NEWARK AND SHERWOOD DISTRICT COUNCIL

Carbon Reduction Target Review

February 2025

Target Review

Executive summary

Introduction

Background

NSDC worked with Carbon Trust in 2020 to establish a climate emergency action plan which included the development of an emissions baseline, a 2035 carbon neutrality target and a pipeline of carbon reduction interventions. The work also included an assessment of the emissions associated with NSDC Homes, and a high-level review of the potential retrofit strategies/costs that would be required to achieve carbon neutrality of housing emissions under various pathways (e.g., 2030, 2035, 2040). The decision was taken not to include NSDC Homes in the target given the relative scale of emissions (>80% of total measured emissions) and associated costs and challenges involved.

Since 2020, a number of carbon reduction measures have been progressed towards implementation such as Solar PV installations and EV charging infrastructure at NSDC corporate and leisure buildings. Additionally, NSDC's portfolio of assets has changed, most significantly with the integration of Southwell leisure centre, now under direct council control (meaning an overall increase in council emissions).

This project

New political **leadership at the council wishes to revisit the previous target commitments** to understand the feasibility of increasing ambition in relation to the **boundary of emissions and/or target dates**. NSDC are now looking to re-commission Carbon Trust to support with the following objectives:

1. Conduct **analysis to understand the feasibility of bringing the 2035 target forward to 2030** (with the existing boundary of emissions: gas, electricity, water, waste, fleet).
2. Conduct analysis to understand the feasibility of integrating the **housing stock (NSDC Homes emissions) into the existing 2035 target.** *Following discussions with the housing team, a target date of 2050 was also explored.*

Report Overview

This report provides details of the assessment carried out to evaluate decarbonisation target options for Newark and Sherwood District council (NSDC). The main sections of the report are as follows:

Carbon footprint overview (2023/24)
- Analysis and calculation of NSDC's carbon footprint for the 2023/24 period.
- Analysis of progress towards the existing 2035 target.
- Recommendations to improve accuracy of reporting.

NSDC Corporate decarbonisation
- Feasibility of decarbonising buildings owned and operated by NSDC, exploring potential phasing, costs and strategies.
- Feasibility of meeting 2030 or 2035 targets, building on existing work completed by BE DESIGN.

Housing decarbonisation
- Focuses on decarbonising housing owned by NSDC, exploring potential phasing, costs and strategies.
- Feasibility of achieving a 2035 or 2050 target for housing.

Target review
- Explores the feasibility of achieving different target dates for all emission sources (2030, 2035 and 2050), across different scenarios.

Next steps
- Summarises next steps and recommendations required to move forward with decarbonisation.

Carbon footprint overview

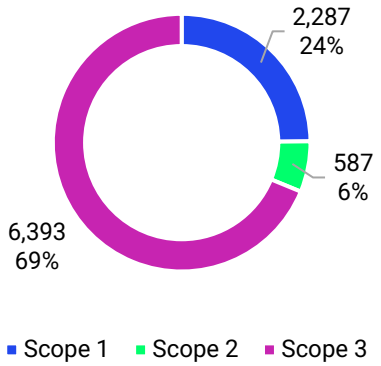
Here we provide NSDC corporate emissions from 2023/24 (FY) excluding NSDC Homes.

- Total NSDC emissions for the 2023/24 baseline year total **9,267 tCO_2e**.
- Scope 1 emissions, which arise from natural gas and diesel combustion in NSDC's buildings and fleet, total **2,287 tCO_2e**.
- Scope 2 electricity usage is responsible for **587 tCO_2e**, and arise almost entirely from buildings.
- The largest contribution to NSDC's footprint is from Scope 3 emission sources, totalling **6,393 tCO_2e.** This includes emissions from the treatment of waste and wastewater, water usage, business travel, commuting and purchased goods & services (PG&S).
- Upstream emissions associated with the extraction, refinement and distribution of fuels and electricity, classified as "upstream energy related activities" contribute **658 tCO_2e**. These emissions also fall under Scope 3.

Emission sources from 2023/24 have been compared with 2018/19 emissions here.

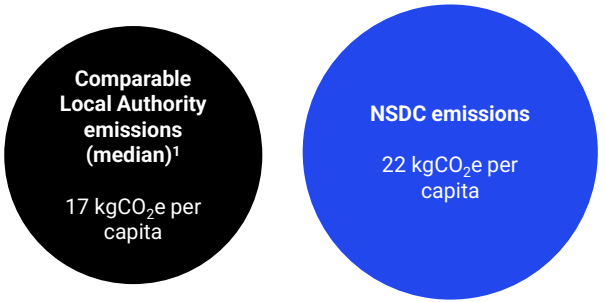
[1] Average LA emissions relate to the median Scope 1 and 2 emissions across all comparable CIPFA Neighbours Local Authorities, where data was publicly available. The emissions boundary and completeness of emissions reported are expected to vary considerably across each Local Authority.

Total NSDC emissions by source, 2023/24*

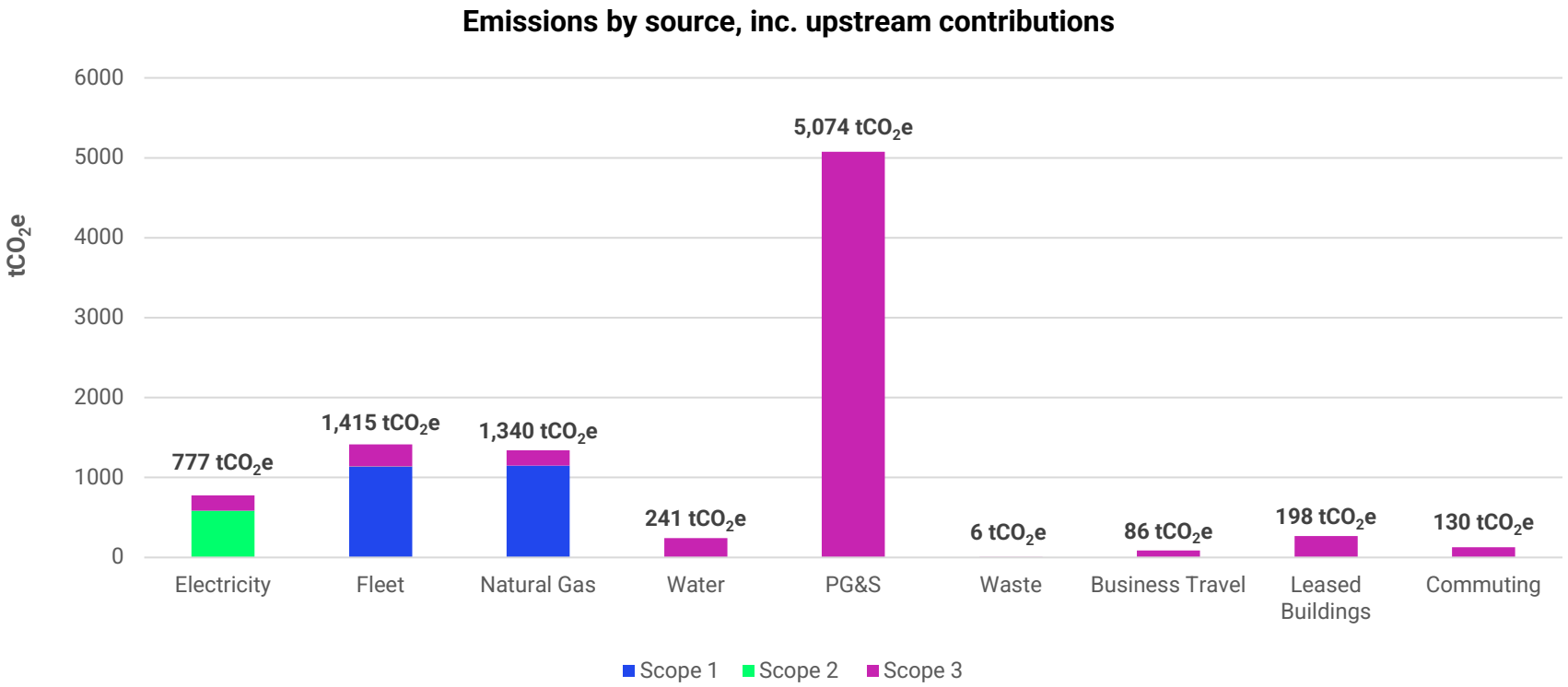


* Rounding leads to percentages not totalling 100% in all instances.

Comparison of organisational emissions (Scope 1 and 2)



Emissions by source



Housing decarbonisation

NSDC's housing portfolio of 5,603 houses is not currently included within the existing 2035 target. We have explored options for inclusion into the existing 2035 target or inclusion into an alternate 2050 target for **housing only**.

Baseline:

- Baseline emissions (2023/24), **19,921 tCO_2e**, with 75% of emissions from heating.
- Of the total emissions, **17,315 tCO_2e** are attributed to direct emissions (i.e excluding those from WTT)
- 97% of houses rely on burning fossil fuels (gas, oil, LPG), the remainder use electricity (resistance/heat pumps) or wood burners.

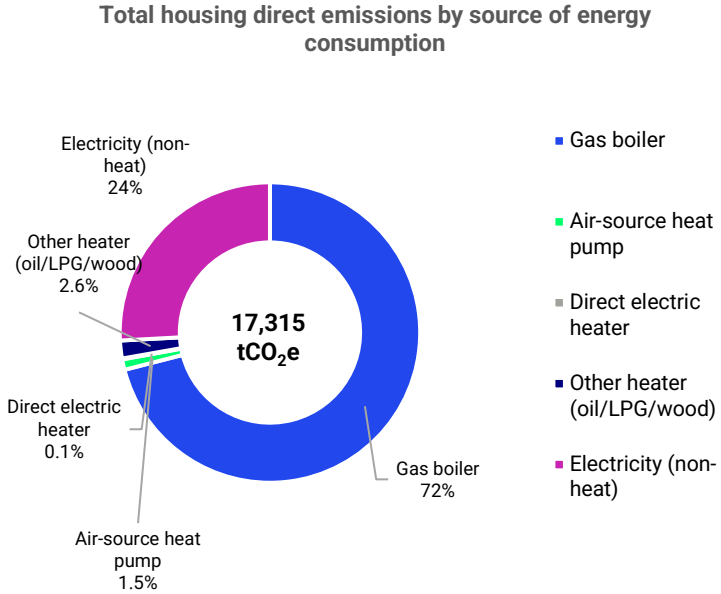
Carbon Reduction Pathways (more detail overleaf)

- Low retrofit scenario –improve energy efficiency for poorly rated housing (EPC D-G), with full electrification of all buildings.
- High retrofit scenario - extensive energy efficiency improvements (whole house deep retrofit, solid wall insulation) with full electrification

Decarbonisation targets:

- 2035 target: retrofit ~560 houses/year, ~£8m - £15m CAPEX per annum.
- 2050 target: retrofit ~220 houses/year, ~£3m - £6m CAPEX per annum.

NB. Significant offsets required in all scenarios to achieve carbon neutrality due to residual emissions present in the electricity grid.



Comparison with 2019

Existing target

NSDC's 2035 carbon neutral target

Emission source	2019 emissions (tCO_2e)	2024 emissions (tCO_2e)
Electricity	715*	777 (+9%)
Fleet	1,058*	1,415 (+34%)
Natural gas	715*	1,340 (+87%)
Water	10	241 (n/a)
Waste	11	6 (-39%)
Total:	**2,510**	**3,779 (+51%)**
Other sources:		
Housing	15,645 (direct emissions only)	17,315 (direct emissions only) 19,921 (including WTT)
Purchased goods and services	280	5,074
Business travel	49	86
Leased buildings	408	198
Commuting	108	130

* Updated to include Scope 3 emission sources, further explanation is provided here.

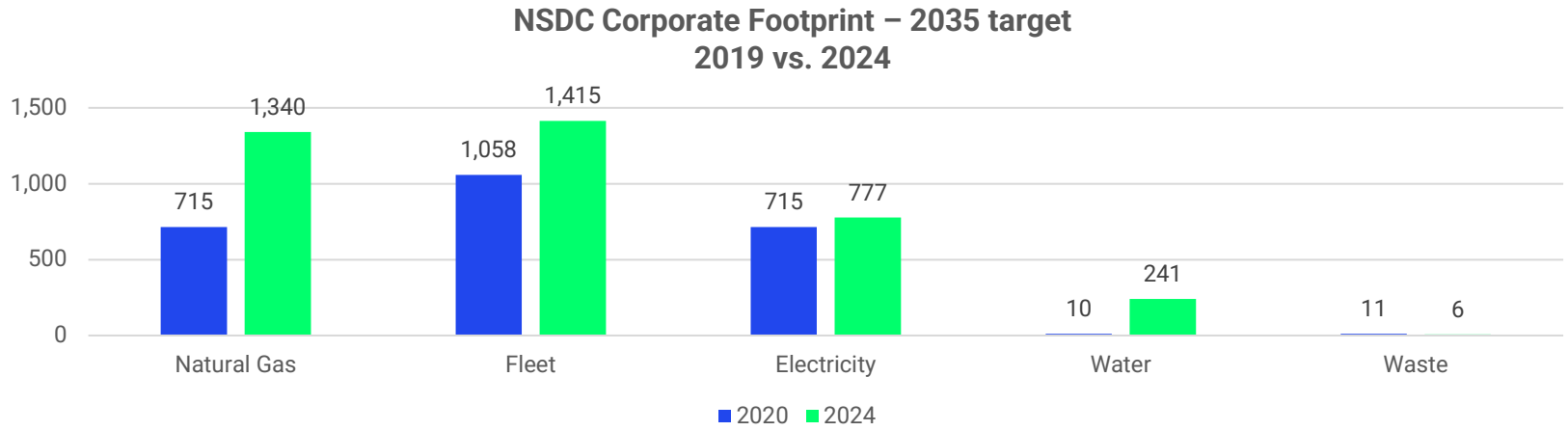
Comparison with 2019

Existing target

Emissions from natural gas, fleet operations, and electricity have increased. While some progress has been made in reducing fleet and natural gas emissions, significant efforts are still needed. Achieving full electrification by 2035 is essential to meet the carbon neutrality target.

The rise in emissions between 2019 and 2024 is primarily driven by:

1. An increase in the number of buildings under NSDC's control
2. Expansion of NSDC's operations and workforce (FTE rising from 493 in 2019 to 587 in 2024)
3. Enhancements in accuracy and novel calculation methodology, particularly for PG&S



Housing scenarios

- Energy use and emissions reductions were calculated for NSDC's housing.
- Carbon savings and associated costs for each of the decarbonisation interventions are calculated based on two retrofit options, targeting either 2035 or 2050.
  - High retrofit: All houses have energy efficiency measures and heat electrified.
  - Light retrofit: Some houses (EPC C-G) have energy efficiency measures, and all housing have heat decarbonised

ID	Scenario Explanation	2030 emissions remaining (tCO_2e)	2035 emissions remaining (tCO_2e)	2050 emissions remaining (tCO_2e)	Cumulative emissions to 2050 (tCO_2e)
H1	**High retrofit:** All houses have extensive energy efficiency measures and heat decarbonised **by 2035**	11,847	1,543	376	147,348
H2	**High retrofit:** All houses have extensive energy efficiency measures and heat decarbonised **by 2050**	13,970	9,818	376	238,287
H3	**Light retrofit**: Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing **by 2035**	11,933	1,624	395	148,620
H4	**Light retrofit:** Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing **by 2050**	13,928	9,788	395	238,562

Housing costs

The estimated capital expenditure (CAPEX) varies significantly across scenarios, as illustrated in the table.

High retrofit scenarios incur considerably higher costs, ranging from £139m to £145m, with annual estimates of £14.5m for the 2035 target and £5.6m for the 2050 target.

In contrast, the light retrofit scenario requires £76m across both target years, with annual costs estimated at £7.6m for 2035 and £3m for 2050.

This analysis indicates that the speed of retrofitting properties, whether faster or slower, has minimal impact on the overall CAPEX required. Instead, the primary constraints in decarbonisation are expected to be staff resourcing, annual capital allowances, and supply chain capacity.

Scenario	Est. total CAPEX	Est. CAPEX (per year)
H1: High retrofit 2035	£145m	£14.5m
H2: High retrofit 2050	£139m	£5.6m
H3: Light retrofit 2035	£76m	£7.6m
H4: Light retrofit 2050	£76m	£3m

Notes:

- Inflation has not been considered in the costings, figures presented in the table represent 2024 prices.
- Running costs, such as OPEX and general maintenance, are not included in the costings.
- Decreases and/or increases in natural gas and electricity bills as a result of the interventions are not included in the costings.

NSDC Corporate overview

- In 2024, *Be Design* audited the majority of NSDC's corporate buildings, responsible for most of the natural gas, electricity, waste and water-related emissions. These energy audits provided the basis of the corporate estate emissions target feasibility appraisal. This included forecasts for emissions arising from **natural gas** and **electricity** usage for 13 of NSDC's buildings.

- The target feasibility appraisal aims to provide NSDC with an understanding of realistic pathways to reaching Net Zero for its corporate buildings, considering both the type of interventions and phasing. **Four different scenarios** are modelled to gauge the ambition and deployment rate of interventions highlighted in the audits, and we present the cost and carbon implications for each of these 4 scenarios (see outline below).

- The baseline emissions associated with these modelled energy values were calculated by Carbon Trust using 2022 emissions factors and totalled **1,572 tCO_2e**, which equates to **17% of the total footprint** (not including NSDC homes). Of these emissions, **825 tCO_2e** are attributed to natural gas consumption, with electricity making up the remaining **747 tCO_2e.**

ID	Scenario Explanation	Baseline Emissions	Residual emissions by 2030 (tCO_2e)	Residual emissions by 2035 (tCO_2e)	Capital Investment (£)[1]
C1	Deep retrofit (all interventions) implemented by 2030	1,572	389	126	£3,882,000
C2	Deep retrofit (all interventions) implemented by 2035		791	126	£3,882,000
C3	Light retrofit (LED lights and heat decarbonisation[2]) implemented by 2030		524	170	£2,209,000
C4	Light retrofit (LED lights and heat decarbonisation[2]) implemented by 2035		865	170	£2,209,000

1 - Capital investment is presented in 2024 real terms and has not been adjusted for inflation
2 - Refers to natural gas boiler(s) being replaced by ASHP, GSHP or electric heating

Overview of targets

NSDC have an existing 2035 Carbon Neutrality target covering corporate (buildings), waste and water, and fleet. We have explored the feasibility of three potential targets based on the scenarios developed for NSDC Corporate (C1-4) and Housing (H1-4), compared with this existing 2035 target.

An overview of the targets is provided below, outlining how they would differ from NSDC's existing target.

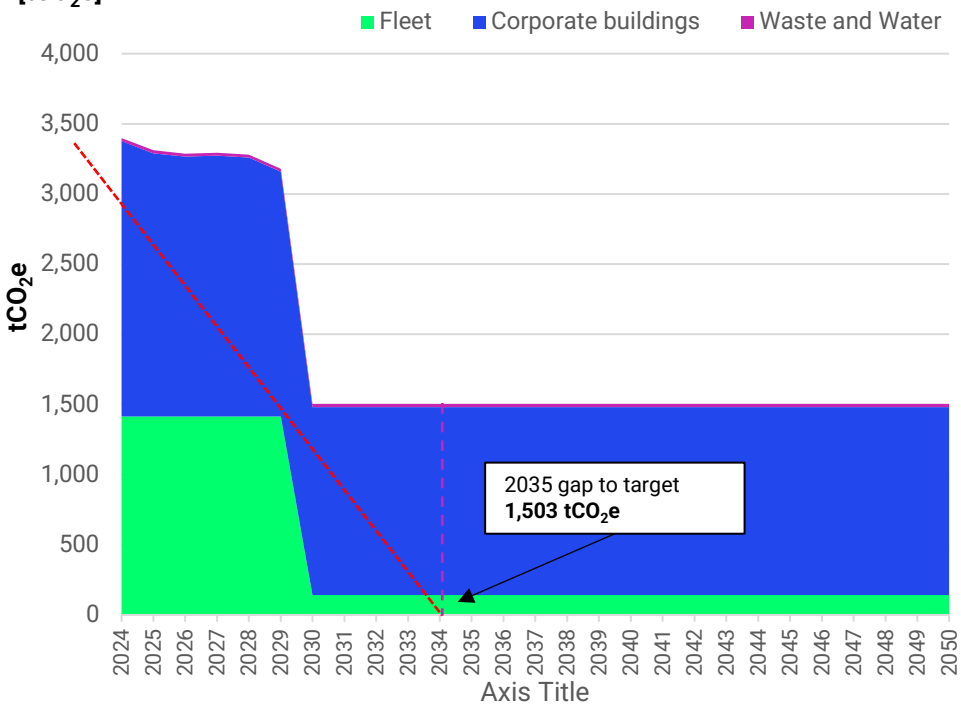
Potential target	Changes to the existing 2035 target
2030 target: moving existing target forwards to 2030	Moving the existing target forwards by 5 years to 2030, keeping the emission sources the same.
2035 target: integrate housing with the existing 2035 target.	Integrate housing with the existing 2035 target.
2050 housing target: a separate housing-specific target aims to achieve carbon neutrality by 2050, in addition to NSDC's existing 2035 target.	In addition to retaining the existing 2035 target, this would involve creating a separate 2050 target for the decarbonisation of housing only.

Business as usual

In this business-as-usual scenario, the existing 2035 target is established, incorporating initiatives already considered by NSDC, such as HVO for fleet (90% emissions reduction) and a green tariff for electricity by 2030.

- Other initiatives, like tree planting and solar PV, are acknowledged but not included in the pathway due to uncertainties about their impact.
- Achieving carbon neutrality under this plan will require carbon offsets of 1,503 tCO_2e in 2035. (£30k - £75k per annum)
  - Tree-planting schemes are expected to sequester 338 – 1,351 tCO_2e per annum.
- This pathway continues to use natural gas to 2050 and is heavily reliant on biofuels. While HVO is stated to reduce emissions by 90%, this does not account for significant indirect land-use changes, biodiversity loss, or the full lifecycle footprint of biofuel production. Further details on our recommended positioning on HVO available here.
- Given these challenges, there is a need to explore more sustainable long-term solutions, such as electrification for heating and transport.

