



CO₂ Capture Project



CCP Economics Overview

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Final Cost Estimates and Economics

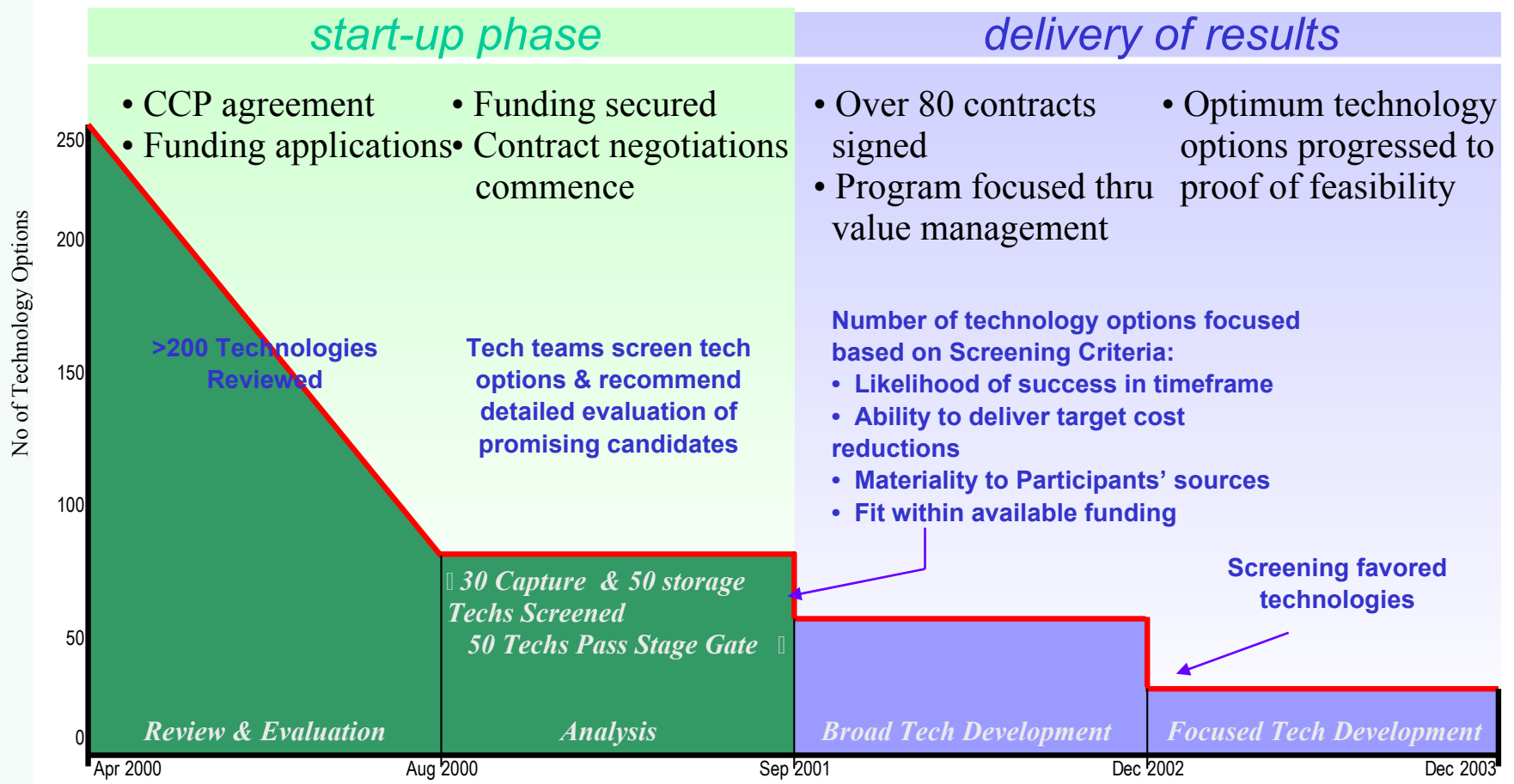
- Background and motivation
 - Objectives and targets
 - Work program 2000-2004
- Approach and challenges
 - Scenarios and technologies
 - Baseline technologies and new technologies
 - Cost estimation and screening
- Results and findings
 - CO₂ costs

Objectives and Targets

- Develop new, more efficient CO₂-capture technologies
- Reduce capture cost 50 – 75%
 - calculated CO₂-costs cover the capture processes, excl. CO₂-transport and –storage part



Work Program 2000-2004





Approach

- **Capture technologies**
cost-reducing development of pre/post/oxy technology options within the context of ...
- **“Scenarios”**
or case studies of representative, real-life, industrial-plant applications, and
- **“Baselines”**
or currently best available capture technologies (mainly post-combustion amines) established as benchmarks in evaluating ...
- **New technologies**
evaluating capture performance and costs

