APPENDIX E

eunomia

Carbon Audit: Results and Recommendations

London Borough of Hammersmith and Fulham

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Report for the London Borough of Hammersmith and Fulham

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Version Control Table

Version	Date	Author	Description
V1.0	16/07/20	GB/AM/WS/PM/KF	Draft Report
V2.0	26/8/20	GB/AM/WS/PM/KF	Final Report
V3.0	18/01/21	GB/AM/PM	Report Update

Executive Summary

The London Borough of Hammersmith and Fulham (H&F) commissioned Eunomia Research & Consulting to undertake a carbon audit of the authority estate and its operations. The audit was designed to:

- Measure the size of the council's annual carbon footprint;
- Review opportunities for reducing this footprint;
- Produce three carbon reduction scenarios the council may follow;
- Identify the likely 'gap' to achieving Net Zero in 2030; and
- Provide approximate costs associated with each reduction pathway.

The key findings highlighted by the audit are shown in Box 1. This summarises the major issues. Following this, a summary of the core elements of the council's current carbon footprint is provided in Figure 1-1. A set of reduction pathways are subsequently presented in Figure 1-2.

A 'Net Zero Action Plan' for H&F is then presented in Table 1-1. This includes short-, medium- and long-term actions and goals. To achieve Net Zero greenhouse gas (GHG) emissions by 2030, the council must implement all decarbonisation recommendations, including energy efficiency and low carbon heating in buildings, procuring green electricity, transitioning its vehicle fleet to electric vehicles (EVs) and improving commuting practices.

Even with the greatest ambition there are technical limits to the impact and feasibility of some of these measures, such as logistical barriers to the installation of insulation, or the viability of suitable electric vehicle replacement models (see section 2.7 for further details). Therefore, H&F is very likely to have a residual carbon footprint in 2030, and to reach Net Zero H&F will have to balance these emissions by supporting high quality carbon offsetting projects.

Box 1: Key Findings

Data and monitoring: Enhancing the council's oversight of key data sources will be essential to progressing towards Net Zero. It is recommended that systems are created to access and monitor these data sources in an efficient way. Existing data management systems should be reviewed to understand current practices, new data sources required for Net Zero planning should be identified, and where necessary adaptations made to existing data management systems to accommodate these new requirements.

Social housing: Social housing is responsible for a substantial proportion of the council's carbon footprint (40% of the total footprint, 83% of the influenceable category). Capital investment programmes must include measures to reduce emissions from these buildings, in particular installation of energy efficiency measures and low carbon heating sources. Building surveys for the capital programme are already underway and requirements for Net Zero should be integrated within these activities as a priority. Following stock evaluation, retrofit works should be planned and costed in detail. Plans should be developed to minimise disruption to tenants during retrofit works. Residents should be engaged with in order to communicate plans and help the council understand potential challenges in good time.

Corporate buildings and schools: Other buildings in the council's portfolio will also require these measures to be implemented. Although they produce a smaller proportion of the council's footprint than social housing (7% of total emissions, 14% of influenceable emissions), this is still a substantial emissions source and should also be prioritised. Similar to domestic properties, stock surveys will be required to understand current conditions and the suitability of low carbon interventions. The likely future of buildings within the property portfolio should be considered when planning retrofit works.

Waste management: Emissions from the council's provision of waste management largely arise from waste incineration. Recommended actions to reduce these emissions include minimising quantities of plastic that are sent for incineration, and increasing recycling rates.

Electric fleet: The council is aiming to achieve Net Zero for its fleet by 2022. Switching to electric vehicles will therefore be a priority action for the next two years, as this falls under the council's control and accounts for 3% of influenceable emissions (and 2% of total emissions). The charging infrastructure requirements for this transition will need to be considered as a priority. Potential replacement vehicles should be assessed, considering factors such as cost, required vehicle mileage, and the remaining lifetime of existing vehicles. The council should continue working with third party vehicle providers to plan for the replacement of contracted vehicles.

Procurement: Procured goods and services are associated with a substantial proportion of H&F's footprint (49% of total emissions). Reviewing procurement practices and implementing changes to encourage suppliers to reduce emissions will be essential to making reductions in this area. This could include integrating elements of the National TOMs Framework (Themes, Outcomes, Measures) into procurement specifications and contracts. Opening dialogue with key suppliers will also help identify opportunities to achieve supply chain emission reductions. In addition, requiring suppliers to submit carbon footprint information will help provide more detail about H&F's supply chain footprint and encourage suppliers to think carefully about their own footprints.

