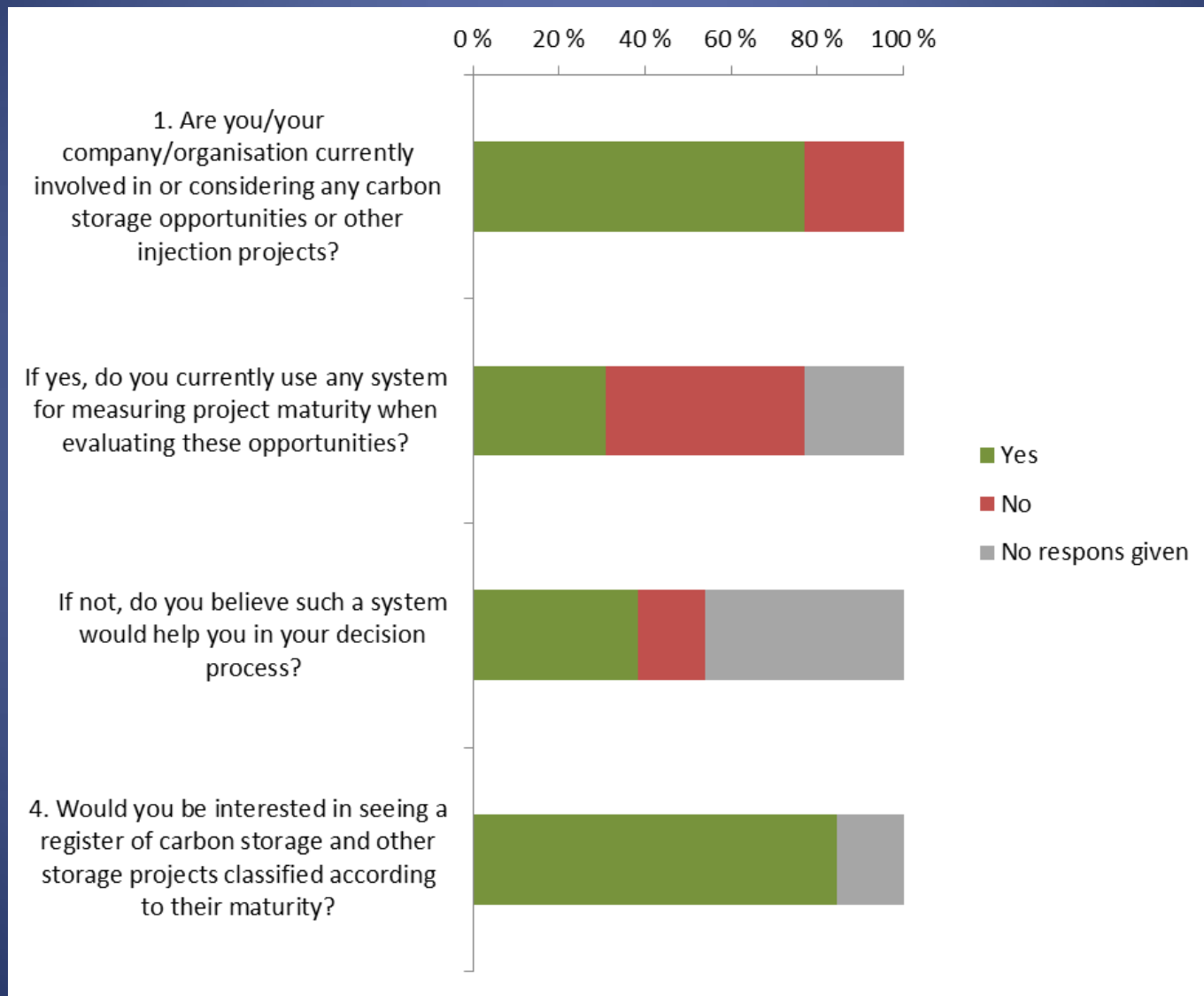
3. Are you aware of any other classification systems currently applied to injection projects?

If yes, please specify:

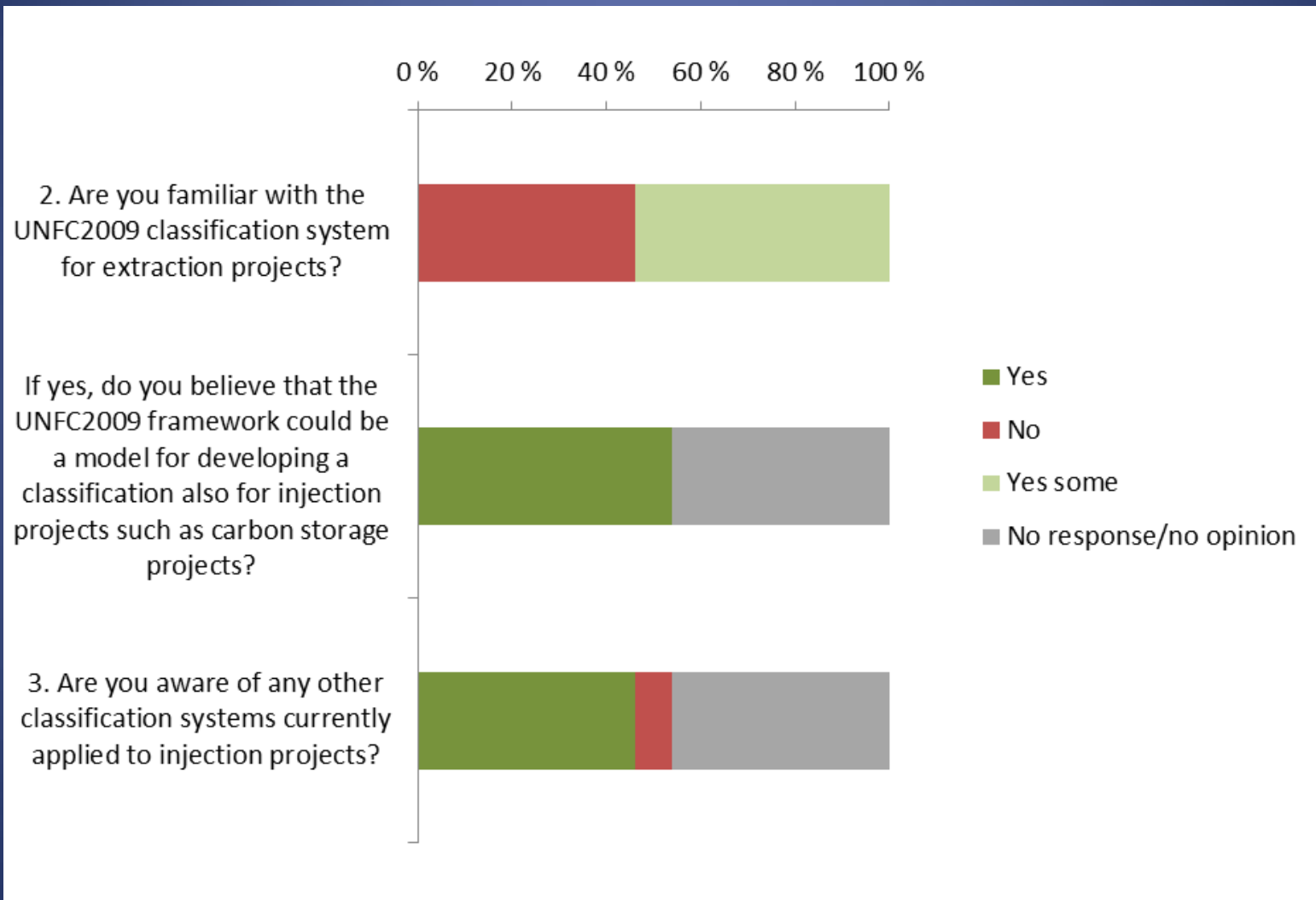
4. Would you be interested in seeing a register of carbon storage and other storage projects classified according to their maturity?

