

The background of the slide is a 3D-rendered landscape. In the foreground, there are two large rectangular arrays of white solar panels. To the right of these panels, a white high-speed train is shown moving across a dirt path. In the middle ground, there is a large field of solar panels. In the background, several wind turbines are scattered across a rolling landscape under a bright, hazy sky. The sun is visible on the left side, creating a lens flare effect.

Catalysing hydrogen investment

What steps do we need to take

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October 2021

Catalysing hydrogen investment

What the market needs to deliver investment in hydrogen infrastructure



<https://www.arup.com/perspectives/publications/research/section/catalysing-hydrogen-investment>

Up to date research

Written by Arup in collaboration with the GIA, this report is centred on the **opinions of investors from around the world**, gathered through a survey of GIA members and in-depth interviews.

It therefore **presents the sentiments of the world's leading fund managers, insurance investors, pension funds and a sovereign wealth fund**. Their opinions matter because these are the decision makers that hold the purse strings when it comes to private sector investment in hydrogen infrastructure.

Catalysing hydrogen investment

What the market needs to deliver investment in hydrogen infrastructure

GIIA

The Global Infrastructure Investor Association is a membership body representing the leading investors and advisers in global infrastructure.

GIIA works closely with policy makers, regulators and other industry bodies to achieve our shared ambition of increasing infrastructure investment around the world.

We aim to do this by building understanding of the positive role played by private investors in long-term infrastructure and helping to shape the policies that will facilitate further investment to meet the low carbon, digital and transport infrastructure requirements of the future.

Arup

Arup is a global independent firm of more than 15,000 designers, planners, engineers, architects, consultants and technical specialists, working across every aspect of today's built environment.

Arup is working across the globe on hydrogen projects, from strategy, through concept design and into construction.



The Climate Imperative

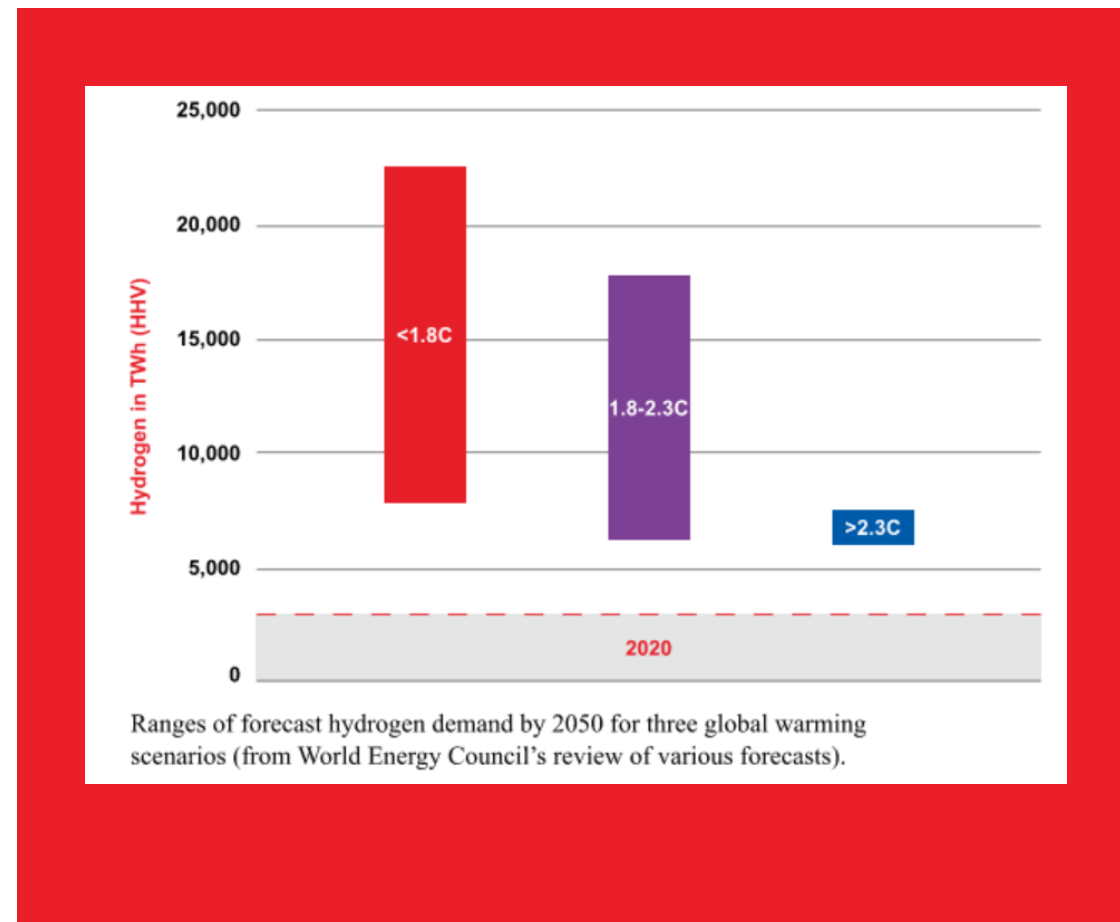
Its clear, and unequivocal

Need for hydrogen

- “immediate, rapid and large-scale cuts to greenhouse gas (GHG) emissions”

IPPC

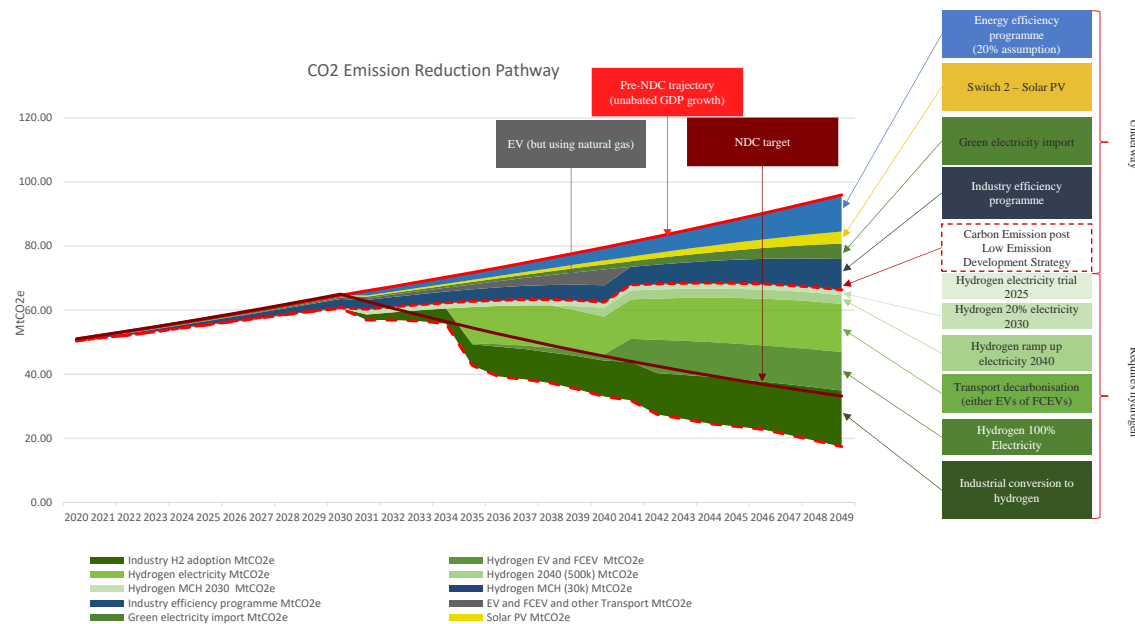
- World Energy Council suggests 6,000 – 25,000 TWh of hydrogen needed
- 75 Countries have announced net-zero ambitions



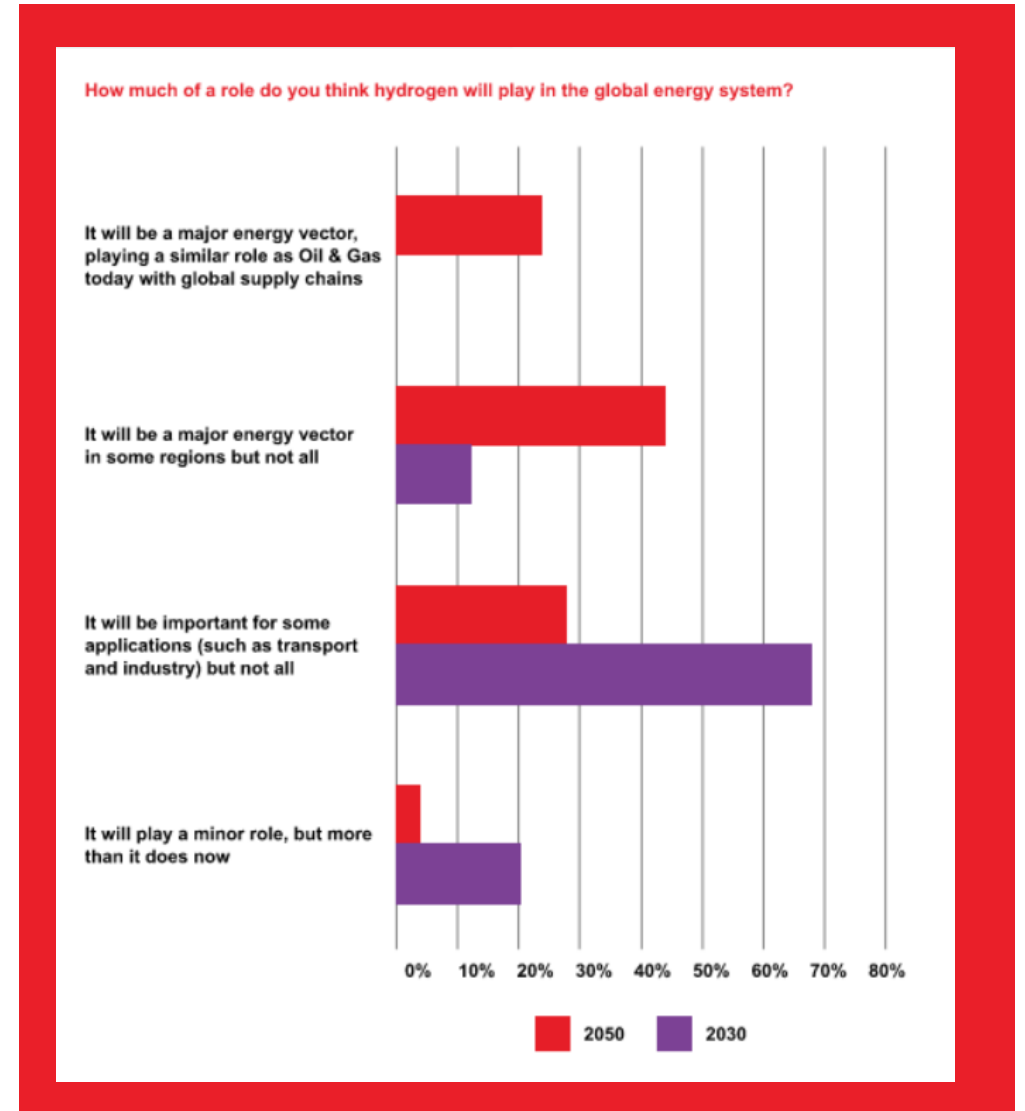
How big can hydrogen be?

