Hydrogen Storage Capacity in Porous Media Sites

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The hydrogen storage team
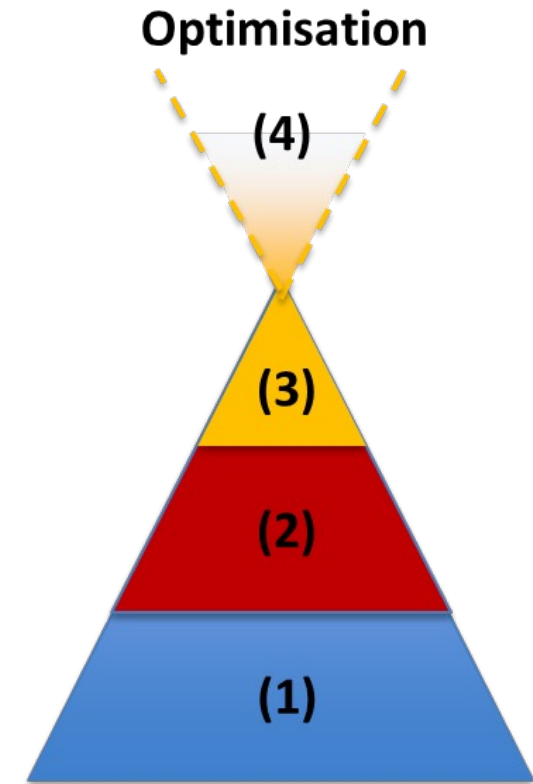
Capacity vs capacity vs …

Optimisation
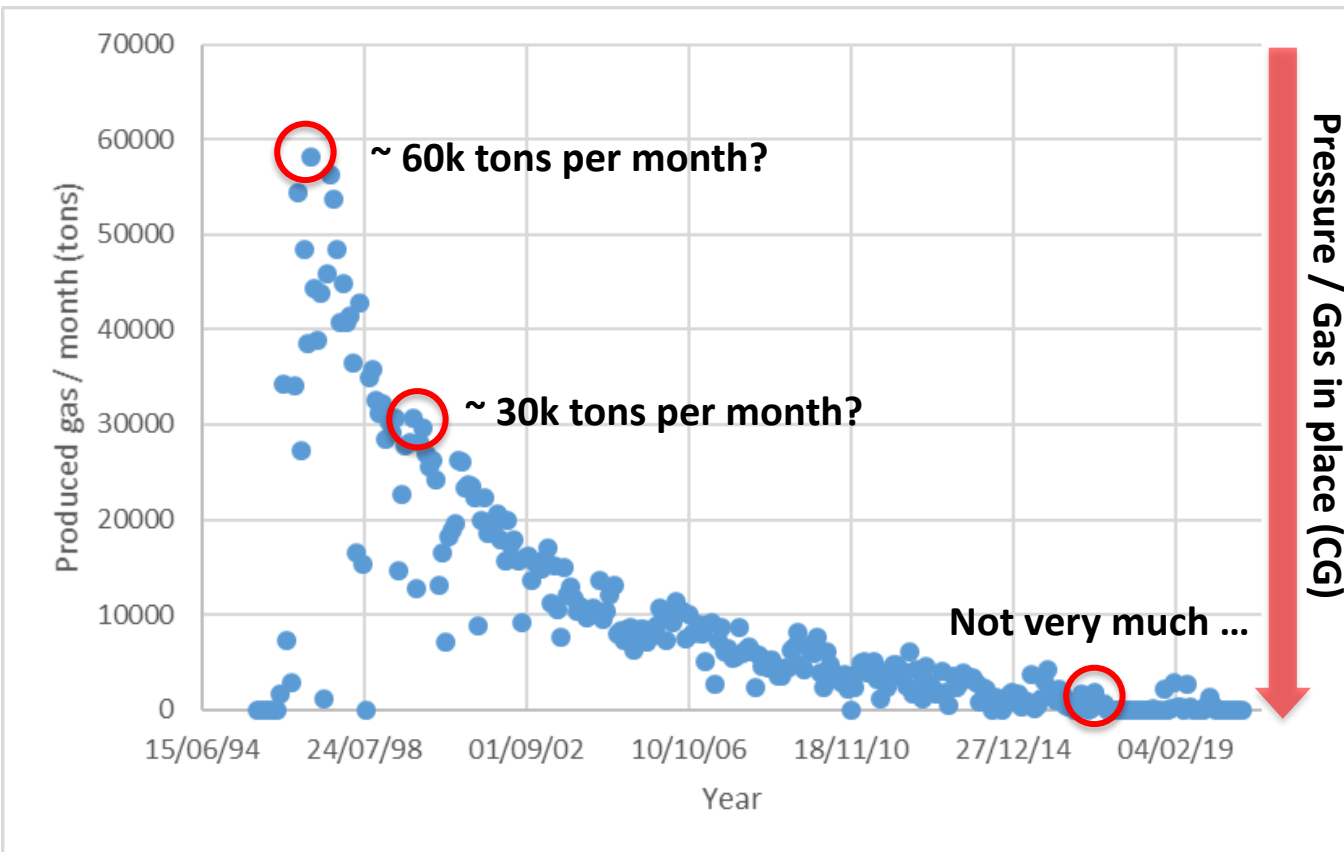
(4)

