Industrial policy for enhanced oil & gas production in Europe with CO2

The EU answer to the US shale gas/oil boom?

Makings CCS investable in The Netherlands

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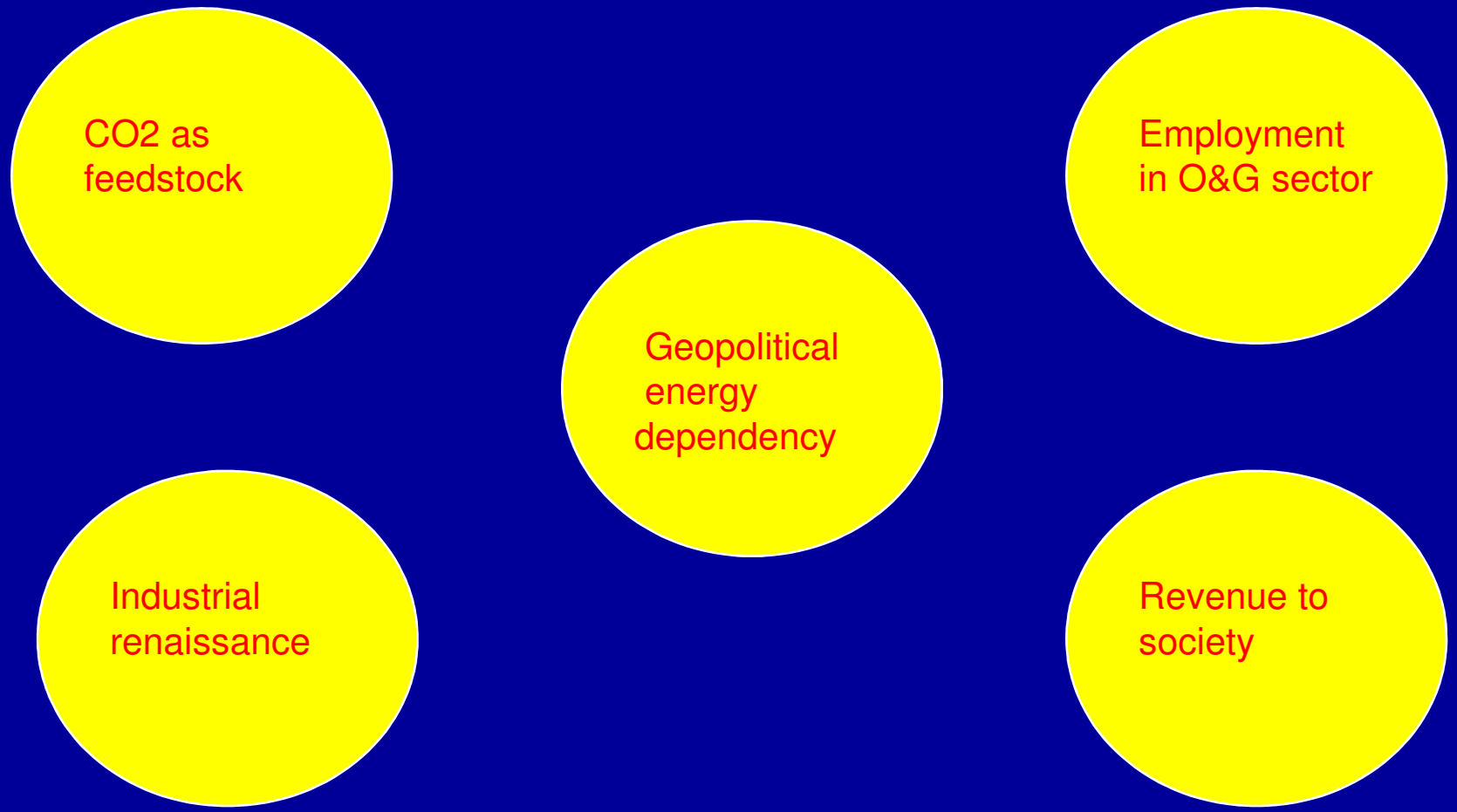
Agenda

- Why and how; the business case
- Value of CO2-EOR and CCS in North Sea
- Comparison USA and Europe
- Innovations and drivers to stimulate CO2-EOR in Europe
- Business model for CO2-EOR
- Conclusions

Why CO2-EOR-EGR….?



How to get to CO2-EOR-EGR?
In which business case would you invest?

