

Sofia Offshore Wind Farm

The largest wind farm for RWE

Chris Smith, Lead Electrical Engineer



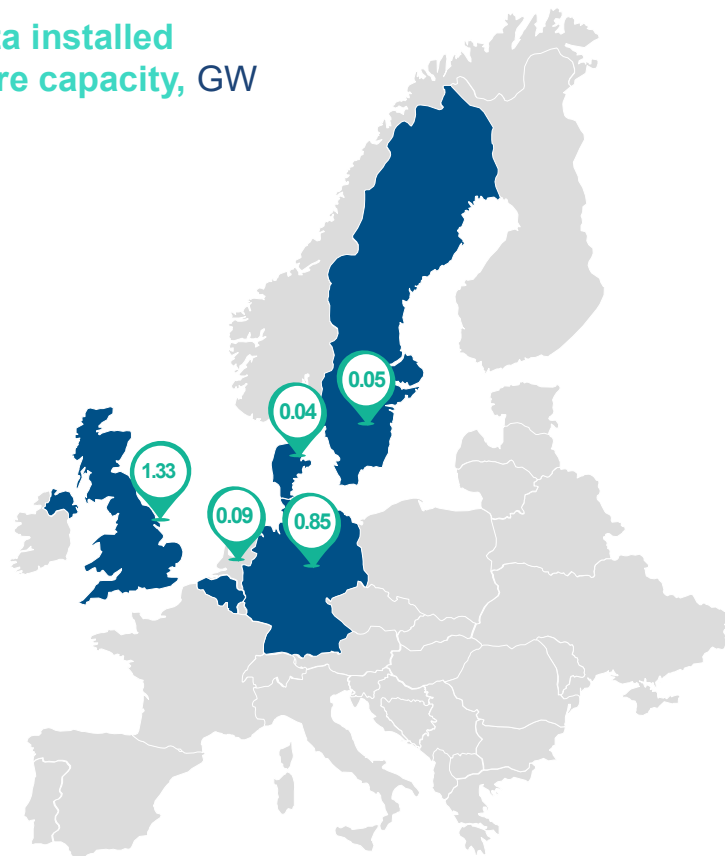
RWE

RWE: global leader in offshore wind



RWE

Pro rata installed offshore capacity, GW



Key facts

- RWE owns **2.36 GW** of offshore wind globally across Europe
- RWE is operating an additional ~800MW for partners
- » • **Uniquely positioned** to drive step change and take leadership role throughout entire industry
- **Development pipeline of 10.2 GW¹** and additional central tender/lease auctions in **Europe, Americas** and **APAC** with more than 20 GW
- **Strong track record** in developing and delivering complex projects on budget and in time
- **New offshore markets – such as Japan and Taiwan –** are planned to substantially contribute to our global leadership from 2024 onwards
- **Triton Knoll (857 MW), Kaskasi (342 MW) and Sofia¹ (1,400 MW) wind farms** under construction

Note: pro rata figures as of 31 December 2020. Numbers may not sum due to rounding. | ¹ FID for Sofia project taken in Q1 2021 (1.4 GW)

RWE's role in offshore wind in the UK



RWE

- The UK is RWE's largest market and plays a critical role in how we achieve our target of net zero carbon emissions by 2040.
- RWE currently operate **17 offshore wind farms globally, nine of those in the UK** with a total installed capacity of almost 2.5GW.
- We have **two UK projects under construction** totalling 2.3GW: **Triton Knoll** nearing completion and **Sofia**, which started onshore works in June last year.
- RWE has the **UK's largest offshore wind development pipeline** with six projects in development likely to add at least another 5.6GW to the UK's offshore wind capacity.
- RWE expects to **invest around £15 billion in the UK** in new green technologies and infrastructure by 2030.