Business as usual
(sustainable electricity tariff, grid decarbonisation and HVO)[1]
[tCO_2e]

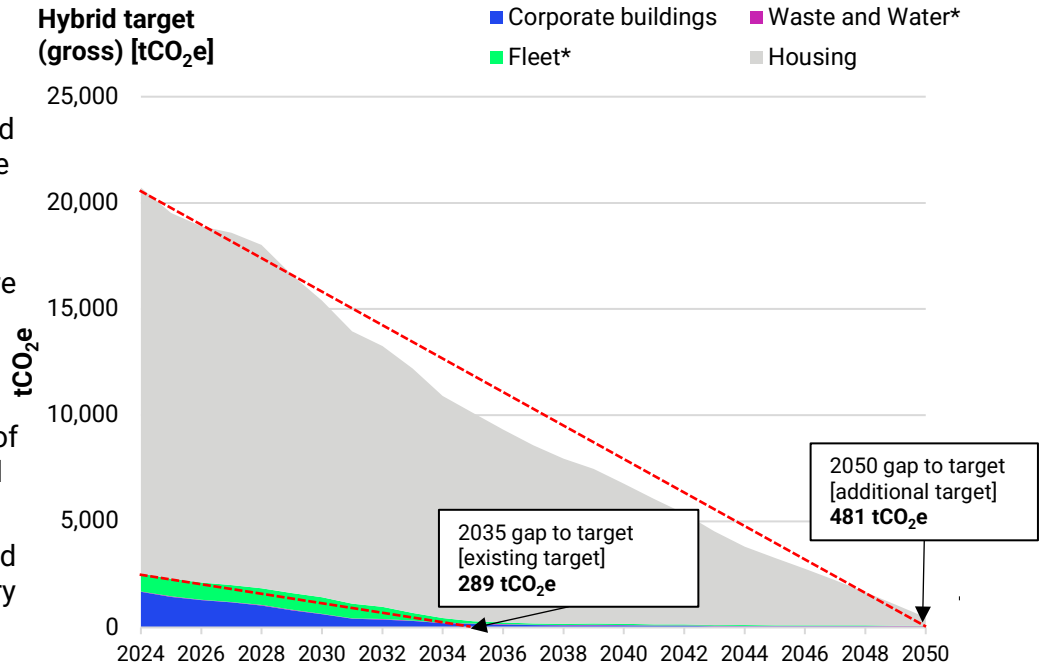


[1]There are variations in the emissions reported from fleet and corporate emissions as the methodology varies from other pathways explored in this report.

Example scenario: 2050 target

Under this proposed target, a hybrid approach is proposed. In this scenario, two emission targets would be created, the existing 2035 target and a separate housing-specific target aiming to achieve Net Zero by 2050.

- By 2035, emissions are projected to decrease by 51%, and by 2050, the reduction is expected to reach 98%, inclusive of residual emissions from electricity generation.
- Achieving carbon neutrality under this plan will require carbon offsets: 289 tCO_2e in 2035 (offsets for housing are not yet needed) and 481 tCO_2e in 2050 after the housing target is met (£10k - £25k per annum).
- The analysis estimates that decarbonising corporate buildings and housing in this scenario will require £78m of capital expenditure, with additional costs expected for all buildings, waste and water, and fleet.
- This target still involves significant capital investment and additional staffing to support a large-scale capital delivery program for corporate buildings and housing.
- Compared to other targets, this plan is considered the most achievable within the existing NSDC capacity for delivering retrofits.



Corporate emissions pathway modelled using C4, light retrofit (LED lights and heat decarbonisation) implemented by 2035. Housing emissions modelled using H4, Light retrofit: Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing by 2050.

*Emission projections for these emission sources have been carried across from the existing study as they weren't included in this study. All emissions intensity factors (e.g. gCO_2e/kWh) have been updated to reflect the most recent projections.

Recommended approach

Based on our analysis, we recommend that NSDC retain its existing 2035 target while introducing a new 2050 target for housing, as this is likely to be the most feasible pathway to achieving full decarbonisation.

Potential target	Scope	Emissions reduction by 2030	Emissions reduction by 2040	Total emissions (to 2050)	Estimated CAPEX (excludes fleet, water and waste)
Business as usual: 2035 target with green electricity tariff and HVO	• Corporate buildings • Water and waste • Fleet	-56%	-56%	**51,302 tCO_2e**	n/a
2030 target: 2030 target: moving NSDC's existing target to 2030	• Corporate buildings (C3) – light retrofit by 2030 • Water and waste • Fleet	-63%	-91%	**17,700 tCO_2e**	£2.2m (corporate only)
2035 target: integrate housing with the existing 2035 target.	• Corporate buildings (C4) – light retrofit by 2035 • Housing (C3) – light retrofit by 2035 • Water and waste • Fleet	-36%	-95%	**168,855 tCO_2e**	£78m (corporate and housing only)
2050 housing target: a separate housing-specific target aims to achieve carbon neutrality by 2050, in addition to NSDC's existing 2035 target.	2035 target (existing) • Corporate buildings (C4) – light retrofit by 2035 • Water and waste • Fleet 2050 housing target • Housing (H4) – light retrofit by 2050	-25%	-67%	**259,522 tCO_2e**	£78m (corporate and housing only)

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Target Review

1. Background

Introduction

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Since 2019, a number of carbon reduction measures have been progressed towards implementation such as Solar PV installations and EV charging infrastructure at NSDC corporate and leisure buildings. Additionally, NSDC's portfolio of assets has changed, most significantly with the integration of Southwell leisure centre, now under direct council control (meaning an overall increase in council emissions).

This project

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1. Conduct **analysis to understand the feasibility of bringing the 2035 target forward to 2030** (with the existing boundary of emissions: gas, electricity, water, waste, fleet).
2. Conduct analysis to understand the feasibility of integrating the **housing stock (NSDC Homes emissions) into the existing 2035 target.** *Following discussions with the housing team, a target date of 2050 was also explored.*

Workflow

Phase 1:
KO, Mobilisation & Carbon Footprint

- Project kick-off
- Mobilisation, data & info collection
- Carbon footprint assessment
- Carbon footprint briefing

Phase 2:
Emissions Reduction Feasibility

- Housing portfolio emissions reduction feasibility
- NSDC corporate portfolio emissions reduction feasibility

Phase 3:
Emissions Target Feasibility Appraisal

- Model targets and interventions pathways
- Develop target options appraisal report
- Summary presentation and close-out

Report Overview

This report details a variety of data and actions towards achieving net zero, please find further details on each section below.

Carbon footprint overview (2023/24)
- Analysis and calculation of NSDC's carbon footprint for the 2023/24 period
- Analysis of progress towards the existing 2035 target.
- Recommendations to improve accuracy of reporting

NSDC Corporate decarbonisation
- Feasibility of decarbonising buildings owned and operated by NSDC, exploring potential phasing, costs and strategies
- Explores the feasibility of 2030 and 2035 target, building on existing work completed by BE DESIGN.

Housing decarbonisation
- Focuses on decarbonising houses owned by NSDC, exploring potential phasing, costs and strategies
- Explores the feasibility of achieving a 2035 and 2050 target.

Target review
- Explores the feasibility of achieving different target dates (2030, 2035 and 2050) across different scenarios.

Next steps
- Summarises next steps and recommendations required to progress towards decarbonisation.

Target Review

2. Carbon footprint overview (23/24)

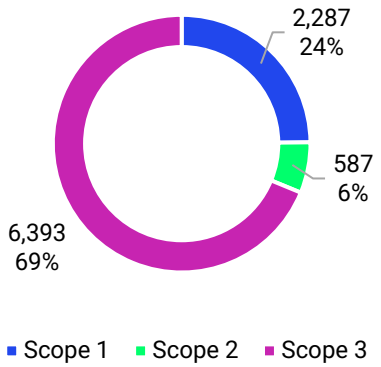
Overview

This section explores NSDC's emissions from 2023/24 (FY), with each source of emissions broken down by category and analysed. It provides insights into the key contributors to the carbon footprint, highlighting trends and potential areas for reduction.

- Total NSDC emissions for the 2023/24 baseline year total **9,267 tCO_2e**
- Scope 1 emissions, which arise from natural gas and diesel combustion in NSDC's buildings and fleet, total **2,287 tCO_2e.**
- Scope 2 electricity usage is responsible for **587 tCO_2e**, coming almost entirely from buildings.
- The largest contribution to NSDC's footprint is from Scope 3 emission sources, totalling **6,393 tCO_2e.** This includes emissions from the treatment of waste and wastewater, water usage, business travel, commuting and purchased goods & services (PG&S).
- Of the scope 1 and 2 emissions, upstream emissions associated with the extraction, refinement and distribution of fuels and electricity, classified as "upstream energy related activities" contribute **658 tCO_2e**. These emissions also fall under Scope 3.

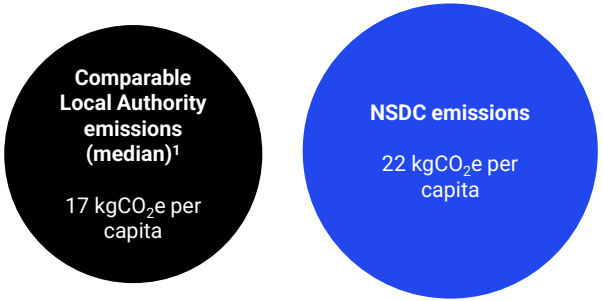
[1] Average LA emissions relate to the median Scope 1 and 2 emissions across all comparable CIPFA Neighbours Local Authorities, where data was publicly available. The emissions boundary and completeness of emissions reported are expected to vary considerably across each Local Authority.

Total NSDC emissions by source, 2023/24*



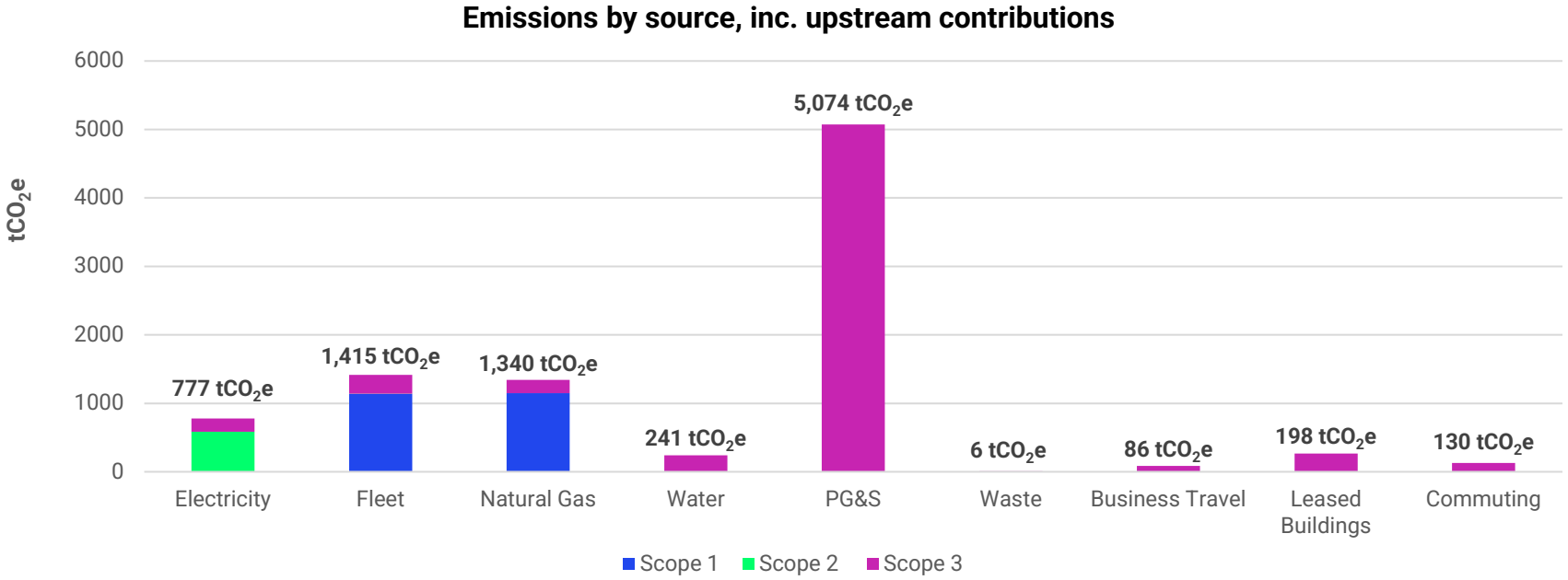
* Rounding errors lead to percentages not totalling 100%

Comparison of organisational emissions (Scope 1 and 2)



Emissions by source

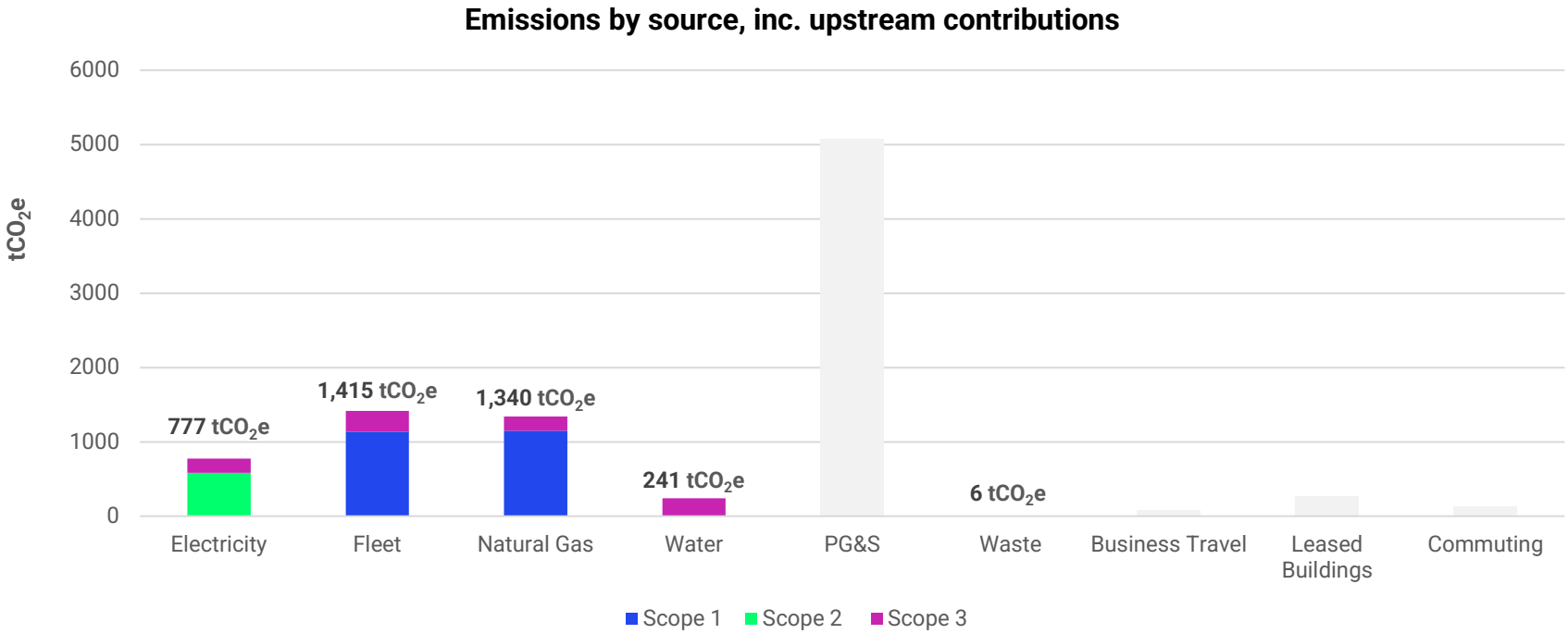
The chart below shows all emission sources calculated as part of NSDC's 2023/24 footprint, overleaf details which of these emission sources are currently included within NSDC's 2035 carbon neutrality target. Comparisons for all emission sources with 2018/19 are available here.



Emissions by source

2035 target sources

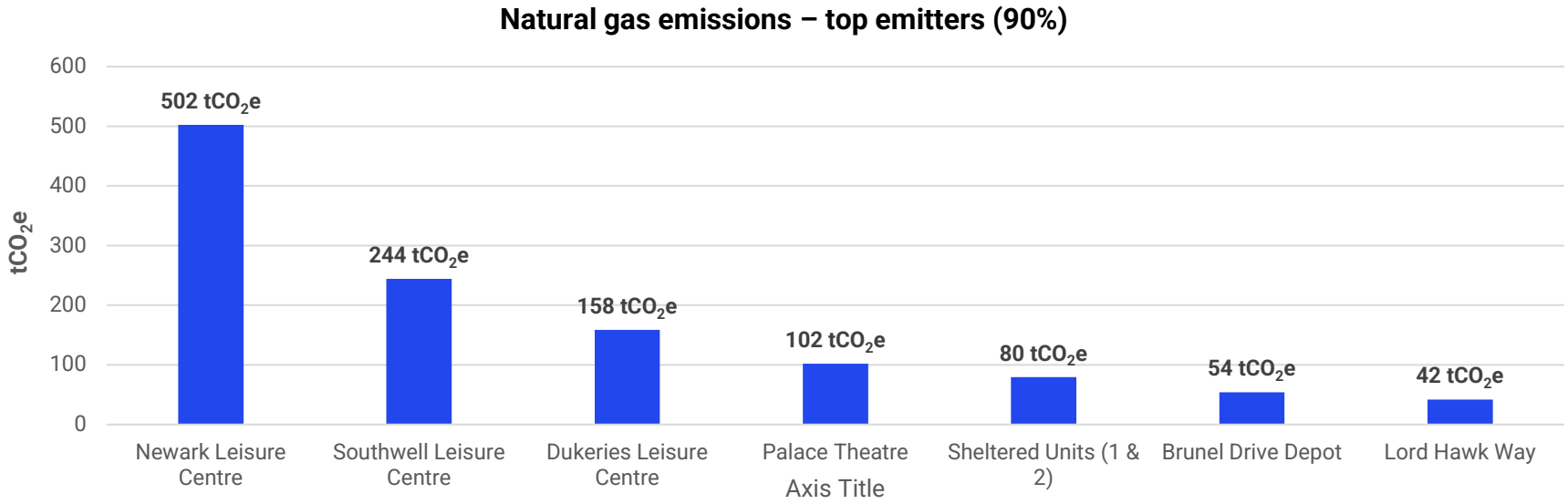
The chart below shows all emission sources that are included within NSDC's 2035 carbon neutrality target. The emissions from these emission sources total **3,779 tCO_2e.**



Stationary emissions

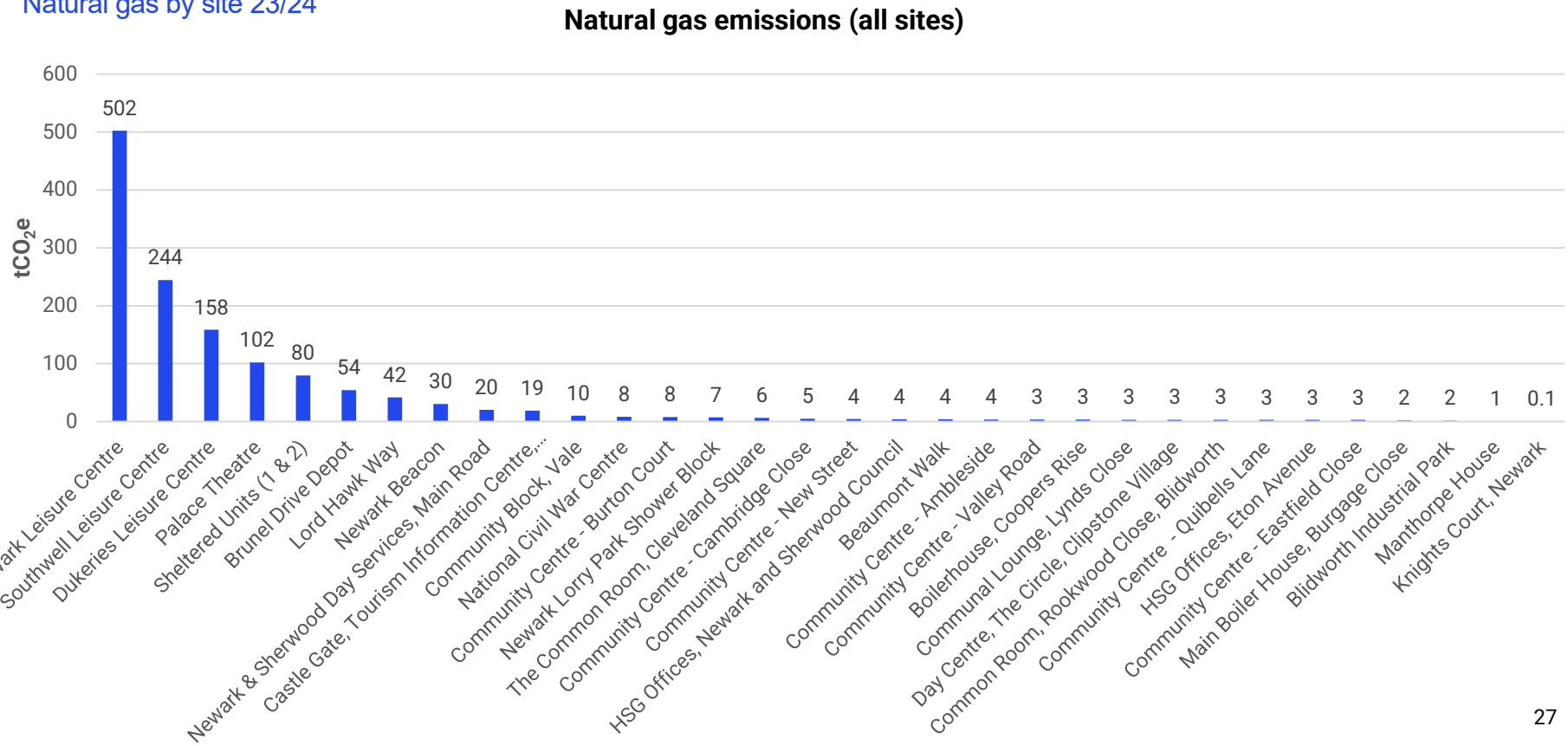
Natural gas 23/24

- Natural Gas emissions, which arise from the heating of NSDC buildings, total **1,340 tCO_2e**.
- The 7 highest-emitting sites are presented on this page, which make up ~90% of all natural gas emissions.
- Newark Leisure Centre makes over a third of all the emissions (33%), **502 tCO_2e.** Together with Southwell Leisure Centre **(244 tCO_2e)** and Dukeries Leisure Centre **(158 tCO_2e)**, these 3 sites alone make up 67% of NSDC natural gas emissions.
- Leisure Centres typically have high heating demands, especially in instances where a heated swimming pool is present.