Emissions Footprint

This report calculates H&F's 2019 carbon footprint from its operations and supply chain as 127,178 tonnes of CO_2e[1], 63,722 tonnes of which (50%) are considered directly influenceable. Of this footprint,

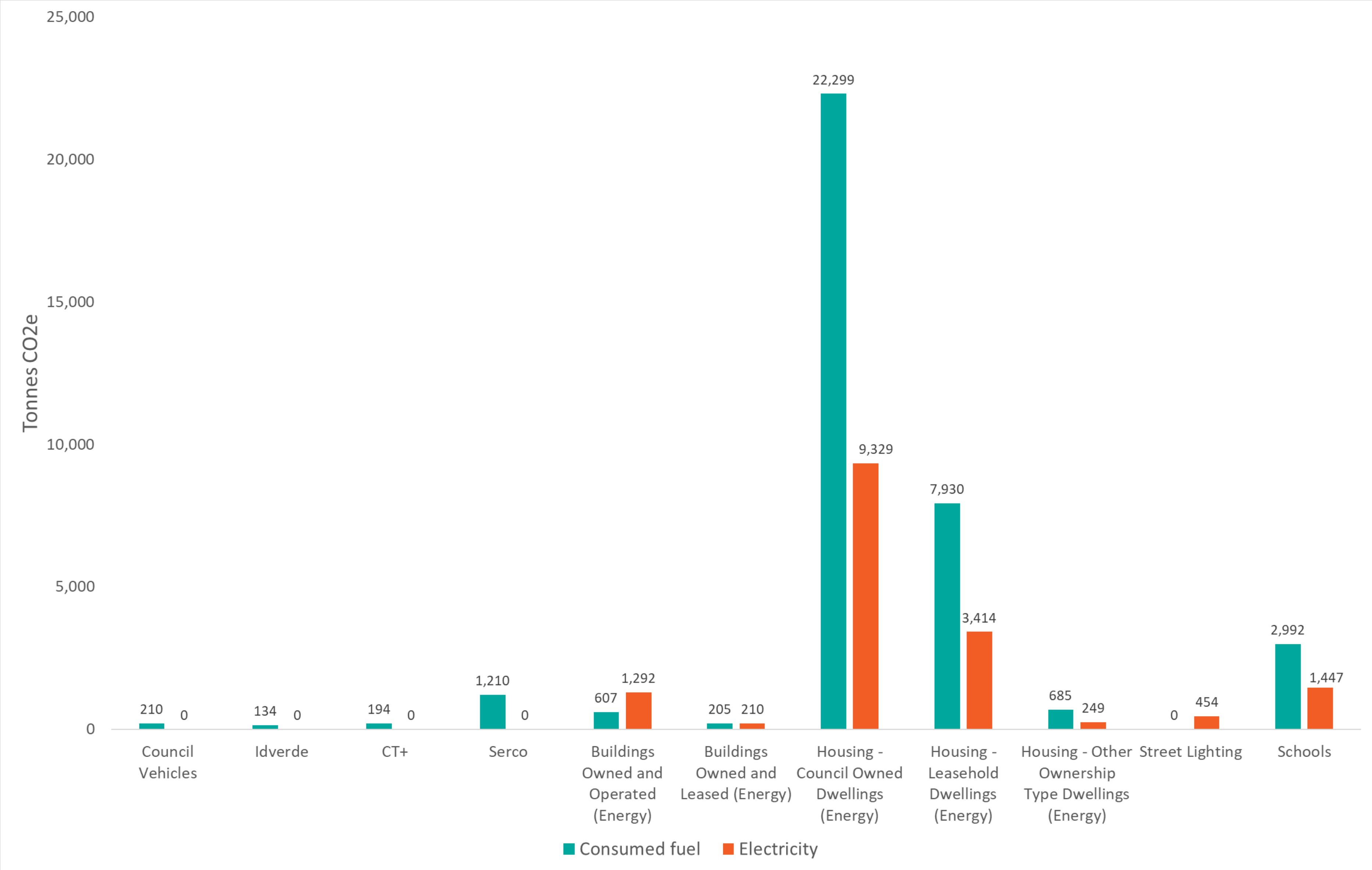
- 43,906 tonnes CO_2e (35%) are generated by the social housing portfolio,
- 7,208 tonnes CO_2e (6%) are generated from council buildings, street lighting and schools,
- 1,747 tonnes CO_2e (1%) are from fuel in council vehicles (both owned and contracted by the council),
- 8,809 tonnes CO_2e (7%) are 'upstream' energy emissions[2],
- the remaining 65,509 tonnes CO_2e (52%) are emitted from procured goods and services.

