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University of Strathclyde Engineering

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 floating wind farm

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***Abstract*— Non-grid connected (NGC) floating offshore wind (OW) turbines can signify a solution for harvesting wind energy far offshore, addressing some key issues including the deep waters and lack of grid connection, while also exploiting the higher capacity factors. Towards this direction, on-board energy storage in the form of hydrogen production is one of the most promising solutions, often cited in literature. This study aims to perform a preliminary techno-economic analysis to assess the trade-offs, in terms of cost, between a far offshore grid-connected (GC) floating wind 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 installations are employed. The model is applied to a hypothetical wind farm located 200km from the shore. For the GC system, O&M costs along with the costs of acquisition of the electric system (offshore cable and offshore substation) appeared to be the main contributors to the Levelised Cost of Electricity (LCOE). As far as the NGC system is concerned, it was concluded that a higher annual capacity factor (>60%) could potentially achieve viability of the investment.**

Keywords—non-grid connected offshore wind farm, hydrogen storage system, techno-economic analysis

I. Introduction

According to the Offshore Valuation Study published in May 2010, Scotland has 206 GW of offshore wind (OW), wave and tidal resources - almost 40% of the total UK resource [1]. NGC floating OW can address some key issues of Scottish OW, including the deep waters and the lack of grid connection. Furthermore, NGC wind can be used to take advantage of the far OW energy potential (characterised by high winds and limited seasonal variations), which would be prohibitively expensive to connect to the grid. UK is one of the windiest countries in Europe and it has been argued that the scale of wind power development exceeds the ability of the grid to integrate the intermittent wind energy capacity.

To further increase the technical potential, offshore wind farms which can be deployed far offshore must be considered. At such long distances, economic aspects of grid-connected wind turbines need to be further investigated, as connection to the grid becomes a complicated process. On board storage of electricity in a series of forms (compressed air energy storage, batteries, hydrogen, etc.) can address this issue by transferring the energy from the source of production to the consumer. Energy storage solutions, such as hydrogen, can help manage the issue of intermittency, as the stored energy can be fed back 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 transport applications [2].

Innovative solutions, presenting market potential, have been explored by industry and academia, at a conceptual level, to exploit the untapped wind energy potential, far offshore. Related activities that can be possibly performed for NGC wind farms include, for example, the production of hydrogen through water electrolysis, the production of ammonia and for the production of aquaculture (fish, shellfish, sea weeds, etc.). Concepts for multi-purpose platforms in deep waters have been investigated in the past by research projects, such as the TROPOS project [3], which aims to develop a modular multi-use platform, coupling several activities, amongst which aquaculture production and renewable energy conversion, as well as the H2Ocean project [4] developing a wind-wave power open-sea platform equipped for hydrogen generation.

In this paper, we perform a preliminary techno-economic analysis to compare the feasibility of grid-connected in comparison to non-grid connected wind farms. Hydrogen production as a means of energy storage for far NGC offshore wind farms was chosen for further analysis of its techno-economic potential.

The rest of the paper is organized as follows: in the next section, a short overview of energy storage options is performed

OSES2019, Brest, France, July 10-12

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.

Benchmarking against Upstream Oil & Gas

Key points for 2017:

- There were a total of 84 injuries reported under RIDDOR, with a rate of 282 injuries per 100,000 full-time equivalent workers (FTE)
- were no fatal injuries in 2017