Stationary emissions

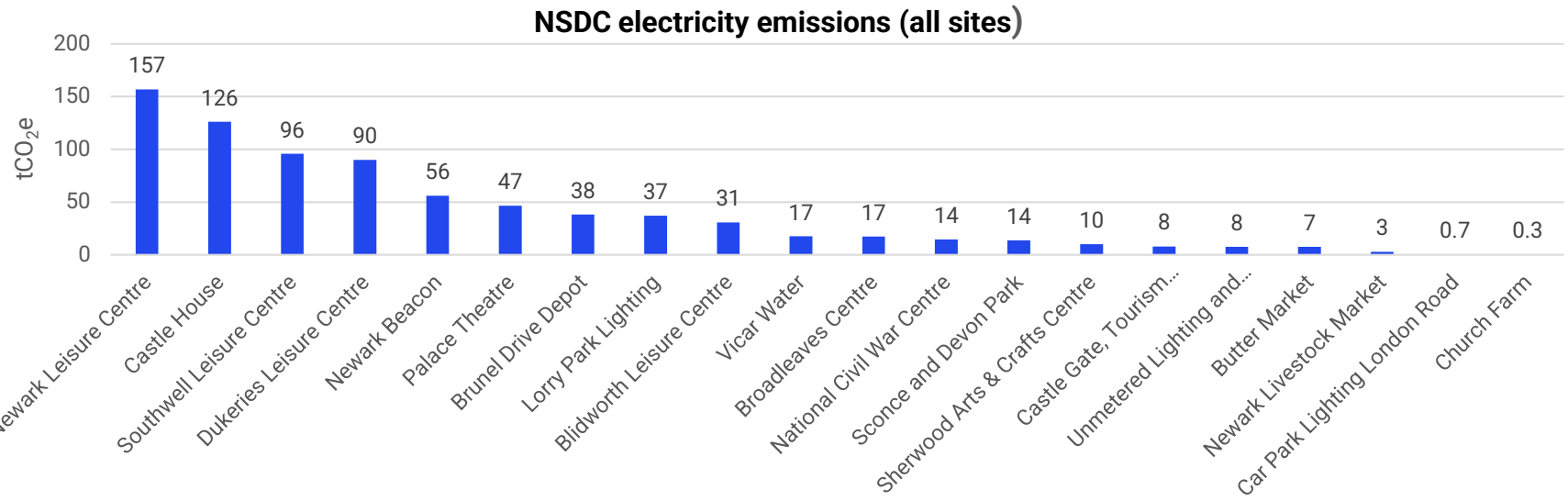
Natural gas by site 23/24



Stationary emissions

Electricity 23/24

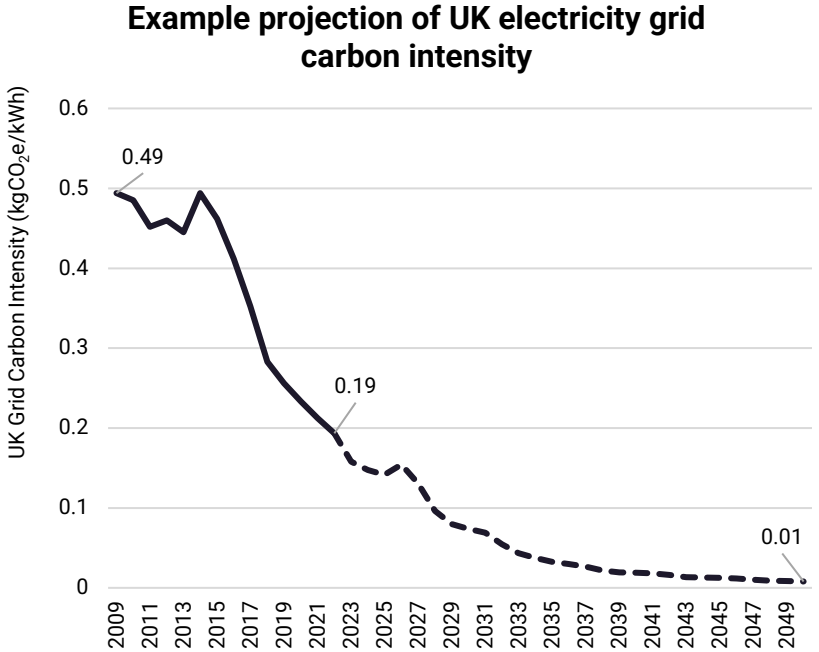
- Electricity emissions total **777 tCO_2e**.
- Less than half of the sites (40%) make up 75% of all electricity-related emissions.
- Castle House, NSDC's headquarters, is the second largest contributor to corporate electricity emissions.
- Similar to the natural gas emissions, leisure centres are identified as some of the most energy-intensive sites in NSDC's corporate portfolio. Newark Leisure Centre, Southwell Leisure Centre and Dukeries Leisure Centre are the first, third and fourth highest-emitting sites, respectively.



Stationary emissions

Electricity – grid decarbonisation

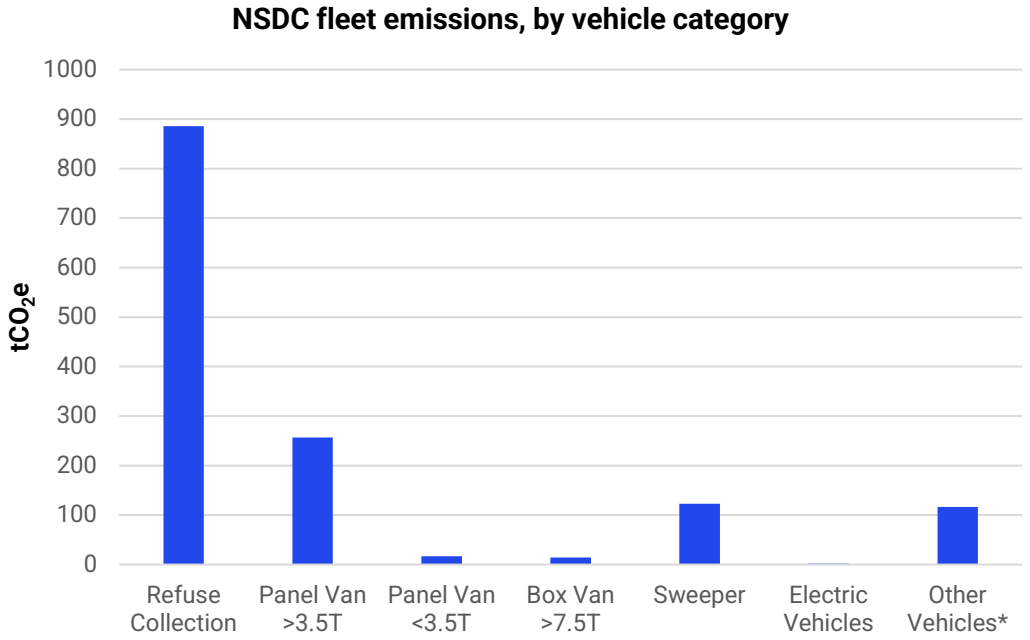
- The UK power sector has undergone significant changes in the last 10 years: coal power stations have been increasingly phased out and replaced by renewable electricity generation sources such as solar and offshore wind. Between January and May 2019, Britain generated more power from clean energy than from fossil fuels for the first time since the Industrial Revolution.
- In 2010 consuming 1 kWh of electricity would result in 0.49 $kgCO_2e$ being emitted, by 2021 this value had more than halved.
- The UK plans to have 100% of electricity generated to be renewable by 2030.
- By 2030, it is expected the emission factor for UK electricity will approach 0.1 $kgCO_2e$ per kWh; and almost zero by 2050.
- The 'greening of the grid' means that NSDC's footprint will naturally shrink over time. **The more NSDC moves to electrify its heating systems and transport, the more its footprint will decrease over time**.



Transport

Fleet 23/24

- Fleet is one of the biggest contributors to NSDC's total footprint.
- Emissions from NSDC's fleet comprised of 100 vehicles is equal to **1,414 tCO_2e.**
- Of these emissions, there is an overwhelming contribution from **diesel consumption (~99.9%).**
- Diesel vehicles offer a better fuel efficiency compared to petrol vehicles, and therefore fewer carbon emissions on a km driven basis; however, they also produce more particulate matter, SO_x and NO_x which greatly contribute to poorer air quality.
- The largest contribution to fleet emissions can be attributed to the Dennis Eagle Refuse vehicles, which are responsible for ~63% of the total fleet emissions (**886 tCO_2e**).

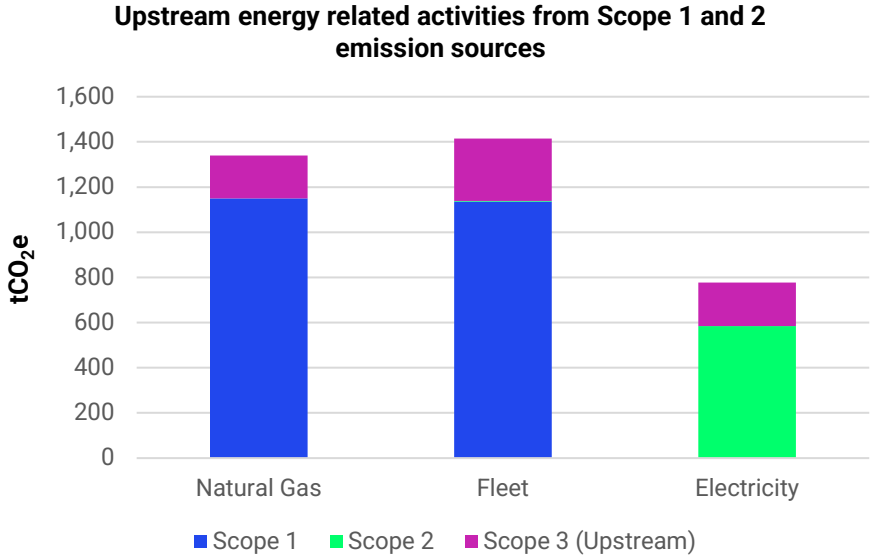


*Includes the following categorisations: Single Cab, Double Cab, 4x4 Vehicle, Rigid, Compact Tractor, Workshops

Upstream energy related activities

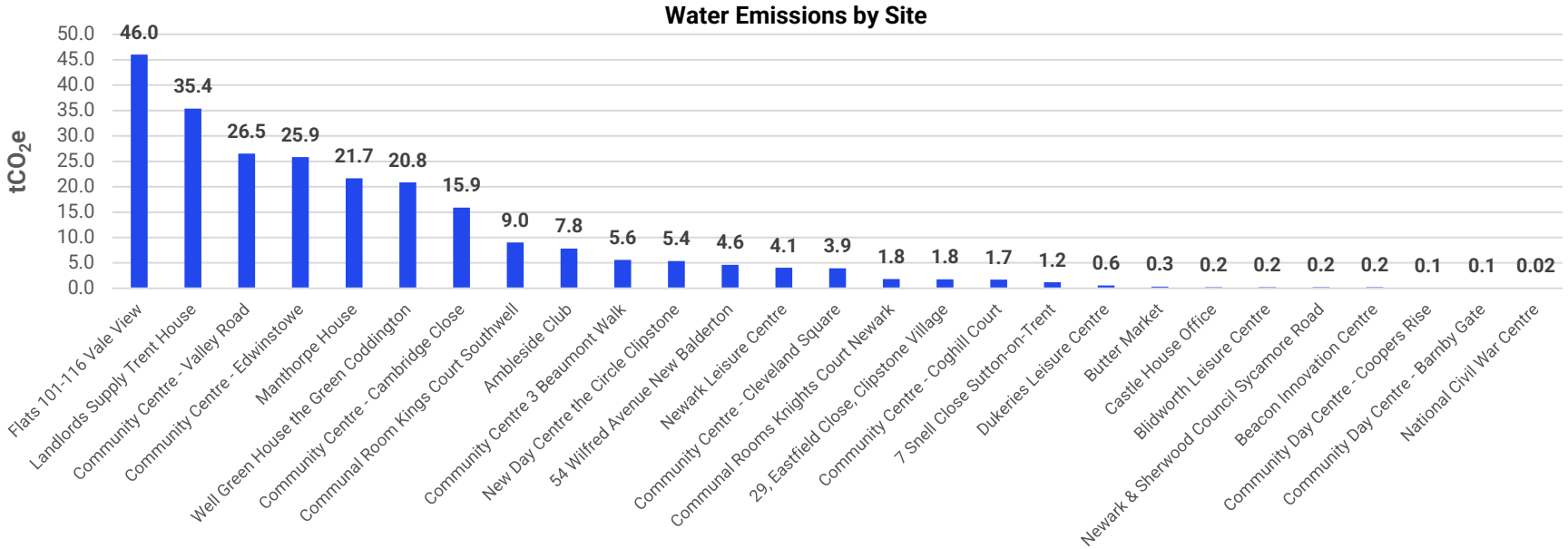
- The use of fossil-fuel based energy produces emissions associated with the production of that fossil-fuel energy and its distribution to the point of use. This is why certain **Scope 1 and Scope 2 emissions sources also have a Scope 3 contribution to their emissions**. These emissions are classed under 'upstream energy related activities' and typically fall into two categories: Well-to-tank (**WTT**) emissions and Transmission & distribution **(T&D)** emissions.
- **WTT captures the emissions produced during the extraction, refining and transportation of the raw fuel sources to an organisation's site (or asset)**, prior to combustion. These emissions therefore relate to the natural gas consumed for heating; the fuels used in fleet vehicles and the gas and coal used in power stations when producing electricity.
- **T&D applies only to electricity consumption and includes the emissions associated with the energy loss that occurs in getting the electricity from the power plant to the organisations that purchase it**. A subset of this is the additional WTT emissions associated with the energy loss in the electricity grid – WTT & T&D.

	Natural Gas	Fleet	Electricity
Scope 1	1,150	1,136	0
Scope 2	0	1.7	585
Scope 3 (Upstream)	190	277	192
Upstream emissions contribution to total footprint	**14%**	**20%**	**25%**



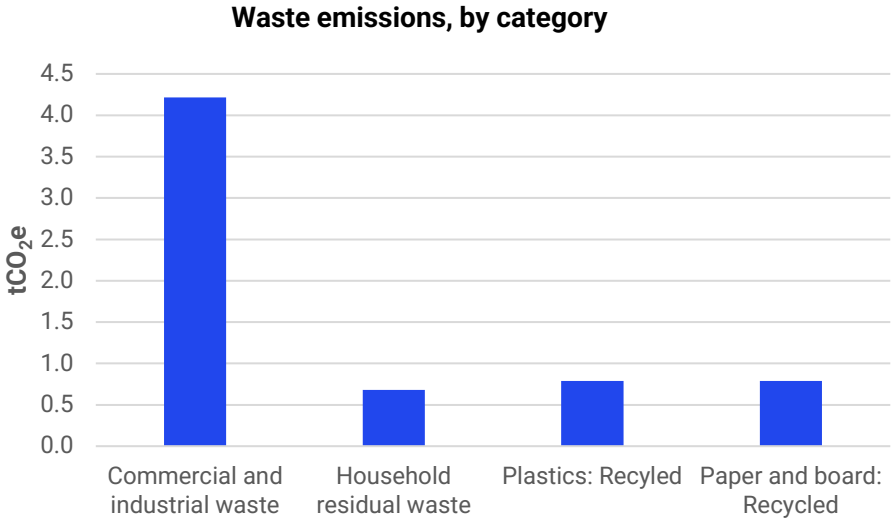
Water

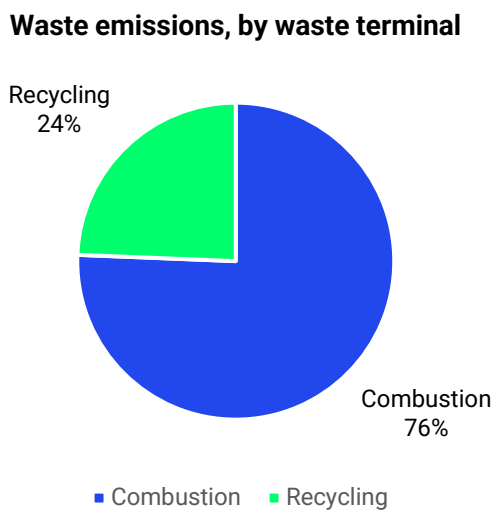
- Water emissions total **241 tCO_2e,** these stem from a combination of upstream supply and downstream processing
- Unlike gas and electricity, the sites with the highest emissions are residential areas, rather than commercial spaces like leisure centres.
- The site with the highest emissions from water and wastewater treatment are **Flats 101-116 Vale View**. Community centres also make significant contributions.
- 7 sites emit 80% of the total water emissions, equivalent to **192 tCO_2e.**



Waste

- Waste emissions include those resulting from the downstream processing of waste generated by NSDC. These emissions only apply to waste generated from the Council. Emissions from waste management and treatment services for Housing will be captured in the PG&S footprint.
- In total, NSDC's waste contribution is low, with emissions totalling **6.5 tCO_2e,** less than 0.1% of the total footprint**.**
- Data on waste terminals was provided, but NSDC did not provide any information on waste types. It was assumed that any waste originating from residential housing was classed as "household residual waste", and any waste from leisure centres, offices or other commercial buildings was classed as "commercial and industrial waste". It was also assumed that the recycled waste was a 50:50 split between paper and board, and plastics.



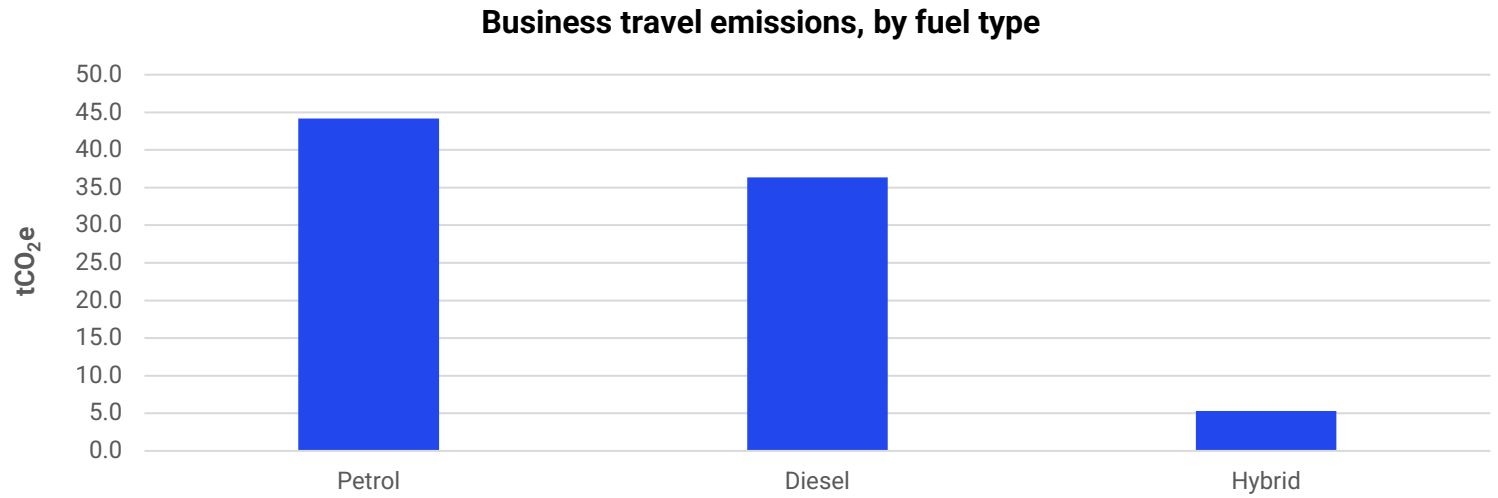


Transport

Commuting and business travel 23/24

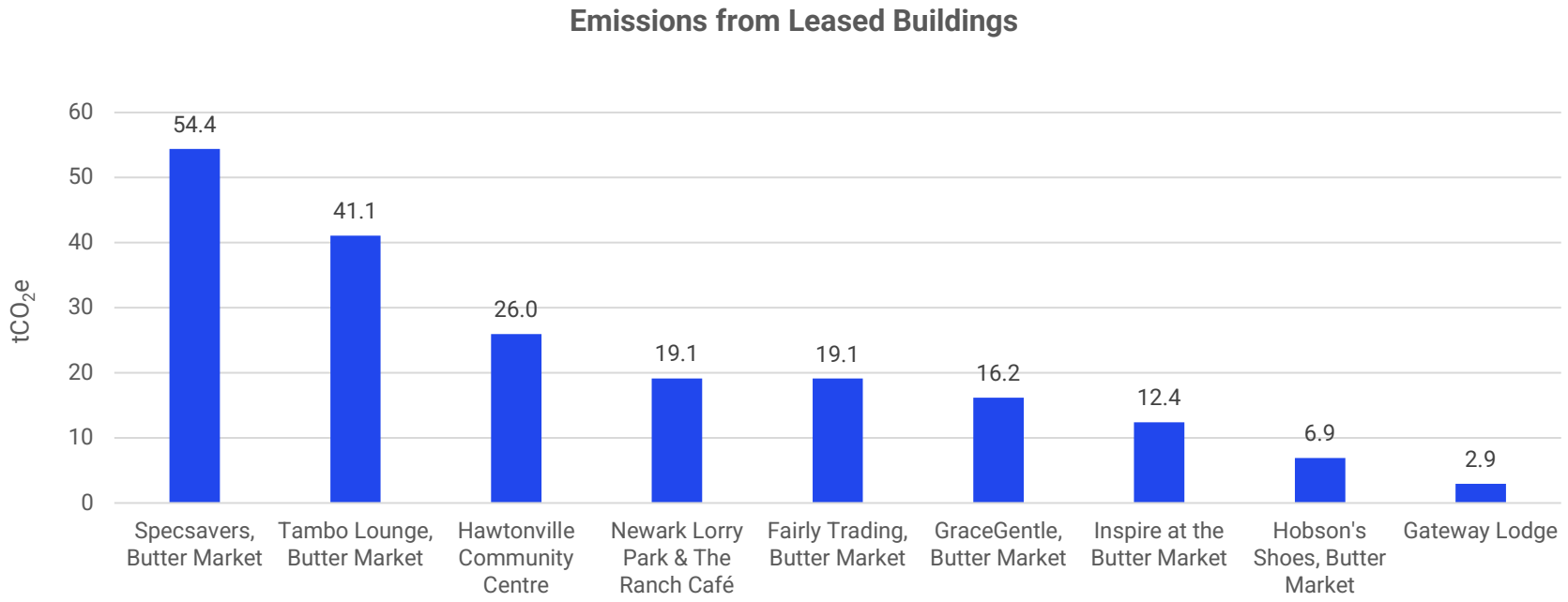
- Commuting emissions are substantial, responsible for **130 tCO_2e.** No information on journey type, journey distance, or vehicle type was provided. Emissions were estimated using 2019 baseline figures and the latest FTE count (proxy approach).

- Business travel makes a minimal contribution to NSDC's total footprint, amounting to **86 tCO_2e**.
- All of the emissions associated with business travel arise from cars, with the largest contribution being petrol (51%), followed by diesel (42%).
- There are known minor contributions from rail travel and taxis, but these were not accounted for due to insufficient data.



Leased assets

- Leased buildings make a small contribution to NSDC's total footprint, amounting to an estimated **198 tCO_2e**.



