‘Subsea Water Treatment and Injection – tailored water quality for EOR’

Seabox™ and SWIT™ -

‘More oil out of new and old reservoirs !’

FORCE seminar, NPD

14 February 2017

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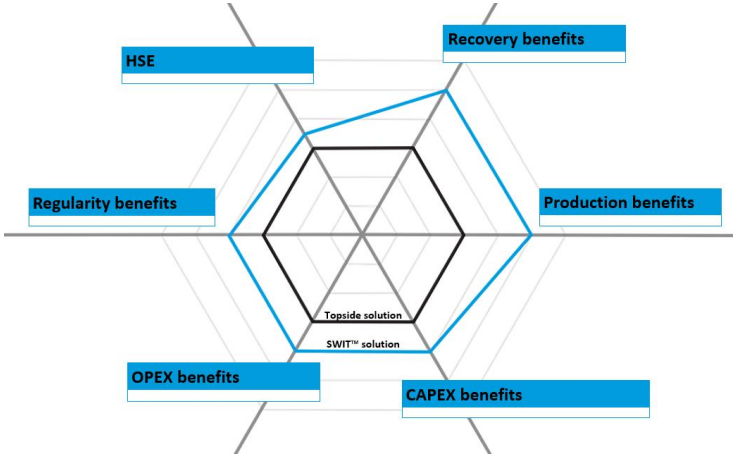
Overview

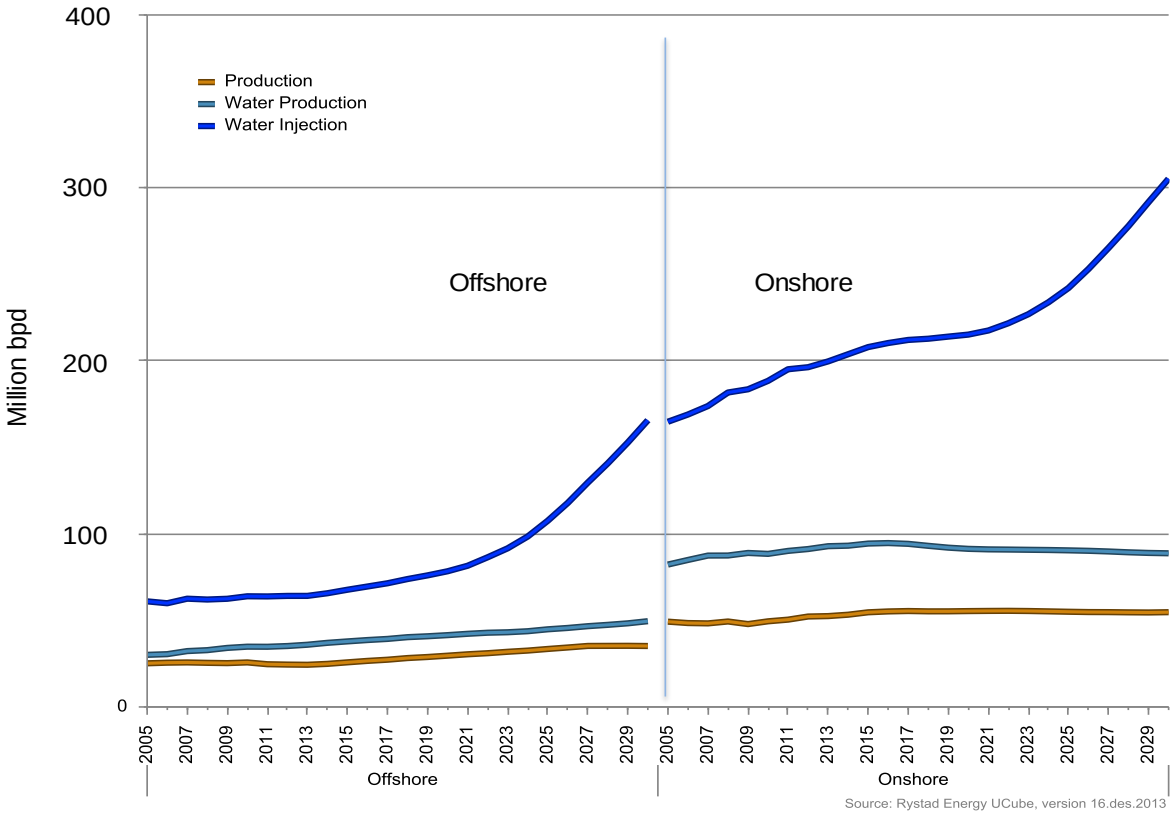
- Big Picture – importance of water
- Everything starts with the reservoir…
- Technology – a very different approach



- Value proposition – flexibility, reduced / delayed cost, increased oil recovery
- New solutions – new opportunities - examples
- Summary

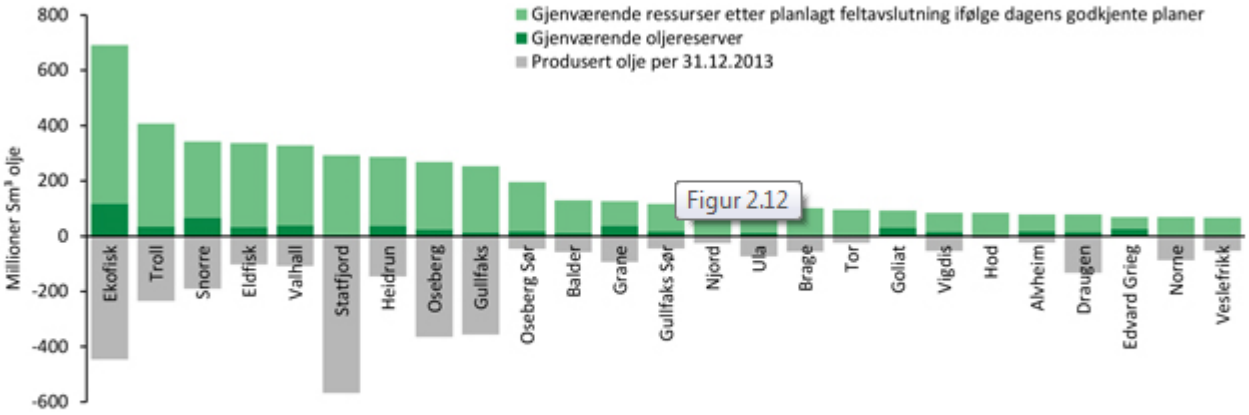
Global Water Injection Volumes

- As oil fields mature, they require more water injection to sustain oil production
- The global requirement for water injection is expected to double or trippel over the next 10 years
- New technical solutions are essential to be able to meet these demands in a cost effective and HSE friendly way
- SWIT™ technology may become a game changer in this picture

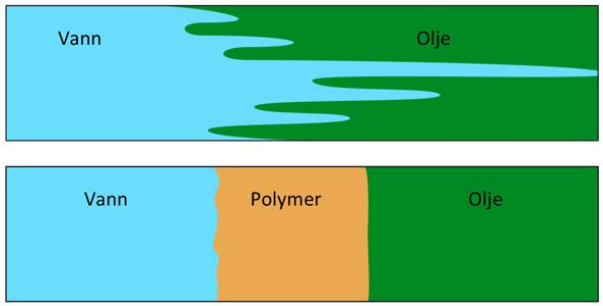


Global Water Injection Volumes by Offshore / Onshore Regions.
Source: Rystad Energy research and analysis, Rystad Energy UCube.

Micro Displacement Efficiency, Sweep and Enhanced Recovery Methods



Figur 2.12 *Ressursoversikt for de 25 største oljefeltene, solgte mengder, reserver og gjenværende olje uten nye tiltak.*