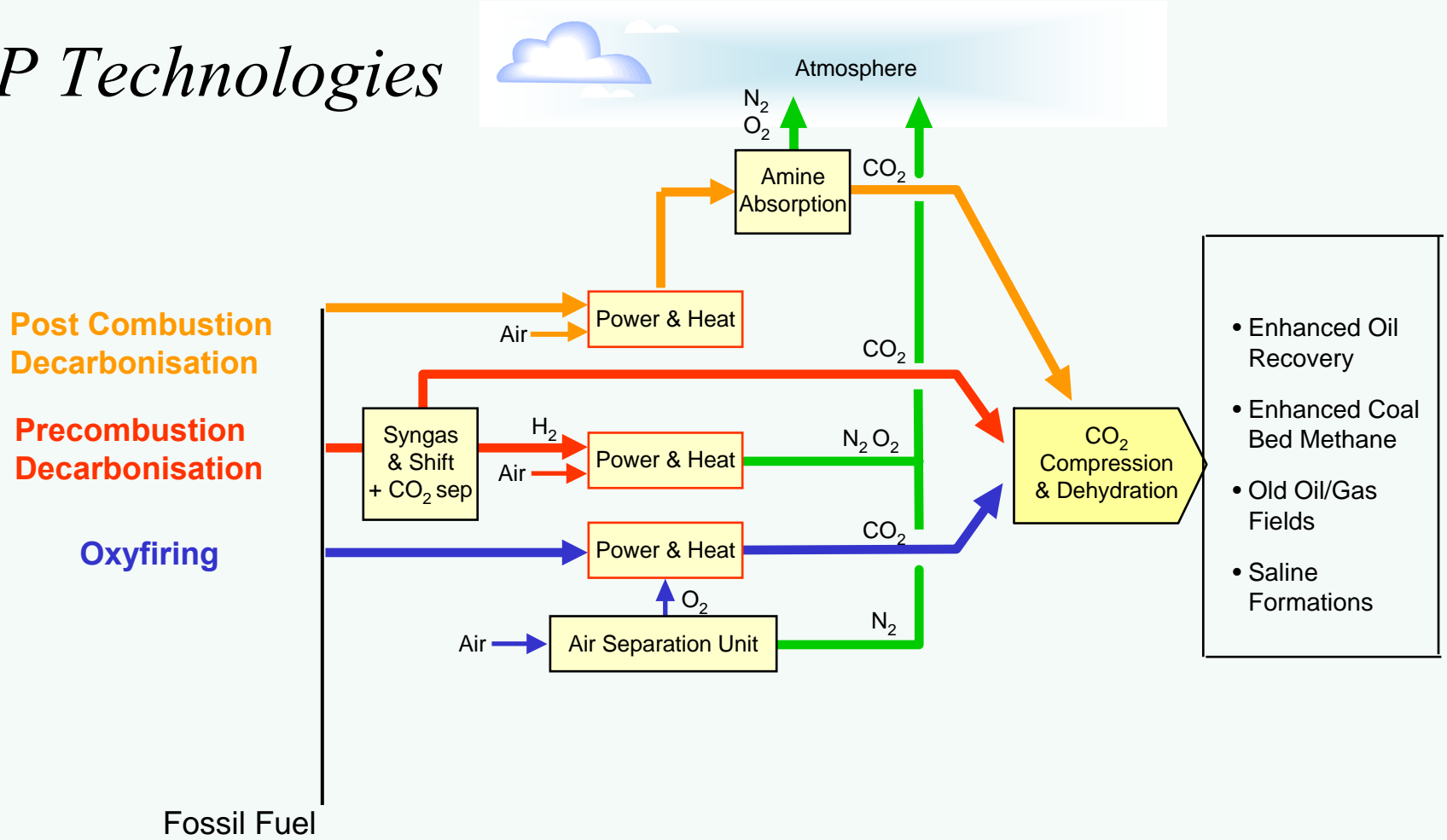


CCP Scenarios

<u>Scenario</u>	<u>Fuel Source</u>	<u>CO₂ Source</u>	<u>Geologic Sink</u>	<u>Location</u>
<u>Refinery</u>	Hydrocarbon Gas + Liquids	Heaters and Boilers	Storage	UK Scotland
<u>Large Gas Turbines</u>	Natural Gas	Large Electric Power (CCGT)	Storage	Western Norway
<u>Distributed Gas Turbines</u>	Natural Gas	Small Distributed Turbines	Storage	Alaska North Slope
<u>Gasification</u>	Solid Gasification (pet coke)	Steam, H ₂ , and Electric Cogen	Storage	Western Canada