Purchased goods and services

By supplier

- Purchased goods and services are the largest contributor to NSDC's footprint, totalling **5,074 tCO_2e**, representing **58% of the total footprint**.
- Spend data used as a proxy was provided for just under 30,000 supplier invoices. Using the *Level 9 Account Name*, this spend data was matched to SIC codes to estimate emission contributions.
- In total, contracts were divided into 15 broad categories and 45 sub-categories. A full breakdown of all 15 emission source categories is on the next page.
- Of the 5 highest-emitting contract types, the top 4 all represent services, rather than physical goods. The highest contributions to PG&S emissions relate to water supply & treatment, and waste remediation services.

In the future, supplier-specific data for purchased goods and services should be used wherever possible to calculate associated emissions, instead of using expenditure proxies.

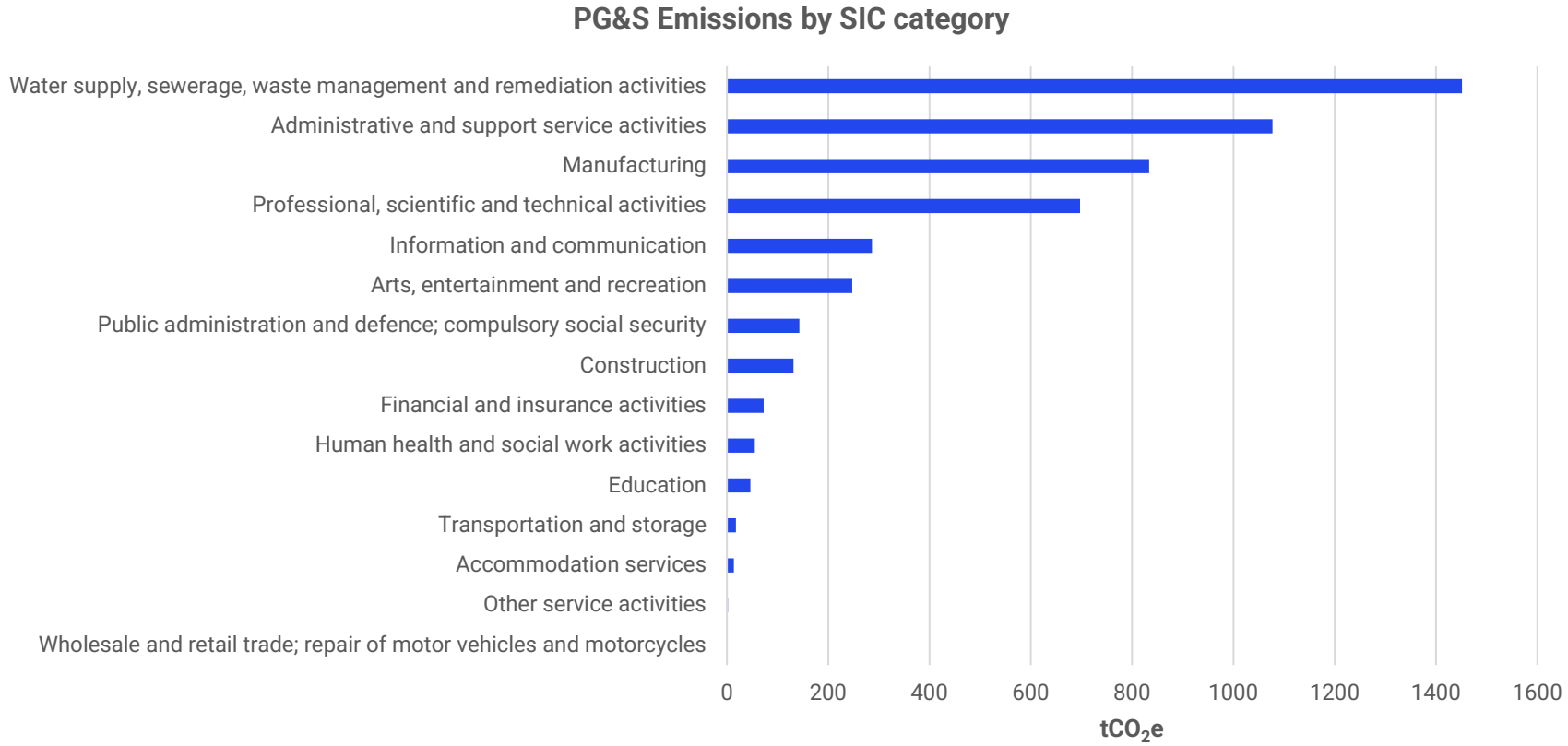
- Despite this being an indirect source of emissions, NSDC will have some influence over third-party product and service-based emissions. This can be usually be achieved through active supplier engagement and selection.

The top 5 categories of spend by highest emissions are:

- Water supply, sewerage, waste management - Remediation services and other waste management services: **853 tCO_2e**
- Water supply, sewerage, waste management - Waste collection, treatment and disposal services; materials recovery services: **524 tCO_2e**
- Administrative and support service activities – Services to buildings and landscape: **421 tCO_2e**
- Professional, scientific and technical activities – Other professional, scientific and technical activities **329 tCO_2e**
- Manufacturing – Machinery and equipment n.e.c: **223 tCO_2e**

Purchased goods and services

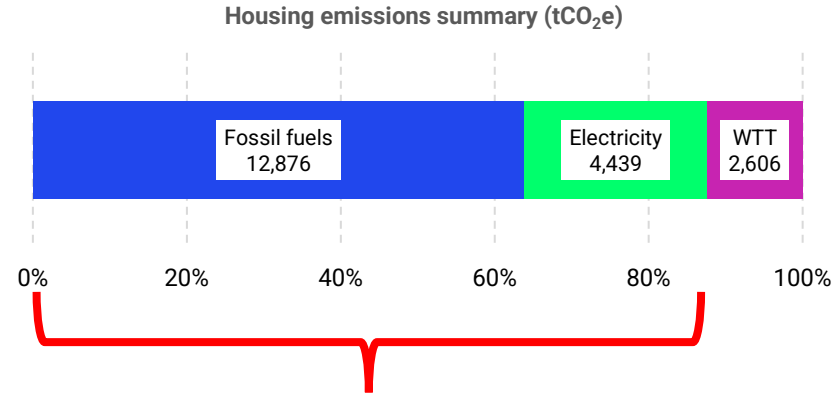
By category

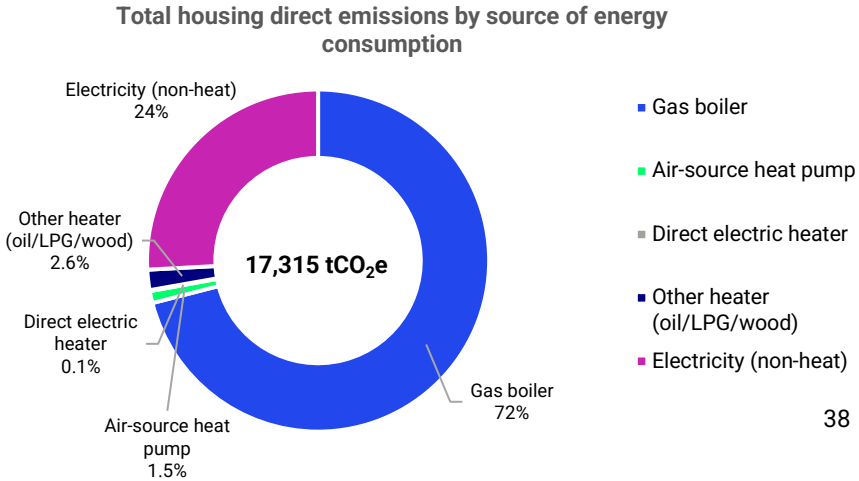


Housing

Summary of emissions 23/24

- Emissions associated with housing total **19,921 tCO_2e,** direct emissions (i.e. excluding WTT) total **17,315 tCO_2e.**
- Fossil fuels for heating are the largest source of emissions from Housing, producing **12,876 tCO_2e** in 2023.
- Emissions from electricity consumption were **4,439 tCO_2e** in 2023.
- Upstream well-to-tank (WTT) emissions, associated with the production and transportation of fuels, were **2,606 tCO_2e** in 2023.
- Of the direct emissions from fuel combustion and electricity (17,315 tCO_2e), 72% comes from gas boilers and 24% from ancillary electricity use (i.e. appliances and lighting).
- Of the 5,603 tenant properties owned by NSDC, 95% have gas boilers, 2.8% have an air-source heat pump, and 2% use heating oil.

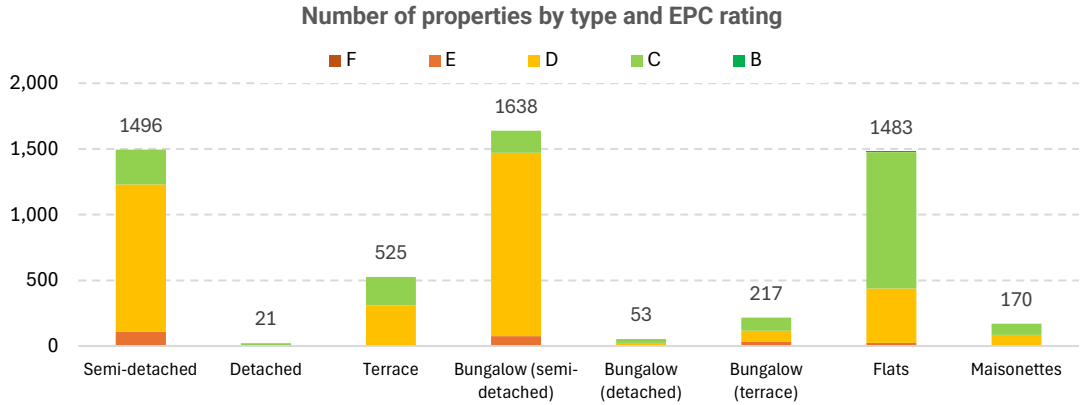


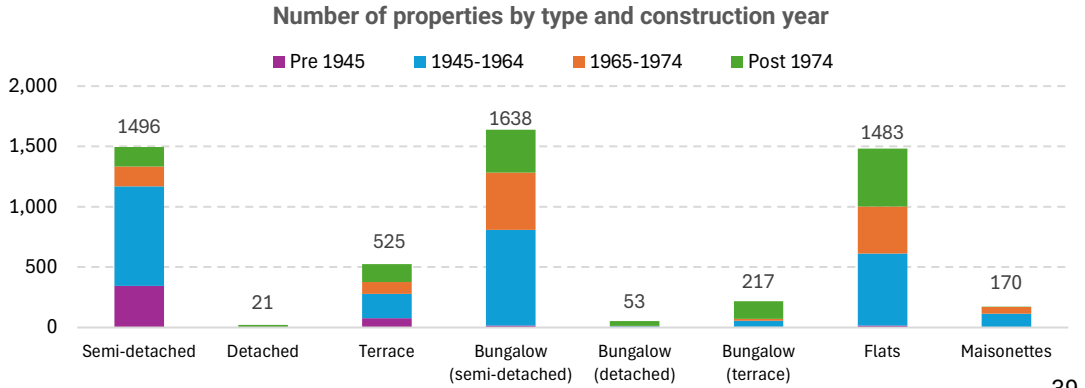


Housing

Breakdown of building types 23/24

- There are a total of **5,603 tenant properties** in the dataset supplied by NSDC.
- Semi-detached bungalows are the most prominent building type (1,638), the majority of these are EPC D (85%) and almost entirely built after 1945 (99%)
- The next most common building type is semi-detached houses but there are very similar amounts of semi-detached houses and flats.
- 24% of properties were built after 1974 making the building stock relatively modern.





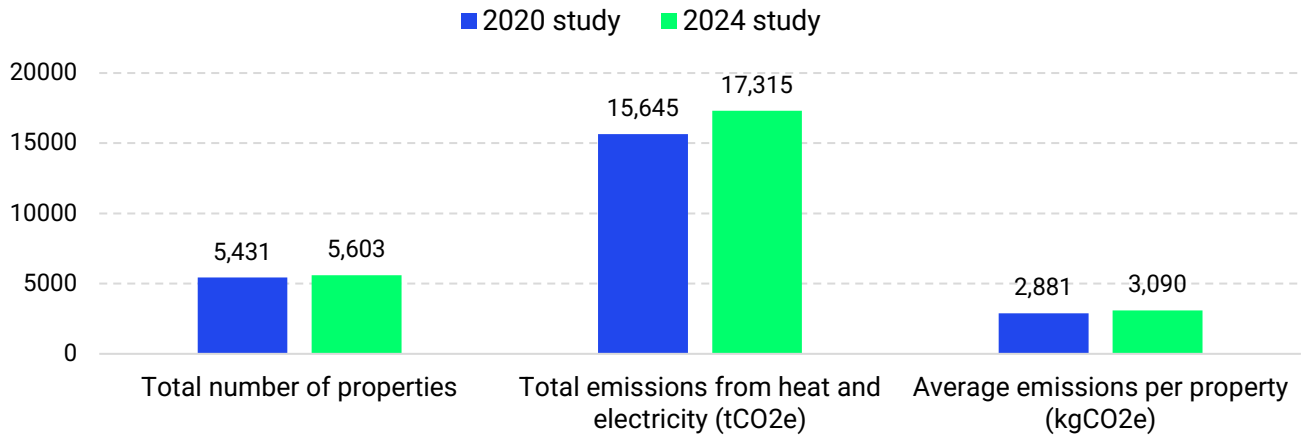
Housing

2019 vs 2024

The main changes to the tenant building footprint since 2019 are:

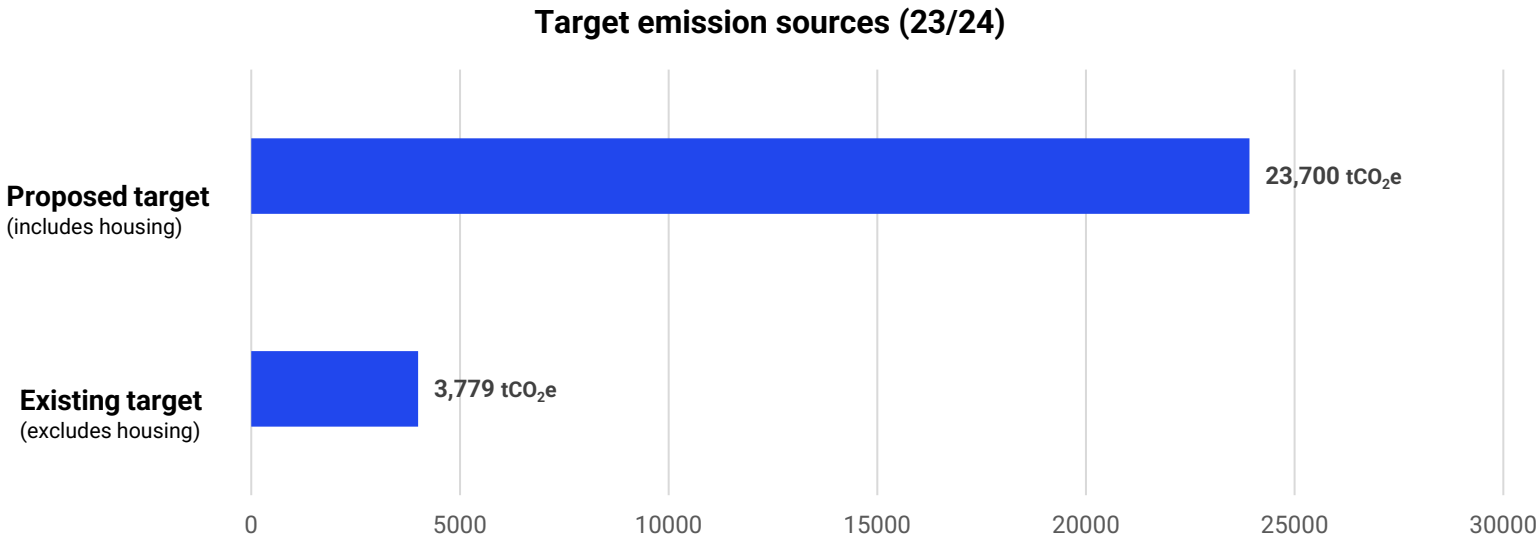
- Increase in the total number of properties included in the analysis, from **5,431 to 5,603.**
- A more accurate methodology was used to estimate building energy consumption – the *Glow Simulator* (see appendix) uses real half-hourly data from smart meters, in contrast to 2019 which used unreliable EPC cost data and CIBSE benchmarks.

The average emissions per property are similar between the two studies, with a **7% increase between reporting years**. Whilst emissions cannot be directly compared due to the different methodologies. It is expected that average emissions per property would reduce slightly as the building stock modernises, the electricity grid decarbonises, and from fabric retrofits installed over the last 4 years. This indicates that former estimates of emissions were likely to be an underestimate.



2035 target

- Total NSDC emissions for the 2023/24 baseline year total **3,779 tCO_2e (excluding housing)** (emission sources shown here) or **23,700 tCO_2e (including housing).**
- The existing 2019 baseline was 2,165 tCO_2e, these figures have been updated **2,510 tCO_2e** to include upstream and WTT Scope 3 emissions (further rationale available here).
- Emissions between 2018/19 and 2023/24 increased by 51% (see more detail here)
- Both options have been considered to allow for the next phase of work where the feasibility of integrating the housing stock (housing emissions) into the existing 2035 target will be considered alongside bringing forward the 2030 target (without housing).



Comparison with 2019

Existing target

NSDC's existing 2035 carbon neutral target

Emission source	2019 emissions (tCO_2e)	2024 emissions (tCO_2e)
Electricity (scope 2 & 3)	715	777 (+9%)
Fleet (scope 1, 2 & 3)	1,058	1,415 (+34%)
Natural gas (scope 1, 2 & 3)	715	1,340 (+87%)
Water (scope 3)	10	241 (n/a)
Waste (scope 1)	11	6 (-39%)
Total:	**2,510**	**3,779 (+51%)**
Housing	15,645 (direct emissions only)	17,315 (direct emissions only) 19,921 (including WTT)
Purchased goods and services	280	5,074
Business travel	49	86
Leased buildings	408	198
Commuting	108	130

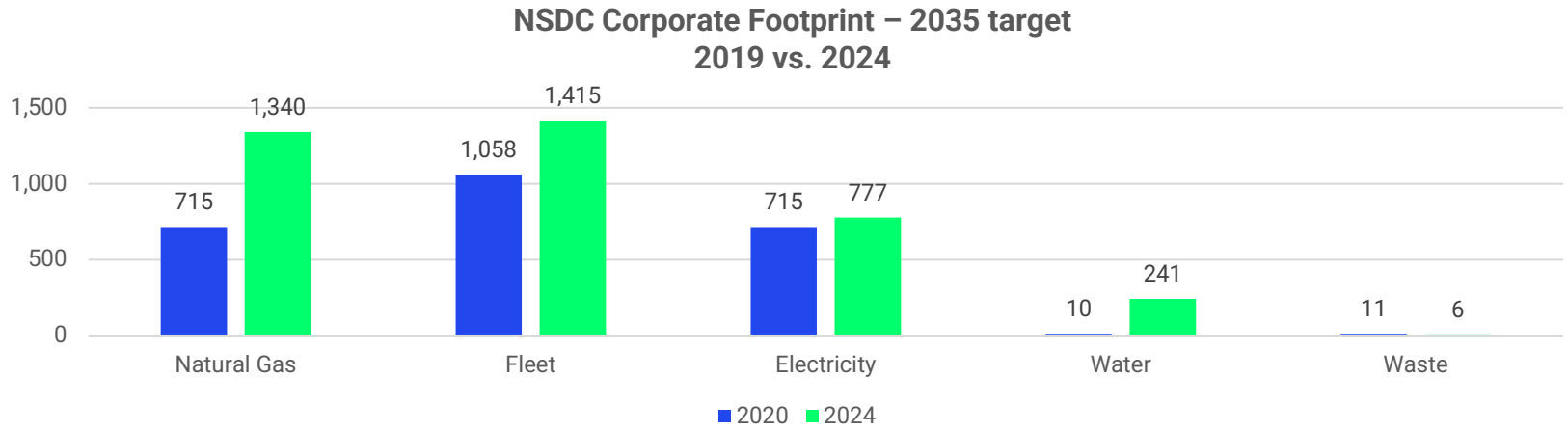
Comparison with 2019

Existing target

Emissions from natural gas, fleet operations, and electricity have increased. While some progress has been made in reducing fleet and natural gas emissions, significant efforts are still needed. Achieving full electrification by 2035 is essential to meet the carbon neutrality target.

The rise in emissions between 2019 and 2024 is primarily driven by:

1. An increase in the number of buildings under NSDC's control
2. Expansion of NSDC's operations and workforce (FTE rising from 493 in 2019 to 587 in 2024)
3. Enhancements in accuracy and novel calculation methodology, particularly for PG&S



Recommendations

As part of NSDC's efforts to continuously improve the accuracy and ease of reporting their carbon footprint, we recommend the following enhancements:

1. **Comprehensive Emission Scope Inclusion:** Ensure all future carbon footprint reports cover all relevant emission scopes, including Scope 1, Scope 2, and Scope 3 – as shown here.
2. **Business Travel Reporting:** Improve internal reporting mechanisms to capture detailed data on business travel, specifically tracking trips using public transportation. This would offer insights into broader travel emissions, helping to identify areas where improvements can be made.
3. **Commuting Survey Implementation:** Conduct regular commuting surveys among all employees to assess the environmental impact of staff travel. By understanding commuting patterns and the associated carbon emissions, NSDC can better implement measures to reduce emissions through initiatives.
4. **Audit of Gas Usage Data:** Since a large proportion of sites currently lack gas usage data, we recommend a full audit of these sites. This should confirm whether they have an active gas supply point by verifying Meter Point Reference Numbers (MPRNs).
5. **Database for Property Information:** Build a database that captures detailed information about each property in NSDC's portfolio. The database should include essential data such as the Unique Property Reference Number (UPRN), building archetype, size, heating system type, and EPC.
6. **Review of Water Usage:** Carry out a review of sites with particularly high-water usage or anomalies in consumption data. Investigate the root causes of unusual water patterns, and implement water-saving strategies where appropriate
7. **Enhanced EPC Coverage**: Undertake a review to ensure that Energy Performance Certificate (EPC) ratings are available for all properties under NSDC's control.
8. **Purchased Good and Service:** transitioning from spend-based emissions calculations to more accurate and granular methodologies, such as supplier-specific data or product-level life cycle assessments (LCAs).

Target Review

3. NSDC Corporate decarbonisation

Overview

- In 2024, *Be Design* audited the majority of NSDC's corporate buildings, responsible for the majority of natural gas, electricity, waste and water-related emissions. These energy audits provided the basis of the emissions target feasibility appraisal which measures and forecasts emissions arising from **natural gas** and **electricity** usage for 13 of NSDC's buildings.

- The target feasibility appraisal aims to provide NSDC with a preferred pathway to reaching Net Zero for its corporate buildings, considering both the type of interventions and the phasing approach. **Four different scenarios** are modelled to gauge the ambition and deployment rate of interventions highlighted in the audits, and this next section presents the cost and carbon implications for each of these 4 scenarios.

