CO2 Capture Project 3:

Financing and Incentives (F&I) Options for CCS

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For the CO2 Capture Project
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Project Objectives

To provide:

1. An overview and understanding of existing and proposed near-term support mechanisms to CCS projects (EU, US, Canada); and
2. A quantitative assessment of the extent to which these mechanisms are sufficient to facilitate CCS deployment
   - Discounted cash-flow modelling of 5 CCS project types
   - Calculate Project IRR under a range of ‘support scenarios’
   - What levels and types of support needed to encourage CCS?

CCS support options

EU	- EU ETS (€30/tCO_2 in Phase III?) - Grants (free allowances) under the NER 300 + EEPR; disbursement rules, use of auctioning and timing? - National support (e.g. UK Demonstration Competition; Norwegian carbon tax)
US	- US Cap and trade scheme? ($17-22/tCO2 in 2015-2020) - DOE Industrial Carbon Capture and Storage programme ($1.5bn fund) - Sequestration tax credits ($20/tCO2 CCS; $10/tCO2 with EOR) - Bonus allowances? Phase I up to $90/tCO2; subsequent bidding
Canada	- Regulatory Framework for Industrial Greenhouse Gas Emissions (C$20/tCO2 in 2012-2020) - Alberta CCS Fund ($2bn total; three projects now with LOI) - Accelerated capital cost allowances (proposed): 50% tax relief over initial years

Project Assumptions

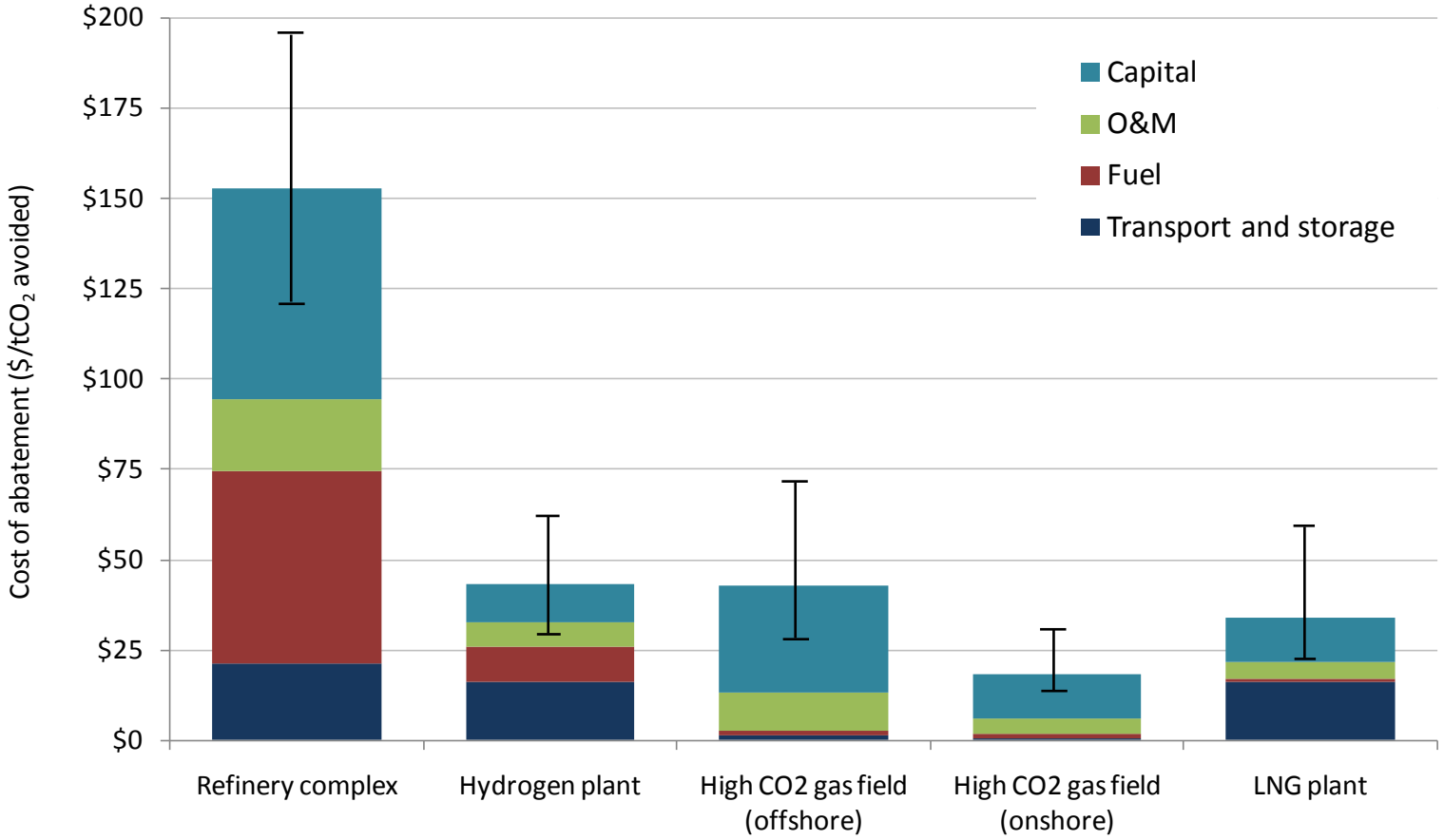
	Refinery complex	Hydrogen plant	High CO_2 gas field (offshore)	High CO_2 gas field (onshore)	LNG plant
Captured ($MtCO_2$/yr)	2.00	0.68	2.00	2.00	2.00
Capture rate (%)	90%	91%	98%	98%	98%
Avoided ($MtCO_2$/yr)	1.40	0.63	1.87	1.87	1.87
Add. capex ($M)	701	57	496	204	204
O&M ($/$tCO_2$ captured)	14.02	6.23	9.91	4.07	4.07
Fuel (GJ/tCO_2 captured)	6.20	1.45	1.15	1.15	1.15
Fuel cost ($/GJ)	6.00	6.00	1.00	1.00	1.00
T&S cost ($/$tCO_2$ captured)	15	15	in-situ (<$2)	in-situ (<$2)	15

