CNS ELECTRIFICATION

A radically different off-grid concept with much lower costs

ORCADIAN ENERGY

NSTA Electrification Competition

- The “£1million decarbonisation competition for the electrification of offshore oil and gas installations” was launched by the NSTA on the 23rd September 2021
- Orcadian submitted an entry offering to evaluate an off-grid concept for electrification of the Central Graben fields
  - *Chosen as there was a coherent and focussed group (CNSE) already working on more conventional electrification schemes*
  - *Timetable for delivery was by end of March 2022 which was in line with the CNSE group’s decision making schedule*
- Orcadian’s entry was selected by the NSTA and the Orcadian consortium delivered a report to the NSTA in the first week of April 2022

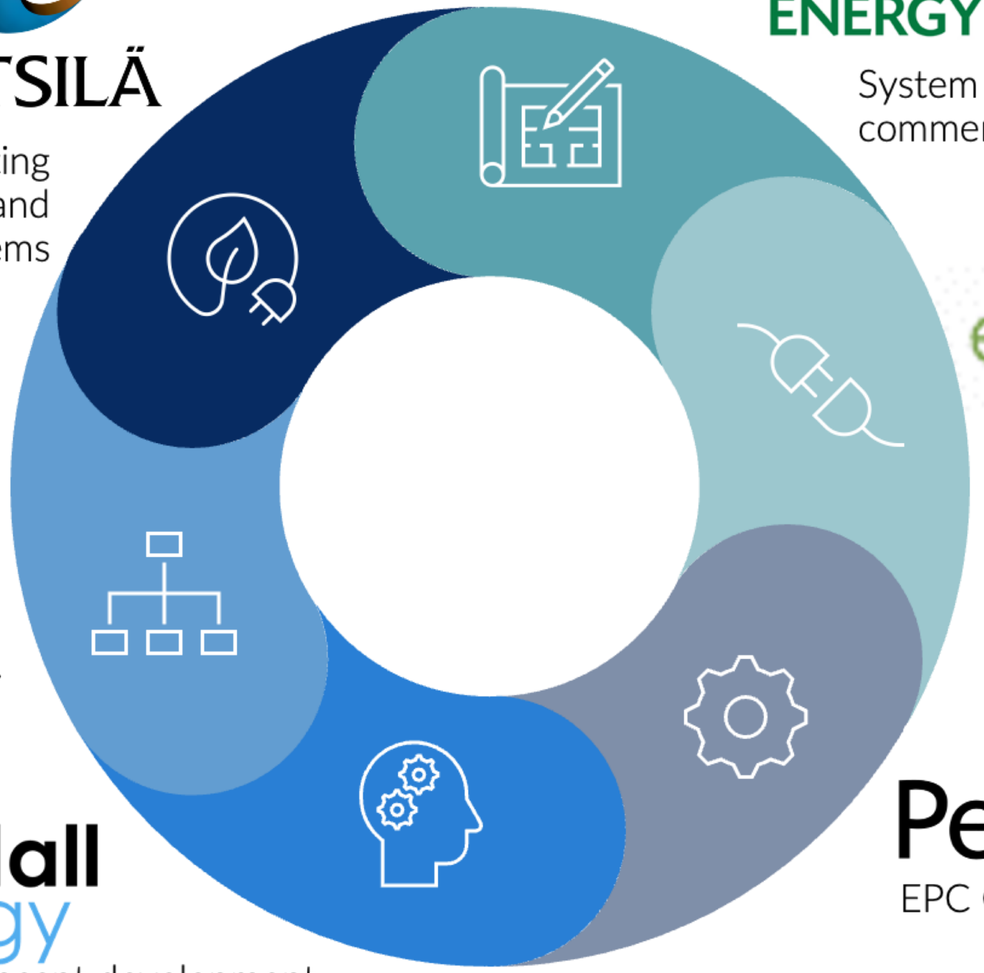
Orcadian Power Consortium

WÄRTSILÄ

Key vendor of reciprocating engines, energy storage and island grid management systems