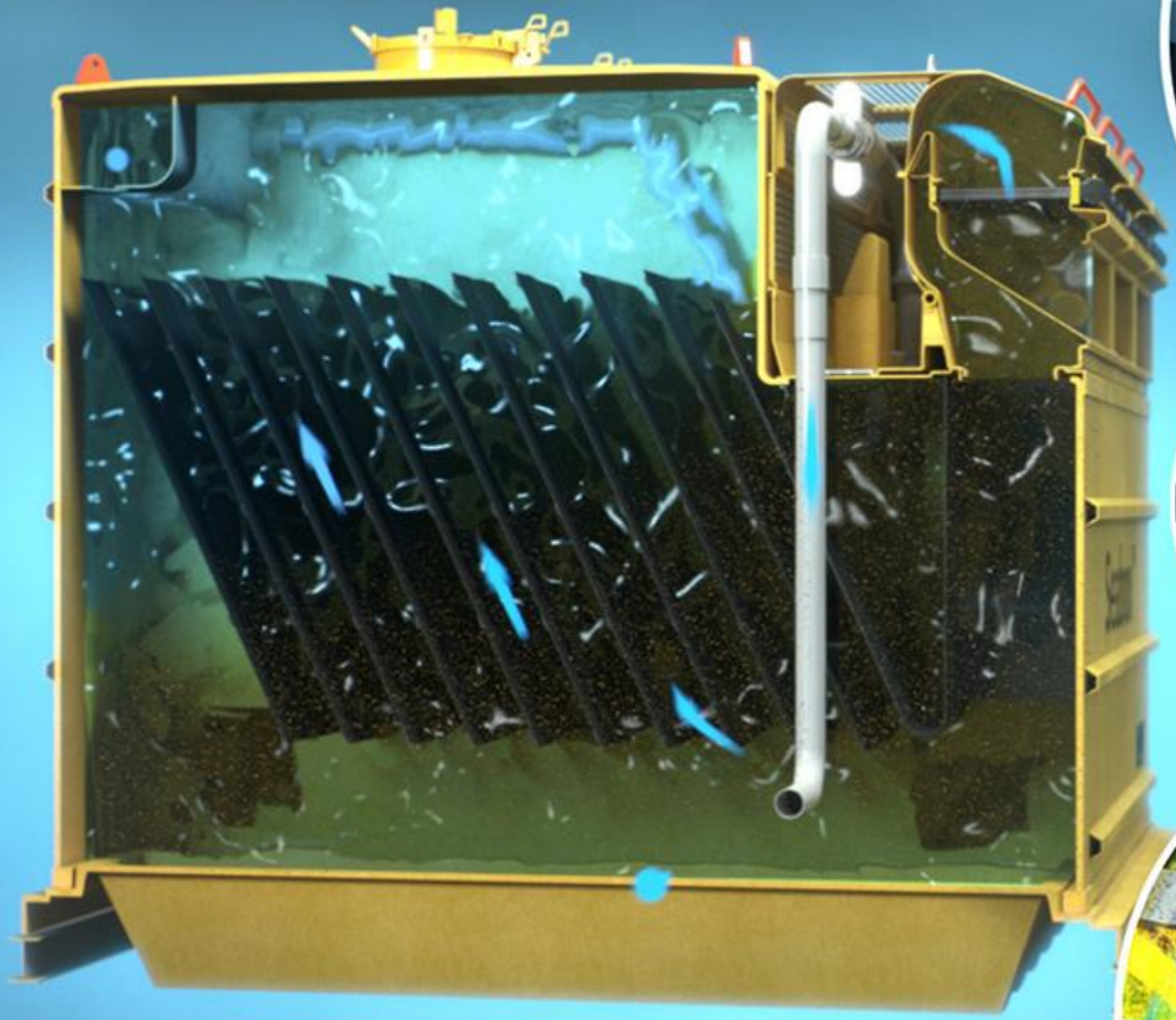


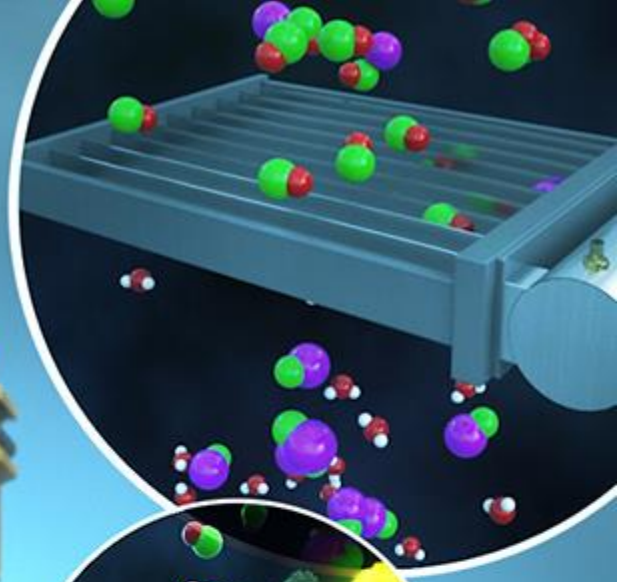
Source: NPD, ressurs rapport 2014

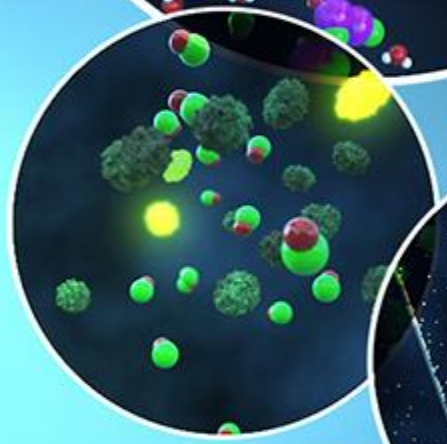
Importance of clean water

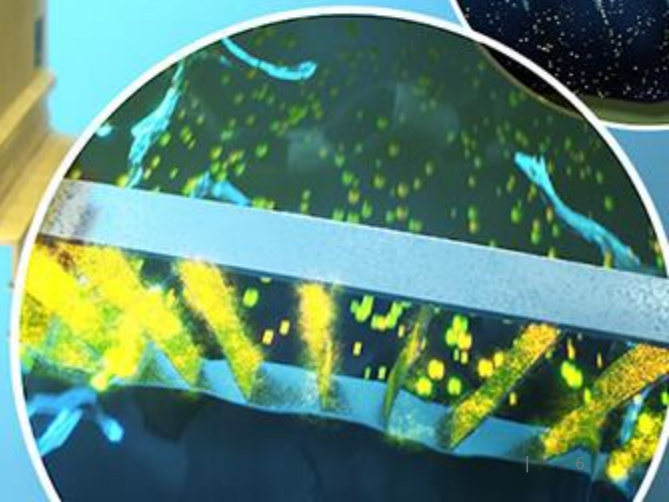
- with the right chemical composition

Technology fundamentals



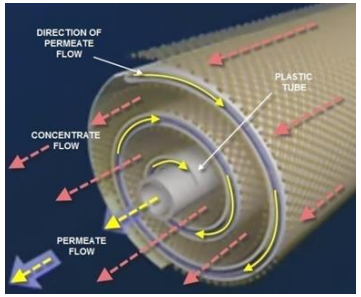






Solids Removal –What each equipment item is doing

EQUIPMENT



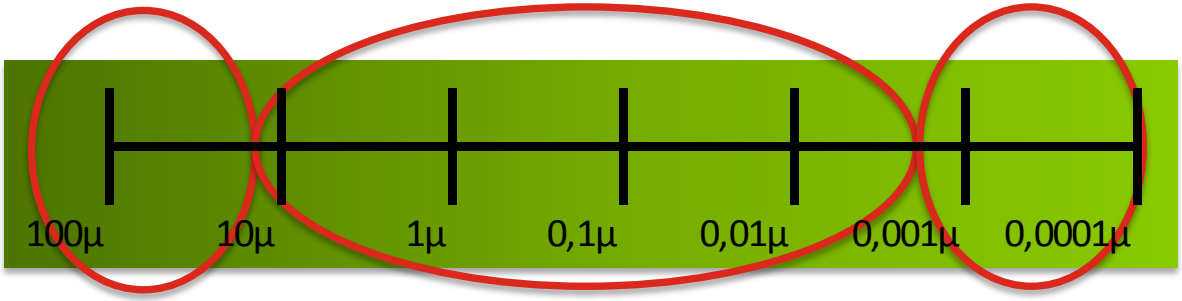
DUTY

1) Chlorination
2) Settlement
3) Radicals

4) Suspended Solids (Re-generable)

5) Dissolved (ionic) Solids (Non re-generable)

SOLIDS SPECTRUM



Suspended

Dissolved

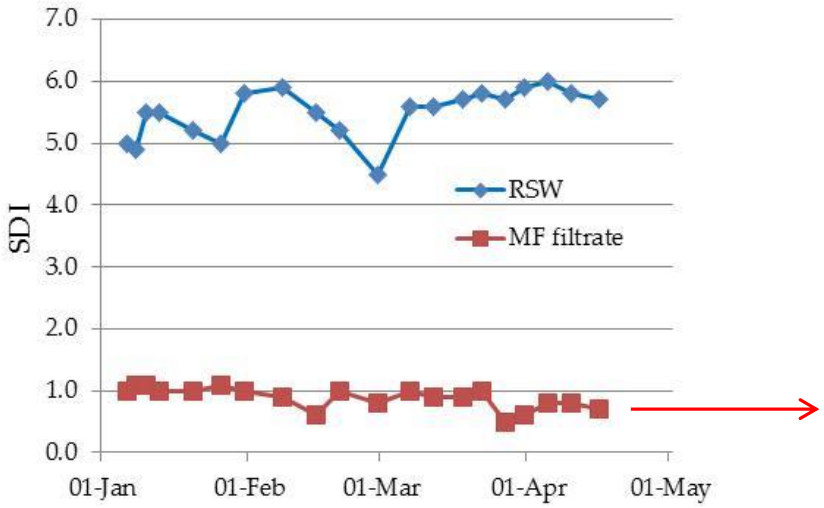
Normal / Fractured

Matrix

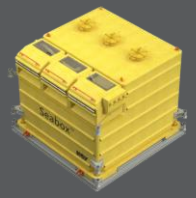
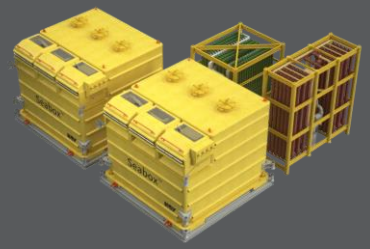
Low Sulphate / Low Salinity