CCP Technologies





Final Scenario-Technology Cases

Case	Scenario				Process Group			Technical Provider	Contractor
	N	U	A	C	Po	Pr	Ox		
Uncontrolled	x							Norsk Hydro	(CCP)
				x				Fluor	Fluor
Baseline Amine	x				x			Fluor	Fluor
		x			x			Fluor	Fluor
			x		x			Fluor	Fluor
				x	x			Fluor	Fluor
Very Large Scale ATR			x			x		Jacobs	(CCP)
Membrane WGS (DOE)		x				x		Eltron Res., SOFCo	Fluor
Membrane WGS (GRACE)		x				x		BP	(CCP)
Hydrogen Membrane Reformer	x					x		Norsk Hydro	Fluor
Sorption Enhanced WGS			x			x		Air Products	Fluor
Sorption Enhanced WGS- O ₂	x					x		Air Products	(CCP)
Sorption Enhanced WGS- Air	x					x		Air Products	(CCP)
Advanced Gasification				x		x		Fluor	Fluor
Flue Gas Recycle ASU		x					x	Air Products	Air Products
Flue Gas Recycle ITM		x					x	Air Products	Air Products
Amine – Normal Cost	x				x			Nexant	Nexant/(CCP)
Amine – Low Cost	x				x			Nexant	Nexant/(CCP)
Amine – Low Cost Integrated	x				x			Nexant	Nexant/(CCP)
Best Integrated Technology (BIT)	x				x			(Nexant/MHI) CCP	(CCP)
Membrane Contactor/KS1	x					x		Kværner/MHI	Kværner/MHI

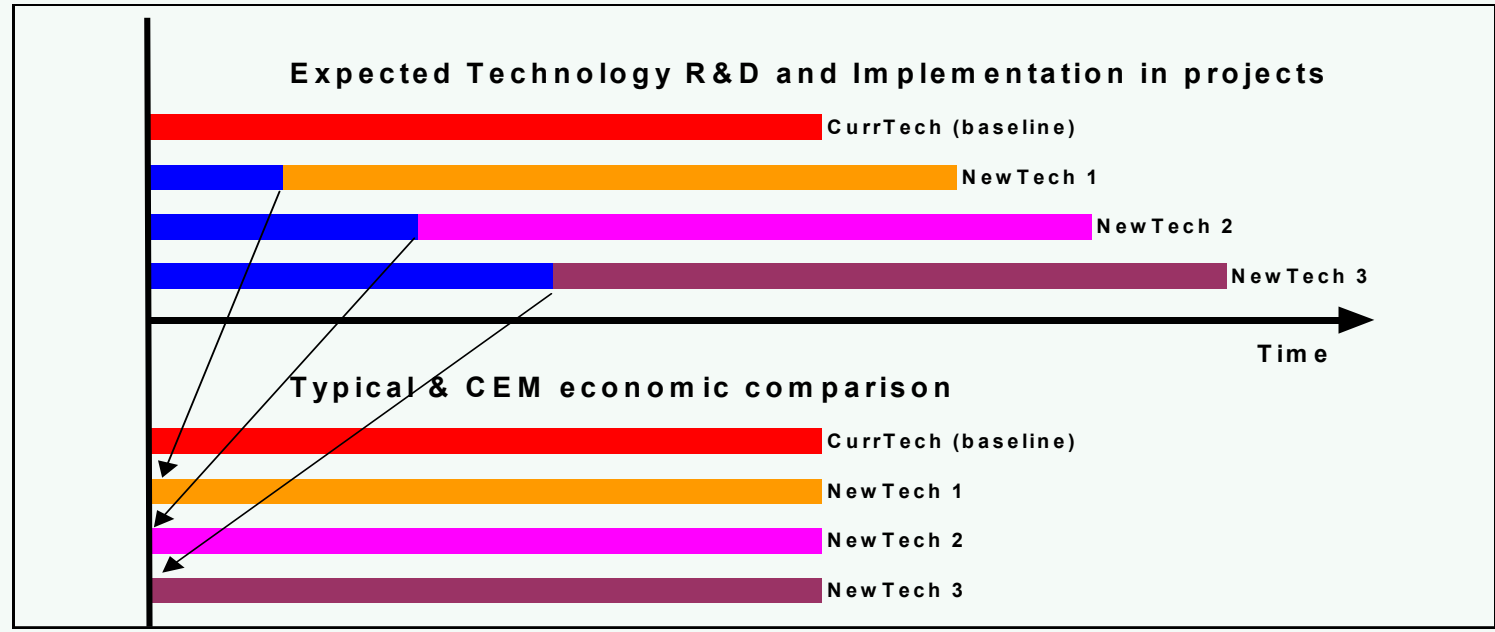
N – Norway, U– UK, A – Alaska, C– Canada. Po– Post-Combustion, Pr– Pre-Combustion, Ox– Oxyfuel



Comparing Mature & Non-mature Technologies

Estimates and screening cover the realization phase of technologies

- do not include pre-realisation technology development / R&D-costs (blue lines)
- handle technologies at various development states similarly w.r.t. cost estimates and economic screening