(3)

(2)

(1)

(static capacity)

(FDP based capacity)

(dynamic capacity)

(max. production rates)

Cushion gas (CG) in gas storage

~ 60k tons per month?

~ 30k tons per month?

Not very much …

Pressure / Gas in place (CG)

Data from OGA.co.uk

Hydrogen storage capacity estimation

- Open system is assumed (100mD, 20%)
- Gas injection: BHP (80% of the overburden)
- Gas production: THP (250 kPa)
- 3 Working gas cycles (3 months of Inj/Prod)

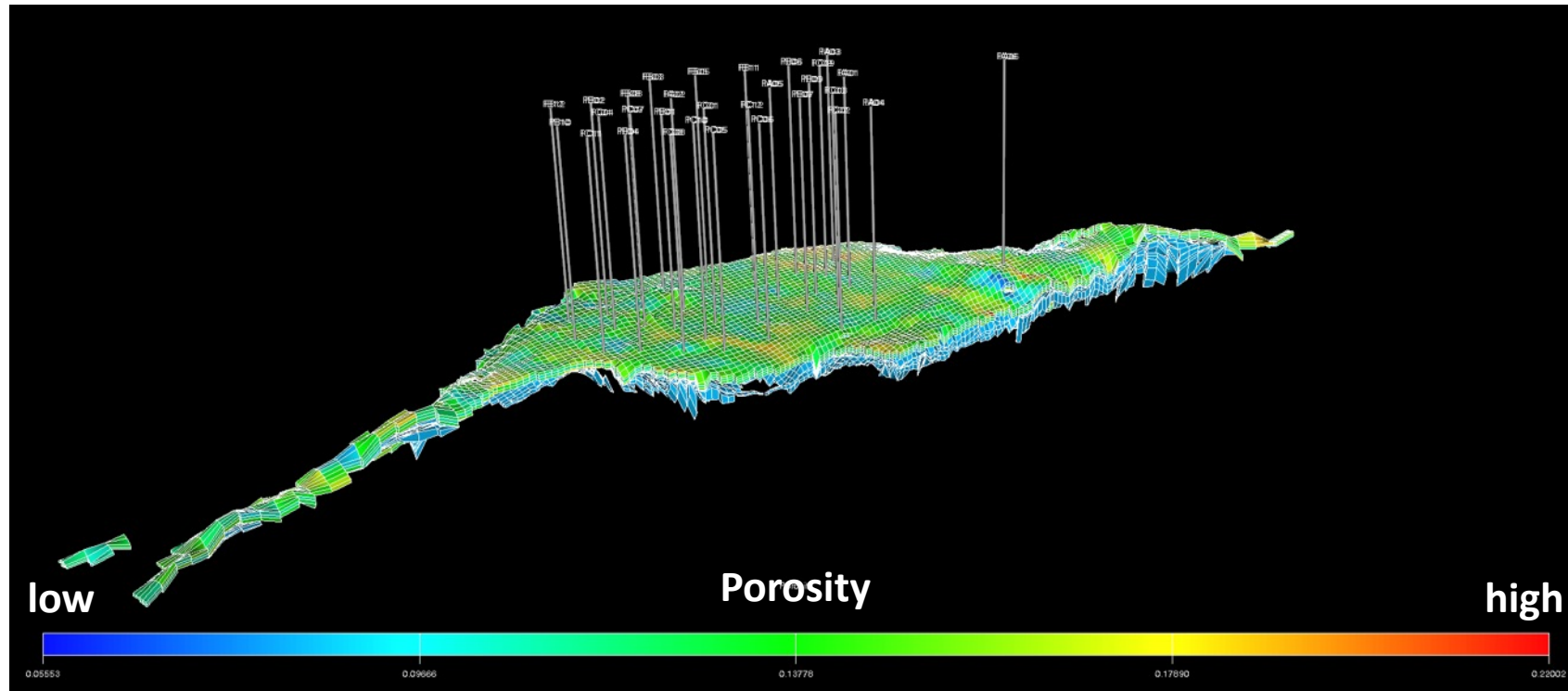| CG (TWh)	0.1 INJ	TWh PROD	0.11 INJ	TWh PROD	0.115 INJ	TWh PROD	0.12 INJ	TWh PROD	0.125 INJ	TWh PROD	0.15 INJ	TWh PROD
0.075	0.100	0.100	0.110	0.107	0.116	0.111	0.124	0.116	0.125	0.119	spill	
0.086	0.100	0.101	0.111	0.110	0.115	0.114	0.122	0.118	0.126	0.121		
0.098	0.101	0.100	0.112	0.110	0.115	0.115	0.120	0.120	0.126	0.123	spill	
0.110			0.110	0.110	0.115	0.116	0.120	0.120	spill			
0.120	0.101	0.101	0.110	0.110	spill		spill		spill			
0.130	0.100	0.100	spill		spill		spill		spill			
0.142	spill				spill		spill		spill		spill	

