

CO₂ for EOR
Norwegian Continental Shelf
Possibilities and Challenges

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“Carbon Capture and Storage – where are we today?”

Felix Conference Center

Oslo, 26 April 2005

CO₂-injection for Enhanced Oil Recovery and storage of a problematic emission gas



A wonderful vision

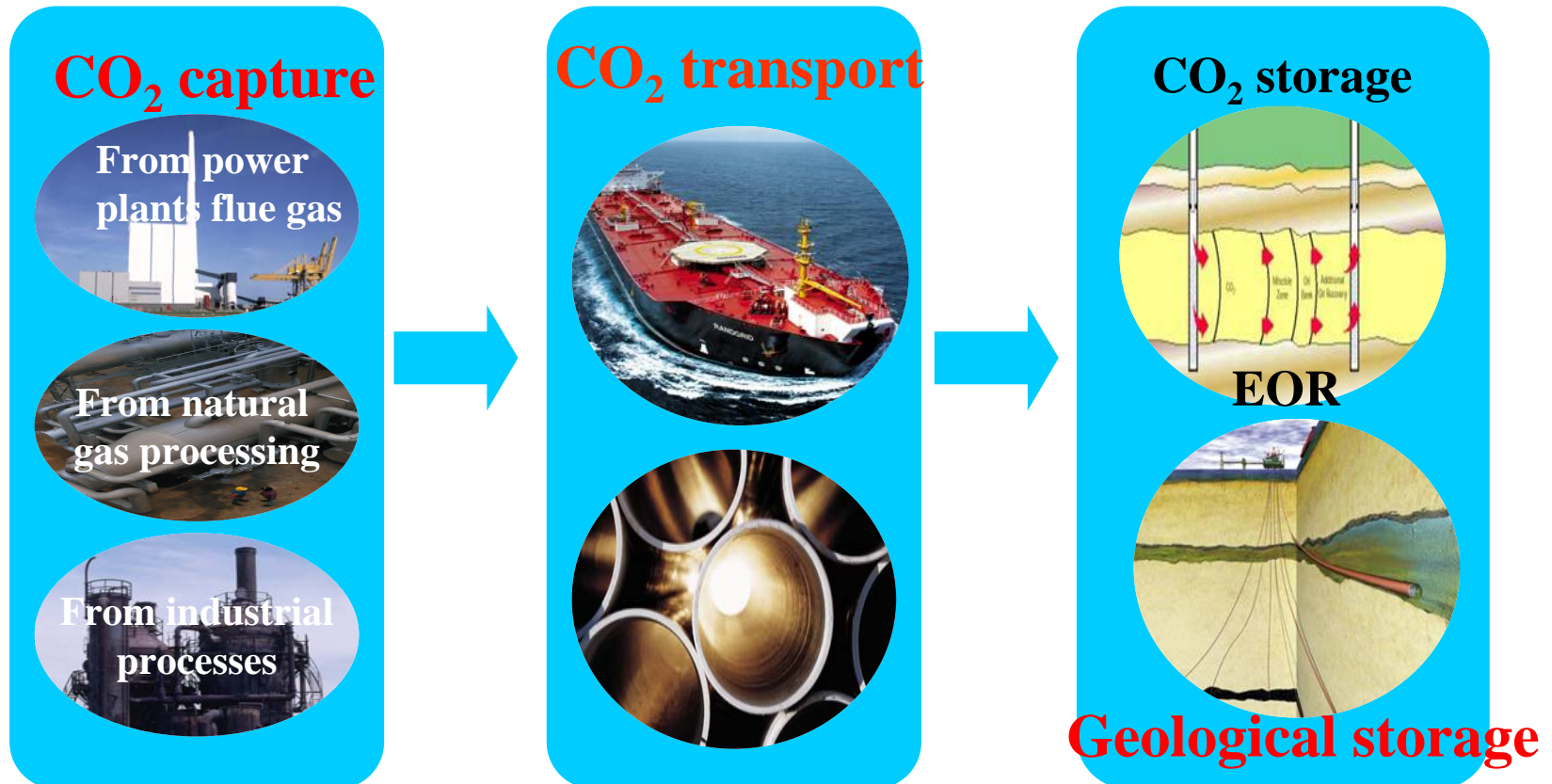


that needs more than one party lifting !