Figure 1-1 shows a breakdown of the emission sources over which H&F has the greatest extent of control. These sources include vehicles, council buildings, social housing, street lighting and schools.

[1] CO_2e = carbon dioxide equivalent, a metric used to compare the emissions from the various greenhouse gases that H&F produced on the basis of their global-warming potential.

[2] The Greenhouse Gas Protocol's definition of these emissions is "the extraction, production, and transportation of fuels and energy purchased" which are not already accounted for in scopes 1 and 2.

Figure 1-1 Breakdown of Fuel and Electricity Emissions Generated by Council Vehicles, Buildings and Street Lighting, Schools and Social Housing



Three scenarios for reducing emissions up to 2030 under have been modelled, featuring different levels of ambition and technical feasibility:

- In a scenario where there are significant technical limitations and lower ambition the council would have a residual footprint of c.20,000 tonnes CO_2e in 2030 once electricity use in social housing is excluded (Scenario 3 in Figure 1-2).
- In a best-case scenario the residual footprint would be just under 5,000 tonnes CO_2e once electricity use in social housing is excluded (Scenario 1 in Figure 1-2).

These residual emissions would need to be balanced through investing in carbon offsetting projects. Best practice carbon offsetting for local authorities is still evolving. However, for illustrative purposes, if using tree planting, H&F would have to plant approximately 1,000 hectares of trees to meet the annual offsetting requirement in Scenario 1 (best case). The reality of achieving this level of carbon offsetting is complex and requires further detailed assessment.

Achieving Net Zero emissions in 2030 will require significant investment. In a scenario where the council achieves the maximum potential decarbonisation of buildings and vehicles, capital costs are estimated to be in the region of £300 million, spread over the next decade (note that this is not all 'additional' cost and does not take into account what H&F would have spent anyway). The action plan recommends further work in the short term to improve the accuracy of these cost estimates.

The action plan in Table 1-1 has been designed to give H&F clear next steps for the council's climate neutral transition. It is divided into three stages:

- The next 6-18 months are used to undertake more detailed investigations in each of the action areas, to lay strong foundations for the implementation phases;
- The following period up to 2025 is used to begin roll out of low carbon technologies, and where technologically feasible ramp up implementation to make early progress; and
- 2025-2030 is characterised by achieving the maximum potential of actions that are technically feasible with present-day technologies. For areas of the council's operations where new technologies are required, alternatives must be sought out during this period and implemented ahead of 2030.

Achieving Net Zero carbon operations by 2030 is a challenge now being grappled with by hundreds of local authorities across the country – Hammersmith and Fulham is not alone. Whilst there are easy solutions in some areas, creativity, sharing experiences and ideas, and learning from others will all be required to successfully achieve the transition.