ORCADIAN ENERGY

System operator and designer of commercial and technical concept



enertechnos

Cable Technology Provider

NSMP
NORTH SEA MIDSTREAM PARTNERS

Infrastructure investor

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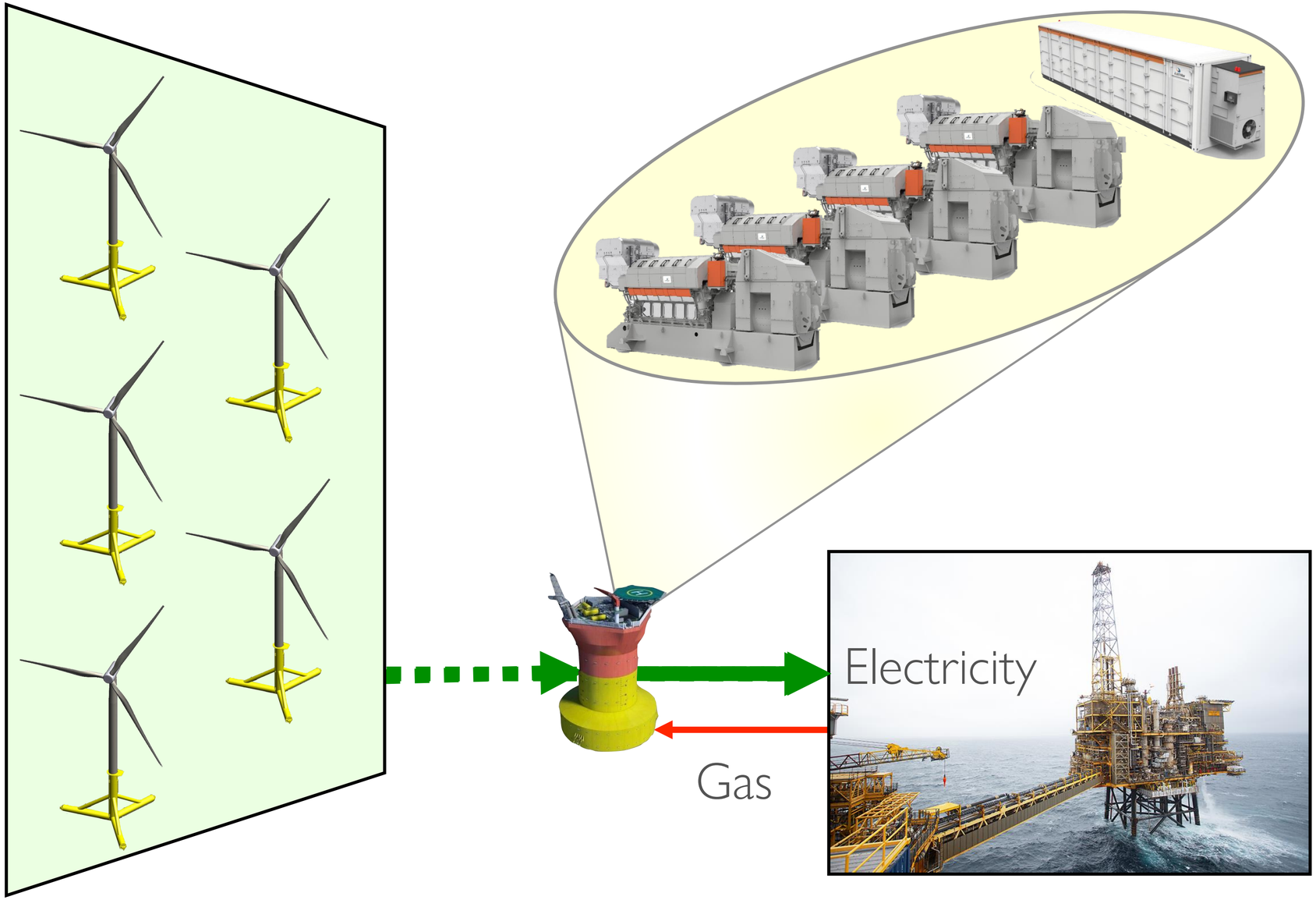
Client Engineer and concept development

Petrofac

EPC Contractor and O&M contractor

Microgrid schematic

- Local wind farms sized at c. 120% of demand
- Distribution hubs located close to platforms with electricity exported to the platforms at 33kV to minimise modifications
- Highly efficient reciprocating gas engines fuelled by gas (or in-time Net Zero fuels) for back-up
- Supported by battery storage to minimise physical “spinning reserve”
- An “Island microgrid” delivering reliable low emissions power



Wind turbines illustrated are from SBM – other wind turbines are available

Reciprocating engines – Wärtsilä 31DF

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High efficiency ~49%

➢ High efficiency from 20-100% Load Factors

Fast start up time ~45s

➢ Reduces operating reserve and size of batteries

Net zero compatible

➢ Compatible with net zero fuels; Ammonia, bio-methanol, hydrogen

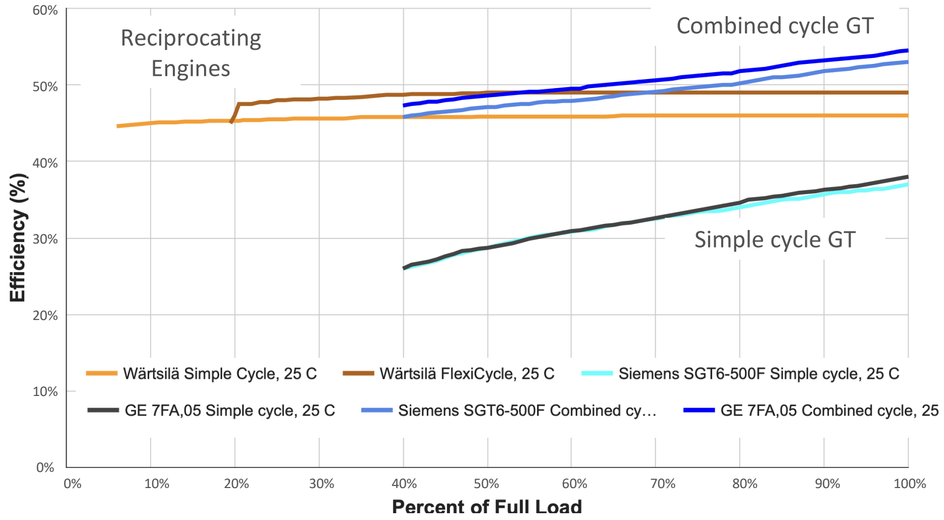
➢ Waste heat available for Carbon Capture

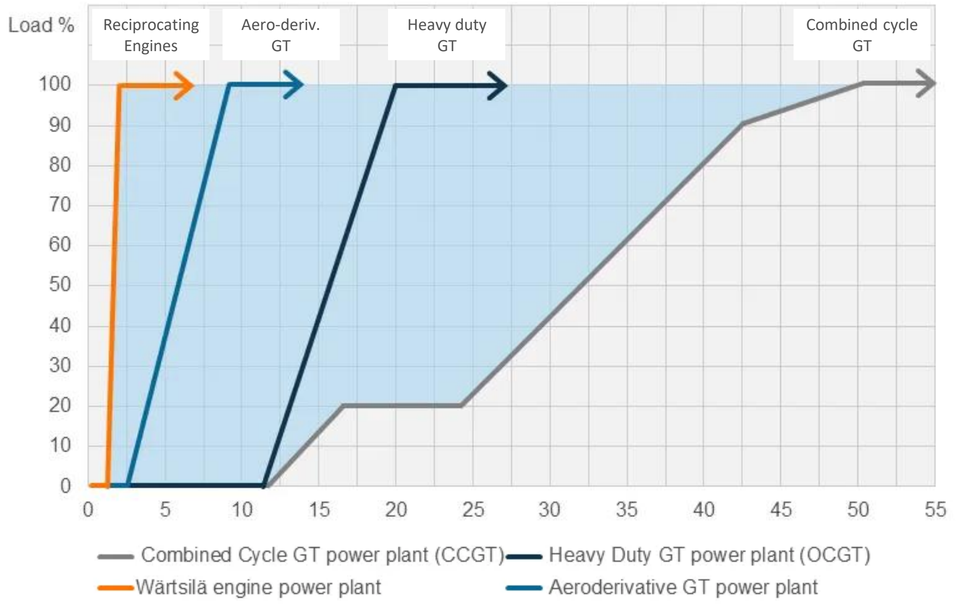
Compact – Similar footprint to offshore CCGT