Numerous entities and authorities involved in the CO₂ chain - challenges.

These elements exist or can be controlled by the companies on NCS.

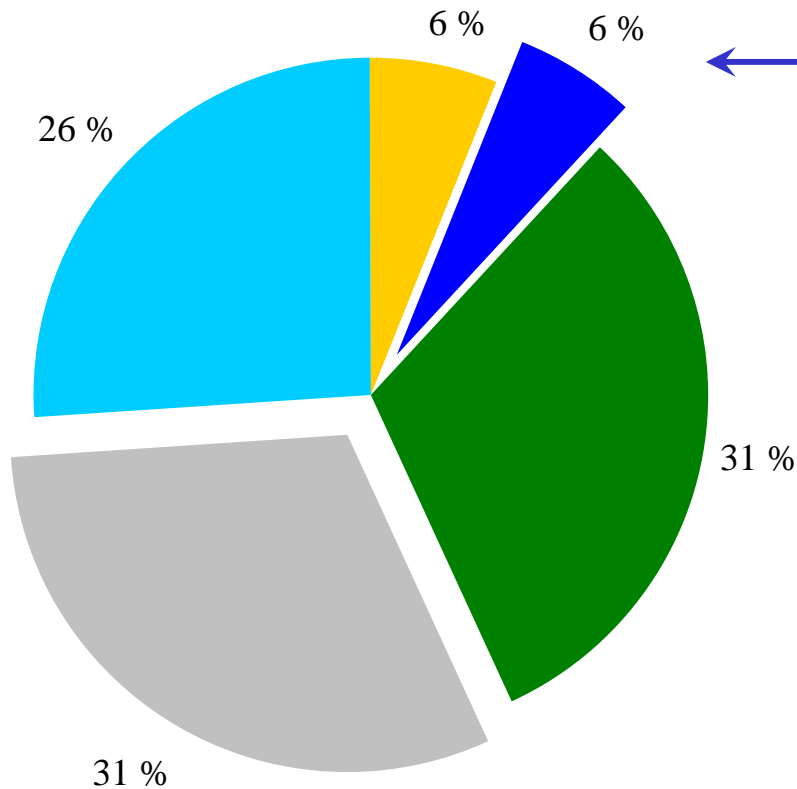
How do we make the red elements attractive to commercial entities?



Estimate of recoverable reserves, Jan.1. 2005



12.9 billion Sm³ o.e.



