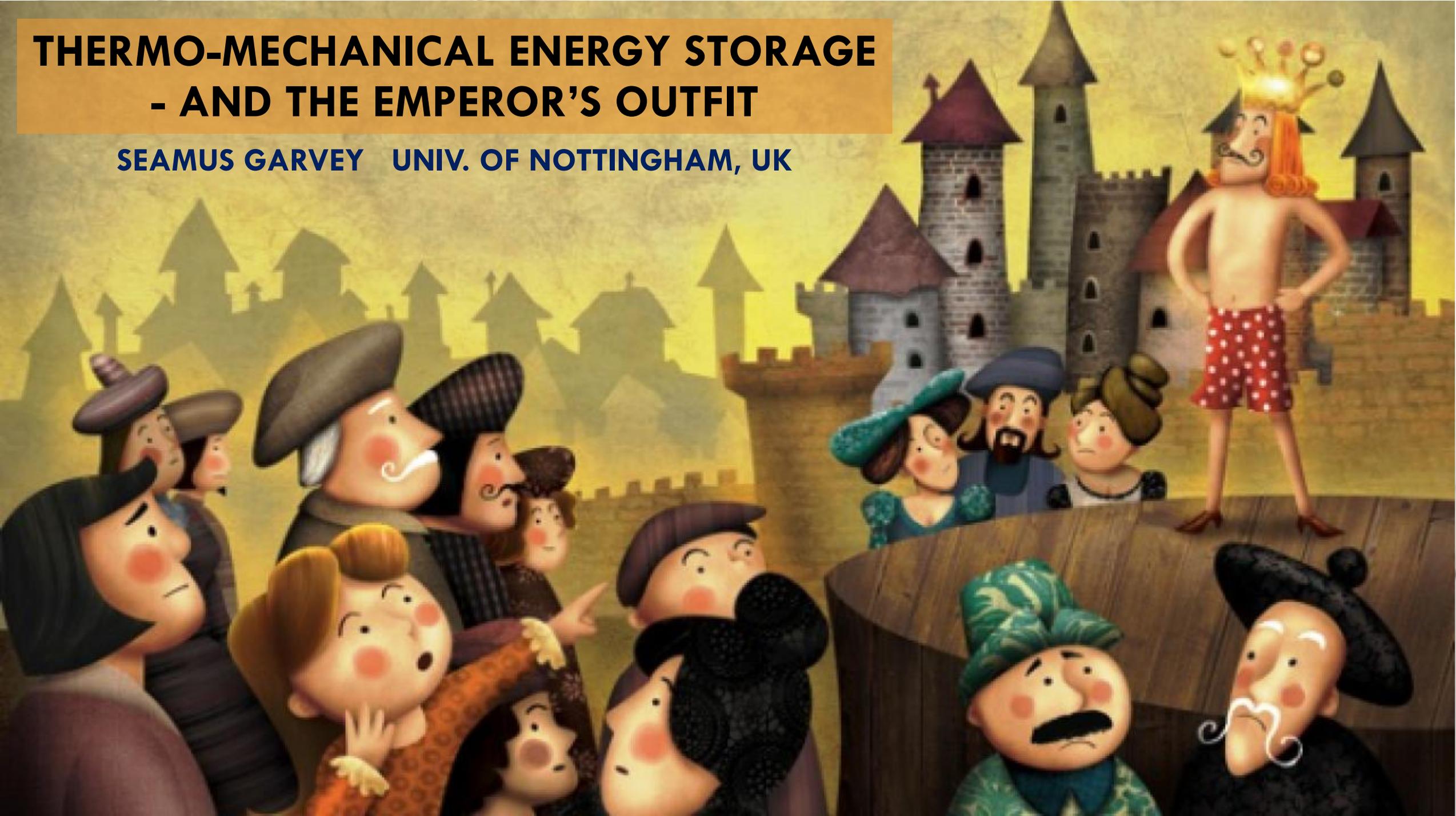


# THERMO-MECHANICAL ENERGY STORAGE - AND THE EMPEROR'S OUTFIT

SEAMUS GARVEY UNIV. OF NOTTINGHAM, UK



# CONTENTS OF THIS TALK

- I. T.M.E.S. = THERMO-MECHANICAL ENERGY STORAGE
- II. WHY IT SHOULD BE A GOLDEN TIME FOR T.M.E.S.
- III. ALAS, THE EMPEROR IS NOT GETTING THE MESSAGE

# THERMO-MECHANICAL ENERGY STORAGE (TMES)

TMES includes

- Compressed air energy storage
- Pumped thermal energy storage
- Liquid air energy storage
- Pumped hydro
- Other “through-flow” gravitational potential energy storage
- Non “through-flow” gravitational potential energy storage
- Flywheels

This presentation focuses on the “longer-duration” TMES options.

