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Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

NIA Project Close Down Report Document

Date of Submission

Jul 2022

Project Reference Number

NIA2_NGESO007

Project Progress

Project Title

Decarbonisation of Heat – Integrated Market Study

Project Reference Number

NIA2_NGESO007

Funding Licensee(s)

NG ESO - National Grid ESO

Project Start Date

December 2021

Project Duration

0 years and 4 months

Nominated Project Contact(s)

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Scope

The project will produce insights on the following key questions:

- What trajectories for the development of the heating mix will arise economically under different cost assumptions and constraints?
- What are the consequences of different future mixes of heat technologies for power, gas and hydrogen markets?
- What policy options are available, and what effects are they likely to have for different market participants and for consumer costs?
- How will heating affect the profile and flexibility of electricity demand, and how will that affect revenues for renewables, thermal generation and storage?
- How will peak energy demand be met on extremely cold days, especially if power generation from wind is low?
- How could different global decarbonisation trajectories affect gas prices and the economics of the heating mix?

Objectives

We currently estimate about 2.5GW growth in new heat flexibility by 2030, that is electricity demand shifted away from peak which is equivalent to avoided capacity reservation worth £45million (based on £18/MWh auction clearing price on 10/03/2021). This project will produce insight and data to help reduce the current high levels of uncertainty around these estimates. It will help assess if more or less of these savings could be achieved and how network operability will need to evolve to maximise benefits to consumers

The final outputs will be:

- Forecast data for power, gas hydrogen markets and for heating technology deployment in a range of scenarios
- A detailed internal report and more concise external summary report with insights and implications for stakeholders, policy and regulation

Following completion of the study:

- Outputs to be used (directly or indirectly) as input into the Spatial GB Clean Heat Model, the integrated tool for developing FES heat scenarios
- Insight from the project to be used to shape future FES scenario frameworks especially around heat decarbonisation but also in areas like system flexibility, industrial demand, and hydrogen supply and storage.

Success Criteria

The following will be considered when assessing whether the project is successful:

- Insight into key factors that will be used to shape FES scenario frameworks around heat decarbonisation
- Sufficient forecast data which can be fed into our models and frameworks to increase confidence
- Clearer understanding of the relationship between prices and demand for electric heating

Performance Compared to the Original Project Aims, Objectives and Success Criteria

This study investigated what could drive the future mix of heating technologies, and how this mix will affect the energy system.

The modelling process was conducted in two main parts:

Part 1 - An economic model of residential heat technology deployment to simulate the development of the future mix

Five scenarios were constructed to understand the range of potential outcomes for the heating system. These featured different assumptions for:

- The extent of use of hydrogen for heating
- Limits on how quickly heat pumps can practically be deployed
- The potential for deploying ambient heat networks (also called network heat pumps)

The model accounts for a range of types of homes with different characteristics, and for the future development of CAPEX, OPEX and fuel costs for a range of technologies. The model was used to assess rates of economic deployment in each scenario, accounting for a prospective ban on replacing fossil fuel boilers in 2035.

Under current policies, it is thought that gas boiler replacements will remain more economical than new heat pumps, therefore the model took into consideration what could be done to encourage heat pump deployment including:

- An assessment of the effect of shifting some of the policy costs currently levied on electricity onto gas instead
- An assessment of the effect of providing government grants to support heat pump installations
- Analysis of the potential impacts of non-cost barriers or consumer hesitancy on deployment of heat pumps

Part 2 - Power and hydrogen system models to assess the effects of the heating mix on the energy system

For each of the five scenarios, energy system impacts for consumers, generators and the environment was analysed, this included:

- An assessment of future demand for electricity, gas and hydrogen for heating
- Forecasting of the development of market prices (baseload prices and those captured by generators)
- Forecasting of the economic deployment of electricity generation and storage technologies
- An assessment of future CO2emissions from the heating sector
- Testing of a sensitivity in which the prospective ban on fossil fuel boiler replacements is delayed to 2040

The effect of electrical heating on the power system depends on how flexible the heating demand is, given this the consequences for demand profiles and for prices of deploying thermal storage in large numbers of homes was investigated in the course of the project.

Challenges for electrified heating are likely to arise at times of very cold weather, especially when renewables output is low, as a result how our heating mix scenarios are affected by an extreme weather week was included in the analysis.

The overall system cost consequences of each scenario were quantified, looking at energy costs from power, gas and hydrogen as well as an approximation of power and gas network costs.

In light of the analysis carried out, key policy considerations for decarbonising the heating system were produced.

Required Modifications to the Planned Approach During the Course of the Project

No modifications were required in the course of the project.

Lessons Learnt for Future Projects

- As a large multi-stakeholder project. regular updates were useful to keep up to date with the project progress
- Regular meetings allowed questioning on the modelling methods and gain insight into other participants' perspectives.