- UK offshore wind farms operated, fully or partly owned by RWE



● In Operation ● In Construction

Sofia site: Dogger Bank in the central North Sea

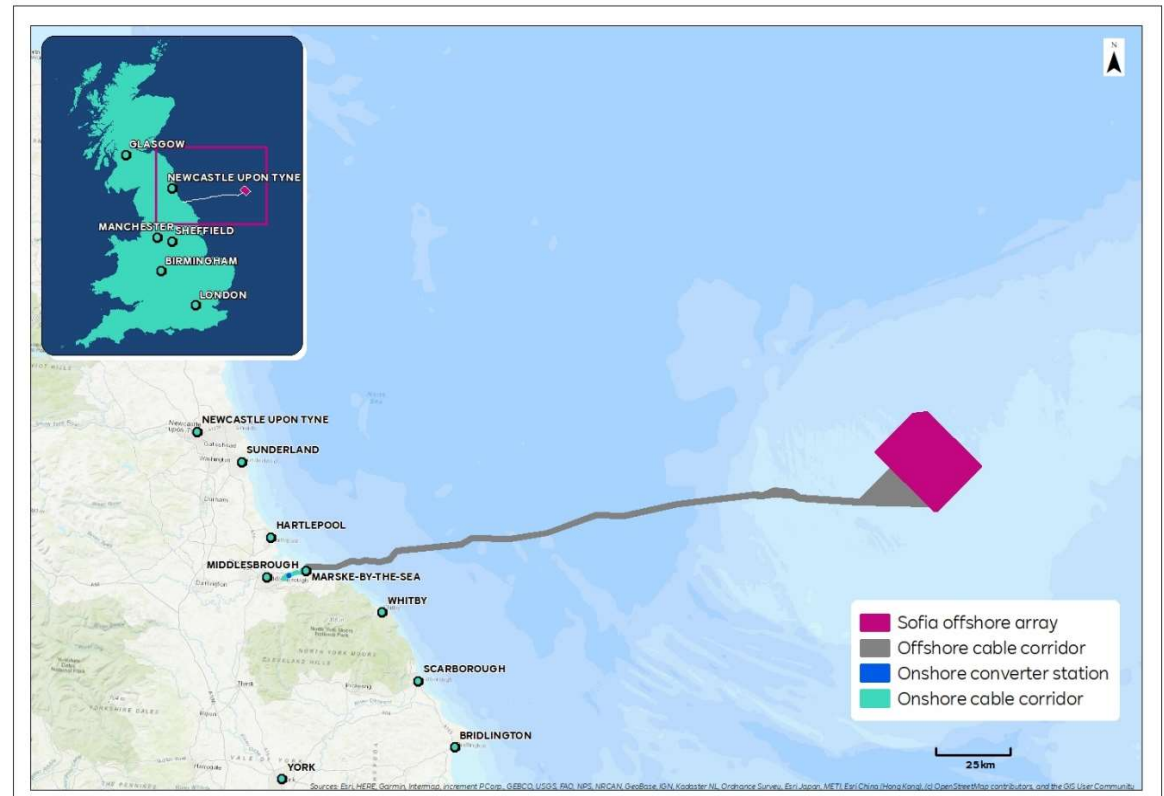


About Sofia

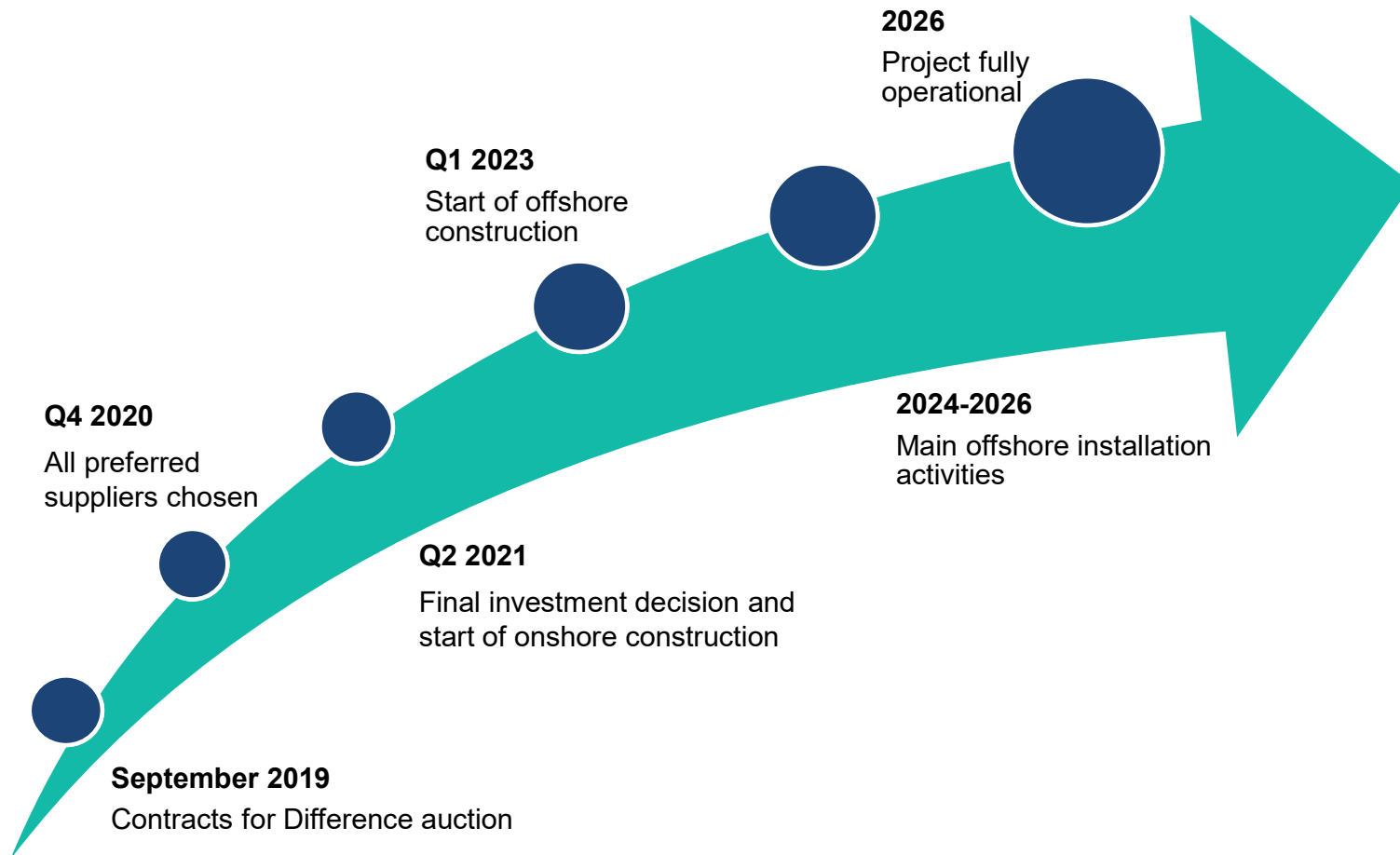
- One of the **largest single offshore wind farms** in the world, and one of the farthest from shore - **195km** from the North East coast.
- Now **under construction**

Key UK benefits

- A more than **£3 billion investment** in the UK's electricity infrastructure.
- Lowest ever strike price (**£39.65 per MWh**) making offshore wind now the UK's cheapest source of new electricity.
- More than **2.5 million tonnes** of carbon emissions saved per year compared to the use of fossil fuels.
- Significant economic opportunity with supply chain benefits, **direct and indirect jobs** and contracts.



Sofia project timelines



HVDC Electrical System: contract with GE Grid Solutions and Sembcorp Marine



RWE

<p>Technology</p>	<p>1320MW HVDC +/- 320kV DC converter system including two converter stations - one offshore / one onshore - with innovative converter modules and a new high-tech control system. The offshore converter station will be the most powerful fabricated to date, and farthest from shore.</p>
<p>Current status</p>	<p>11000 tonne platform is now being fabricated in Batam. Kier appointed by GE for onshore works.</p>



Wind Turbine Generators: contract with Siemens Gamesa for 100 SG 14-222 DD turbines



Technology

- 14MW state-of-the-art turbines
- Three blade horizontal axis with 108m blades cast in a single mould
- 222 metre-diameter rotor sweeping an area of 39,000 m².
- 25 year design life and 25% more powerful than SGRE's previous version
- One turbine could provide enough energy to power approximately 18,000 average European households every year.
- Sofia will be the first project in the world to install this model

Current status

- Contract to supply and install 100 turbines awarded in March 2021.
- The final blade of the first SG 14-222 DD prototype – now the world's largest and most powerful installed turbine – put in place in Denmark on 12 November 2021.



