Net Zero Terrace

A Strategic Innovation Fund Alpha Phase Project

WP5 – Beta Commercial Arrangements (CBA)

10 May 2024

Project Partners:

RV Energy

Buro Happold

Centre for Energy Equality

Rossendale Borough Council

Urban Chain

Salford University

Version

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Contents

Glossary

ANM	Active Network Management – use of control systems to monitor import and/or export in line with previous agreed limits
BAU	Business As Usual
CEMS	Community Energy Management System - monitors, controls and optimises energy generation, storage and consumption within the community and establish flexibility potential to the grid
DSR	Demand Side Response – incentivising customers to change their demand
ENWL	Electricity North West Limited
EPC	Energy Performance Certificate
GHG	Green House Gas
GSHP	Ground Source Heat Pump
HEMS	Home Energy Management System – monitors, controls and optimises energy generation, storage and consumption within a household
KW	Kilowatts
LV	Low Voltage
NPV	Net Present Value – difference between the present value of cash inflows and the present value of cash outflows over a period of time
NZT	Net Zero Terrace
OLTC	On Load Tap Changer
PV	Photo-Voltaic
SLES	Smart Local Energy System – A group of assets together within a local area operating in a smarter more efficient way

1 Introduction

Net Zero Terrace (NZT) aims to solve the problem of mixed-tenure terraced houses/streets where space and noise constraints restrict access to air source heat pumps. The solution will use a Smart Local Energy System (SLES) that is integrated into the distribution network, affordable to consumers and easily replicable across Great Britain.

For many of the 10 million terrace homes in the UK not suitable for heat pumps, the low carbon heating option is an electric boiler, meaning increased costs and demand on the grid. The solution overcomes multiple barriers to the rapid deployment of low carbon, affordable heat at community scale. The project addresses innovation challenge 1, "Supporting a just energy transition" and project scope 2, "Supporting decarbonisation of heat... for consumer groups with reduced access for opportunities to decarbonisation", in several ways but primarily by providing an affordable option with no upfront capital costs and by delivering with a high degree of community engagement and benefit.

2 Counterfactual

The NZT CBA considers the counterfactual situation of the disparate, uncoordinated replacement of gas boilers with customers choosing, likely as a distressed purchase, electric boilers as opposed to heat pumps due to limited space. Adding up to a 12kW electric boiler per property sees a significant increase in the local network demand. This is the Baseline case that the other options are considered against.

Network intervention is triggered once the volume of new electric boilers utilises the existing headroom of the simulated local area network model. Standard network solutions of increased substation capacity (via transformer upsizing), cable overlays (via cable upsizing) and new substation capacity (via new substations are employed).

3 Net Zero Terrace SLES

The NZT solution will involve retrofitting terraced properties to increase the energy efficiency to an EPC rating of B. An individual Kensa 1.6kW ground source Heat Pump (GSHP) will be installed at each property along with a shared rooftop PV array across the terraced row promoted and managed by the Community Energy Group.

4 Options

The NZT CBA considers two options:

1. **NZT: Innovative traditional/BAU solution**

    - Increased network demand is addressed by overlaying low voltage (LV) cables, increasing and/or developing local transformer capacity.
    - Increased generation impact is addressed by installing an on-load tap changer (OLTC) transformer (i.e. Smart Street design) to mitigate voltage excursions.

- Scale of the impact and the extent of the remedies varies due to the volume of terraced houses converted to GSHPs instead of electric boilers, the more properties converted to NZT solution, the less impact from the demand.

2. **NZT: Smart SLES/LV ANM solution**

- LV Active Network Management (ANM) system is installed that monitors the network and interacts with the SLES Community Energy Management System (CEMS) to reduce demand and generation as required.
- Some network demand is addressed by overlaying LV cables, increasing and/or developing local transformer capacity.
- Some generation impact is addressed by installing On Load Tap Changer (OLTC) transformers (i.e. Smart Street design) to mitigate voltage excursions.
- ANM and SLES is able to reduce the demand and/or generation to mitigate the need for reinforcement.

5 Timelines

The Counterfactual and Options are considered within the timeline of up to 2045.

6 Assumptions

1. Timeline is from 2024 up to 2044, whereby it is assumed all properties have had their gas boilers replaced with an electric alternative.

2. Under the NZT: Innovative/BAU solution ENWL will employ distribution transformers with onload tap changers (as demonstrated in the LCN Fund second tier project, Smart Street) to manage the network voltage.

3. Under the NZT: Smart SLES/LV ANM solution ENWL would employ a local ANM system installed at the substation to manage the network and interact with the SLES CEMS system to coordinate control of the demand the generation across the terrace houses.

4. The capital and operating costs, greenhouse gas (GHG) and losses analysis has been developed using a simulation local area network model providing electricity to groups of terrace streets from five distribution substations.

