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Sustainable Design for Wind Turbine Foundations

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Abstract

Green energy resources are essential to meet the world growing energy demands while reducing the effects of global warming. Wind energy being one of the main efficient renewable energy sources, drives the ever-increasing expansion of both onshore and offshore wind farms globally. In addition, wind energy technologies are improving and wind turbines capacity continues to grow, making energy production more affordable. For example, new offshore wind turbine projects with capacity more than 315GW will be added over the next decade (2022-2031), which will result in total offshore wind energy of 370GW by 2031 (Global Wind Energy Council, 2022). However, one of the main challenges for wind projects is the cost of foundation construction, especially for offshore installations, which can be as high as 40% of the total cost. This presentation presents recent developments in sustainable design of foundations for wind turbine foundations, both onshore and offshore. It discusses innovative hybrid foundation system for onshore and offshore installations, which has the potential to reduce the foundation cost, utilization of resources and minimize impact on the environment while satisfying the performance and capacity criteria for large wind turbines. The presentation also discusses tripod suction buckets foundation system that offers many advantages for supporting offshore wind turbines including fast and economic installation and high overturning resistance. The dynamic responses of offshore wind turbine supported on large diameter monopile in sands and clays are also discussed. Finally, the presentation evaluates the uplift criteria for design of gravity base foundations for onshore wind turbines and offers some guidance for more efficient design that may allow re-purposing of foundations of existing wind turbines and optimizing the design of shallow foundations for new wind turbines.