WTG Foundations and Array Cables: EPCI contract with Van Oord



RWE

Technology

- The 100 foundations will be 80 to 90 metres in length and weigh 1200 to 1400 tonnes each.
- There will be 109 individual array cables, totalling approximately 360 kilometres, installed in 18 strings feeding into the offshore converter station.
- Van Oord's jack-up vessel Aeolus will install the foundations and cable installation vessel Nexus will install the cables.

Current status

Van Oord awarded contract to supply and install the foundations and array cables in March 2021.



Export Cables: contract with Prysmian Group



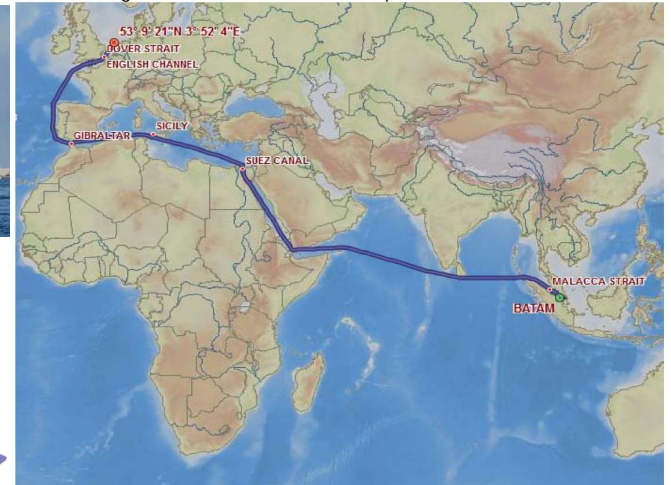
RWE

Technology	<ul style="list-style-type: none">• 320kV HVDC export cable plus fibre optic communications• A turn-key high voltage submarine and land export cable connection• Use of brand-new cable installation vessel <i>Leonardo da Vinci</i>
Current status	Prysmian Group was awarded the contract to supply and install the export cables in March 2021. Sofia the first project to use the Leonardo da Vinci (under construction)

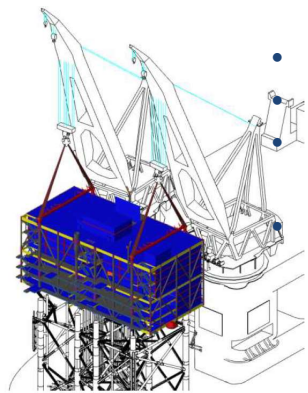
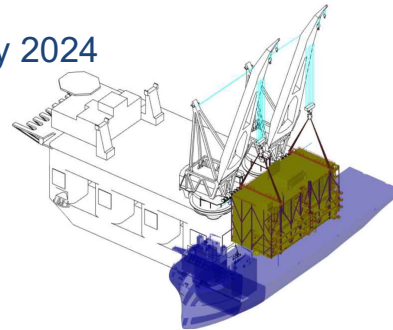


Offshore Converter Platform T&I

- Transportation
 - Heavy Transport Vessel (HTV)
 - GPO Grace (or similar)
 - Jacket and topsides on board
 - Batam > Suez Canal > Installation Site
 - Ready for sail-away Feb 2024 installation May 2024
- Installation
 - Heavy Lift Vessel (HLV) –SSCV Sleipnir
 - Max. Tandem lift capacity – 20,000 MT
 - Lift and place jacket
 - Pile through 8 jacket legs
 - Jacket installed with vessel in DP mode
 - Lift and place Topsides, weld connection onto 8 piles
 - Topsides installed on anchors (potentially DP mode)



The route is approximately 8,400 nautical miles.