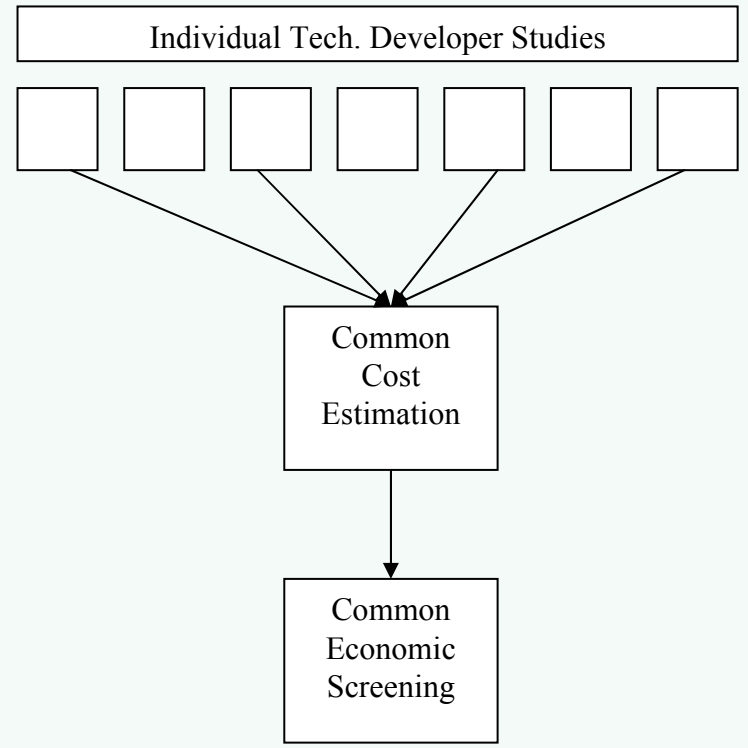




Consistency in Estimation and Screening

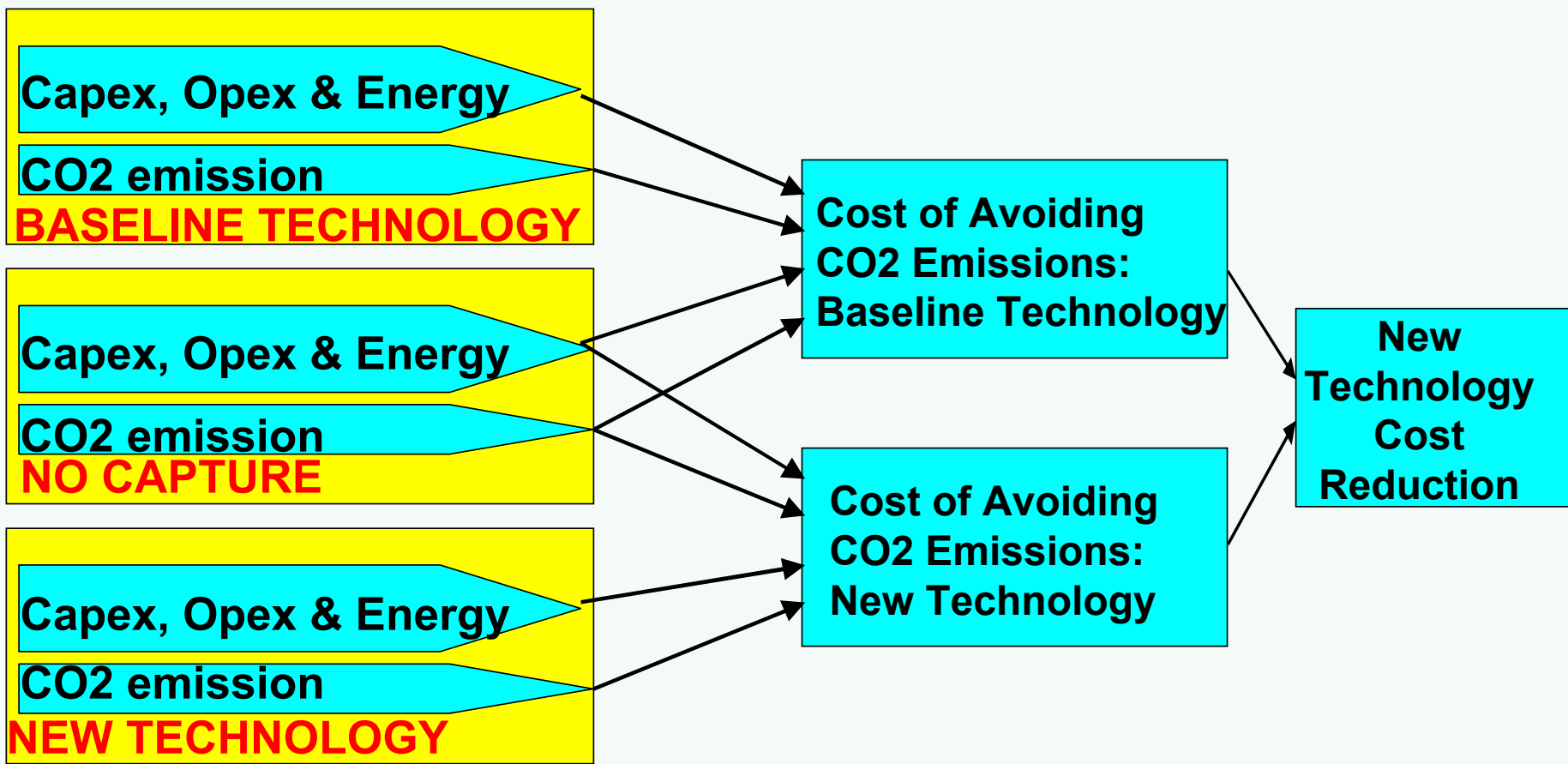
Transforming a multitude of individual technology studies into a comparable and quantified set of Scenario/Technology options

