EFG/UNECE conference:
International cooperation on natural resources

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Applying UNFC to Injection Projects and relationship with other initiatives

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Background

Mandate from 2013

The Task Force has been asked to investigate how, for example, oil and gas companies classify and evaluate the maturity of their gas injection projects today, and propose a draft bridging document for application of UNFC-2009 to injection projects, in particular to the storage of carbon dioxide.

Submission to the EGRC 6th session and Public Commenting

At the EGRC 6th session, the Task Force presented its proposed DRAFT Specifications for Application of the UNFC to Injection Projects for the Purpose of Geological Storage. These specifications have since been subject to a public comment period and updated based on comments received.

Approval by the UNECE Committee on Sustainable Energy

On 30 September 2016, the final document *ECE/ENERGY/2016/6 – Specifications for the application of UNFC-2009 to injection projects for the purpose of geological storage* was approved by the UNECE Committee on Sustainable Energy.

Task Force Members

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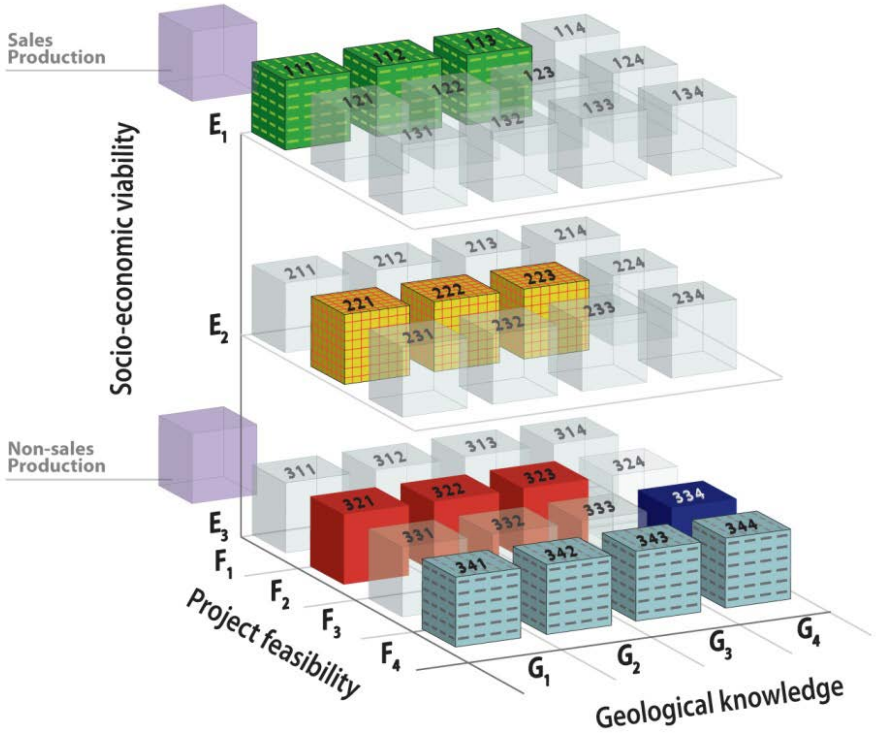
Outline of my presentation

- Introduction to the *UNFC-2009 as Applied to Injection Projects for the Purpose of Geological Storage*
- Short discussion on a few typical challenges
- Other initiatives
- Simple example using Statoil's *Snøhvit long term CO_2 solution project*