A

- Politically enforced market demand
- Distributor has take or pay obligation
- First in merit order due to very low variable costs
- Guaranteed revenue by large stable financial incentives for 15 years
- Off–balance financing possible with only 20 % equity
- Project can be sold to institutional investors

or

B

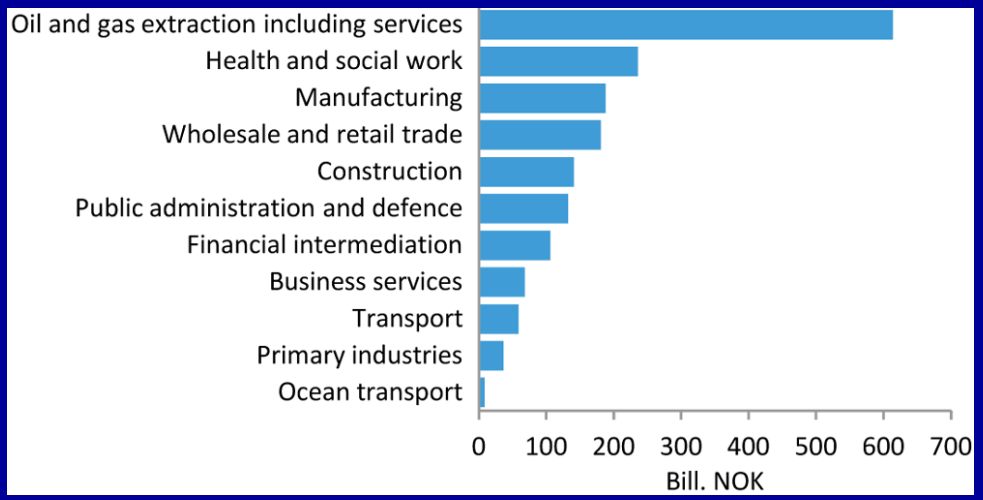
- Small and volatile financial incentives with incentive contract duration < 3 years
- Only financing with solid balance sheet (40 % equity)
- Difficult to get long term contractually agreed demand for baseload
- Potential requirement to put a very costly unit in place in exchange for a once-off investment subsidy that does not deliver required revenues
- With extra unit low in merit order and no certainty on demand

General information on the Dutch power market

- Market capacity is 24 GW, with 10 GW extra capacity coming on stream in 8 years
- Average market demand is 9 GW with peak of 14 GW, reducing with 2 % per year
- Fast growing import on the market, now roughly 3 GW

Revenue and employment North Sea Oil & Gas sector

- Employment growth (120.000 extra needed next decade UK only)
- 2013 investment budget 15 billion euro (UK)
- Median salary US$ 98.000
- Past employment growth Norway 39 % 2000 till 2008