- Integrating capture technologies into scenarios
- Calibrating physical scopes and capacities
- Capex vs. opex tradeoffs
- Capex and opex estimation methods and assumptions
- Consistent CO₂-cost evaluation





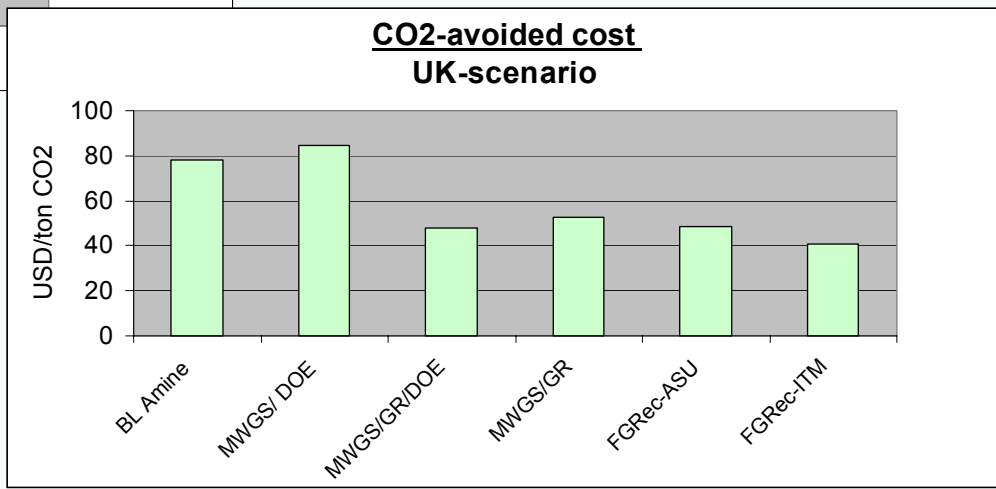
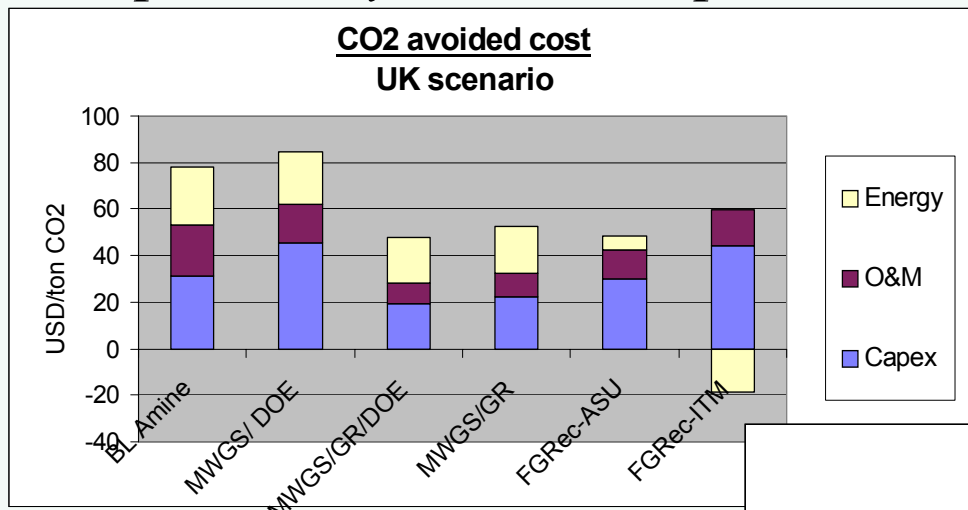
Economic Screening Criteria – CO₂-Avoided Cost