UNFC-2009 Definition of Categories



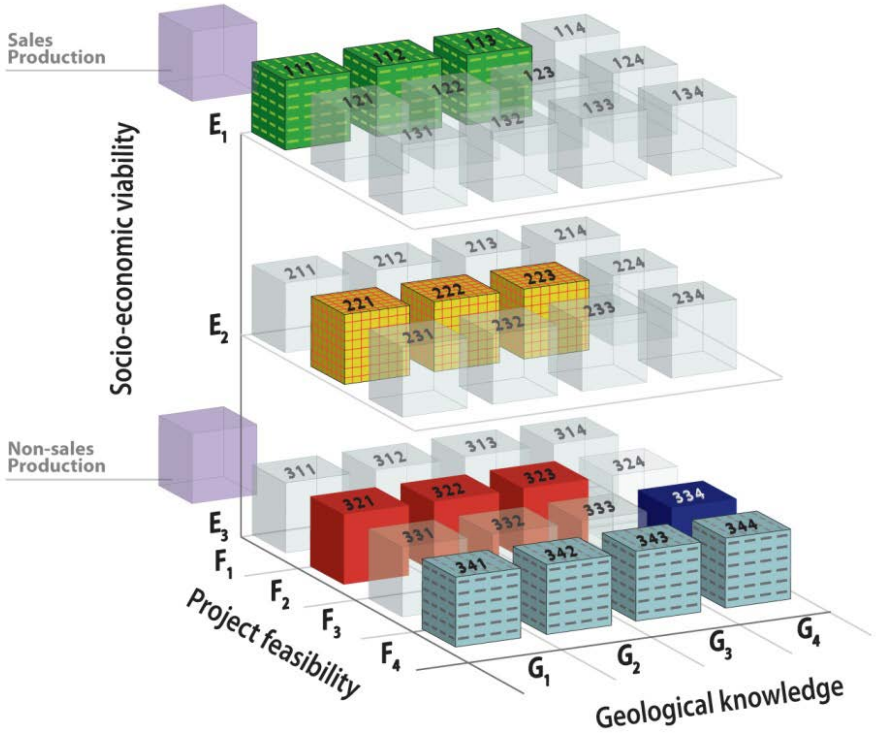
Each project is evaluated and its associated quantities classified based on:

E. Socio-economic viability

F. Project feasibility

G. Geological knowledge

Injection project activities - the simple picture



We need to:

- Understand the geology and dynamic behaviour of the recipient reservoir
- Design a technical concept and evaluate the project feasibility
- Calculate the costs and evaluate the economic and social viability of the project
- Make decisions

These are all activities that we know from oil and gas extraction projects and that are well defined in the UNFC2009

Comparing UNFC-2009 to other proposed classifications

Extraction Projects

UNFC-2009 defined by Classes, Sub-classes and Categories: Class	Sub-class	Categories E	F	G	PRMS		
Commercial projects	On Production	1	1.1	1,2,3	Discovered	Reserves	On Production
	Approved for Development	1	1.2	1,2,3			Approved for Development
	Justified for Development	1	1.3	1,2,3			Justified for Development
Potentially commercial projects	Development Pending	2	2.1	1,2,3		Contingent resources	Development Pending
	Development on Hold	2	2.2	1,2,3			Developmet Unclarified or On Hold
Non-commercial projects	Development Unclarified	3.2	2.2	1,2,3			
	Development Not Viable	3.3	2.3	1,2,3			Development Not Viable
Additional Quantities in Place		3.3	4	1,2,3		Unrecoverable	
Exploration Projects	(No sub-classes defined)	3.2	3	4	Undiscovered	Prospective resources	Prospect
							Lead
							Play
Additional Quantities in Place		3.3	4	4		Unrecoverable	

Injection Projects

Techno-economic Resource-reserve Pyramid: CSLF	CCOP	NPD	CO2CRC Classification (2008)	Classification System proposed by Gorecki et al, SPE126421 (2009)			
Matched Capacity	Operational capacity	Development of Injection Site	Operational Storage Capacity	Theoretical Storage Resource*	Characterized Storage Resource	Effective Storage Resource	Practical Storage Capacity
Practical Capacity	Contingent Capacity	Suitable for Long Term Storage	Contingent Storage Capacity				Contingent Storage Resource
						Unusable Storage Resource	
Effective Capacity	Prospective Capacity	Exploration	Prospective Storage Capacity		Uncharacterized Storage Resource		
Theoretical Capacity	Total Pore Volume	Theoretical Volume					

DOE/NETL Geologic Storage Framework (Adapted PRMS)			CSRCC Frailey & Finley (2009)			Global CCS Institute: Project Status	Project Stage
Commercial	Storage Capacity	Current Injection	Commercial	Capacity	Active Injector	Active	Operate
		Approved Injection Project			Under Development		Execute
		Planned Injection Project			Planned for Development		
Sub-Commercial	Contingent Storage	Site Characterization/ Project Pending	Sub-Commercial	Contingent Resource	Development Pending	Planned	Define
		Site Characterization/ Development on hold			Development on Hold		Evaluate
		Site Characterization/ Development Not Viable			Development Not Viable		
	Un-Injectable CO2			Unattainable			
Geologic Storage	Prospective Storage	Site Characterization (Initial)	Undiscovered	Prospective Resource	Propsect		Identify
		Site Selection			Lead		
		Site Screening (Sub-Regional)			Play		
	Un-Injectable CO2			Unattainable			