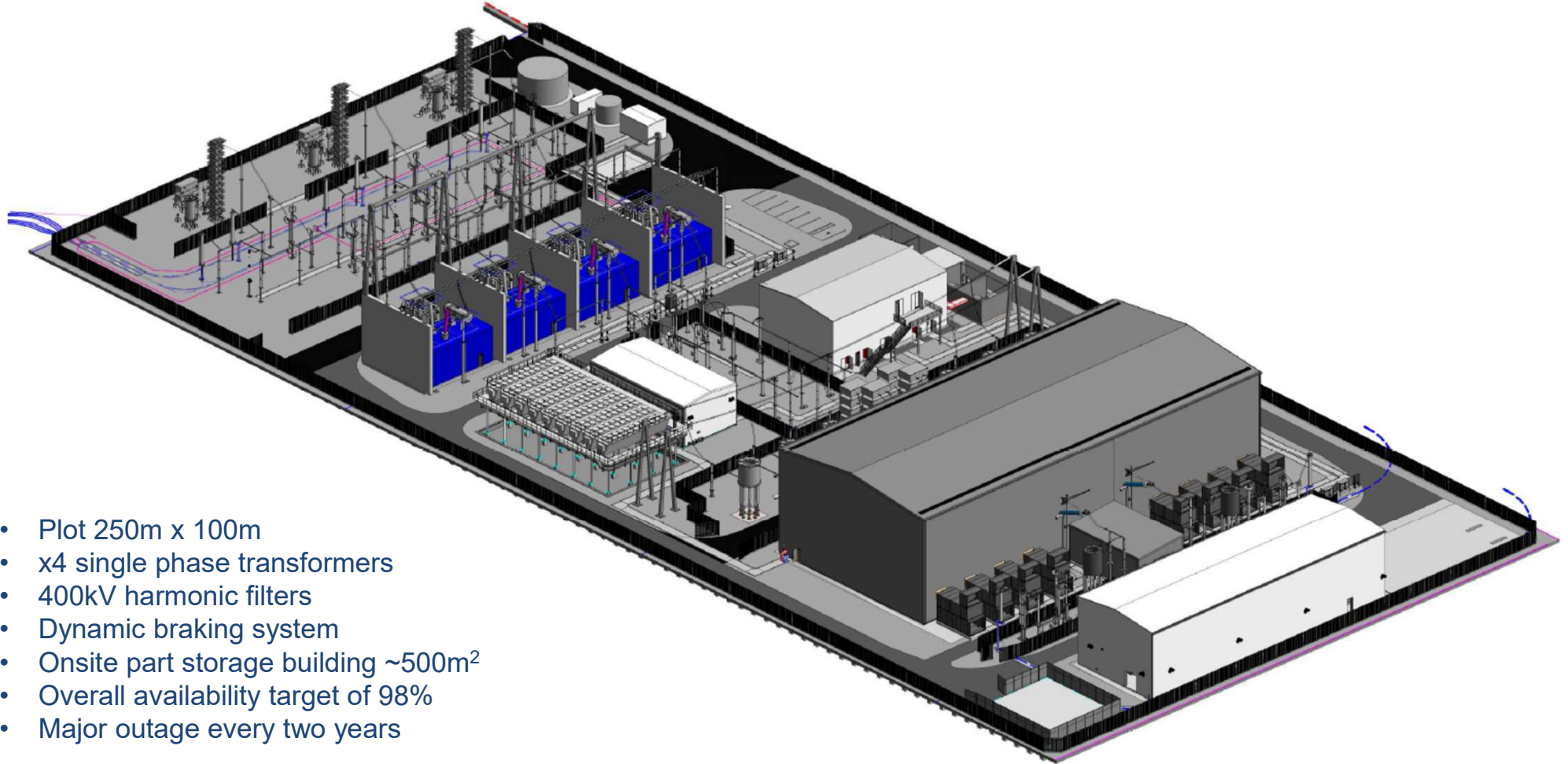
Grid Connection into NGET Lackenby Substation

The design consists of;