Its clear it has a role, the question is how big

Regional hydrogen demand differences



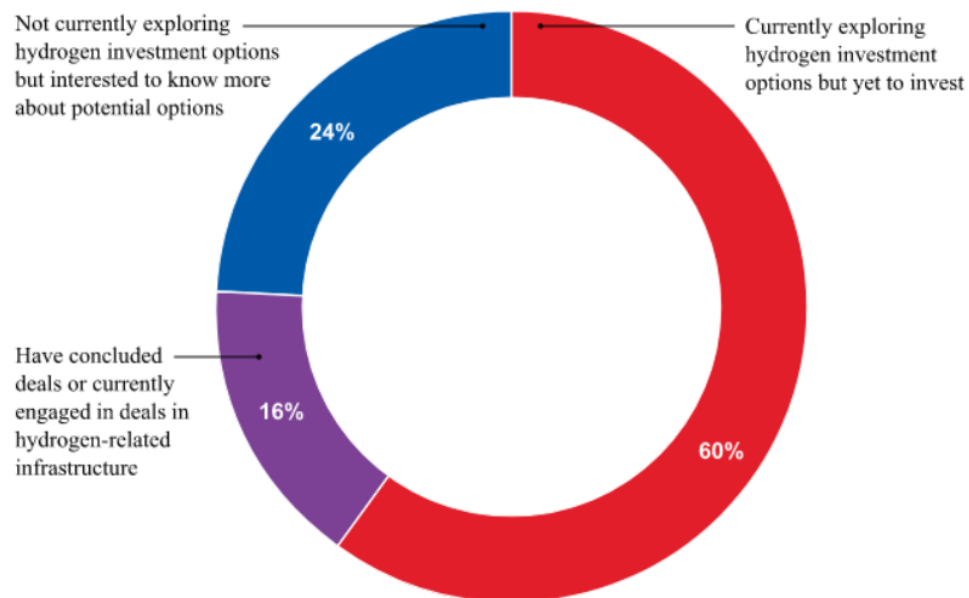
Source: Illustration of hydrogen need to decarbonize Singapore, Arup 2021



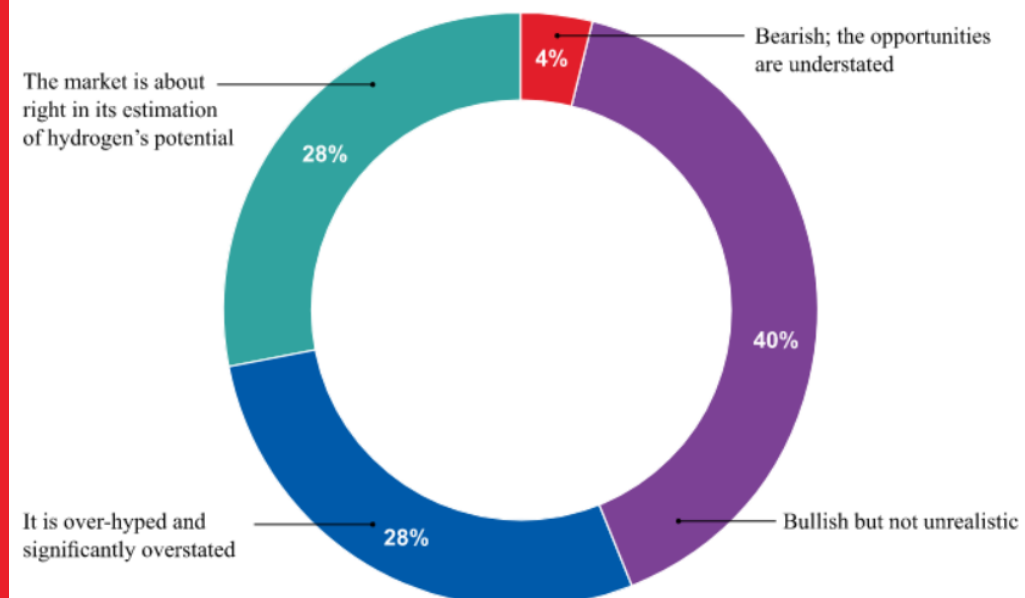
The Climate Imperative

Are we moving fast enough

What is the status of your organisation's approach to investment in hydrogen-related infrastructure?



What is your impression of the market's current attitude towards investment in hydrogen-related infrastructure?



Investment is starting from a low base but with potential to grow

Feedback from GIIA investor members

16%

Have concluded deals or are currently engaged in hydrogen-related deals

70%

Believe hydrogen will be important for some applications by 2030

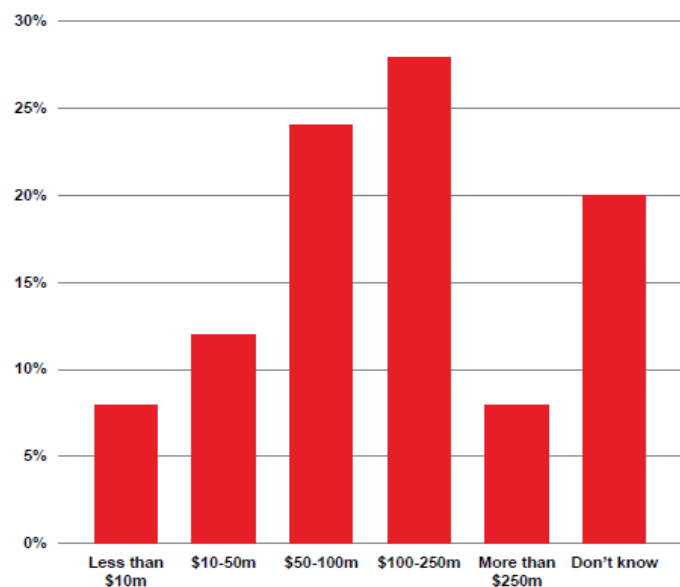
90%

Believe hydrogen will play some role in the future energy system

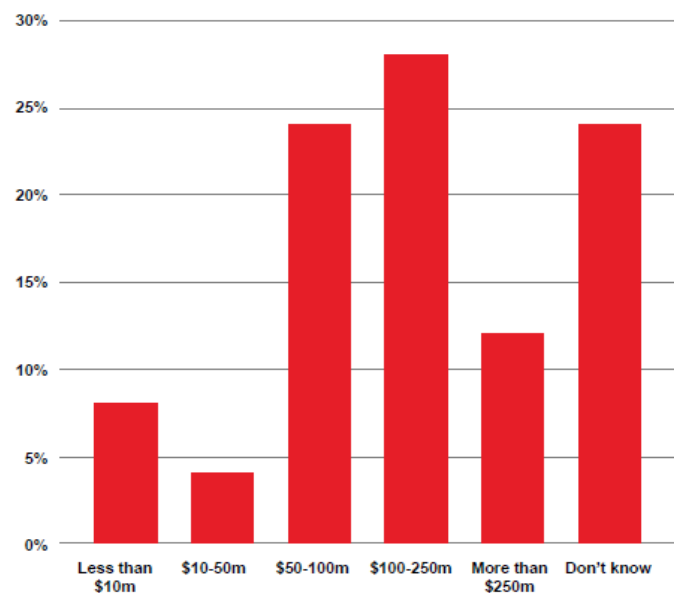
Expected levels of investment by 2025

What range of investment are you likely to make in each stage of the value chain by 2020?