Pressure

High

Low
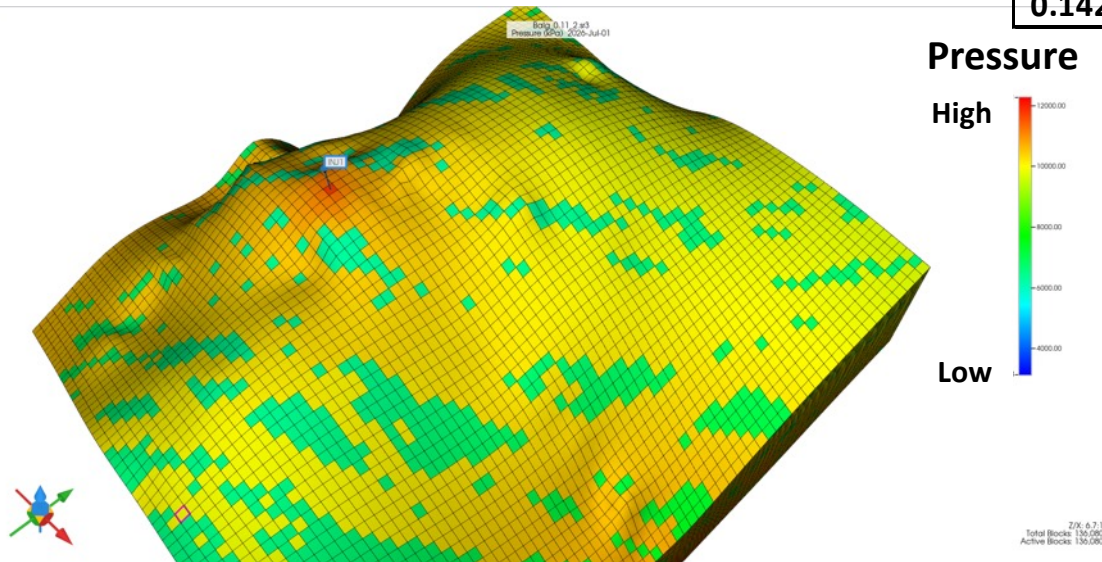
Three "modes"

