Resilience assessment of offshore wind to green hydrogen production systems

Ofgem Strategic Innovation Fund project:
Hydrogen Cost Reduction – HyCoRe (Alpha)

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From Newcastle. For the world.

In a nutshell

In this work we explored:

How to assess and quantify an offshore wind to hydrogen system configuration from a perspective of resilience and robustness, so that this can be accounted for in strategic and investment decisions.

1. Why hydrogen?

2. The project

3. Our task

What next?

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What next?

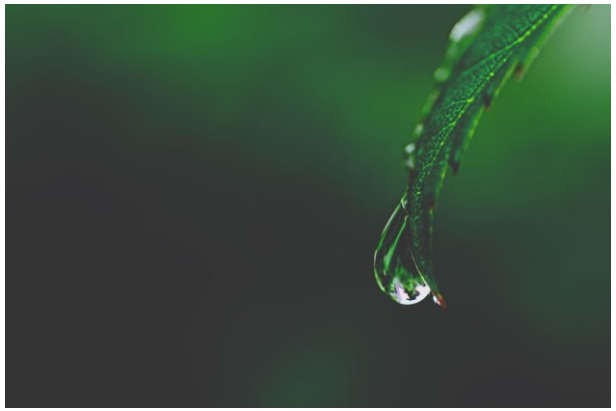
Hydrogen : Challenges & opportunities

Why do we need hydrogen?

Transport , Electricity generation & Industry

Why do we need to produce it?

Hydrogen is rarely found ‘alone’ in nature



Why in the UK?

Low carbon hydrogen may comprise 20-35% UK final energy consumption by 2050

Source (right box) | UK Parliament (2023), First Special Report - The role of hydrogen in achieving Net Zero: Government Response to the Committee’s Fourth Report - Science and Technology Committee | Images: PowerPoint stock images

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Project partners

Northern Gas Networks
Lead funding licensee

Newcastle University

Arup

Kinewell Energy

Offshore Renewable Energy Catapult

Unasys

National Gas Transmission

Project summary

Project Aim

Identify UK regions with strong potential for green hydrogen

National Modelling

Identify high-potential areas based on offshore/onshore constraints and opportunities