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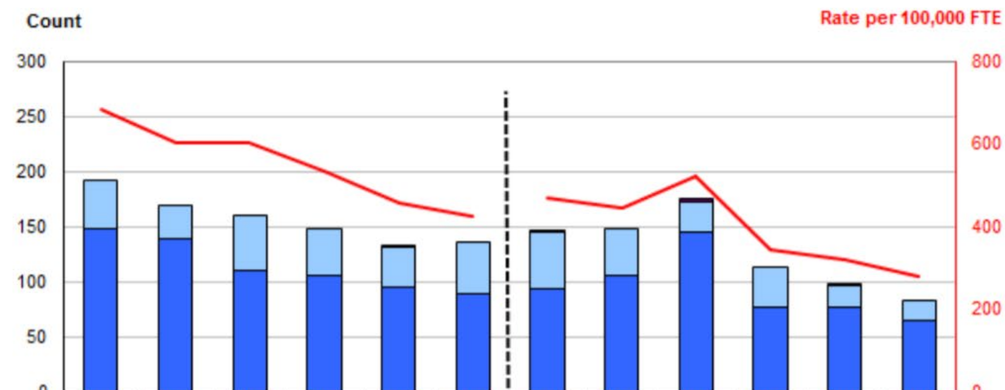
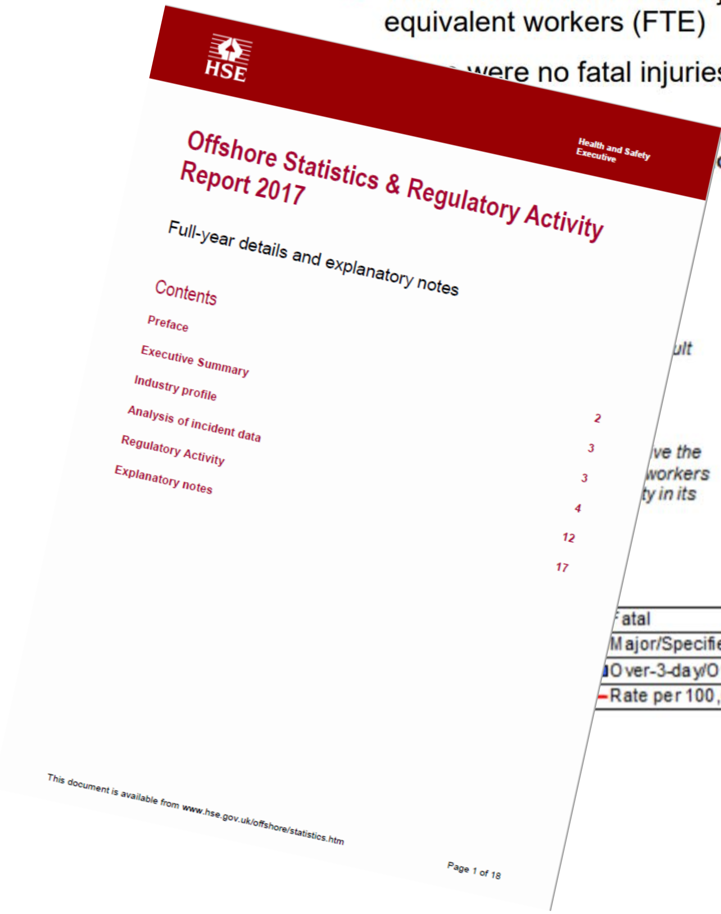


	07/08	08/09	09/10	10/11	11/12	12/13	2012	2013	2014	2015	2016	2017p
atal	0	0	0	0	2	0	1	0	2	0	1	0
Major/Specified	44	30	50	42	36	47	51	43	28	36	19	19
Over-3-day/Over-7-day	148	140	110	106	95	89	94	106	145	77	78	65
Rate per 100,000 FTE	682	602	602	535	458	428	469	447	521	346	323	282