Membrane Lifetime

Findings from JIP Phase IV



SWIT™ system roadmap

			
	IOR		**EOR**
	Seabox™	**Seabox™ + Micro Filtration (MF)**	**Seabox ™ + MF + RO or Nano membranes**
Flooding Regime	Water Flooding	Matrix Flooding	Low Salinity Low Sulfate
Technology	Electrochlorination Solids Settlement HRG treatment	Micro Filtration (MF)	Reverse Osmosis (RO)
Sediment Size (µm)	≤ 24	≤ 0,1	NA

SWIT™ system

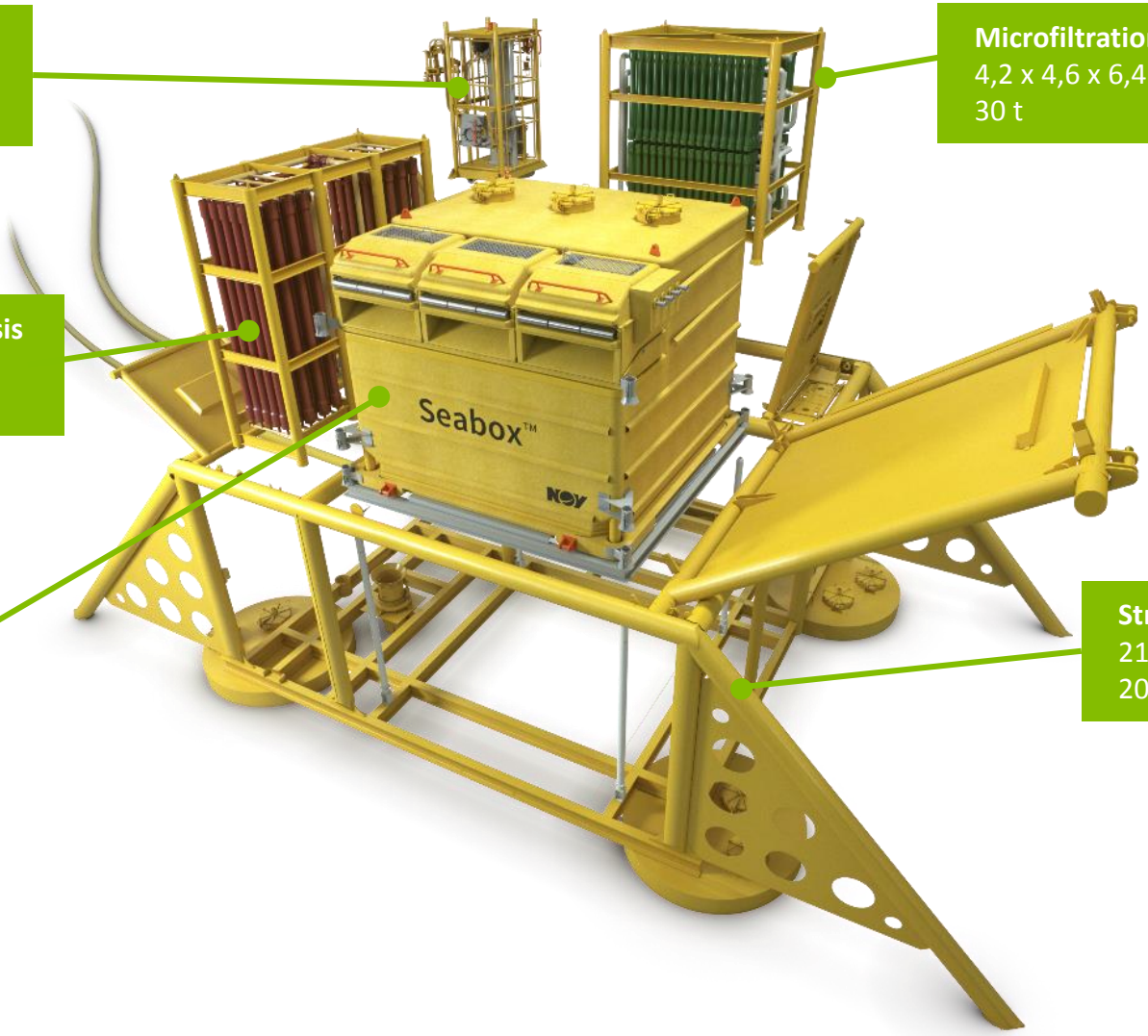
Membrane feed pump
2,0 x 2,5 x 6,0 (m)
20 t