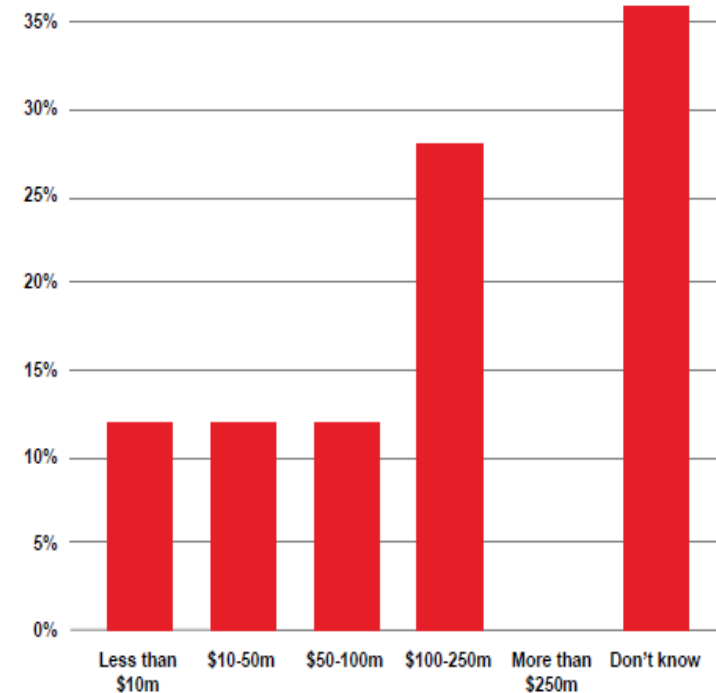
Production



Transport and storage



End-use



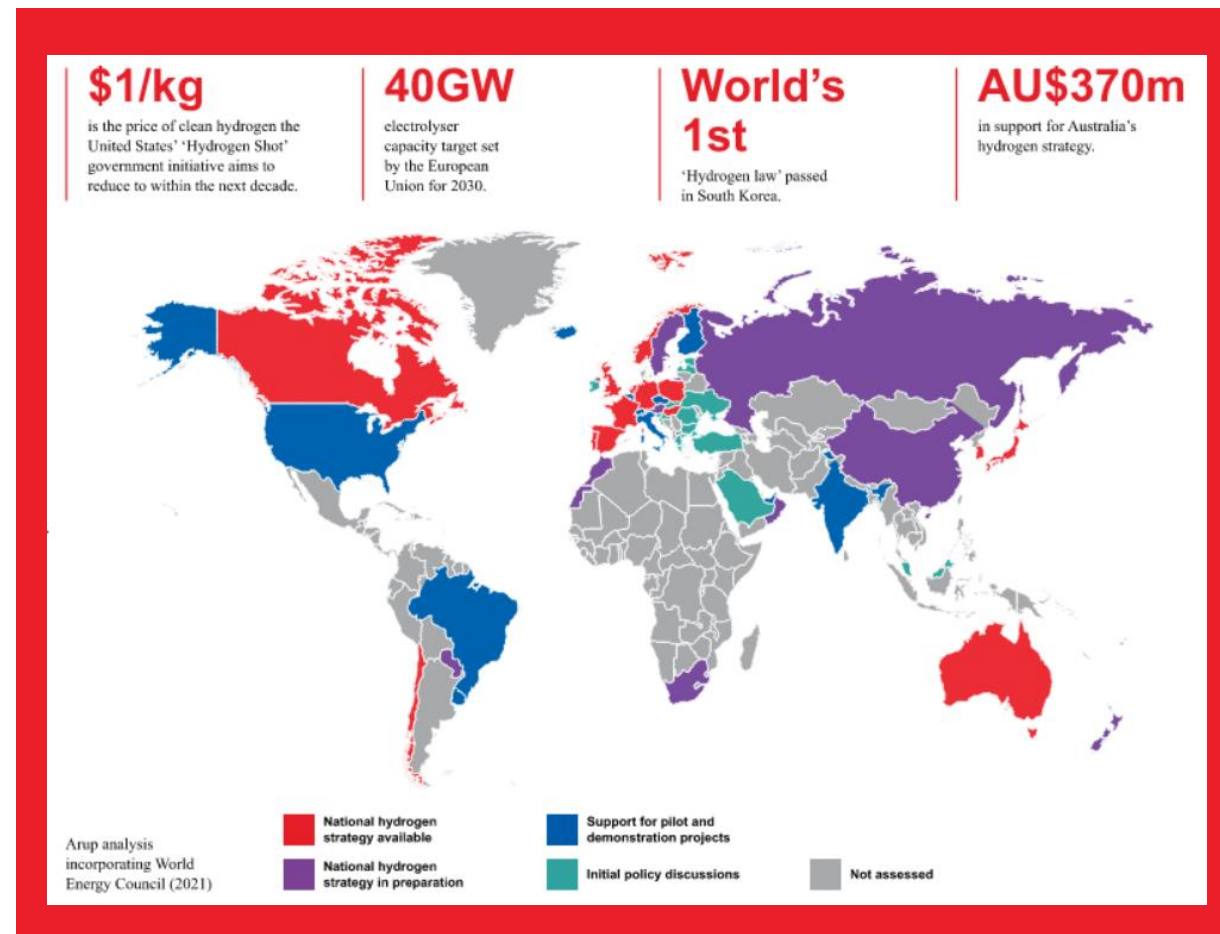
Gathering pace of hydrogen

30 countries have announced hydrogen strategies

Huge investment need

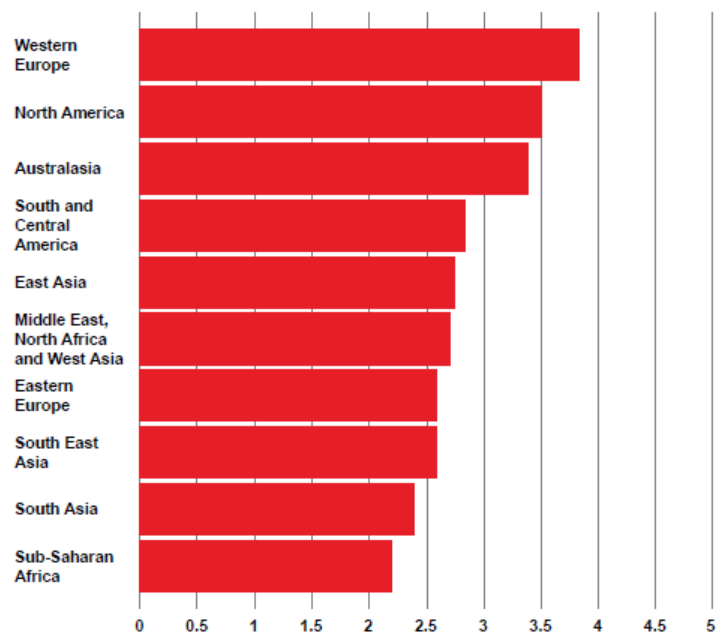
- **\$300bn** by 2030, **\$1.5tn** by 2050
- “When it comes to investment, it really comes down to having a clear understanding of risk and return. If there is a remuneration framework that makes it attractive, people will invest. But people don’t invest on government announcements of plans.”

North American Pension Fund

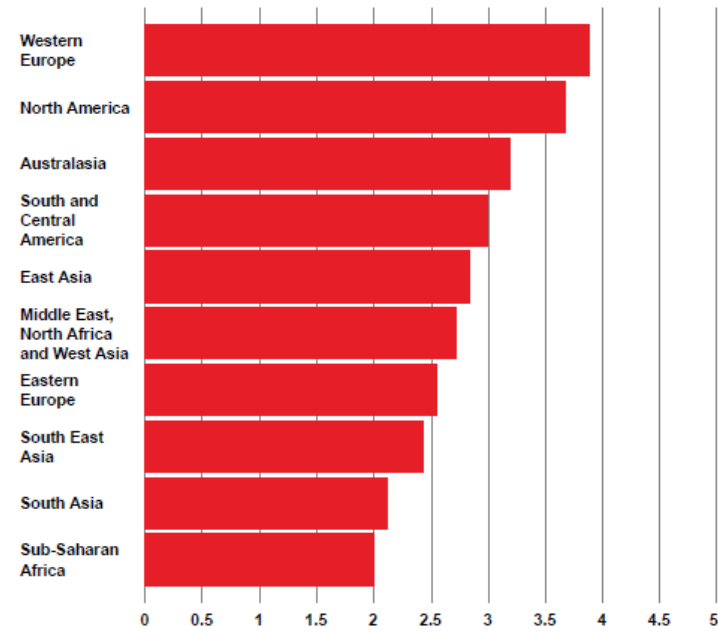


Western Europe, North America and Australasia are most attractive

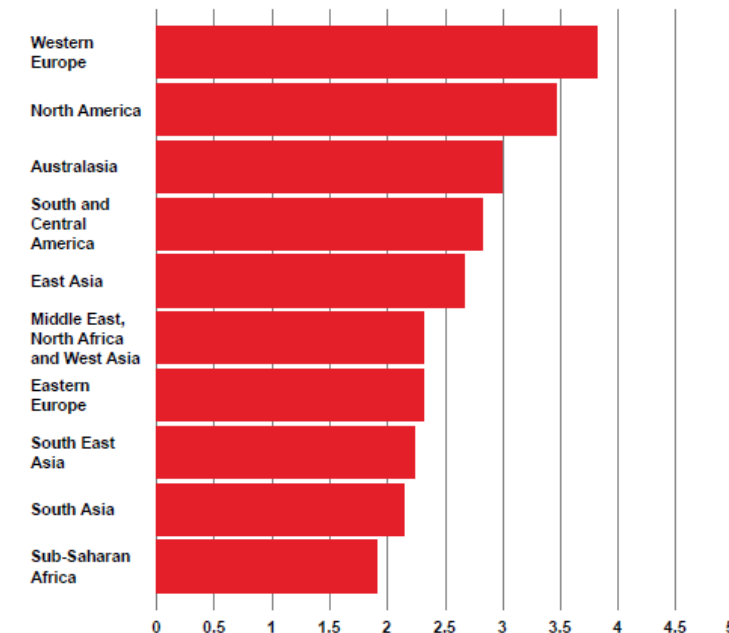
Attractiveness for investment at each stage in the value chain
(rating out of 5)