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

LINK to document on UNFC web page

Definition of Categories – E axis

	UNFC-2009	UNFC-2009 applied to Injection Projects for the purpose of Geological Storage	
Category	Definition	Definition	Supporting Explanation
E1	***Extraction and sale*** *has been confirmed to be economically viable.*	**Injection for the purpose of geological storage** has been confirmed to be economically viable [a].	Injection 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/contracts 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 positive.
E2	***Extraction and sale*** *is expected to become economically viable in the foreseeable future.*	**Injection for the purpose of geological storage** is expected to become economically viable in the foreseeable future.	Injection 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	***Extraction and sale*** *is not expected to become economically viable in the foreseeable future, or the evaluation is at too early a stage to determine economic viability.*	**Injection for the purpose of geological storage** is not expected to become economically viable in the foreseeable future, or the evaluation is at 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 injection in the foreseeable future; or, economic viability of injection cannot yet be determined due to insufficient information (e.g. during the screening phase).

Definition of Categories – F axis

	UNFC-2009	UNFC-2009 applied to Injection Projects for the purpose of Geological Storage	
Category	Definition	Definition	Supporting Explanation
F1	*Feasibility of **extraction by a defined development project or mining operation** has been confirmed.*	Feasibility of **an injection project for the purpose of geological storage** has been confirmed.	Injection is currently taking place; or, implementation of an injection project is underway; or, sufficiently detailed studies have been completed to demonstrate the feasibility of geological storage by implementing a defined injection project.
F2	*Feasibility of **extraction by a defined development project or mining operation** is subject to further evaluation.*	Feasibility of **an injection project for the purpose of geological storage** is subject to further evaluation.	Preliminary studies demonstrate the existence of a Reservoir in such form, quality and quantity that the feasibility of geological storage by a defined injection project can be evaluated. Further data acquisition and/or studies may be required to confirm the feasibility of injection for the purpose of geological storage.
F3	*Feasibility of **extraction by a defined development project or mining** operation cannot be evaluated due to limited technical data.*	Feasibility of **an injection project for the purpose of geological storage** cannot be evaluated due to limited technical data.	Very preliminary studies (screening phase), which may be based on a defined injection project, indicate the need for further data acquisition and/or further geological studies in order to confirm the existence of a reservoir in such form, quality and quantity that the feasibility of injection for the purpose of geological storage can be evaluated.
F4	*No **development project or mining operation** has been identified.*	No **injection project for the purpose of geological storage** has been identified.	Reservoir which may be suitable for injection for the purpose of geological storage but which will not be utilised by any currently defined injection project.

Definition of Categories – G axis

	UNFC-2009	UNFC-2009 applied to Injection Projects for the purpose of Geological Storage	
Category	**Definition**	**Definition**	**Supporting Explanation**
G1	*Quantities associated with a **known deposit** that can be estimated with a high level of confidence.*	Quantities associated with a **known reservoir** that can be estimated with a high level of confidence.	The G-axis represents the level of confidence in the estimated quantities of a fluid that can be stored in the reservoir through a defined injection project. The quantities are typically categorised discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the reservoir. The estimates are categorised as G1, G2 and/or G3 as appropriate. The quantities that can be stored should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	*Quantities associated with a **known deposit** that can be estimated with a moderate level of confidence.*	Quantities associated with a **known reservoir** that can be estimated with a moderate level of confidence.	
G3	*Quantities associated with a **known deposit** that can be estimated with a low level of confidence.*	Quantities associated with a **known reservoir** that can be estimated with a low level of confidence.	
G4	*Estimated quantities associated with a **potential deposit**, based on primary or indirect evidence.*	Estimated quantities associated with a **potential reservoir**, based on primary or indirect evidence.	Undiscovered storage quantities that are estimated during the screening phase. Normally subject to a substantial range of uncertainty as well as a major risk that no injection project may be implemented.