Low maintenance

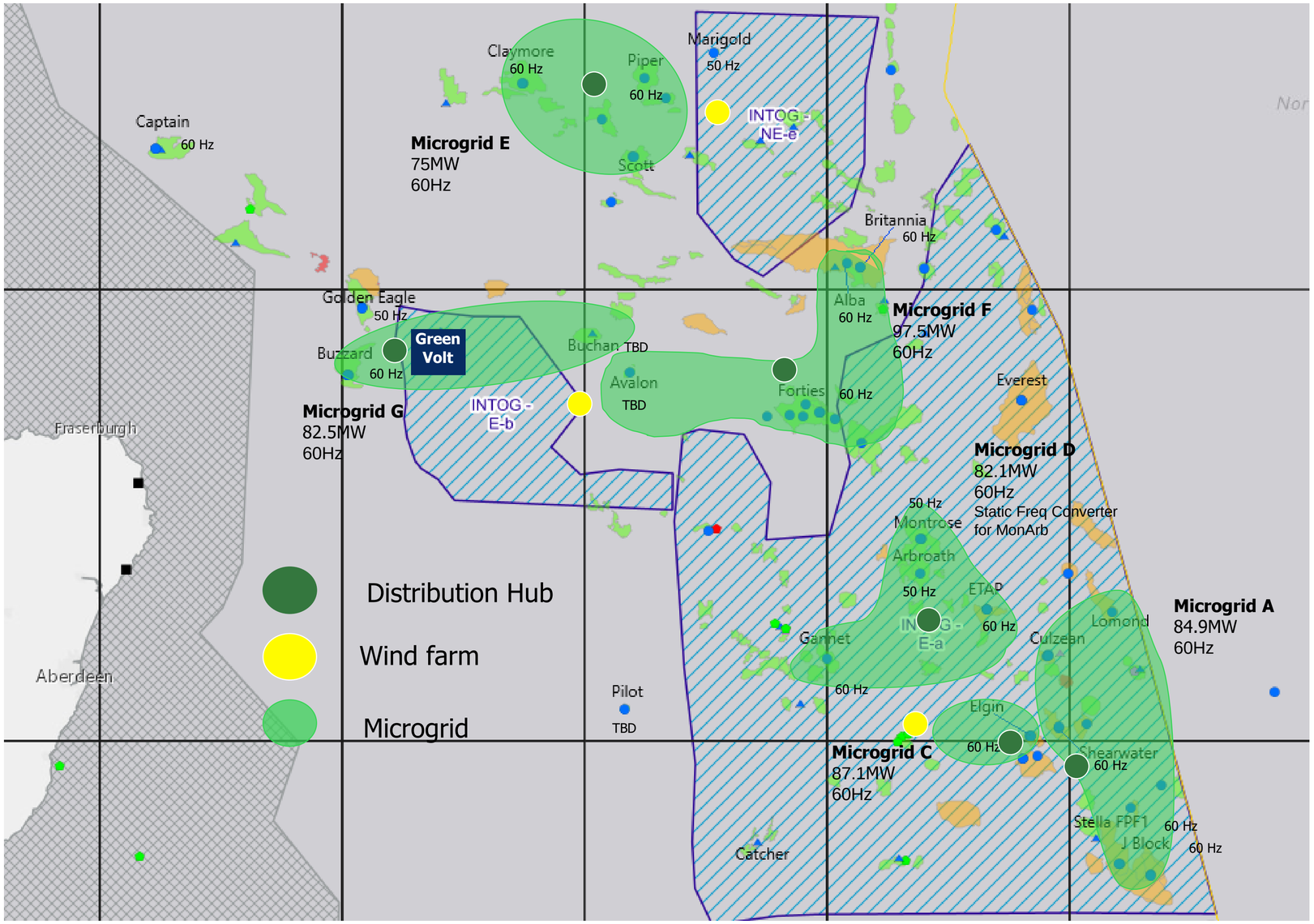
➢ Plug and play maintenance, reducing offshore maintenance hours