Figure 1-2 Emission Reduction Scenarios

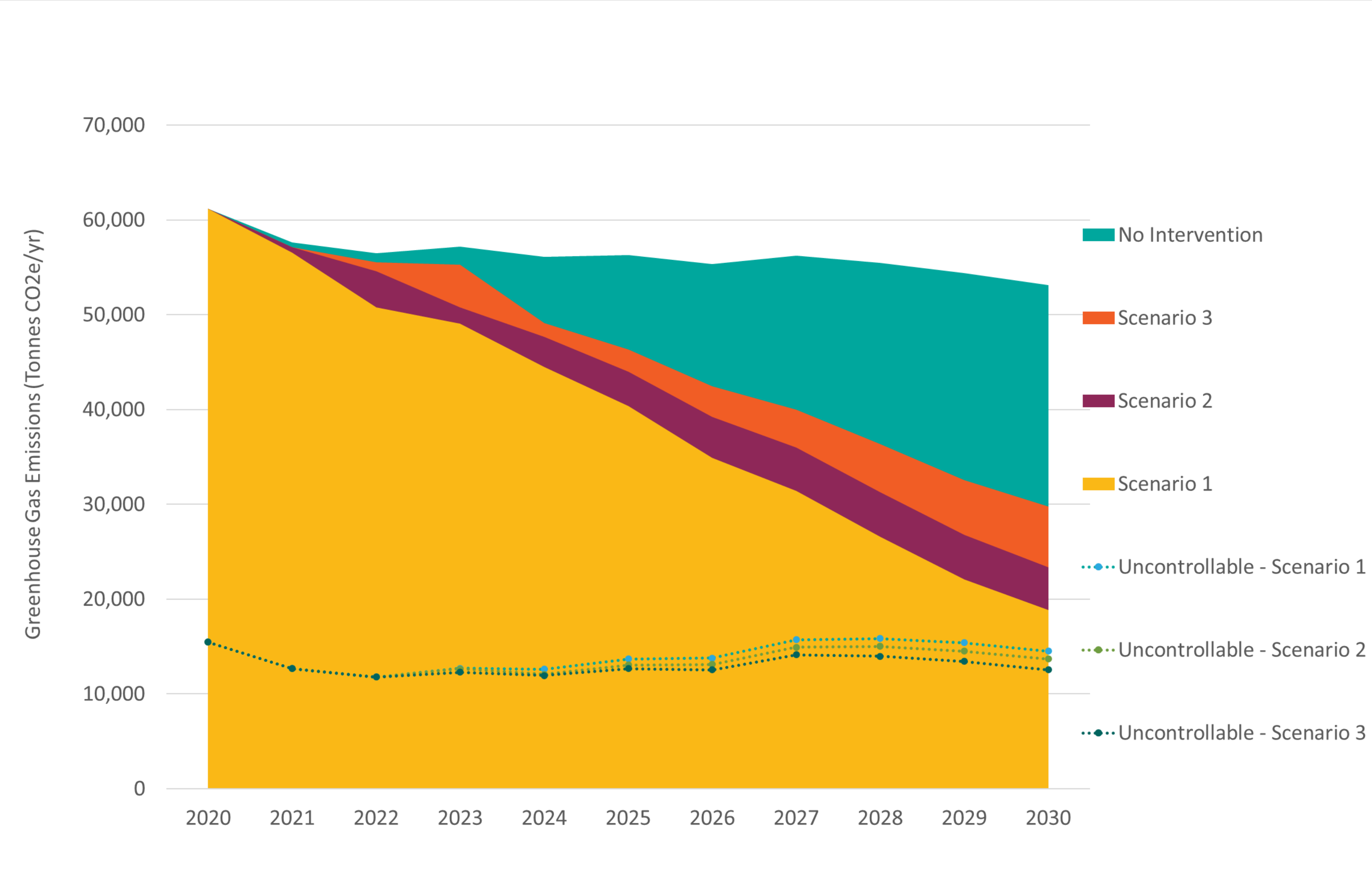


Table 1-1: A Climate Change Action Plan for H&F

Action Area	Short Term (6-18 months)	Medium Term (2021-2025)	Long Term (2025-2030)
Decarbonising Heat	Implement a programme of **smart meter energy monitoring in large corporate buildings**, which will provide data to inform the selection of appropriate measures for individual buildings.		
	Using smart meter data where available, undertake **portfolio-wide building surveys** to accurately assess the feasibility of possible measures including insulation, heat pumps and heat networks, and receive quotations. Use the findings of these assessments to develop a long term **retrofit and decarbonisation plan** for buildings.	Begin a programme of **building insulation.** **Review buildings where insulation is required but yet to be installed**. Develop plan to address these shortfalls.	Begin insulating final properties and develop plan for ‘hard to insulate’ properties.
		Begin a programme of **heat pump installation**, starting in buildings that do not need additional insulation.	Review heat pump installation progress and **assess where alternative heating sources may be required**. Implement these alternative heat sources.
		Identify partners and achieve an **advanced stage of heat network planning**, moving to installation or about to move to installation.	**Review heat network progress** and identify remaining challenges. Identify and implement suitable contingencies, extending existing networks to more buildings.