CO₂-Cost Results UK

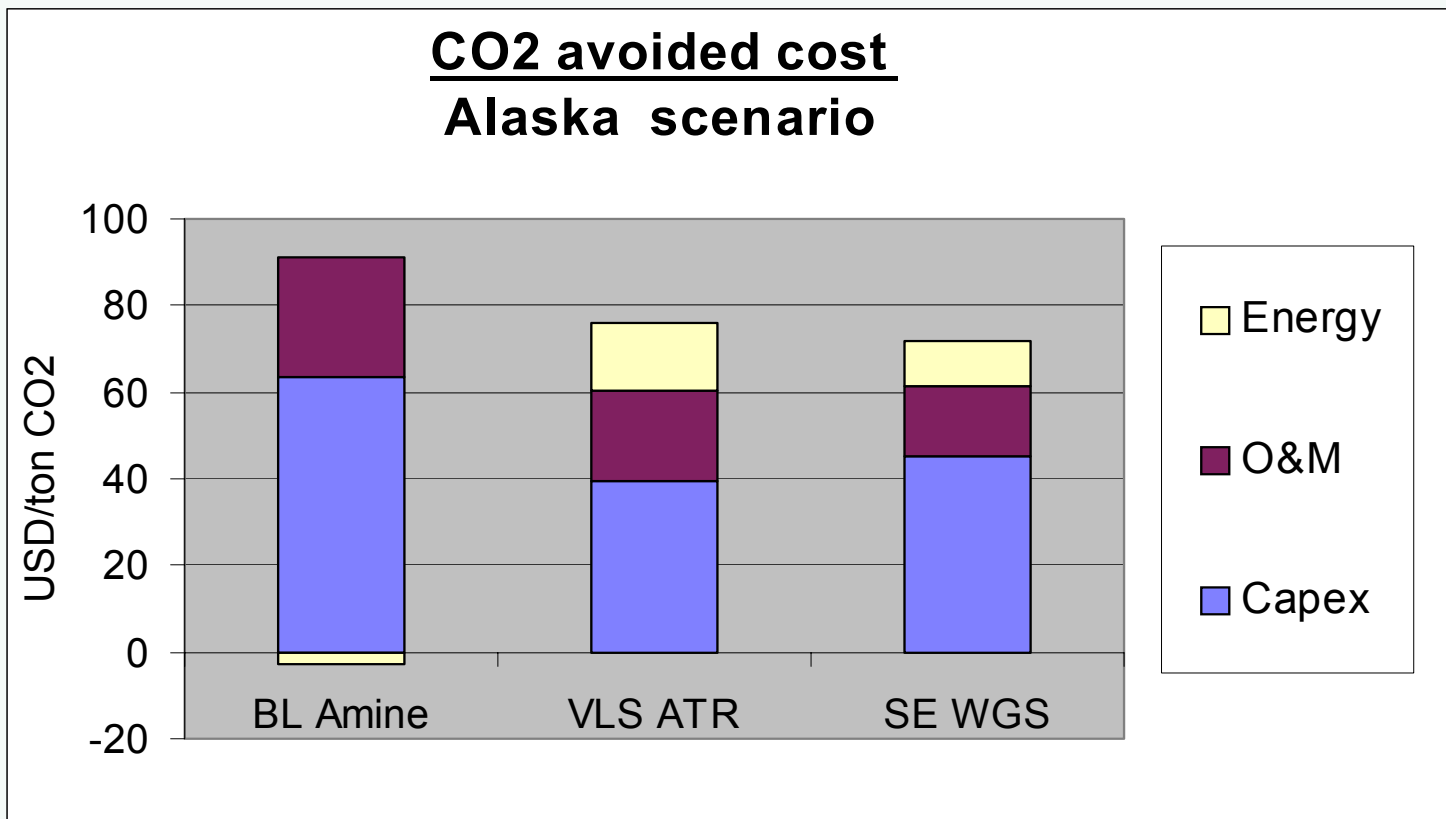
- capture only, excl. transport & storage