Orange: Not able to produce the desired WG

Red: H$_2$ reaching the spill point

Green: Successful scenario

NZTC / HyStorPor funded research (in collaboration with K. Adie / UoE and SGN)

Hydrogen storage capacity estimation

(Data from Centrica storage, modelling by UoE)

- Rough depth of the Permian Rotliegend SST is 2700 m.
- 10-15km long and 3.5km wide
- Reservoir is composed of aeolian and fluvial sediments, and sealed by several boundary faults/Zechstein salt.
- Rough produced gas from 1975 onwards, first injection was achieved in 1985.
- Storage in Rough ceased in January 2018, final production commenced.
- **"British Gas-owner Centrica has reopened its giant gas storage facility to boost the UK's supply over the winter" (BBC - OCT2022)**
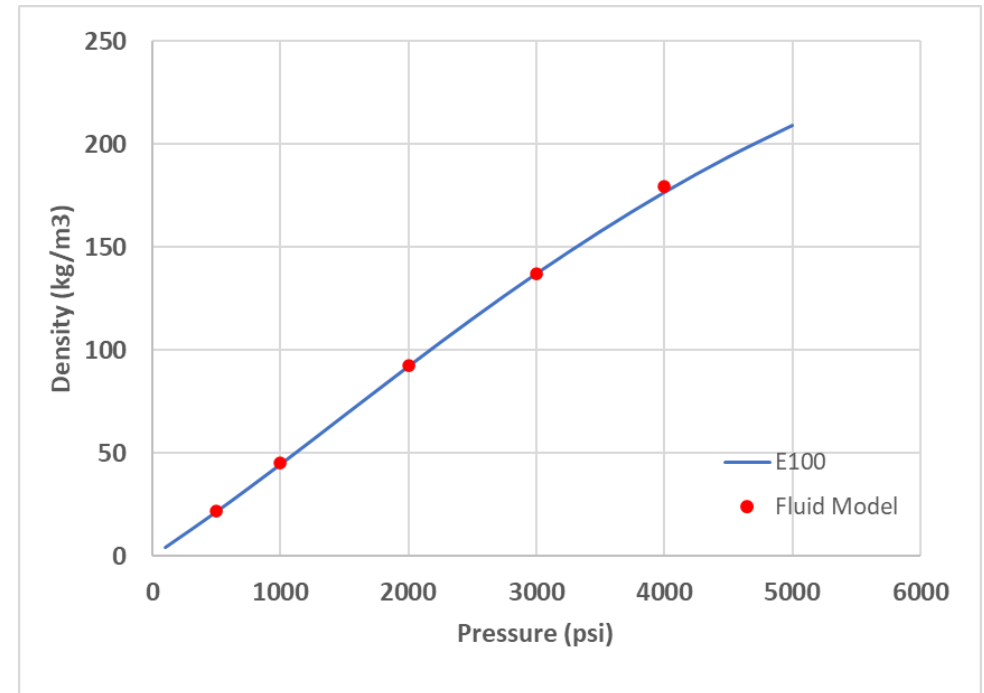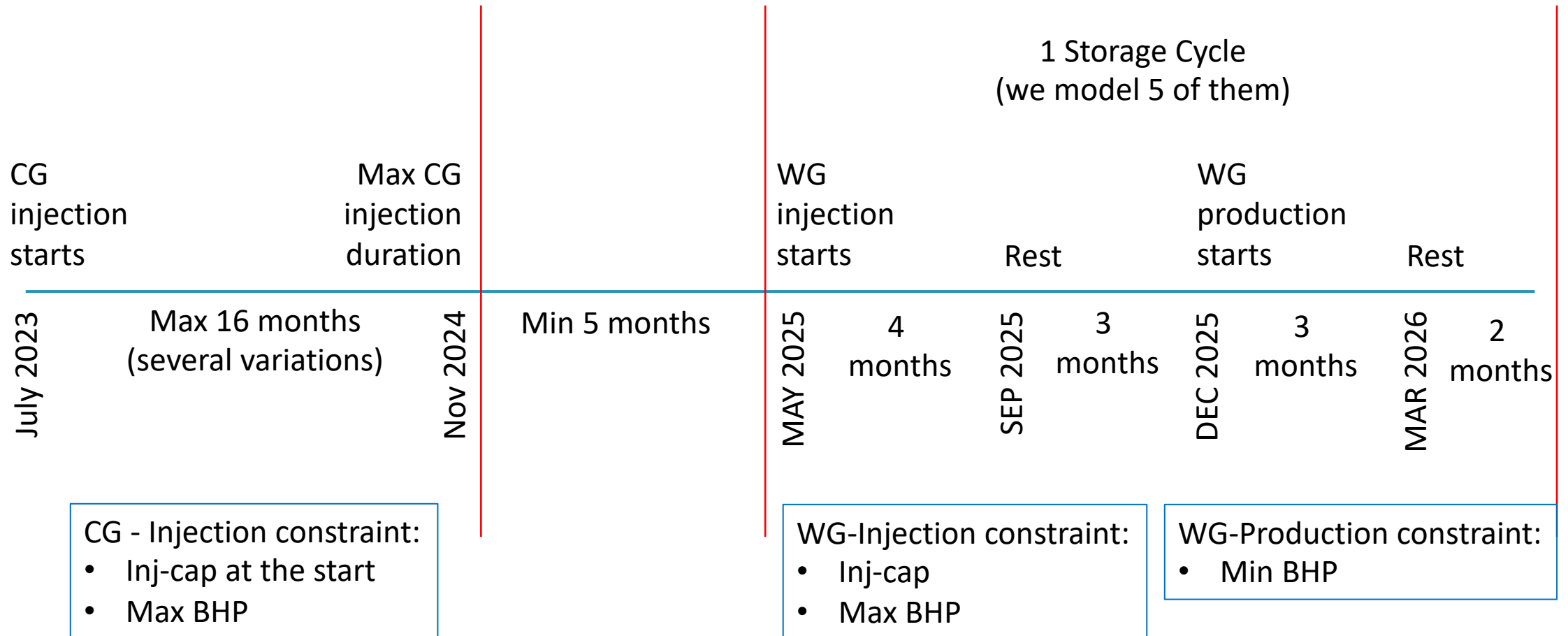
The reservoir model