Yes ☐ No ☐

# Questions on current use and general interest

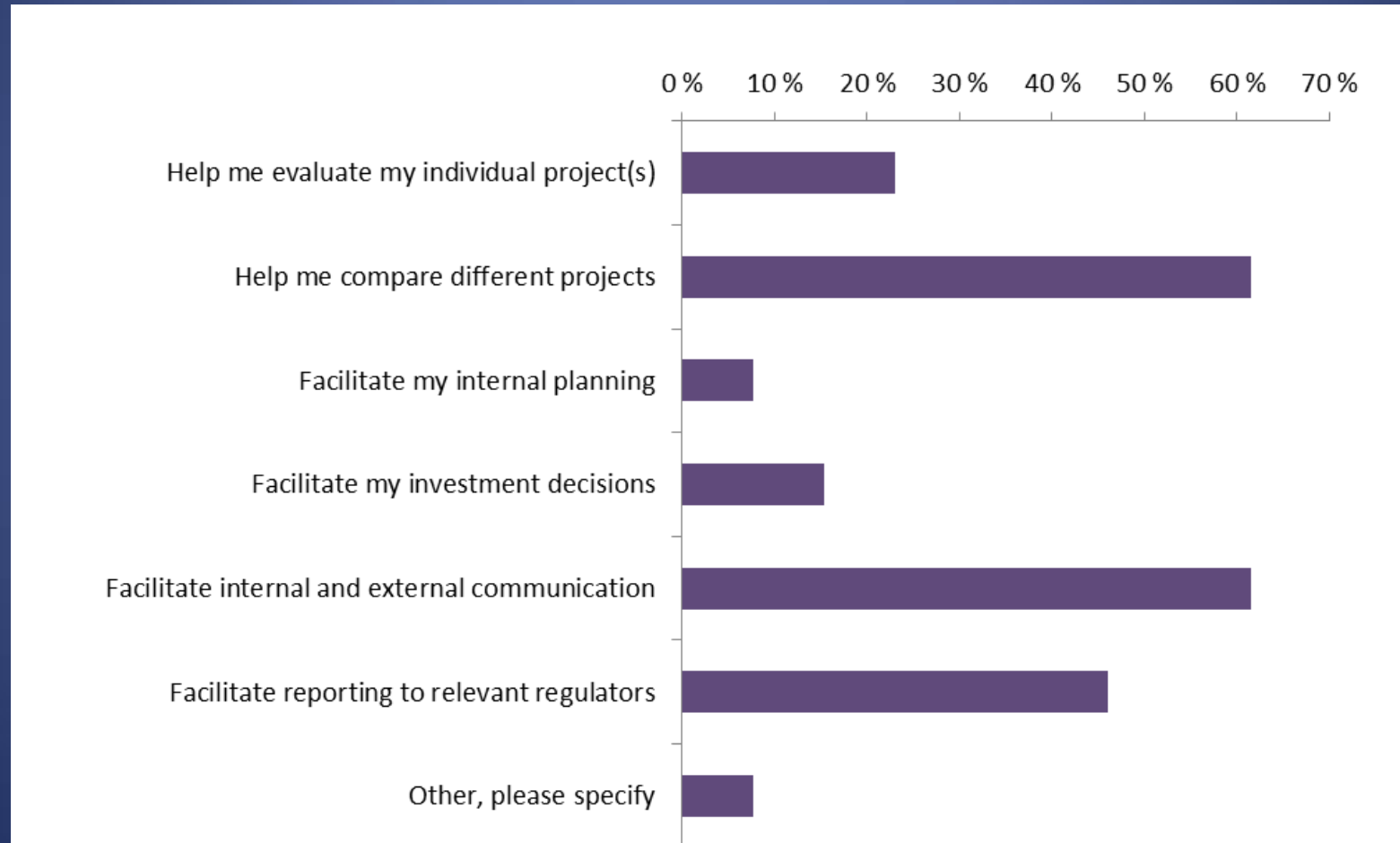


# Questions directly related to the UNFC-2009



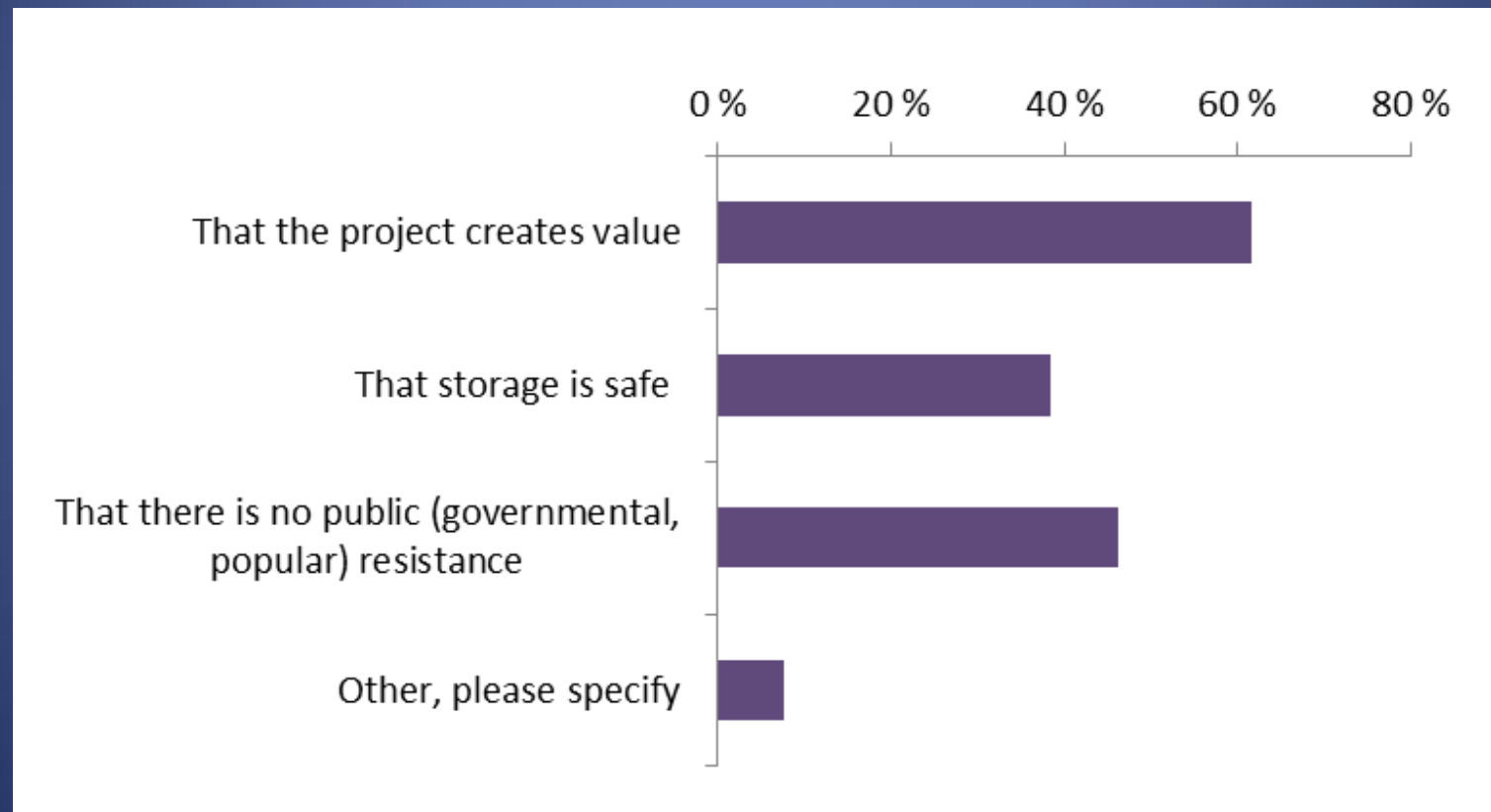
# Expectations to a classification system for injection projects

## 5. What would you expect from such a classification system?



# Challenges related to the UNFC E-axis

6. Given that you have a technically and geologically feasible storage site, and that a potential injection project is in line with both national and international laws and regulations, what would in your opinion be the most important challenges for an injection project?