UNFC-2009 Main Classes and Categories

UNFC as Applied to Extractive Industries

Total Commodity Initially in Place					
Extracted	Sales Production				
	Non-sales Production				
	Class	Categories			
		E	F	G	
Future recovery by commercial development projects or mining operations	Commercial Projects	1	1	1, 2, 3	
Potential future recovery by contingent development projects or mining operations	Potentially Commercial Projects	2	2	1, 2, 3	
	Non-Commercial Projects	3	2	1, 2, 3	
Additional quantities in place associated with known deposits		3	4	1, 2, 3	
Potential future recovery by successful exploration activites	Explration Projects	3	3	4	
Addtional quantities in place associated with potential projects		3	4	4	

UNFC as Proposed Applied to Injection Projects

Total Geological Storage					
Injected and Stored Quantities					
Lost Quantities					
	Class	Categories			
		E	F	G	
Future storage by commercial injection projects	Commercial Injection Projects	1	1	1, 2, 3	
Potential future storage in known reservoirs by injection projects	Potentially Commercial Injection Projects	2	2	1, 2, 3	
	Non-Commercial Injection Projects	3	2	1, 2, 3	
Storage Not Feasible		3	4	1, 2, 3	
Potential future storage in undiscovered reservoirs by injection projects	Screening Projects	3	3	4	
Storage Not Feasible		3	4	4	

Sub-Classes and Sub-Categories

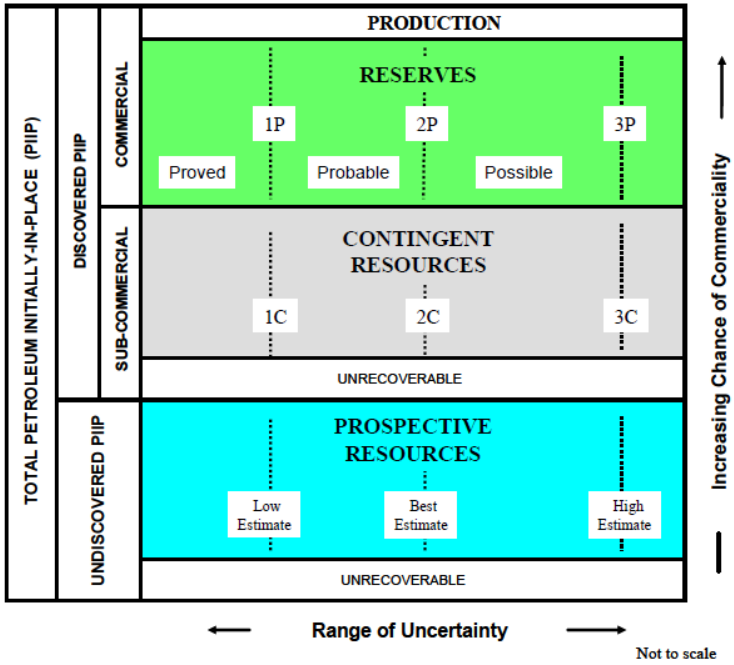
UNFC Classes Defined by Categories and Sub-Categories as Applied to Injection Projects for the Purpose of Geological Storage						
Total Geological Storage	Injected and Stored Quantities					
	Lost quantities					
	Class		Sub-class	Categories		
				E	F	G
	Known Reservoir	Commercial Injection Projects	Active Injection	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 Injection Projects	Development Pending	2	2.1	1, 2, 3
			Development on Hold	2	2.2	1, 2, 3
		Non-Commercial Injection Projects	Development Unclarified	3.2	2.2	1, 2, 3
			Development not Viable	3.3	2.3	1, 2, 3
		Storage Not Feasible		3.3	4	1, 2, 3
	Undiscovered Reservoir	Screening Projects	Geological Storage Identified	3.2	3.1	4
			Geological Storage Indicated	3.2	3.2	4
			Geological Storage Inferred	3.2	3.3	4
		Storage Not Feasible		3.3	4	4

Other ongoing initiative

SPE-SRMS: CO_2 Storage Resources Management System

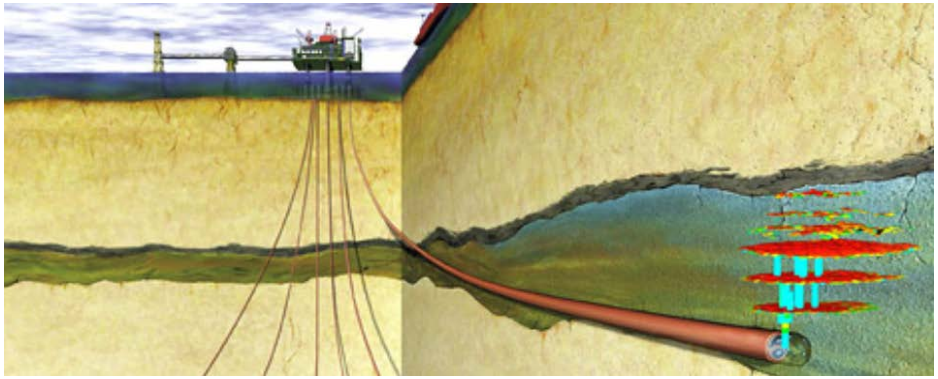
- Currently under development by an SPE sub-committee to the SPE CCUS Technical Section
- Seed Document: Petroleum Resources Management System (PRMS)
- Intention that the system shall be sufficiently aligned with the UNFC-2009 to allow the classifications to be mapped
- Scheduled to be released for public comments in April-May and submitted to the SPE Board for final approval in June 2017