➢ Digitally enabled, facilitating predictive maintenance





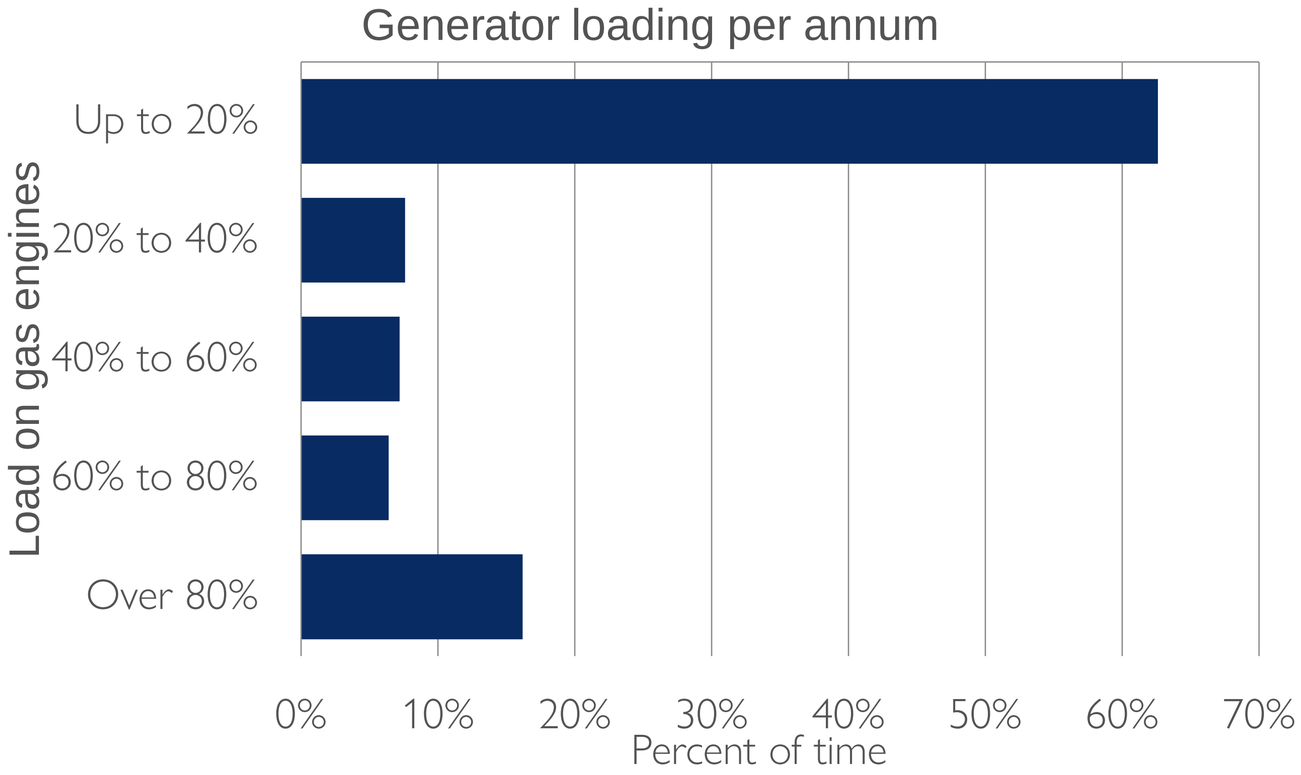
Proposed microgrids and distribution hubs

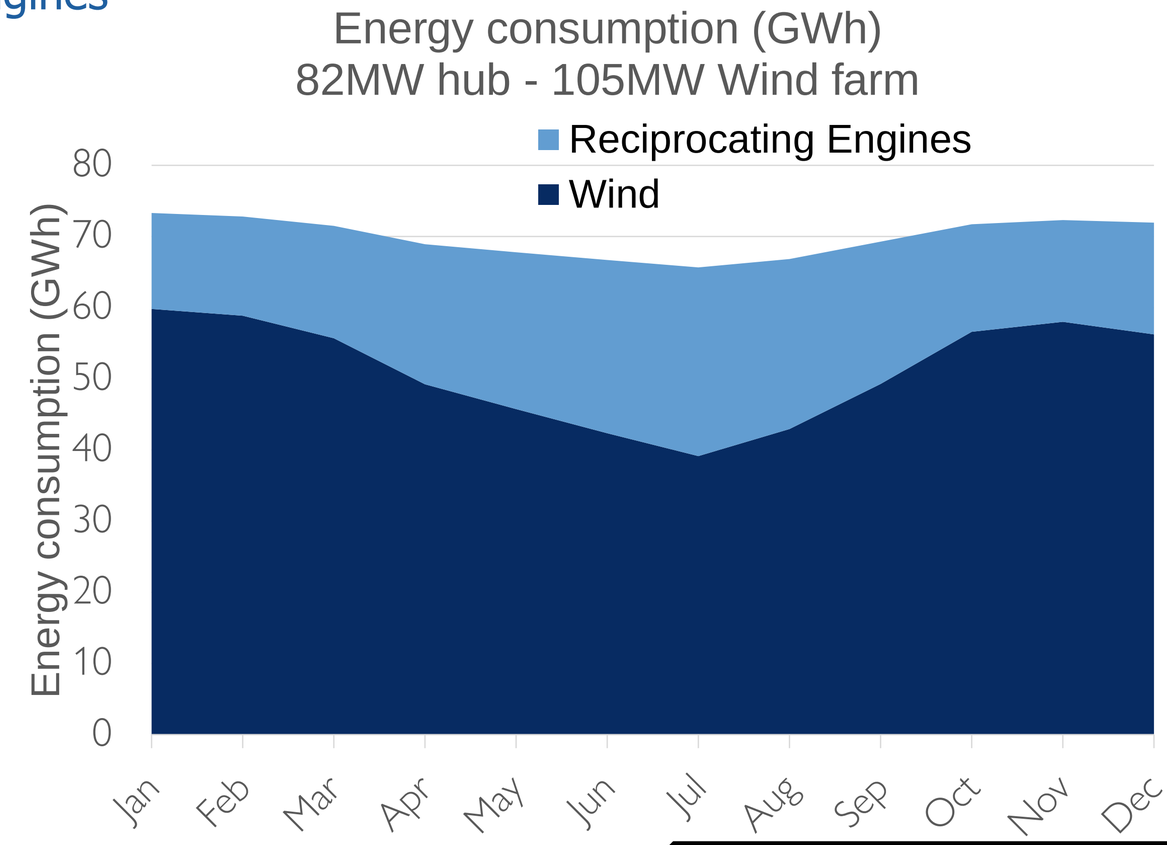


- **Main focus has been on the CNSE platforms**
- **Microgrid A: Shearwater, Culzean, Lomond, Stella**
- **Microgrid C: Elgin/Franklin**
- **Microgrid D: ETAP, Gannet, Montrose/Arbroath (50Hz)**
- **Microgrid E: Piper (incl. Marigold), Claymore, Scott**
- **Microgrid F: Forties, Alba, Britannia, Avalon**
- **Potential to integrate microgrid G, and possibly E & F with GreenVolt**