- Value creation in selected industries NPD 2011, Norway
- Tax 30 % till 68 %

Value of CO2-EOR and CO2-EGR

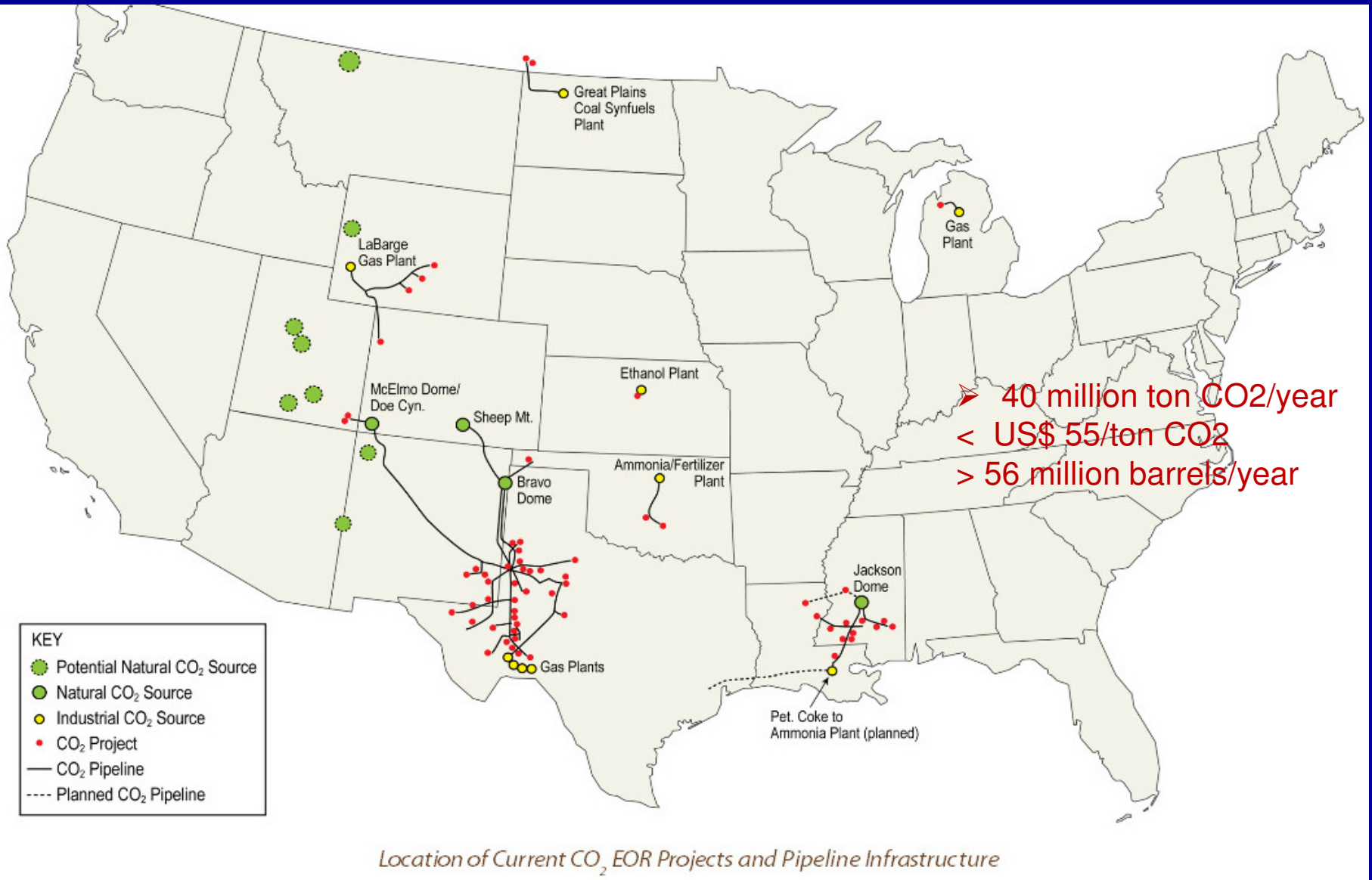
- Technically 6,8 billion barrels of oil (based on 10 % of STOIP, roughly 20 % of all cumulative oil produced) for UK, DK and NO > US$ 680 billion
- Economically 0,7 billion barrels of oil at US$ 70/barrel and CO2 cost of US$45/ton excluding government funding > US$ 49 billion till US$ 240 billion
- Deferred abandonment US $48 billion (UK only)
- Free up locked-in natural gas CO2-EGR (not yet quantified, possibly US$ 50 billion)
- Funding gap at high end oil recovery 40 euro/ton CO2
- Current government funding in NL for offshore wind 183 euro/ton CO2 (excluding network and system costs)
- Total estimated value in the range of US$ 400 billion with maximum 40 euro/ton government funding

Value of CCS

- CCS globally leads to 9,4 Gton CO2/year reduction in 2050
- Without CCS marginal abatement costs rise to US$300,-/ton CO2 instead of US$175,-/ton CO2
- Assumptions:
  - without CCS abatement costs increase US$125,-/ton CO2 for 4 Gton/year CO2 reduction
  - No value from CO2-EOR and fossil fuel value chain
- CCS value then equates US$500 billion per year in 2050 (in dollars at 2008)
- CCS value in EU at 2050 roughly US$75 billion per year
- Total estimated value in EU in the range of US$ 750 billion

However; CCS government budget globally 1,5 % of EU spending on renewables....

Reality in USA. Future in North Sea?