Microfiltration
4,2 x 4,6 x 6,4 (m)
30 t

Nano- / Reverse Osmosis
2,8 x 5,3 x 7,8 (m)
20 t

Seabox
8 x 8 x 7 (m)
47 t

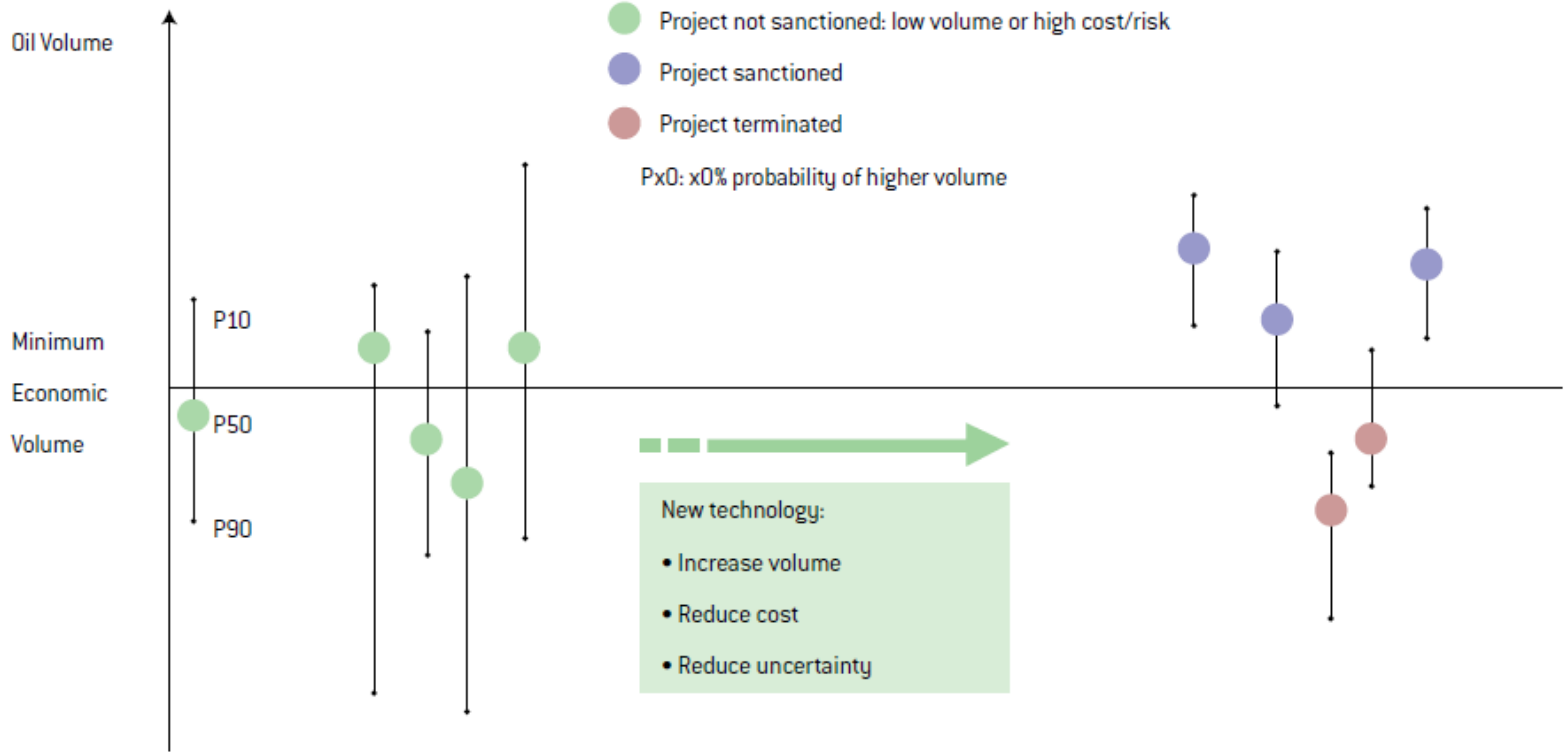
Structure
21 x 21 x 10 (m)
200 t



20,000 bpd low salinity / sulfate free solution

Optimize recovery and reduce uncertainty

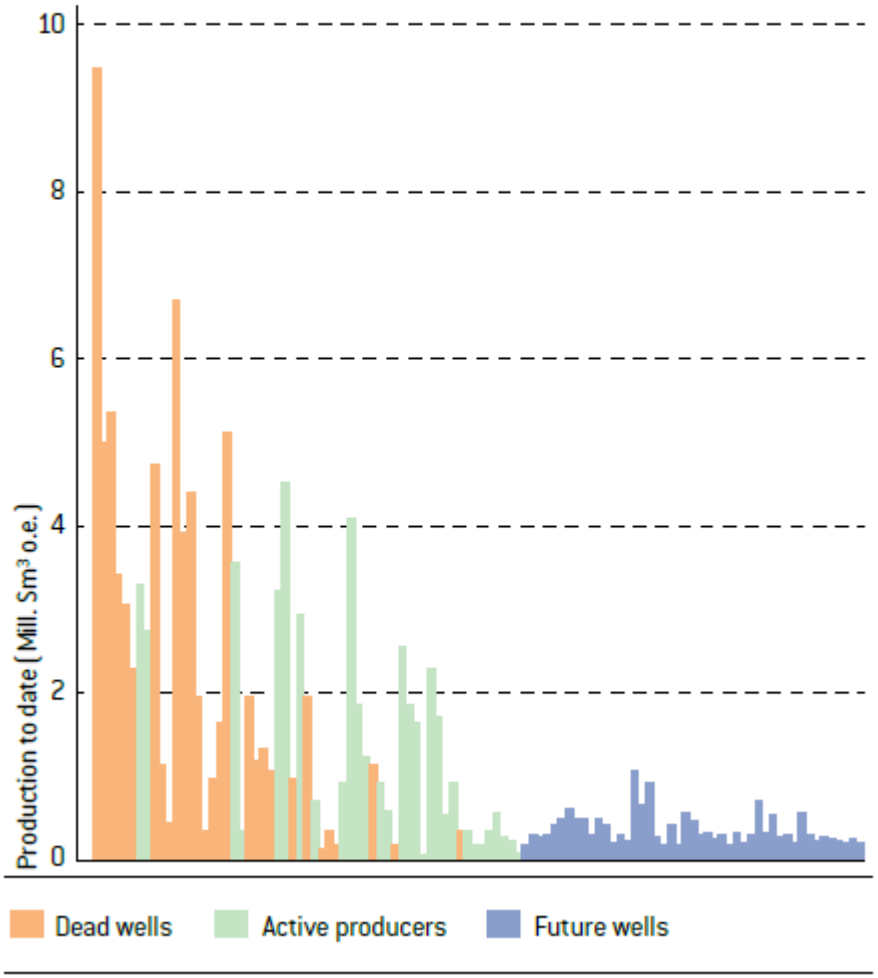
FIG 4.10: NEW IOR TECHNOLOGY TYPICALLY OPTIMIZES OIL AND GAS VOLUMES OR REDUCES THE UNCERTAINTY OF THE VOLUME ESTIMATE, BOTH ARE CENTRAL IN DECISION MAKING.



Source: OG21 – National technology strategy for the 21th century

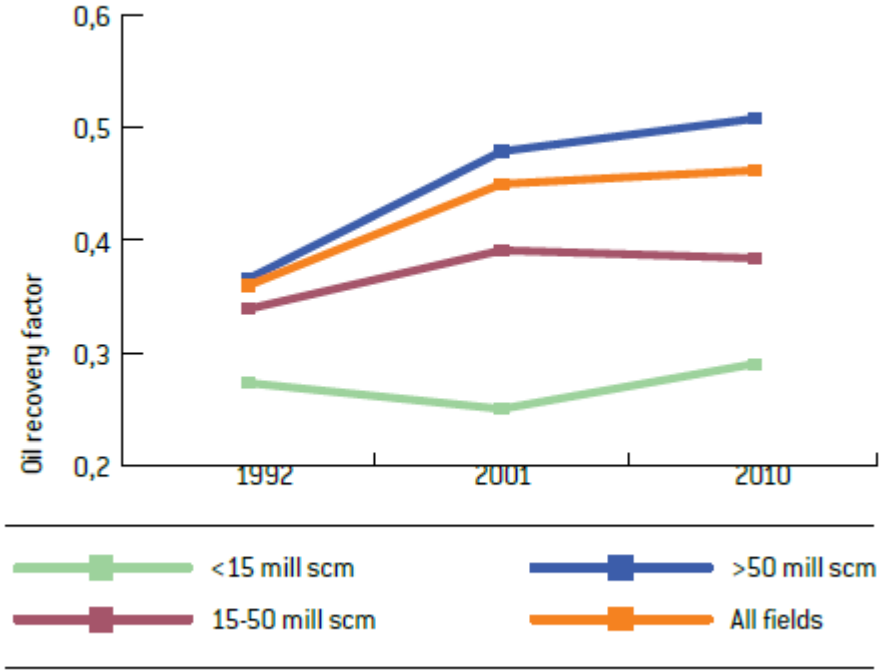
Smaller volumes per reservoir and well

FIG 4: THE RESERVES CAPTURED PER WELL IS FORECAST TO SIGNIFICANTLY DECREASE



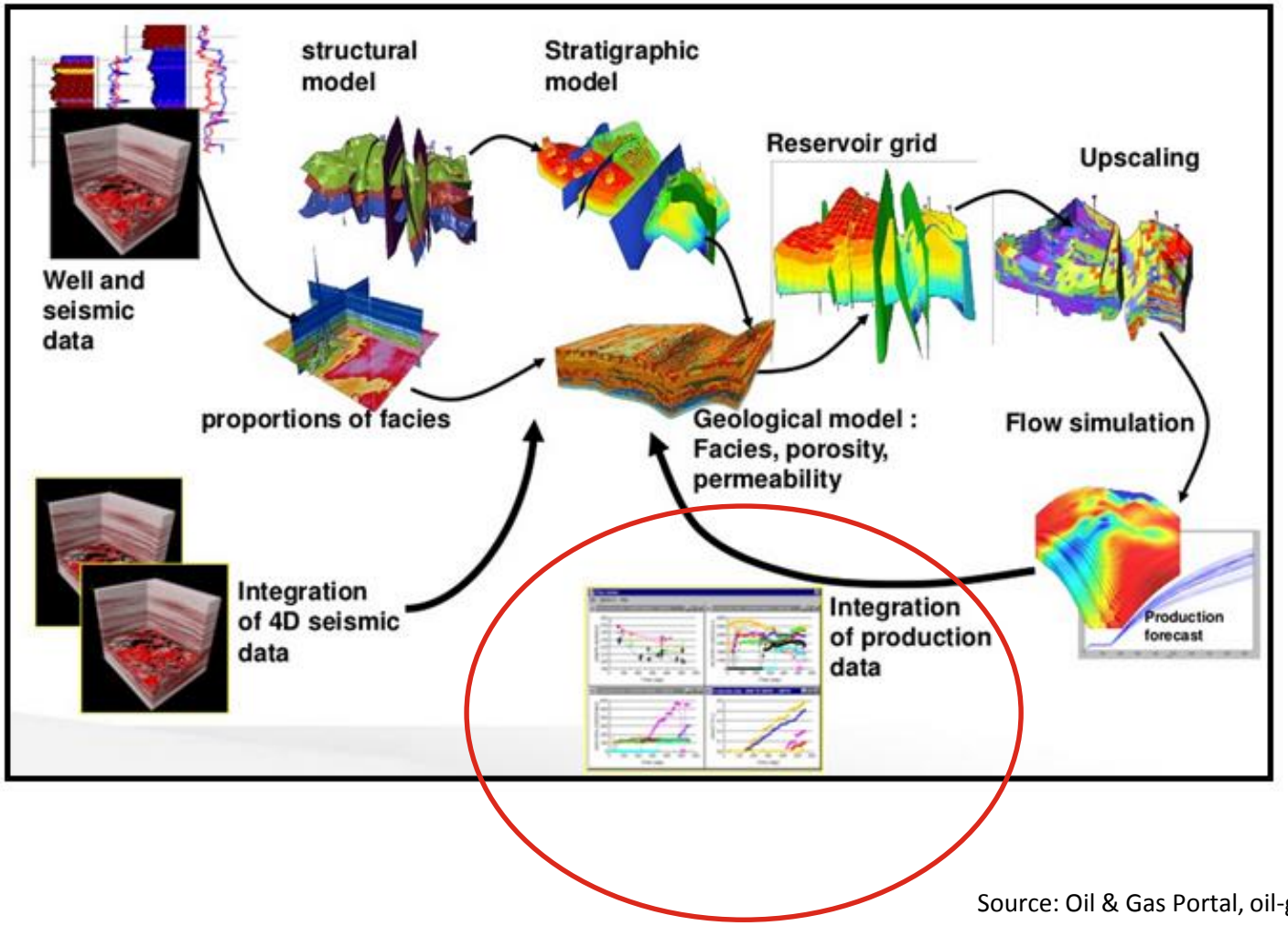
Source: Statoil

FIG 13: HISTORICAL ESTIMATES OF RECOVERY FACTOR FOR NCS FIELDS (NPD)