Action Area	Short Term (6-18 months)	Medium Term (2021-2025)	Long Term (2025-2030)
Decarbonising Electricity	**Finalise the switch to a green electricity tariff** across the controlled elements of the building stock.	Review evolving green energy tariffs and **consider long term approach**, for example entering into **Power Purchase Agreements.**	Maintain green energy purchasing, **maximise the additionality of green energy contracts.**
	Undertake detailed **feasibility assessment across the building portfolio for solar PV installation**, in addition to other renewable technologies such as solar thermal. Receive quotations and set installation targets.	Begin **renewable energy technology implementation.**	Assess the benefit of existing renewable energy infrastructure and **consider further roll outs**, in the context of progress in other areas of decarbonisation.
	Assess opportunities for **green electricity tariffs for council tenants.**	Where possible, **implement solutions that enable tenants to access green electricity.**	**Assess challenges to further roll** out of tenant green energy purchasing and develop solutions.
Decarbonising Transport	**Engage green fleet transport user group** (which was established in August 2020) to understand transportation needs; **review the current fleet replacement programme** and identify the potential for streamlining fleet and electric replacement.	All council services to trial using ***Parcels not Pollution*** scheme, which aims to reduce emissions from freight delivery.	Implement suitable **vehicle maintenance programme** to maximise longevity of purchased vehicles.

Action Area	Short Term (6-18 months)	Medium Term (2021-2025)	Long Term (2025-2030)
	Undertake **cost benefit analysis to assess the economic case of electric vehicle** replacements. Where technologically feasible, **begin vehicle replacements.** Environmentally, this is best achieved at vehicle end-of-life.	**Regularly review opportunities** and the cost effectiveness of **decarbonising larger vehicles.**	For vehicles where electric replacement does not prove viable, **select alternative replacements** that have emerged over this period.
	Assess required charging infrastructure at depot and receive quotations from contractors. **Begin implementation of green charging infrastructure at depot** in line with demand generated by vehicle replacement programme.	**Expand charging infrastructure as necessary** to account for increasingly electrified fleet.	
	Understand grey fleet use by employees and develop **strategy for minimising transport need** or **alternative transport solutions.**		
	Complete trial of eRCVs with Serco and assess trial, and **switch supervisor vans** to electric.	**Progress the transition to eRCVs.**	

Action Area	Short Term (6-18 months)	Medium Term (2021-2025)	Long Term (2025-2030)
Carbon Balancing	**Identify potential implementation structures** that will enable the Borough, as well as local organisations, to balance their emissions.	Engage with and/or implement pilot carbon balancing programmes to **test the process.**	Assess the impact of pilot programmes and **scale projects delivering the greatest outcomes.**
	Review integration of carbon balancing within the **planning process S106 mechanism** and whether impact can be enhanced.	**Put in place necessary governance processes** to enable regulated and robust carbon balancing.	**Undertake necessary ongoing monitoring and evaluation** to maintain confidence in the outcomes of carbon balancing projects.
	Begin **building partnerships** with other local authorities to identify larger scale carbon balancing opportunities.		
Enabling Actions	Develop necessary **business case assessments and financial plans,** and **evaluate funding sources** to support required investment.	**Continually review available funding sources** to support implementation of Net Zero plans.	
	Develop communications plan for informing residents of progress and achievements.	Implement **system for demonstrating the impact of actions** and communicating success and challenges.	
	Identify high profile, show-case activities that can **publicly illustrate the Borough's intent.**	Deliver show-case activities and **engage residents in implementation.**	
	Develop staff **education programme** to ensure officers understand how they can contribute to reduced greenhouse gas emissions.	**Identify where blocks exist to emissions reductions** due to awareness, and provide additional support to officers to facilitate change.	

Contents

1.0 Carbon Footprint

The foundation of H&F's decarbonisation strategy is its baseline footprint, which represents the emissions generated by the organisation over a one-year period.