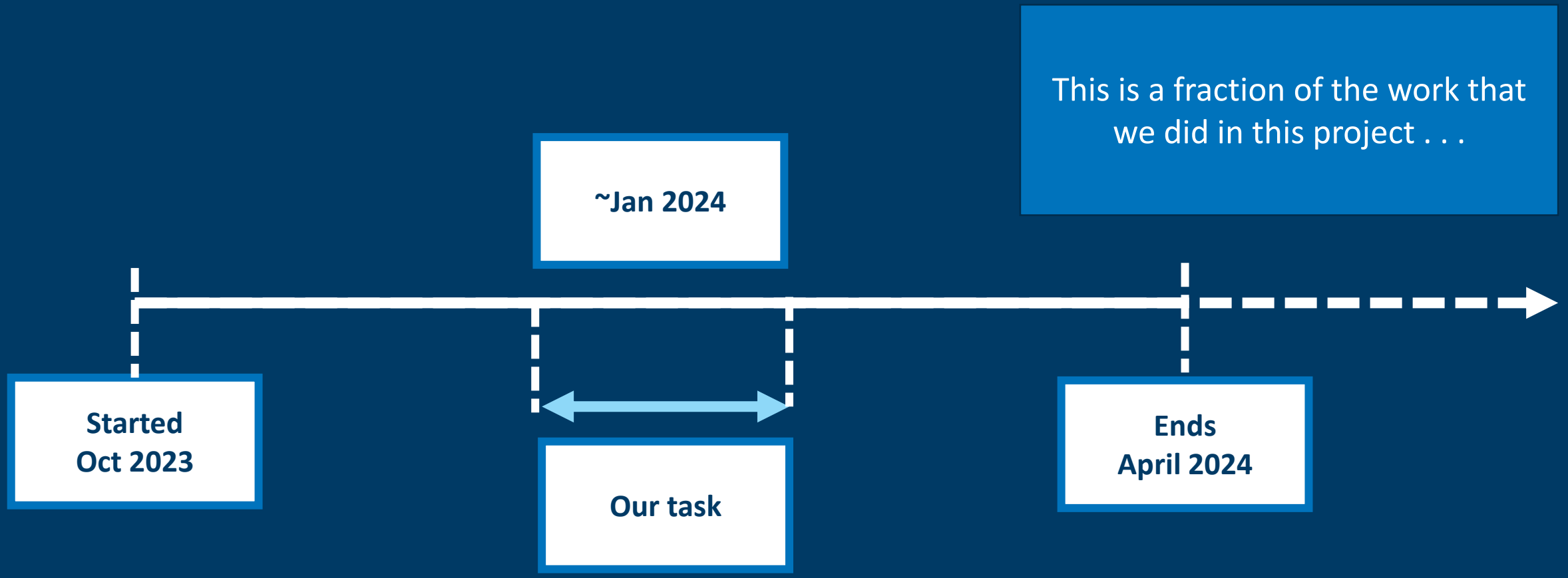
Technical challenges assessment

Identify technical challenges that may impede deployment and design/optimisation of test/validation solutions to de-risk technology pathways

Modelling of a selected regional specific solution

Understand infrastructure solutions that will provide connectivity between offshore wind production areas and energy consumers/gas network

Timeline


This is a fraction of the work that we did in this project . . .
~Jan 2024
Started Oct 2023
Our task
Ends April 2024

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Background - Reliability analysis

Definition

‘Reliability is defined as the ability of an item to perform a desired function under the stated conditions at a particular time interval’

Source | O. Alavi et al, International Journal of Hydrogen Energy 42 (2017) 14968-14979

Reliability indicators

Failure rates
Mean time to failure/repair
Availability

(*per component*)

Source | O. Alavi et al, International Journal of Hydrogen Energy 42 (2017) 14968-14979

Resulting in the question:

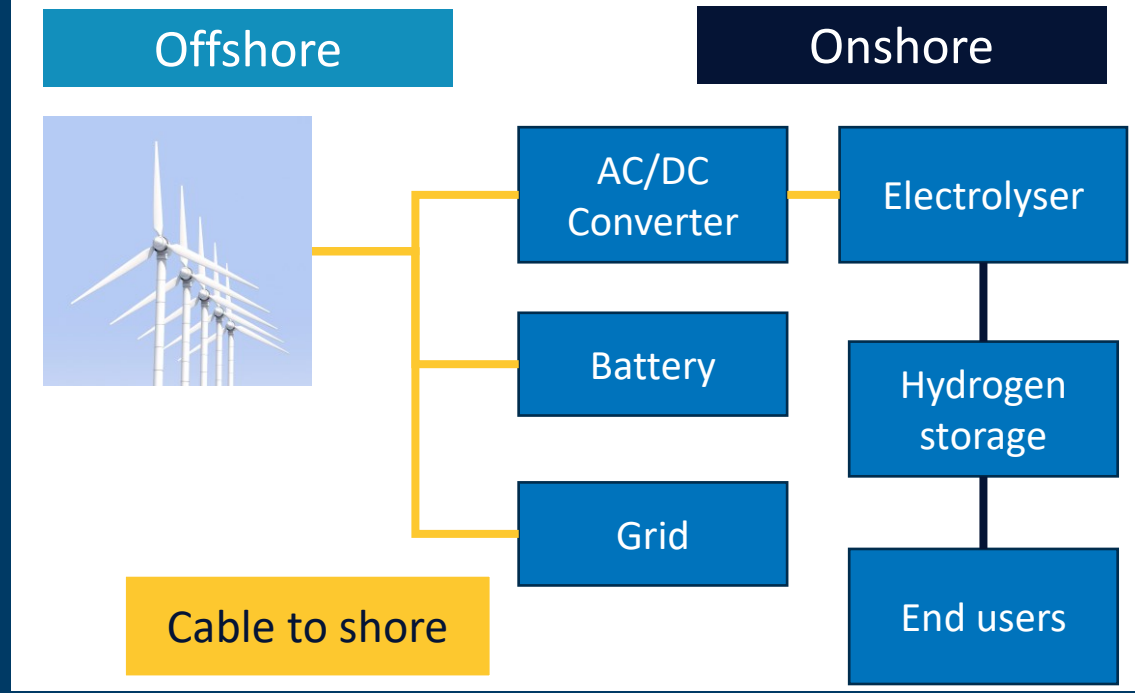
Cables and Pipelines have different failure rates

