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Offshore Windfarm System and Foundation Design – in brief

Technical webinar by **Peter Thompson** of ARUP, geotechnical engineer, and east Asia energy business leader in conjunction with the AGS-HK AGM for the year 2023. Narrated by Caleb Sang for AGS-HK.

The following is a simplified overview of offshore windfarm systems and its foundation design. Plus, an attempt to increase awareness on the urgency of de-carbonisation in our pursuit of mass electrification.

Global electricity consumption is expected to increase by 2–5 folds globally as human embark on energy- intensive missions of artificial intelligence development and manufacturing more power-hungry equipment. As we recognise the need to energise intensely, we ought to turn our attention to renewables and development of the infrastructure and ecosystem to suit. Such as robust onshore grid and hydrogen producing facilities.

We know that electricity generation is responsible for >40% of our atmospheric CO2 emissions. Major power producing countries such as China depend on coal powered plants that generate >70x more carbon in its lifecycle compared to onshore windfarms.

Conversely, wind-based electricity production is growing rapidly across the globe due to its high availability and sustainability. Peter's focus on the developing Asia market is due to the energy transition outlook and the sheer wind density and speeds in oceanic regions off countries like Japan, Korea, Vietnam, and the Philippines.

So how do typical wind energy systems come to be? First, a site suitability analysis adhering to environmental, geopolitical, and other engineering constraints in the vicinity is made. Once the options are set, site characterisation studies supplemented by on-site instrument are carried out to assess ocean environmental, geotechnical conditions and wind resources. This directly weighs on the choice of turbines, their foundation, and layout.

The calculation of the Levelized Cost of Energy (LCOE) including the recommended foundations and turbine types allows multiple scenarios to be tested. The energy potential per unit dollar is primarily influenced by wind resources, water depth and distance from shore. From then on, it's project programming, financial models, risk identification& mitigation, permitting & licensing support.

Peter states that the foundation design is not too different from considerations for onshore structures. Offshore concerns include the limit states (SLS, ULS, FLS), soil-foundation-turbine interactions and in the Asia pacific region, seismic analysis. Highlighting the risk of fracture initiation and propagation on the turbine structure, the emphasises on eliminating overlap between frequencies of the 3-blade rotor, the turbine column, and the foundation.

Furthermore, foundations and ground works for ports, substations, cable laying, and grid connections need to be considered in precarious marine conditions. It is noted that despite having a suitable site, an onshore grid that is capable of efficiently transmitting the electricity generated is just as important. Decommissioning of these windfarms is often a huge task overlooked, and developers often try to increase their lifespan of 25 years and connecting infrastructure to increase the return of investment.

In the 2050 1.5°C temperature threshold scenario, we will require 90% of our electricity generation of an estimated 90 Petawatt Hour to come from renewable sources, wind being a key component. Renewable energy deployment, improvements in energy efficiency and electrification of the end-user sector will contribute to this shift.