## Comments related to injection projects in general (i)

- *“The classification system should distinguish between storage options, i.e. mature technologies and developing technologies. Analogies with mineral reserves/resources classification may be difficult, as storage space can be used only for one commodity, though the potential may be there for various substances and thus reserves or resources can not be added up.”*
- *“If, possible classification should be applicable to all kinds of injections: CCS, geothermal, waste disposal, natural gas storage, etc.”*
- *“There are standard petroleum industry methods for estimating resource and reserves that can be applied to injection projects, and industry workflows to determine project maturity.”*

## Comments related to injection projects in general (ii)

- *“Some of the challenges I see are :*
  - 1) Business models and project lead times may be very different from what is used in the extraction industries.*
  - 2) Role of government may be different as well.*
  - 3) Ownership of injected substances vs. ownership of the storage pore space.*
  - 4) Criteria for being a commercially viable project.*
  - 5) Large scale implementation may require clusters of storage projects and large scale infrastructure.”*

## Comments related specifically to carbon storage (i)

- *“CO2 storage capacity should be viewed as any other resource and treated as such in evaluating potential, project development, FID, and tenure and permitting applications”*
- *“There are no official or formal classification systems adopted by regulatory agencies and that could be used by industry and regulators. Various schemes have been proposed in the literature.”*
- *“It will greatly help industry, policy makers and regulators in identifying and obtaining permits for CO2 storage and assess the potential for using CCS for reducing GHG emissions.”*

## Comments related specifically to carbon storage (ii)

- *“The UNFC2009 framework could be a starting point; however, it is not directly applicable as CO2 injection projects are not mature enough to form the basis of a robust classification system such as the UNFC2009 framework. A more detailed review of all injection projects, and how those might be compared, could lead to a very interesting injection classification system.”*
- *“No general agreement on how to define CO2 storage capacity of an aquifer, to be clarified first as the saline aquifer 'resource' is to be shared between different projects and operators”*

# High-level mapping

## Comparing UNFC-2009 with other proposed classifications

- Techno-Economic Resource-Reserve Pyramid
  - CSLF
  - CCOP
  - NPD
- The CO2CRC classification
- The Geologic Storage Framework (US DOE/NETL)
- CSRCC (Frailey & Finley, ISGS)
- The Global CCS Institute's project overview
- Classification proposed by Gorecki et al (2009)

Extraction Projects										Injection Projects																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
UNFC-2009 defined by Classes, Sub-classes and Categories										PRMS										Techno-economic Resource-reserve Pyramid						CO2CRC Classification (2008)		Classification System proposed by Gorecki et al, SPE126421 (2009)						DOE/NETL Geologic Storage Framework (Adapted PRMS)				CSRCC Frailey & Finley (2009)				Global CCS Institute																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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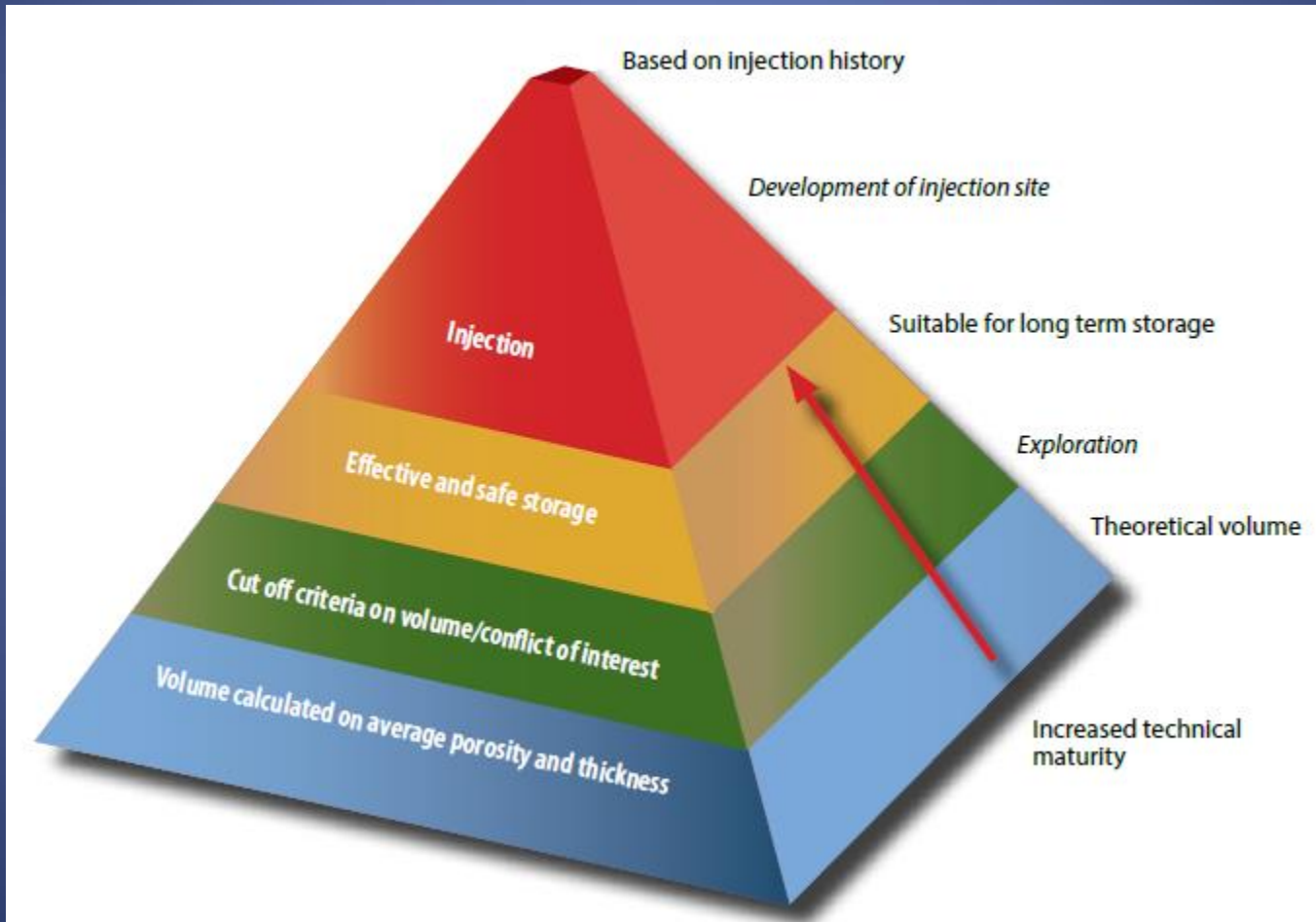
# Draft document for discussion