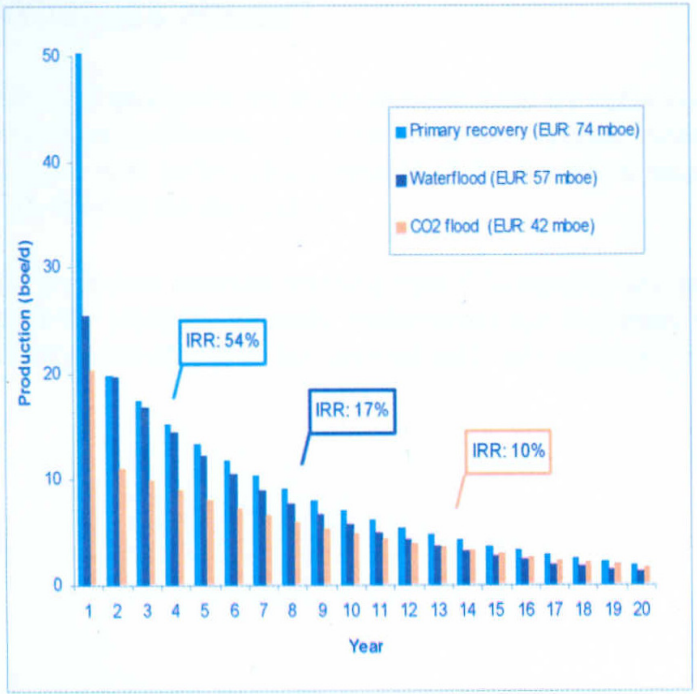


- 40 million ton CO2/year
- < US$ 55/ton CO2
- > 56 million barrels/year

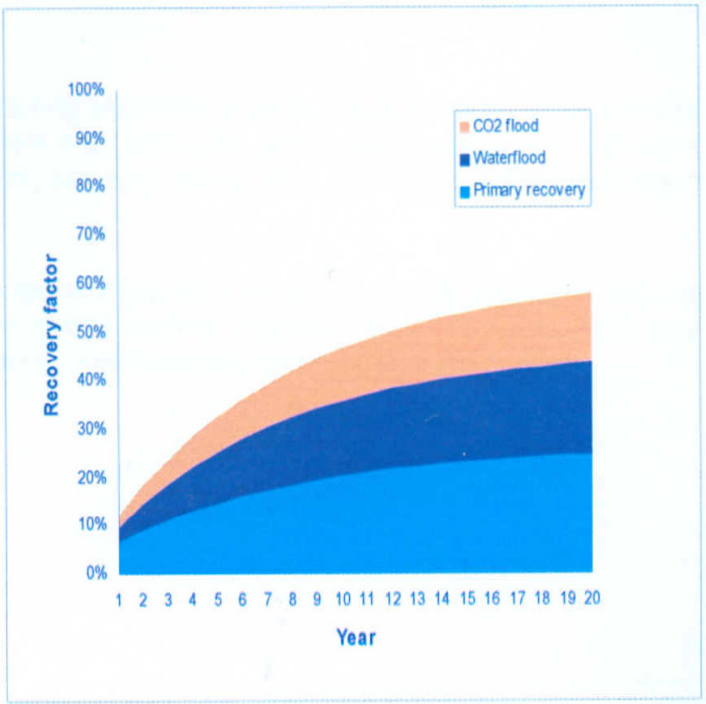
Location of Current CO_2 EOR Projects and Pipeline Infrastructure