- As part of Be Design's surveys, the theoretical energy usage of each building was estimated. These "model" energy values (in kWh) were used to calculate the energy savings (in kWh) of all the interventions recommended by Be Design.

- The baseline emissions associated with these model energy values were calculated by Carbon Trust using 2022 emissions factors and totalled **1,572 tCO_2e**, which equates to **17% of the total footprint** (not including homes). Of these emissions, **825 tCO_2e** are attributed to natural gas consumption, with electricity making up the remaining **747 tCO_2e.** Data on water- and waste-related emissions was not provided and these emissions sources are therefore not considered in this section.

- The emissions target feasibility appraisal builds on the recommended interventions made by Be Design. For this reason, the "model" energy values and the associated emissions are used to form the basis of the appraisal. These differ slightly to the electricity and gas emissions calculated as part of the full footprint (see here) which considered a larger portfolio of buildings.

- The proposed interventions included:
  - LED lighting
  - Fabric upgrades (walls, roof and window glazing)
  - Heat pumps (air source and ground source)
  - Electric heating
  - Roof-mounted solar PV

Corporate buildings

The below table highlights the buildings audited by Be Design, which are included in the target feasibility appraisal. For NSDC to reach Net Zero, they will also need to make efforts to decarbonise other corporate buildings not accounted for in this section.

Buildings included in corporate buildings feasibility appraisal	Emissions calculated using Be Design "model" energy values (tCO_2e/year)	Building area (m^2)	Emissions intensity ($kgCO_2e/m^2$/year)
Newark Leisure Centre	580	4,162	139
Dukeries Leisure Centre	219	2,852	77
Blidworth Leisure Centre	23	920	25
Palace Theatre	31	1,508	20
Brunel Drive Depot	80	1,563	51
Newark Beacon	70	2,834	25
National Civil War Centre	11	1,624	7
Farrar Close Store	14	850	16
Farrar Close Office	7	359	19
Castle House	95	3,211	30
Vicar Water	13	232	57
Sconce and Devon Park	10	125	82
Sherwood Arts & Crafts Centre	6	875	7

Scenarios overview

- Emissions reductions were calculated for NSDC's corporate estates using the Be Design report, which presented various decarbonisation interventions and the associated energy savings of each of these interventions for the 13 buildings. A full list of technical assumptions (e.g.: heat pump efficiencies) can be found in the Be Design report.
- **Four scenarios** have been modelled to better understand the impact of these different measures and the implementation timelines on the total carbon savings and capital investment required. Two of the scenarios represent a "light retrofit" scenario (3 and 4) , which don't see all the recommended measures implemented.
- Electricity related emissions are modelled using National Grid emissions factors (see Appendix: National Grid Factors), which take the gradual decarbonisation of the electricity network into account as a result of the increased contribution from renewable energy sources.

ID	Scenario Explanation	Emissions in 2030 (Scope 1 & 2) (tCO_2e)	Emissions in 2035 (Scope 1 & 2) (tCO_2e)
C1	Deep retrofit (all interventions) implemented by 2030	389	126
C2	Deep retrofit (all interventions) implemented by 2035	563	126
C3	Light retrofit (LED lights and heat decarbonisation*) implemented by 2030	524	170
C4	Light retrofit (LED lights and heat decarbonisation*) implemented by 2035	622	170

**Refers to natural gas boiler(s) being replaced by ASHP, GSHP or electric heating*

Phasing buildings

For modelling purposes, we have assumed that the most energy-intensive buildings, those with the highest gas and electricity consumption, will be decarbonised first. However, we recognise that, in reality, prioritisation should take into account a range of additional factors. These factors can significantly influence the feasibility and timing of decarbonisation efforts and might include:

- Building age and condition
- Asset renewal of existing plant
- Leasing arrangements
- Planned maintenance and/or construction projects

- Since it is unlikely that NSDC will implement decarbonisation measures across all 13 buildings simultaneously, a phasing approach was developed to help understand the impact on emissions across the 4 scenarios. Due to their high gas consumption, it is recommended that **decarbonisation efforts are prioritised for the leisure centres** (Phase 1). Subsequently, NSDC should focus on tackling all remaining buildings with natural gas and electricity consumption (Phase 2), before finally tackling the purely electric buildings (Phase 3).

- It's important to note that while different phasing approaches will impact the year-on-year emission changes, NSDC can only fulfil their decarbonisation ambitions if all buildings come off natural gas and improve their energy efficiency performance.

- While we recommend that NSDC prioritise sites based on the potential emissions reductions impact, **there may be benefits from a financial perspective to implement certain measures simultaneously across all sites**, particularly LED lighting.

Phasing buildings

A proposed phasing approach of which buildings NSDC should prioritise is presented below. This is indicative in nature and is subject to numerous factors. Ultimately, all buildings will need some level of intervention to meet a Net Zero 2030 or 2035 target.
Our model assumes that all buildings at each site are completed at a steady pace within the given phase. For example, in Phase 1 (2030 target), if the phase lasts two years and includes four buildings, we assume two buildings will be completed per year.

	Site	Implementation timeframe, 2030 Target (Scenarios 1 and 3)	Implementation timeframe, 2035 Target (Scenarios 2 and 4)
Phase 1	Newark Leisure Centre Dukeries Leisure Centre Southwell Leisure Centre* Blidworth Leisure Centre	**2025-26**	**2025-28**
Phase 2	Palace Theatre Brunel Drive Depot Newark Beacon National Civil War Centre Farrar Close Store Farrar Close Office	**2027-28**	**2029-31**
Phase 3	Castle House Vicar Water Sconce and Devon Park Sherwood Arts & Crafts Centre	**2029-30**	**2032-35**

**Although not surveyed by Be Design, Southwell Leisure Centre should be considered in the rollout of interventions. Additional surveys will likely be required to identify the optimal decarbonisation methods.*

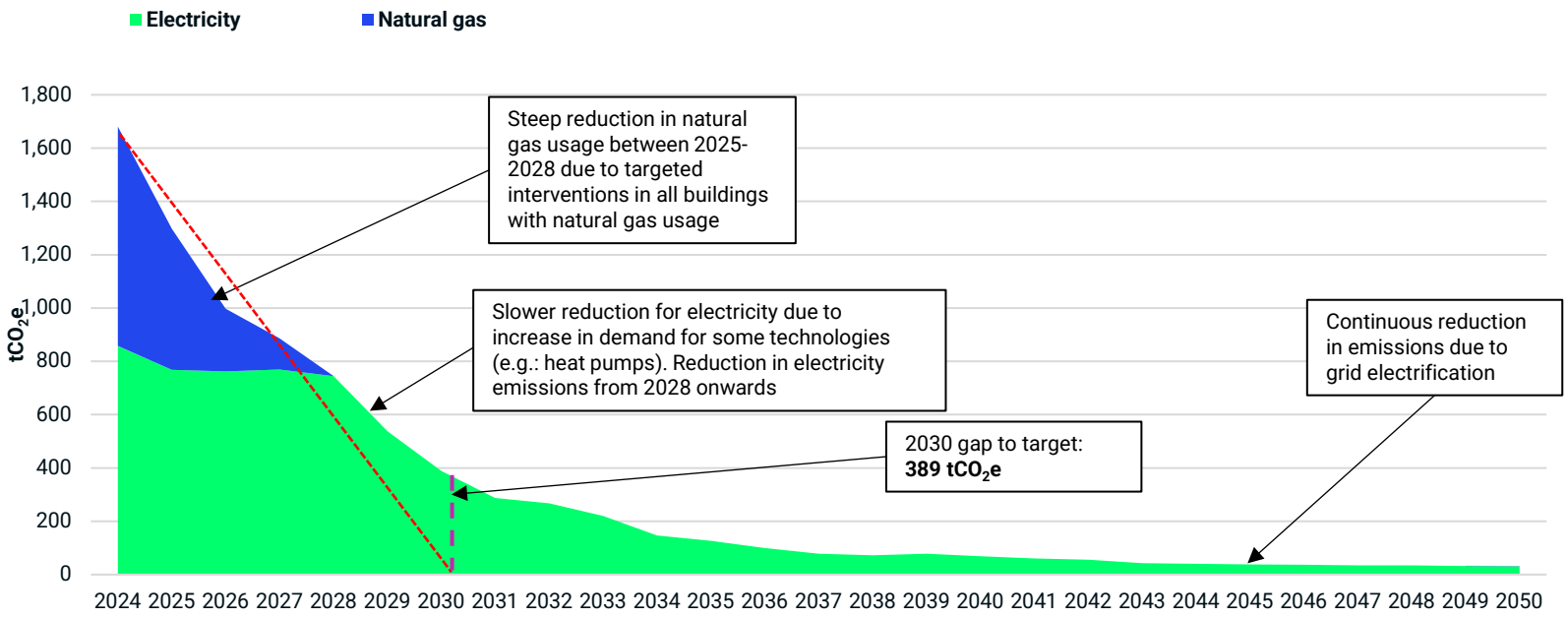
Proposed interventions

The table below highlights the interventions identified by Be Design for each of the audited buildings. Scenarios 1 and 2 see all measures implemented, while scenarios 3 and 4 only model LED lighting and heat electrification.

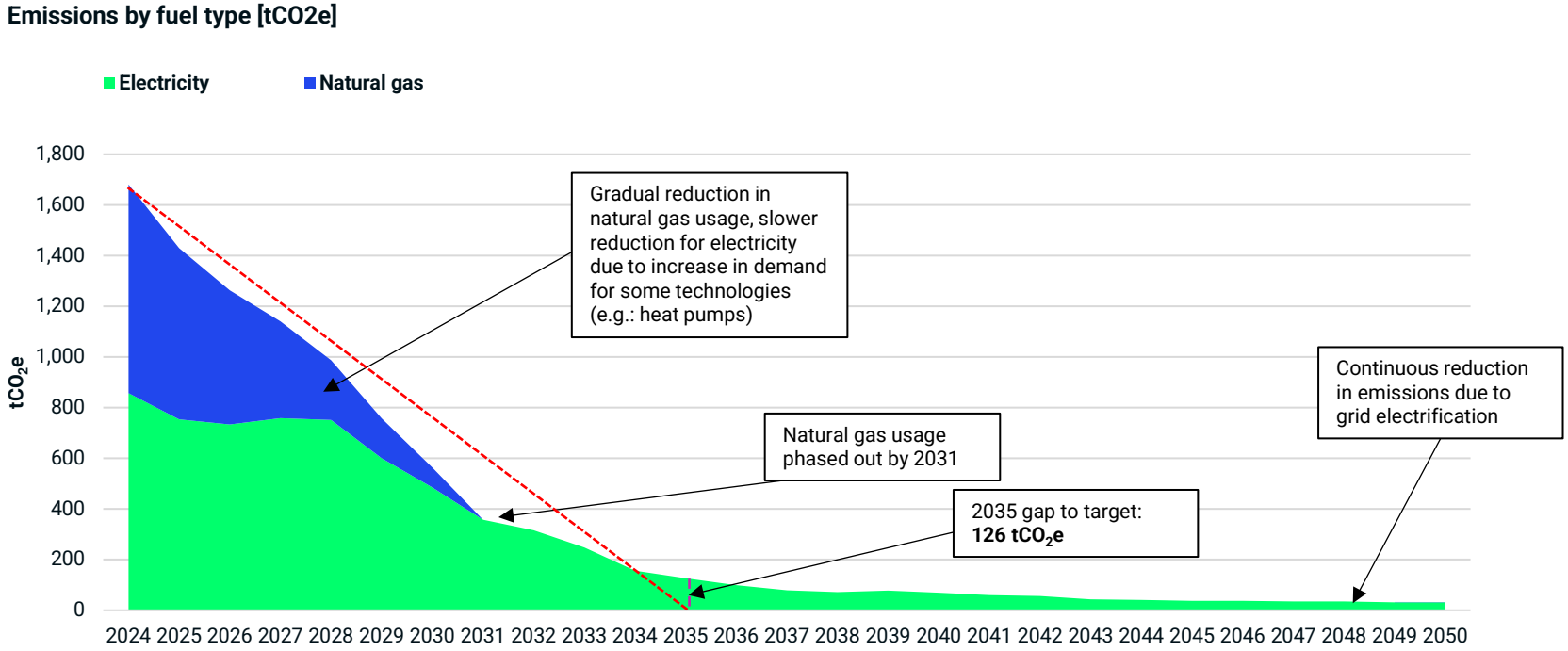
Site	Intervention Phasing – Scenarios 1 & 2 (deep retrofit)	Intervention Phasing – Scenarios 3 & 4 (light retrofit)
Newark Leisure Centre	LED > ASHP > Solar PV	LED > ASHP
Dukeries Leisure Centre	LED > Fabric > ASHP > Solar PV	LED > ASHP
Blidworth Leisure Centre	LED > Fabric > Solar PV	LED
Palace Theatre	ASHP	ASHP
Brunel Drive Depot	LED > Fabric > ASHP > Solar PV	LED > ASHP
Newark Beacon	LED > ASHP	LED > ASHP
National Civil War Centre	LED > ASHP	LED > ASHP
Farrar Close Store	LED > Fabric > ASHP > Solar PV	LED > ASHP
Farrar Close Office	LED > Fabric > Electric Heating > Solar PV	LED > Electric Heating
Castle House	Solar PV	No interventions
Vicar Water	LED > Fabric > ASHP > Solar PV	LED > ASHP
Sconce and Devon Park	LED > Fabric > GSHP > Solar PV	LED > GSHP
Sherwood Arts & Crafts Centre	LED > Fabric > ASHP > Solar PV	LED > ASHP

Scenario 1 – Deep retrofit (all interventions) implemented by 2030

Emissions by fuel type [tCO2e]

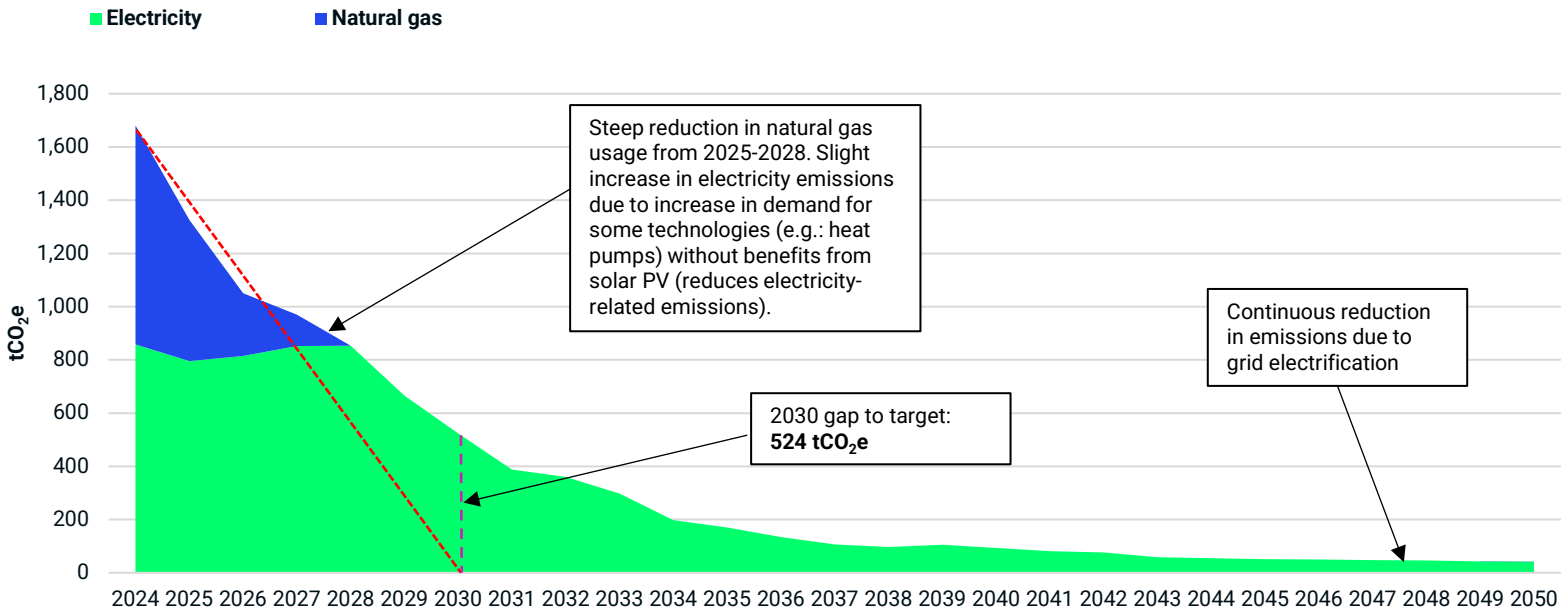


Scenario 2 – Deep retrofit (all interventions) implemented by 2035



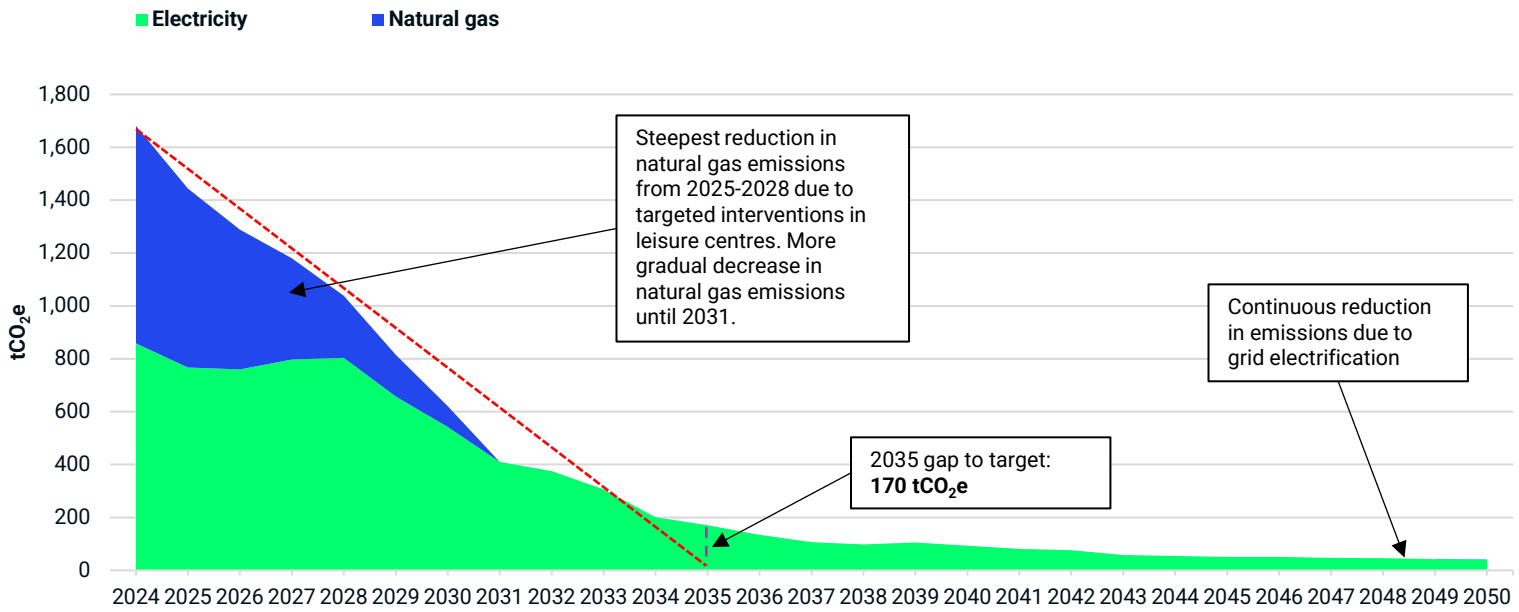
Scenario 3 – Light retrofit (LED lights and heat decarbonisation) implemented by 2030

Emissions by fuel type [tCO2e]



Scenario 4 – Light retrofit (LED lights and heat decarbonisation) implemented by 2035

Emissions by fuel type [tCO2e]



Cumulative emissions

The table below shows the impact of implementing different interventions and target dates across the four scenarios.

1. By moving **target dates from 2035 to 2030** reduces total emissions to 2050 by 1,800 – 2,200 tCO_2e.
2. Pursuing a **deep retrofit strategy over light retrofit** reduces total emissions to 2050 by 900 –1,300 tCO_2e.

ID	Scenario Explanation	Cumulative emissions to 2035 (tCO_2e)	Cumulative emissions to 2050 (tCO_2e)
C1	Deep retrofit (all interventions) implemented by 2030	11,576	12,381
C2	Deep retrofit (all interventions) implemented by 2035	13,801	14,606
C3	Light retrofit (LED lights and heat decarbonisation*) implemented by 2030	12,571	13,656
C4	Light retrofit (LED lights and heat decarbonisation*) implemented by 2035	14,429	15,515

**Refers to natural gas boiler(s) being replaced by ASHP, GSHP or electric heating*

Costs

The table below highlights the impact of each of the 4 scenarios on target year emissions, as well as the capital investment required to implement all of the identified interventions. A breakdown of costs per intervention is presented on the next slide.

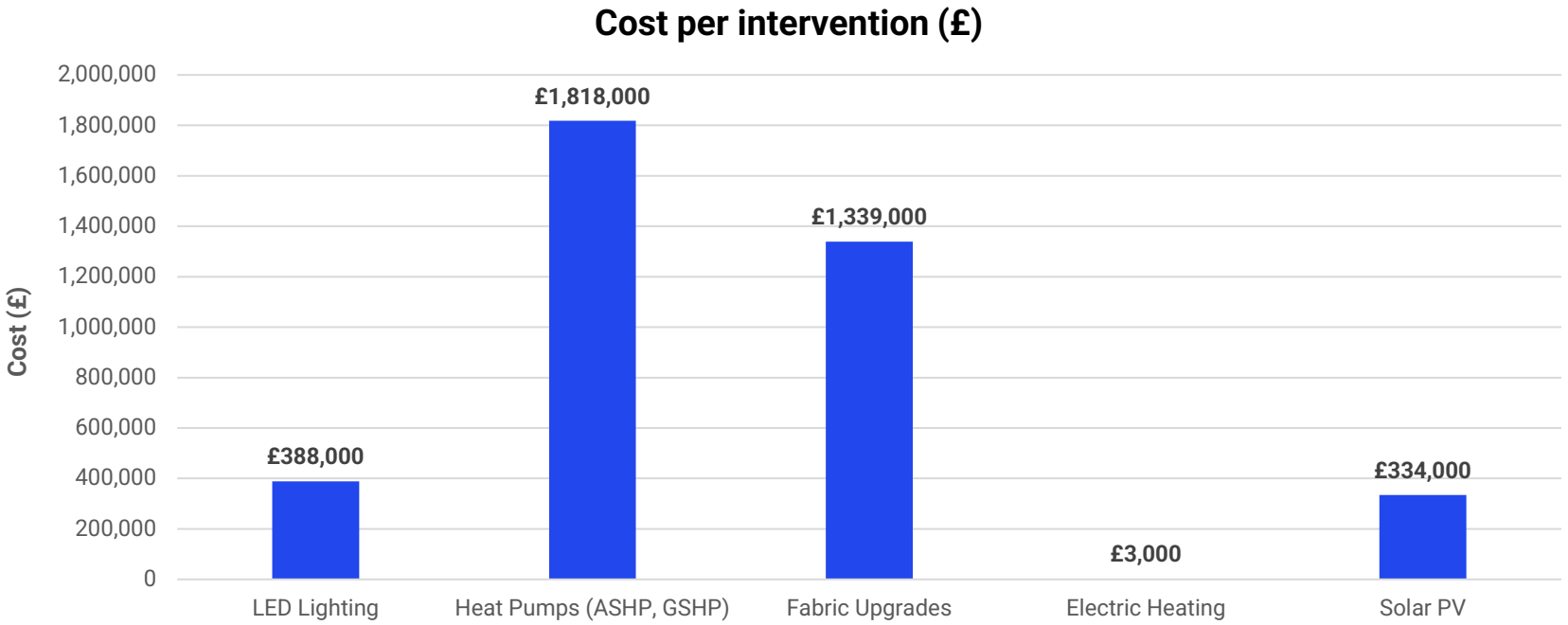
- All costs are provided by Be Design and are indicative in nature. Costs for Southwell Leisure Centre are not included in the figures presented below.
- A full list of cost assumptions can be found in the Appendix.