- Draft for discussion prepared by the Task Force on UNFC-2009 and Recipient Reservoirs is available as a room document for this meeting.



# Comparing UNFC-2009 with other classifications for injection projects

## - Techno-economic resource-reserves pyramid



Source: NPD

# Comparing UNFC-2009 with other classifications for injection projects

## - Techno-economic resource-reserves pyramid

Extraction Projects					Injection Projects						
UNFC-2009 defined by Classes, Sub-classes and Categories					Techno-economic Resource-reserve Pyramid						
Class	Sub-class					CSLF		CCOP		NPD	
		Categories									
		E	F	G							
Commercial projects	On Production	1	1.1	1,2,3		Matched Capacity			Operational Capacity		Development of Injection Site
	Approved for Development	1	1.2	1,2,3							
	Justified for Development	1	1.3	1,2,3							
Potentially commercial projects	Development Pending	2	2.1	1,2,3		Practical Capacity			Contingent Capacity		Suitable for Long Term Storage
	Development on Hold	2	2.2	1,2,3							
Non-commercial projects	Development Unclassified	3.2	2.2	1,2,3							
	Development Not Viable	3.3	2.3	1,2,3							
Additional Quantities in Place		3.3	4	1,2,3		Effective Capacity			Prospective Capacity		Exploration
Exploration Projects	(No sub-classes defined)	3.2	3	4							
Additional Quantities in Place		3.3	4	4		Theoretical Capacity			Total Pore Volume		Theoretical Volume



# Comparing UNFC-2009 with other classifications for injection projects

## - Classification based on PRMS (Frailey & Finley, ISGS)

Extraction Projects					Injection Projects			
UNFC-2009 defined by Classes, Sub-classes and Categories					CSRCC Frailey & Finley (2009)			
Class	Sub-class					Injection	Project Status	
		Categories						
		E	F	G				
Commercial projects	On Production	1	1.1	1,2,3		Commercial	Capacity	Active Injector
	Approved for Development	1	1.2	1,2,3				Under Development
	Justified for Development	1	1.3	1,2,3				Planned for Development
Potentially commercial projects	Development Pending	2	2.1	1,2,3		Sub-Commercial	Contingent Resource	Development Pending
	Development on Hold	2	2.2	1,2,3				Development on Hold
Non-commercial projects	Development Unclassified	3.2	2.2	1,2,3				Development Not Viable
	Development Not Viable	3.3	2.3	1,2,3				
Additional Quantities in Place		3.3	4	1,2,3			Unattainable	
Exploration Projects	(No sub-classes defined)	3.2	3	4		Undiscovered	Prospective Resource	Propsect
								Lead
								Play
Additional Quantities in Place		3.3	4	4		Unattainable		

# Global CCS Institute – Project Overview

## Projects status:

- Active
- Planned

## Project stage:

- Operate
- Execute
- Define
- Evaluate
- Identify

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### Projects

Listing and analysis of CCS projects around the world

#### Large-scale Integrated CCS Projects

This interactive map provides an overview of the large-scale integrated CCS projects identified by the Global CCS Institute around the world. The data displayed in this map and in the table below is regularly updated. A downloadable version of this data is available [here](#).

Large-scale integrated CCS projects (LSIPs) are defined as those which involve the capture, transport and storage of CO<sub>2</sub> at a scale of:

- › at least 800,000 tonnes of CO<sub>2</sub> annually for a coal-based power plant, or
- › at least 400,000 tonnes of CO<sub>2</sub> annually for other emission-intensive industrial facilities (including natural gas-based power generation).

Project status: -- Project status --  
Stage: -- Stage --  
Region: -- Region --  
Capture type: -- Capture type --  
Transport type: -- Transport type --  
Storage type: -- Storage type --  
Industry: -- Industry --

Search:



Showing 60 of 60 projects.