Could this mean that one make a more resilient/robust configuration than the other?

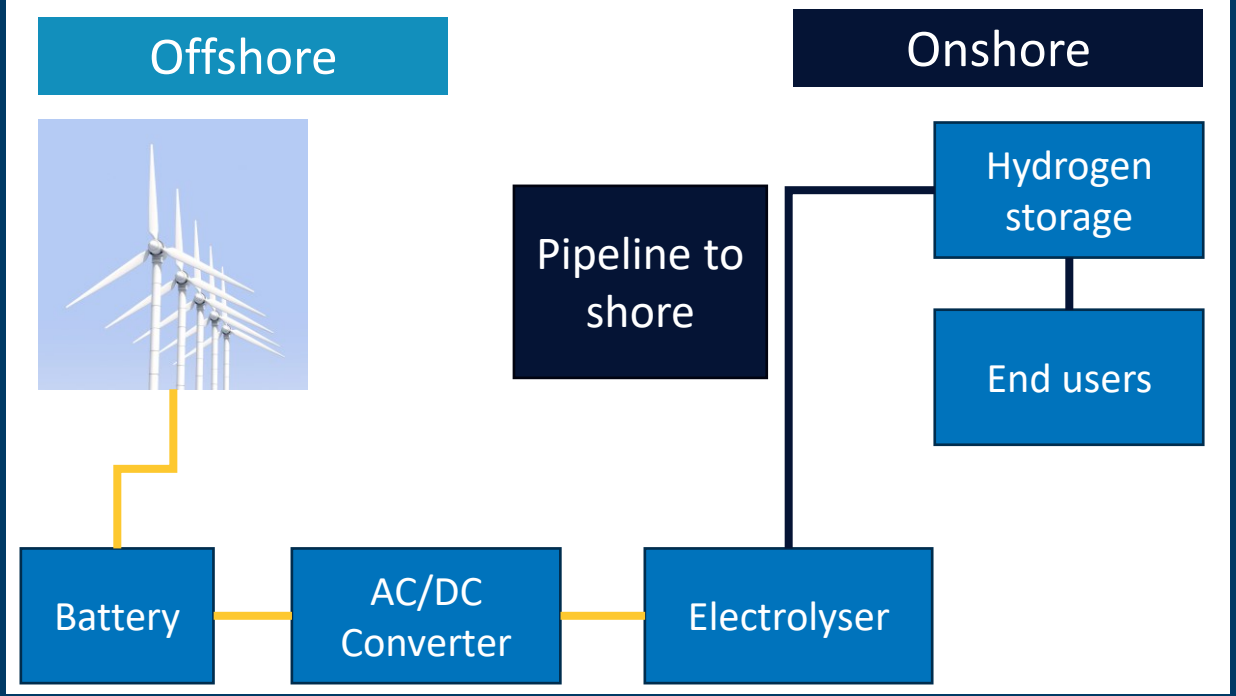
How can this be assessed/quantified?