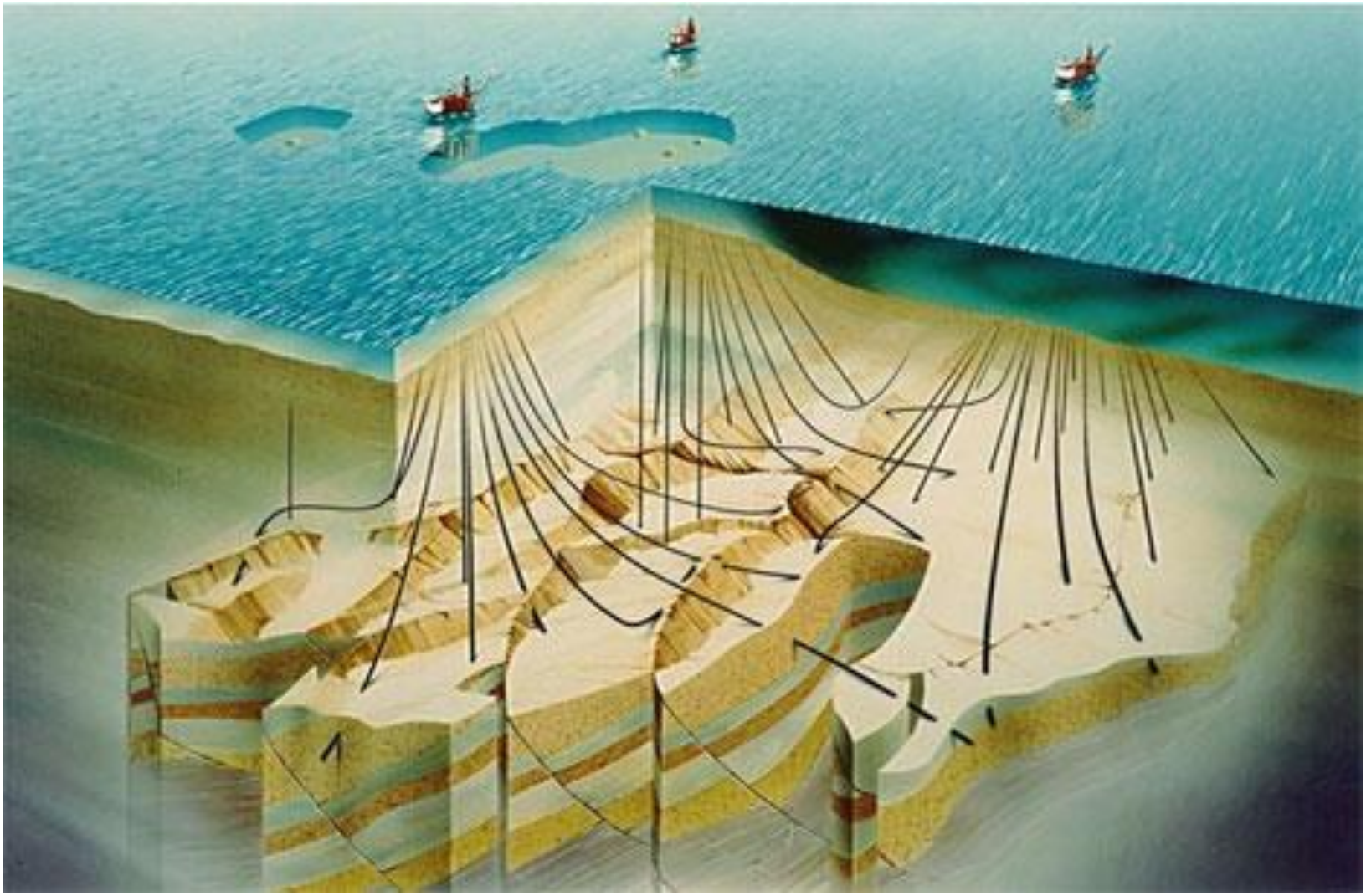
Source: Norwegian Petroleum Directorate.

Importance of Dynamic data – and Flexibility



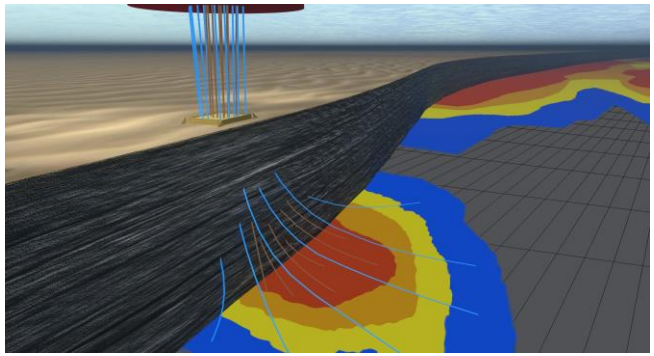
Source: Oil & Gas Portal, oil-gasportal.com

Example: Gullfaks (and Tampen area)



Source: Statoil

Seabox™ and SWIT™ benefits

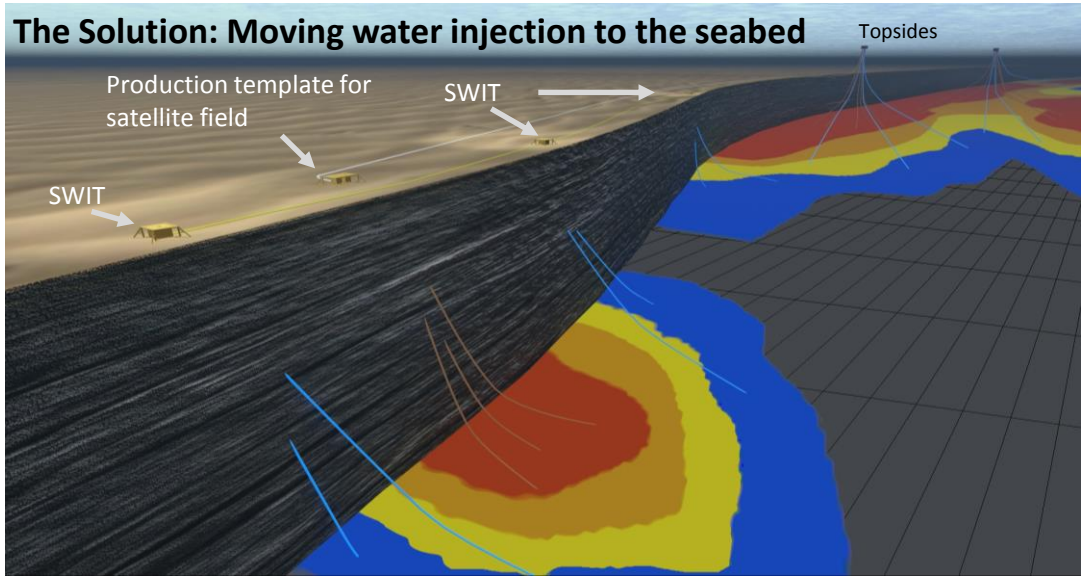


Restrictions and limitations with topside solutions

- Restriction in number of available well slots
- Restriction in drilling reach from the topside
- Difficulty in achieving optimal flood regime
- Limited weight and space capacity topside

Seabox and SWIT benefits

- Seabox and SWIT provide all required treatment and WI capacities on the seabed
- Flexibility with Seabox and SWIT allows for optimization of sweep and recovery of main field
- Seabox and SWIT simplify process and reduce overall capex and opex related to new WI capacity
- Stand alone from topside and distributed approach allow for increased reach, added flexibility and deferred investment



SWIT™ technology – Value Proposition

Operational & Economical Benefits Compared to Topside WI Solution

HSE

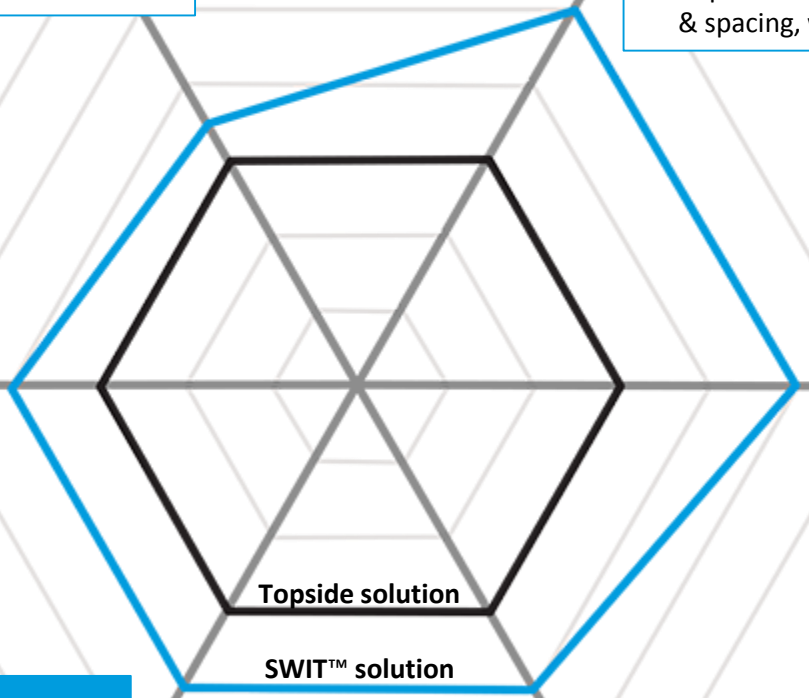
- 15-20% less power / emissions
- No liquid chemicals use or handling
- No human exposure to chemicals