1.1 Baseline Carbon Footprint

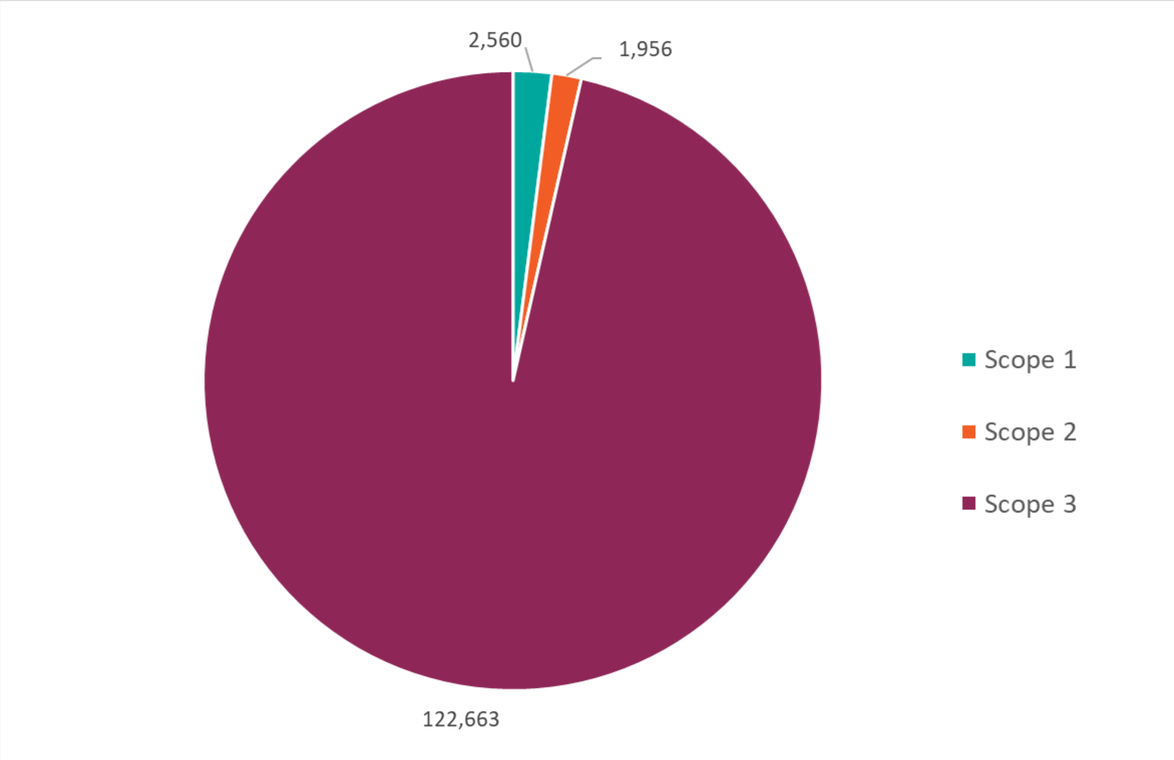
This assessment has been made using a variety of data sources provided by H&F officers. The details of the footprint are described in Table 1-1, and graphically displayed in Figure 1-1. A detailed breakdown of H&F's carbon footprint is given in Table 4-7 in A.1.1.

Table 1-1: Summary of Baseline Footprint

Emissions Category	Description	Data source	Year of data source	Tonnes CO_2e
Scope 1	Emissions generated directly via H&F's owned and operated assets. This includes: - Fuel used by the H&F vehicle fleet (petrol and diesel) and subsidiary fleets (CT+, Idverde and Serco). - Fuel used to heat the Corporate Estate buildings. This is principally gas with a small quantity of heating oil.	- Bagley's Lane Fuel Pump data and Fuel Card Purchase data for the council's own fleet provided by the transport team. - Separate datasheets for CT+, Idverde and Serco provided by the transport team. - Gas data provided by the facilities team, separated into buildings owned and operated and buildings owned and leased. - Oil data for Linford Christie Stadium provided by the facilities team.	2019/20 financial year	2,560
Scope 2	Electricity consumed in: - The Corporate Estate - Street lighting	- Electricity data for the Corporate Estate provided by the facilities team, separated into buildings owned and operated and buildings owned and leased. - Electricity data for Street Lighting provided by the facilities team.	2019/20 financial year	1,956

Emissions Category	Description	Data source	Year of data source	Tonnes CO_2e
Scope 3	Other emission sources associated with H&F's operations. Due to their complexity these emissions should be considered estimations only. Scope 3 can be broken down into: - Emissions from council-owned dwellings leased to tenants, dwellings where residents own the leasehold and dwellings with other ownership structures. - Emissions from electricity and gas consumption in schools. - Emissions from water use in the Corporate Estate and social housing. - Emissions from staff commuting. - Emissions from council funded taxi and ambulance journeys to/from council services. - Emissions from procured goods and services. These emissions are produced by other organisations, but feature in H&F's baseline to illustrate the scale of emissions associated with your procurement activities.	- Social housing emissions estimated based on the number of dwellings in different categories (e.g. flat, maisonette), and typical energy consumption per building type. Split into council owned and dwellings that are leased to tenants, leasehold dwellings and other ownership type dwellings. - Schools electricity and gas data provided by the facilities team. Secondary schools are not included, and there may be some missing data from the primary schools and academies. - Water consumption and spend data provided by the facilities team. - Emissions from staff commuting estimated based on full-time equivalent (FTE) staff numbers and commuting distance and transport mode data from the Department for Transport (DfT). - Spend data on council funded taxi and ambulance journeys provided by the transport team. - Annual procurement spend data provided by H&F's procurement team and categorised by Eunomia. - Data on grounds maintenance and capital spend on construction provided separately by relevant officers.	2019/20 financial year	122,663
			Total	127,178