Production



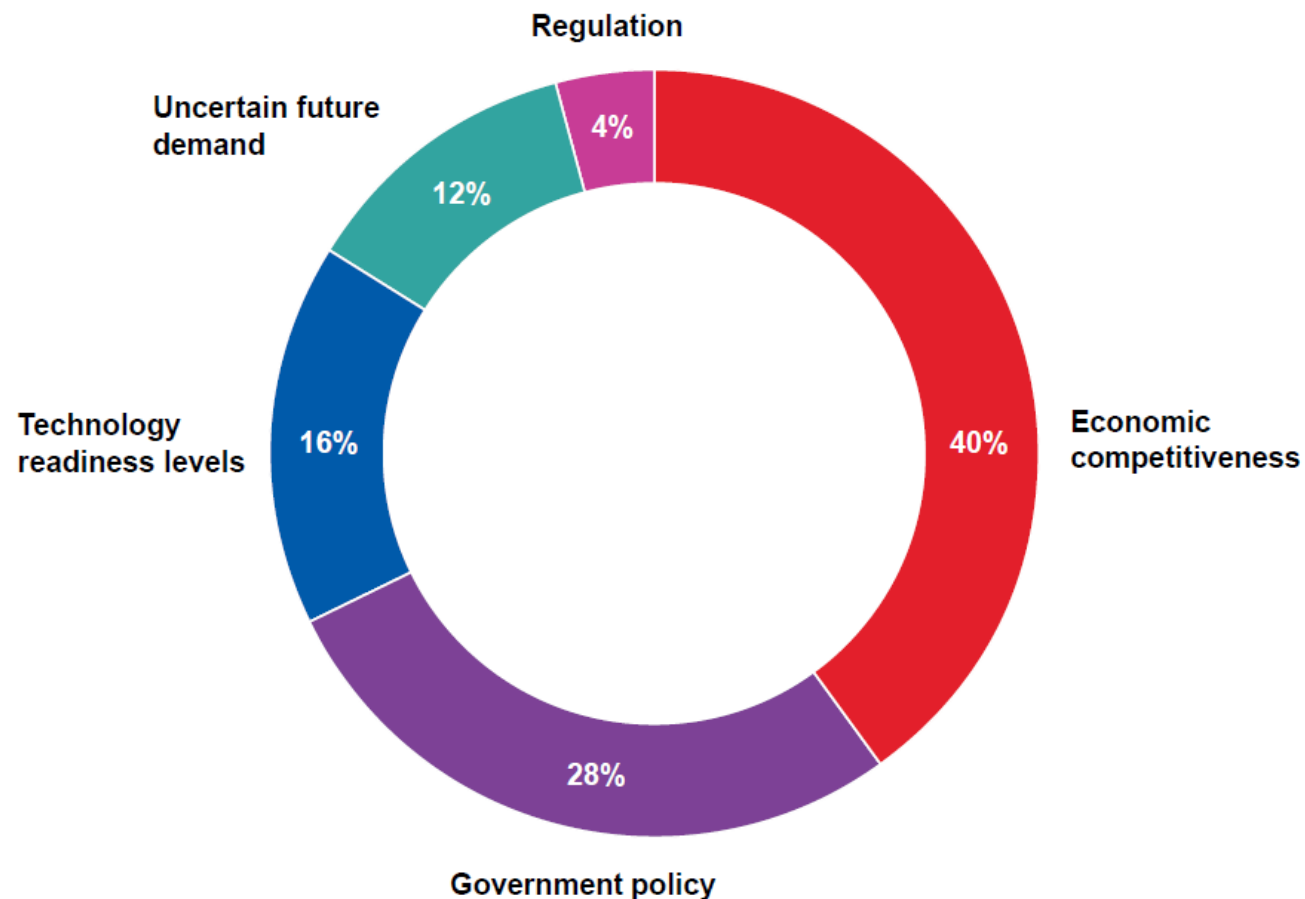
Transport and storage



End-use

Government policy support is needed to increase economic competitiveness

What is the biggest barrier to investment in hydrogen infrastructure?



“By 2040 create an economically viable hydrogen production facility providing London, and parts of south east England, with ultra low-carbon energy for transport, industrial use, power and heating, as well as supporting economic growth.”



The Project Cavendish Consortium

An evolving group of companies



nationalgrid
ventures



uni
per

JM Johnson Matthey
Inspiring science, enhancing life

nationalgrid



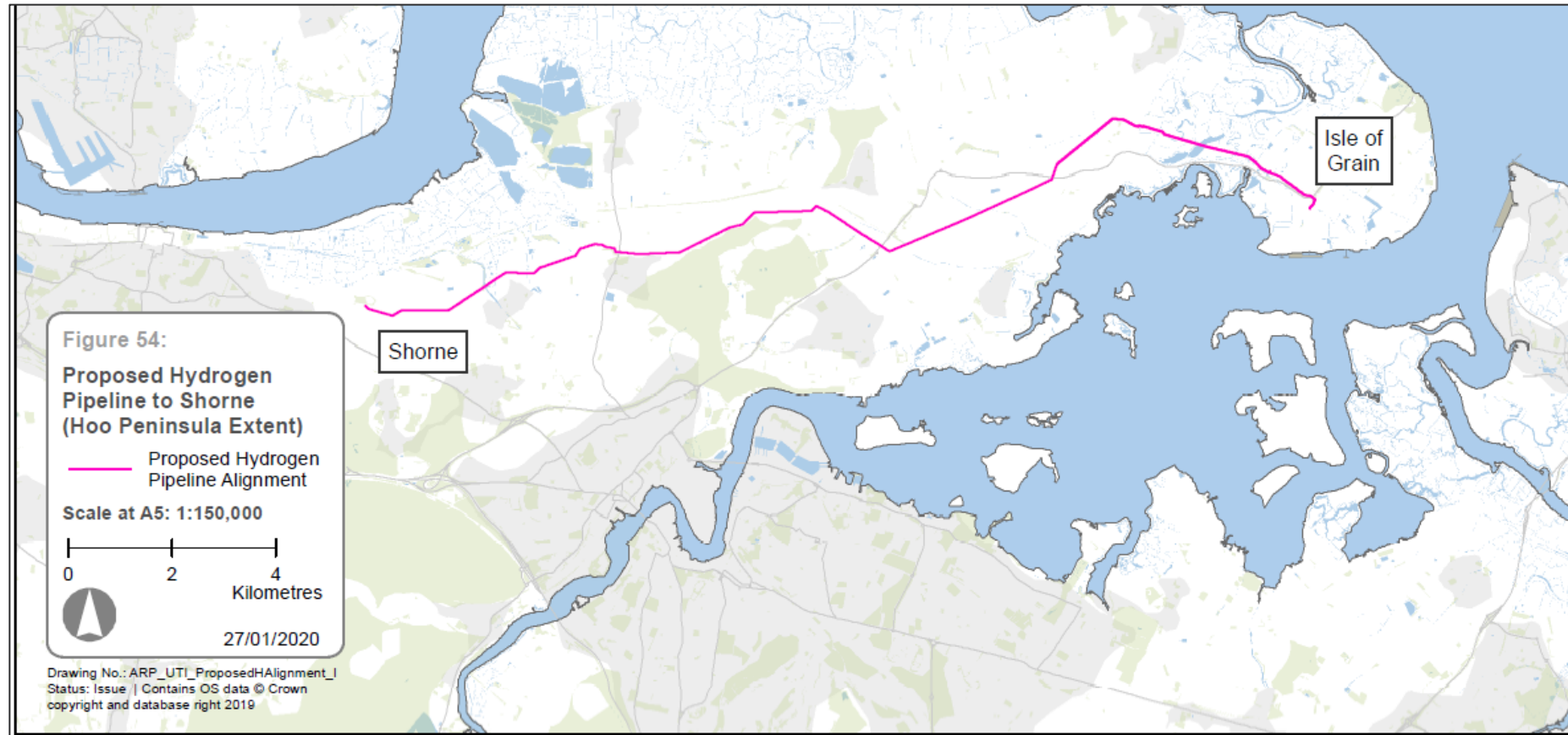
Project Cavendish Existing infrastructure

