ECCO

Economic Aspects in the ECCOTool

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Structure of Presentation

Purpose of economic analysis
Economics in the ECCOTool
Key design points
Output KPIs

Strategic Purpose for Economics

The ECCOTool is designed to construct a CCS value chain tool primarily focusing on the

- *Correct* calculation of output time-series (flux, cashflows) and KPIs per actor (where correctness is defined w.r.t. the potential impact on decision-making)
- CCS investment decision support tool for technical / economic feasibility decision gate (not detailed engineering)

ECCOTool is a single case study / scenario tool and not a tool that can integrate multi case studies / scenarios into a regional policy making study.

ECCOTool will not be an expert system + workflow manager (some guidance on default input values is however given)

ECCOTool v2 should be a good starting point for possible further maintenance and development post-ECCO.

Module economics

- Modules support technical continuity and compatibility through the CCS chain
- From the physics and cost data they produce cash flows for Capex, Opex in Money Of the Day (MOD) levels - ie nominal values
- Generally the cost data will be held at constant prices, so modules need to use escalation
- Escalation uses central routines to produce MOD values:

$$\text{Value (MOD)} = \text{Value (base year)} \times \frac{\text{Index (current)}}{\text{Index (base year)}}$$

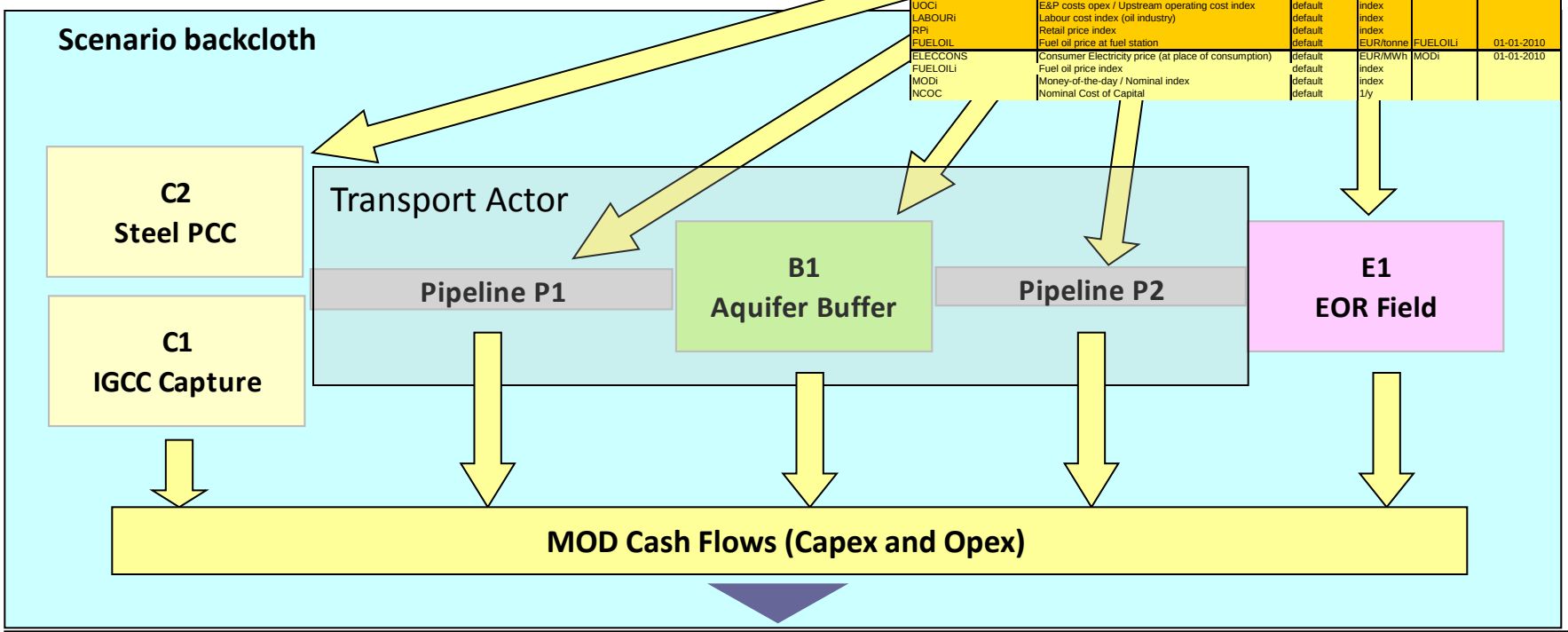
- Linear interpolation is used as necessary from user-supplied price grid

Module economics

ECCOTool Scenario "Happy Planet"

This is a standard scenario and DOES NOT allow for regional differences.