ID	Scenario Explanation	Baseline Emissions	Residual emissions by 2030 (tCO_2e)	Residual emissions by 2035 (tCO_2e)	Capital Investment (£)
C1	Deep retrofit (all interventions) implemented by 2030	1,572	389	126	£3,882,000
C2	Deep retrofit (all interventions) implemented by 2035		791	126	£3,882,000
C3	Light retrofit (LED lights and heat decarbonisation*) implemented by 2030		524	170	£2,209,000
C4	Light retrofit (LED lights and heat decarbonisation*) implemented by 2035		865	170	£2,209,000

**Refers to natural gas boiler(s) being replaced by ASHP, GSHP or electric heating*

Cost breakdown

The graphic below provides a breakdown of the capital investment required to implement each intervention identified by Be Design. This page summarises which interventions apply to which buildings.



Conclusions & Recommendations

This section has provided various pathways to help NSDC identify the most appropriate route to decarbonising 13 of their corporate buildings.

- The different pathways see **emissions savings of 950 – 1,446 tCO_2e**, depending on the level of retrofit and target year.
- The existing BE Design covered the majority of buildings, NSDC will need to make **additional efforts to decarbonise their remaining buildings** not covered by these surveys, with particular emphasis on Southwell Leisure Centre.
- NSDC should be aware that the capital investment and associated emissions reduction of this **target feasibility appraisal only considers natural gas and electricity emissions**, and additional efforts will be required to reduce emissions from other sectors, such as waste, water and PG&S.
- The total baseline footprint totals 9,267 tCO_ee. As a result, the **proposed interventions only tackle 10-16% of total emissions**, not including emissions arising from housing.
- Going forward, NSDC will need to ensure that **energy consumption is recorded clearly and consistently**, in order to continuously improve the accuracy of subsequent carbon footprints and the impact of any interventions. This will include a review of all building metering arrangements and heating technologies.
- The exact phasing of which buildings and/or interventions to prioritise will depend on a multitude of factors, and NSDC should aim to identify opportunities that will reduce capital costs, such as benefiting from economies of scale (e.g.: implementing LED lighting across all sites) or making strategic decisions around when to install heat pumps (e.g.: if a boiler is nearing end-of-life). Most importantly, NSDC need to be aware that **all buildings will need some level of intervention** to minimise the residual emissions by 2030 or 2035.

Target Review

4. Housing decarbonisation

Overview

NSDC's housing portfolio of 5,603 houses is not currently included within the existing 2035 target. We have explored options for inclusion into the existing 2035 target or inclusion into an alternate 2050 target for **housing only**. Comparison of emissions to 2018/19 can be found here.

Baseline:

- Baseline emissions (2023/24), **19,921 tCO_2e**, with 75% of emissions from heating.
- Of the total emissions, **17,315 tCO_2e** are attributed to direct emissions (i.e excluding those from WTT)
- 97% of houses rely on burning fossil fuels (gas, oil, LPG), the remainder use electricity (resistance/heat pumps) or wood burners.

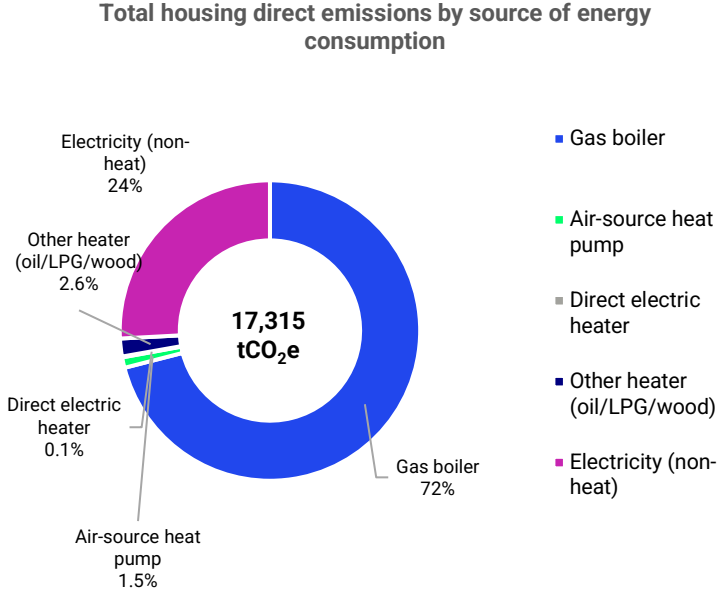
Carbon Reduction Pathways (more detail overleaf)

- Low retrofit scenario –improve energy efficiency for poorly rated housing (EPC D-G), with full electrification of all buildings.
- High retrofit scenario - extensive energy efficiency improvements (whole house deep retrofit, solid wall insulation) with full electrification

Decarbonisation targets:

- 2035 target: retrofit ~560 houses/year, ~£8m - £15m CAPEX per annum.
- 2050 target: retrofit ~220 houses/year, ~£3m - £6m CAPEX per annum.

NB. Significant offsets required in all scenarios to achieve carbon neutrality due to residual emissions present in the electricity grid.



Methodology overview

To model the impact of different interventions on NSDC's housing stock, EPC data provided by NSDC was used to understand the existing energy use.

- Hydrogen was not selected as a heating solution due to several challenges, including its lower efficiency compared to heat pumps, high production costs, and the current lack of infrastructure for widespread domestic use. The UK Government is set to make announcement in 2026 regarding the future of hydrogen for home heating.
- To model the decarbonisation of heat, heat pumps were chosen as the primary solution due to their high efficiency and ability to significantly reduce carbon emissions compared to conventional heating systems. Heat pumps offer a proven, readily deployable technology that aligns with the UK's decarbonisation goals.
- Heat pumps can utilise energy from a range of sources including the surrounding air, geothermal energy stored in the ground, or nearby sources of water or waste heat from a factory.
- Deep retrofit of properties will require significant enhancements in the energy efficiency of the property, with multiple major interventions required to enhance energy efficiency.
- Assumptions from the baseline and modelling of housing decarbonisation can be found in the appendix.

Interventions

To model the impact of differing strategies for decarbonising housing, two core strategies were developed for each archetype.

- Low retrofit represents a scenario where basic energy efficiency improvements (e.g. loft insulation) are made to older and worst performing properties with full electrification through the installation of heat pumps.
- High retrofit represents a scenario where most properties undergo extensive energy efficiency improvements (whole house deep retrofit, solid wall insulation) with full electrification through the installation of heat pumps. Deep retrofit implies that each property will have to undergo multiple energy efficiency measures.

A summary of interventions for the top 3 archetypes is available below, full details of all the interventions and CAPEX that were modelled for all archetypes can be found in Appendices.

	Low retrofit scenario	High retrofit scenario
Post 1930 bungalow; On-gas D-G	Individual 6kW ASHPs plus basic energy efficiency measures.	Whole house deep retrofit to net zero energy standard including 6kW ASHP and a package of insulation and air tightness measures.
Post 1930 flat; On-gas A-C	Individual heat pump within each flat (4kW). Update hot water cylinders.	Individual heat pump within each flat (4kW). Update hot water cylinders plus air tightness improvements.
Post 1930 semi-detached house; On-gas D-G	Individual 8kW ASHPs plus basic energy efficiency measures.	Whole house deep retrofit to net zero energy standard including 6kW ASHP and a package of insulation and air tightness measures.

Phasing

To model the decarbonisation of the housing stock, the following steps were taken to phase dwellings. This approach ensures that the most carbon-intensive buildings are addressed early, maximising the impact of emissions reductions.

Phase 1

Starting in 2025 it is expected that when phasing dwellings, oil/LPG buildings with the lowest energy efficiency will be retrofitted first, concluding by 2029 for all scenarios.

Phase 2

For all scenarios, EPC D-G housing are retrofitted next, these dwellings are prioritised next.

Phase 3

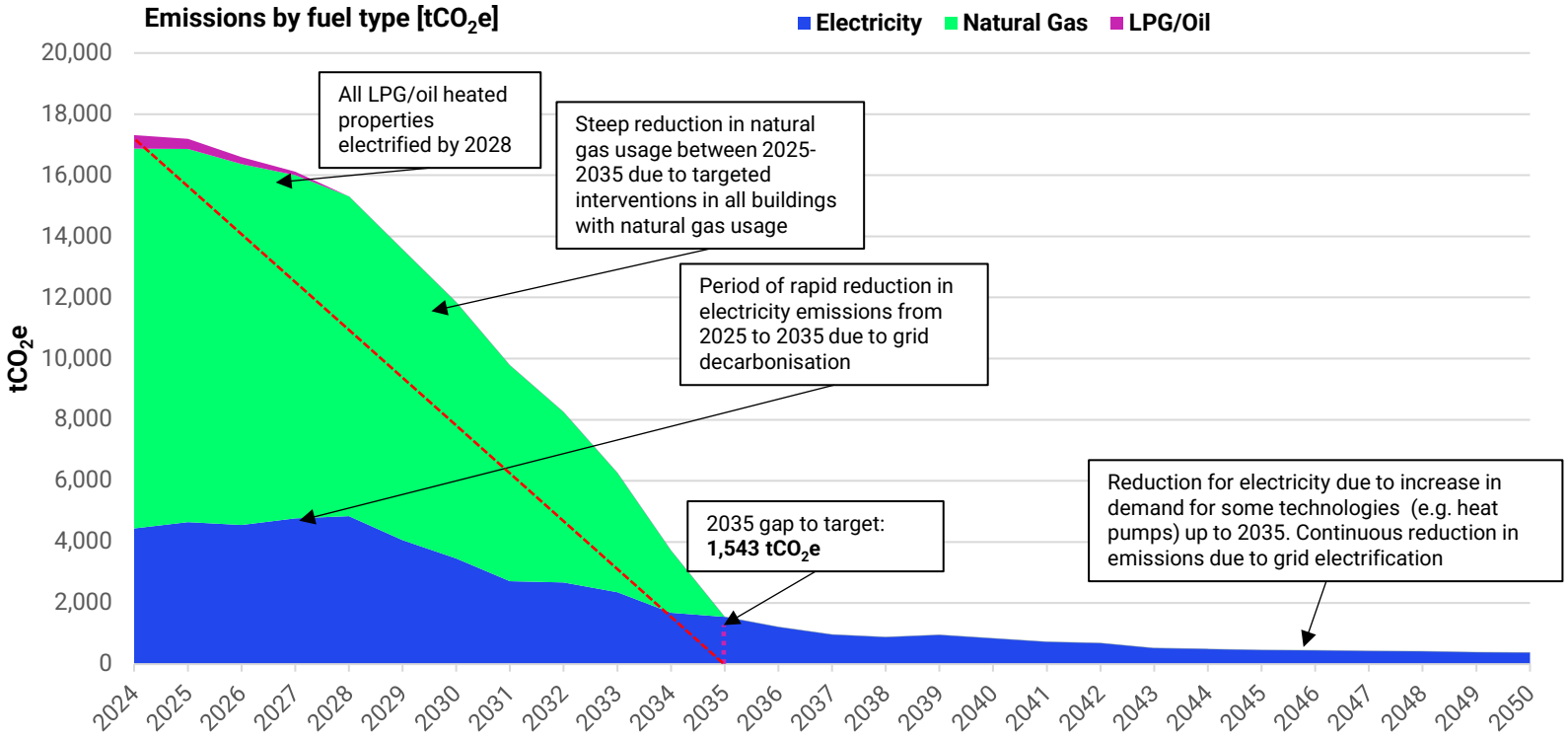
The remaining properties (EPC A-C) are retrofitted last due to their higher energy efficiency.

Scenario overview

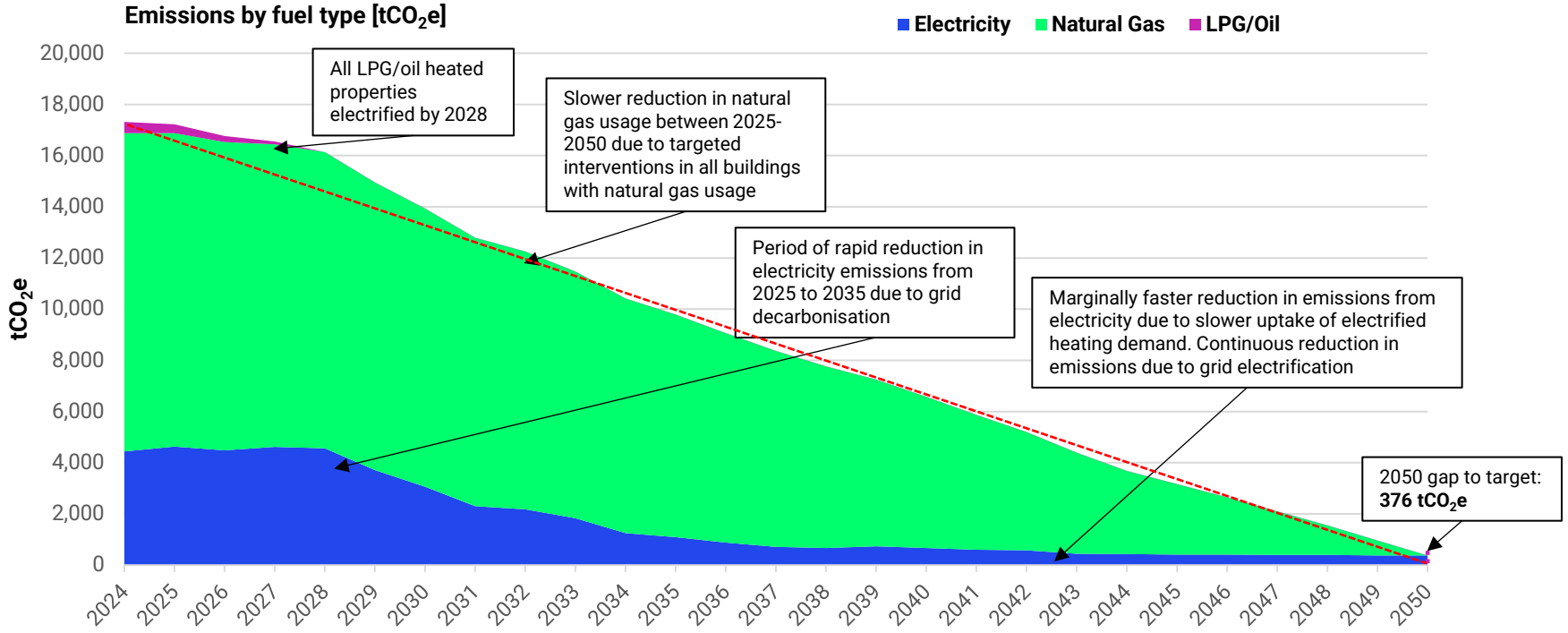
- Energy use and emissions reductions were calculated for NSDC's housing.
- Carbon savings and associated costs for each of the decarbonisation interventions are calculated based on two retrofit options, targeting either 2035 or 2050.
  - High retrofit: All houses have energy efficiency measures and heat electrified.
  - Light retrofit: Some houses (EPC C-G) have energy efficiency measures and all housing have heat decarbonised

ID	Scenario Explanation	2030 emissions remaining (tCO_2e)	2035 emissions remaining (tCO_2e)	2050 emissions remaining (tCO_2e)	Total emissions to 2050 (tCO_2e)
H1	**High retrofit:** All houses have extensive energy efficiency measures and heat decarbonised **by 2035**	11,847	1,543	376	147,348
H2	**High retrofit:** All houses have extensive energy efficiency measures and heat decarbonised **by 2050**	13,970	9,818	376	238,287
H3	**Light retrofit**: Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing **by 2035**	11,933	1,624	395	148,620
H4	**Light retrofit:** Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing **by 2050**	13,928	9,788	395	238,562

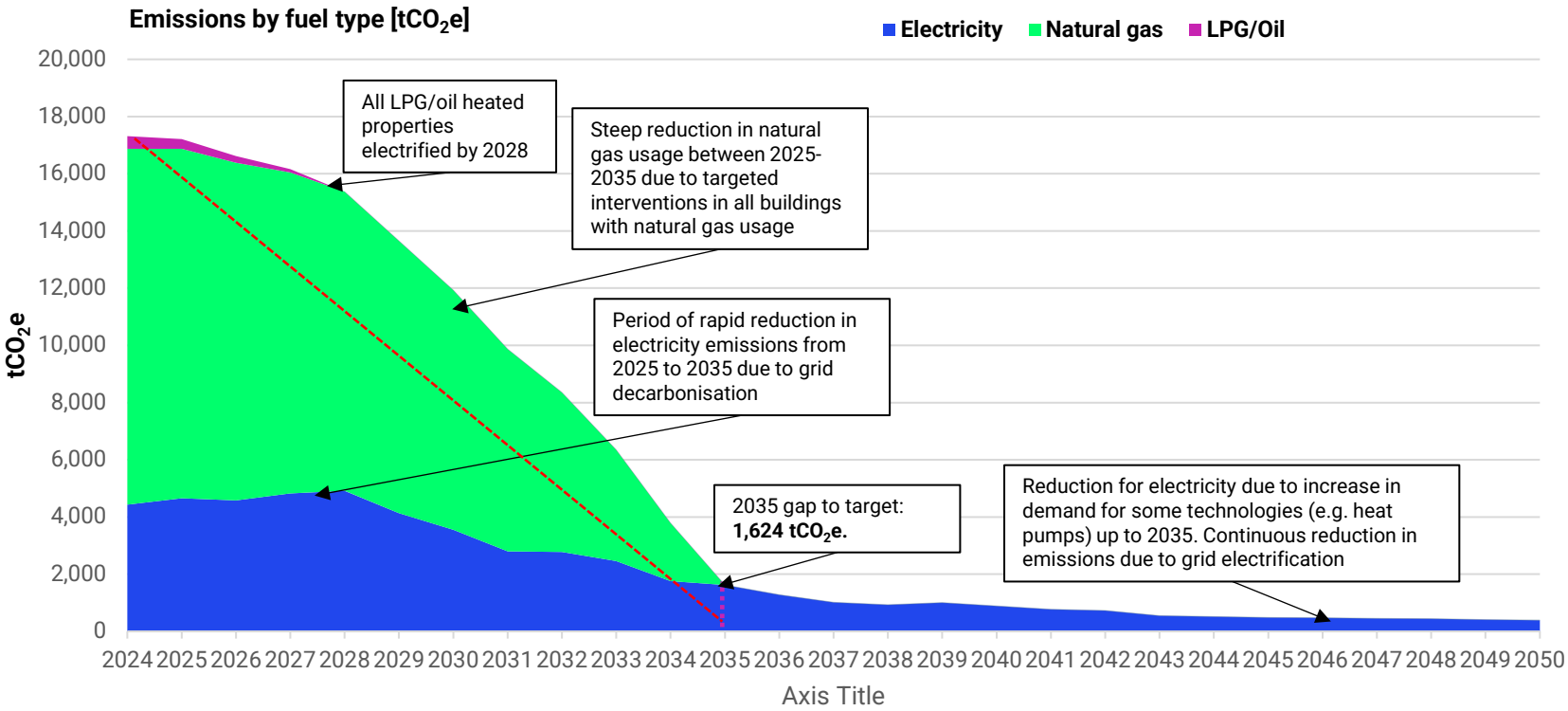
Scenario 1: High retrofit: All houses have extensive energy efficiency measures and heat decarbonised **by 2035**



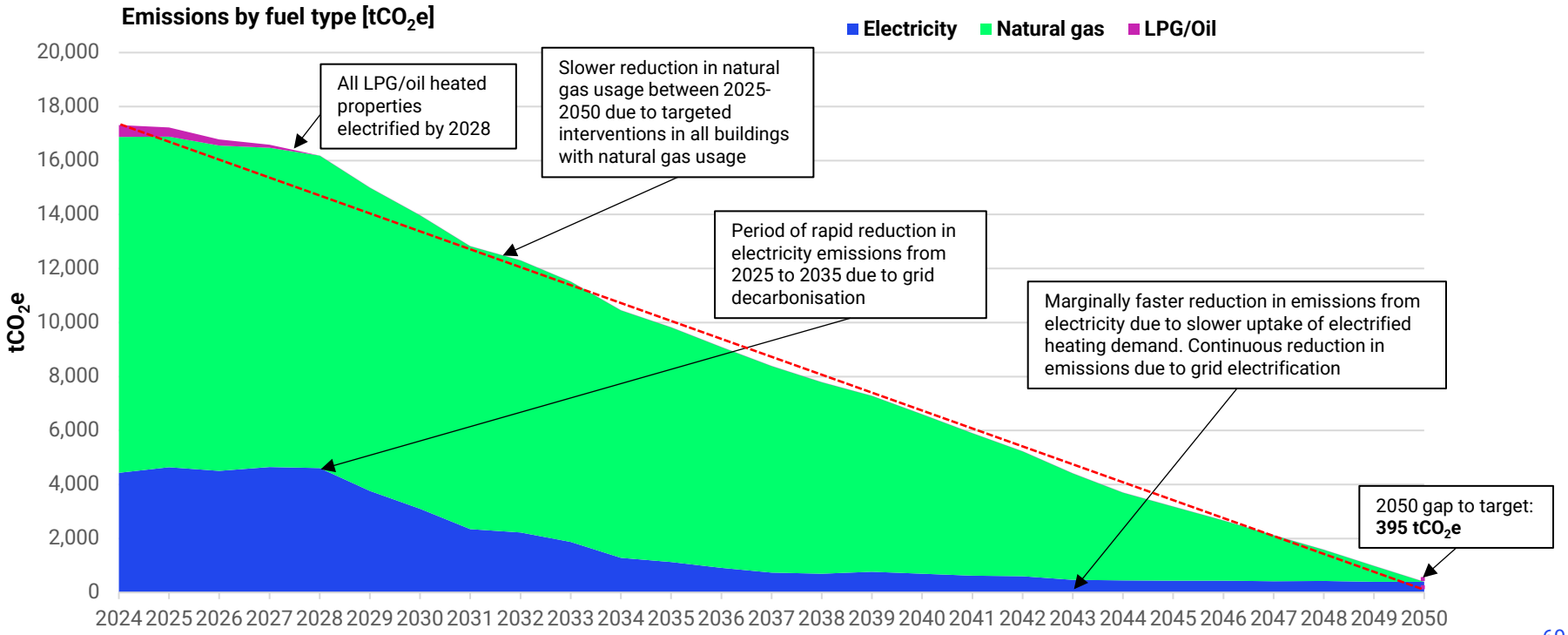
Scenario 2: High retrofit: All houses have extensive energy efficiency measures and heat decarbonised **by 2050**



Scenario 3: Light retrofit: Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing **by 2035**



Scenario 4: Light retrofit: Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing **by 2050**



Costs

The estimated capital expenditure (CAPEX) varies significantly across scenarios, as illustrated in the table.