Isle of Grain



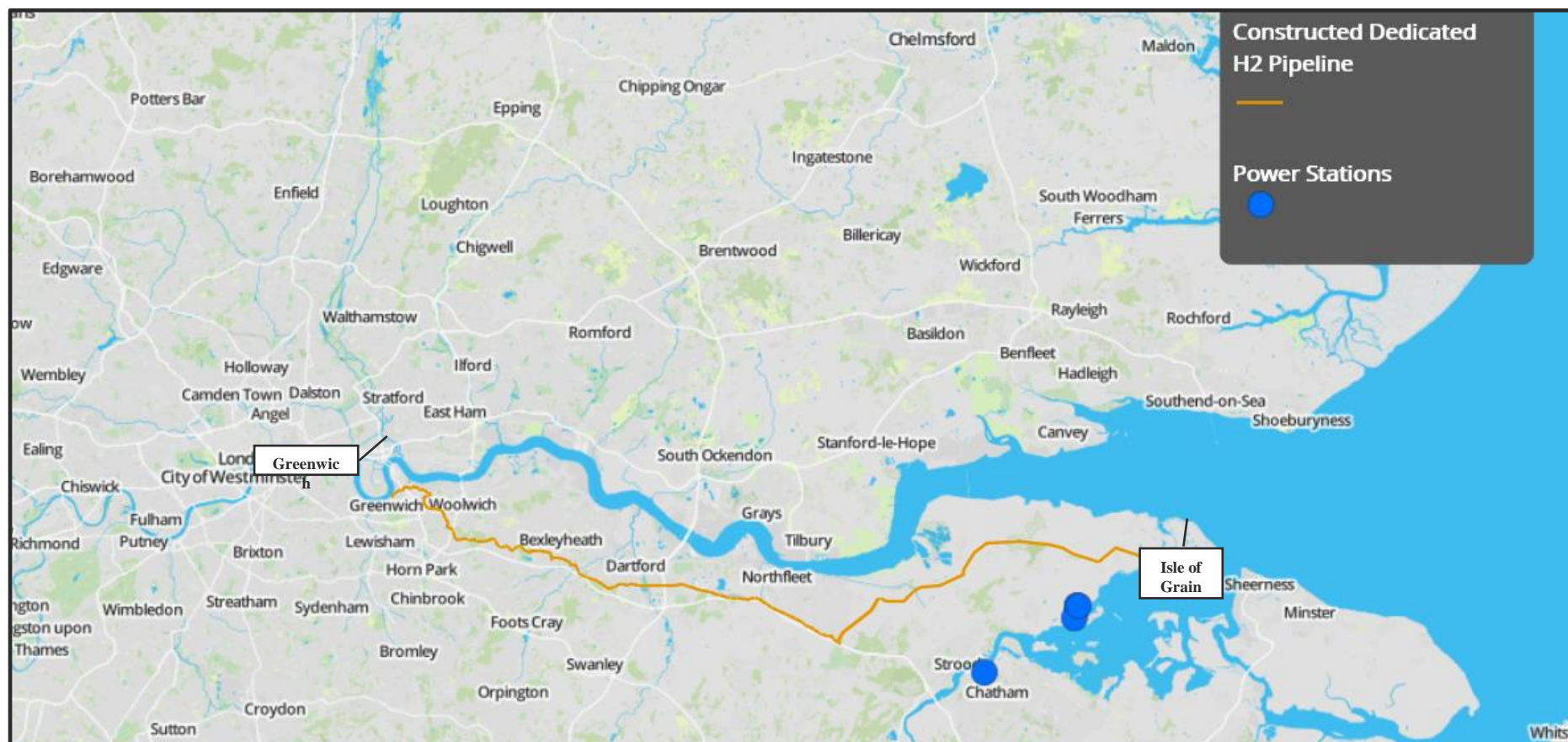
Project Cavendish - proposed hydrogen pipeline

Alongside existing natural gas network



Project Cavendish – distribution networks

For supply into central London



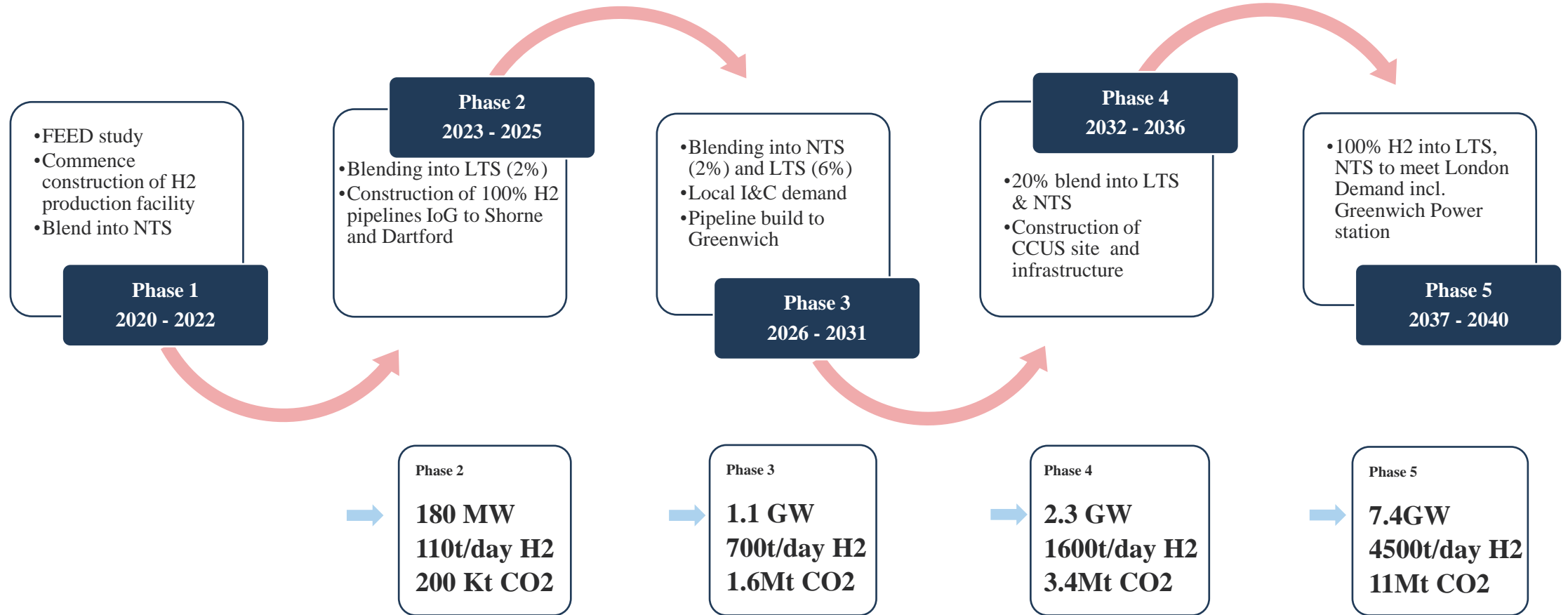
Project Cavendish – potential site layout

