



Technical challenges for floating energy systems in the North Sea

Jan van Kessel

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Shell’s Net Carbon Intensity

Also, in this presentation we may refer to Shell’s “Net Carbon Intensity” (NCI), which includes Shell’s carbon emissions from the production of our energy products, our suppliers’ carbon emissions in supplying energy for that production and our customers’ carbon emissions associated with their use of the energy products we sell. Shell’s NCI also includes the emissions associated with the production and use of energy products produced by others which Shell purchases for resale. Shell only controls its own emissions. The use of the terms Shell’s “Net Carbon Intensity” or NCI are for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell’s net-zero emissions target

Shell’s operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and NCI targets over the next ten years. However, Shell’s operating plans cannot reflect our 2050 net-zero emissions target, as this target is currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell’s operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Forward-Looking non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as cash capital expenditure and divestments. We are unable to provide a reconciliation of these forward-looking non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc’s consolidated financial statements.

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Floating Energy Research Forum

Jan van Kessel
Offshore Structures Engineer





Penguins FPSO



Penguins Overview

- Penguins field was producing via a 65 km tie-back to Brent Charlie until 2021. It is 50/50 owned by Shell and NEO, operated by Shell UK.
- Brent field depletion triggered start of decommissioning, Brent Charlie was last to stop production in 2021.
- This triggered the Penguins Redevelopment Project: Sevan cylindrical FPSO, re-use of existing subsea infrastructure, but also new wells and new subsea infrastructure.
- 20 years design life for new facilities.
- Multiphase pipeline to Brent Charlie was converted into Gas-Export line with bypass around Brent Charlie, running to St. Fergus onshore.
- Crude will be stored on board the FPSO and offloaded to shuttle tankers.



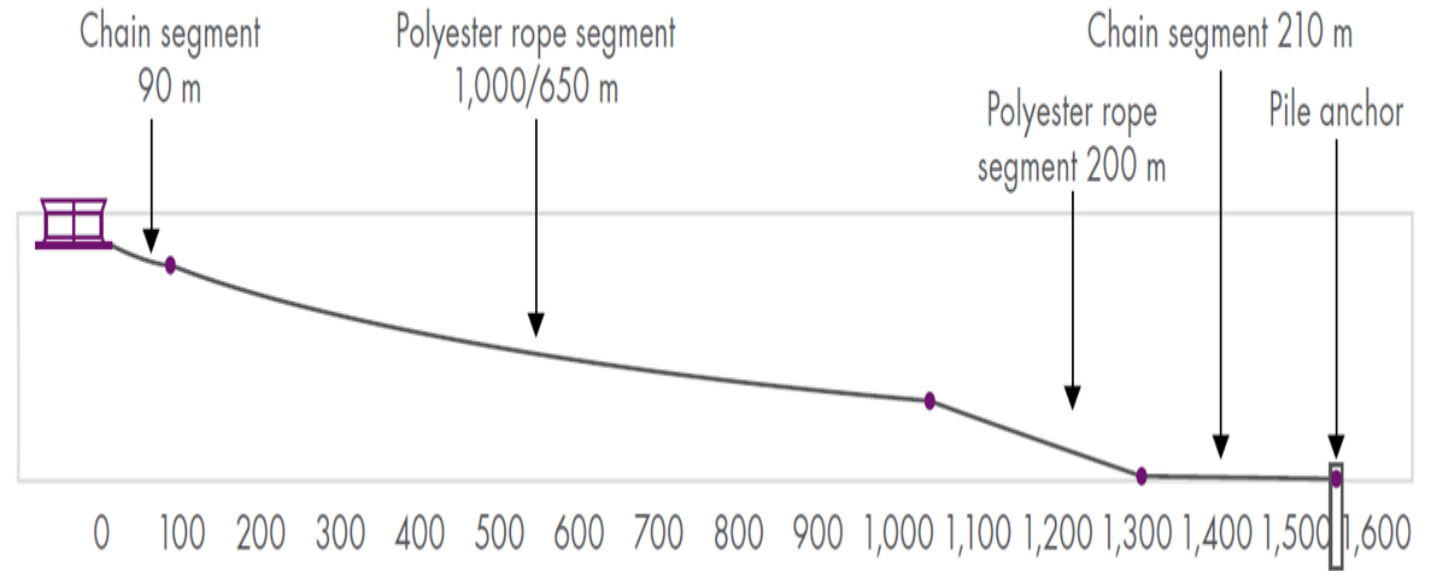


Technical Challenges

- How to reduce the costs, size and impact of the offloading system?
- How to replace hose sections without deck space?
- How to reduce impact of a high bulwark on a small FPSO?