CO₂-Cost Results Alaska

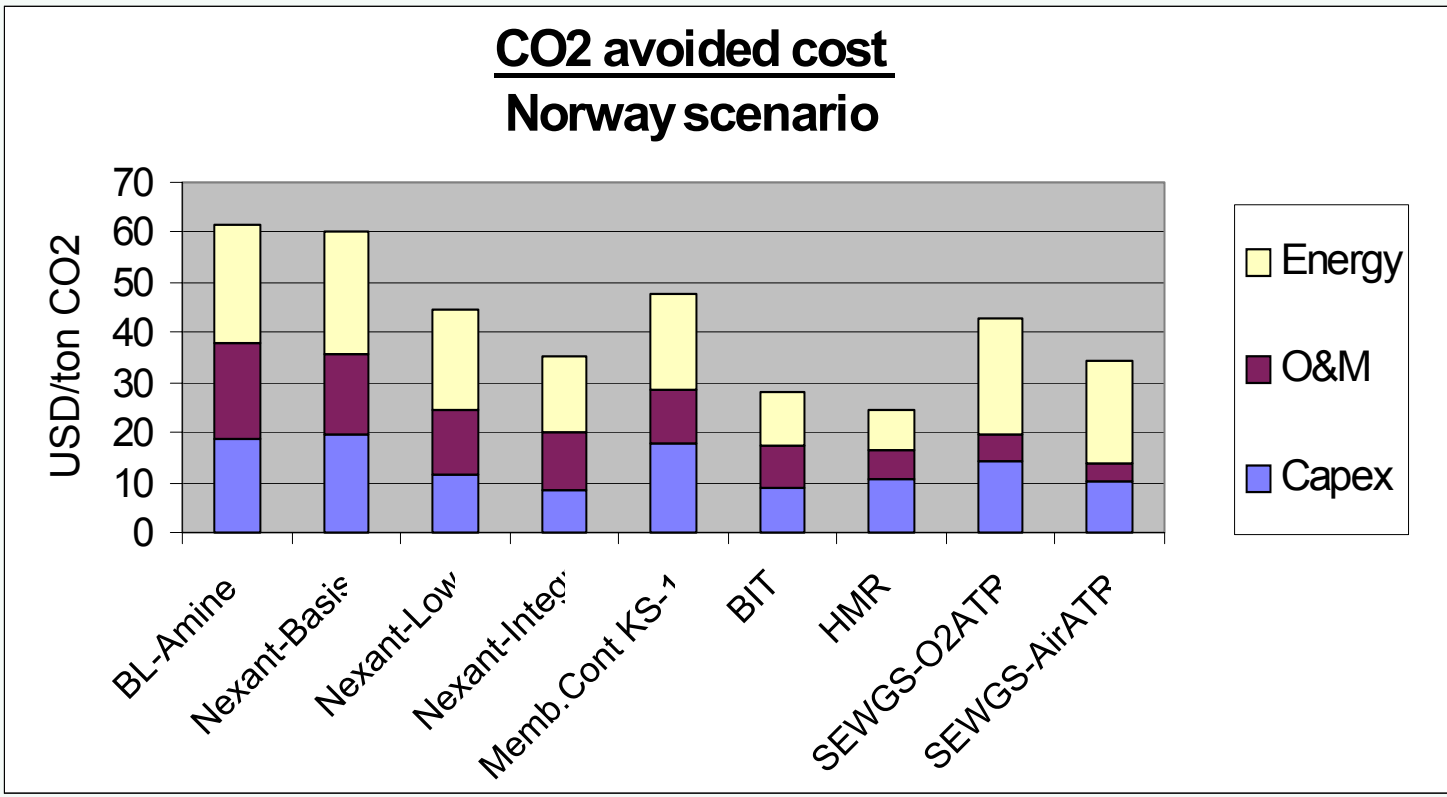
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CO₂-Cost Results Norway

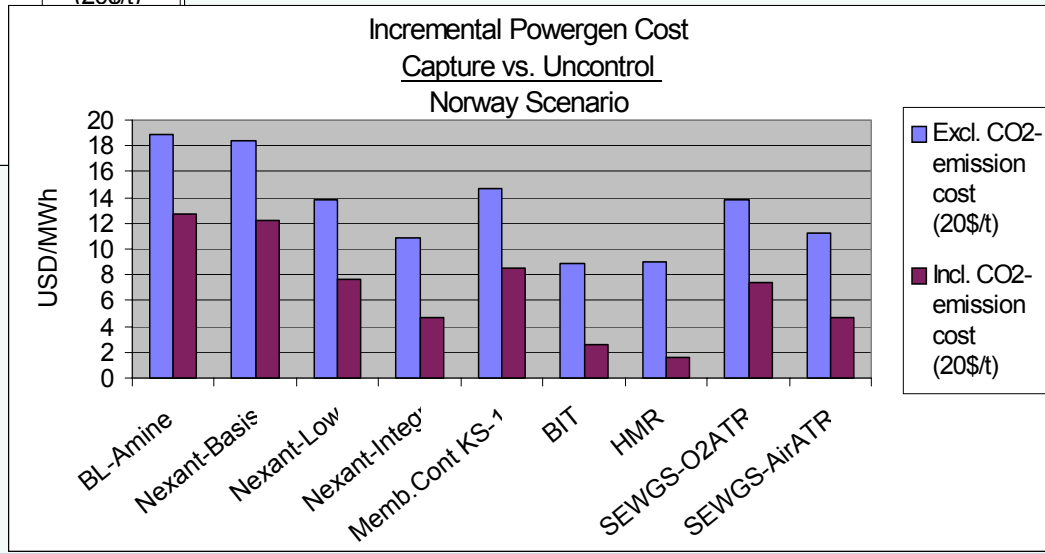
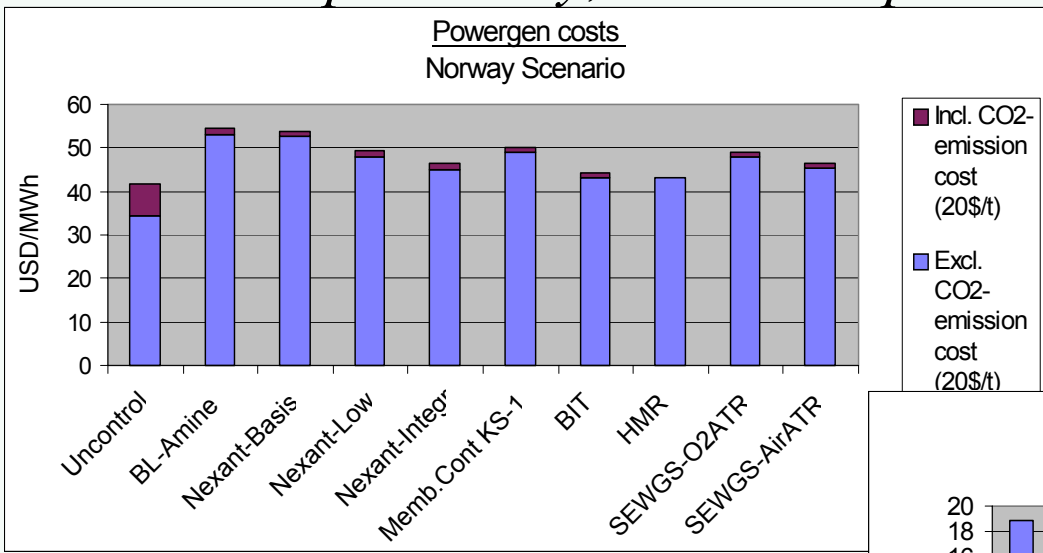
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Powergen costs Norway