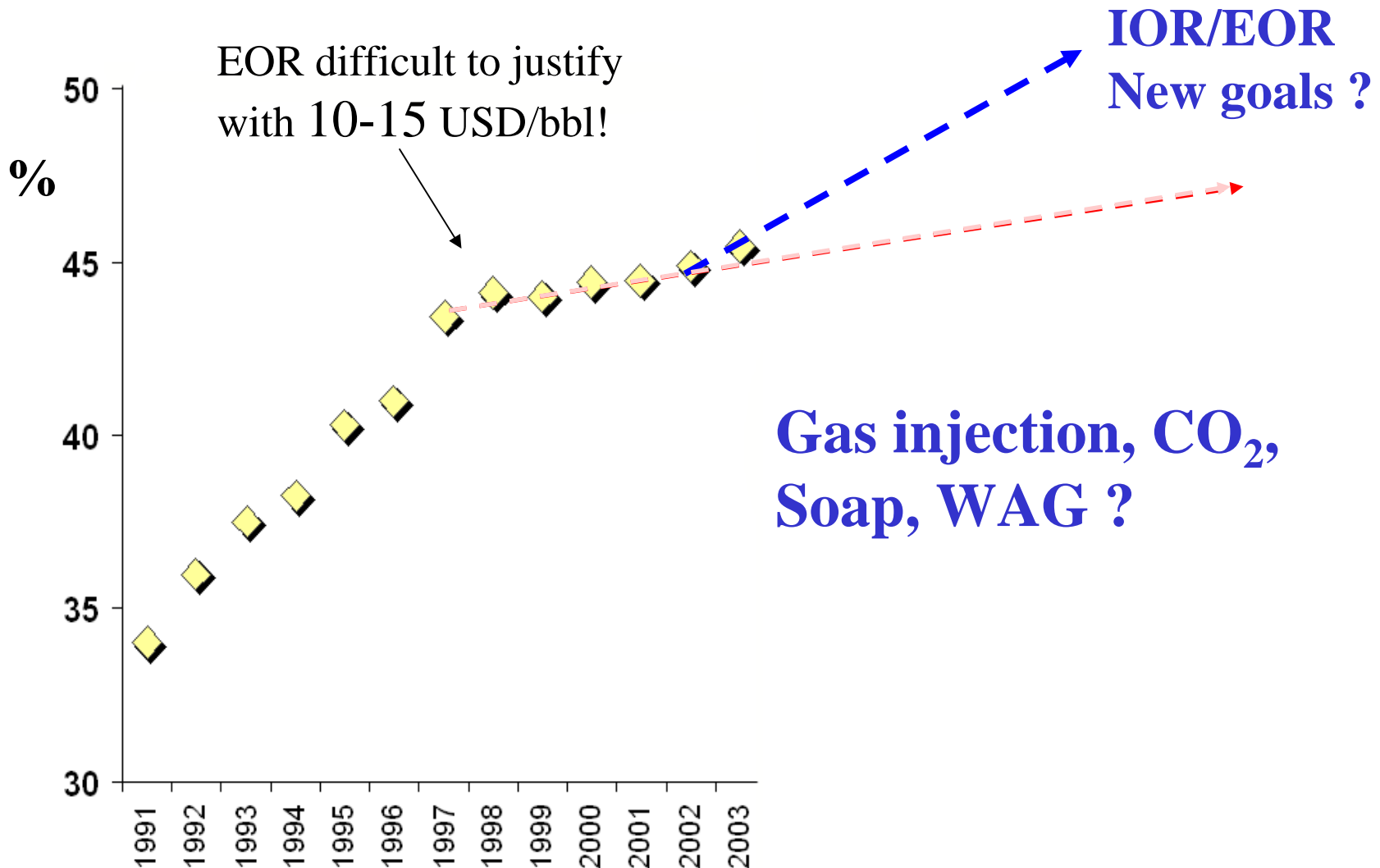
Improved recovery from existing fields

180 specific improved recovery projects on fields under assessment,

CO₂ possibilities NOT included

- Contingent resources - discoveries
- Reserves
- Undiscovered resources
- Contingent resources - fields
- Sold and delivered