Recovery benefits

- Improved recovery (adaptable 'real time' drainage strategies)
- Improved sweep (well locations & spacing, water quantity)

Regularity benefits

- No rotating or moving parts
- Redundancy installed
- Favorable & more stable seabed conditions



Production benefits

- Drilling - WI wells decoupled from production wells (less time to plateau, platform rig dedicated to production)
- WI can run independently from platform shutdowns
- Less risk of souring

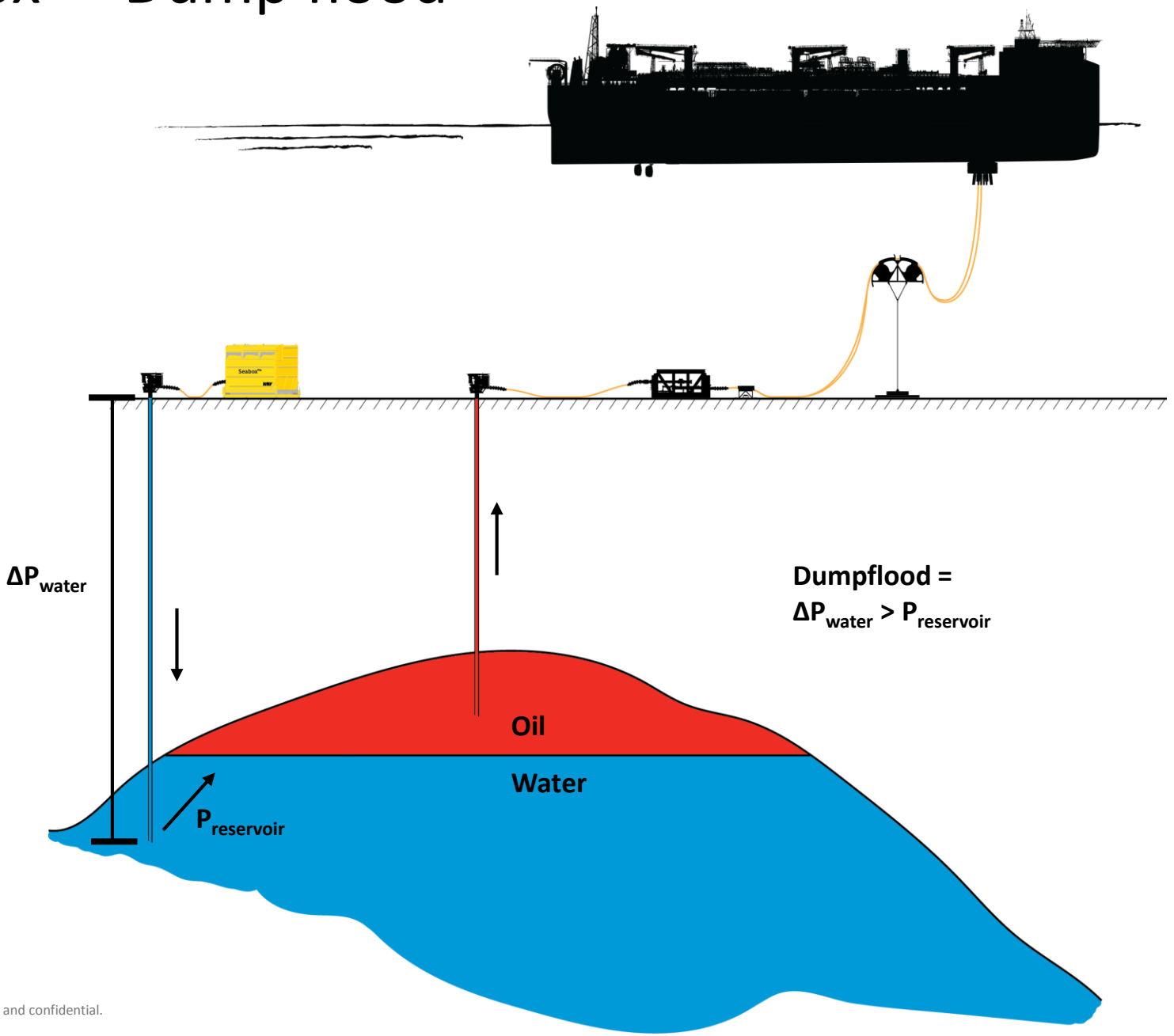
OPEX benefits

- Reduced power consumption
- Reduced offshore manning (remote operation – 5 year maint. intervals)
- Reduced chemical consumption and supply logistics

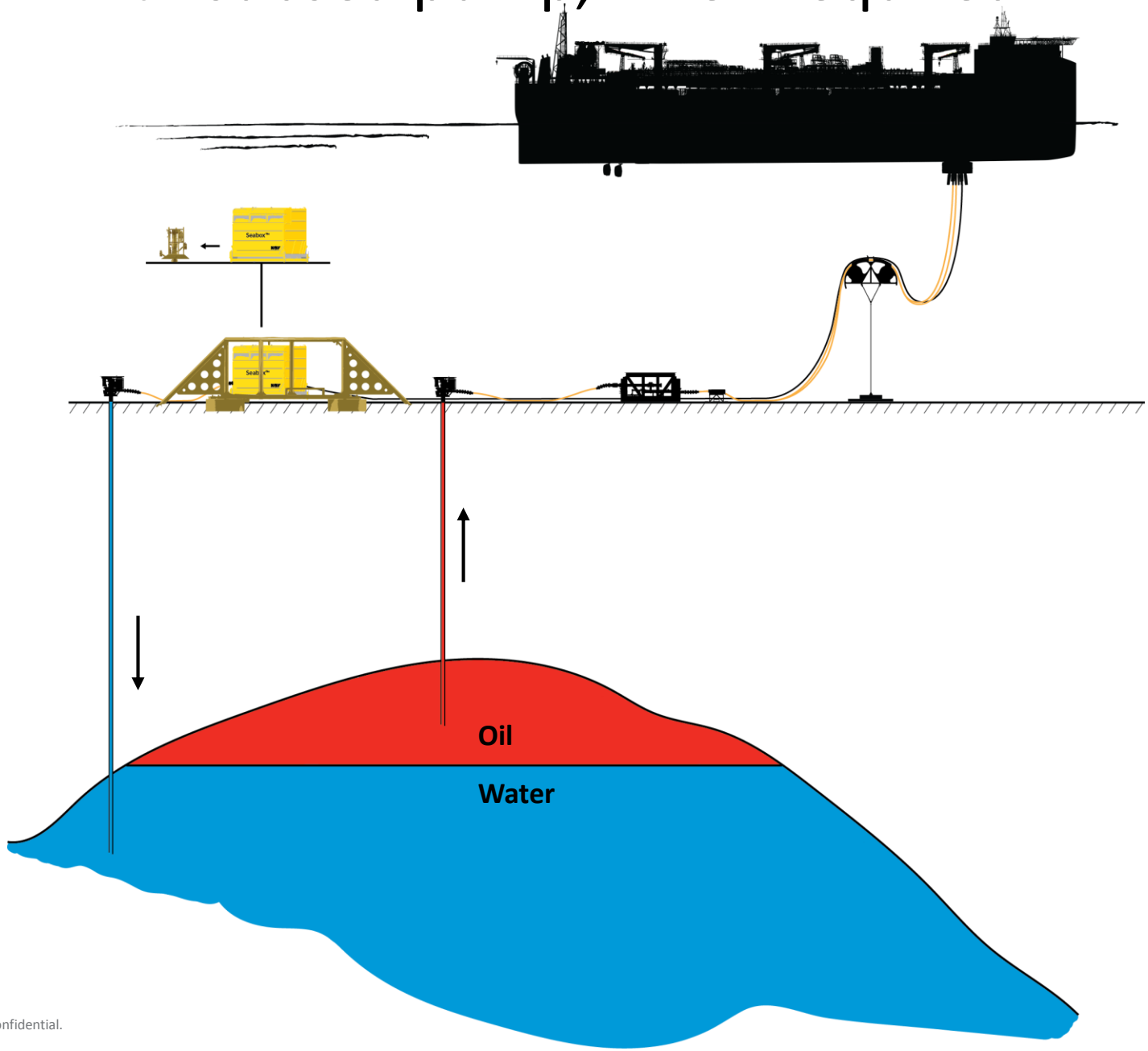
CAPEX benefits

- Reduced investments on topsides infrastructure
- Reduced cost to get water to injection zone (shorter wells, no HP pipelines)
- CAPEX deferment (WI installed as / when required) - increased NPV

