Image courtesy of London Array Limited



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Hydrogen: Challenges and opportunities for offshore wind and Oil &Gas integration for mutual benefit

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#### **Presentation Overview**



- Different Cultures combining the good bits;
- Technical challenges and opportunities
- Summary and Conclusions



A preliminary techno-economic comparison between a grid-connected and non-grid connected offshore Anastasia Ioannou Anastasia Ioannou Department of Naval Architecture, Ocean & Marine Engineering Theoremity of Greatherlands 100 Montrose, G4 0LZ Feargal Brennan Department of Naval Architecture, Ocean & Marine Engineering Glasgow, UK To further increase the technical potential, offshore wind 100 Montrose, G4 0LZ 10 nurtuer increase the technical potential, ortshore wind farms which can be deployed far offshore must be considered. arms which can be deployed far offshore must be considered. At such long distances, economic aspects of grid-connected wind musices wand to be further investigated as connection to At such long distances, economic aspects of gine-connectea wind turbines need to be further investigated, as connection to wind nuroines need to be nurner investigated, as connection to the grid becomes a complicated process. On board storage of Associations in a series of former (associated as a series of former (as a series of forme the grid becomes a complicated process. Un board storage of electricity in a series of forms (compressed air energy storage) Abstract-Non-grid connected (NGC) floating offshore wind electricity in a series of forms (compressed ar energy storage, batteries, hydrogen, etc.) can address this issue by transferring the mercury from the sources of weakening to the communi-batteries, hydrogen, etc.) can address this issue by transferring the energy from the source of production to the consumer. (ON) turbines can signify a solution for harvesting wind energy far offshore, addressing some key issues including the deep viater and tests of mid connection while also averlaiting the higher isr ormore, addressing some key issues including the deep waters and lack of Frid Connection, while also exploiting the higher remedie forester transmit is succession. uie energy nom uie source of production to uie consumer. Energy storage solutions, such as hydrogen, can help manage the series of intermentenergy to the storad endower on the cod back the issue of intermittency, as the stored energy can be fed back and lack of grid connection, value also exploiting the arguer capacity factors. Towards this direction, on-board energy storage is the form of budgeness menderation is one of the mean reconstruction the usue of intermittency, as the stored energy can be ted back into the grid when demand rises or used for other purposes, as capacity factors. Towards this direction, on-board energy storage in the form of hydrogen production is one of the most promiting solutions, often cited in literature. This study sims to perform a into the grid when demand rises or used for other purposes, as well as offer the potential to channel renewable electricity to sectors which are difficult to decarbonize, such as industrial and eccenter to embodie or prosolutions, onted anterature. LIDE SHOP and to perform a preliminary techno-economic analysis to assess the trade-offs, terms of between a far offshore grid-connected (GC, floating wind form and a NGC wind form integrated with an electrolyser terms of cost, between a far offshore grid-connected (GC) floating wind farm and a NGC wind farm integrated with an electrolyser Innovative solutions, presenting market potential, have been vind farm and a NGC wind farm integrated with an electrolyser for the production of hydrogen. To this end, a lifecycle techno-economic model coupled with an O&M model developed for offshore wind inclutions are ownlowed The model is emploid a Innovanve sonutons, presenting market potential, nave oeen explored by industry and academia, at a conceptual level, to transport applications [2]. economic model coupled with an O&M model developed for offshore wind installations are employed. The model is applied a hypothesia wind farm located 2000m from the shore. For the GC system. O&M costs along with the costs of acautizing of the explored by industry and academia, at a conceptual level, 10 exploit the untapped wind energy potential, far offshore, Related excision date can be receively undermaded for NICC mind form erploit the untapped whild energy potential, far outshorte. Keinted activities that can be possibly performed for NGC wind farms a hypothetical wind farm located 200km from the shore. For the GC system, O&M costs along with the costs of acquisition of the activities wat can be possibly performed for NUC wind farms include, for example, the production of hydrogen through water descendaries the meaduring of according and for the meaduring GC System, OcMI costs along with the costs of acquisitions of the electric system (offshore cable and offshore substation) appeared to be determine constructions of the transition from at reservoir to be determine constructions of the transition of the set of t include, for example, the production of hydrogen through wrater electrolysis, the production of azamonia and for the production of aquaculture (find. shellfind. see weeds. etc.). Concents for multi-controose elasforms in deep waters have been investigated electric system (offshore cable and offshore substation) appeared to be the main contributors to the Levelised Cost of Electricity of COS As for the NYCC content is a second as a second state. to be the main contributors to the Levelized Cost of Electricity (LCOE). As far as the NGC system is concerned, it was concluded of aquaculture (fish, shellfish, sea weeds, etc.). Concents for multi-purpose platforms in deep waters have been investigated (LCUE). As tar as the NGC system is concerned, it was concluded that a higher annual capacity factor (>60%) could potentially achieve viability of the investment. multi-purpose platforms in Geep Waters have been investigated in the past by research projects, such as the TROPOS project [3], which since to devote a modular multi-tree statement constitute in the past of research projects, such as the 1KUFUS project [2], which sims to develop a modular multi-use platform, coupling accord estimates encount which encountered enderstore and which aims to develop a modular multi-use platform, coupung several activities, amongst which aquaculture production and Koywords—non-grid connected offihore wind farm, hydrogen storage system, techno-economic analysis several activities, amongst which aquaculture production and renewable energy conversion, as well as the H2Ocean project and another transformer and the second activities activities and the second activities activit renewavie energy conversion, as well as the H2Ucean project [4] developing a wind-wave power open-sea platform equipped According to the Offibore Valuation Study published in In this paper, we perform a preliminary techno-economic According to the Offshore Valuation Study published in May 2010, Scotland has 206 GW of offshore wind (OW), wave In this paper, we perform a preliminary termic-economic analysis to compare the feasibility of gild-connected in the feasibility of gild-connected wind former Underscan for hydrogen generation. May 2010, Scotland has 206 GW of offshore wind (UW), wave and tidal resources - almost 40% of the total UK resource [1]. analysis to compare the reastrolliny of grid-connected in comparison to non-grid connected wind farms. Hydrogen comparison to non-grid connected wind farms. Hydrogen production as a means of energy storage for far NGC offshore accommunic volumential and tidal resources - amost 40% of the total UK resource [1]. NGC floating OW can address some key issues of Scottish OW, NGC floating OW can address some key issues of scottish OW, including the deep waters and the lack of grid connection. including the deep waters and the lack of grid connection. Furthermore, NGC wind can be used to take advantage of the far Furthermore, NGC wind can be used to take advantage of the far OW energy potential (characterised by high winds and limited personal variations), which must be maded in the maded in the second structure of the second struc The rest of the paper is organized as follows: in the next section, a short overview of energy storage options is performed OW energy potential (characterised by high winds and limited seasonal variations), which would be prohibitively expensive to seasonal variations), which would be prohibitively expensive to connect to the grid. UK is one of the windiest countries in formed and it has been sended due to the count of the second connect to the grid. UK is one of the windlest countries in Europe and it has been argued that the scale of wind power development exceeds the ability of the grid to integrate the intermittant wind ensure conscript ueverupunear enveeus use avanty intermittent wind energy capacity.