Back up generation

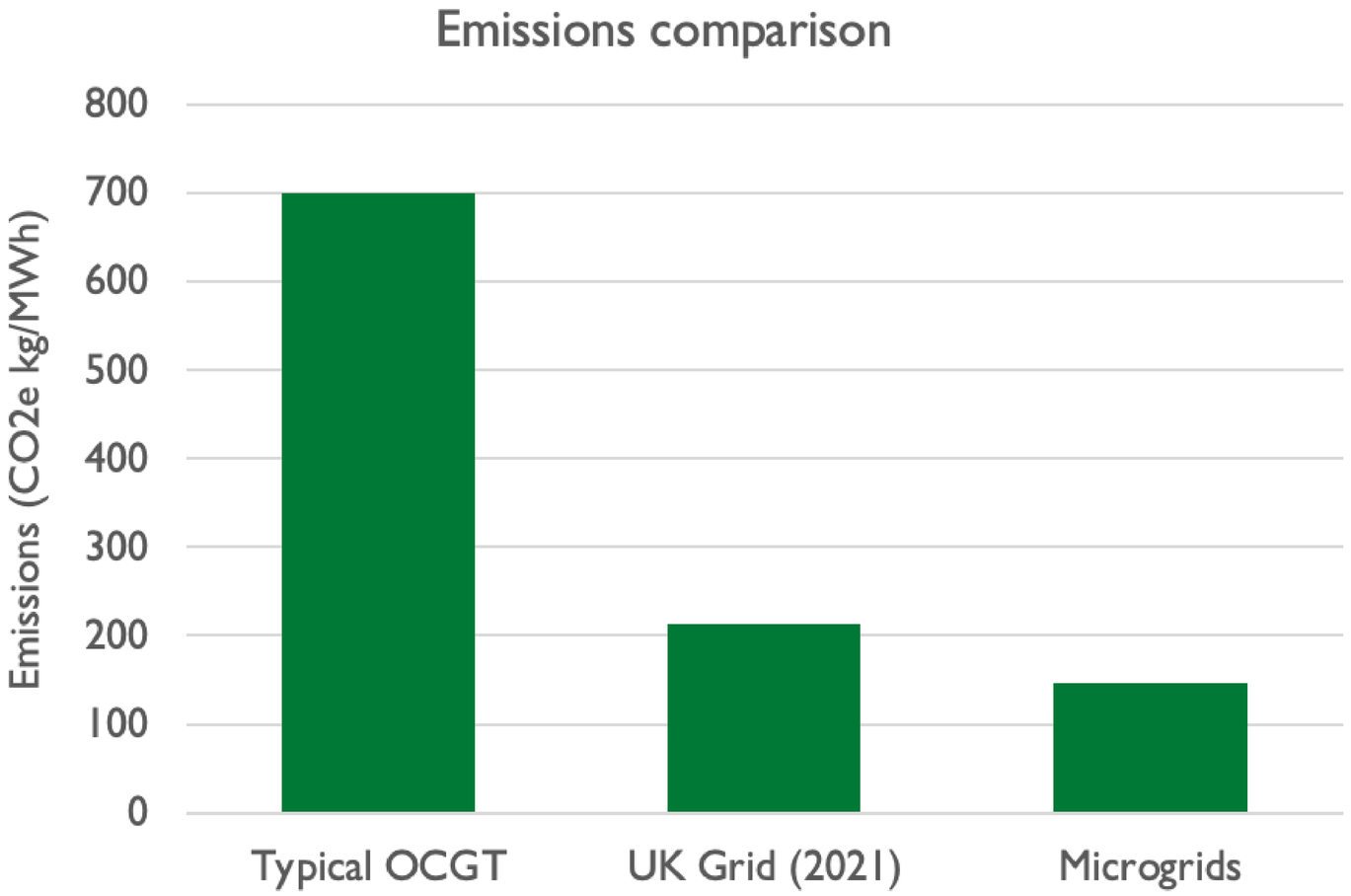
- Back up generation runtime at low load (0-16.4MW): 55-63% of the year (~4,800-5,500hrs)
- Backup generation runtime at full load (82MW): 10-16% of the year (~900-1,400hrs) so a low level of sparing acceptable
- Smaller generators to achieve high loads on individual engines and high efficiency





Emissions reduction

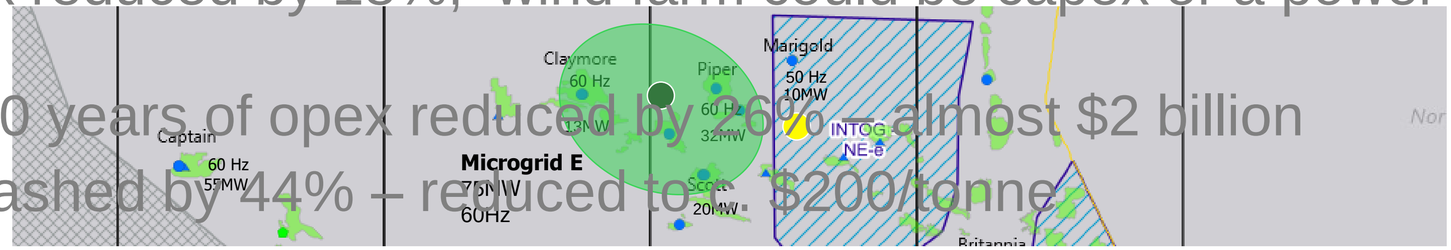
- Very significant reduction in emissions possible, approaching 80% assuming a wi farm sized at 120% of demand, and that current offshore power generators perforn as well as a typical OCGT
- 35% reduction in emissions possible with power from the distribution hubs alone
- Possible to meet 2030 50% emissions reduction targets with a wind farm sized a about 35% of platform power demands
- Potential to further reduce emissions by further oversizing a grid connected wind farm, using Net Zero fuels, or implementir carbon capture