# THERMO-MECHANICAL ENERGY STORAGE (TMES)

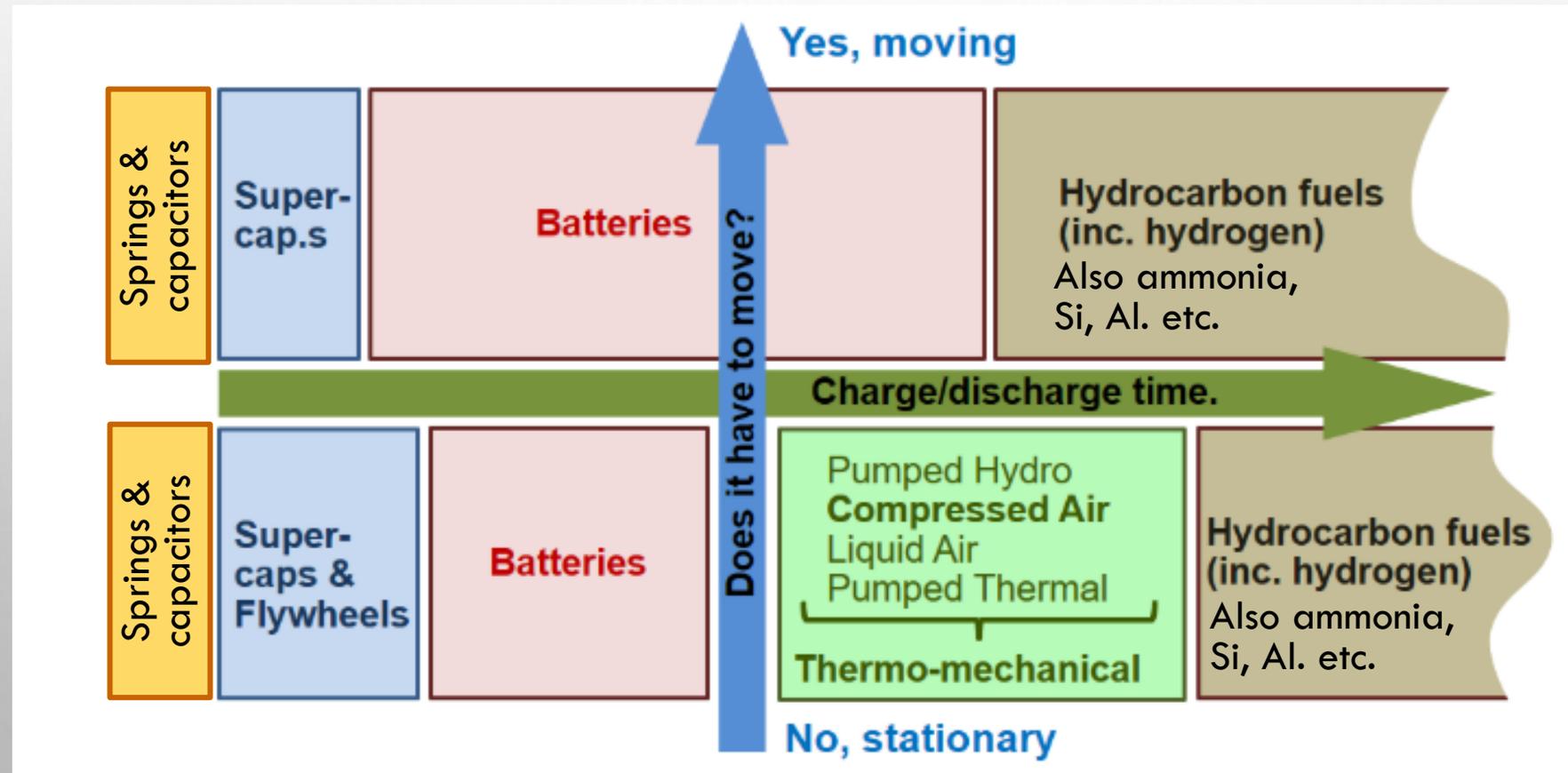
TMES systems are generally characterised by these attributes ...

- **Competitive for medium-duration (4hrs – 200hrs) charge/discharge durations**
- Separate parts of system for power conversion and for energy storage.
- Naturally long life in calendar years (also in cycles but this less relevant)
- **Good economics depends on large scale** in most cases.
- No requirement for mining rare / ethically-dubious elements
- Generally well suited to existing UK industrial expertise
- Generally very good customers for a steel industry
- “Medium” levels of turnaround efficiency (normally 60% - 80%)
- Relatively low energy per unit volume (more like 5-100kJ/litre than 2000kJ/litre)
- Relatively low energy per unit mass (more like 5-100kJ/kg than 900kJ/kg)

(LAES has higher energy per unit mass & per unit volume than most other TMES systems)

# THERMO-MECHANICAL ENERGY STORAGE (TMES)

A 2-axis categorisation of energy storage.