HSE

Health and Safety Executive

Offshore Statistics & Regulatory Activity Report 2017

Full-year details and explanatory notes

Contents

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

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

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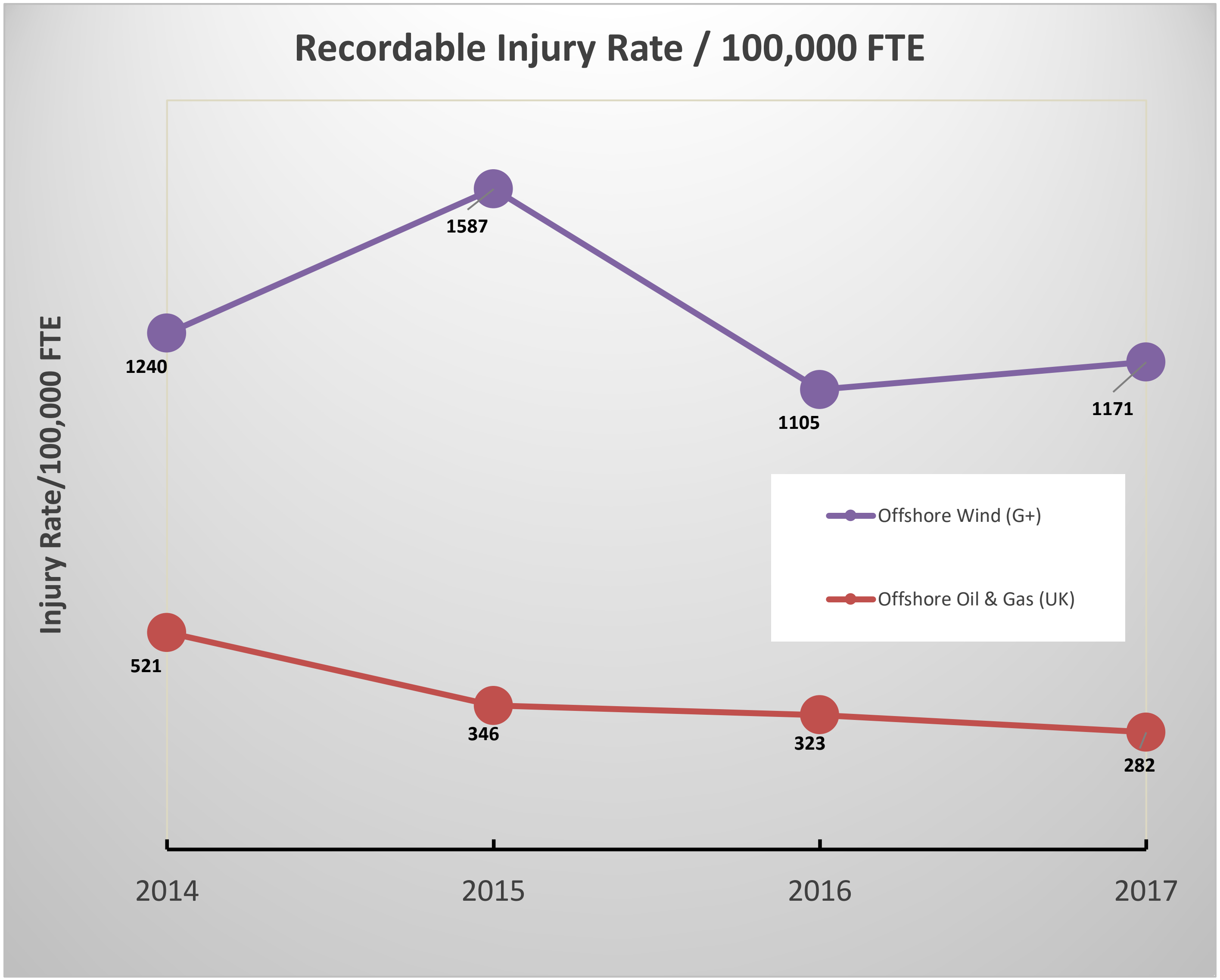