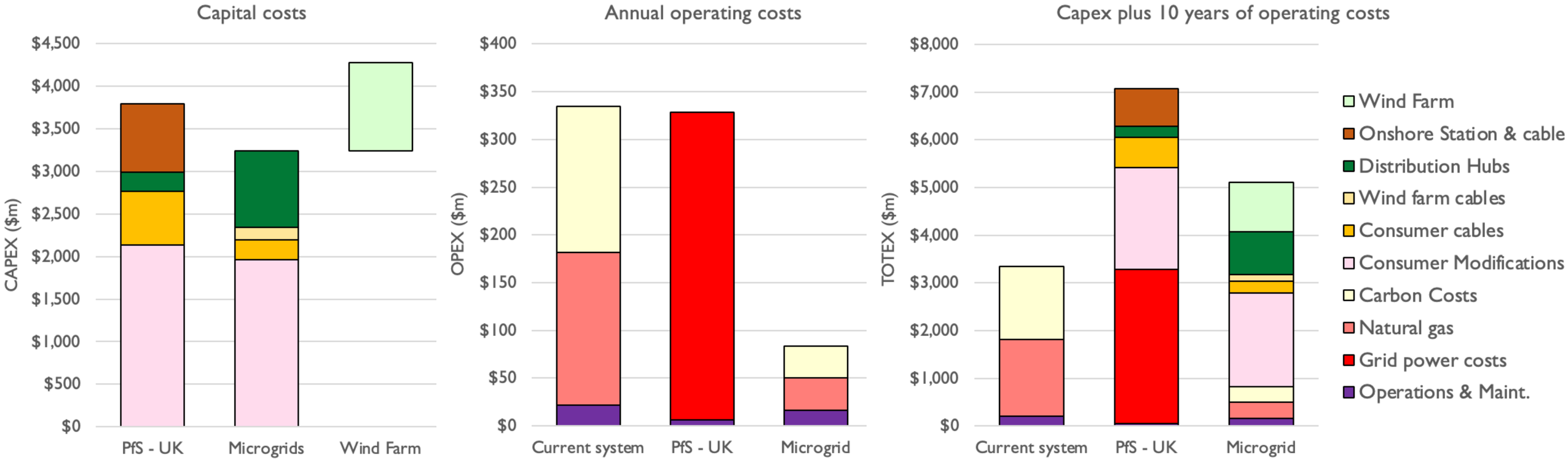


Typical OCGT performance as per NZTC guidance

Cost comparison with Power from Shore

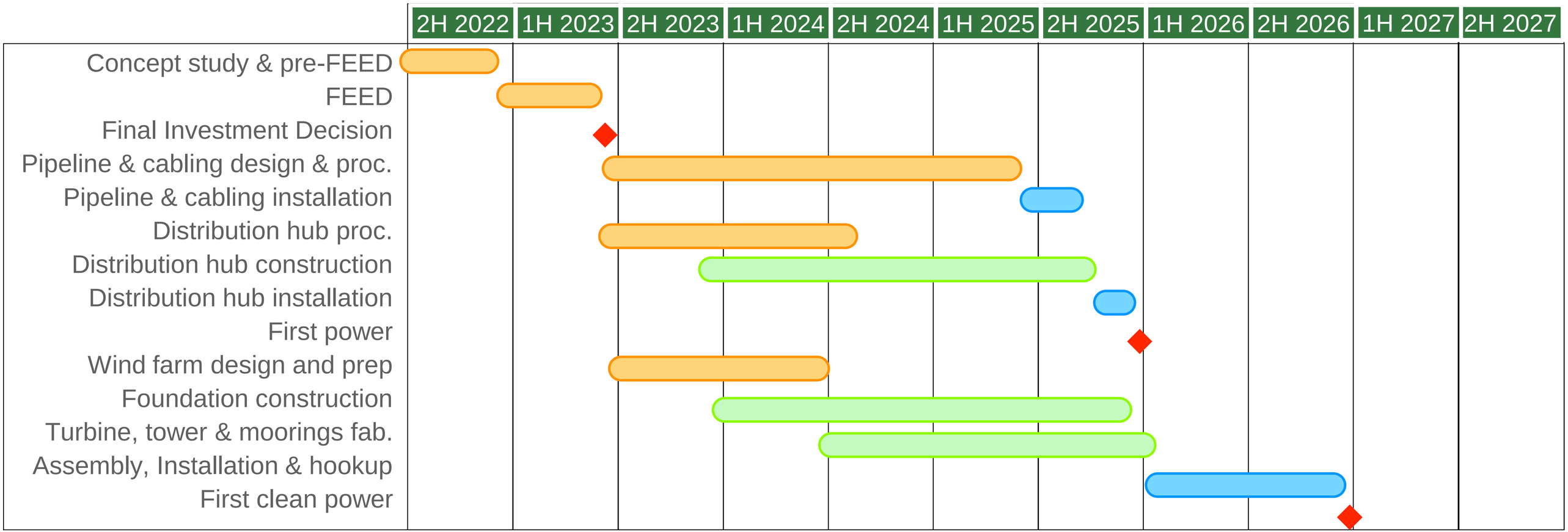
- Nine platforms in Central Graben compared with a power from shore option (A, C & D)
- Comparable capex reduced by 18%; wind farm could be capex or a power purchase contract
- Total capex plus 10 years of opex reduced by 26% – almost $2 billion
- Abatement cost slashed by 44% – reduced to c. $200/tonne





