



CO₂ EOR

Perspectives from researchers point of view

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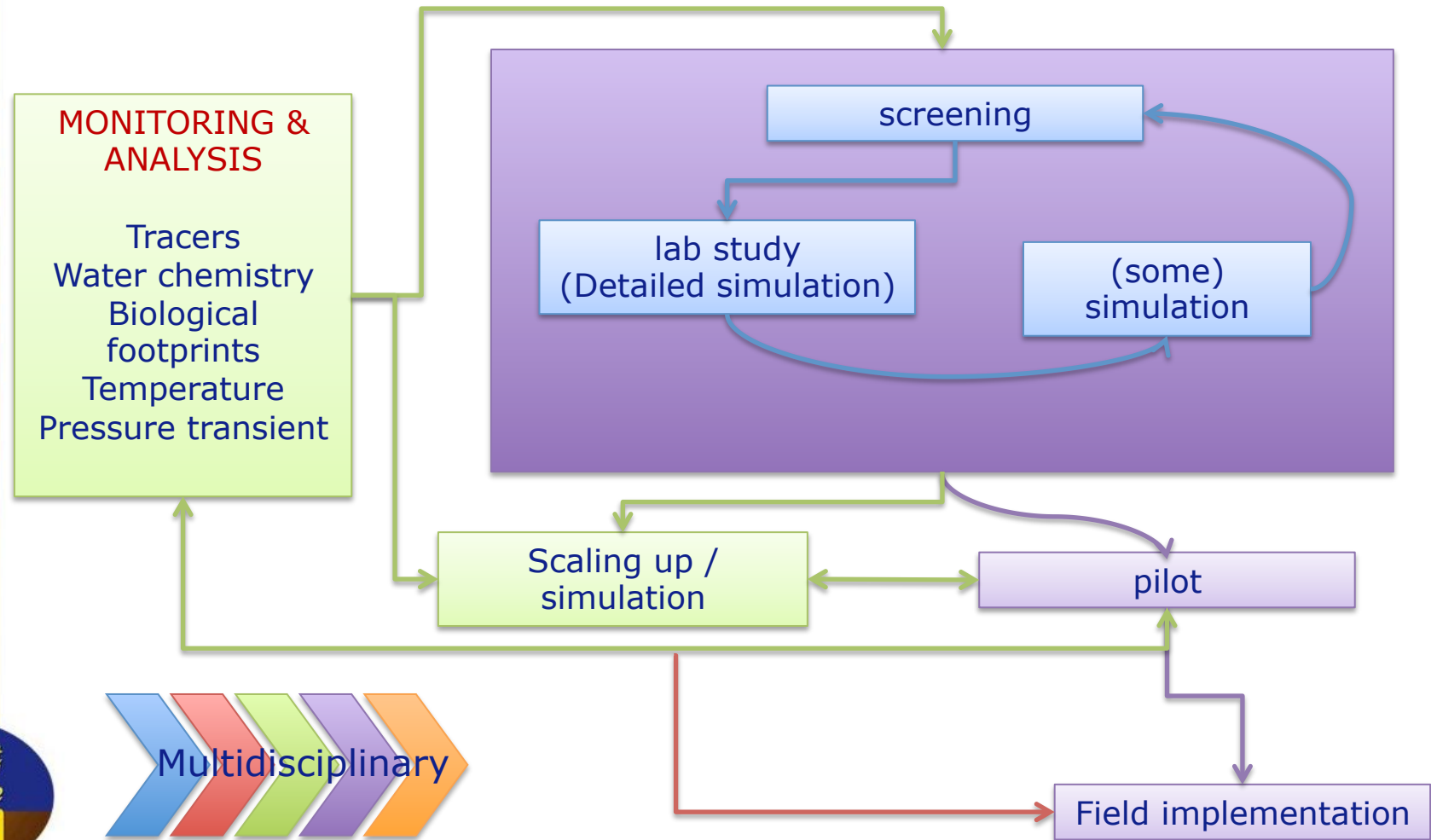


Just to set up a scene

- Representing just my own experience and point of view
- Research perspective meaning that some (many) operational points of view are not represented well enough
- You might not like it, disagree with it, or use it at your own risk and all that...

