DIGITAL TWIN FOR BUSINESS PARKS: HYBRID RENEWABLES AND STORAGE IN EDINBURGH PARK

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INTRODUCTION

- The path to Scotland's 2045 Net-Zero goal requires smarter, low-carbon energy systems.
- Digital Twin (DT) technology enables real-time energy optimisation and predictive analytics.
- Edinburgh Park is used as a testbed to demonstrate the integration of renewables and smart storage.

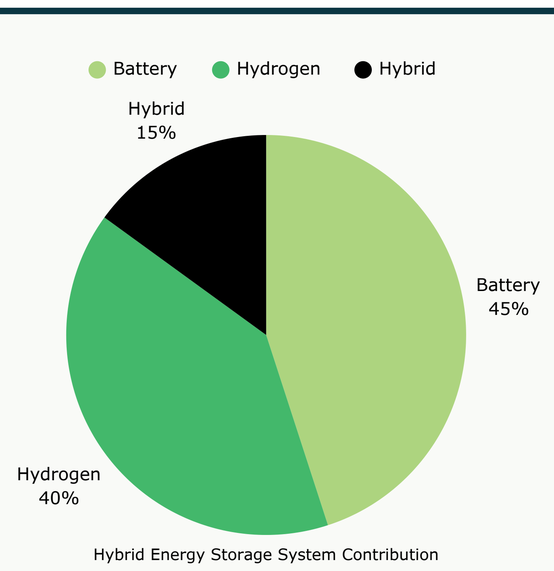
OBJECTIVES

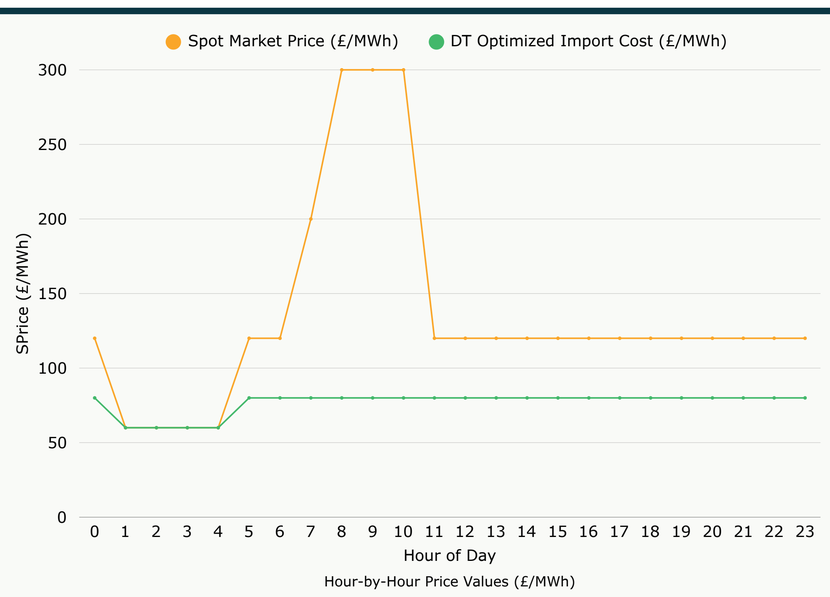
- Develop a scalable DT framework for business parks.
- Integrate offshore wind, solar energy, and hybrid storage systems.
- Optimise energy use, cost, and carbon emissions using AI-driven analytics.

METHODOLOGY

RESULTS

- Battery: Best for peak shaving; reduced grid import by (25 ± 5)%.
- Hydrogen: Converted (75 ± 5)% of curtailed wind to reserves; cut 12,500 tCO_2/year.
- Hybrid (Battery + Hydrogen): Achieved (85 ± 5)% energy autonomy





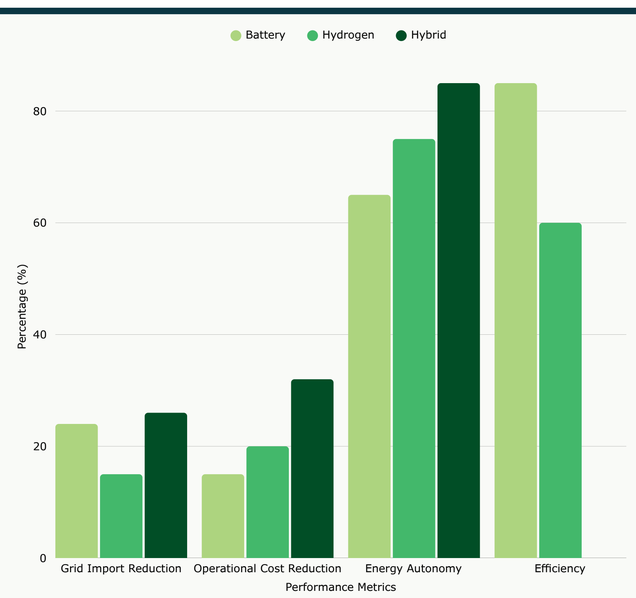


Figure 1. Performance and Cost Optimisation of Hybrid Energy Storage Systems

CONCLUSION

Digital Twin systems, when combined with hybrid renewables and smart storage, offer a transformative pathway toward resilient, self-sufficient industrial clusters. This approach not only reduces carbon emissions and costs but positions Scotland at the forefront of green innovation.

RESEARCH IMPACT AND RELEVANCE

This research aligns with Scotland's Hydrogen Action Plan and Net-Zero Industrial Clusters Roadmap

🌍 Potential Impact:

- Transforms business parks into smart, low-carbon hubs.
- Offers a model for scalable, equitable decarbonisation.
- Supports AI integration in energy policy and planning.

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