Across different phases

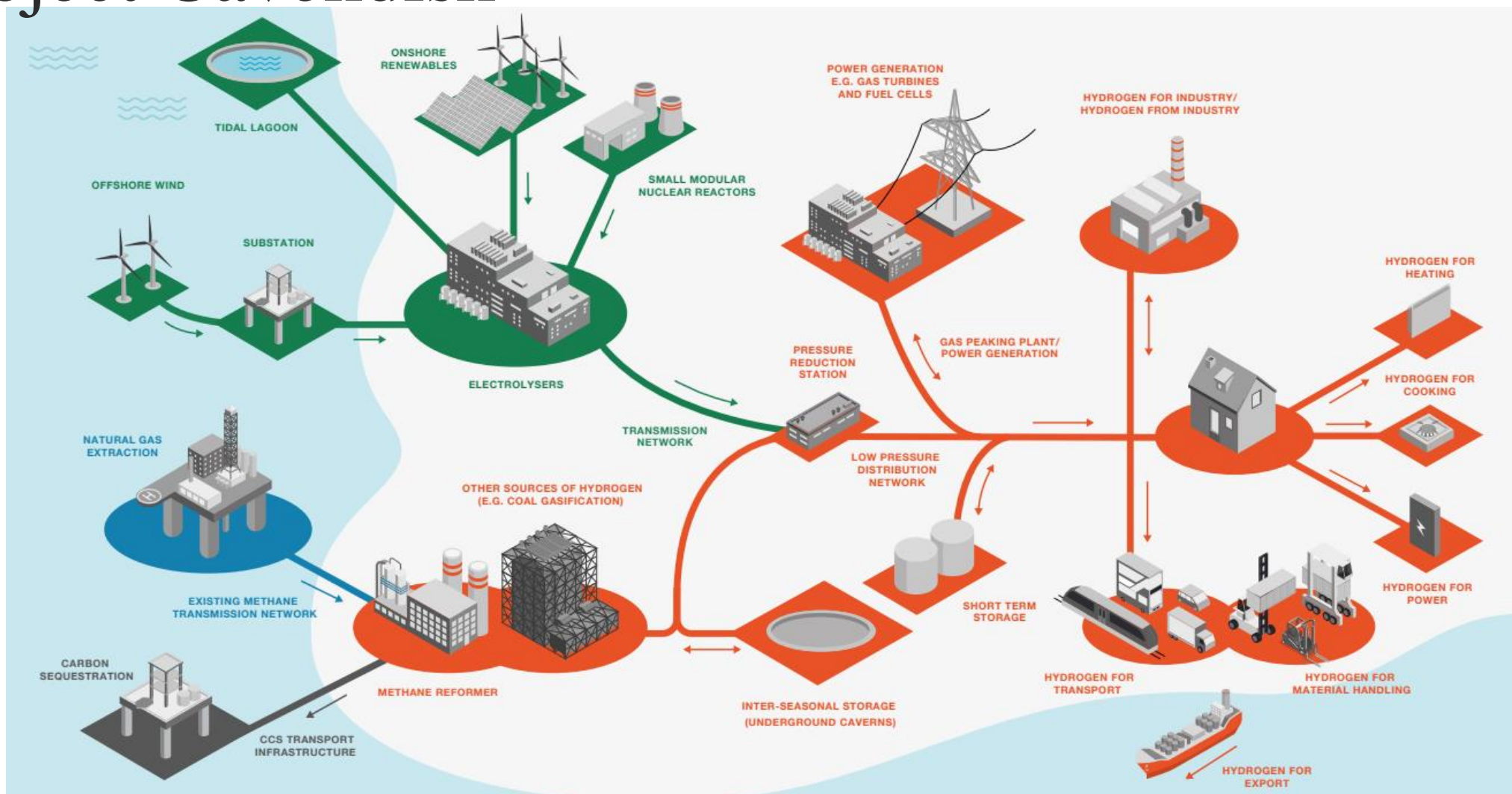


Project Cavendish – a roadmap to 100% H₂

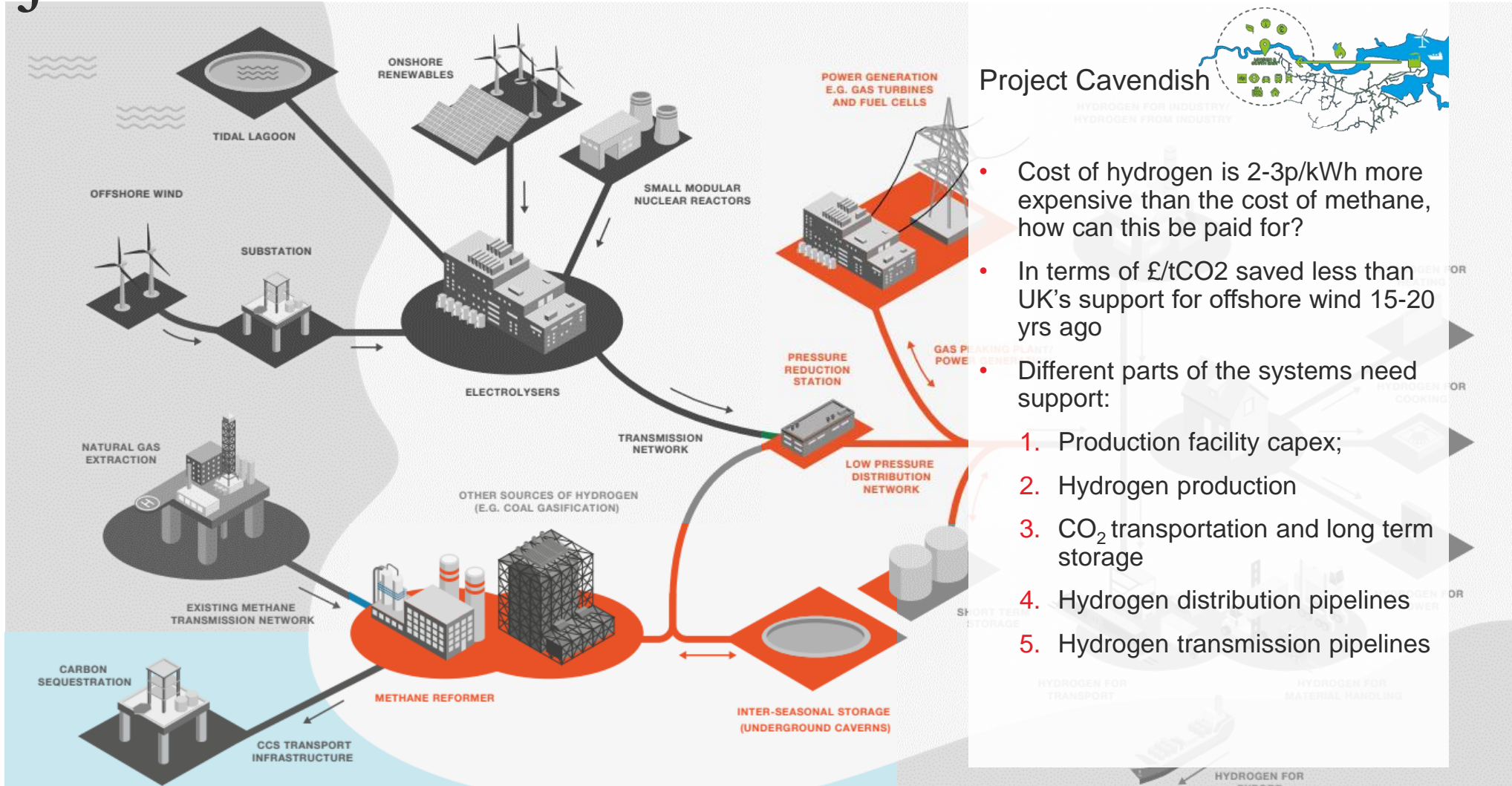
An ambitious but doable plan



Project Cavendish



Project Cavendish

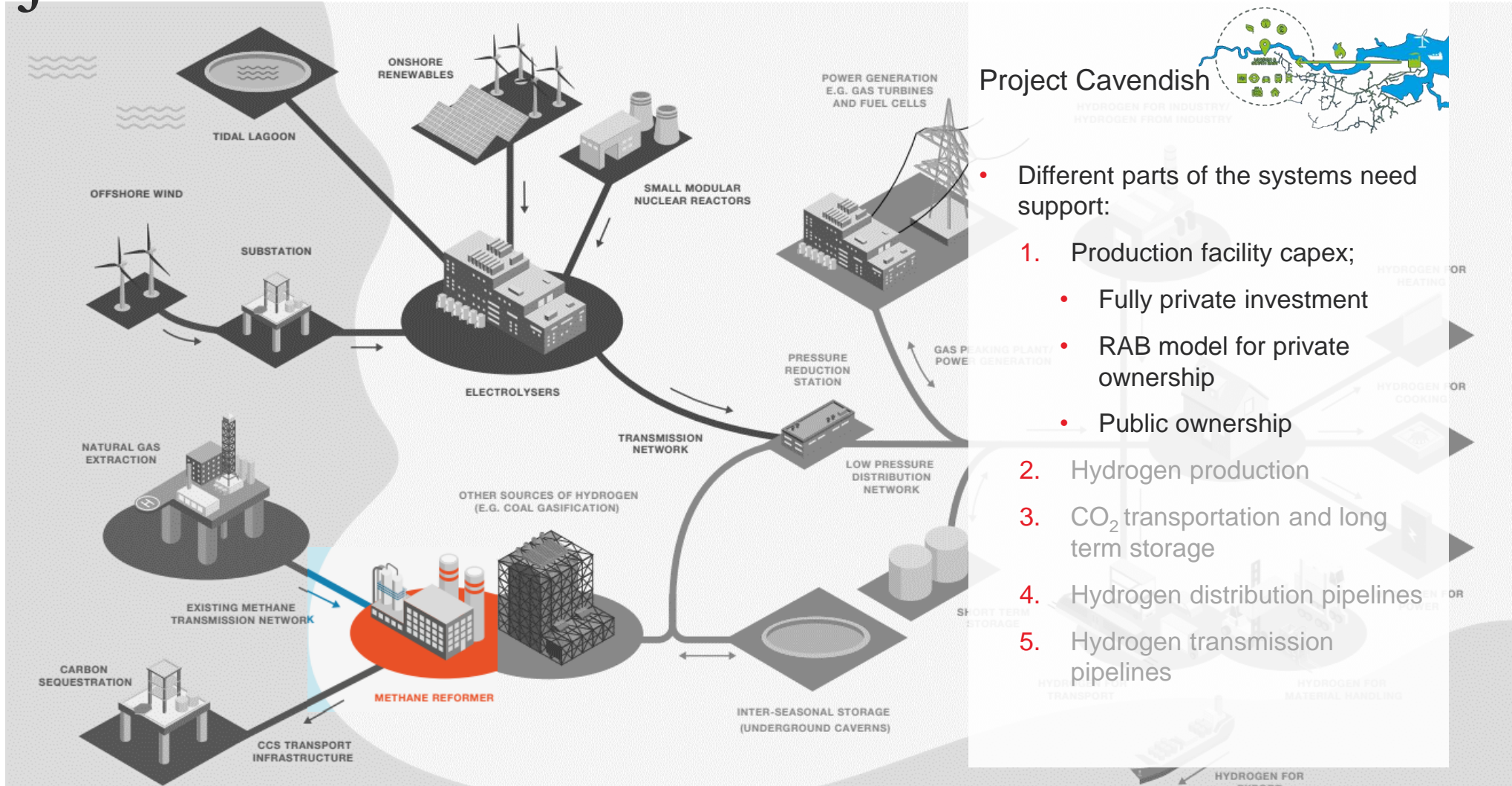


Project Cavendish

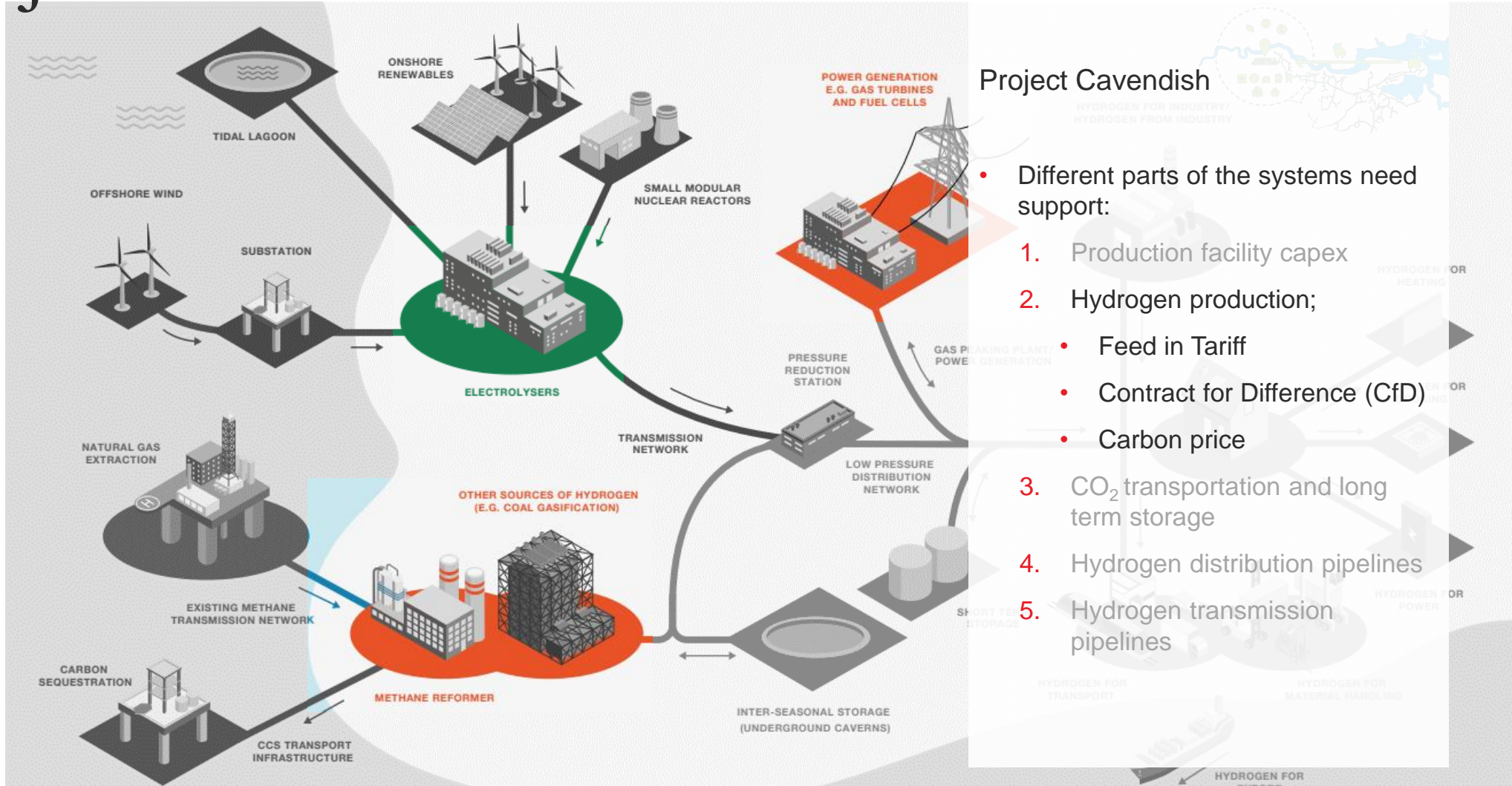
- Cost of hydrogen is 2-3p/kWh more expensive than the cost of methane, how can this be paid for?
- In terms of £/tCO₂ saved less than UK's support for offshore wind 15-20 yrs ago
- Different parts of the systems need support:

1. Production facility capex;