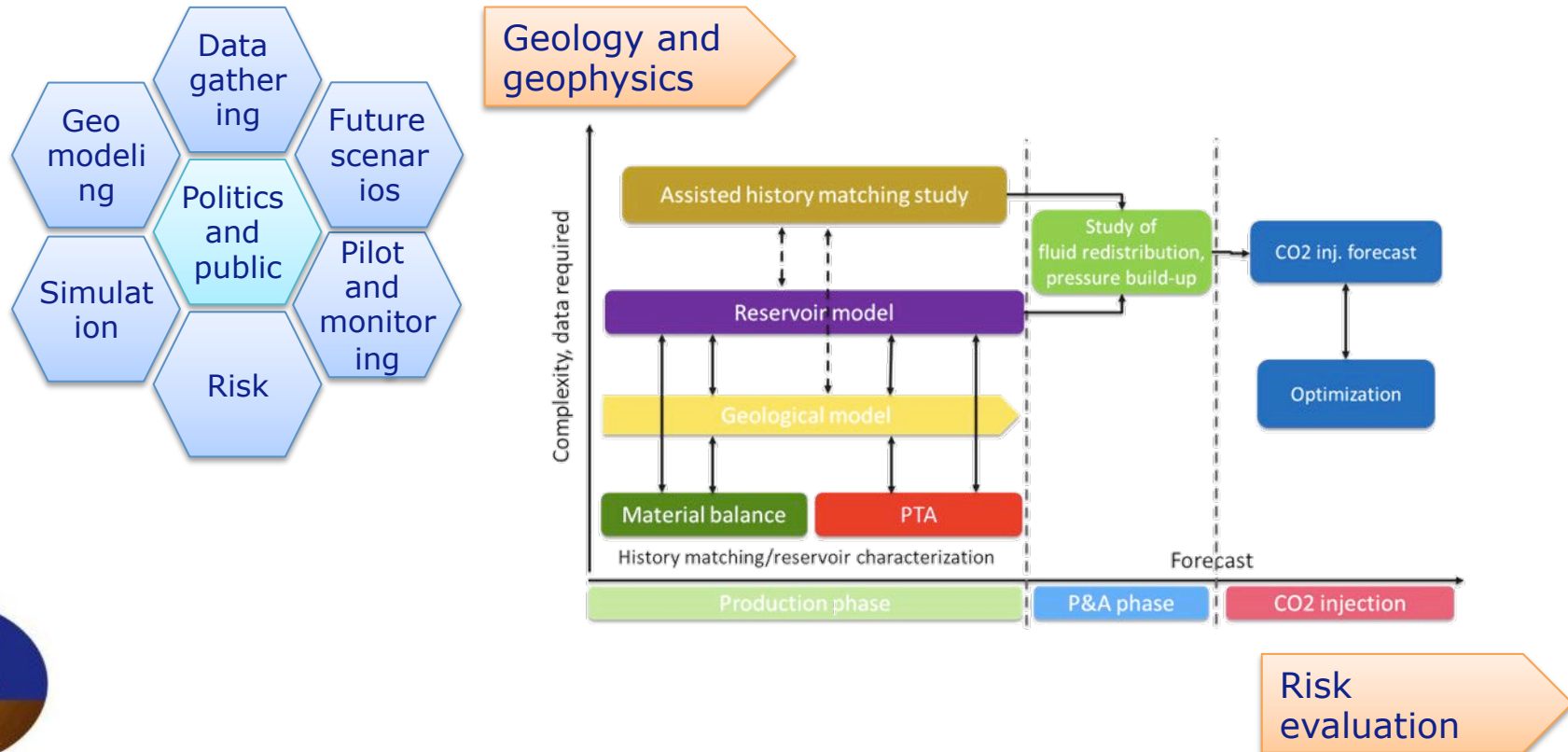


What is our EOR routine?