High retrofit scenarios incur considerably higher costs, ranging from £139m to £145m, with annual estimates of £14.5m for the 2035 target and £5.6m for the 2050 target.

In contrast, the light retrofit scenario requires £76m across both target years, with annual costs estimated at £7.6m for 2035 and £3m for 2050.

This analysis indicates that the speed of retrofitting properties, whether faster or slower, has minimal impact on the overall CAPEX required. Instead, the primary constraints in decarbonisation are expected to be staff resourcing, annual capital allowances, and supply chain capacity.

Scenario	Est. total CAPEX	Est. CAPEX (per year)
H1: High retrofit 2035	£145m	£14.5m
H2: High retrofit 2050	£139m	£5.6m
H3: Light retrofit 2035	£76m	£7.6m
H4: Light retrofit 2050	£76m	£3m

Notes:

- Inflation has not been considered in the costings, figures presented in the table represent 2024 prices.
- Running costs, such as OPEX and general maintenance, are not included in the costings.
- Decreases and/or increases in natural gas and electricity bills as a result of the interventions are not included in the costings.

Deployment

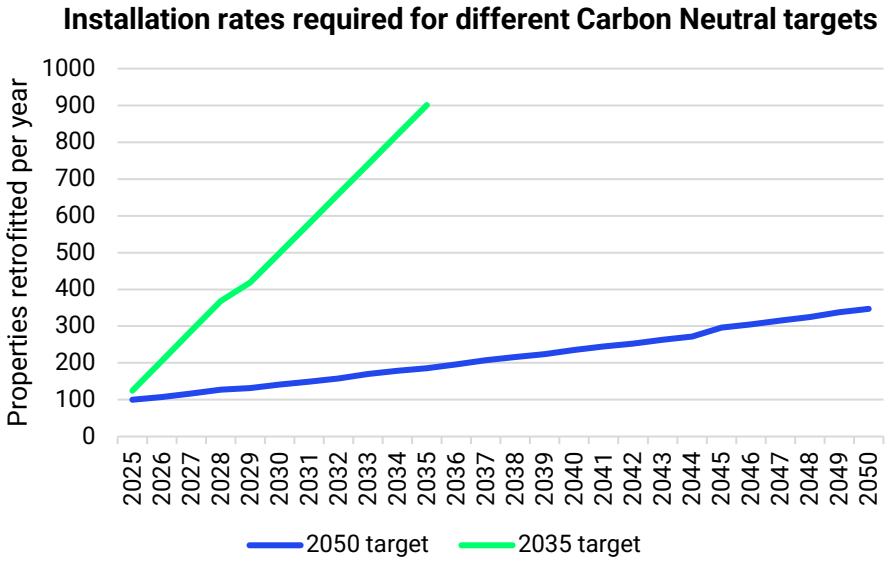
NSDC currently estimates that they currently have the capacity to retrofit 100 buildings per year. In all scenarios, a significant increase in this existing capacity will be required to meet the proposed targets.

Scaling the installation rate earlier will result in faster progress towards decarbonisation.

The required increase in installation rates is the same for both high and light retrofits, since it is based purely on the number of properties retrofitted, this does not consider the additional staff likely needed for high retrofits.

Deep retrofits typically take longer to complete, making higher staffing levels essential to meet the targets.

The table illustrates the average number of properties that need retrofitting annually to achieve decarbonisation by the target date. To support emissions modelling, required increases in installation capacity have also been considered, as shown in the graph.



Target year	Houses retrofitted per year
2035	560
2050	220

Target Review

5. Target review

Overview

NSDC already has a 2035 Carbon Neutrality target, covering corporate (buildings), waste and water, and fleet. This section explores the feasibility of three potential targets alongside Business as Usual based on the scenarios developed for NSDC Corporate (C1-4) and Housing (H1-4), compared with this existing 2035 target.

Overview of the targets is available below, providing detail on how they would differ from NSDC's existing target.

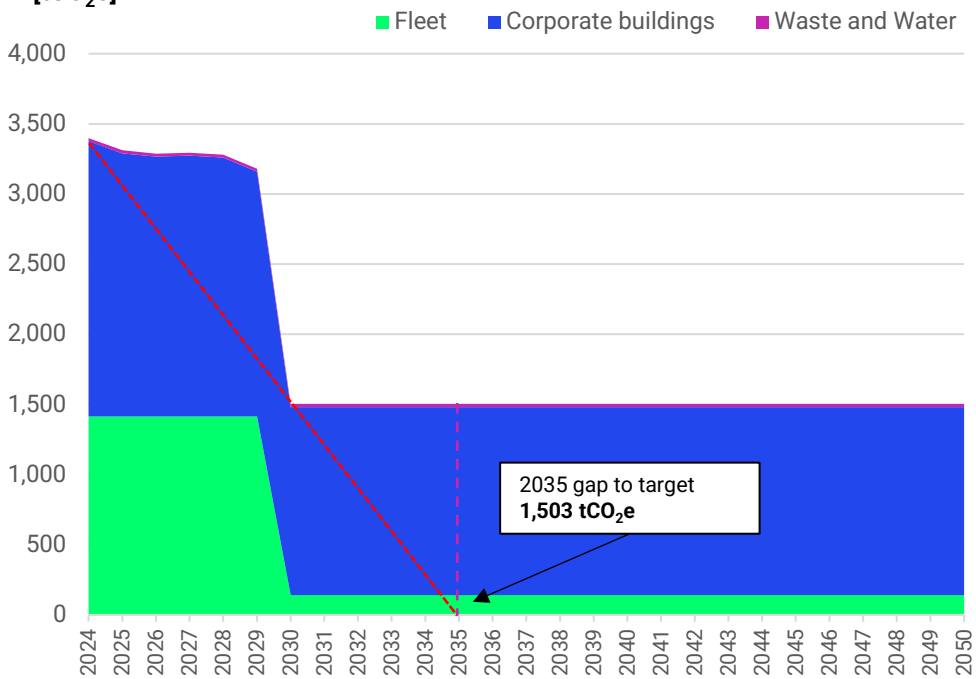
Potential target	Changes to the existing 2035 target
2030 target: moving existing target forwards to 2030	Moving the existing target forwards by 5 years to 2030, keeping the emission sources the same.
2035 target: integrate housing with the existing 2035 target.	Integrate housing with the existing 2035 target.
2050 housing target: a separate housing-specific target aims to achieve carbon neutrality by 2050, in addition to NSDC's existing 2035 target.	In addition to the existing 2035 target, this would involve creating a separate 2050 target for the decarbonisation of housing only.

Business as usual

In this business-as-usual scenario, the existing 2035 target is established, incorporating initiatives already considered by NSDC, such as HVO for fleet (90% emissions reduction) and a green tariff for electricity by 2030.

- Other initiatives, like tree planting and solar PV, are acknowledged but not included in the pathway due to uncertainties about their impact.
- Achieving carbon neutrality under this plan will require carbon offsets of 1,503 tCO_2e in 2035. (£30k - £75k per annum)
  - Tree-planting schemes are expected to sequester 338 – 1,351 tCO_2e per annum.
- This pathway continues to use natural gas to 2050 and is heavily reliant on biofuels. While HVO is stated to reduce emissions by 90%, this does not account for significant indirect land-use changes, biodiversity loss, or the full lifecycle footprint of biofuel production.
- Further details on our recommended positioning on HVO are available here.
- Given these challenges, there is a need to explore more sustainable long-term solutions, such as electrification for heating and transport.

Business as usual
(sustainable electricity tariff, grid decarbonisation and HVO)[1]
[tCO_2e]

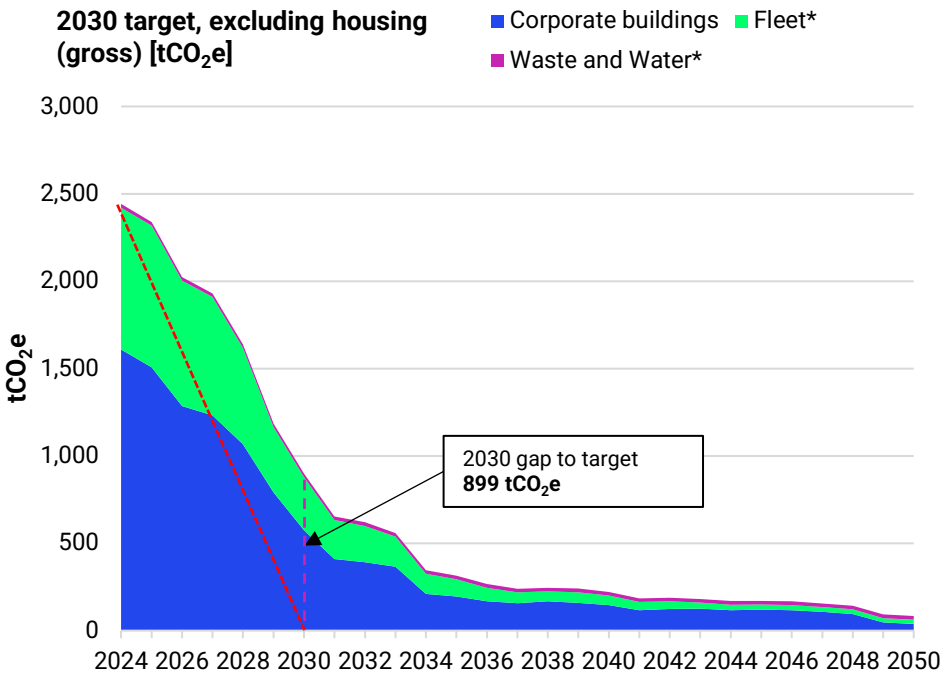


[1]There are variations in the emissions reported from fleet and corporate emissions as the methodology varies from other pathways explored in this report.

2030 target: moving existing target

Under the most ambitious emissions target, all Scope 1 emission sources (e.g., natural gas, diesel, petrol) are fully electrified by 2030. This would involve moving the existing 2035 target forwards by 5 years.

- By the target year, emissions are projected to decrease by 63%. This reduction accounts for residual emissions associated with electricity generation.
- Achieving carbon neutrality under this target will require extensive carbon offsets, estimated at ~900 tCO_2e. (£20k - £45k per annum)
- The capital investment required from NSDC is anticipated to be £2.2m for corporate with additional costs expected for further buildings, waste and water, and fleet.
- Decarbonising houses has been excluded from this target, as addressing all housing by 2030 is not considered feasible.



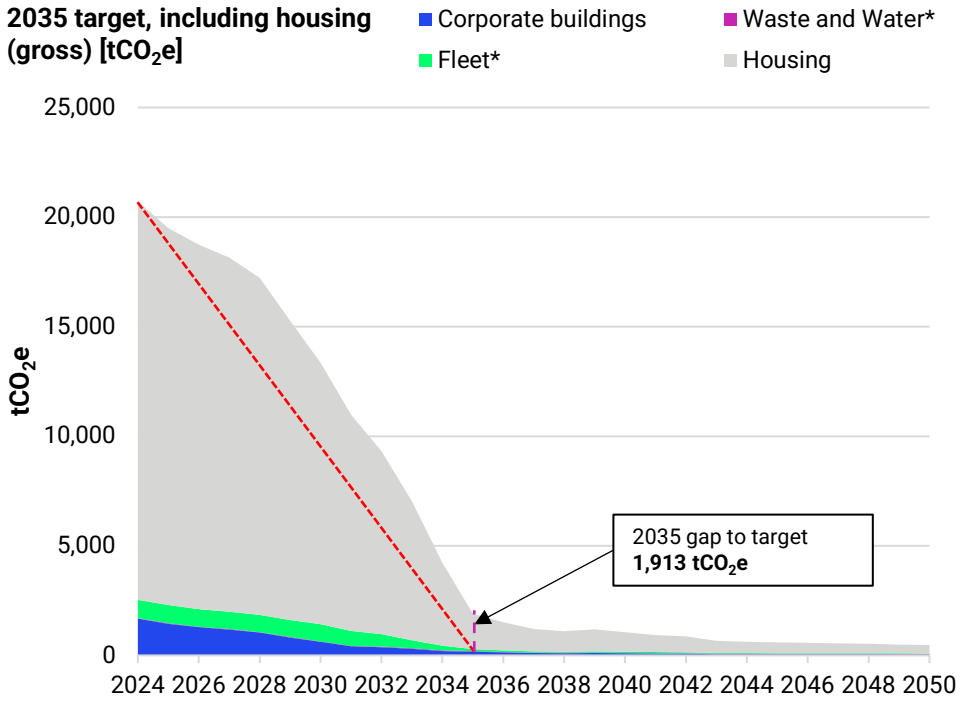
Corporate emissions pathway modelled using Scenario 3, light retrofit (LED lights and heat decarbonisation) implemented by 2030

*Emission projections for these emission sources have been carried across from the existing study as they weren't included in this study. All emissions intensity factors (e.g. gCO_2e/kWh) have been updated to reflect the most recent projections.

2035 target: increasing boundary of existing target

Under the 2035 emissions target pathway, all Scope 1 emission sources, including housing (e.g., natural gas, diesel, petrol) are fully electrified by 2035.

- By the target year, emissions are projected to decrease by 91%. This reduction accounts for residual emissions associated with electricity generation.
- Achieving carbon neutrality under this target will require extensive carbon offsets, estimated at ~1,900 tCO_2e. (£40k - £100k per annum)
- The analysis estimates that decarbonising corporate buildings and housing in this scenario will require £78m of capital expenditure, with additional costs expected for all buildings, waste and water, and fleet.
- Due to this substantial capital investment, significant increases in staffing are required to execute the extensive capital delivery program.
- This target is currently not considered feasible without a significant increase in capacity and access to capital funding for retrofits.
- See here for more detail on the required rates to deliver each target year.



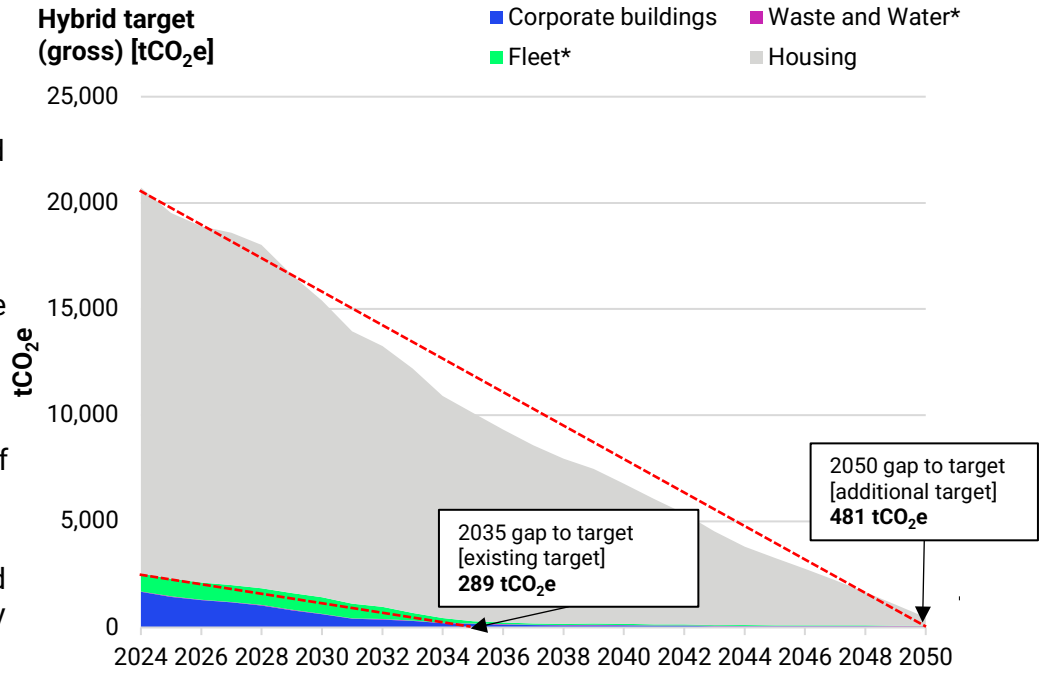
Corporate emissions pathway modelled using Scenario 4, light retrofit (LED lights and heat decarbonisation) implemented by 2035. Housing emissions modelled using Scenario 2, Light retrofit: Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing by 2035.

*Emission projections for these emission sources have been carried across from the existing study as they weren't included in this study. All emissions intensity factors (e.g. gCO_2e/kWh) have been updated to reflect the most recent projections.

2050 housing target: new target for housing only

Under the final proposed target, a hybrid approach is proposed. In this scenario, two emission targets would be created, the existing 2035 target and a separate housing-specific target aiming to achieve Net Zero by 2050.

- By 2035, emissions are projected to decrease by 51%, and by 2050, the reduction is expected to reach 98%, inclusive of residual emissions from electricity generation.
- Achieving carbon neutrality under this plan will require carbon offsets: 289 tCO_2e in 2035 (offsets for housing are not yet needed) and 481 tCO_2e in 2050 after the housing target is met (£10k - £25k per annum).
- The analysis estimates that decarbonising corporate buildings and housing in this scenario will require £78m of capital expenditure, with additional costs expected for all buildings, waste and water, and fleet.
- This target still involves significant capital investment and additional staffing to support a large-scale capital delivery program for corporate buildings and housing.
- Compared to other targets, this plan is considered the most achievable within the existing capacity for delivering retrofits.



Corporate emissions pathway modelled using C4, light retrofit (LED lights and heat decarbonisation) implemented by 2035. Housing emissions modelled using H4, Light retrofit: Some houses (EPC D-G) have energy efficiency measures and heat decarbonised in all housing by 2050.

*Emission projections for these emission sources have been carried across from the existing study as they weren't included in this study. All emissions intensity factors (e.g. gCO_2e/kWh) have been updated to reflect the most recent projections.

Overview

Following the development of scenarios for NSDC Corporate (C1-4) and Housing (H1-4), this section explores the feasibility of achieving different target dates (2030, 2035 and 2050) across different scenarios, compared with the existing 2035 target.

The three different targets with varying scopes are explained in the table below.

We recommend that NSDC consider retain its existing 2035 target while introducing a new 2050 target for housing, as this is likely to be the most feasible pathway to achieving full decarbonisation.

Potential target	Scope	Emissions reduction by 2030	Emissions reduction by 2040	Total emissions (to 2050)	Estimated CAPEX (excludes fleet, water and waste)
Business as usual: 2035 target with green electricity tariff and HVO	• Corporate buildings • Water and waste • Fleet	-56%	-56%	**51,302 tCO_2e**	n/a
2030 target: 2030 target: moving NSDC's existing target to 2030	• Corporate buildings (C3) – light retrofit by 2030 • Water and waste • Fleet	-63%	-91%	**17,700 tCO_2e**	£2.2m (corporate only)
2035 target: integrate housing with the existing 2035 target.	• Corporate buildings (C4) – light retrofit by 2035 • Housing (C3) – light retrofit by 2035 • Water and waste • Fleet	-36%	-95%	**168,855 tCO_2e**	£78m (corporate and housing only)
2050 housing target: a separate housing-specific target aims to achieve carbon neutrality by 2050, in addition to NSDC's existing 2035 target.	2035 target (existing) • Corporate buildings (C4) – light retrofit by 2035 • Water and waste • Fleet 2050 housing target • Housing (H4) – light retrofit by 2050	-25%	-67%	**259,522 tCO_2e**	£78m (corporate and housing only)

Offsetting standards and frameworks

NSDC is expected have some residual emissions in 2035 and offsetting will be required to achieve their carbon neutral ambition, there are currently three main standards that outline approaches to offsetting:

Science-based target initiative net-zero corporate standard

October 2021

First net-zero standard that private-sector organisations can be accredited against

COP26 Universities Network: FE and HE carbon offset briefing

January 2021

Guidance to support the development of further and higher education offsetting policies

The Oxford Principles for Net Zero Aligned Carbon Offsetting

September 2020

Outline of key principles required to ensure offsetting helps to achieve a net-zero society

Each of the standards is nuanced and there is slight variation between them. However, they are broadly aligned across three key areas, which set out how an organisation's offsetting strategy should evolve over time to be considered net-zero aligned. We estimate that good quality offsets are likely to cost £20-50.

1

Cut emissions and use high quality offsets

Reductions must be prioritised in the first instance to minimise the need for offsets. Where offsets are required, organisations should perform robust due diligence to ensure offsets are credible and maintain environmental integrity. All reporting should be done transparently and current emissions, accounting methodology, target setting, and offsetting strategy should all be disclosed.

2

Shift to carbon removal offsetting

To ensure compatibility with the Paris Agreement, users of offsets should increase the portion of offsets that come from carbon removals. By 2050, 100% of offsets should be sourced from emission removals.

3

Shift to long-lived storage

Transition to methods of carbon removal that have a low risk of reversal over centuries to millennia, for example storing CO_2 in geological reservoirs or mineralising carbon into stable forms (e.g., timber used in construction).

Requirements of an offset or inset

Regardless of the exact nature of the scheme, the following criteria are required for an offset/inset scheme to be credible, and a robust due diligence process should be implemented to ensure all criterion are met.