2. Hydrogen production
3. CO₂ transportation and long term storage
4. Hydrogen distribution pipelines
5. Hydrogen transmission pipelines

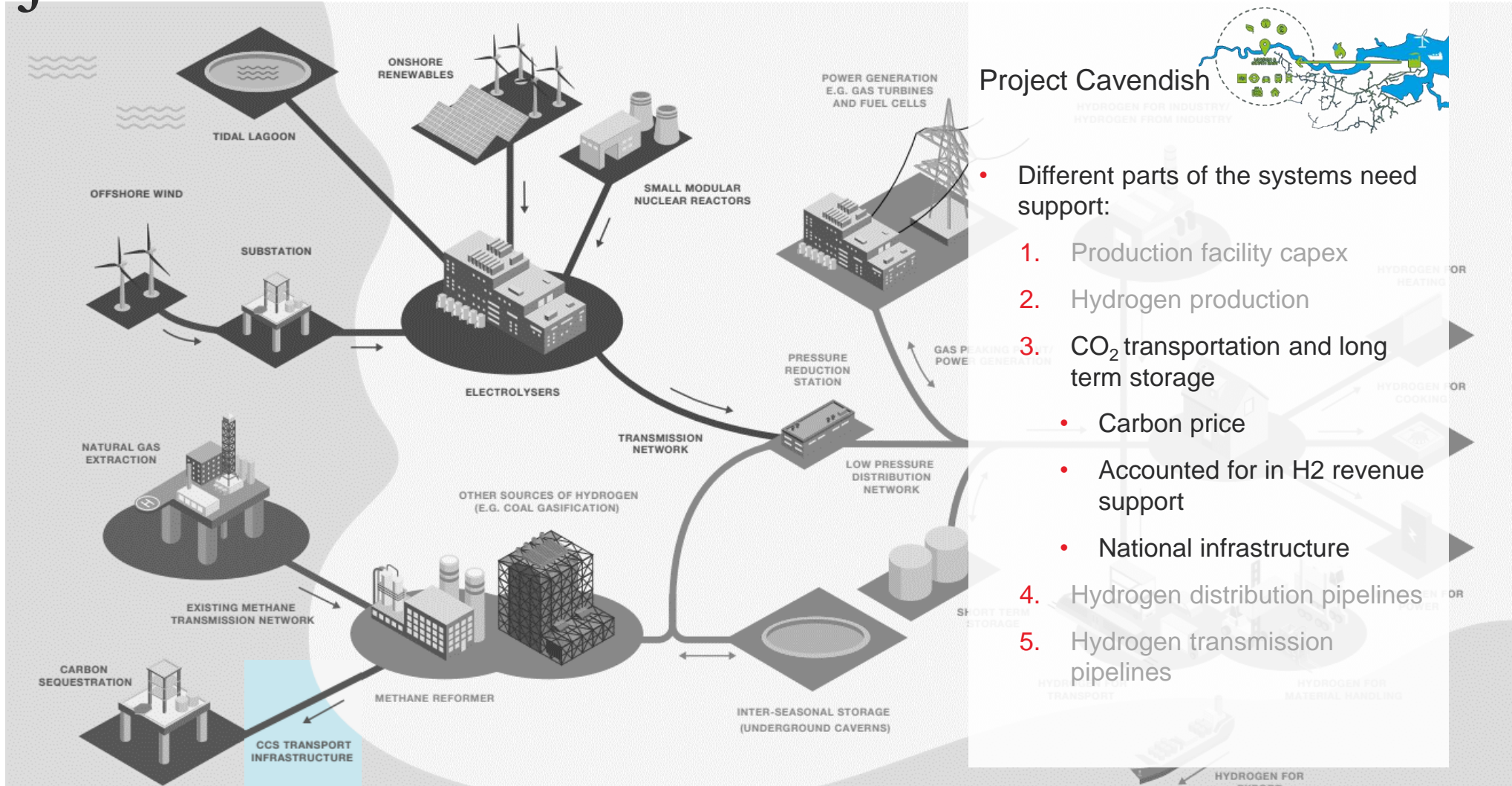
Project Cavendish



Project Cavendish



Project Cavendish



Project Cavendish

Different parts of the systems need support:

1. Production facility capex
2. Hydrogen production
3. CO₂ transportation and long term storage

- Carbon price
- Accounted for in H₂ revenue support
- National infrastructure

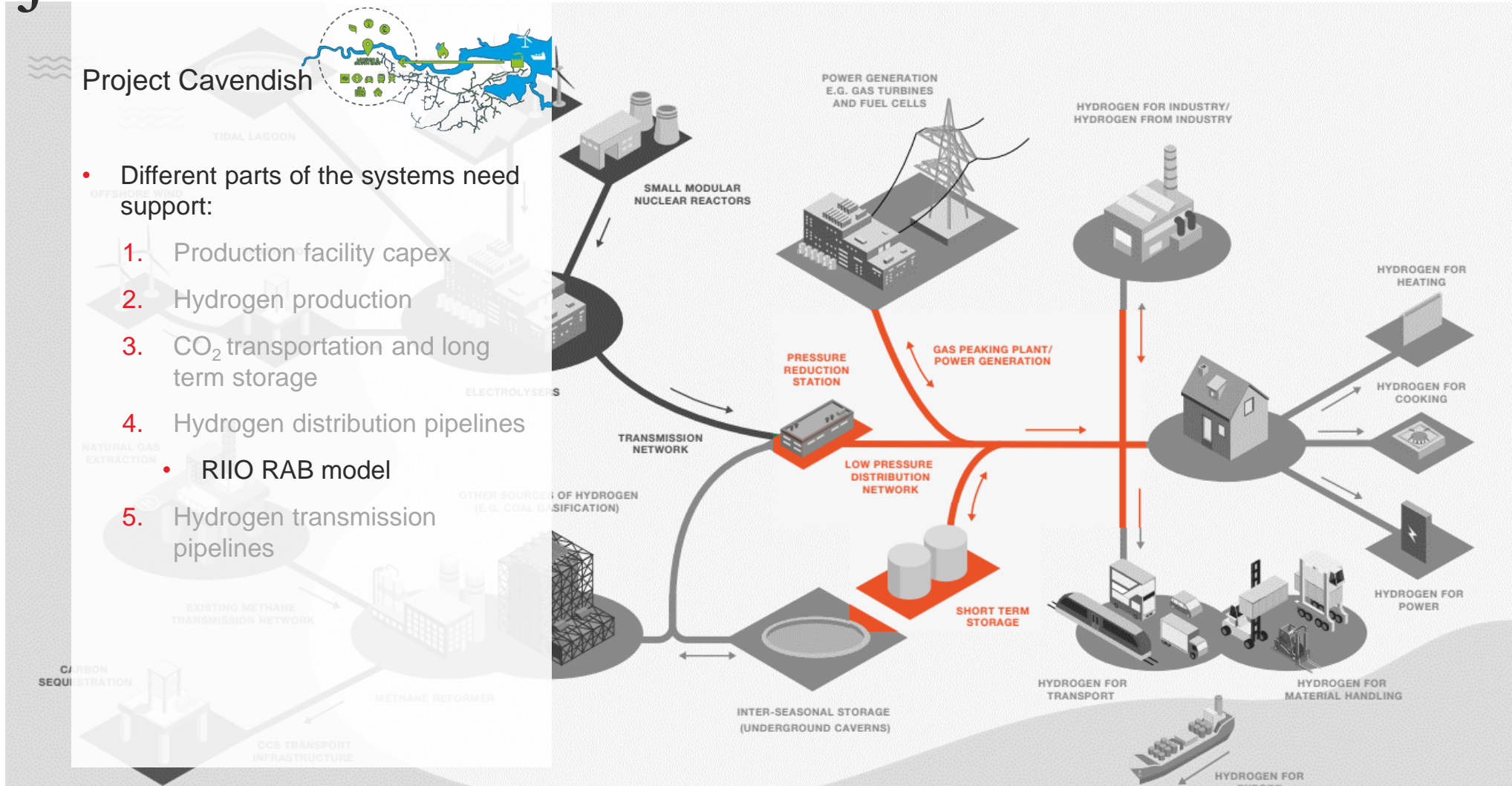
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Project Cavendish