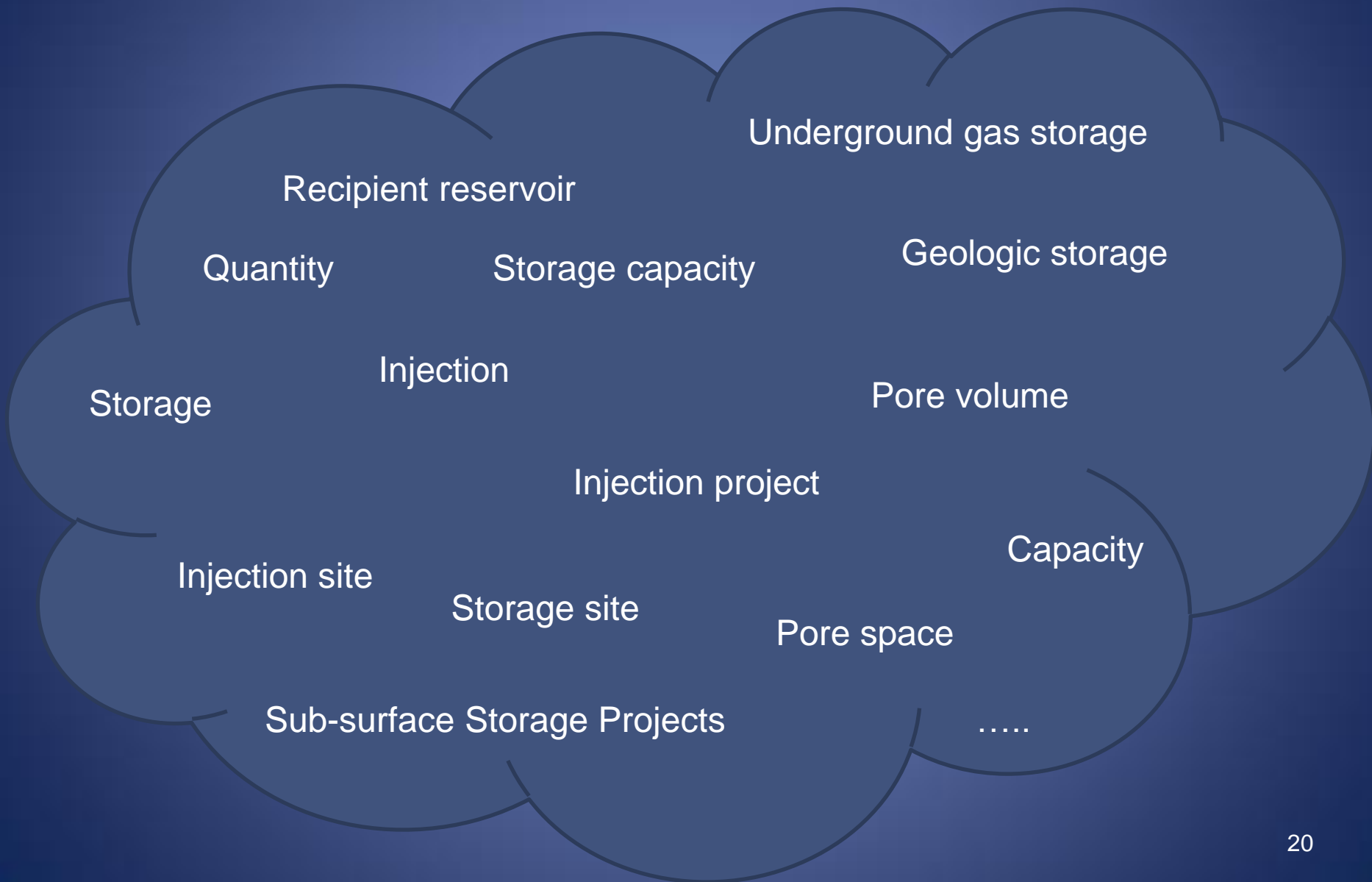
Bruksvilkår | Rapportør en feil med kartet

# Comparing UNFC-2009 with proposed classifications for injection projects

## - Global CCS Institute

Extraction Projects					Injection Projects		
UNFC-2009 defined by Classes, Sub-classes and Categories					Global CCS Institute		Statoil CVP process
Class	Sub-class	Categories			Project Status	Project Stage	Project maturity
		E	F	G			
Commercial projects	On Production	1	1.1	1,2,3	Active	Operate	Operations
	Approved for Development	1	1.2	1,2,3		Execute	Execution
	Justified for Development	1	1.3	1,2,3			
Potentially commercial projects	Development Pending	2	2.1	1,2,3	Planned	Define	Definition
	Development on Hold	2	2.2	1,2,3		Evaluate	Concept planning
Non-commercial projects	Development Unclassified	3.2	2.2	1,2,3			Business planning
	Development Not Viable	3.3	2.3	1,2,3			
Additional Quantities in Place		3.3	4	1,2,3			
Exploration Projects	(No sub-classes defined)	3.2	3	4		Identify	Business identification
Additional Quantities in Place		3.3	4	4			

# Terminology...



# UNFC-2009 Application to Injection Projects

## Abbreviated version

Total Pore Volume in Place	Injected				
		Class	Categories		
			E	F	G
	Future <b>storage</b> by commercial <b>injection</b> projects	Commercial <b>Storage</b> Projects	1	1	1, 2, 3
	Potential future <b>storage</b> by commercial <b>injection</b> projects	Potentially Commercial <b>Storage</b> Projects	2	2	1, 2, 3
		Non-Commercial <b>Storage</b> Projects	3	2	1, 2, 3
	<b>Storage Unattainable</b>		3	4	1, 2, 3
	Potential future storage by succesful screening activities	<b>Screening Projects</b>	3	3	4
	<b>Storage Unattainable</b>		3	4	4

Red color shows where text has been altered for injection project classification purposes.