7 Sensitivity Analysis

The simulation local area network model was developed to run a range of scenarios to understand the impact of different levels of NZT GSHP rollout across a range of network investment levels to highlight the sensitivities for a combination of assumptions.

8 Benefits

- **Option 1**

The 20-year NPV of the benefits range from -£17.06M with a pessimistic level of investment for a penetration rate of 0-20% up to £16.95M with an optimistic level of investment for a penetration rate of 80-100% for a NZT innovative/BAU solution.

Pessimistic level of investment for a penetration rate of 0-20%

CBA Option	CBA Option 1

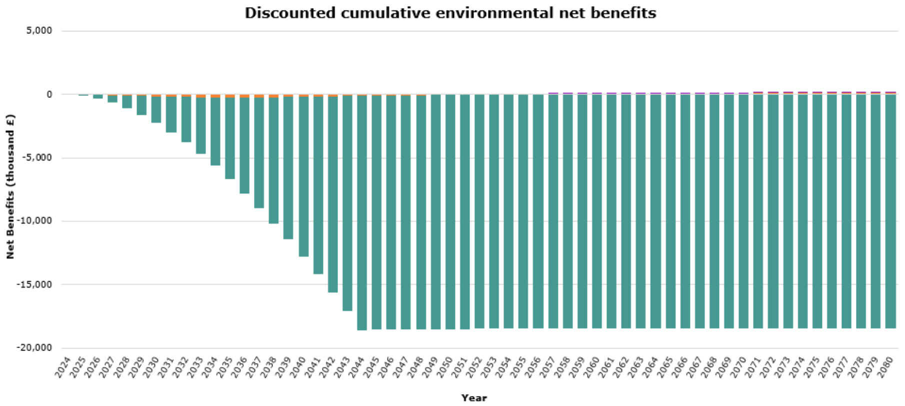
Key Financial Metrics

Term	NPV
10	-£4,670,782
20	-£17,055,613
30	-£18,468,940
45	-£18,368,611
Whole Life	-£18,310,080

Payback period	Years
Project breaks even in	

Benefits by Category

Lifetime net financial benefits	Lifetime net environmental benefits	Lifetime net societal benefits
£155,963	-£18,466,084	£41



Optimistic level of investment for a penetration rate of 80-100%

CBA Option	CBA Option 1

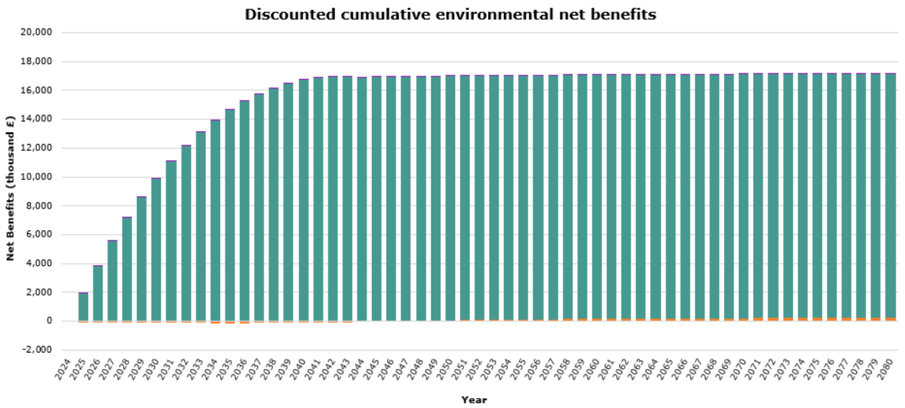
Key Financial Metrics

Term	NPV
10	£12,967,239
20	£16,950,340
30	£17,003,832
45	£17,100,733
Whole Life	£17,149,102