Figure 1-1: London Borough of Hammersmith and Fulham Council Emissions by Scope - tonnes CO2e



Whilst emissions Scopes help create consistency between organisations in terms of emissions reporting, they do not necessarily help local authorities think clearly about where they have the greatest opportunity to reduce emissions. This is because local authorities often have a reasonable extent of control over some Scope 3 emission sources. The following tables and figures provide a more granular breakdown of where emissions are generated across the council, to demonstrate priority areas for emission reductions.

Table 1-2 breaks down H&F's Scope 1-3 footprint into important emission generating categories, and is intended to provide a simple level of insight into where emissions are generated across the council.

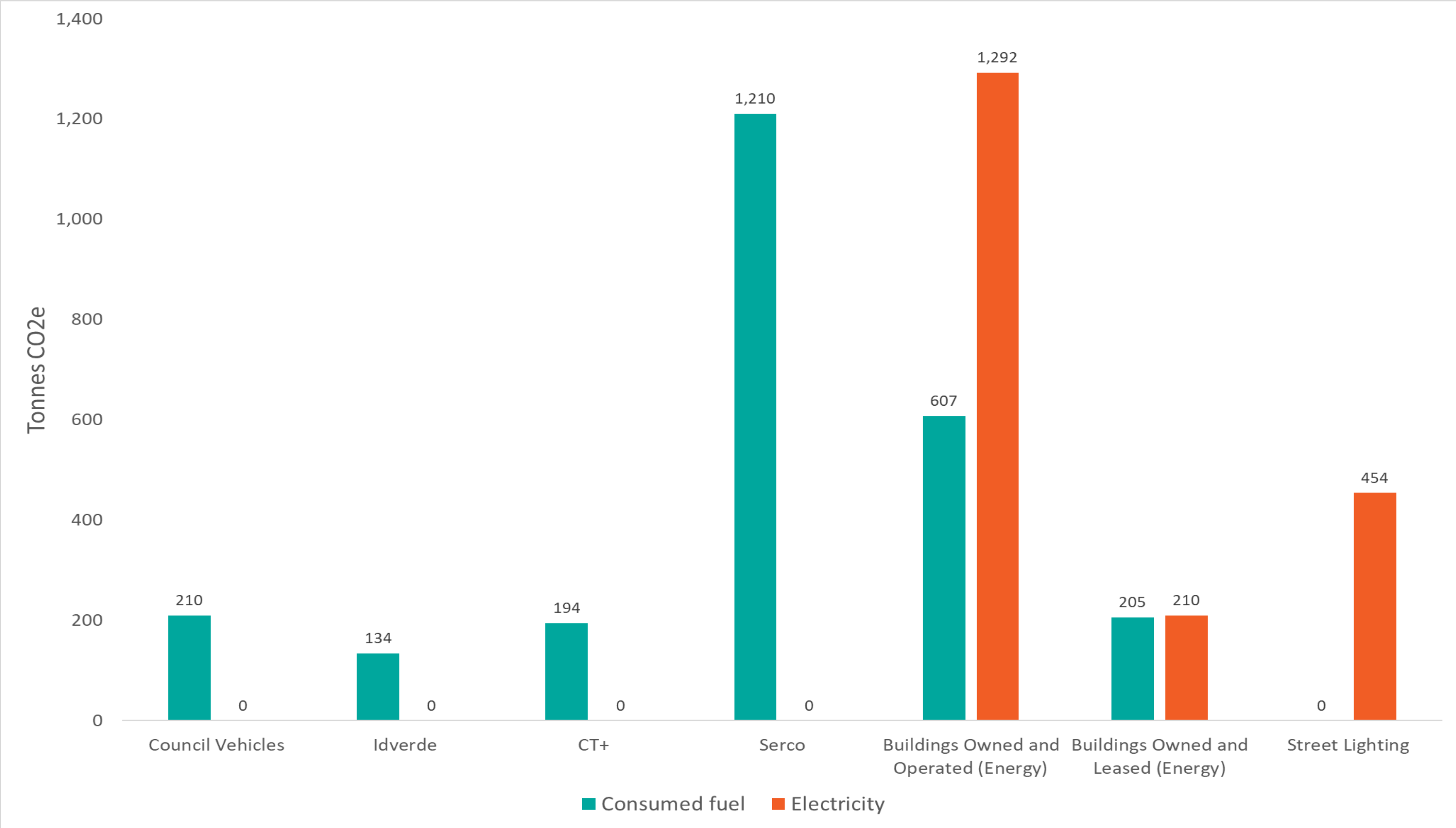
Table 1-2: Breakdown of Emission Sources. Note that this Includes Scopes 1-3.