Return on capital IRR versus time with EOR

Decreasing recoverable and economics

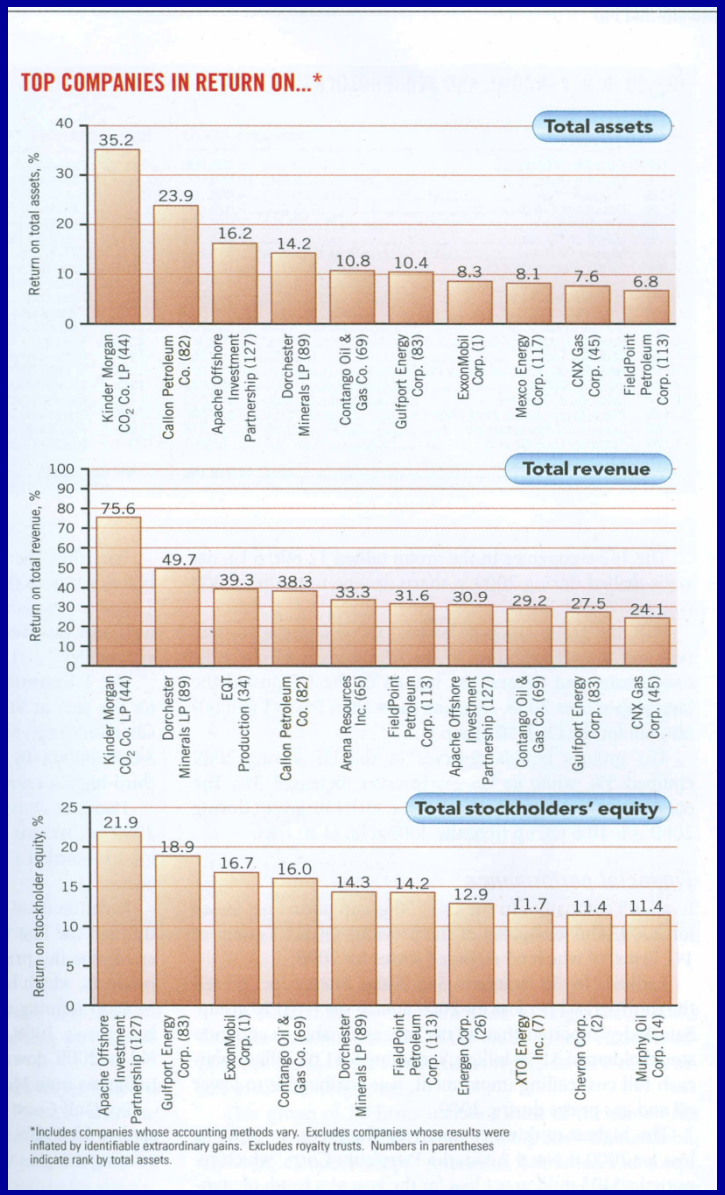


Increased recovery of a reservoir



IRR calculated at US$80/bbl

Source: Wood Mackenzie



Financial performance US oil companies:

- KinderMorgan CO2 No. 1 in return on assets (35 %) and profit margin (75 %) in USA in 2009 (Oil & Gas journal)

SWOT analysis CO2-EOR North Sea (1)

Strengths

- Miscible flooding conditions
- Abundant high volume CO2 emission point sources
- Abundant buffer storage capacity
- Low seawater depth
- No hurricanes & icebergs
- CO2-EGR experience K12B field by SUEZ

Weaknesses

- No experience in offshore CO2-EOR
- No CO2 supply yet at wellhead
- Production loss during revamp
- Regulatory uncertainty
- Organization structure and culture

SWOT analysis CO2-EOR North Sea (2)

Opportunities

- Novel EP operators with different business model
- Free up locked-in natural gas
- Revitalize O&G business
- Low cost solution to mitigate CO2 emissions
- Investor appetite for (pipeline) infrastructure
- Deferred abandonement costs

Threats

- Uncertain CO2 supply due to market penetration intermittent renewables
- Prevailing national interests

Culture/business gap Oil & Gas companies versus power companies

Oil & Gas

- Global players
- Process engineering skills
- Low level of regulation
- Minor technology and business model competition

Power

- Regional markets
- Electrical engineering skills
- High level of regulation
- High technology and business model substitution

Innovations to realize CO2-EOR projects (1)

Technical

- Shipping liquid CO2 in early stage
- CO2 buffering in aquifer to allow WACO2
- Water/oil/CO2 separator installed at ship

Financial

- Fiscal policy; tax rate to 30 %
- Accounting; remove exploration cost sharing
- Lower hurdle rate
- CO2 transport companies; reduce CAPEX for EP operator

Innovations to realize CO2-EOR projects (2)