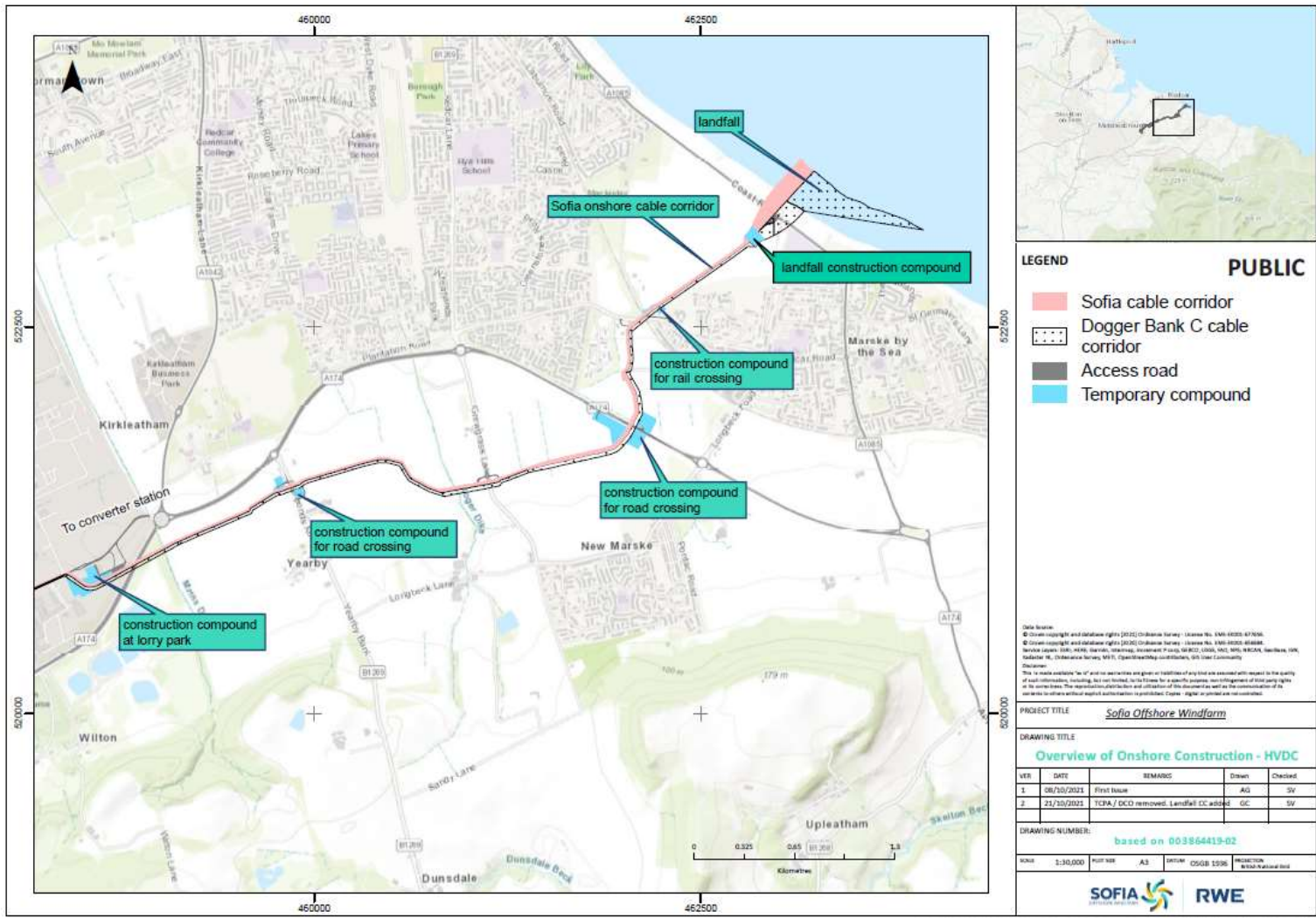
- One circuit of two sets of 400kV cables, with separate GIS disconnectors to enhance availability
- Legacy GIS switchgear being extended