Illustration: PRMS as applied to petroleum



Typical challenges and examples of discussions

- Undiscovered versus discovered resources
  - Utsira example
  - Understanding the project concept



- Economic viability of an injection project

Category	*Sub-Category*	*Sub-Category Definition*
E1	E1.1	Injection for the purpose of geological storage is economic on the basis of current market conditions and realistic assumptions of future market conditions.
	E1.2	Injection for the purpose of geological storage 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.

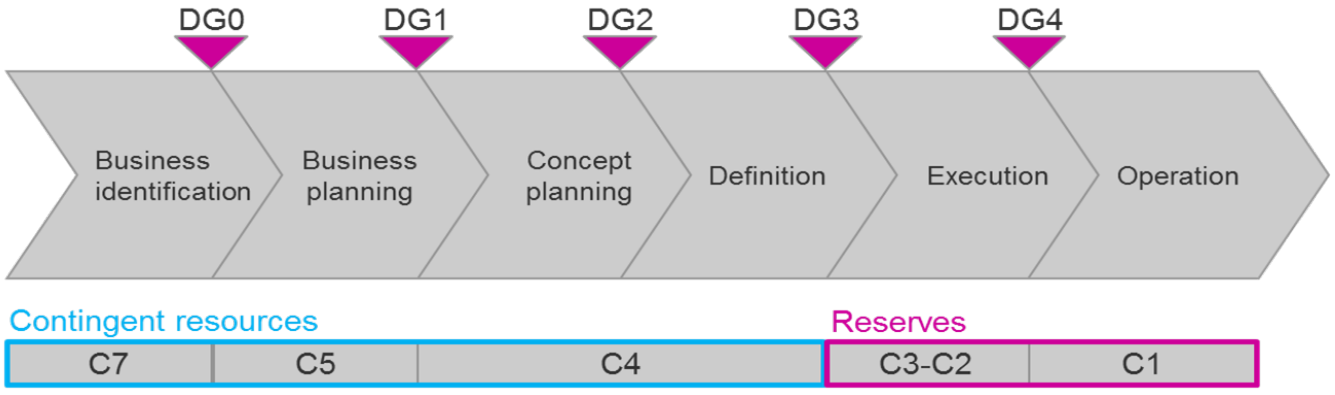
How it could be applied

Classifying the *Snøhvit long term CO2 solution* project

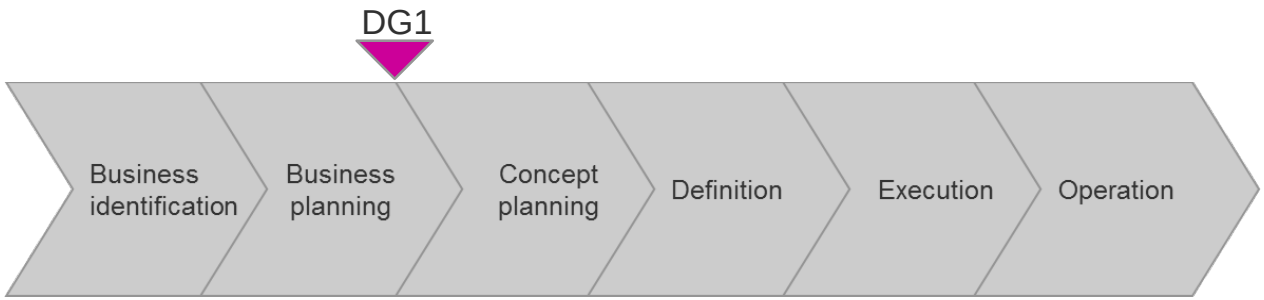
- Snøhvit was the first field development in the Barents Sea offshore Norway
- The Snøhvit Area includes three fields; Snøhvit, Albatross and Askeladd
- All offshore installations are subsea
- The natural gas is transported to shore through a 143 km long pipeline and processed in an LNG plant at Melkøya
- The CO_2 in the feed gas is removed due to freezing constraints in the process system
- To reduce carbon emissions to the air the removed CO_2 is liquefied, transported through a pipeline and injected into a storage reservoir in Snøhvit
- The CO_2 injection started in 2008