Payback period	<1 Years
Project breaks even in 2025	

Benefits by Category

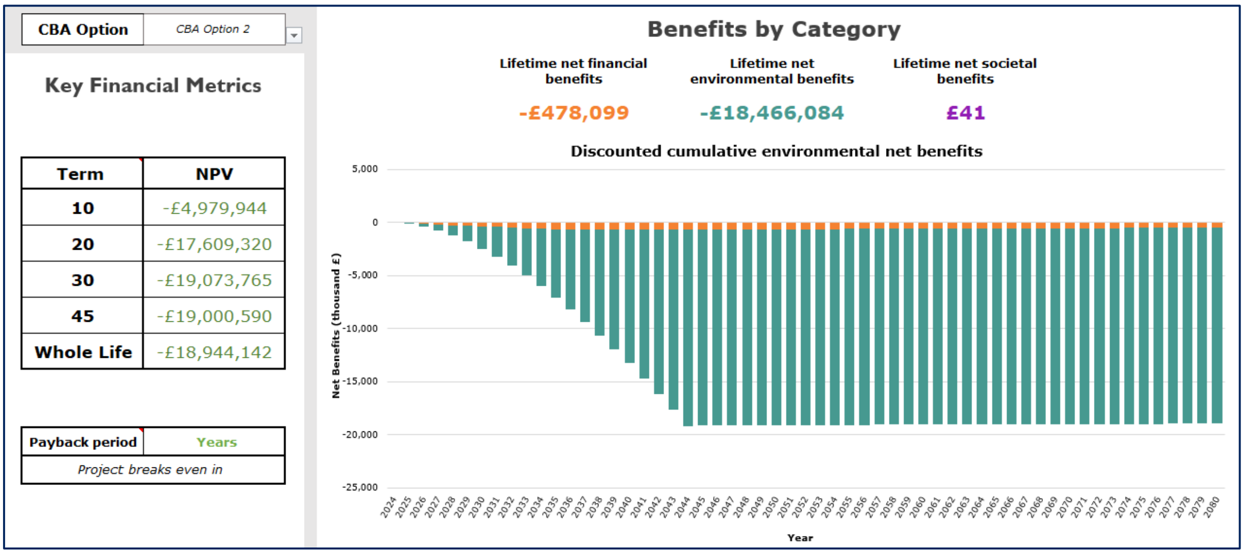
Lifetime net financial benefits	Lifetime net environmental benefits	Lifetime net societal benefits
£248,812	£16,900,250	£41



- **Option 2**

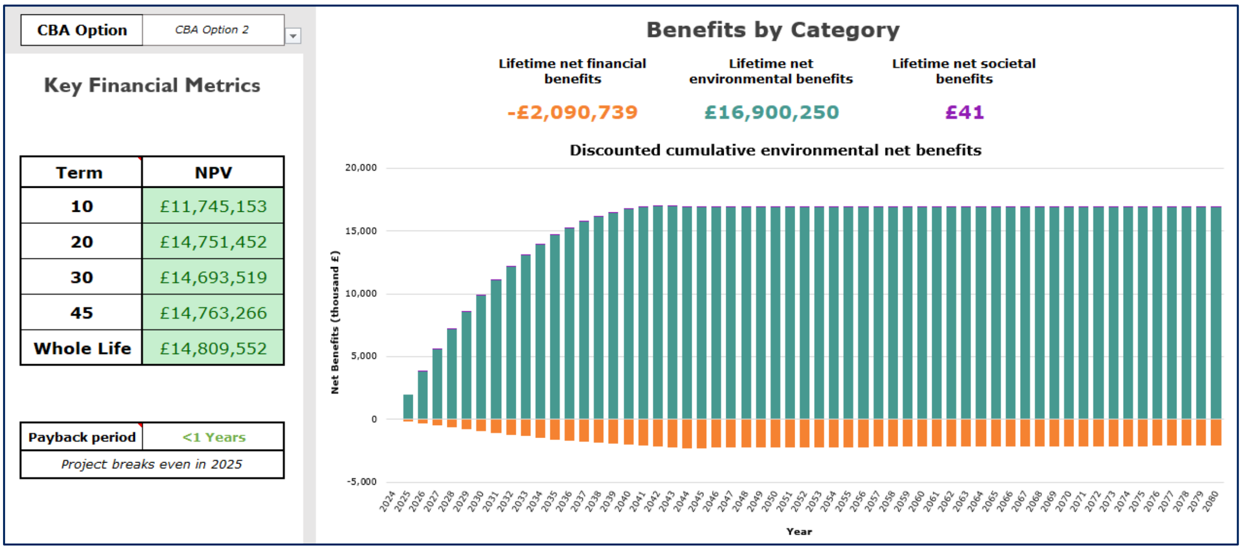
Alternatively, the 20-year NPV of the benefits range from -£17.61M with a pessimistic level of investment for a penetration rate of 0-20% up to £14.75M with an optimistic level of investment for a penetration rate of 80-100% for a NZT Smart SLES/LV ANM solution.

Pessimistic level of investment for a penetration rate of 0-20%



Term	NPV
10	-£4,979,944
20	-£17,609,320
30	-£19,073,765
45	-£19,000,590
Whole Life	-£18,944,142

Optimistic level of investment for a penetration rate of 80-100%



Term	NPV
10	£11,745,153
20	£14,751,452
30	£14,693,519
45	£14,763,266
Whole Life	£14,809,552

9 Conclusion

The early and planned replacement of gas boilers with ground loop heat pumps is financially sensible both from a societal perspective (savings in carbon), the customers' perspective (lower energy costs, warmer homes, lower reinforcement costs) and the network's perspective (minimum reinforcement, minimum disruption).

Option 1 is preferred, and this will be recommended going forward. Option 2 is also a feasible solution however the demand side response (DSR) elements as yet are unproven and unquantified.