# UNFC-2009 Application to Injection Projects

## Sub-classes Defined by Categories

UNFC-2009 for Injection Projects				
UNFC2009 - Proposed Application to Injection Projects such as CO <sub>2</sub> Storage Projects				
Class	Sub-class	Categories		
		E	F	G
Commercial <b>Storage</b> Projects	<b>Active Injection</b>	1	1.1	1, 2, 3
	Approved for Development	1	1.2	1, 2, 3
	Justified for Development	1	1.3	1, 2, 3
Potentially Commercial <b>Storage</b> Projects	Development Pending	2	2.1	1, 2, 3
	Development on Hold	2	2.2	1, 2, 3
Non-Commercial <b>Storage</b> Projects	Development Unclassified	3.2	2.2	1, 2, 3
	Development not Viable	3.3	2.3	1, 2, 3
<b>Storage Unattainable</b>		3.3	4	1, 2, 3
<b>Screening Projects</b>	Storage Potential Identified	3.2	3.1	4
	Storage Potential Indicated	3.2	3.2	4
	Storage Potential Inferred	3.2	3.3	4
<b>Storage Unattainable</b>		3.3	4	4

Sub-classes and Categories shown here are the same as those used for Extraction Projects.

# E-axis Categories

## Definitions and Supporting Explanations

Category	Definition	Supporting Explanation
E1	<b>Injection and storage</b> has been confirmed to be economically viable.	<b>Injection and storage</b> is economic on the basis of current market conditions and realistic assumptions of future market conditions. All necessary approvals/contracts have been confirmed or there are reasonable expectations that all such approvals/contract will be obtained within a reasonable time frame. Economic viability is not affected by short-term adverse market conditions provided that longer term forecasts remain
E2	<b>Injection and storage</b> is expected to become economically viable in the foreseeable future.	<b>Injection and storage</b> has not yet been confirmed to be economic but, on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic injection and storage in the foreseeable future.
E3	<b>Injection and storage</b> is not expected to become economically viable in the foreseeable future, or the evaluation is a too early a stage to determine economic viability.	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic <b>injection and storage</b> in the foreseeable future; or, economic viability of injection and storage cannot yet be determined due to insufficient information (e.g. during the screening phase).

# E-axis Categories

## Sub-Categories with Definitions

Category	Sub-Category	Sub-Category Definition
E1	E1.1	<b>Injection and storage</b> is economic on the basis of current market conditions and realistic assumptions of future market conditions.
	E1.2	<b>Injection and storage</b> is not economic on the basis of current market conditions and realistic assumptions of future market conditions, but is made viable through government subsidies and/or other considerations.
E2		<i>No sub-categories for extraction projects, probably also applicable for injection projects?</i>
E3	E3.1	<b>Non-sales production. Not relevant for injection projects.</b>
	E3.2	Economic viability of <b>injection</b> cannot yet be determined due to insufficient information (e.g. during the <b>screening</b> phase).
	E3.3	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic <b>injection and storage</b> in the foreseeable future.



# F-axis Categories

## Definitions and Supporting Explanations

Category	Definition	Supporting Explanation
F1	Feasibility of <b>storage</b> by a defined <b>injection project</b> has been confirmed.	<b>Injection</b> is currently taking place; or, implementation of <b>an injection</b> project is underway; or, sufficiently detailed studies have been completed to demonstrate the feasibility of <b>injection</b> by implementing a defined project.
F2	Feasibility of <b>storage</b> by a defined <b>injection project</b> is subject to further evaluation.	Preliminary studies demonstrate the existence of a <b>recipient reservoir</b> in such form, quality and quantity that the feasibility of <b>injection</b> by a defined project can be evaluated. Further data acquisition and/or studies may be required to confirm the feasibility of <b>injection</b> .
F3	Feasibility of <b>storage</b> by a defined <b>injection project</b> cannot be evaluated due to limited technical data.	Very preliminary studies ( <b>screening</b> phase), which may be based on a defined <b>project activity</b> , indicate the need for further data acquisition and/or further geological studies in order to confirm the existence of a <b>porous and permeable geologic formation and seal</b> in such form, quality and quantity that the feasibility of <b>injection</b> can be evaluated.
F4	No <b>injection project</b> has been identified.	<b>Pore volume</b> that will not be utilised for injection by any currently defined <b>project activity</b> .

# G-axis Definitions

Category	Definition
<b>G1</b>	Quantities associated with a known <b>recipient reservoir</b> that can be estimated with a high level of confidence.
<b>G2</b>	Quantities associated with a known <b>recipient reservoir</b> that can be estimated with a moderate level of confidence.
<b>G3</b>	Quantities associated with a known <b>recipient reservoir</b> that can be estimated with a low level of confidence.
<b>G4</b>	Estimated quantities associated with <b>screening projects</b> .

# Draft document for discussion

- Draft for discussion prepared by the Task Force on UNFC-2009 and Recipient Reservoirs is available as a room document for this meeting.