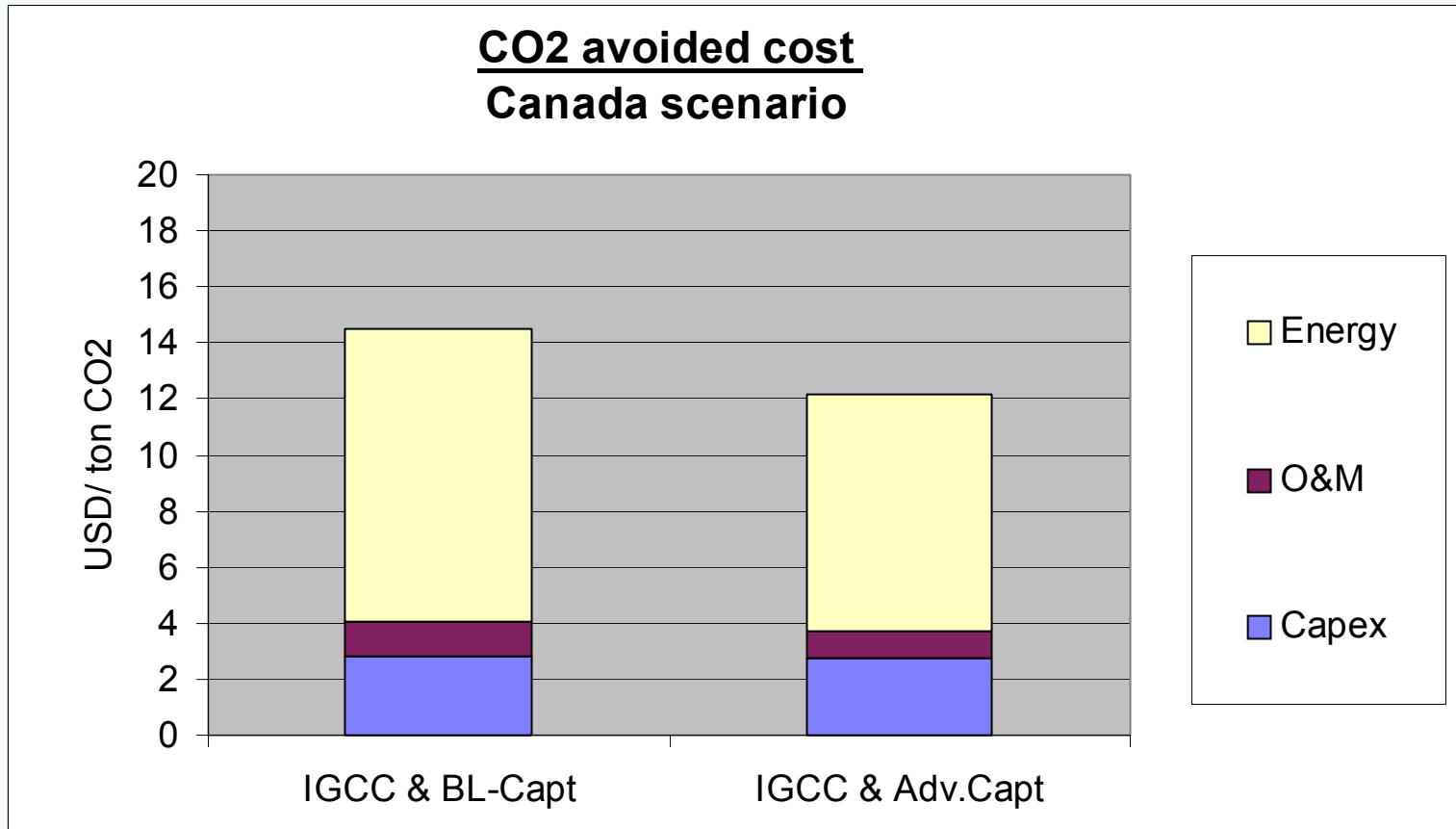
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CO₂-Cost Results Canada

- capture only, excl. transport & storage





CO₂-Cost Results Overall

- capture only, excl. transport & storage