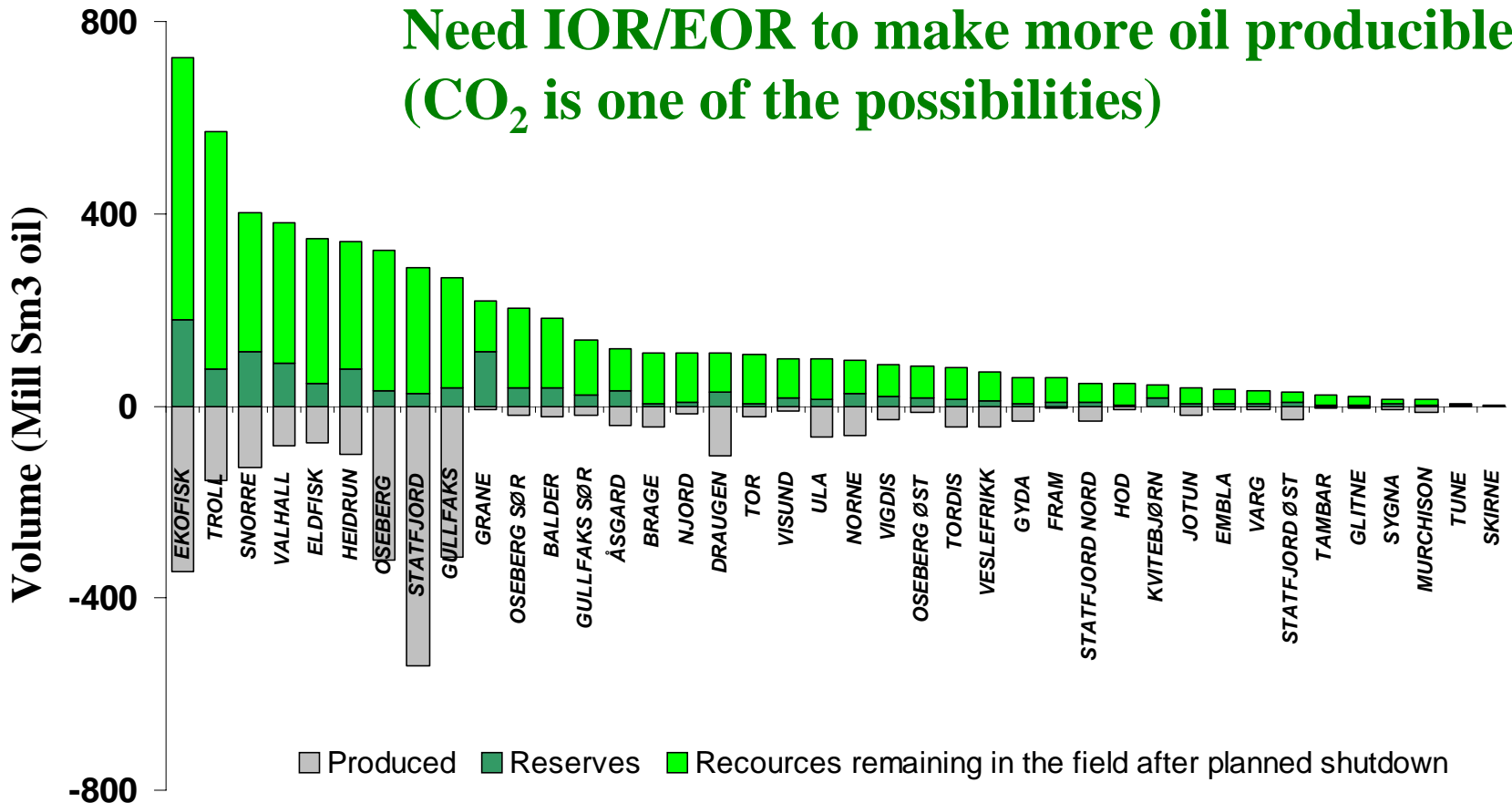
Average oil recovery factor (%) - NCS



NCS - Around 54 % (average) of the oil left in the ground with present plans and technology!



Need IOR/EOR to make more oil producible
(CO₂ is one of the possibilities)



CO₂ and Enhanced Oil Recovery

- ◆ More than 30 years experience onshore. No big offshore fields to learn from.

- ◆ Difficult to transfer experience
 - ◆ Geology and fluids are different.
 - ◆ Fewer wells drilled in offshore fields
 - ◆ NCS big fields have already been subjected to advanced methods to increase recovery so less oil is remaining as a CO₂ target

- ◆ CO₂-injection may increase recoveries 3-7 % on NCS versus a history of 7-15 % onshore USA.

NCS potential for added oil using CO₂

- ◆ The report has identified 20 fields as candidates for CO₂-injection, based on reservoir conditions and size
- ◆ The fields vary in geology, development solutions and present production strategies