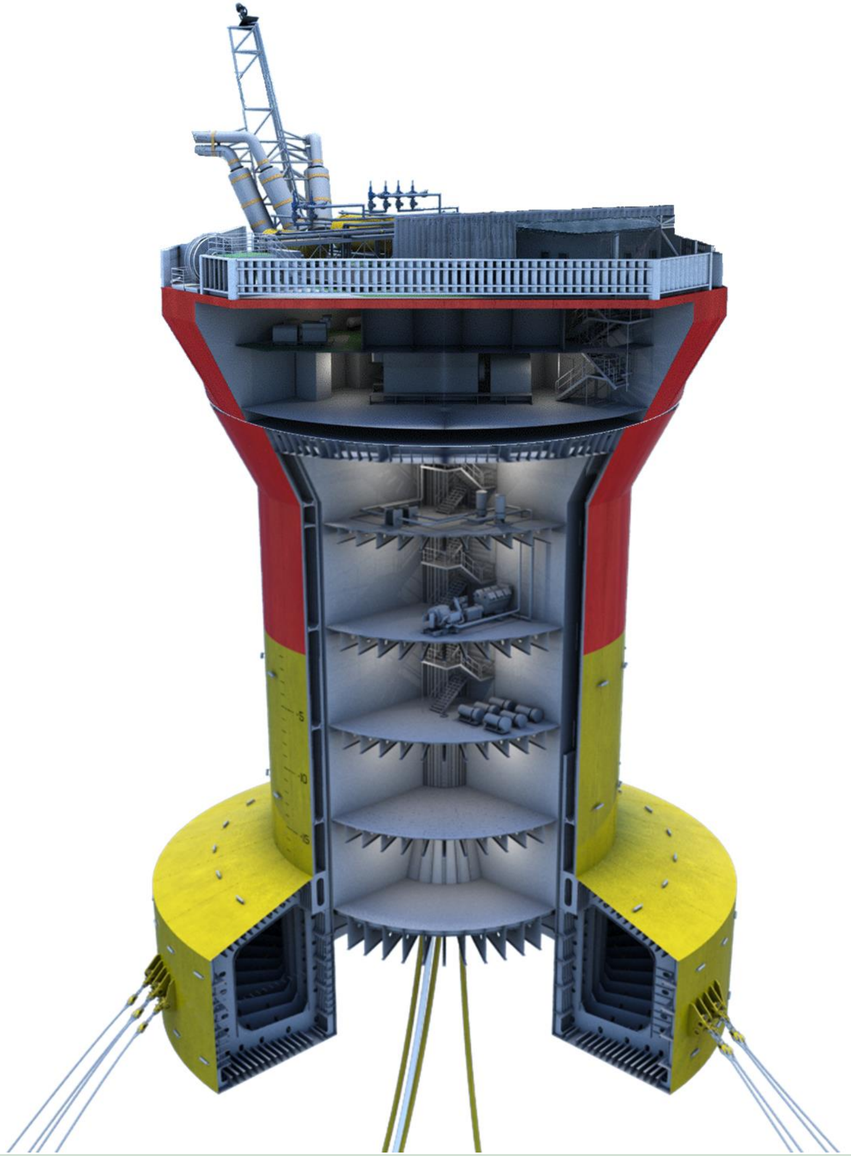
Grid power purchase costs £110/MWh; Carbon costs $100/tonne and assume no free allocation; Gas 50p/therm

Schedule for first microgrid



Orcadian advantages

- We can transform intermittent clean power into **very reliable, low emissions, fully backed-up power**
- Power will be delivered as close as possible to the voltage the platforms already use (probably 33kV), to **minimise brownfield modifications**
- **Scalable and easy to deploy** – relatively modest, repeatable, local solutions, not a big complex infrastructure project, can start with a few customers on partial electrification and move to full electrification later
- Can interconnect distribution hubs, to add further resilience, and ultimately connect to grid to **create legacy infrastructure** and provide low emissions energy to the grid when local demand wanes, but early grid connection is not necessary
- Potential to **expand wind farms** and deliver reliable baseload power to the grid; potential for carbon dioxide capture or to use alternative fuels to **fully decarbonise**



Next steps

- Report delivered to the NSTA in April, now distributed to operators participating in the CNS Accelerated Energy Transition Plan forum
- Presentation to operators scheduled for 4th May
- Orcadian and the consortium preparing a phased work programme to enable delivery of this system for one-to-many operators
  - *Operators will be offered the opportunity to secure an option to commit to this project by funding the pre-FEED and FEED work programmes*
- Formalisation of a consortium agreement including participation from a wind power project partner and/or developer
- INTOG application to support delivery of wind power

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Operating reserve

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Operating reserve capacity impacts emissions +/- 20%

Two operating reserve scenarios;

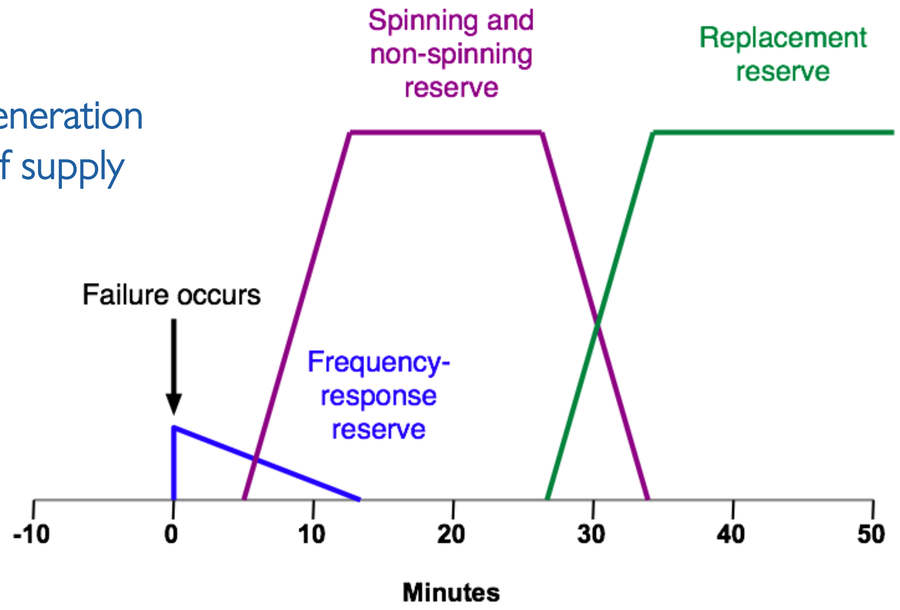
- ➢ Maximum wind generation – All power provided by wind turbines, thus no back-up generation
- ➢ Partial or no wind generation – Back-up generation operational to ensure continuity of supply