Mooring system



- 1500 kN pre-tension in ballast condition
- Shallow water limiting the use of subsea mooring line tensioners.
- Tensioning of mooring lines with on-deck chainstoppers, winches & HPU

Mooring Line Buoyancy Modules

- Large buoys used to lift polyester from the seabed
- Complicates installation of mooring lines
- Motions of the buoy enhance chain fatigue
- Buoyancy on the ropes was not an option at the time due to low TRL





Floating Wind

Tetraspar Floating Wind
Demonstrator



M a k a n i



T e t r a s p a r



Fabrication of floating wind structures (Tetraspar)



Assembly of floating wind structures (Tetraspar)



WTG installation (Tetraspar)



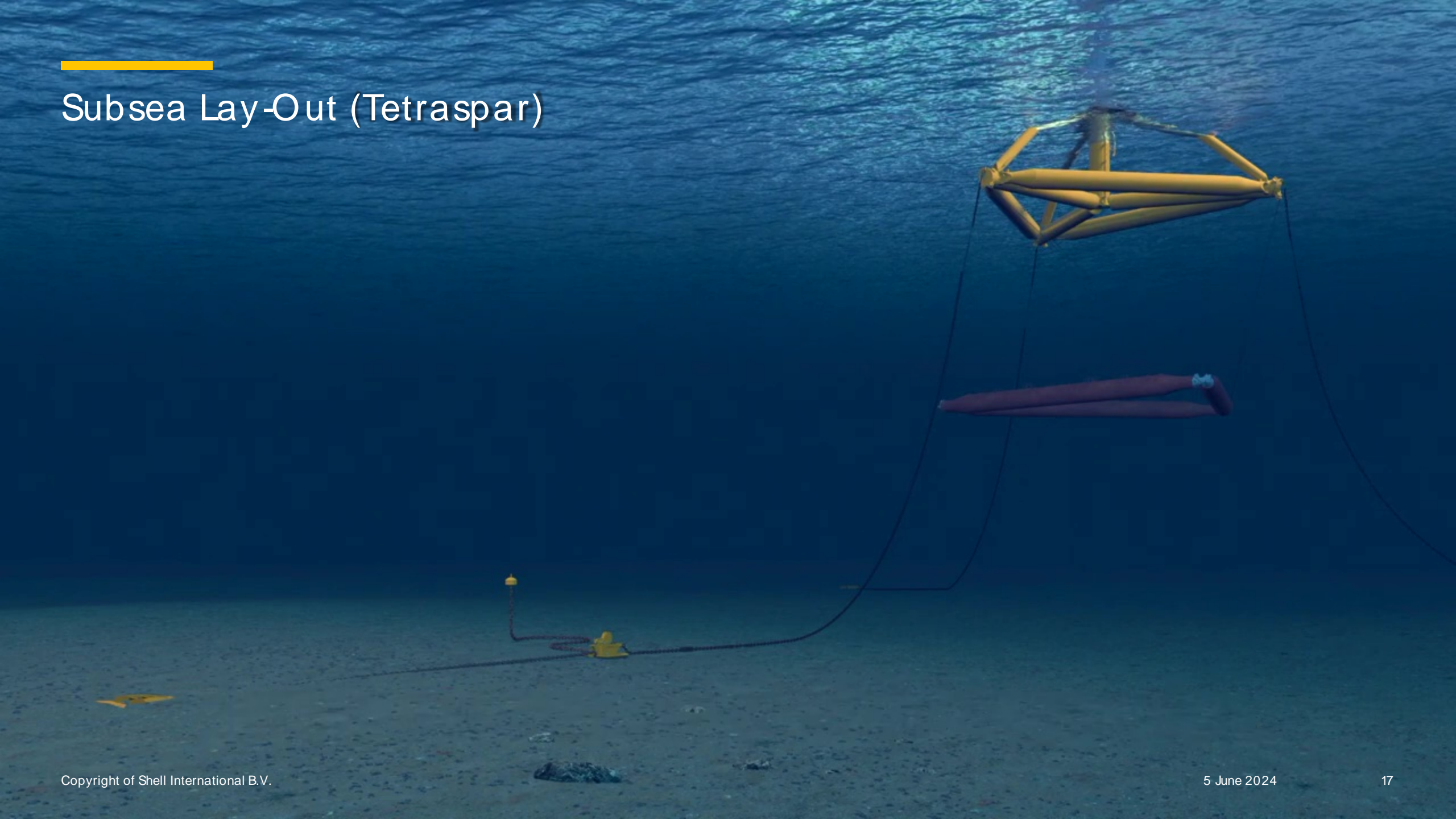
Tow (Tetraspar)



Mooring hook-up (Tetraspar)



Subsea Lay-Out (Tetraspar)



A large offshore wind turbine, the TetraSpar Demonstrator, is silhouetted against a dramatic sunset sky. The sun is low on the horizon, creating a bright glow and reflecting on the dark blue ocean. The sky is filled with scattered clouds, and a small, bright light source is visible in the upper right. The turbine's three blades are spread out, and its central tower and floating foundation are clearly visible.