Technical potential



The 20 fields have a potential for 150-300 million Sm³ extra oil

IF enough CO₂ could be made available

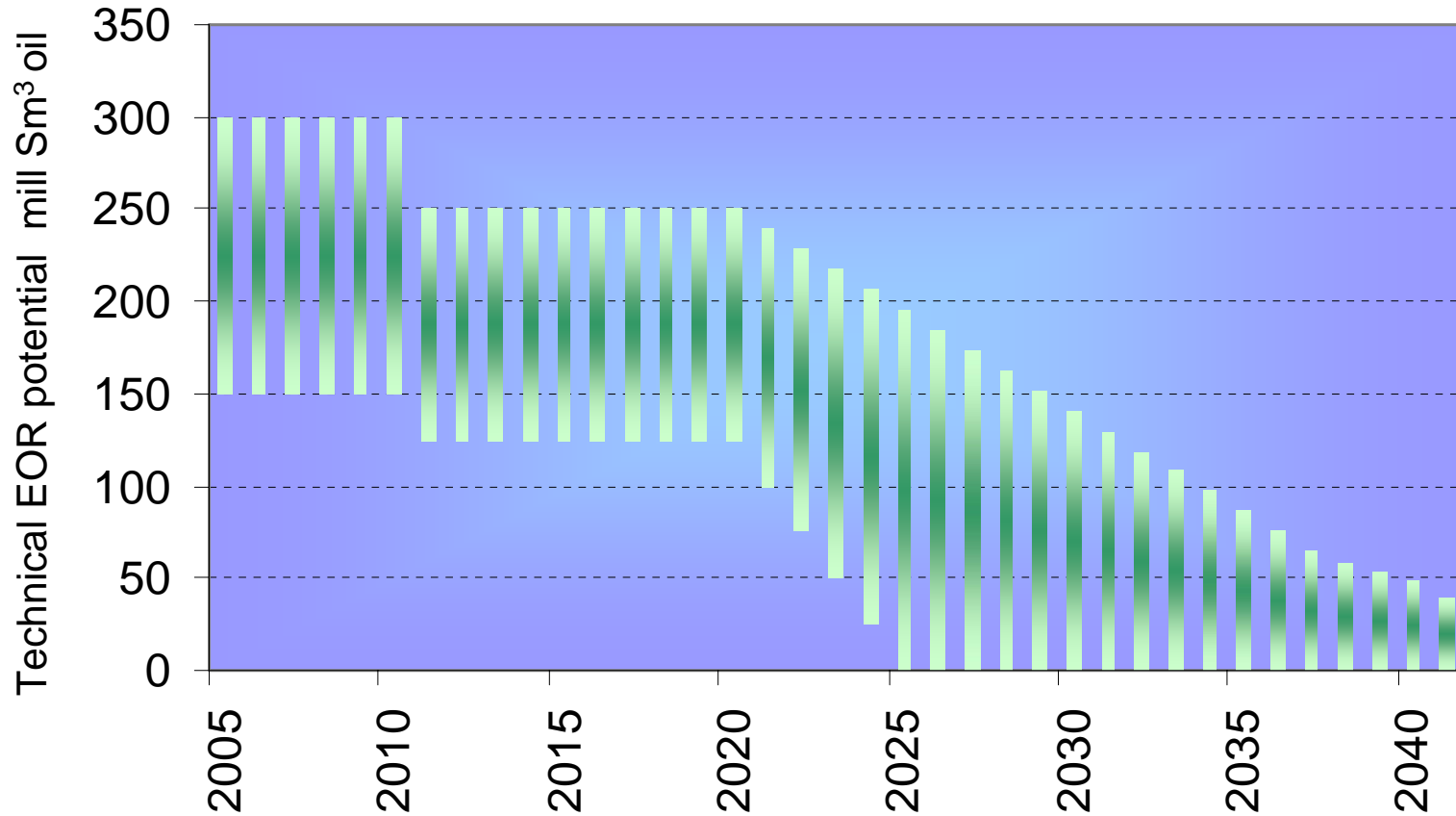
- ◆ **at the optimum time in their production life**
- ◆ **at commercial conditions.**

CO₂ – potentials

Window of opportunity (20 fields NCS)



UK has a similar curve losing potentials earlier !



CO₂ injection and production require extensive modifications in an expensive offshore environment



- ◆ New installations may be needed to get all the equipment onboard.
- ◆ Modifications for our big fields have estimates between 3 to 6 billion NOK:
 - ◆ process upgrades
 - ◆ corrosion protection
 - ◆ additional wells
 - ◆ separation plant to meet sales gas and transportation specifications when justified.