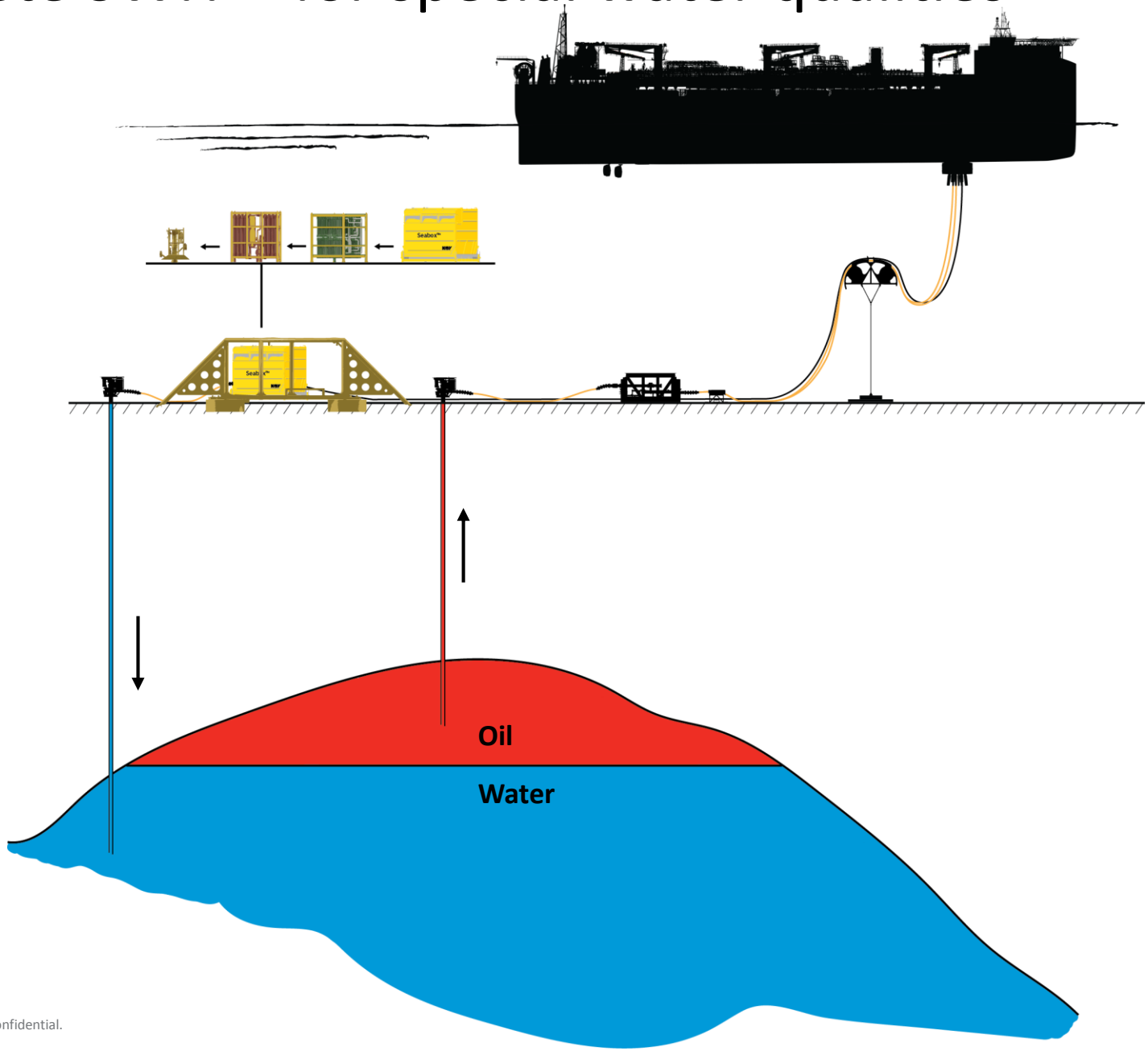
Seabox™«Dump flood»



Seabox™ with subsea pump, when required



Complete SWIT™ for special water qualities

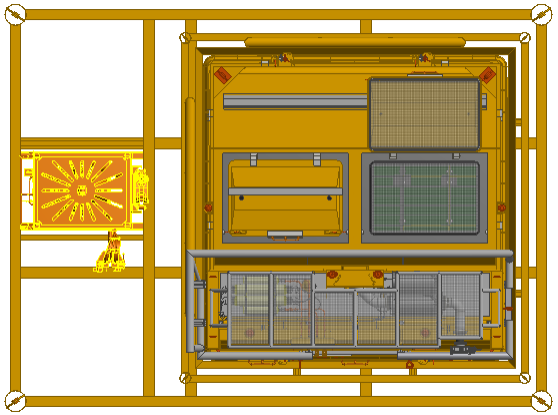


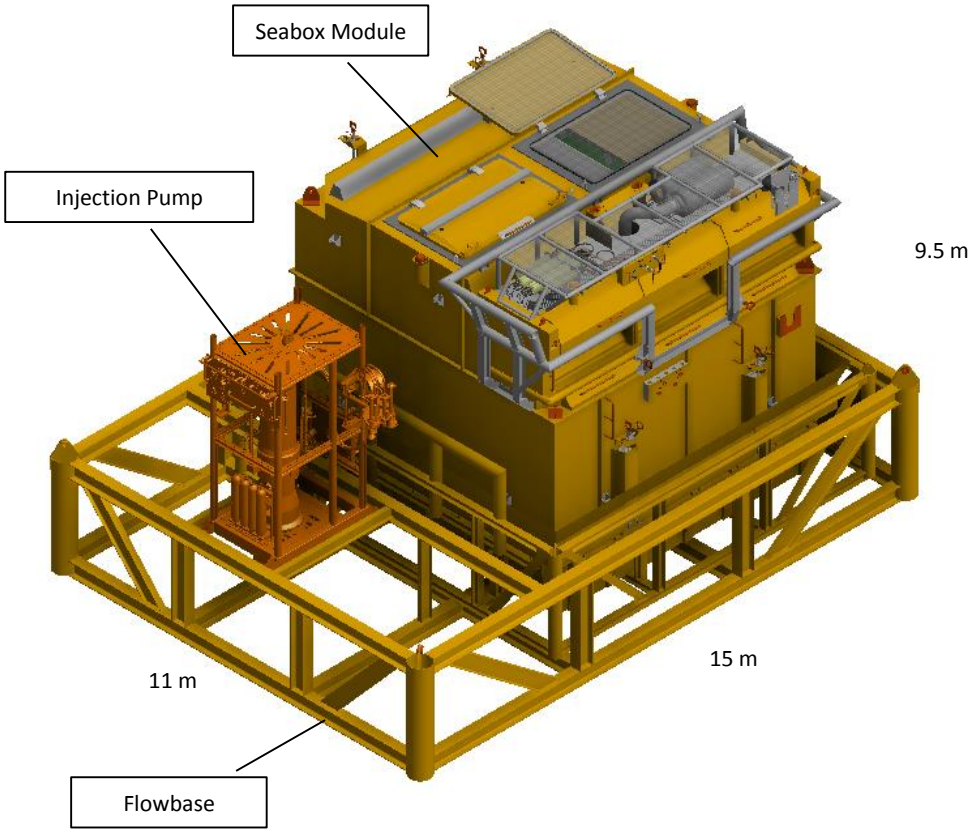
Subsea Water Treatment and Injection

SEABOX 40 + INJECTION PUMP

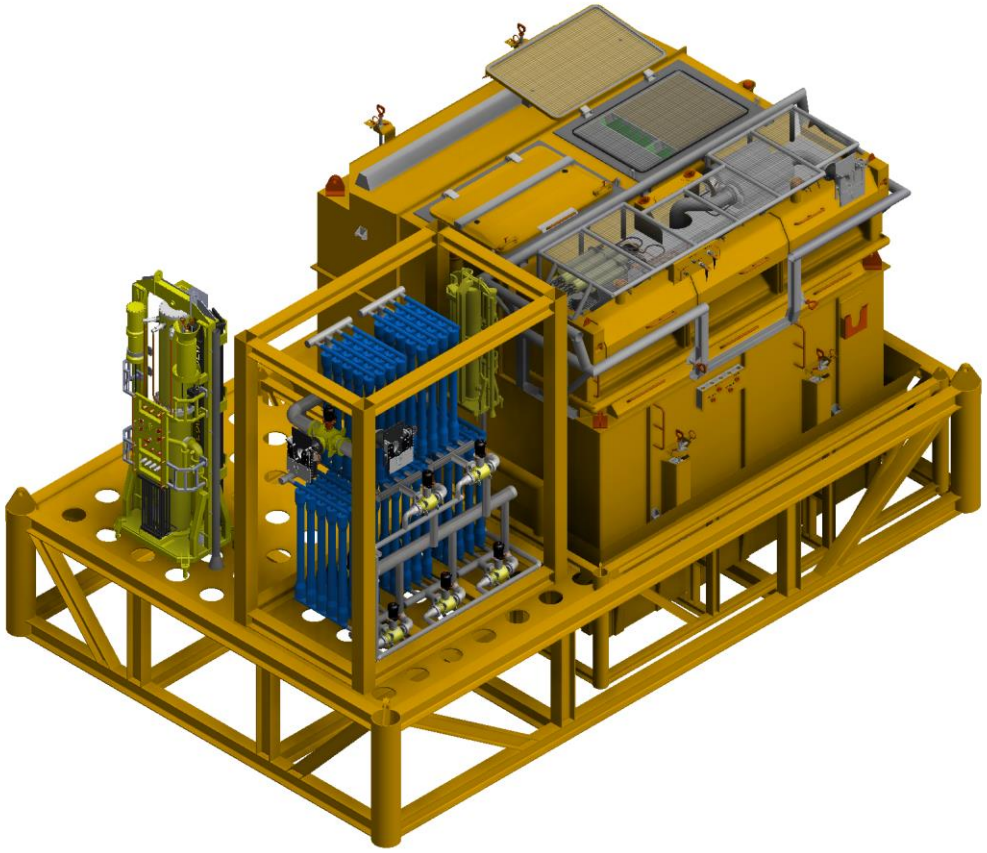
SWIT Modules installed onto the flowbase