Below: criteria for a credible offsetting/insetting strategy

	Criteria	Description
1	**Real**	All the GHG emission reductions or removal enhancements and the projects that generate them must be proven to have genuinely taken place.
2	**Additional**	Double causality: Reductions/removals would not have been realised if the project had not been carried out, and the project itself would not have been undertaken without the proceeds from the sale of carbon credits.
3	**Based on realistic and credible baselines**	Credited only beyond performance against a defensible, conservative baseline estimate of emissions that assumes the BAU trajectory in the absence of the activity. Baselines should be recalculated at a regular, conservative timeframe.
4	**Monitored, reported and verified**	Projects calculated in a conservative and transparent manner, based on accurate measurements and quantification methods. Must be verified by an accredited, third-party entity. MRV should be conducted at specified intervals.
5	**Permanent**	Only issued for GHG reductions or removals that are permanent or, if they have a reversal risk, must have requirements for a multi-decadal term and a comprehensive risk mitigation and compensation mechanism in place, with a means to replace any units lost.
6	**Leakage accounted for and minimised**	Leakage is defined as an unintended increase in GHG emissions caused by a project. E.g., a forest sequestration project that simply shifts deforestation activities to other forest land, thereby reducing or eliminating the net sequestration from the project.
7	**Only counted once**	Not double-issued or sold.

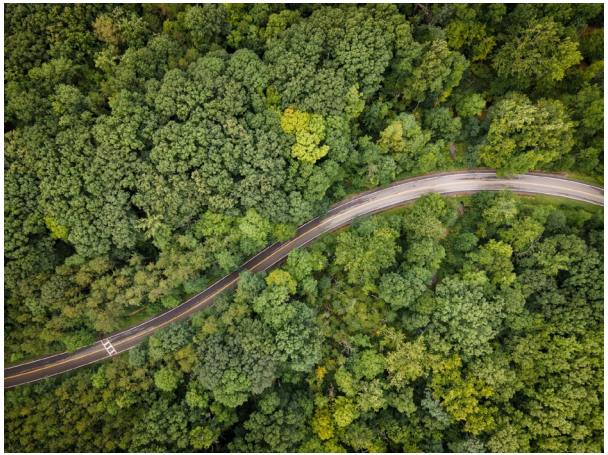
Target Review

6. Next steps

Next steps

Our analysis has provided a high-level assessment of the viability of achieving different targets across NSDC's portfolio, we recommend the following next steps:

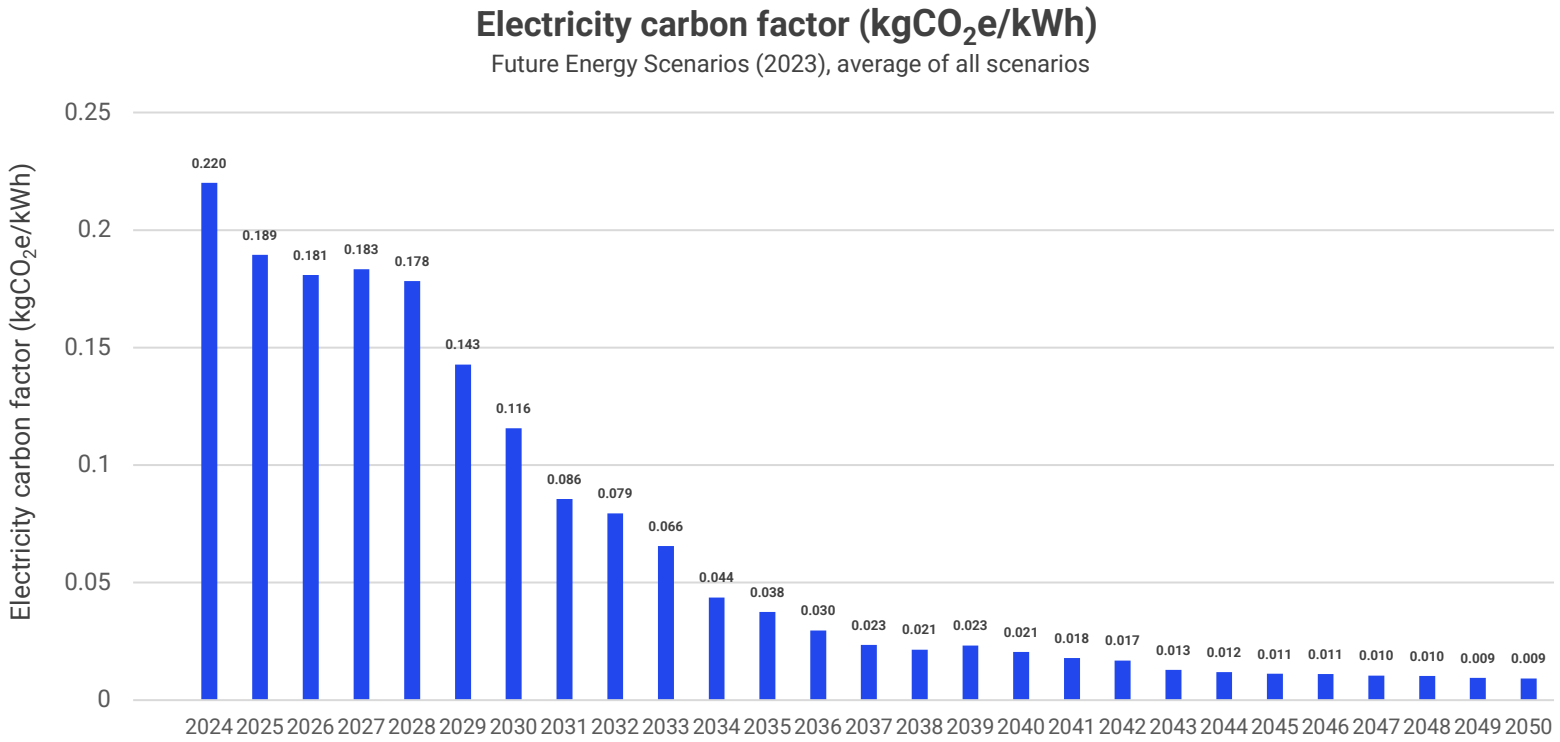
- **Agree on approach to updating targets:** achieve senior sign off to any changes to target, communicating this to any relevant stakeholders.
- **Consider definition of the existing 2035 target**: NSDC could technically achieve its current 2035 carbon neutrality target immediately by purchasing offsets to balance emissions. This approach risks fostering complacency and slowing meaningful emissions reductions. In line with ISO 14068 and the SBTi Net Zero approach, we recommend defining the target to prioritise minimum direct carbon reductions before offsets are used. While carbon neutrality can be a step on the pathway to net zero, any investment in offsets should be balanced with direct mitigation efforts. Resources allocated to offsets should not come at the expense of investment in emissions reductions.
- **Planning for decarbonisation:** agree on a strategy and action for decarbonisation of each emissions source, detailing estimates for investment and resourcing requirements.
- **Corporate buildings:** begin to scope out detailed engineering works to decarbonise NSDC's Corporate estate. Options for Southwell Leisure Centre and other buildings should be developed as these are not covered by existing surveys.
- **Monitoring of targets:** to achieve long-term targets (e.g. 2035), regular reviews of progress are required. NSDC should consider implementing interim and/or annual targets to monitor progress towards their existing carbon neutrality ambition.



Target Review

Appendices

Appendix: National Grid Factors



Appendix: NSDC Target Emissions

In the target set by NSDC in 2020, upstream Scope 3 emissions were not included. For clarity and consistency in reporting, we have now incorporated upstream Scope 3 emissions and updated the figures accordingly to reflect this revised methodology. We acknowledge that this adjustment may create the appearance that the original target is noted incorrectly and we provide this explanation to clarify the changes.

As a result, the totals presented for 2019/20 may not always align with NSDC's 2020 report and target.

Emission totals for 2019/20 and 2023/24, **excluding Scope 3 emissions** as per the 2035 target, are provided below:

Emission source	2019 emissions (tCO_2e)	2024 emissions (tCO_2e)
Electricity	659	585
Fleet	857	1,138
Natural gas	628	1,150
Water	10	241
Waste	11	6
Total:	**2,165**	**3,120**

Appendix: Intervention Overview - NSDC Corporate

Extracted from BE Design report

Improvements Measures

	LED	Glazing	Walls	Roof	ASHP	Solar PV	Electric heating	GSHP
Newark Leisure Centre	★	☆	☆	☆	★	★	☆	☆
Dukeries Leisure Centre	★	★	★	★	★	★	☆	☆
Newark Beacon	★	☆	☆	☆	★	★	☆	☆
Sherwood Arts & Craft Centre	★	★	★	★	★	★	☆	☆
Vicars Water Visitor Centre	★	★	★	★	★	★	☆	☆
Farrar Close - Store & Offices	★	★	★	★	☆	★	★	☆
Sconce & Devon Visitors Centre	★	★	★	★	★	★	☆	☆
Brunel Drive Depot	★	★	★	★	☆	★	☆	★
Castle House Offices	☆	☆	☆	☆	☆	★	☆	☆
Blidworth Leisure Centre	★	★	★	★	☆	★	☆	☆
National Civil War Centre	★	☆	☆	☆	★	☆	☆	☆
Palace Theatre	★	☆	☆	☆	★	☆	☆	☆

★ Applicable for the Asset ☆ Not applicable for the Asset

Interventions highlighted in red apply to all scenarios

Appendix: Cost Overview - NSDC Corporate

Extracted from BE Design report

BUILDINGS	Lighting	Heat Pumps	Solar PV	Electric Heating	Fabric
Newark Leisure Centre	£116,550	£499,440	NA		
Dukeries Leisure Centre	£15,000	£313,720	£48,750		£408,220
Newark Beacon	£59,745	£256,050	NA		
Sherwood Arts & Craft Centre	£30,625	£105,000	£48,125		£366,881
Vicar Water Visitor Centre	£8,120	£27,840	Already purchase		£48,566
Sconce & Devon Visitors Centre	£4,375	£18,125	£14,000		£49,163
Blidworth Leisure Centre	£19,320	NA	£55,825		£187,400
Castle House Offices	NA	NA	£28,613		
Brunel Drive Depot	£43,764	£168,804	£74,375		£178,096
National Civil War Centre	£56,840	£146,160	NA		
Palace Theatre	NA	£180,960	NA		
Farrar Close - Offices	£12,565	NA	£9,975	£3,231	£33,893
Farrar Close - Store	£20,860	£102,120	£54,425		£66,454

Appendix: NSDC Corporate, cost breakdown

Site	Approximate cost per site (£) – Scenarios 1 and 2	Approximate cost per site (£) – Scenarios 3 and 4	Recommended phasing
Newark Leisure Centre	616,000	616,000	**Phase 1**
Dukeries Leisure Centre	786,000	329,000	
Blidworth Leisure Centre	263,000	19,000	
Southwell Leisure Centre	n/a	n/a	
Newark Beacon	316,000	316,000	**Phase 2**
Brunel Drive Depot	465,000	213,000	
National Civil War Centre	203,000	203,000	
Palace Theatre	181,000	181,000	
Farrar Close Office	60,000	16,000	
Farrar Close Store	244,000	123,000	
Sherwood Arts & Crafts Centre	551,000	136,000	**Phase 3**
Vicar Water	85,000	36,000	
Sconce and Devon Park	86,000	23,000	
Castle House	29,000	0	
Total	**3,882,000**	**2,209,000**	

Appendix: Corporate costs assumptions

- The changes in electricity and gas emissions are calculated using National Grid forecasts.
- Running costs, such as OPEX and general maintenance, are not included in the costings.
- Development costs are not included.
- VAT is excluded.
- Decreases and/or increases in natural gas and electricity bills as a result of the interventions are not included in the costings.
- Inflation has not been considered in the costings, Figures presented in the table below represent 2024 prices.

Appendix: Housing assumptions

Baseline data

- All properties were allocated as one of 26 archetypes, based on their built form, EPC, heating type and construction year.
- For properties where this data was not available, nearby buildings (based on postcode) were used to assume their attributes and archetype.
- Glow Simulator was used to create an energy profile for each archetype. This data is based on UK smart meter data and is therefore based on real world information.
- Demand profiles for each archetype were created assuming an average temperature year, assuming 88 winter days, 2 extreme winter days, 183 intermediate days and 92 summer days.
- Emissions from energy use were converted into emissions using Greenhouse gas reporting: conversion factors 2023.

Housing decarbonisation

- A variety of retrofit strategies were allocated to each archetype, these reflected the level of retrofit each property required.
- For the purposes of modelling, buildings with the lowest EPC standards (i.e. EPC D-G) were selected to be retrofitted first.
- Costs for each intervention are available here.
- The number of buildings retrofitted per year is required to significantly increase across all scenarios. This underscores the need for a gradual, year-on-year expansion of capacity. Careful consideration must be given to the required pace of growth to meet NSDC's decarbonisation targets. For instance, achieving decarbonisation by 2035 and 2050 demands an average of 510 and 215 retrofits per year, respectively.
- The UK Government's current policy proposals aim to require all private-rented properties with an EPC rating below D to achieve at least EPC C by 2030. This would necessitate upgrading approximately 3,677 properties to improve their energy efficiency ratings within this given timeframe. This target is likely to pose significant challenges considering the current pace and scale of retrofitting activities.
- Our model has outlined a phased approach to target properties but has not accounted for how the interventions themselves could be staged. Addressing this requires a more detailed portfolio analysis to identify optimal phasing strategies, taking into account factors such as property characteristics, prioritisation criteria, resource allocation and proposed EPC standards.

Appendix: Housing archetypes

All archetypes developed for the purposes of modelling are available below, these have been based on:

- Attributes relevant to heat loss calculations
- Attributes relevant to heat system decarbonisation
- Prevalence of the archetype in the stock

#	Archetype	Count	Average Electricity Consumption (kWh)	Average Heating Consumption (kWh)
1	Post 1930 semi-detached house; On-gas A-C	227	4266	13356
2	Pre 1930 semi-detached house; On-gas A-C	26	4263	17870
3	Post 1930 semi-detached house; On-gas D-G	858	4268	16494
4	Pre 1930 semi-detached house; On-gas D-G	292	4268	22136
5	Post 1930 detached house; On-gas A-C	15	4864	13826
6	All other detached houses; On-gas	5	4865	16603
7	Post 1930 terrace; On-gas A-C	191	3857	11068
8	Pre 1930 terrace; On-gas A-C	24	2965	11526
9	Post 1930 terrace; On-gas D-G	256	2965	16386
10	Pre 1930 terrace; On-gas D-G	46	2965	18252
11	Post 1930 bungalow; On-gas A-C	291	4178	10770
12	Post 1930 bungalow; On-gas D-G	1432	4180	13835
13	Pre 1930 bungalow; On-gas D-G	18	3940	13952
14	Post 1930 flat; On-gas A-C	1026	3524	7400
15	Pre 1930 flat; On-gas A-C	10	3524	7731
16	Post 1930 flat; On-gas D-G	434	3926	9935
17	Post 1930 maisonette; On-gas A-C	85	3927	12319
18	Post 1930 maisonette; On-gas D-G	85	3876	11885
19	Post 1930 semi-detached house; Electric A-C	14	4287	3020
20	Semi-detached house; Electric D-G	35	7278	10810
21	Pre 1930 terrace; Electric D-G	6	3897	3686
22	Post 1930 bungalow; Electric D-G	98	8001	9082
23	Post 1930 flat; Electric	12	3934	2752
24	Post 1930 semi-detached house; Off-gas D-G	28	4221	16376
25	Pre 1930 semi-detached house; Off-gas D-G	19	4200	21635
26	Bungalow; Off-gas D-G	70	4263	13830

Appendix: Housing interventions

	Low retrofit scenario			High retrofit scenario		
Archetype	**Retrofit package measure**	**EE measures**	**CAPEX**	**Retrofit package measure**	**EE measures**	**CAPEX**
Post 1930 semi-detached house; On-gas A-C	*Individual 8kW ASHPs.*	-	£11,728	*Individual 8kW ASHPs plus air tightness improvements.*	*Air tightness*	£12,902
Pre 1930 semi-detached house; On-gas A-C	*Individual 9kW ASHPs. Update hot water cylinder.*	-	£13,919	*Individual 9kW ASHPs. Update hot water cylinder plus air tightness improvements.*	*Air tightness*	£15,697
Post 1930 semi-detached house; On-gas D-G	*Individual 8kW ASHPs plus basic energy efficiency measures.*	*Loft top-up and solid floor insulation*	£17,069	*Whole house deep retrofit to net zero energy standard including 6kW ASHP and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£47,061
Pre 1930 semi-detached house; On-gas D-G	*Individual 8kW ASHPs. Update hot water cylinder plus basic energy efficiency measures.*	*Loft and suspended floor insulation*	£17,521	*Whole house deep retrofit to net zero energy standard including 6kW ASHP and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£62,696
Post 1930 detached house; On-gas A-C	*Individual 9kW ASHPs.*	-	£12,474	*Individual 9kW ASHPs plus air tightness measures.*	*Air tightness*	£14,478
All other detached houses; On-gas	*Individual 9kW ASHPs plus basic energy efficiency measures.*	*Loft top-up and solid floor insulation*	£20,339	*Whole house deep retrofit to net zero energy standard including 8kW ASHP and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£70,836
Post 1930 terrace; On-gas A-C	*Individual 6kW ASHPs.*	-	£9,276	*Individual 6kW ASHPs.*	-	£9,276
Pre 1930 terrace; On-gas A-C	*Individual 8kW ASHPs. Update hot water cylinder.*	-	£13,173	*Individual 8kW ASHPs. Update hot water cylinder plus air tighness improvements.*	*Air tightness*	£13,902
Post 1930 terrace; On-gas D-G	*Individual 6kW ASHPs plus basic energy efficiency measures.*	*Loft top-up and solid floor insulation*	£14,475	*Whole house deep retrofit to net zero energy standard including 6kW ASHP and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£44,813
Pre 1930 terrace; On-gas D-G	*Individual 8kW ASHPs. Update hot water cylinder plus basic energy efficiency measures.*	*Loft and suspended floor insulation*	£18,424	*Whole house deep retrofit to net zero energy standard including 6kW ASHP and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£55,689
Post 1930 bungalow; On-gas A-C	*Individual 6kW ASHPs.*	-	£9,276	*Individual 6kW ASHPs plus air tightness improvements.*	*Air tightness*	£10,278
Post 1930 bungalow; On-gas D-G	*Individual 6kW ASHPs plus basic energy efficiency measures.*	*Loft top-up and solid floor insulation*	£17,141	*Whole house deep retrofit to net zero energy standard including 6kW ASHP and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£37,526
Pre 1930 bungalow; On-gas D-G	*Individual 6kW ASHPs. Update hot water cylinder plus basic energy efficiency measures.*	*Loft and suspended floor insulation*	£20,170	*Whole house deep retrofit to net zero energy standard including 6kW ASHP and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£39,403
Post 1930 flat; On-gas A-C	*Shared ambient ground loop for block of flats. Individual heat pump within each flat (4kW).*	-	£17,941	*Shared ambient ground loop for block of flats. Individual heat pump within each flat (4kW) plus air tightness improvements.*	*Air tightness*	£18,393
Pre 1930 flat; On-gas A-C	*Individual heat pump within each flat (4kW). Update hot water cylinders.*	-	£8,762	*Individual heat pump within each flat (4kW). Update hot water cylinders plus air tightness improvements.*	*Air tightness*	£19,919
Post 1930 flat; On-gas D-G	*Shared ambient ground loop for block of flats. Individual heat pump within each flat (4kW) plus basic energy efficiency measures.*	*Air tightness*	£19,856	*Shared ambient ground loop for block of flats. Individual heat pump within each flat (4kW) plus a package of insulation and air tightness measures.*	*Solid wall and air tightness*	£27,755
Post 1930 maisonette; On-gas A-C	*Shared ambient loop GSHP.*	-	£17,941	*Shared ambient loop GSHP plus individual air tightness improvements.*	*Air tightness*	£18,393
Post 1930 maisonette; On-gas D-G	*Shared ambient loop GSHP plus basic energy efficiency measures.*	*Air tightness*	£19,856	*Shared ambient loop GSHP plus a package of insulation and air tightness measures.*	*Solid wall and air tightness*	£27,755
Post 1930 semi-detached house; Electric A-C	-	-	£0	-	-	£0
Semi-detached house; Electric D-G	*Basic energy efficiency measures.*	*Loft top-up and solid floor insulation*	£5,341	*Deep retrofit and air tightness measures.*	*Whole house deep retrofit*	£58,100
Pre 1930 terrace; Electric D-G	*Basic energy efficiency measures.*	*Loft and suspended floor insulation*	£5,052	*Deep retrofit and air tightness measures.*	*Whole house deep retrofit*	£55,689
Post 1930 bungalow; Electric D-G	*Basic energy efficiency measures.*	*Loft top-up and solid floor insulation*	£7,865	*Deep retrofit and air tightness measures.*	*Whole house deep retrofit*	£37,526
Post 1930 flat; Electric	-	-	£0	-	-	£0
Post 1930 semi-detached house; Off-gas D-G	*Individual 8kW ASHPs. Update hot water cylinder and heat emitters plus basic energy efficiency measures.*	*Loft top-up and solid floor insulation*	£21,058	*Whole house deep retrofit to net zero energy standard including 6kW ASHP, heat system upgrades and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£47,061
Pre 1930 semi-detached house; Off-gas D-G	*Individual 8kW ASHPs. Update hot water cylinder and heat emitters plus basic energy efficiency measures.*	*Loft and suspended floor insulation*	£21,510	*Whole house deep retrofit to net zero energy standard including 6kW ASHP, heat system upgrades and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£62,696
Bungalow; Off-gas D-G	*Individual 6kW ASHPs. Update hot water cylinder and heat emitters plus basic energy efficiency measures.*	*Loft top-up and solid floor insulation*	£21,130	*Whole house deep retrofit to net zero energy standard including 6kW ASHP, heat system upgrades and a package of insulation and air tightness measures.*	*Whole house deep retrofit*	£38,346

Appendix: Housing retrofit cost estimates

Intervention	Cost	
Boiler replacement subsidy/grant	£7,500	
4/5 kW ASHP	£7,317	
6 kW ASHP	£9,276	
8 kW ASHP	£11,728	
9 kW ASHP	£12,474	
Shared ground loop and individual GSHP	£17,941	
Hot water cylinder and pipework	£1,445	
Upgraded triple panel convector radiators (5 kW)	£1,590	
Upgraded triple panel convector radiators (6 kW)	£1,908	
Upgraded triple panel convector radiators (8 kW)	£2,544	
Upgraded triple panel convector radiators (9 kW)	£2,862	
Upgraded double panel convector radiators (5 kW)	£1,269	
Upgraded double panel convector radiators (6 kW)	£1,523	
Upgraded double panel convector radiators (8 kW)	£2,031	
Upgraded double panel convector radiators (9 kW)	£2,285	
Radiator pipework	£14	/m^2 floorspace
High-performance triple glazing	£150	/m^2 glazed area
Cavity wall insulation	£9	/m^2 wall area
Cavity wall insulation top-up	£5	/m^2 wall area
Solid wall insulation	£180	/m^2 wall area
Loft insulation	£19	/m^2 roof area
Loft insulation top-up (house)	£608	
Solid floor insulation	£125	/m^2 floor area
Suspended floor insulation	£102	/m^2 floor area
Air tightness improvements (inc. draught proofing and sealing)	£29	/m^2 glazed area