# Comparing UNFC-2009 with proposed classifications for injection projects

## - Global CCS Institute

Global CCS Institute project overview as of March 2014											UNFC-2009 Numerical Code				
Name	Region	Stage	Status	Capture type	Transport type	Transport details	Storage type	Storage details	Industry	View	E		F		G
											Category	Sub-Cat	Category	Sub-cat	
Air Products Steam Methane Reformer EOR Project	United States	Operate	Active	Pre-combustion capture (gasification)	Pipeline	Onshore to onshore pipeline 101-150km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Hydrogen Production	<a href="#">view...</a>	1	1.2	1	1.1	
Alberta Carbon Trunk Line ("ACTL") with Agrium CO2 Stream	Canada	Execute	Active	Industrial Separation	Pipeline	Onshore to onshore pipeline 201-250km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Fertiliser Production	<a href="#">view...</a>	1		1	1.2 or 1.3	
Alberta Carbon Trunk Line ("ACTL") with North West Sturgeon Refinery CO2 Stream	Canada	Execute	Active	Pre-combustion capture (gasification)	Pipeline	Onshore to onshore pipeline 201 - 250km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Oil Refining	<a href="#">view...</a>	1		1	1.2 or 1.3	
Boundary Dam Integrated Carbon Capture and Sequestration Demonstration Project	Canada	Execute	Active	Post-combustion capture	Pipeline	Onshore to onshore pipeline 51 - 100km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Power Generation	<a href="#">view...</a>	1	1.2	1	1.2 or 1.3	
Bow City Power Project	Canada	Evaluate	Planned	Post-combustion capture	Pipeline	Onshore to onshore pipeline 51-100km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Power Generation	<a href="#">view...</a>	2 or 3		2	2.2 or 2.3	
C.GEN North Killingholme Power Project	Europe	Evaluate	Planned	Pre-combustion capture (gasification)	Pipeline	Onshore to offshore pipeline 151-200km	Dedicated Geological Storage	Offshore deep saline formations	Power Generation	<a href="#">view...</a>	2 or 3		2	2.2 or 2.3	
Captain Clean Energy Project (formerly Caledonia Clean Energy Project)	Europe	Evaluate	Planned	Pre-combustion capture (gasification)	Pipeline	Onshore to offshore pipeline 351-400km	Dedicated Geological Storage	Offshore deep saline formations	Power Generation	<a href="#">view...</a>	2 or 3		2	2.2 or 2.3	
CarbonNet Project	Australia and New Zealand	Evaluate	Planned	Yet to be decided	Pipeline	Onshore to offshore pipeline 51-100km	Dedicated Geological Storage	Offshore deep saline formations	Not Specified	<a href="#">view...</a>	2 or 3		2	2.2 or 2.3	
Century Plant	United States	Operate	Active	Pre-combustion capture (natural gas processing)	Pipeline	Onshore to onshore pipeline 251 - 300km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Natural Gas Processing	<a href="#">view...</a>	1	1.1*	1	1.1	
Coffeyville Gasification Plant	United States	Operate	Active	Industrial Separation	Pipeline	Onshore to onshore pipeline 101-150km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Fertiliser Production	<a href="#">view...</a>	1	1.1*	1	1.1	
Datang Daqing CCS Project	China	Identify	Planned	Oxy-fuel combustion capture	Pipeline	Onshore to onshore pipeline	Dedicated Geological Storage	Onshore deep saline formations	Power Generation	<a href="#">view...</a>	3	3.2	3		4
Don Valley Power Project	Europe	Define	Planned	Pre-combustion capture (gasification)	Pipeline	Onshore to offshore pipeline 151-200km	Dedicated Geological Storage	Offshore deep saline formations	Power Generation	<a href="#">view...</a>	2		2	2.1	
Dongguan Taiyangzhou IGCC with CCS Project	China	Identify	Planned	Pre-combustion capture (gasification)	Shipping (e.g. tanker/barge/shuttle)	Ship/Tanker 201-250km	Dedicated Geological Storage	Offshore depleted oil and/or gas reservoir	Power Generation	<a href="#">view...</a>	3	3.2	3		4
Emirates Aluminium CCS Project	Middle East	Evaluate	Planned	Post-combustion capture	Pipeline	Onshore to onshore pipeline 351-400km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Power Generation	<a href="#">view...</a>	2 or 3		2	2.2 or 2.3	
Enid Fertilizer CO2-EOR Project	United States	Operate	Active	Industrial Separation	Pipeline	Onshore to onshore pipeline 201-250km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Fertiliser Production	<a href="#">view...</a>	1	1.1*	1	1.1	
ESI CCS Project	Middle East	Execute	Active	Industrial Separation	Pipeline	Onshore to onshore pipeline <50 km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Iron and Steel Production	<a href="#">view...</a>	1	1.1*	1	1.2 or 1.3	
FutureGen 2.0 Project	United States	Define	Planned	Oxy-fuel combustion capture	Pipeline	Onshore to onshore pipeline <50 km	Dedicated Geological Storage	Onshore deep saline formations	Power Generation	<a href="#">view...</a>	2		2	2.1	
Gorgon Carbon Dioxide Injection Project	Australia and New Zealand	Execute	Active	Pre-combustion capture (natural gas processing)	Pipeline	Onshore to onshore pipeline <50 km	Dedicated Geological Storage	Onshore deep saline formations	Natural Gas Processing	<a href="#">view...</a>	1	1.2**	1	1.2 or 1.3	
Great Plains Synfuel Plant and Weyburn-Midale Project	Canada	Operate	Active	Pre-combustion capture (gasification)	Pipeline	Onshore to onshore pipeline 301 - 350km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Synthetic Natural Gas	<a href="#">view...</a>	1		1	1.1	
Huaneng GreenGen IGCC Project (Phase 2)	China	Evaluate	Planned	Pre-combustion capture (gasification)	Pipeline	Onshore to onshore pipeline 51-100km	Enhanced hydrocarbon recovery	Use of CO2 in enhanced oil recovery	Power Generation	<a href="#">view...</a>	2 or 3		2	2.2 or 2.3	

# Going forward

- Continue to work towards providing Specifications for application of UNFC-2009 to Injection Projects for review by the EGRC 6th session
- Align with activities in the SPE GSRMC if any
- Investigate possible cooperation with the Global CCS Institute on a case study on CCS
- Carry out a similar case study on a small portfolio of natural gas storage projects or other injection projects

Thank you for your attention

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Application of UNFC-2009 to  
injection projects

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