Estimated dimensions: 15 x 11 x 9.5 m
Estimated weight in air: 140 t



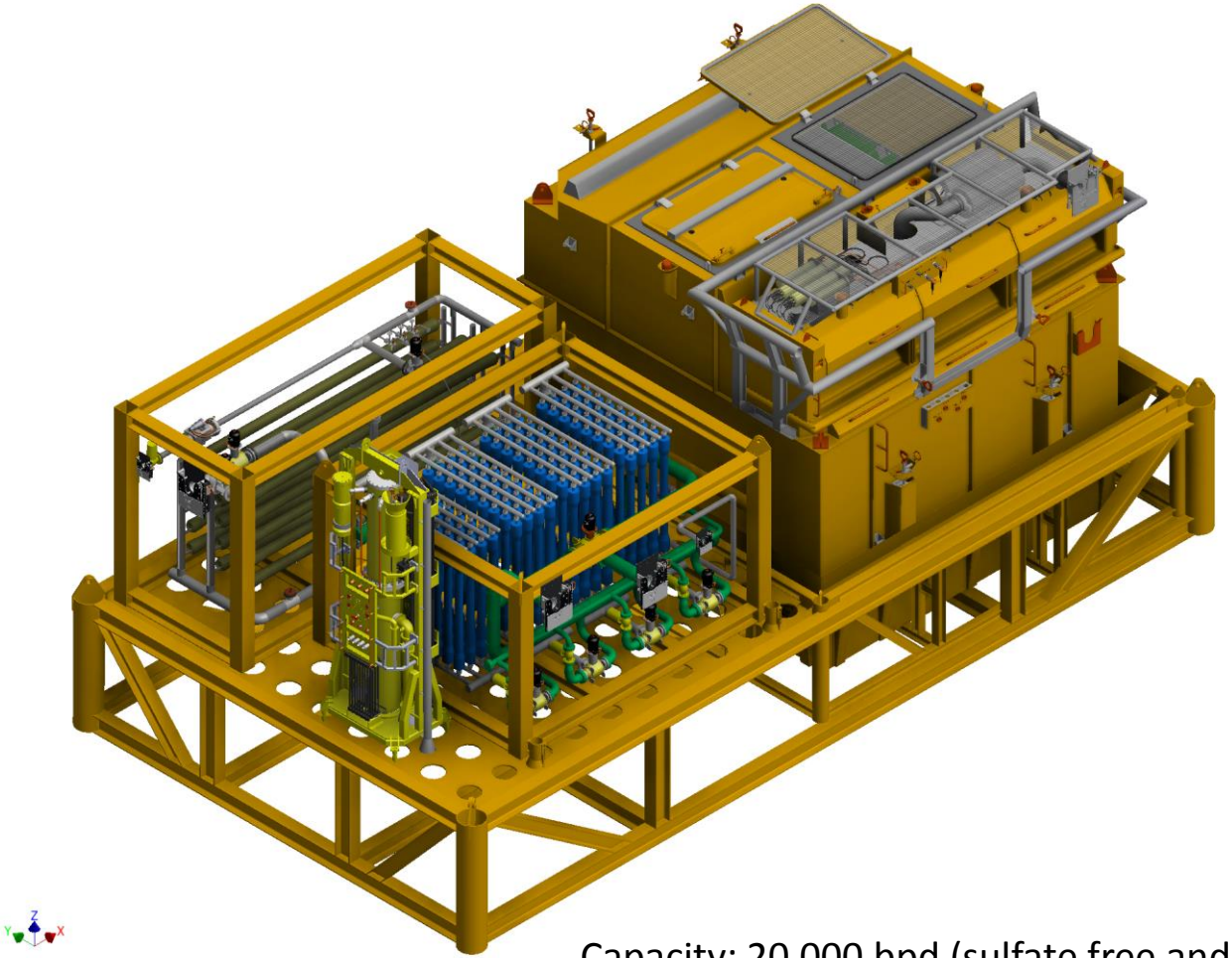


Water Treatment and Injection for Matrix Flooding



Capacity: 40 000 bpd

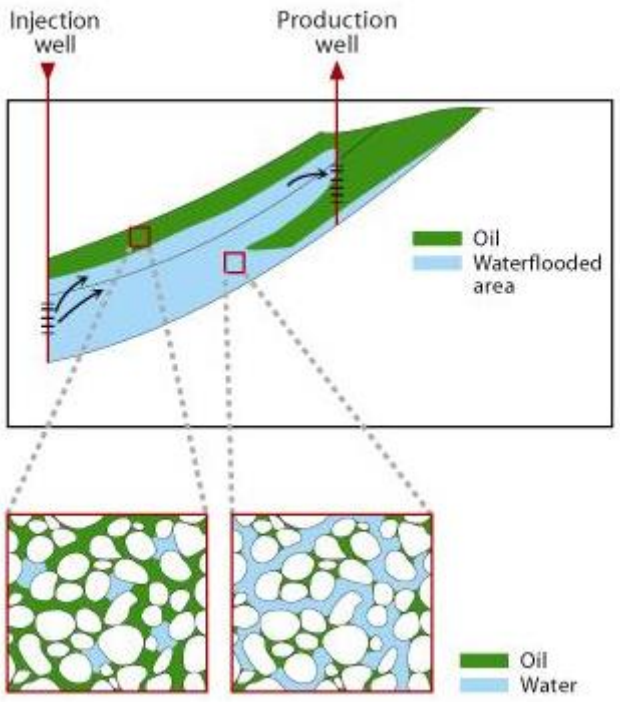
Water Treatment with Sulfate Removal and Low Salinity, and Injection

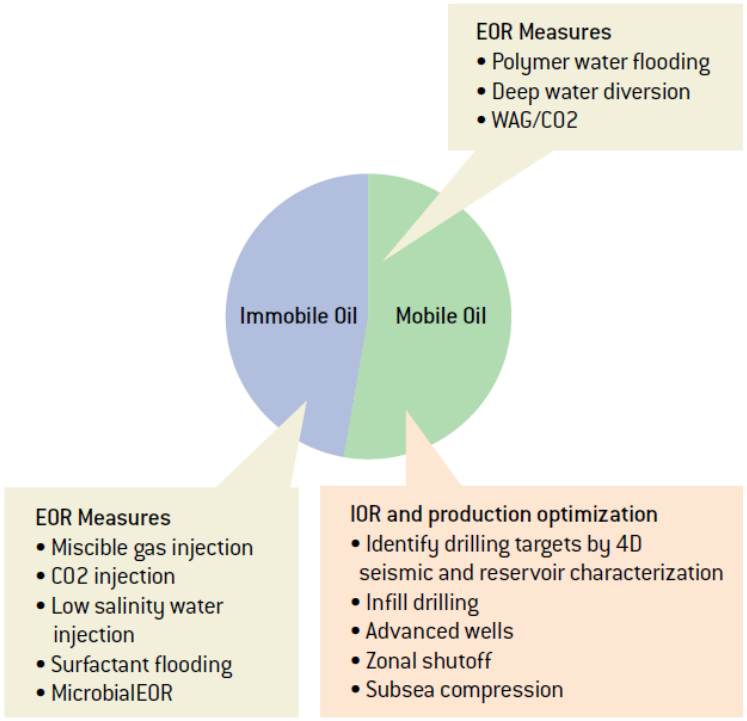


Capacity: 20 000 bpd (sulfate free and low sal water)

Everything starts with the reservoir….

Subsea Water Treatment and Injection
- *Solutions for IOR and EOR*





Source: Ministry of Petroleum and Energy

Summary

- Seabox™ and SWIT™ allow for new ways to develop fields and improve existing, to reduce cost and emissions and to improve recovery
- The stand alone and distributed solution provides complete flexibility – allowing improved reservoir management and reduced total risk
- Simplification and superior water quality give high reliability
- Full range of systems and capabilities currently under construction
- Available now with 12 months delivery time