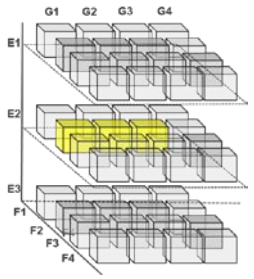
Classifying the *Snøhvit long term CO_2 solution* project

- In 2011 a project was initiated to increase the CO_2 storage capacity at Snøhvit through a second CO_2 injection well, including subsea and pipeline facilities: Snøhvit long term CO_2 solution
- The project was decided by the partners in 2013 and approved by the Norwegian authorities in 2014
- The project was run according to Statoil's Capital Value Process (CVP)



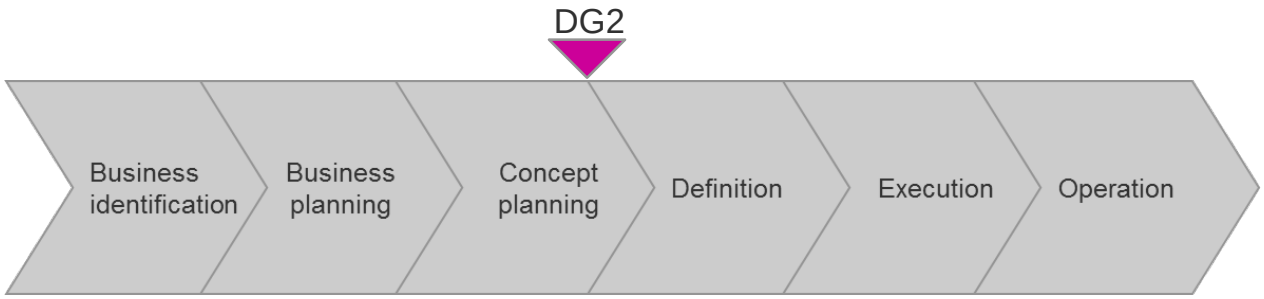
Classifying the *Snøhvit long term CO_2 solution* project

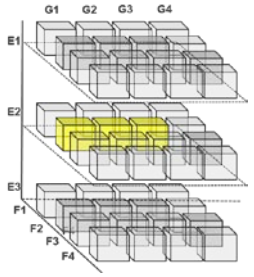




		Norwegian classification			UNFC-2009 as applied to injection projects			
Year	**Reporting**	**Decision gate**	**Decision stage**	**Resource class**	**Sub-class**	**E**	**F**	**G**
2011	RNB2012	DG1	Concept planning	C4A	On hold	2	2.2	1, 2, 3

Classifying the *Snøhvit long term CO_2 solution* project





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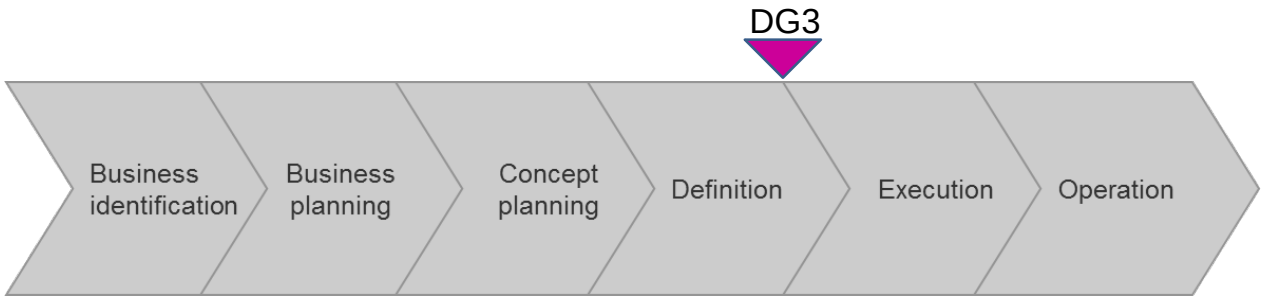
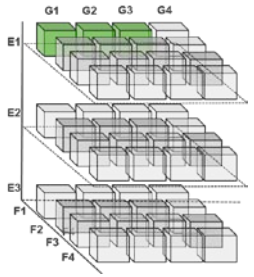
2012	RNB2013	DG2	Definition	C4A	Pending	2	2.1	1, 2, 3