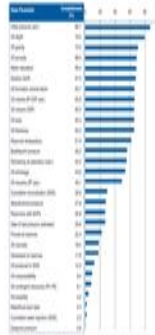
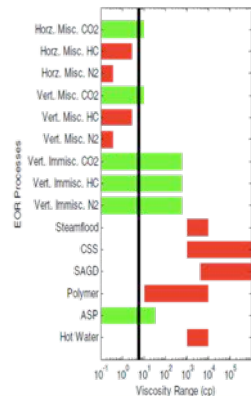
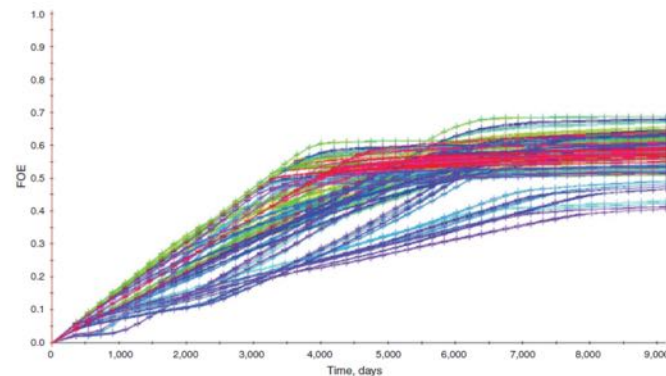
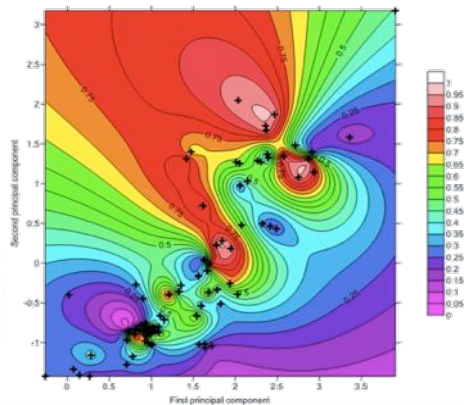
What are the steps?