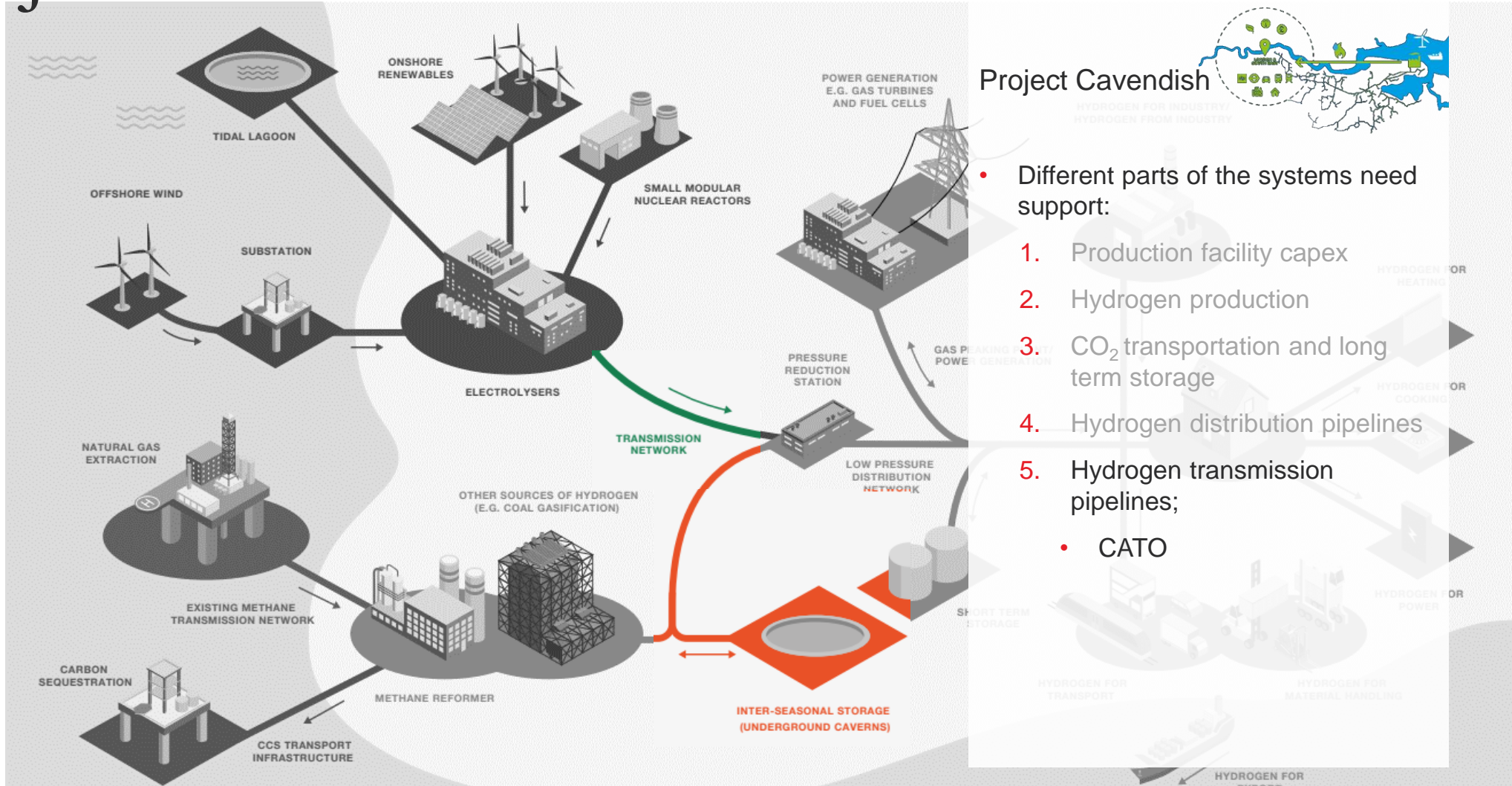
Project Cavendish

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- RIIO RAB model



Project Cavendish



Project Cavendish

Different parts of the systems need support:

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 5. Hydrogen transmission pipelines;
- CATO

Project Cavendish - conclusions

- Only **reformation** can meet the scale and price requirements
- Low carbon advanced gas reformation achieves **97% CO₂ capture** and 85% efficient
- There are significant efficiency gains from **co-location with the LNG terminal** – 20% of UK gas supply
- Initial focus is **decarbonisation of power** generation assets and gas distribution blending needed to kick-start the project
- The **cost of CO₂ reduction using hydrogen is less than that of offshore wind** 15-20yrs ago
- Some form of **revenue support will be needed** for the largescale uptake of hydrogen

Catalysing hydrogen investment

What the market needs to deliver investment in hydrogen infrastructure.

Conclusions



Public sector intervention is vital

Investors have the capital and the technology is available

Publish a clear time-bound plan

Focus on applications with low risks of future regret

Continue to fund research and development

Choose production pathways based on evaluation of their merits

Develop policy mechanisms to incentivise or mandate hydrogen use

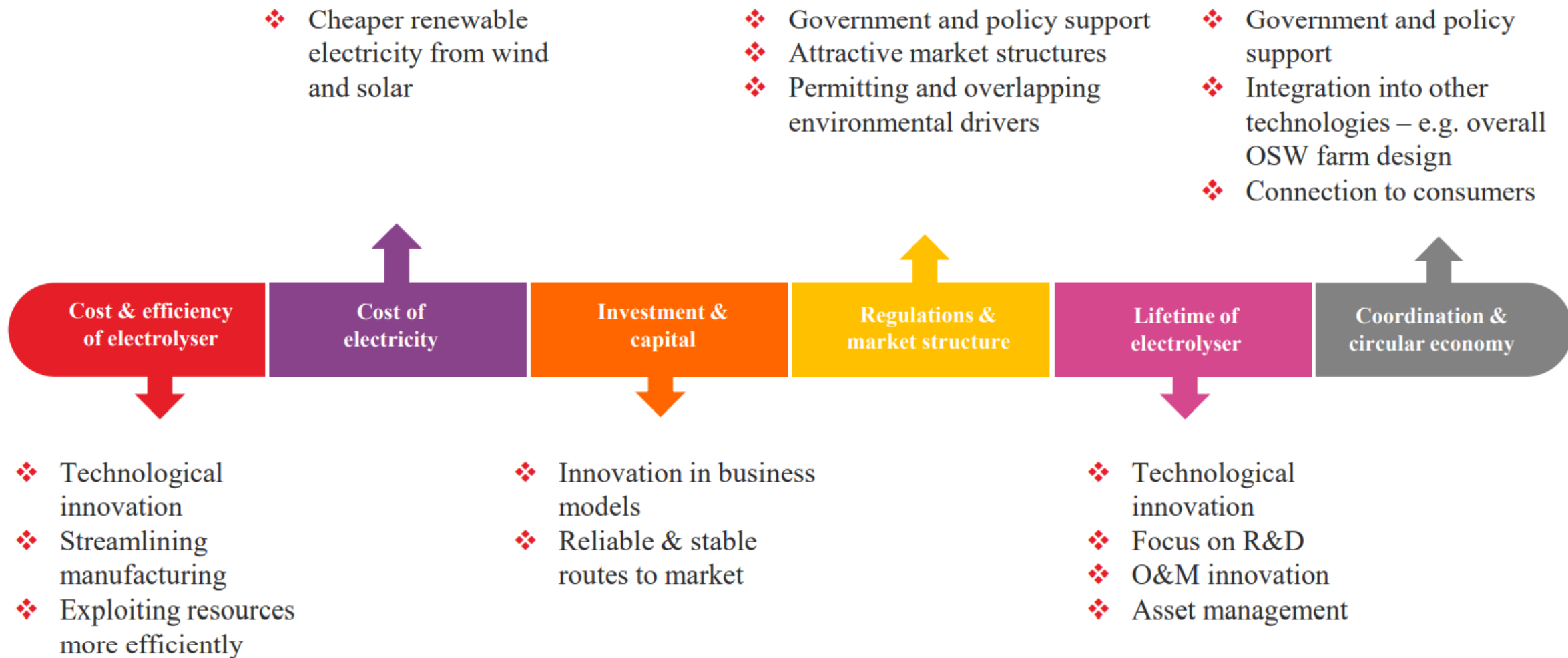
Open the way for hydrogen blending in gas networks

Provide price certainty and foster demand

Develop fiscal incentives and early revenue support

Innovation to reduce LCOH

The required path to cheap green hydrogen is to unlock NEW innovation





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