Data-driven Robust Hydrogen Infrastructure Planning Towards Heat Decarbonisation in Great Britain

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1. Research Motivation

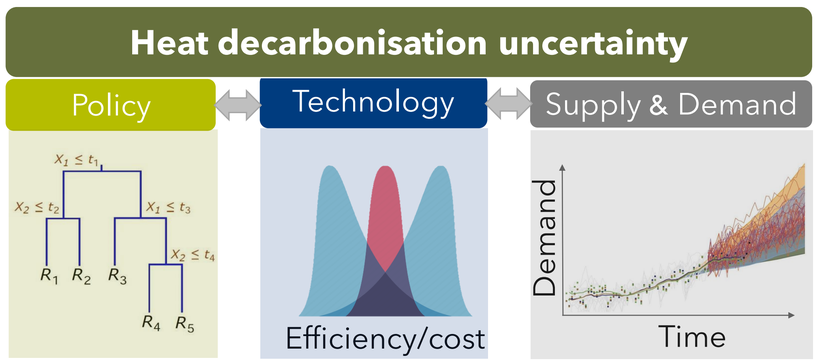
UK target for **81%** emissions reduction by 2035. **Heating** accounts for about **1/3** of total UK carbon emissions.

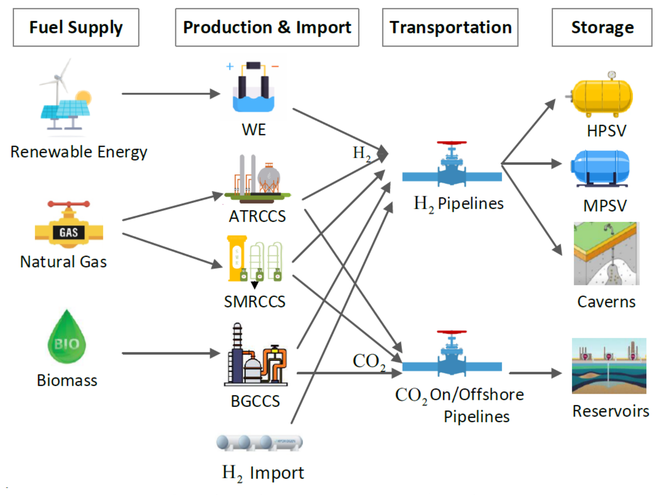
Hydrogen is a low-carbon alternative of natural gas for heating. UK ambition for up to

10 GW

hydrogen production capacity by 2030.

- Resilient national policies necessitate systematic approaches to **uncertainty.**





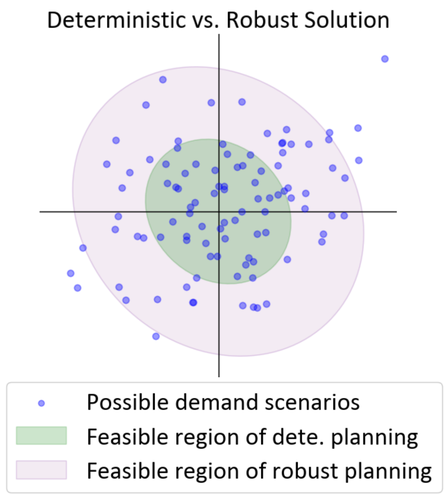
The hydrogen supply chain.

Key Takeaway: Uncertainty-resilient solutions for hydrogen infrastructure planning in GB are needed.

2. Our Solution: Data-driven Robust Hydrogen Infrastructure Planning

What is Robust Planning?

Robust planning ensures **least-regret policies,** providing **more flexibility and resilience for enhanced national energy security.**



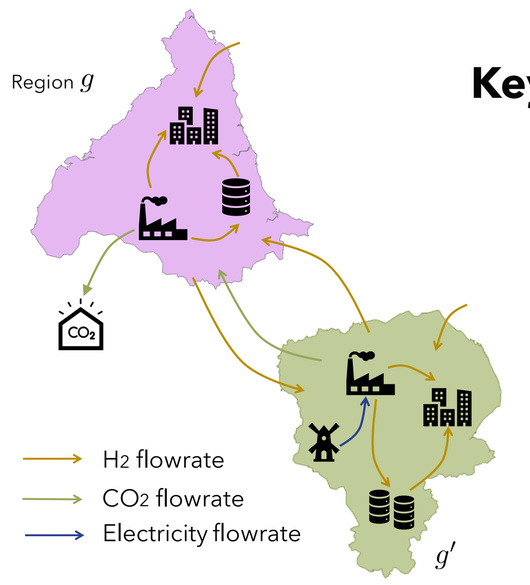
01 Understanding and capturing uncertainties in supply and demand by **Machine Learning techniques**