- ➔ Before we embark on the journey we need to figure out if EHR is feasible

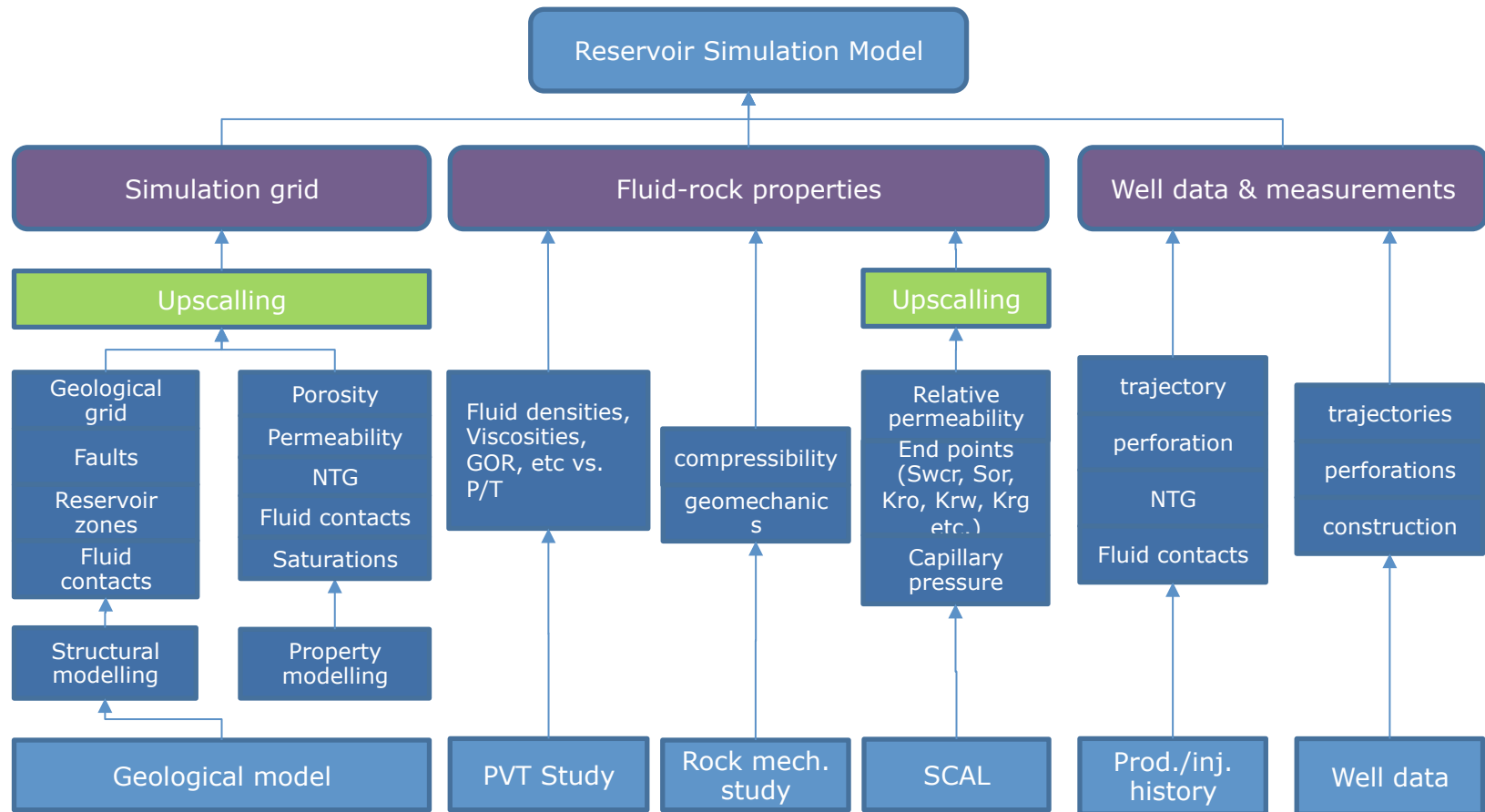


IOR/EOR screening methods

- Preliminary screening over basic field properties ;
- Statistical models – databases are used to find analog(s) / fill data gaps from statistical correlations;
- Analytical: decline curve analysis, material balance and analytical solutions for EOR processes;
- (Lab based)
- Numerical: simplified, surrogate or mechanistic models; segment studies