Onshore Converter Substation



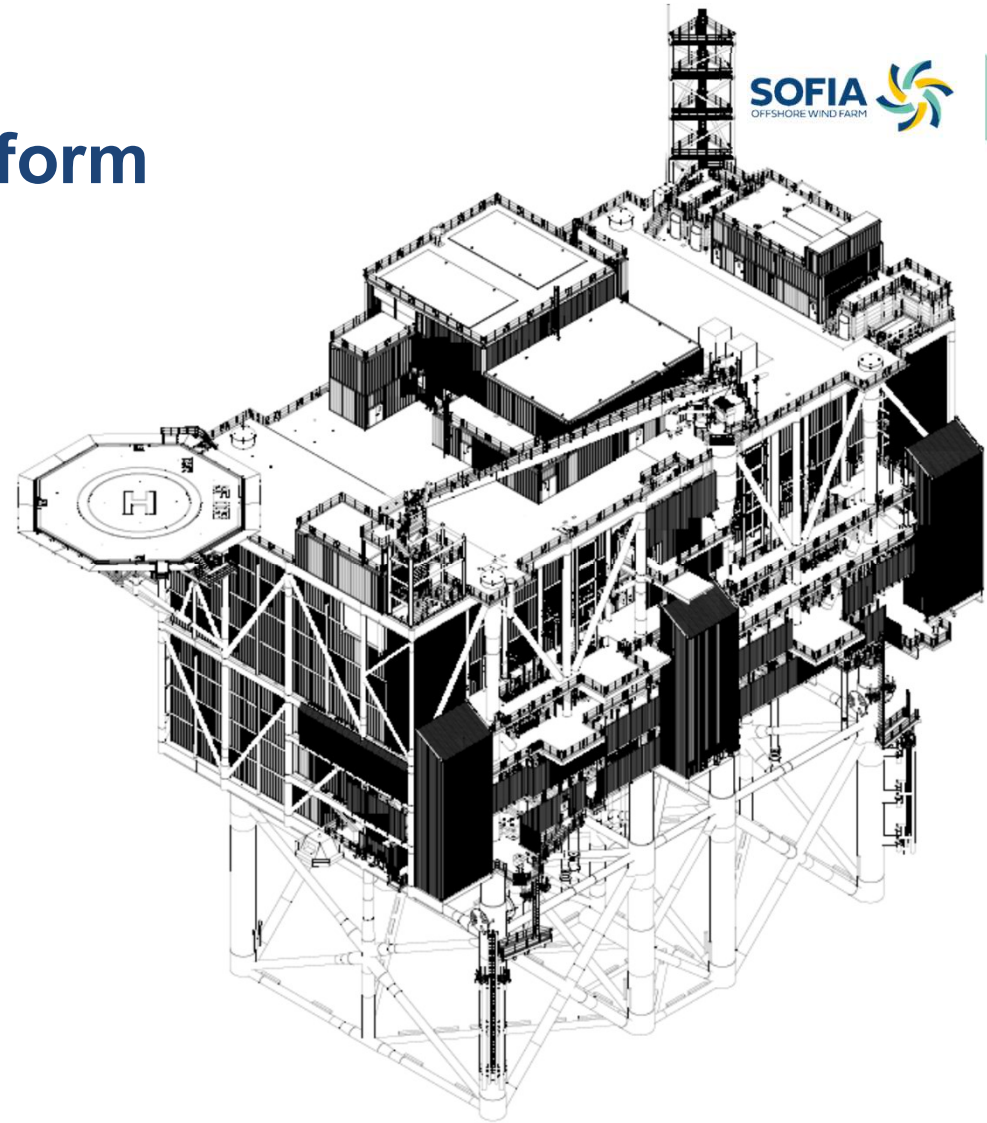
- Plot 250m x 100m
- x4 single phase transformers
- 400kV harmonic filters
- Dynamic braking system
- Onsite part storage building ~500m²
- Overall availability target of 98%
- Major outage every two years



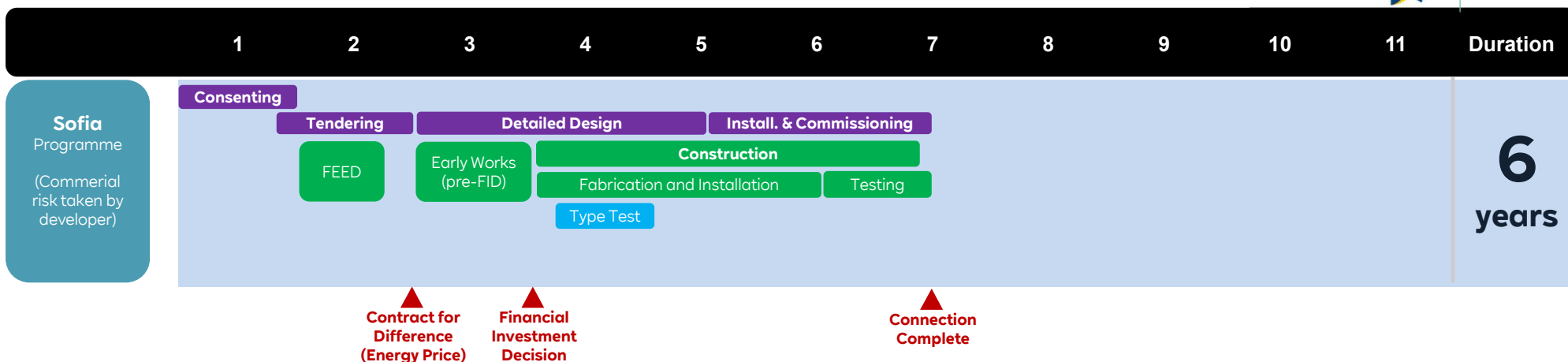
Sofia onshore cable route: overview map

Offshore Converter Platform

- Topside ~11,000 tonnes
- Jacket & Piles ~7,000 tonnes
- Topside size approx. 78m x 36m x 33m
- 6 decks
- Helideck
- Jacket & Topside installed in one campaign
- Fabrication at SMOP's Batam yard, Indonesia