Partial or no wind generation scenario

- ➢ Reciprocating engines operational, providing spinning reserve through partial loading
  - No impact to emissions due to high efficiency of engines at low load factors
  - Supported by ESS sized to cover start up of generator

Maximum wind generation

- ➢ Single generator operational to provide interia for the Microgrid
- ➢ Supported by ESS sized to cover start up of generator, minimising spinning reserve



Wind farm sizing

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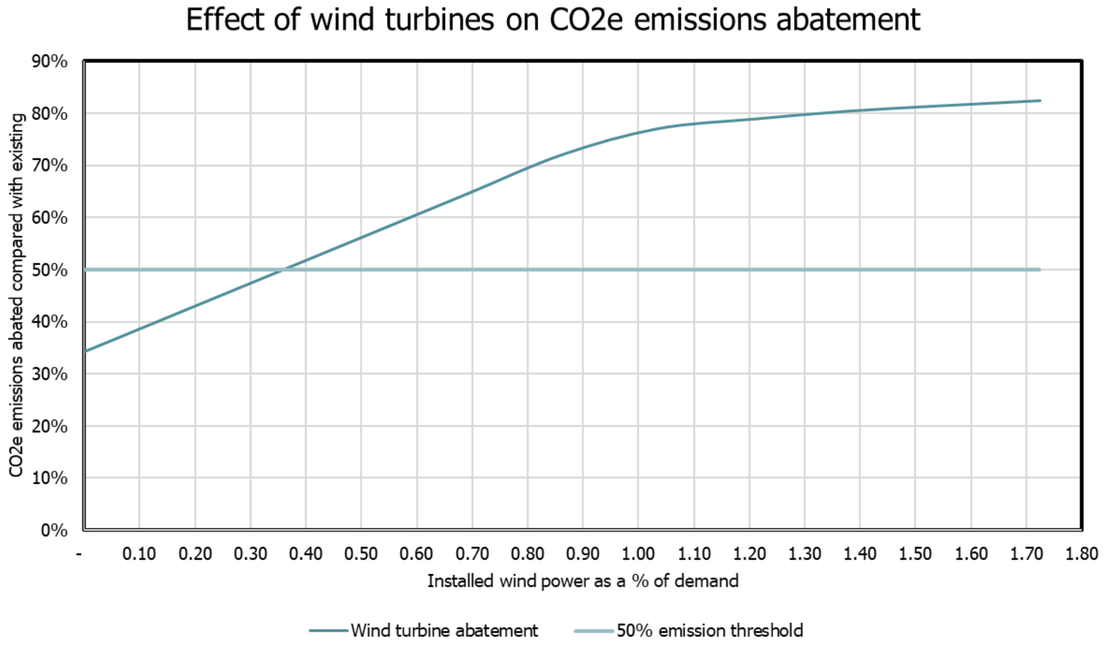

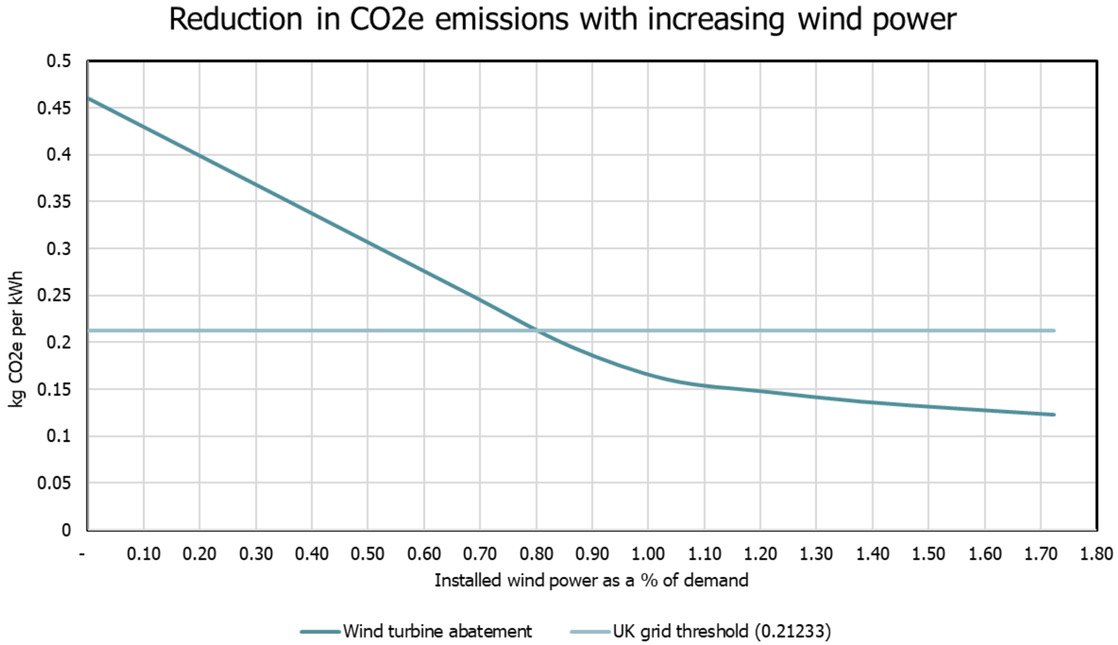

North Sea transition deal target of 50% achievable with low volume of floating wind

Achieving emissions of less than UK grid requires

- >80% renewable energy generation
- Net zero fuels
- Reduction in spinning reserve and/or load shedding capability