Reservoir model

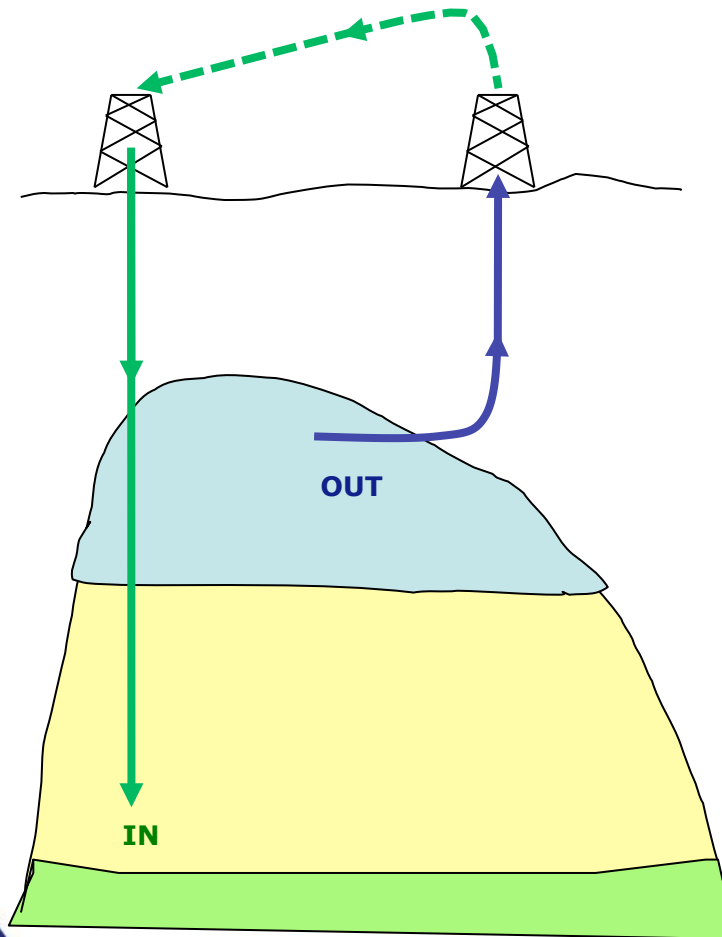


Uncertainties

- ➔ Scarce and potentially uncertain data for old abandoned fields + resources to bring the field back online
- ➔ Rock and fluid properties. Fluid samples. Cores. Scaling up and modelling
- ➔ Well construction. Materials. Current state.



Utilisation + Storage = untraditional?



Classical IOR/EOR

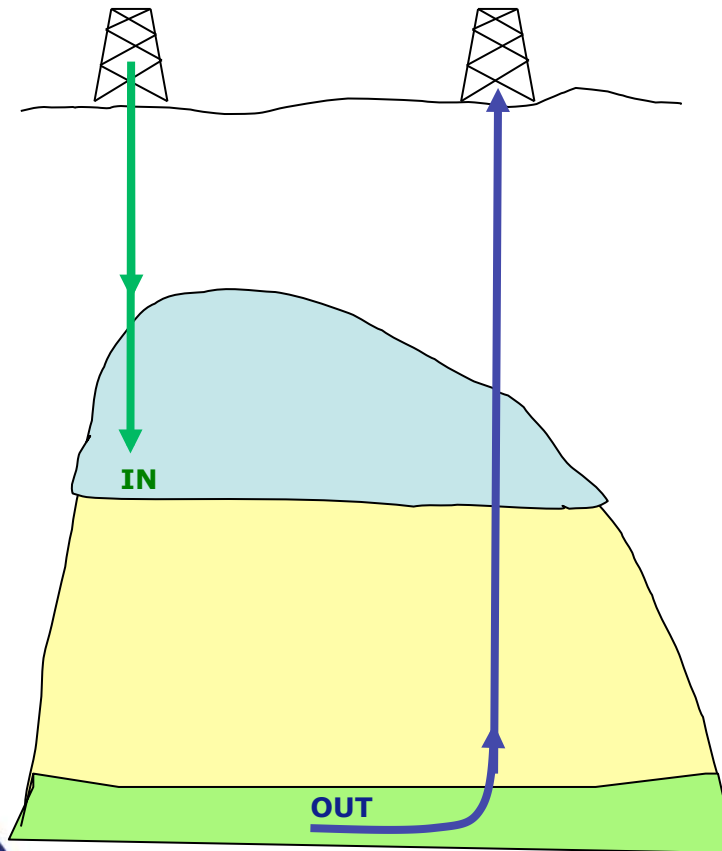
→ Maximise:

- Total "Out"
- Rate of "Out" recovery
- Profit

→ At the same time minimize:

- Total "In"
- Purchased "In"
- Expenses

Utilisation + Storage = untraditional?