TetraSpar Demonstrator

World's first full-scale industrialized floating wind foundation



Floating Solar



HKN (Crosswind) Offshore Wind Farm

- CrossWind is a joint-venture between Shell and Eneco
- CrossWind, TNO & Oceans of Energy will design, install and operate the world's first offshore floating solar plant at 0.5MW that will be placed alongside the wind turbines.
- It will help generate additional power when the sun shines, alongside the power production from the wind turbines.
- Besides increasing the power output per km², the combination with floating solar panels also increases the utilization of the grid connection.

The wind park



Total Capacity 759MW
3.3 TWh per year



Effective area 92km²
in 5 sections



Floating Solar in the North Sea

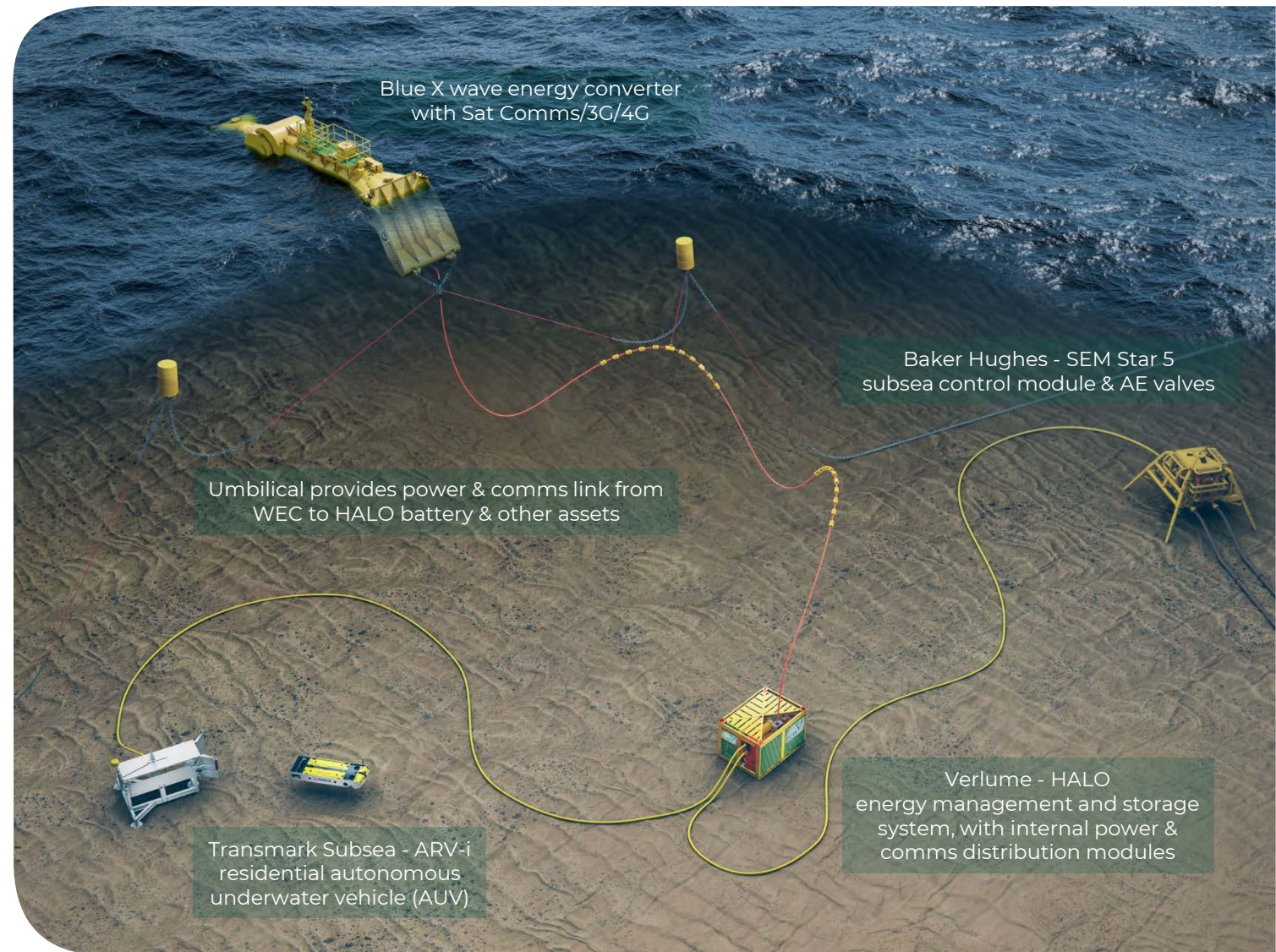
- Several pilots planned in the North Sea
- Ambition of Dutch government: 3 GW in 2030
- Challenges:
 - EPCI
 - Operation & Maintenance
 - Power production & LCOE
 - Ecology & Societal acceptance