02 Proposing robust hydrogen infrastructure planning frameworks with adaptive operations under uncertainty

03 Promoting **Green Computing** by the proposed novel **hybrid decomposition method**

04 Delivering **cost-effective** and **uncertainty-resilient** solutions for **Net Zero Hydrogen Economy**

✓ Systems thinking approach for mitigating unforeseen impacts on **critical energy poverty issues**.

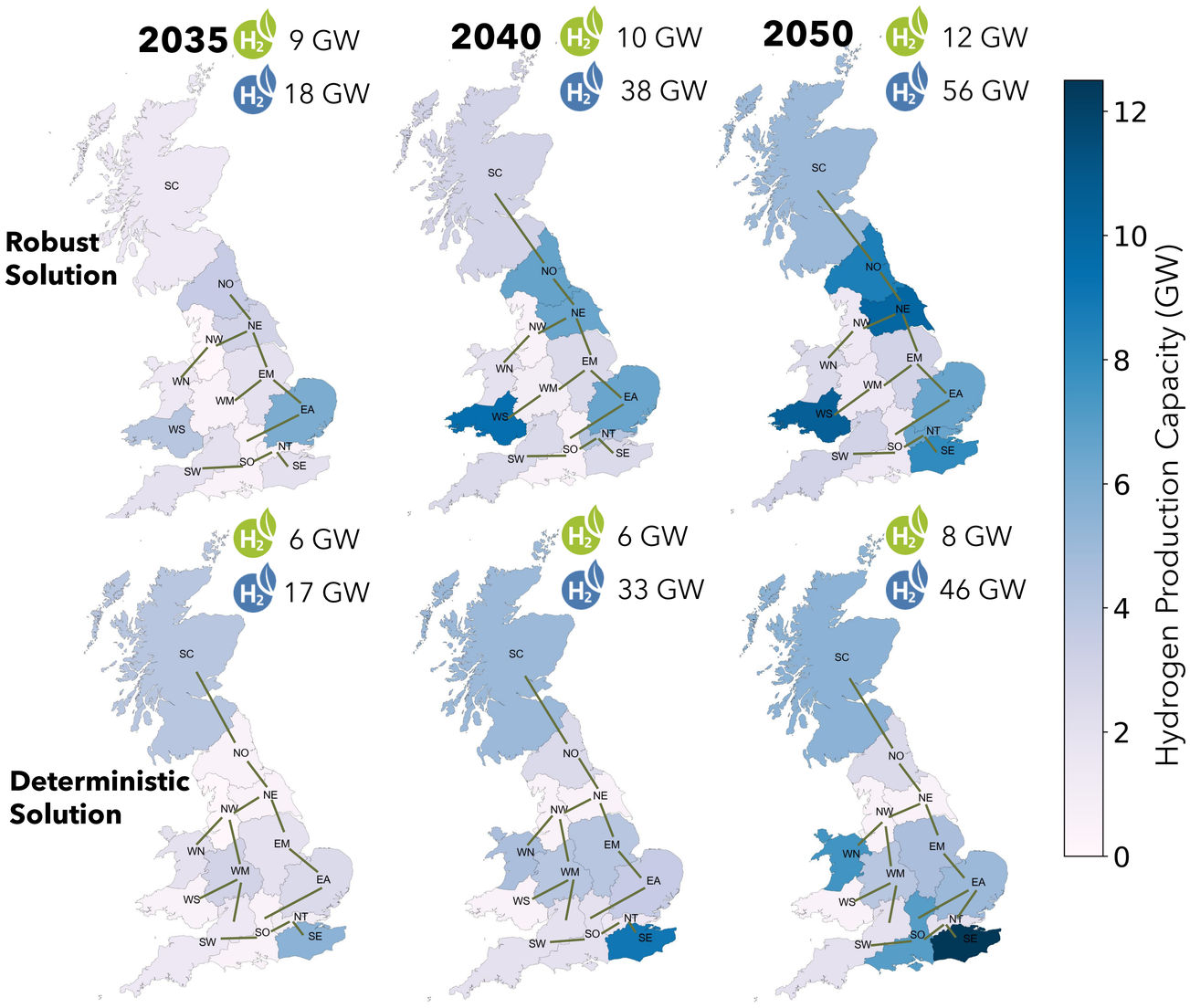


Key Outputs:

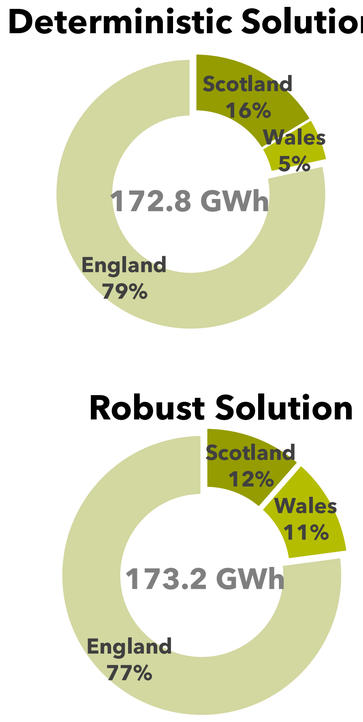
- Investments of production, storage & transmission
- Location, operating schedule
- Generation of renewables
- Hourly H_2 & CO_2 flowrates
- Hourly H_2 production, storage and import rates.

3. Key Insights & Findings

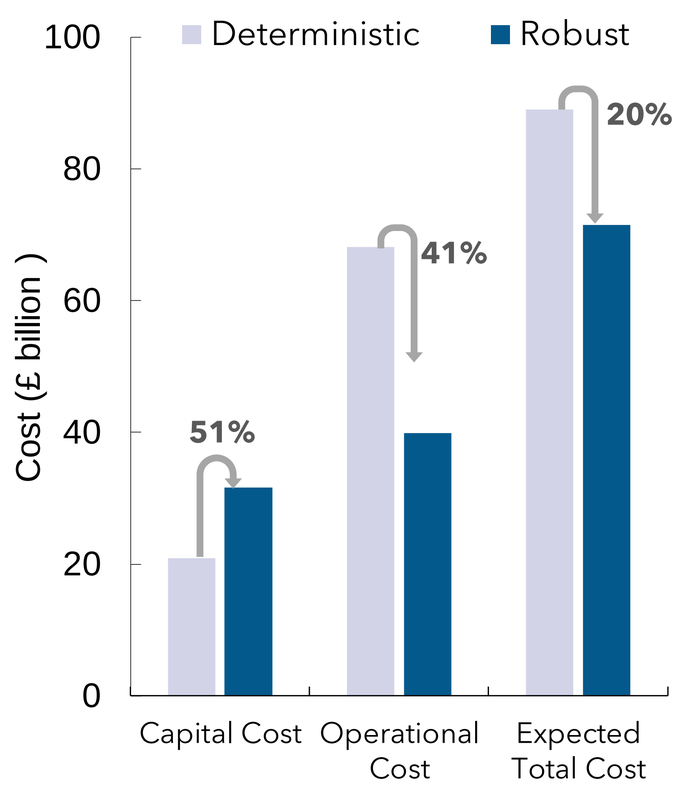
Hydrogen production capacity and pipelines expansion



Hydrogen storage capacity in 2050



Real-life Economic performance



Key Takeaways:

- ☐ **Robust solution reduces** the **levelised cost of H_2** from **52.9** to **49.8** £/MWh;
- ☐ The proposed method reduces the computational complexity **by more than 30%**;
- ☐ The uncertainty-aware robust framework can result in around **20% total cost decrease**.

Impact: Explainable uncertainty-resilient energy policies through next-generation systems thinking.

References

[1] Zhou, X., Efthymiadou, M. E., Papageorgiou, L.G, Charitopoulos, V. M.. (2024). ***Applied Energy*****, 376, 1-20.**

[2] Charitopoulos, V. M., Fajardy, M., Chyong, C. K., & Reiner, D. M. (2023). ***Iscience*****, 26(11), 1-12.**

Acknowledgments

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