System configuration not standardised

Onshore electrolysis



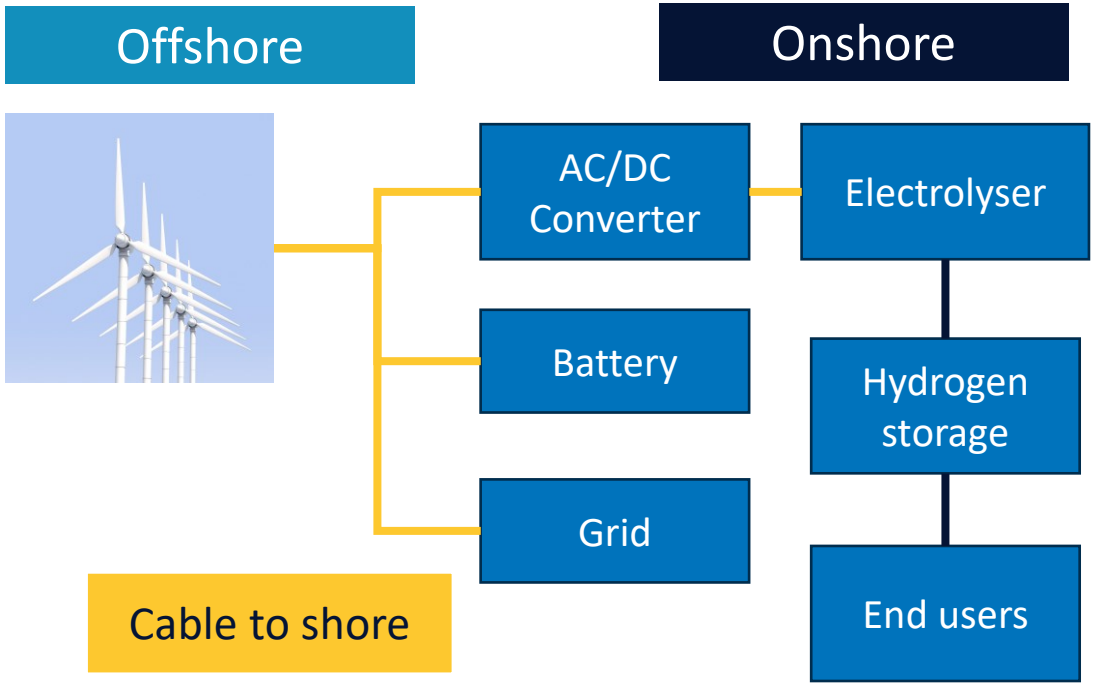
Offshore electrolysis



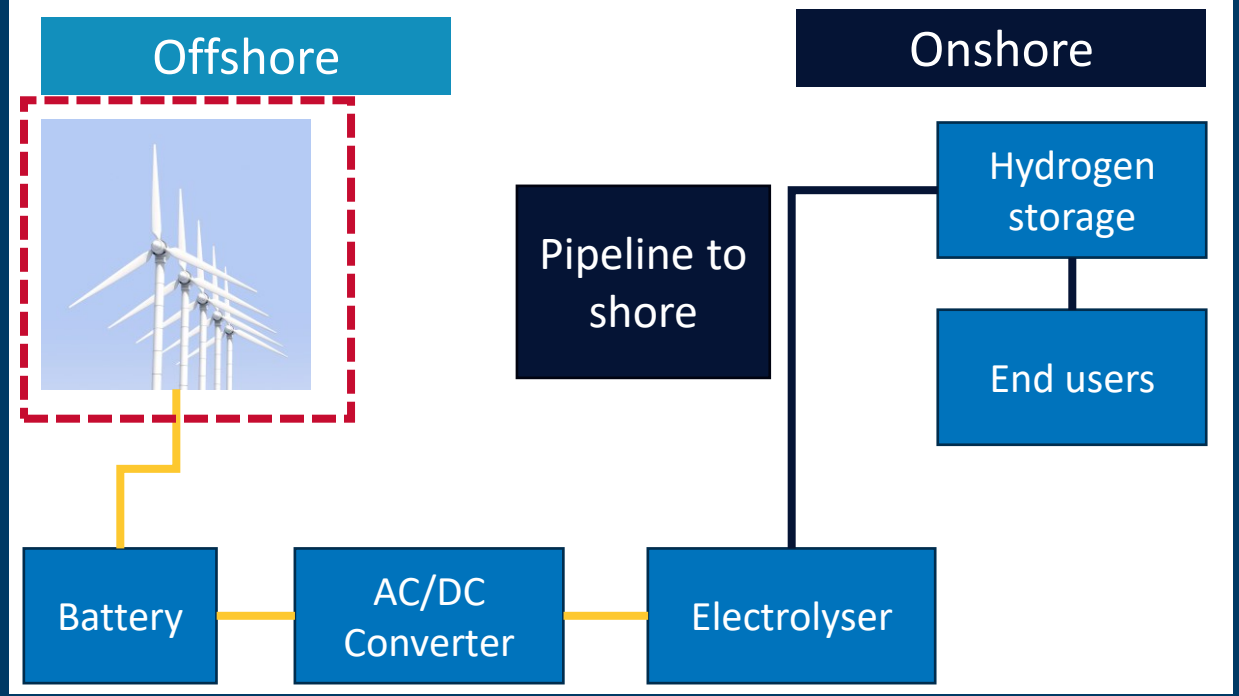
Source | **ORE Catapult (2020), OSW-H2: Solving the Integration Challenge (Public Report)**
Images: Powerpoint stock images