# The opportunity



- Attractive wind resources far offshore;
- Maturing floating wind technologies;
- Potential to contribute significantly to storage, renewable heat and decarbonising transport;
- Coupled with the UK capability and capacity in upstream offshore Oil & Gas, to significantly increase UK content within the offshore wind sector.

# The challenges



- Safety;
- Environmental;
- Port and onshore handling and distribution infrastructure;
- Offshore system design and operations including moorings;
- Cost;
- Regulatory Framework.



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Major/Specified

Over-3-day/Over-7-day

-Rate per 100,000 FTE

08/09

From UK HSE http://www.hse.gov.uk/offshore/statistics/hsr2017.pdf

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This document is available from www.hse.gov.uk.ofshore/statistics.htm



## Oil & Gas TRIR Reporting Format





#### Offshore Wind TRIR Reporting Format





#### **Grid Connected Wind Forecasts**



#### Offshore wind capacity set to reach 520 GW by 2050

 Could raise offshore wind to 520 GW 4% of global power generation by 2050 Average new turbine capacity set to reach 8.3 MW by 2022 - up 184% since 2010 Next-gen turbines offer longer blades and higher output 20 GW 2018 2050 www.irena.org S RENA

## Offshore Wind: The good bits



- Cost competitive sustainable power;
- Cost reduction through volume production and operations;
- Competitive and highly technical and commercially capable OEMs;
- Relatively Environmentally Considerate;
- Strong Societal and government support;
- Strong Investor support;
- High degree of skills and relatively good ED&I record.

#### Oil & Gas: The good bits



- Advanced safety and risk based design/operation culture;
- Used to working within a demanding regulatory regime;
- Advanced materials, marine robotics, autonomous intervention technical capabilities;
- Process systems expertise;
- Whole systems integration of very large operations.

# **Summary & Conclusions**



- TRIRs in Offshore Wind are significantly greater than in upstream Oil & Gas – with volumes of OWTs set to increase greatly over the coming decades, we need to change cultures;
- NGC Wind is an enormous opportunity which could be larger than GC wind globally;
- There is a significant opportunity for the UK Oil & Gas sector to embrace, complement and potentially lead NGC Wind in a safe, environmentally sensitive and cost effective manner.



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