Note: All costs in US$ 2009

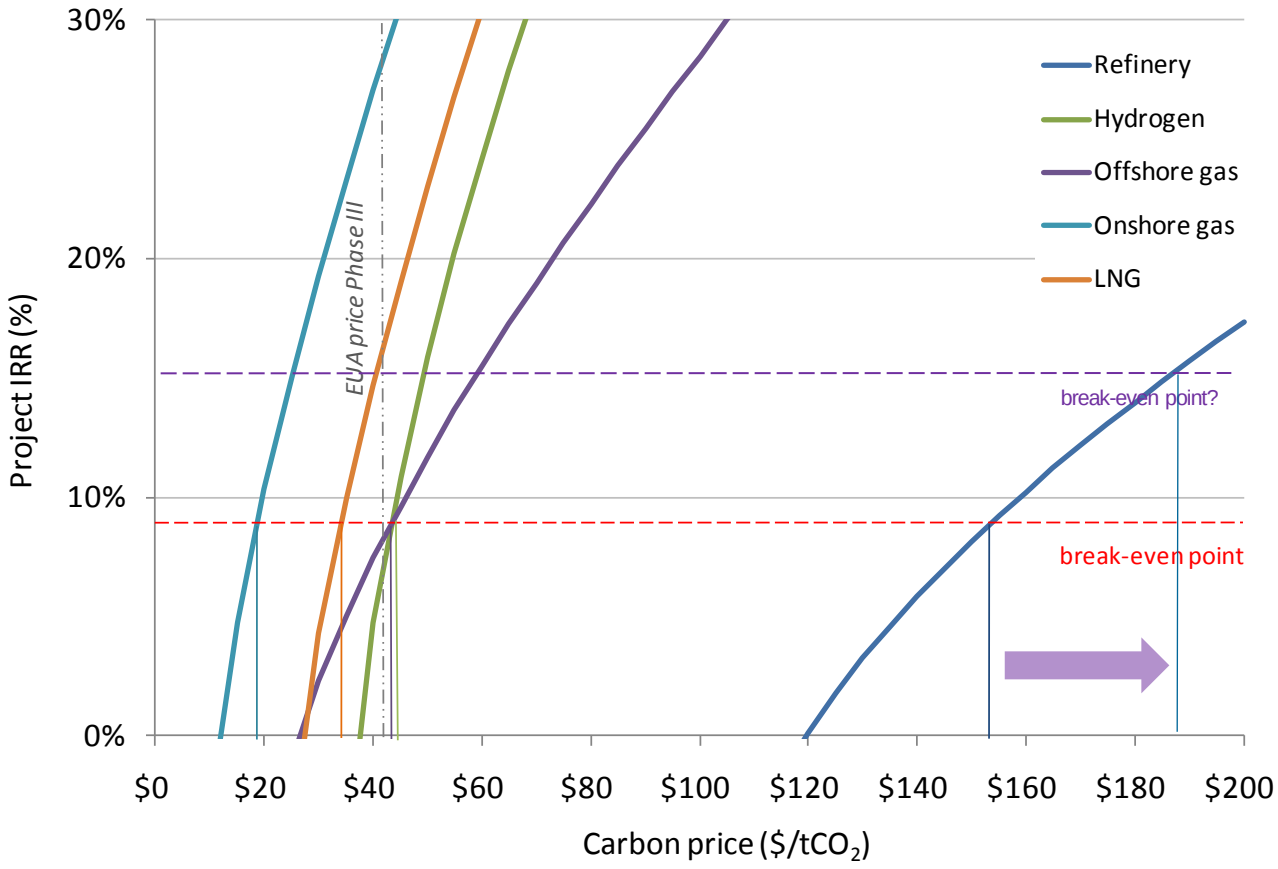
Economic Assumptions

- Project financial lifetime: 20 years
- Weighted Average Cost of Capital (WACC): 8.7%
  - Commercial financing structure: 70% debt (at 9.57%); 30% equity (at 15%)
- Project lead-time
  - 3 years (industry projects); 2 years (upstream projects)
- Corporate tax rate: 30%
- Carbon price assumptions (assumes separate trading schemes):
  - EU: €30/tCO_2 (2012-2020); €45/tCO_2 thereafter
  - US: US$15/$tCO_2$ (2012-2015); US$20/$tCO_2$ (2015-2020); US$30/$tCO_2$ thereafter
  - Canada: CAN$20/$tCO_2$ (2012-2020); CAN$30/$tCO_2$ thereafter