# TIMES SHOULD BE GOOD FOR T.M.E.S.

Renewable energy now has lowest LCoE for new generation:



**PV in Portugal: Bid at €14.7/MWh. July 2019**  
<https://www.businessgreen.com/bg/news/3079660/reports-portugal-solar-auction-attracts-record-low-bids>



**The trend of rapidly falling PV prices – ongoing**  
<https://electrek.co/2017/11/16/cheapest-electricity-on-the-planet-mexican-solar-power/>

# TIMES SHOULD BE GOOD FOR T.M.E.S.

Renewable energy now has lowest LCoE for new generation:

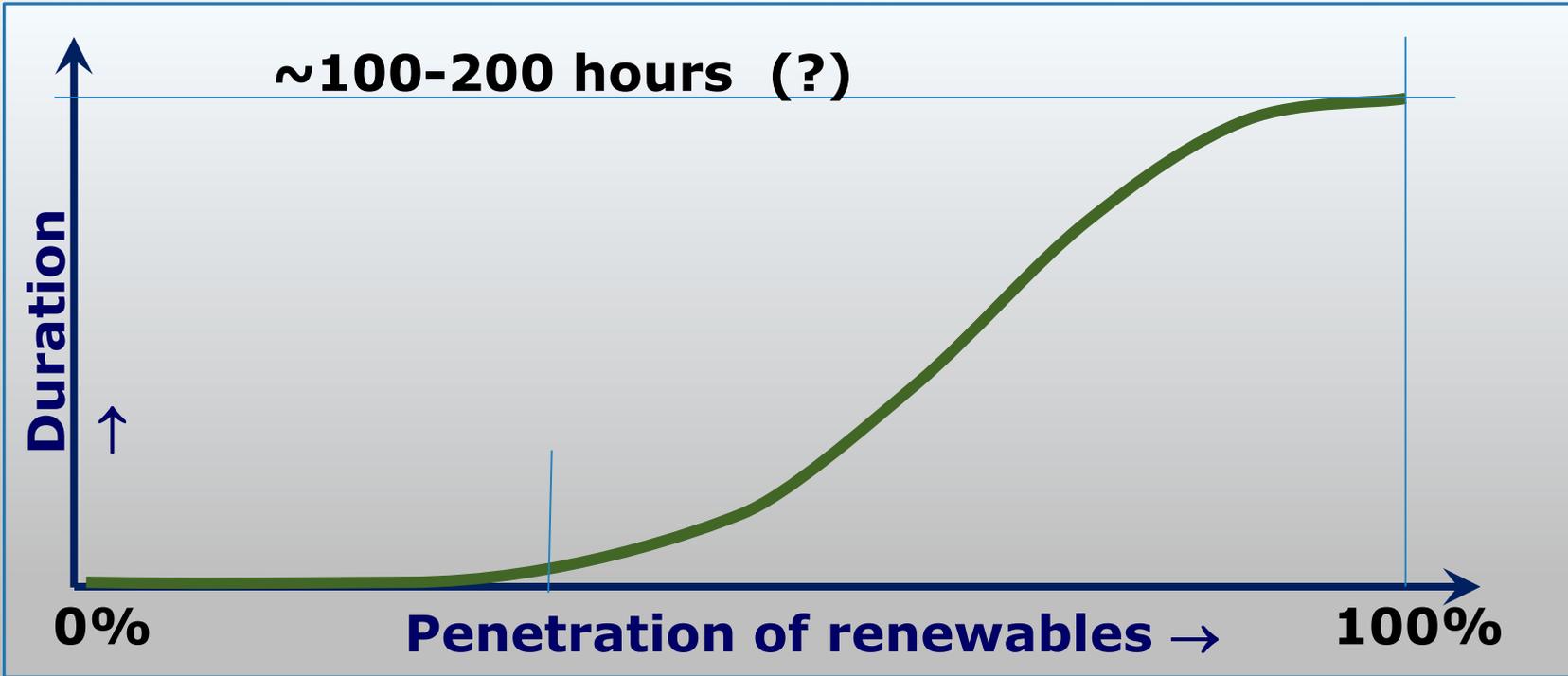


Global Offshore  
Wind Conference  
London, June 2017

**||** We expect to see average auction prices of €30-40/MWh over most European markets by 2025

# TIMES SHOULD BE GOOD FOR T.M.E.S.

With the correct blend<sup>¥</sup> of wind & PV, the UK could be run 100% from renewables.  
If that was to be done ... “medium-duration” storage would be essential



¥ Depending on the degree of over-capacity selected this blend is ~ 80:20 by total energy generated.