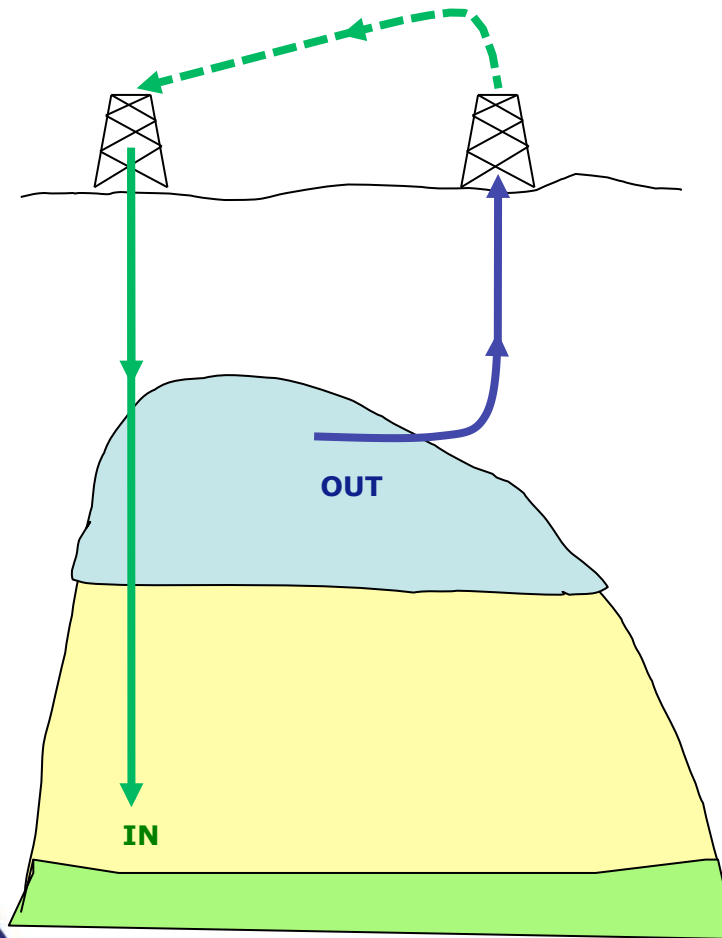


Classical Storage

- ➔ Maximise:
 - ➔ Total "In"
- ➔ Optimise
 - ➔ Rate of "In" injection
- ➔ At the same time minimize:
 - ➔ Total "Out"
 - ➔ Expenses



Utilisation + Storage = untraditional?



EOR + Storage = CCUS

→ Maximise:

- Total "Out"
- Rate of "Out" recovery
- Profit
- Total "In"

→ Optimise

- Purchased "In"

→ At the same time minimize:

- Expenses



Enhanced hydrocarbon recovery (EHR)

- Extending field of life and utilizing existing infrastructure: saving on materials and energy use
- CO₂ stream is compressed. Injecting it underground without utilizing at least its energy is a waste!
- Among other gasses (nitrogen, hydrocarbon) CO₂ is typically the best displacing agent!
- In short: we would need HC in the future (deal with it, mate) and why don't we pay at least part of the bill to inject CO₂?



.....however

- CO₂ is highly corrosive (old wells / infrastructure may not be ready for it)
- Lots of experience is in the injection of natural (not man made CO₂)
- EHR combined with storage is a lot different from either EHR or storage
- Experience with CO₂ EOR is mostly in US, China. Here the focus is North Sea
- Neither hydrocarbons nor CO₂ price exhibit long term price stability...



And then it is offshore!

- Logistics: people and resources
 - Or how do you arrange continuous stream of CO₂ for the pilot? Could we use existing pipelines?...
- Additional equipment (weight, space, electricity) is very restricted and expensive
- Number and geometry of the wells
- Economics



Way forward

- CO₂ – EOR is a proven and working method (mostly natural CO₂ onshore)
- None of the mentioned engineering questions in CCUS are show stoppers.
- What we lack is an insensitive and a set of rules to go for it:
 - General EOR regulations?
 - P&A and take over for storage?
 - Costs and availability of CO₂ in the North Sea?
- Support from R&D community: are **we** presenting the right message?