Offshore: Centralised/Distributed configuration

Onshore electrolysis



Offshore electrolysis



Source (Public reports) | ORE Catapult (2020), OSW-H2: Solving the Integration Challenge | ORE Catapult (2020), MH:EK Longer Time-Horizon Energy Generation Development | Image: PowerPoint stock images

Step 1: Setting system's boundaries

Set system boundaries

System configuration

?

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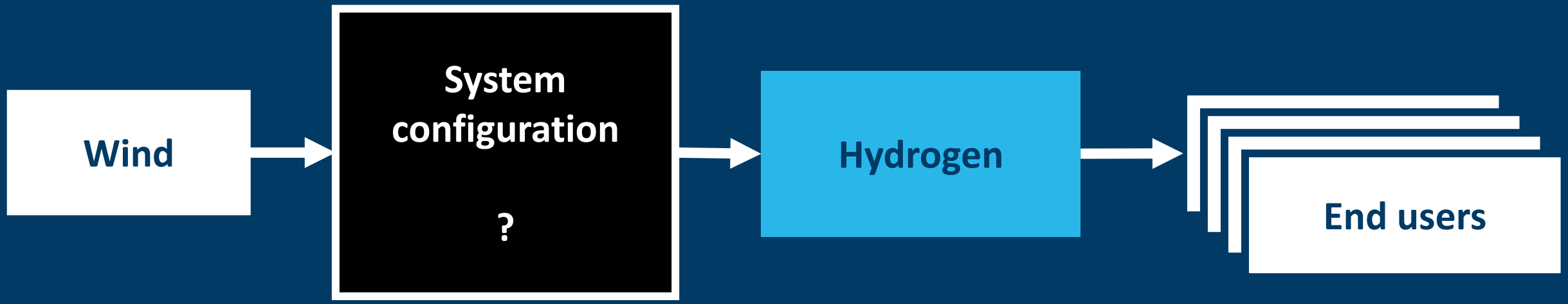
Set system boundaries