# TIMES SHOULD BE GOOD FOR T.M.E.S.

MARCH 7<sup>TH</sup>, 2019: CLAIRE PERRY ANNOUNCED THE OFFSHORE WIND “SECTOR DEAL” IN THE UK

<https://www.gov.uk/government/news/offshore-wind-energy-revolution-to-provide-a-third-of-all-uk-electricity-by-2030>



# ALAS AND ALACK !!

# ../CNTD.



The CCC reports consistently declare that **Carbon Capture and Storage (CCS)** is essential but give essentially **zero attention to any energy storage other than batteries and hydrogen.**

# ALAS AND ALACK !!

# ../CNTD.

MAY 21<sup>ST</sup>, 2019: TASK FORCE  
ANNOUNCED TO EXPLORE  
WAYS TO INTEGRATE MORE  
OFFSHORE WIND

[https://renews.biz/  
53299/uk-seeks-offshore-  
integration-solutions/](https://renews.biz/53299/uk-seeks-offshore-integration-solutions/)



***The group will publish a road map identifying pioneering techniques, such as using electricity from offshore wind to generate and store hydrogen as a power source. It will also examine how to introduce more flexibility into our energy system, for example by expanding battery storage and the use of demand side response (which enables consumers to take advantage of low electricity prices at certain times of day).***

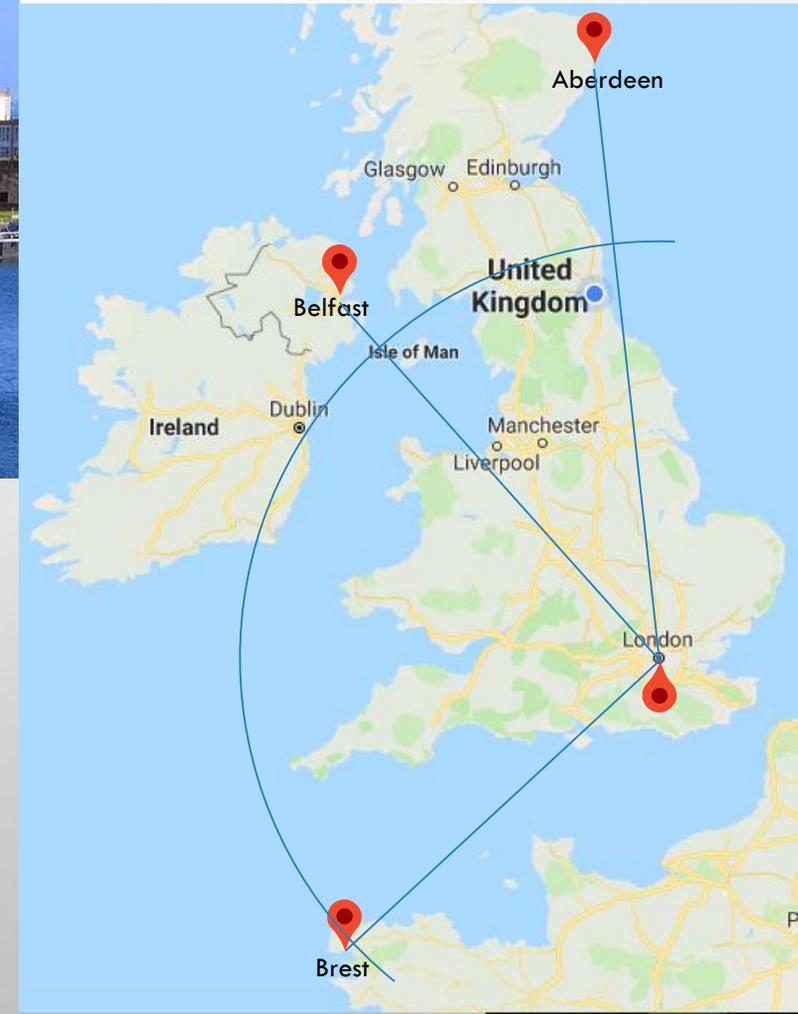
# ALAS AND ALACK !!



**OSES = Off Shore Energy & Storage conference.**

**OSES2019** was the sixth in the series.

BEIS, Carbon Trust, ORE Catapult, Crown Estate, Task Force etc. ... invited to participate (especially in final session on *Getting the Message Across*. “No budget for international travel.”



ALAS AND ALACK !!

../CNTD.

Renewable UK response to Greg Clarke's announcement of Faraday Challenge funding (£246M, July 2017)...

*Battery energy storage is the missing piece of the puzzle ...*

March 2019, *Storage at Scale* competition ... potentially good for TMES ... but

- £20M to fund 2-3 projects
- Minimum TRL 6



# THANKS FOR LISTENING.

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Innovate UK