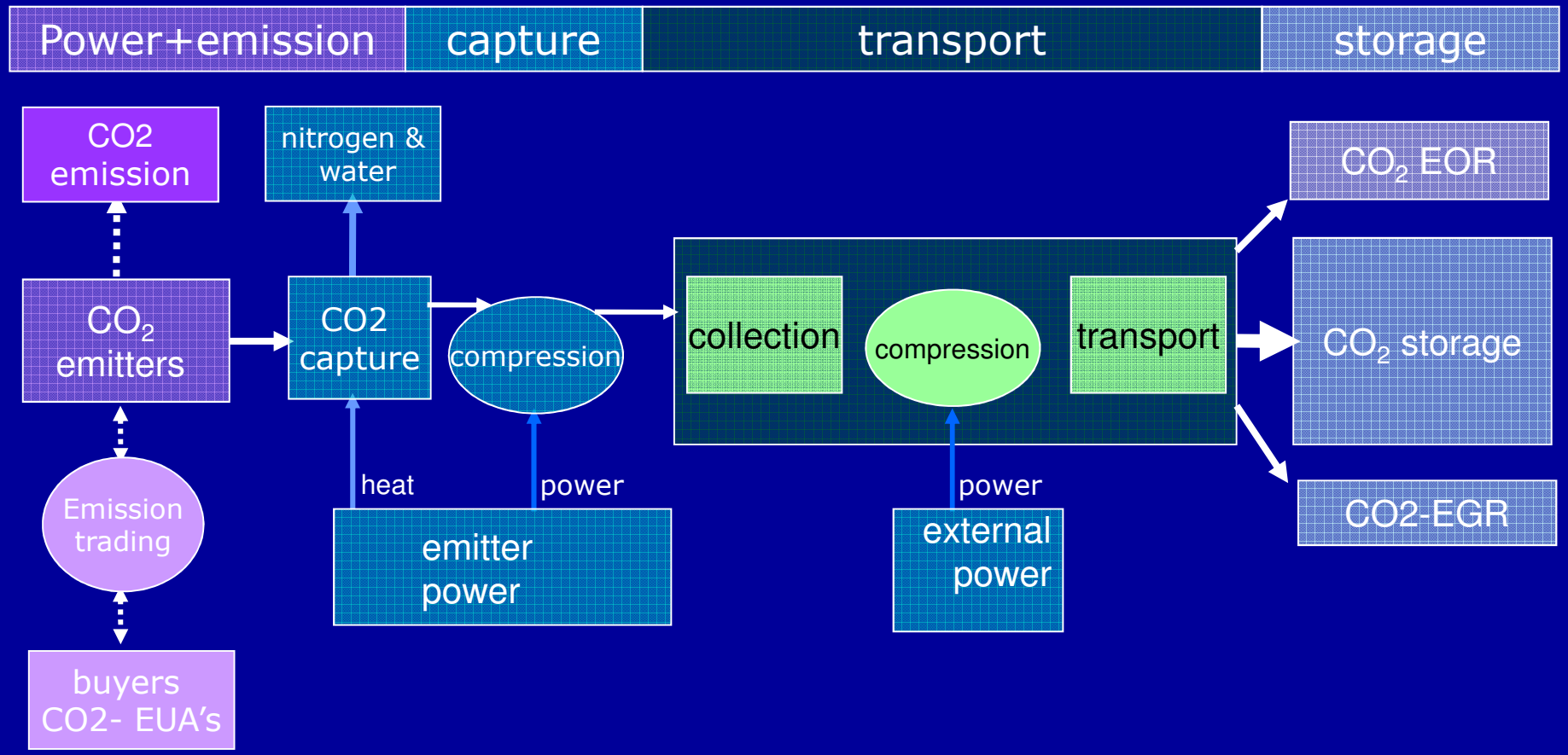
Commercial

- Long term CO2 supply contracts mirrored by long term power & heat contracts
- CO2 sourcing from coal fired power plants (gasification plants)
- Business model for independent transport

Regulatory

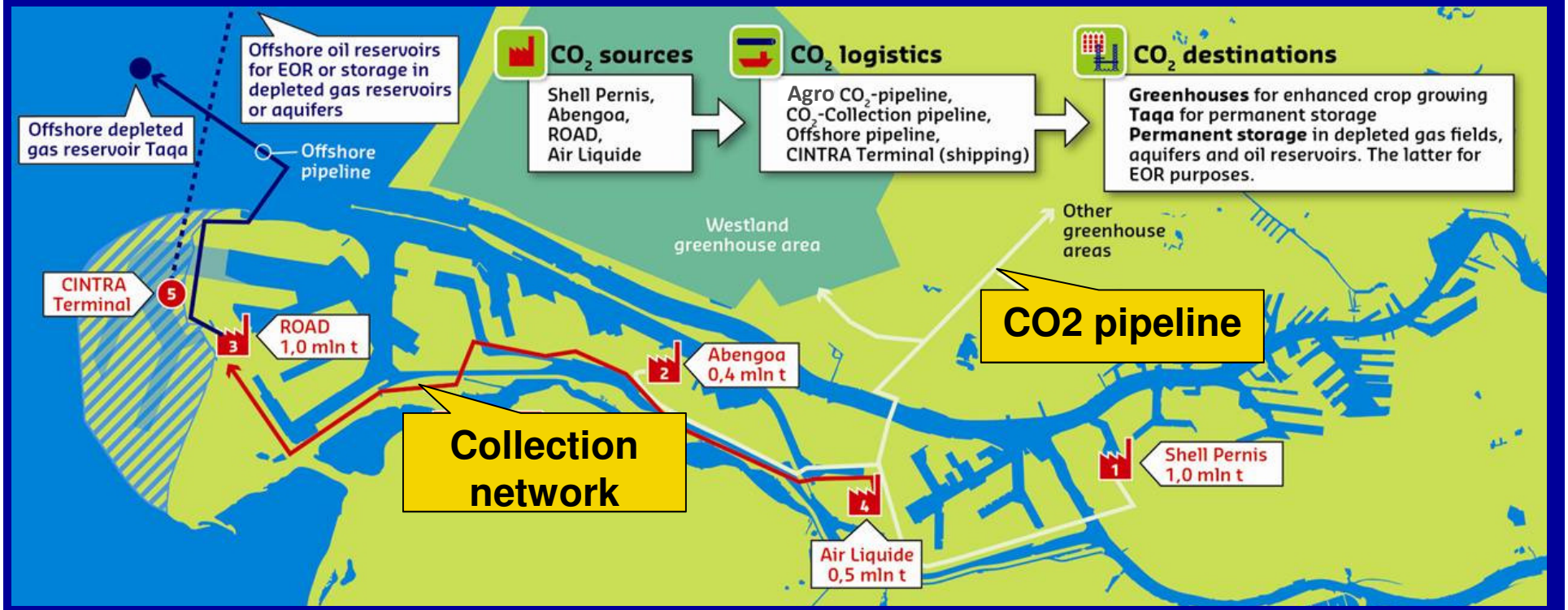
- Reduce CO2 storage liability
- Ensure preference on the grid for decarbonized power production with CO2 supply for EOR
- Tax agreements and earmarking between UK, NL, DK, NO