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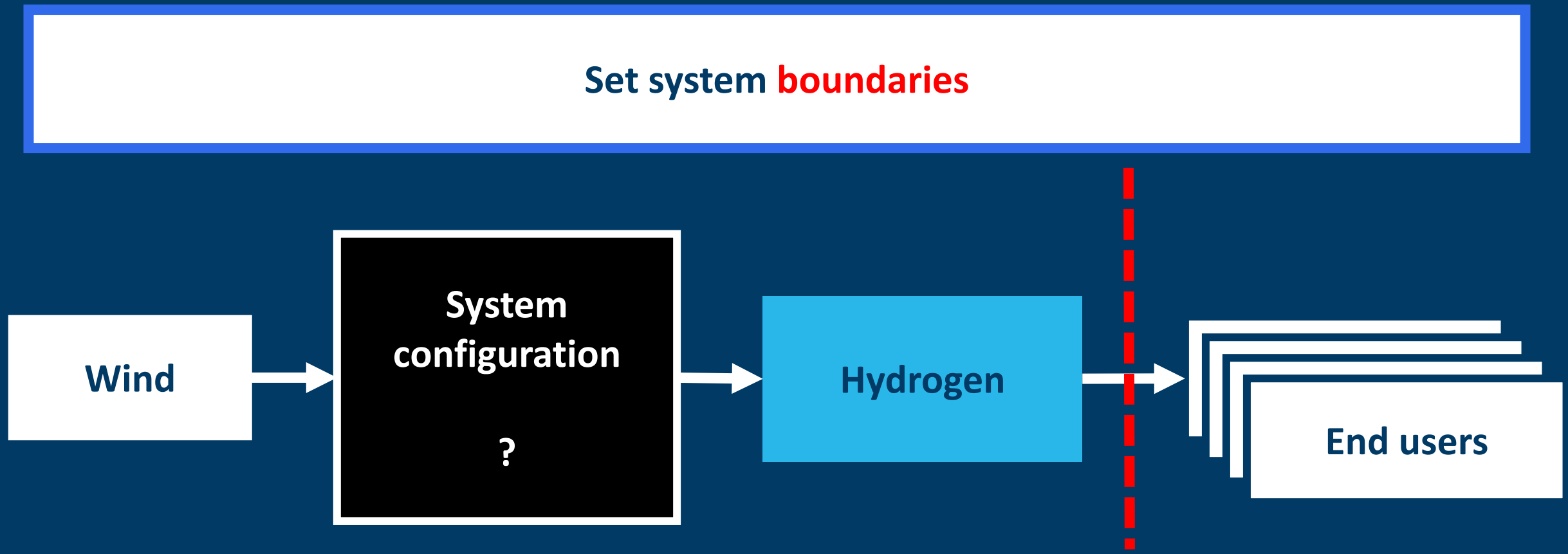


Step 2: Define resilience & robustness

Can hydrogen be supplied to end users?