Limited space and weight capacities on ALL offshore installations



Field examples

Gullfaks and Ekofisk with CO₂ from Norway

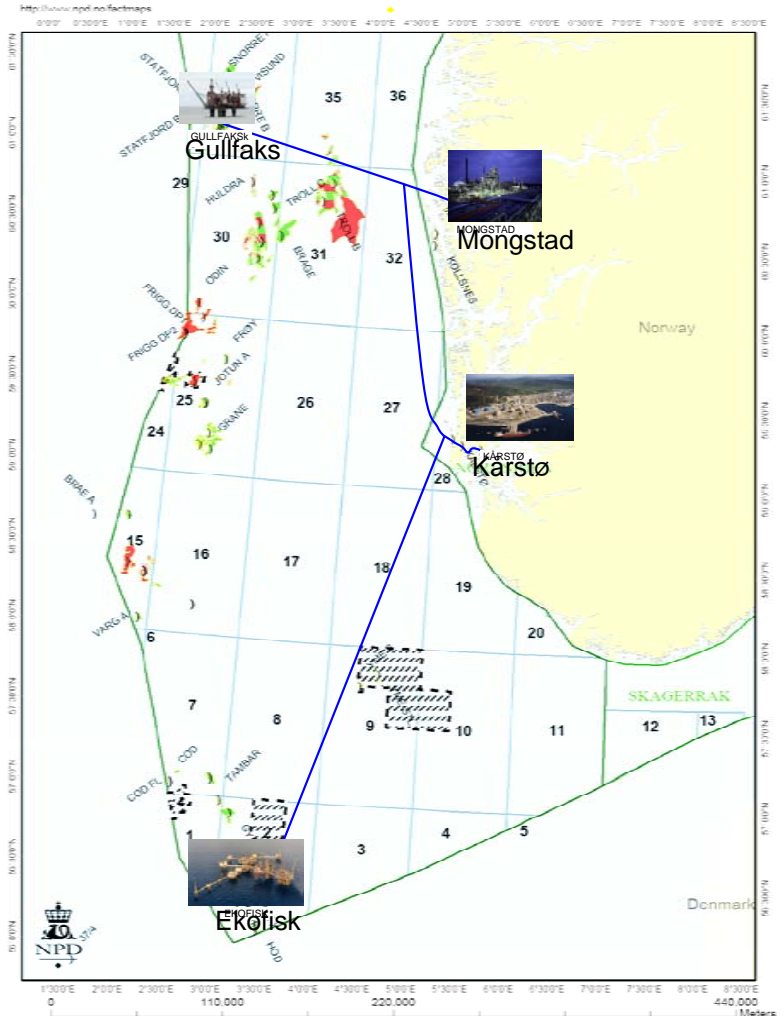


**Break even-prices
for Gullfaks \$26-33/bbl**

**Break even-prices
for Ekofisk, injecting CO₂
after 2020, \$23-33/bbl**

**NB ! Highest recent PDO
less than \$18/bbl**

(10 €/ton quota price assumed)