How to organise CO2-EOR and CCS?

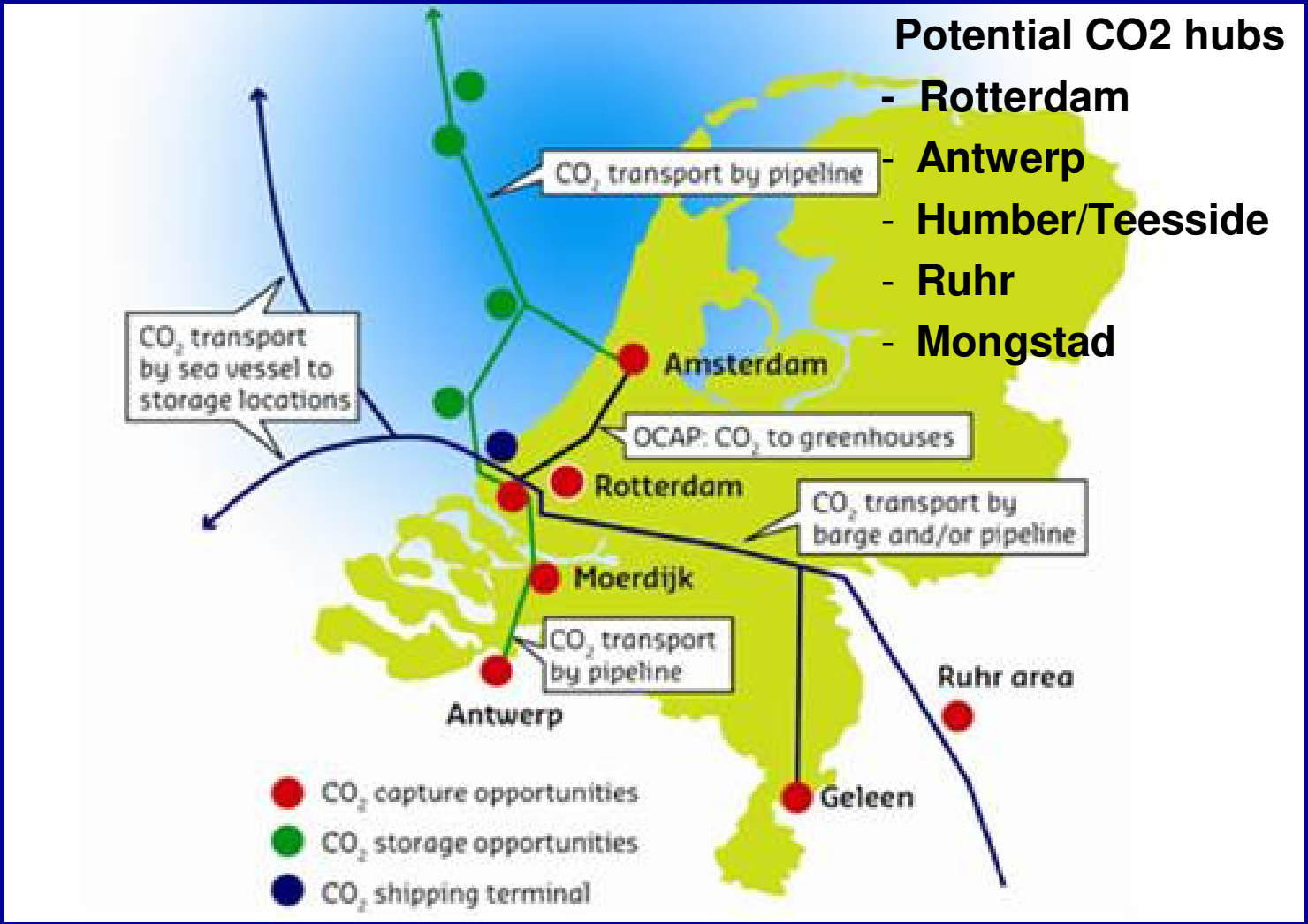


CO2 supply contract mirrors power purchasing contract in time and volume

Foreseen CO2 infrastructure CO2 hub Rotterdam



The bigger picture for CO2 transport



ECCO project: UK

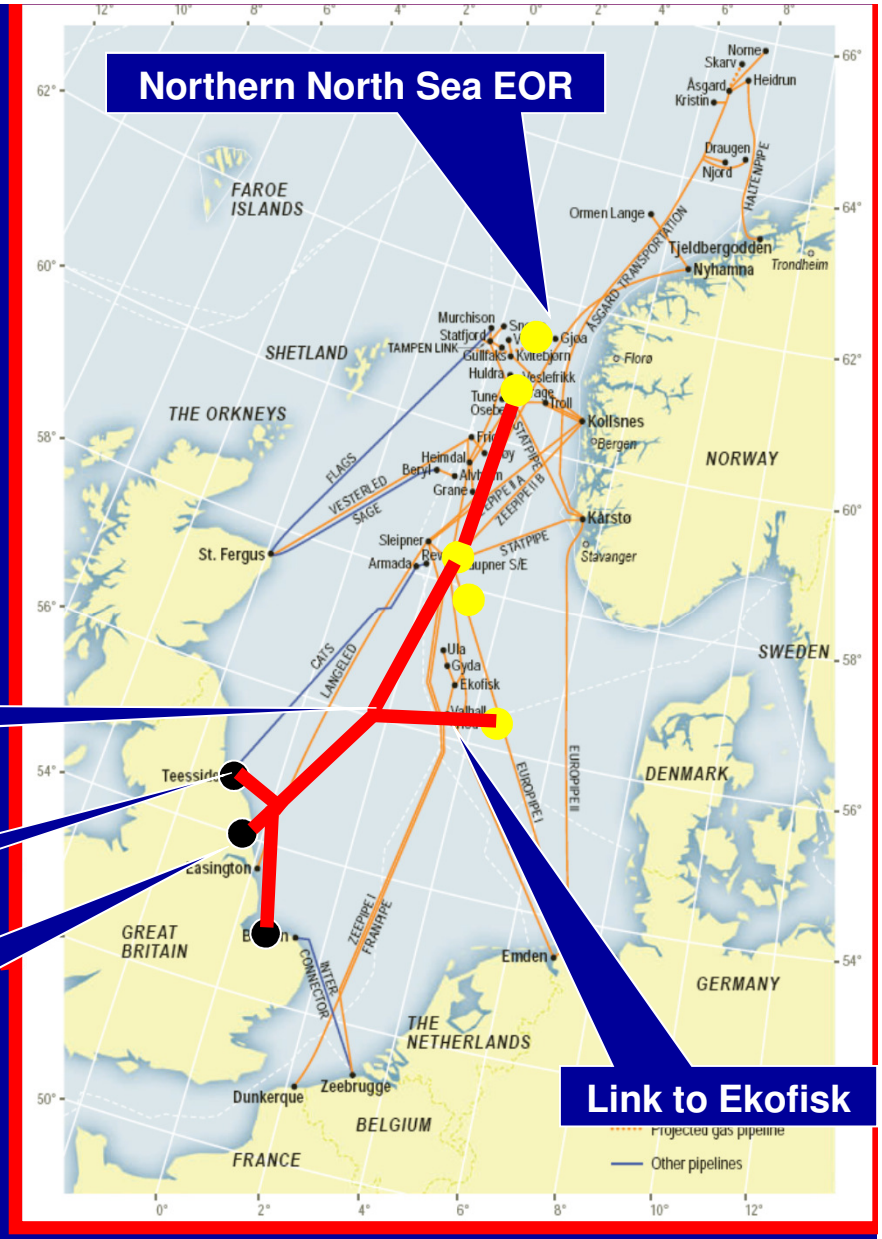
- Key Demonstration points:

  use of buffer aquifer with sub-sea completion
  mixed capture cluster
  over-sized pipeline
  economics of reaching NNS
  linkage to other sectors / Cases

Sub-sea completion with umbilical control

Additional IGCCs at Lynemouth and Teesside

North East Cluster with Industrial Post-CC



Conclusions

- CO2-EOR in The North Sea is technical and economically feasible
- Requires political cooperation between North Sea countries, adaptation of regulatory and fiscal framework and new business model
- Market failure of policies for 20/20/20 ambitions need to be adressed
- Timing is critical in view of infrastructure planning, abandonment and energy/CO2 policies