Classifying the *Snøhvit long term CO_2 solution* project





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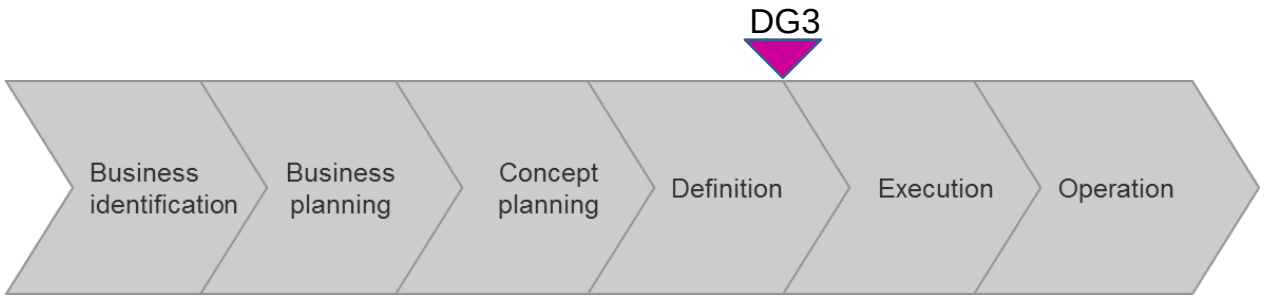
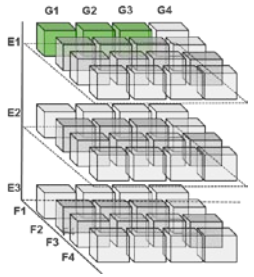
2011	RNB2012	DG1	Concept planning	C4A	On hold	2	2.2	1, 2, 3
2012	RNB2013	DG2	Definition	C4A	Pending	2	2.1	1, 2, 3
2013	RNB2014	DG3	Execution	C3A	Justified	1	1.3	1, 2, 3

Classifying the *Snøhvit long term CO_2 solution* project





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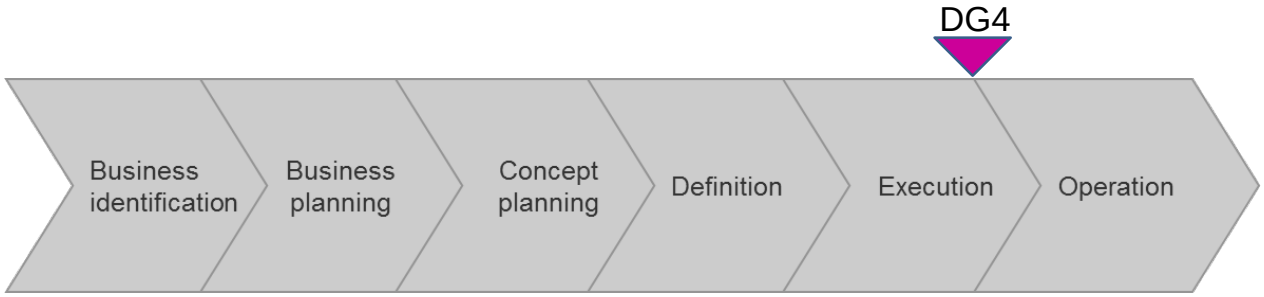
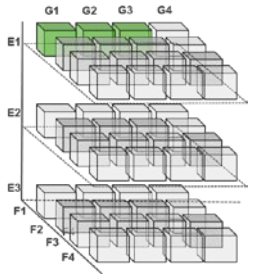
2013	RNB2014	DG3	Execution	C3A	Justified	1	1.3	1, 2, 3
2014	RNB2015	DG3	Execution	C1	Approved	1	1.2	1, 2, 3

Classifying the *Snøhvit long term CO_2 solution* project





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2013	RNB2014	DG3	Execution	C3A	Justified	1	1.3	1, 2, 3
2014	RNB2015	DG3	Execution	C1	Approved	1	1.2	1, 2, 3
2015	RNB2016	DG4	Operation	C1	Active injection	1	1.1	1, 2, 3

Thank you for your attention!

Applying UNFC to Injection Projects and relationship with other initiatives

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