CCS abatement costs differ across project types



Carbon prices needed to incentivise CCS

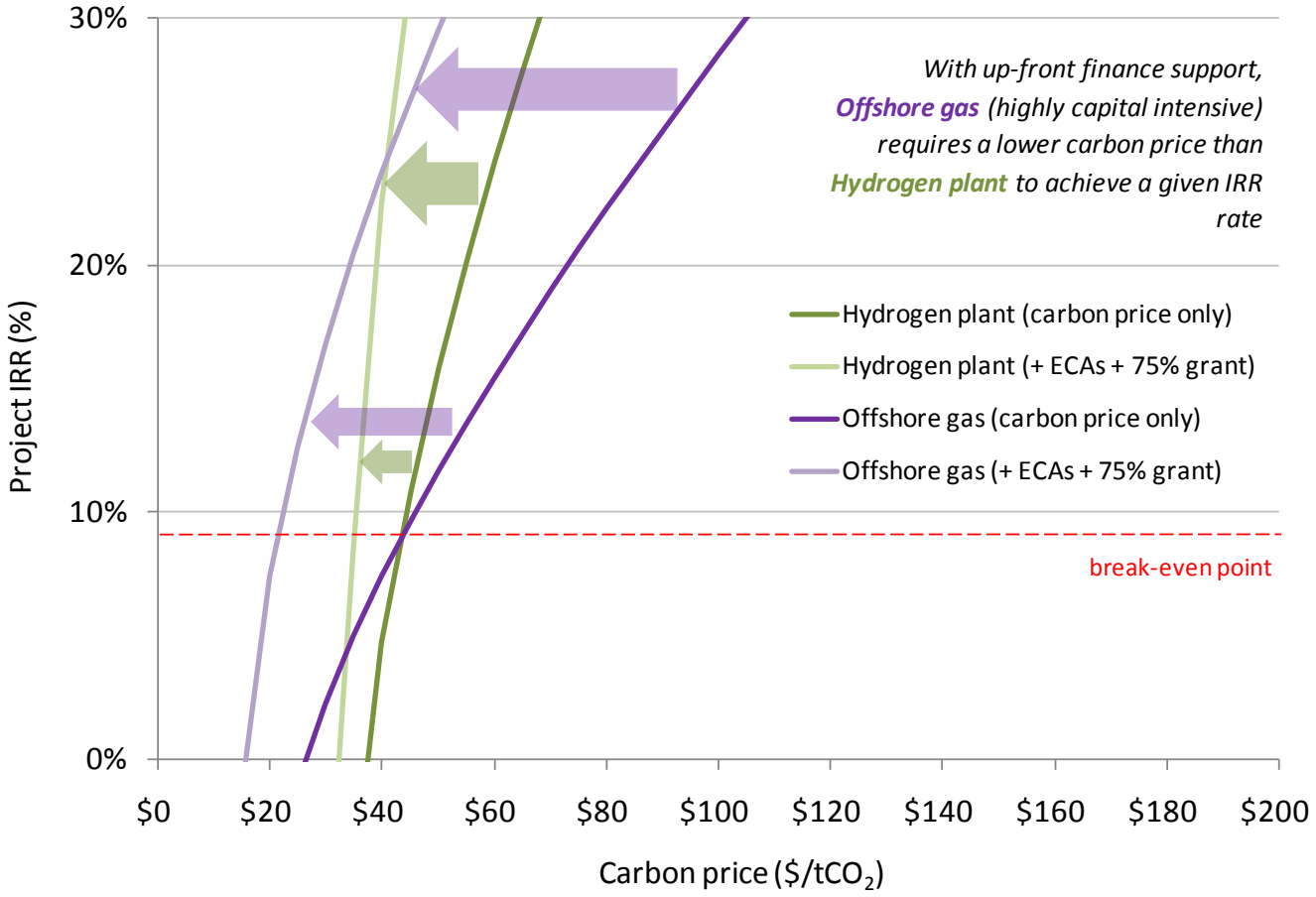


Red dashed line shows required return to meet WACC of 8.7% (mix of debt and equity). No projects would be expected to go forward for the area below the line.

High cost projects e.g. refineries require high carbon prices to be justified; where capex is high, returns are less sensitive to carbon price increases.

Higher project equity or risk?

Up-front support needed for high-capital CCS



Scenario results: EU

Case A: Grants disbursed over 10 yrs "milestone-based"

Project IRR (%)	***Carbon price only***	***Carbon price + 25% grant***	***Carbon price + 50% grant***	***Carbon price + 75% grant***	***Carbon price + 75% grant + ECAs***
Refinery	< 0	< 0	< 0	< 0	< 0
Hydrogen plant	> 15	> 15	> 15	> 15	> 15
Offshore gas	8.7 - 15	8.7 - 15	> 15	> 15	> 15
Onshore gas	> 15	> 15	> 15	> 15	> 15
LNG	> 15	> 15	> 15	> 15	> 15

Case B: Grants disbursed over construction phase

Project IRR (%)	***Carbon price only***	***Carbon price + 25% grant***	***Carbon price + 50% grant***	***Carbon price + 75% grant***	***Carbon price + 75% grant + ECAs***
Refinery	< 0	< 0	< 0	< 0	< 0
Hydrogen plant	> 15	> 15	> 15	> 15	> 15
Offshore gas	8.7 - 15	> 15	> 15	> 15	> 15
Onshore gas	> 15	> 15	> 15	> 15	> 15
LNG	> 15	> 15	> 15	> 15	> 15

Assumes Carbon price of €30/tCO2 [US$42/tCO2] (2012-2020); €45/tCO2 [US$63/tCO2] thereafter [in $2009]

- EU ETS Phase III prices could incentivise low-cost ‘early opportunities’
- Additional up-front support needed to deploy a wide range of projects: timing is key