+

Extreme, unprecedented external/internal events

Resilience

Minimal interruptions

Robustness

Keep level the required, despite extreme events

Resourcefulness

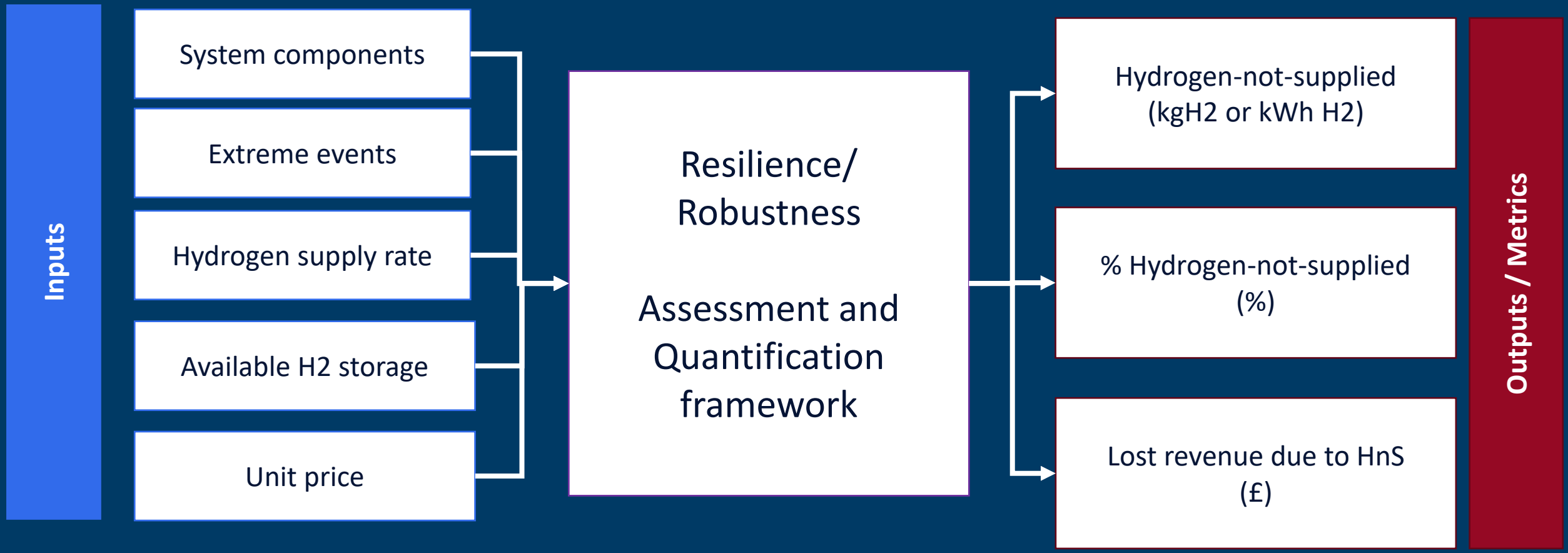
Available resources + £

Recovery

How fast can the system recover?

Reference | International Energy Agency (2015), 'Making the energy sector more resilient'

Step 3: Assessment framework & metrics



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What next?

What is the value of work in Alpha phase?

- Identified key aspects to assess resilience and robustness of systems that produce hydrogen from offshore wind

- Proposed three metrics to quantify the resilience and robustness of such systems

What do we need to do for this to demonstrate an actual solution?

- Incorporate resilience as a key strategic metric in regulatory frameworks

- This requires the development of a **formal methodology** for the assessment of resilience and associated standard resilience metrics

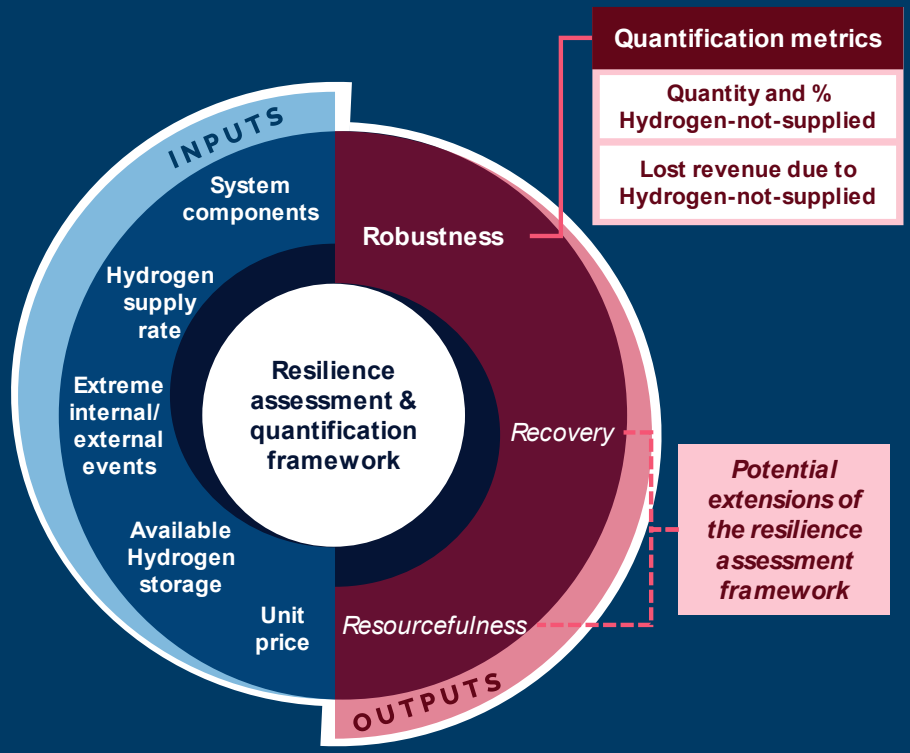

Figure | *Resilience and robustness assessment & quantification framework of HyCoRe (Alpha), indicating paths for future work*

‘Every scientist should be delighted if they are shown to be wrong, because the moment you’re shown to be wrong, it means you’ve learnt something, and that’s the way that knowledge progresses.’

Brian Cox, PhD
Big Think YouTube channel

Thank you.

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