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

A detailed internal report and more concise external summary report with insights and implications for stakeholders, policy and regulation were produced and are available on the Smarter Networks Portal.

The key recommendations contained in these reports were compiled based on the modelling and analysis conducted:

- Phasing out gas boilers is crucial for the decarbonisation of heat: banning gas boiler replacements by 2035 could put Britain on track towards zero carbon heating by 2050, but delaying a ban to 2040 would leave us in 2050 with 15Mt of CO2emissions from residential heating, about a quarter of today's total; to make a gas boiler ban in 2035 practical, action is needed now to ramp up deployment of low carbon alternatives
- Without policy change, gas boiler replacements are expected to remain attractive to households: heat pumps are a technology that can start being deployed today, but today's air source heat pumps (ASHPs) have typically twice the up-front cost of gas boilers; even after accounting for heat pumps' higher efficiency, and declining costs over time, they could still be 50% more expensive on an annualised lifetime cost basis in 2030
- Achieving deployment of 600k heat pumps per year by 2028 will require policy intervention: both cost and non- cost barriers need removing; costs could be addressed through a combination of grants, carbon taxes and reallocation of policy costs away from electricity (for example, onto gas or onto general taxation); an awareness of impacts on low-income households will be important for policy design
- Decarbonisation of heat will drive higher electricity demand: electricity demand from heating could quadruple by 2050 to over 100TWh per year, accounting for more than a quarter of the increase in total electricity demand
- Not all electric heating is equal: technologies like networked ground source heat pumps and thermal batteries can provide greater efficiency and flexibility, and in scenarios with greater deployment of these technologies it is expected that energy system costs could be lower by around £1bn a year on average to 2050, which is roughly 2% of total system costs
- Household economics won't lead to an optimal system: without targeted policy intervention, it is not expected that the more efficient or flexible electrical heating systems will be economically attractive to householders, which could lead to over-dependence on ASHPs; although they are likely to be an important part of the mix, a system with only ASHPs would have unnecessarily high peak power demand and system costs
- Scenarios using hydrogen for a share of heating have lower peak power demand: using hydrogen in some homes means lower demand for electricity at peak times and in extremely cold weather events (assuming flexible electrolysis) and could lower power network costs by £0.5bn per year by 2050
- Green hydrogen could drive higher electricity prices: if around 30% of hydrogen is produced by electrolysis in the 2030s, baseload

power prices could be up to £8/MWh higher in scenarios with hydrogen heating, as flexible electrolysers reduce the occurrence of low-price periods

Data Access

Details on how network or consumption data arising in the course of a NIC or NIA funded project can be requested by interested parties, and the terms on which such data will be made available by National Grid can be found in our publicly available "Data sharing policy related to NIC/NIA projects" and www.nationalgrideso.com/innovation.

National Grid Electricity System Operator already publishes much of the data arising from our NIC/NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Foreground IPR

The following reports have been published on the Smarter Networks Portal:

- Decarbonisation of Heat in Great Britain - Report for participants
- Decarbonisation of Heat in Great Britain - Public Summary

Planned Implementation

The forecast data and knowledge generated in the course of the project have been input into the Spatial GB Clean Heat

Model, the integrated tool for developing FES heat scenarios. Insight from the project will be used to shape future FES scenario frameworks especially around heat decarbonisation but also in areas like system flexibility, industrial demand, and hydrogen supply and storage.

The heat pump uptake limit trajectories were useful to consider constraints for heat pump uptake in the heat modelling.

The study of NHPs (Networked ground source heat pumps) was very interesting due to the significant cost reduction and improved efficiency they suggest and would be good to implement into the modelling in future. The heat model does not currently have this option available so would have to be adapted in some way.

Cost comparisons of the technologies and how these can be reduced were valuable to compare against and gave useful insight for the FES heat modelling.

The hydrogen analysis was also valuable to compare against, with the suggested uptake of hydrogen boilers in both the mixed and max hydrogen scenarios and how cost-effective these were. The analysis of costs for blue vs green hydrogen agreed with that from the heat model.

Other Comments

The Project outcomes and results contain confidential information and intellectual property rights that cannot be disclosed in this Report due to their proprietary nature. Should the viewer of this Report ("Viewer") require further details this may be provided on a case by case basis following consultation of all Publishers. In the event such further information is provided each and any Publisher that owns such confidential information or intellectual property rights shall be entitled to request the Viewer enter into terms that govern the sharing of such confidential information and/ or intellectual property rights including where appropriate formal licence terms or confidentiality provisions. Dependent upon the nature of such request the Publishers may be entitled to request a fee from the Viewer in respect of such confidential information or intellectual property rights.

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Not applicable