Scenario results: US

Case A: Without use of bonus sequestration allowances

Project IRR (%)	***Carbon price only***	***Carbon price + 25% grant***	***Carbon price + 50% grant***	***Carbon price + 75% grant***	***Carbon price + 75% grant + STCs***
Refinery	< 0	< 0	< 0	< 0	< 0
Hydrogen plant	< 0	< 0	< 0	< 0	> 15
Offshore gas	0 - 4	0 - 4	4 - 8.7	8.7 - 15	> 15
Onshore gas	8.7 - 15	> 15	> 15	> 15	> 15
LNG	< 0	0 - 4	4 - 8.7	8.7 - 15	> 15

Case B: With use of bonus sequestration allowances

Project IRR (%)	***Carbon price only***	***Carbon price + STCs***	***+ bonus allowances ($50/tCO2)***	***+ bonus allowances ($90/tCO2)***	***+ bonus allowances ($90/tCO2) + 25% grant***
Refinery	< 0	< 0	< 0	0 - 4	8.7 - 15
Hydrogen plant	< 0	8.7 - 15	> 15	> 15	> 15
Offshore gas	0 - 4	8.7 - 15	> 15	> 15	> 15
Onshore gas	8.7 - 15	> 15	> 15	> 15	> 15
LNG	< 0	> 15	> 15	> 15	> 15

Assumes Carbon price of US$15/tCO2 (2012-2015); US$20/tCO2 (2015-2020); US$30 thereafter [in $2009]

- Lower expected carbon prices in US cap-and-trade (in near-term)
- Ongoing and guaranteed incentives from bonus allowances could be highly supportive *(nb. Waxman Markey had limited number of allowances so no guarantee)*

Scenario results: Canada

Project IRR (%)	***Carbon price only***	***Carbon price + 25% grant***	***Carbon price + 50% grant***	***Carbon price + 75% grant***	***Carbon price + 75% grant + CCAs***
Refinery	< 0	< 0	< 0	< 0	< 0
Hydrogen plant	< 0	< 0	< 0	< 0	< 0
Offshore gas	< 0	0 - 4	4 - 8.7	4 - 8.7	4 - 8.7
Onshore gas	8.7 - 15	> 15	> 15	> 15	> 15
LNG	< 0	< 0	0 - 4	0 - 4	4 - 8.7

Assumes Carbon price of CAN$20/tCO2 [US$18.4/tCO2] (2012-2020); CAN$30/tCO2 [US$27.6/tCO2] thereafter [in $2009]

- Good provision of federal and provincial funds for CCS
- However, weak carbon price signal (with CCAs) does not provide strong incentives

Key findings

Levels of CCS support packages vary across jurisdictions:

EU	- Forecasts of EUA prices incentivise some low-cost early opportunities - For higher-cost industrial CCS, significant upfront support required to incentivise projects (refinery always too expensive under Phase III prices) - Disbursement of EU-level funds has impact on likelihood of CCS projects moving forward
US	- Carbon prices alone are likely to incentivise only a few low-cost projects - Addition of sequestration tax credits creates valuable, known, revenue stream increasing viability of some CCS project types *(limited number of $10-20/t credits on first come first serve basis has limited impact)* - Use of bonus allowances could help to incentivise many project types
Canada	- Carbon price (e.g. avoided Fund payment) alone insufficient to drive investment in range of O+G projects - Additional grant support unlikely to meet ongoing support needs of most O&G/industry project types

Key findings

- **Moderate cost opportunities** in the oil and gas sector could be accelerated for deployment with the appropriate incentives.
- **Carbon markets** will likely incentivize a few unique opportunities only; not demonstration of a wide range of CCS technologies
- **Predictability** is important to investors; upfront grants have benefits here; carbon market volatility is problematic
- The **timing** of grant payments may have real impact on viability
- Where annual CCS costs are high, **ongoing support is critical**
- Ensuring **sufficient upfront *and* ongoing support** is therefore needed to demonstrate a range of CCS projects
- **Many policy unknowns**….. sequestration tax credits, bonus allowances etc. can be decisive

Thank you

This study was conducted by ERM in 2009, under a contract with CCP3 - the joint oil & gas industry project on carbon capture and storage

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