Name	Description	Region	Unit	Index	Reference Date
USDEUR	Exchange rate USD/EUR	default	USD/EUR	MODi	01-01-2010
GBPEUR	Exchange rate GPB/EUR	default	GBP/EUR	MODi	01-01-2010
OILCRUDE	Crude oil sales price (FOB)	default	USD/bbl	MODi	01-01-2010
CO2QUOTA	CO2 Quota/CO2 EU Allowance price	default	EUR/tonne	MODi	01-01-2010
ELECWS	Wholesale Electricity price	default	EUR/MWh	MODi	01-01-2010
GASNATURAL	Natural Gas sales price at wellhead	default	EUR/MWh	MODi	01-01-2010
ANTHRACITEHARDCOAL	Anthracite Hard Coal price	default	USD/tonne	MODi	01-01-2010
BITUMINOUSCOAL	Bituminous Coal price	default	USD/tonne	MODi	01-01-2010
LIGNITE	Lignite price	default	USD/tonne	MODi	01-01-2010
STEEL	Steel price	default	EUR/tonne	RPi	01-01-2010
UCCi	E&P costs capex / Upstream capital cost index	default	index		
UOCi	E&P costs opex / Upstream operating cost index	default	index		
LABOURi	Labour cost index (oil industry)	default	index		
RPi	Retail price index	default	index		
FUELOIL	Fuel oil price at fuel station	default	EUR/tonne	FUELOILi	01-01-2010
ELECCONS	Consumer Electricity price (at place of consumption)	default	EUR/MWh	MODi	01-01-2010
FUELOILi	Fuel oil price index	default	index		
MODi	Money-of-the-day / Nominal index	default	index		
NCOC	Nominal Cost of Capital	default	1/y		



Key Performance Indicators including CO_2 stored, oil produced, employment etc and financial measures (NPV, IRR for components and whole chains, cost per ton stored….)

by: Module or Actor or CCS chain

Economic evaluation

- Many economic indicators require the production of a single figure rather than a time-series
- Generally these figures are evaluated using Discounted Cash Flow - by using a discount per year on the MOD values to reflect the increased worth of money appearing sooner
- DCF calculations use the following formula:

$$DCF_i = D_i C_i \quad \textit{where} \quad D_i = \frac{1}{(1+r_1)(1+r_2)\ldots(1+r_i)} = \frac{1}{\prod_{n=1}^{i}(1+r_i)}$$

- DCF is used in the calculation of (inter alia):
  - €/t costs for CO_2 capture / transportation / storage
  - IRR rate of return calculations for Actors

Economic evaluation

Other factors which affect the chain economics are:

- Contracts
  - €/t – type contracts between actors in the CCS chain
  - Can be used to move reward in chain to match risk
- Tax
  - Will have a significant effect on the net economics
  - Applied by actor and so ownership is relevant to outturn economics

Output KPIs

ECCOTool output parameters have been set in summary as follows:

Capture side	Unit	Transport side	Unit	EOR / Storage side	Unit
Electricity cost of production with capture	€/Mwh				
Electricity cost of production without capture	€/Mwh				
Opex & Capex per year	€M/a	Opex and Capex per year	M€/y	Opex and Capex per year	M€/y
Capture cost / tCO2 captured	€/tCO2	Cost of CO2 transported	€/km/tCO2	Cost of CO2 stored	€/tCO2
Capture cost / tCO2 avoided	€/tCO2 avoided		€/tCO2		
Total Cost of CO2 quotas avoided	€				
Total cost of quotas required if leakage	€	Total cost of quotas required if leakage	€	Total cost of quotas required if leakage	M€
Revenues from electricity	€/year			Oil revenues per year	M€/y
Contract payments per contract per year	€/contracts/y	Contract payments per contract per year	€/contract/y	Contract payments per contract per year	€/contract/year
Net Present Value	€M	Net Present Value	€	Net Present Value	€
Internal Rate of Return Real	%	Internal Rate of Return	€	Internal Rate of Return	€

Examples of usage:

€/t CO_2 down the whole chain can be used to compare project alternatives

€/t CO_2 avoided can be used to assess environmental CBA

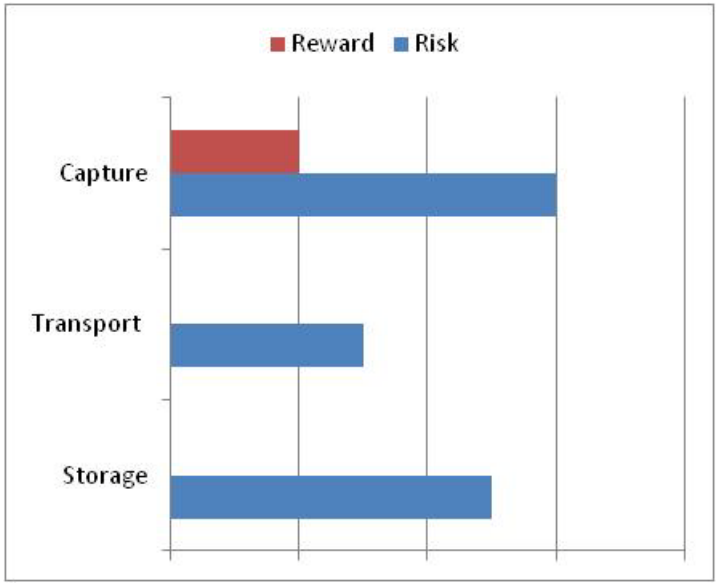
Electricity costs with and without capture can inform political / regulatory strategy

Risk-reward imbalance and correction down chain can drive contract discussions

Risk – Reward balance down chain

Diagram shows natural risk / reward levels by key components

These can be modified by:

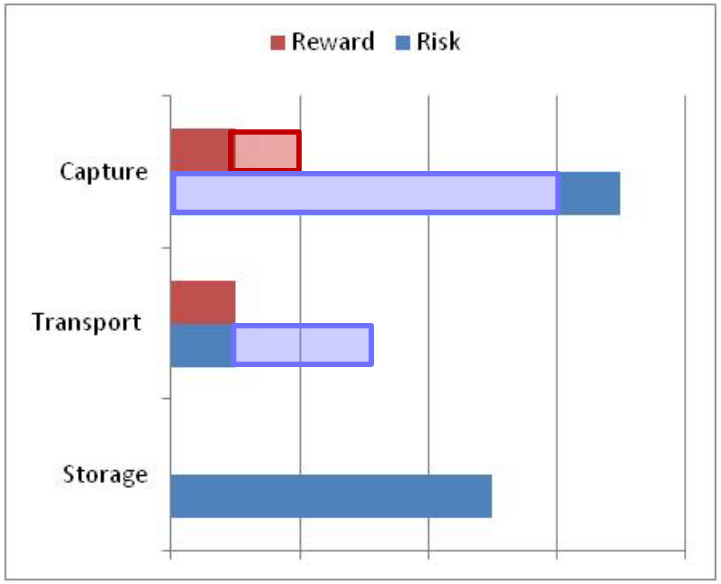


Risk – Reward balance down chain

Diagram shows natural risk / reward levels by key components

These can be modified by:

- Adding a transport contract
  - indemnifying leakage risk
  - Providing TOP CO_2 tariff

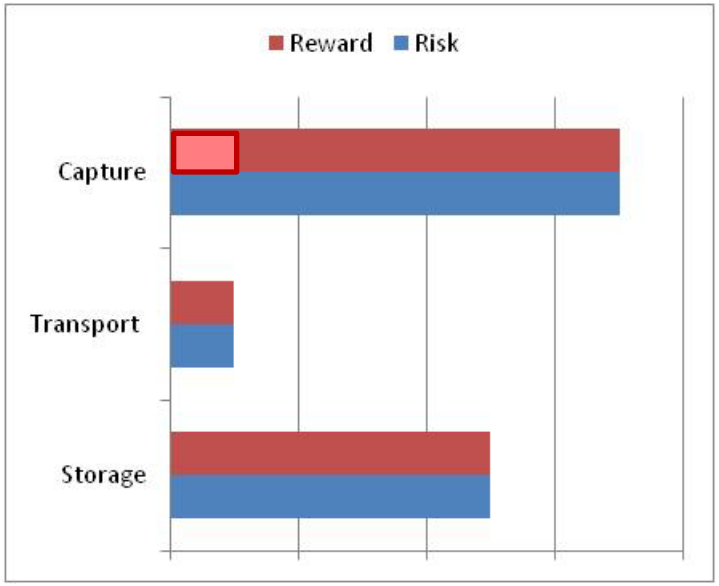


Risk – Reward balance down chain

Diagram shows natural risk / reward levels by key components

These can be modified by:

- Adding a transport contract
  - indemnifying leakage risk
  - Providing TOP CO_2 tariff
- Applying CCS support and a storage contract
  - Improves overall reward
  - Re-balances reward to players



Equivalent effects could be achieved through ownership

Summary

- ECCOTool starts with continuity of CO_2 flow down the defined CCS chain and produces cash flows from this.
- These cash flows are then adjusted to take account of contracts, taxes, support arrangements etc.
- Discounted cash streams are output at the user-required granularity
- KPIs are derived as required based on module or actor or chain and can be user-refined
- These KPIs are designed to inform commercial, regulatory and political strategies