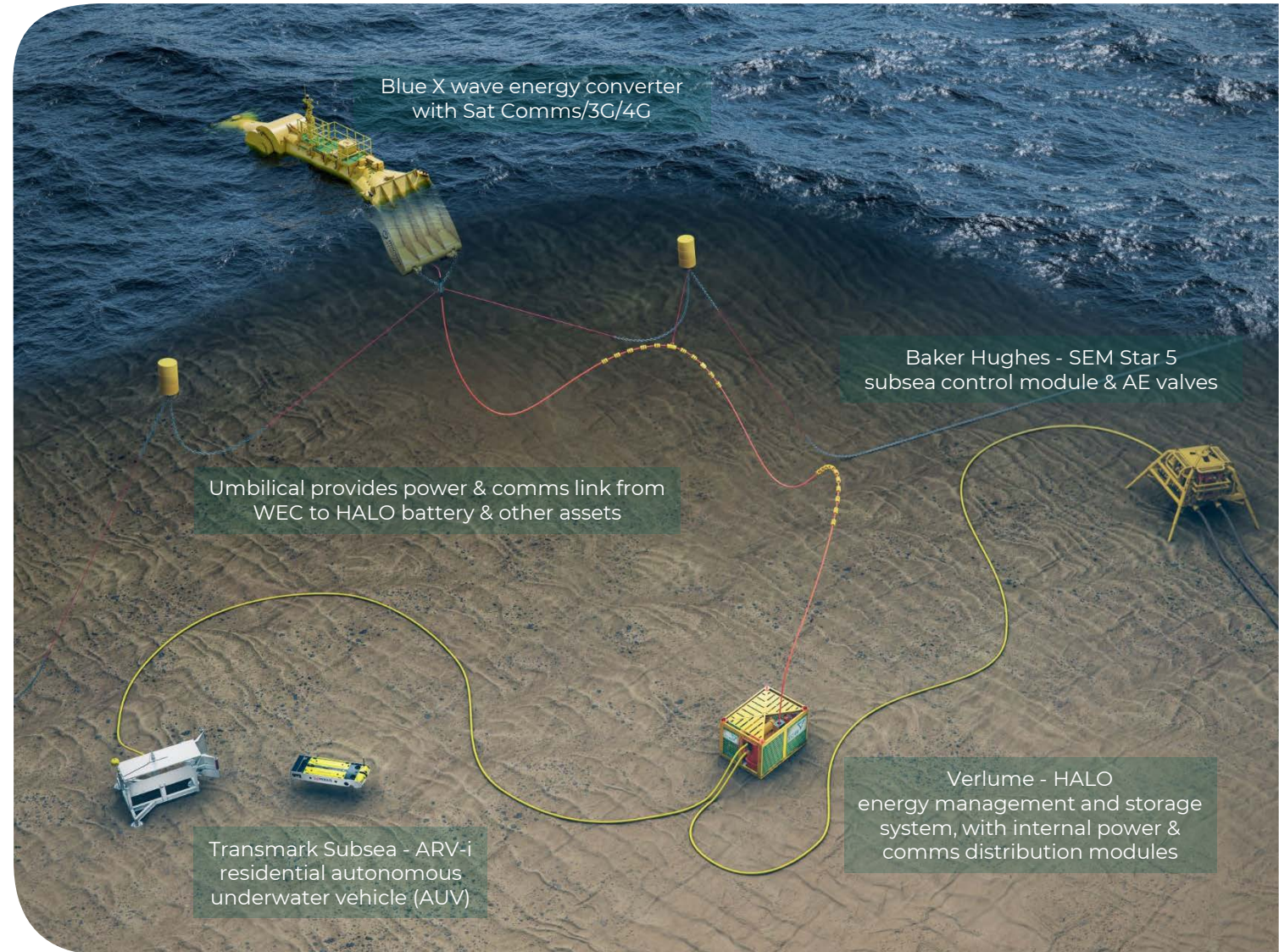
Orkney

Wave power for Subsea Equipment



Orkney - Wave power for Subsea

- Full-scale system
- Remote comms, control & monitoring
- Operational in February 2023 – March 2024
- Objectives:
 - Boost industry confidence
 - Provide lessons on power production, communication system uptime, survivability, reliability
 - Understand O & M





Thank you

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