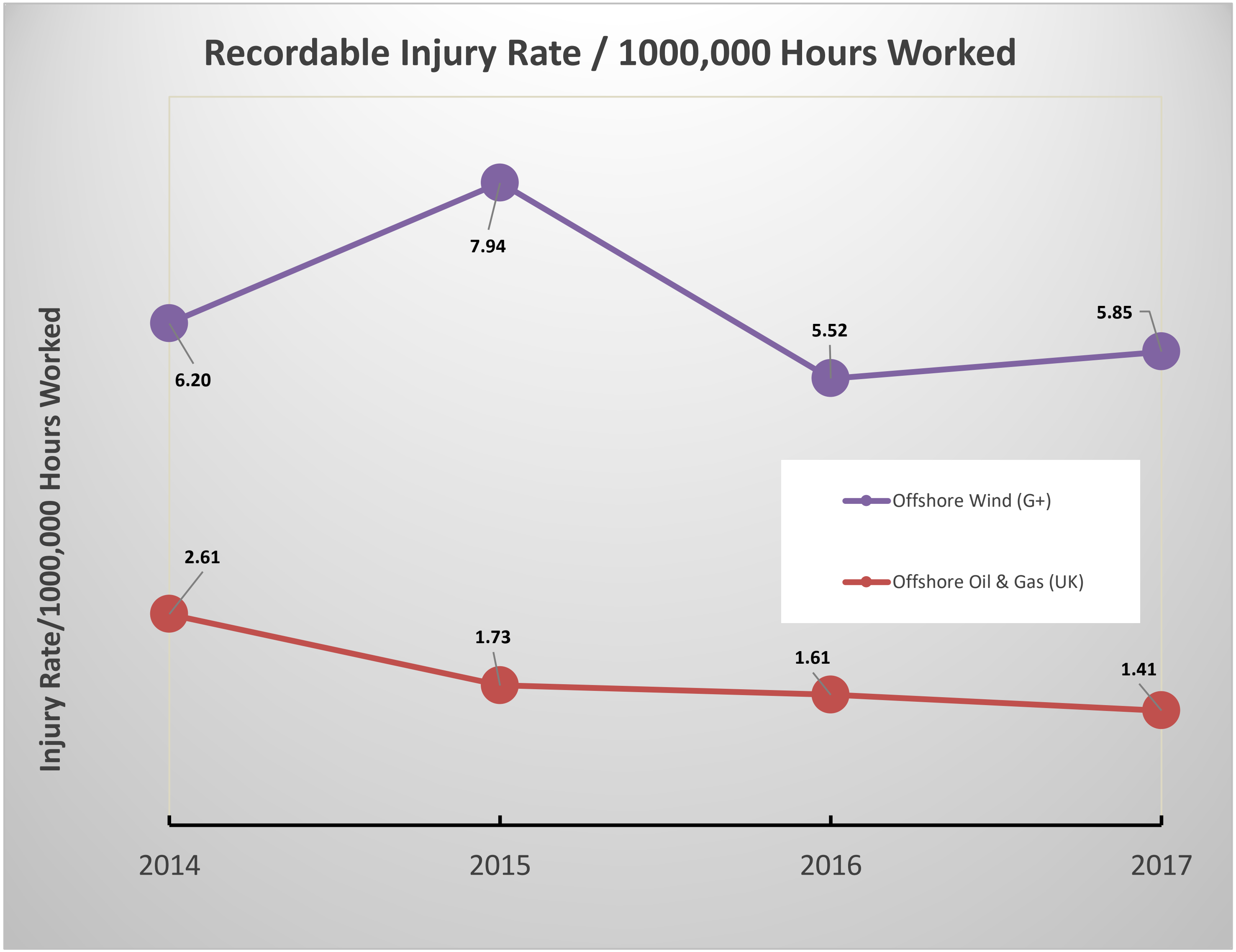
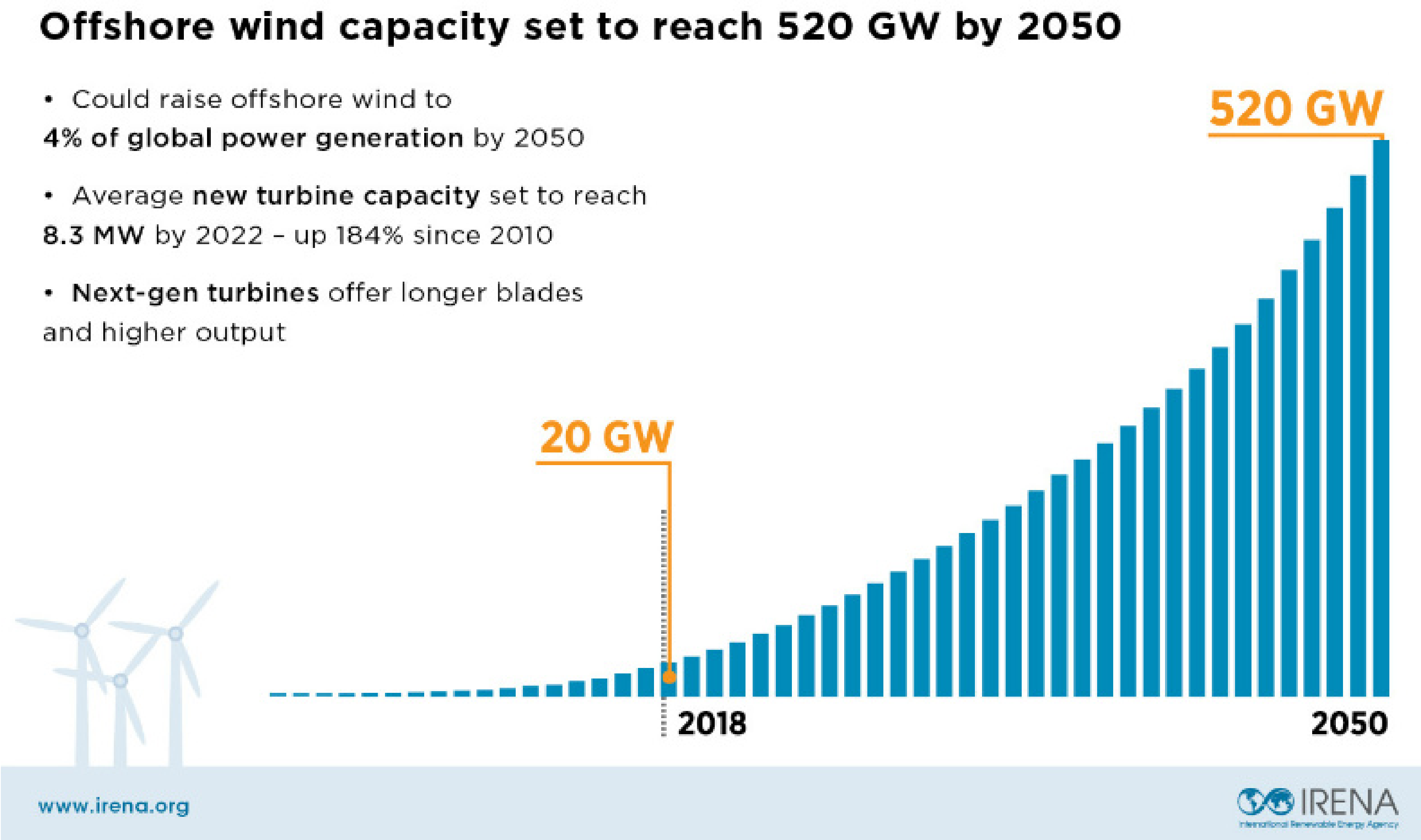
Oil & Gas TRIR Reporting Format



Offshore Wind TRIR Reporting Format



Grid Connected Wind Forecasts



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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