- Original black-oil dynamic reservoir model, including production and storage schedules.

- 5-year depletion cycle controlled by a THP of ~10 bar, down to a reservoir pressure of roughly 50 bar.

- Transferred to compositional model.

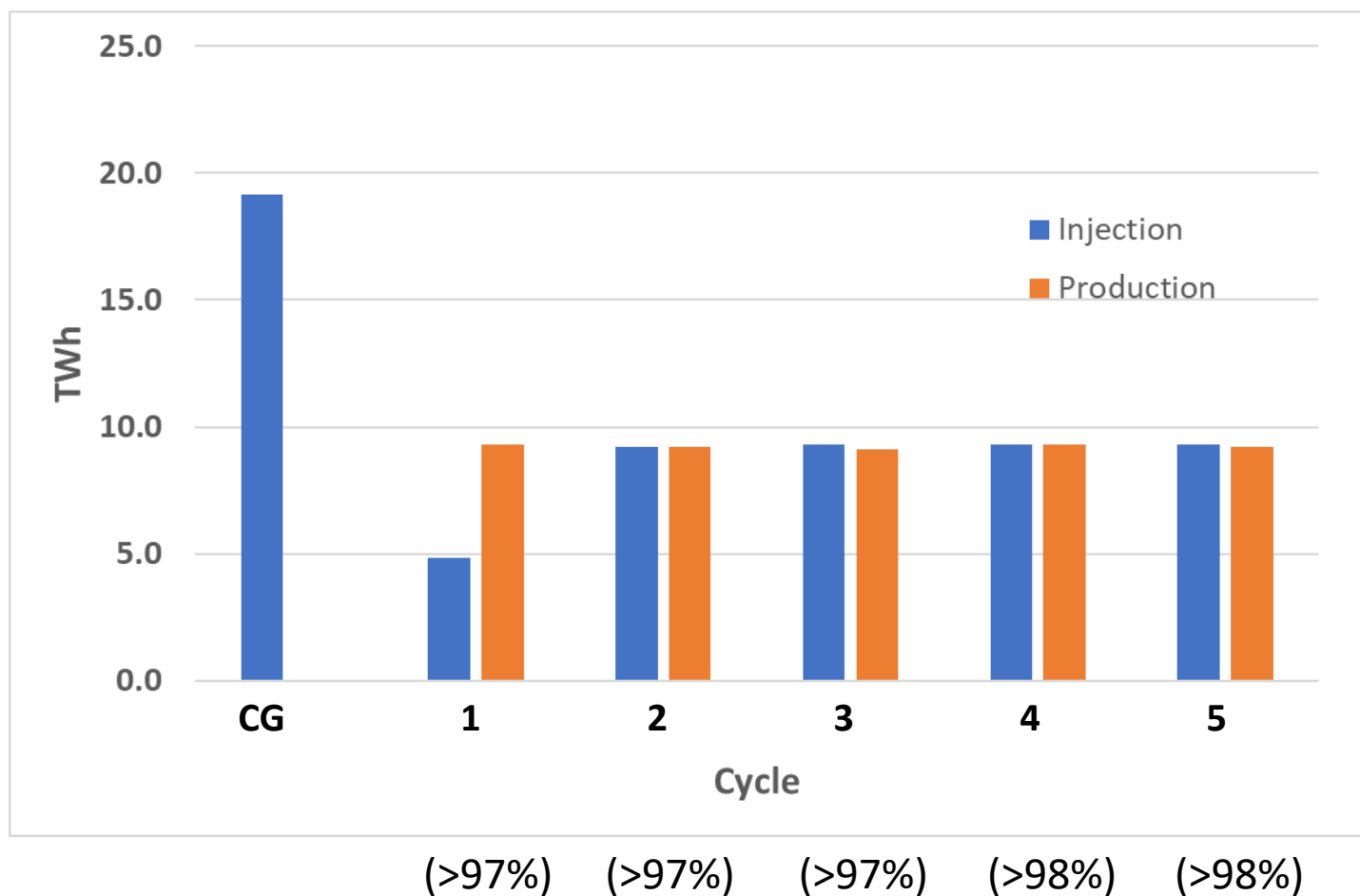- H_2 as a new component.

- New Rel-Perm, modified PR EOS.

In-situ fluid in Rough

Methodology setup

1 Storage Cycle
(we model 5 of them)

CG injection starts | Max CG injection duration | WG injection starts | Rest | WG production starts | Rest

July 2023 | Max 16 months (several variations) | Nov 2024 | Min 5 months | MAY 2025 | 4 months | SEP 2025 | 3 months | DEC 2025 | 3 months | MAR 2026 | 2 months

CG - Injection constraint:
- Inj-cap at the start
- Max BHP

WG-Injection constraint:
- Inj-cap
- Max BHP

WG-Production constraint:
- Min BHP

Example results

CG: 14.9 TWh

Capacity
WG: 9.3 TWh

Efficiency
CG/WG: 1.6

Example results: Well sensitivity

Ongoing / Next steps:

CG as an emergency backup
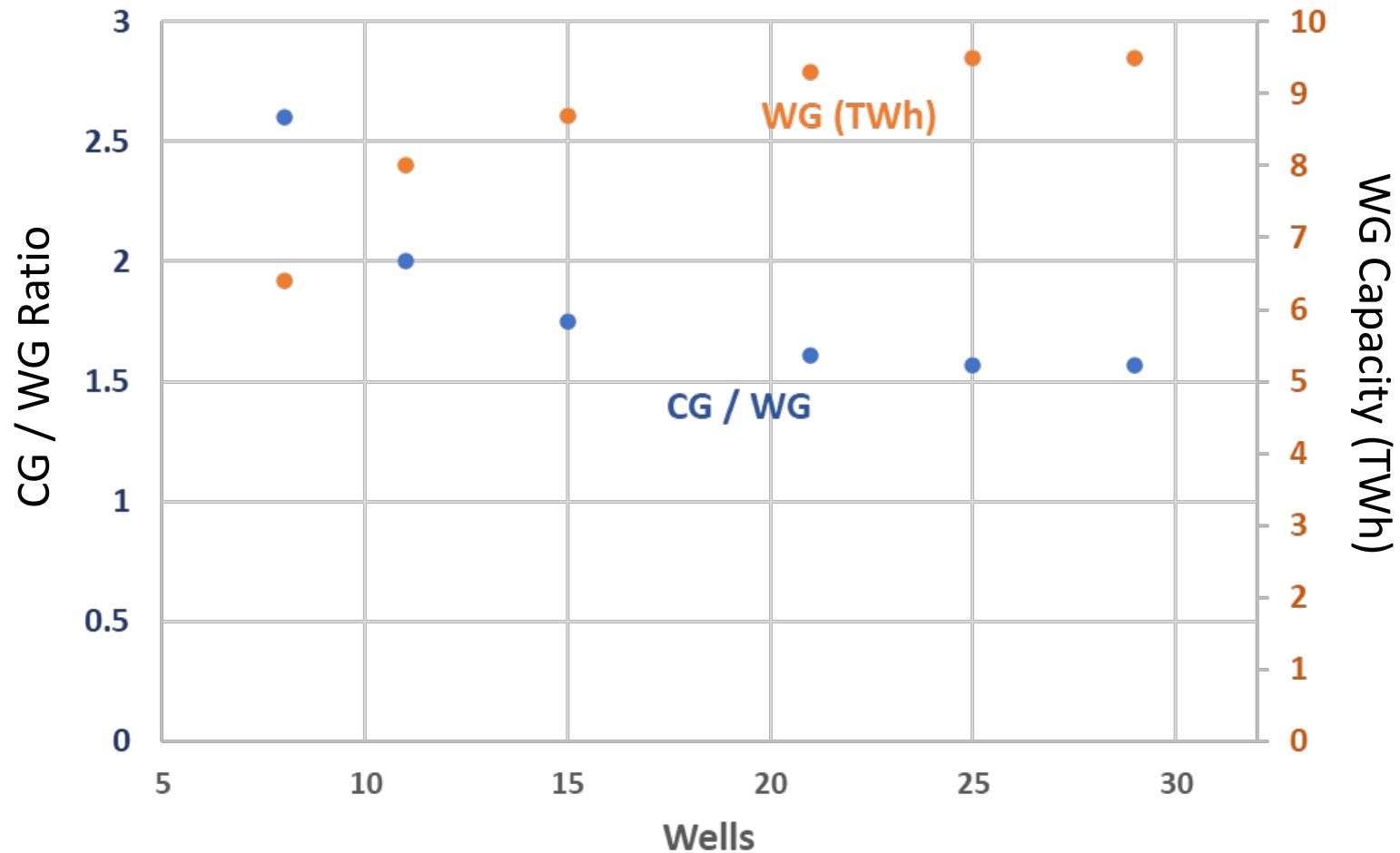
(Heinemann et al., 2022)