Programme



SOWFL awarded FEED contracts to three suppliers in October 2018 for the HVDC System

1. Siemens AG (Consortium formed with Kvaerner)
2. GE - UK Grid Solutions (Consortium formed with Sembcorp Marine)
3. Petrofac - (Consortium formed with GEIRI)

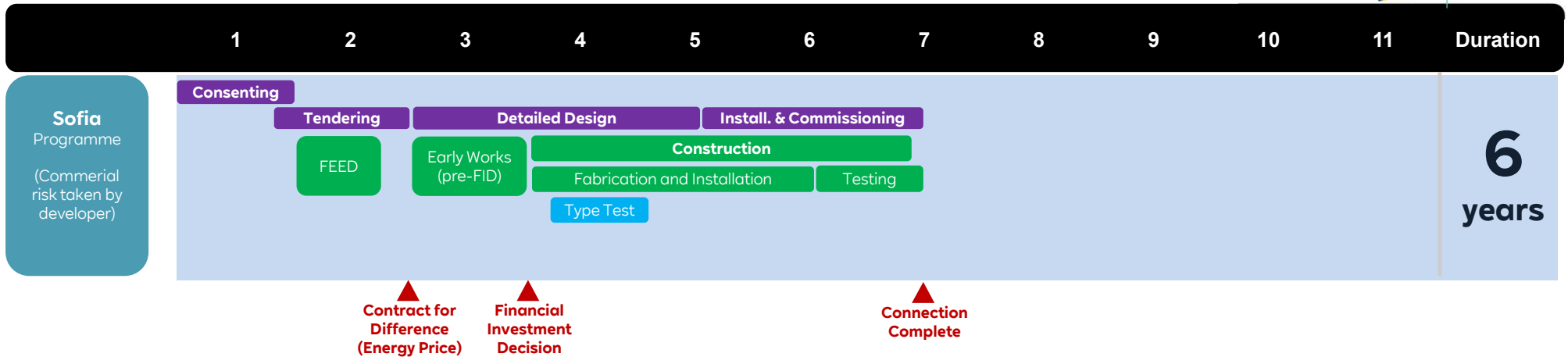
Note: ABB/Aibel did not tender the FEED, could not agree to contract strategy

- A separate Consultancy Contract awarded to Mott MacDonald for HVDC technical support during the FEED & ITT.

Purpose of the FEED's

- Provide a price before CfD bid
- Secure the HVDC works programme by progressing design
- Identify interface & supply risks
- Eliminate options, refine plant and equipment footprint
- Establish system availability targets, and spares portfolio
- FEED outputs included in ITT Employer's Technical Requirements

Programme



- SOWFL awarded Early Works Contract (EWC) to the consortium of GE and Sembcorp Marine July 2020.
- Moved into Main Works Contract (MWC) at FID May 2021, contractually seamless.
- A separate Consultancy Contract awarded to RTEi for HVDC technical support for the duration of the works.

Purpose of the EWC's

- Progress electrical design for export cable parameters
- Develop OCP design so that at FID, platform structural materials could be ordered
- Secure the HVDC works programme

Interaction Studies

- Sofia have contracted RTEi to perform Interaction Studies with the neighbouring Doggerbank C project being developed jointly by SSE and Equinor.



- Scope includes
 - EMT simulations (desk based PSCAD), to investigate power oscillation damping control interaction, frequency control interaction, impact of fault recovery including power and voltage recovery, system energizations (sympathetic interactions), high frequency harmonic interactions and to validate the SSTI study with the presence of both HVDC converters systems.
 - Hardware in the Loop (control systems), to validate key simulations and to investigate specific risk items identified during EMT simulations.

Sofia onshore converter station: progress May 2022



Sofia offshore converter platform: progress May 2022



Thank you



RWE