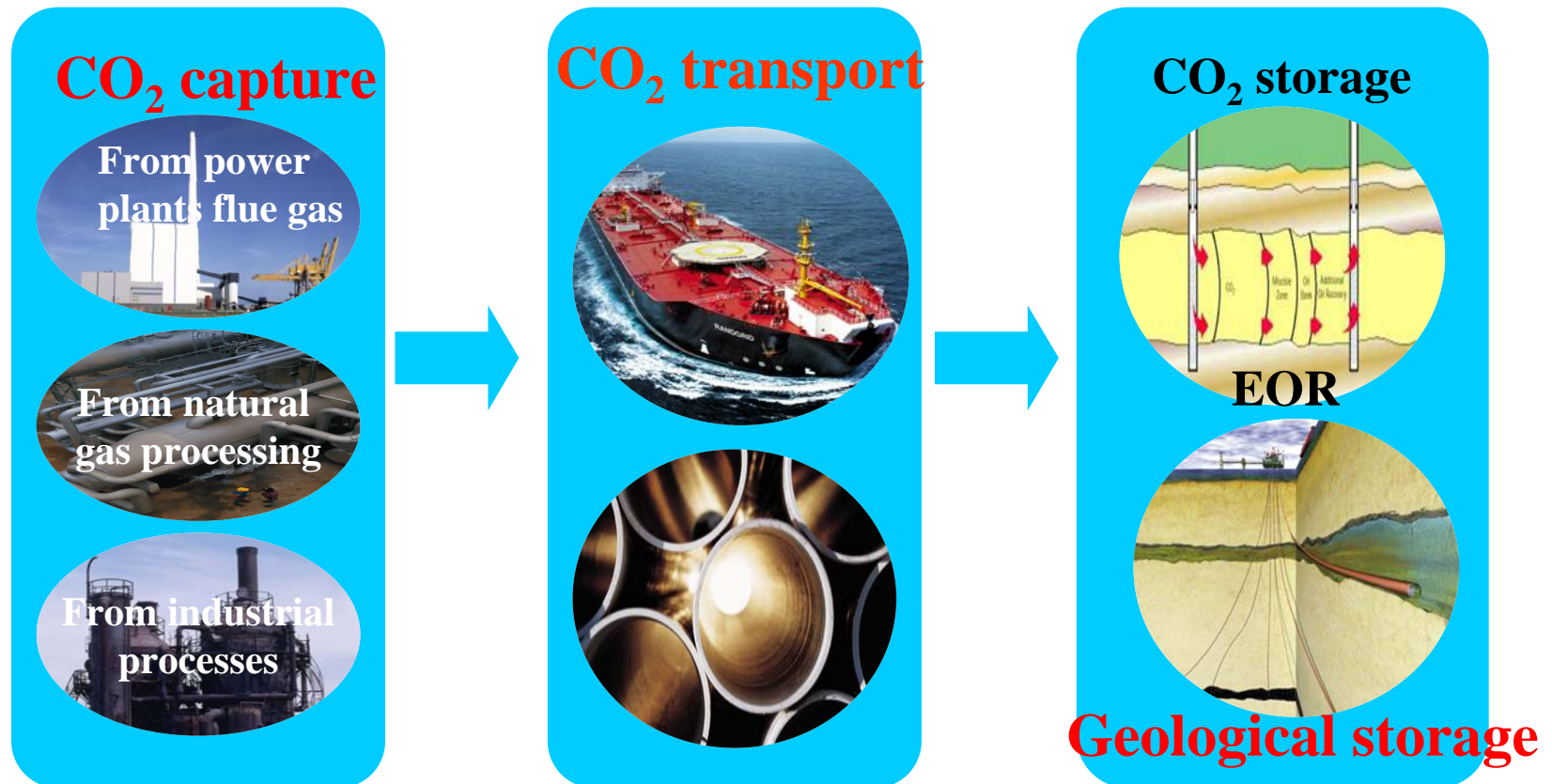


Added possibilities and challenges

- ◆ Higher quota prices for long term storage of CO₂ could make these projects attractive.
- ◆ Huge uncertainties in estimating added oil volumes.
- ◆ The field examples do not include hook-up to alternate storage. That will be added costs to avoid emissions, bad press and risks to valuable hydrocarbon resources.

The report concludes that challenges remain

How to make the red elements commercially attractive?



NPD's CONCLUSIONS FROM THE STUDY



CO₂-injection has a large potential for additional oil recovery on NCS. It is technically feasible to implement, but the projects are not commercially viable for the licensees on NCS today.

The reasons are:

- ◆ The costs involved in capturing and transporting CO₂ based on the technologies available makes other methods more attractive to the licensees, even recognizing that CO₂ would provide additional oil.
- ◆ EOR/CO₂-projects have large upfront investments. Added income comes after several years and over a long period.
- ◆ The risks in these projects are too many for the licensees to lift them alone.
- ◆ Decisions on long term risky projects normally require break even prices no higher than \$22-25/bbl.

Thank you for your attention