Cyclic storage in complex reservoirs
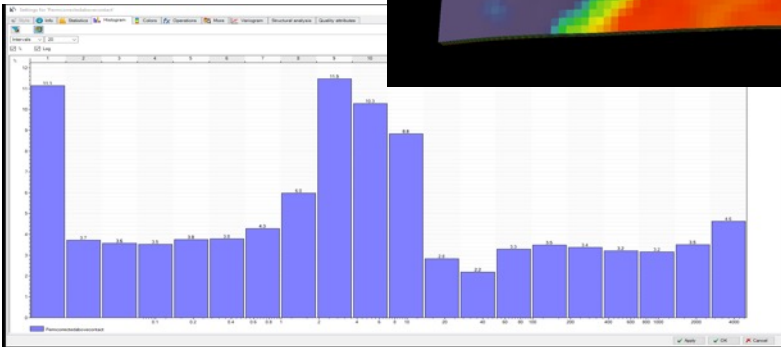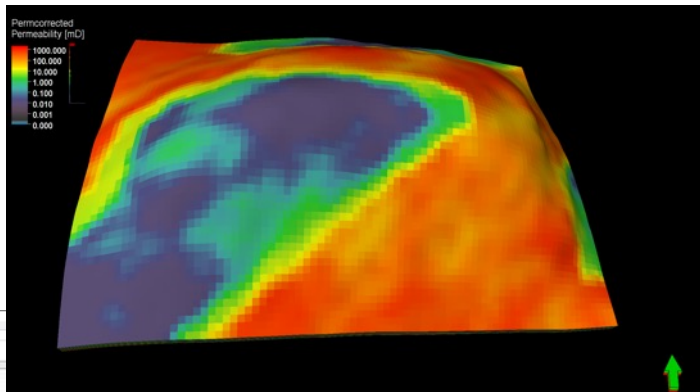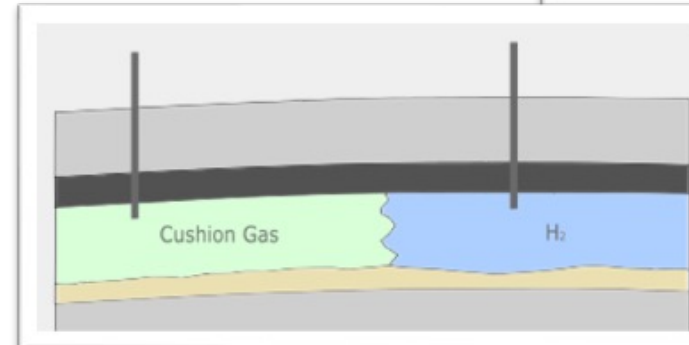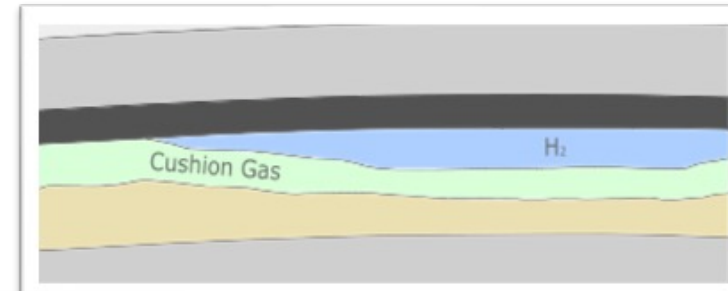

Funded by NZTC in collaboration with SGN and CGG
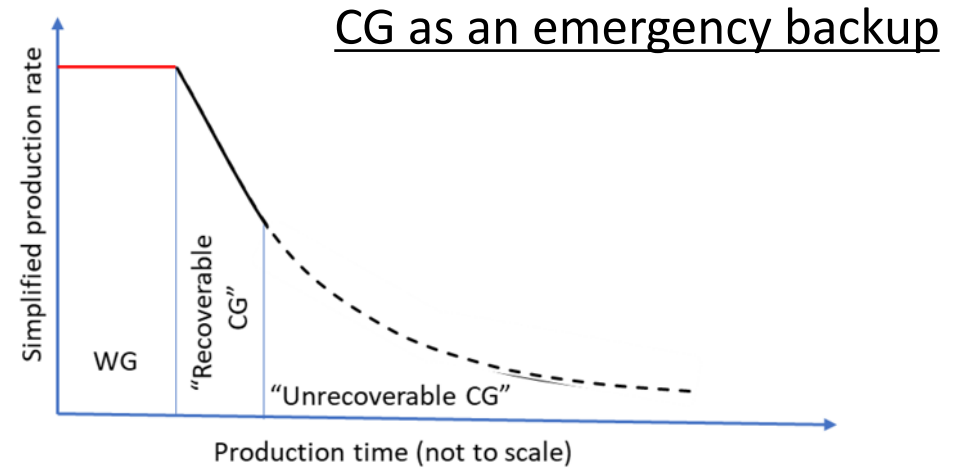
How to optimise the usage of alternative CG?

With H. Williams and T. Rashwan (Open University)

HyStorPor

Thank you – any question?