Category	Total emissions (tonnes CO_2e/year)	Of which is scopes 1 and 2 (tonnes CO_2e/year)	Of which is upstream energy emissions (tonnes CO_2e/year)
Council-owned vehicles	2,163	1,747	416
Council-owned buildings (non-residential)	2,928	2,314	613
Council-owned buildings (residential)	51,070	43,906	7,164
Street lighting	561	454	107
Schools	5,170	4,439	731
Staff commuting	258	N/A	N/A
Expensed taxis	1,794	N/A	N/A
Procured goods and services	63,233	N/A	N/A
Total	**127,178**	**52,861**	**9,028**

Figure 1-2 focusses only on emissions generated by council vehicles (1,747 tonnes CO_2e) and the council's non-residential buildings[3] (2,314 tonnes CO_2e) to provide greater detail on these largest emissions sources. Green bars represent emissions from consumed fuels: petrol and diesel for vehicles, gas and heating oil for buildings. Orange bars show electricity consumption. Note that this figure does not include the upstream energy emissions from transporting and transmitted fuel or energy. Figure 1-2 shows that the fuel consumed by refuse vehicles and electricity usage in owned and operated buildings are the largest sources of emissions within these categories. However, each element of the footprint presents a substantial opportunity to make emission reductions.

[3] The emissions calculations for buildings that are owned and leased are based on data available for tenants at the time of the audit, and do not include all buildings. Further data may be available in future to refine this estimate.

Figure 1-2: Breakdown of Scopes 1 and 2 Emissions Generated by Council Vehicles, Buildings and Street Lighting



Providing further detail, Figure 1-3 shows the same categories that are shown in Figure 1-2, but with the addition of the emissions from council's social housing portfolio (43,906 tonnes CO_2e, not including upstream energy emissions), and from council operated schools for which data were available (4,439 tonnes CO_2e, not including upstream energy emissions). It becomes clear that emissions from the social housing portfolio are far more substantial than those from other buildings and vehicles.

The housing portfolio merits further discussion due to the nature of building ownership and control. The total emissions from council owned dwellings, leasehold dwellings and other ownership type dwellings are presented here. It has only been possible to present an estimate of emissions from dwellings as energy bills are paid by tenants, which means the council does not have easily accessible data on energy consumption in social housing.[4] Dwellings where the tenant is renting from the council constitute the largest set of dwellings (12,023 properties), but emissions from leasehold dwellings (4,644 properties) and other/ non-specified ownership type dwellings (222 properties) are also included. There will also be emissions generated from communal areas such as lifts and walkways, and it is recommended that data relating to these sources is sourced for future footprinting exercises.

Despite council owned dwellings being categorised as a Scope 3 emission source (because they are rented out), as the landlord, the council has control over the building fabric and by extension energy efficiency and the quantity and type of energy tenants require to heat their homes. The council has less control over the electricity tariff tenants choose but may wish to consider ways it could support tenants to procure renewable electricity.

The situation is more complex for leasehold and other ownership types, as the extent of control the council has over each building is likely to vary. It is recommended that the impact of various ownership structures on the council's ability to implement emission reduction measures is investigated further as a follow up to this report.

[4] Emissions estimation from dwellings is based on the number of different property types (e.g. number of flats, number of maisonettes) in the property portfolio, and typical energy consumption data for each property type, sourced from BEIS. For a more detailed explanation, see A.1.1.1

Figure 1-3: Breakdown of Scopes 1 and 2 Emissions Generated by Council Vehicles, Buildings, Street Lighting, Schools and Social Housing

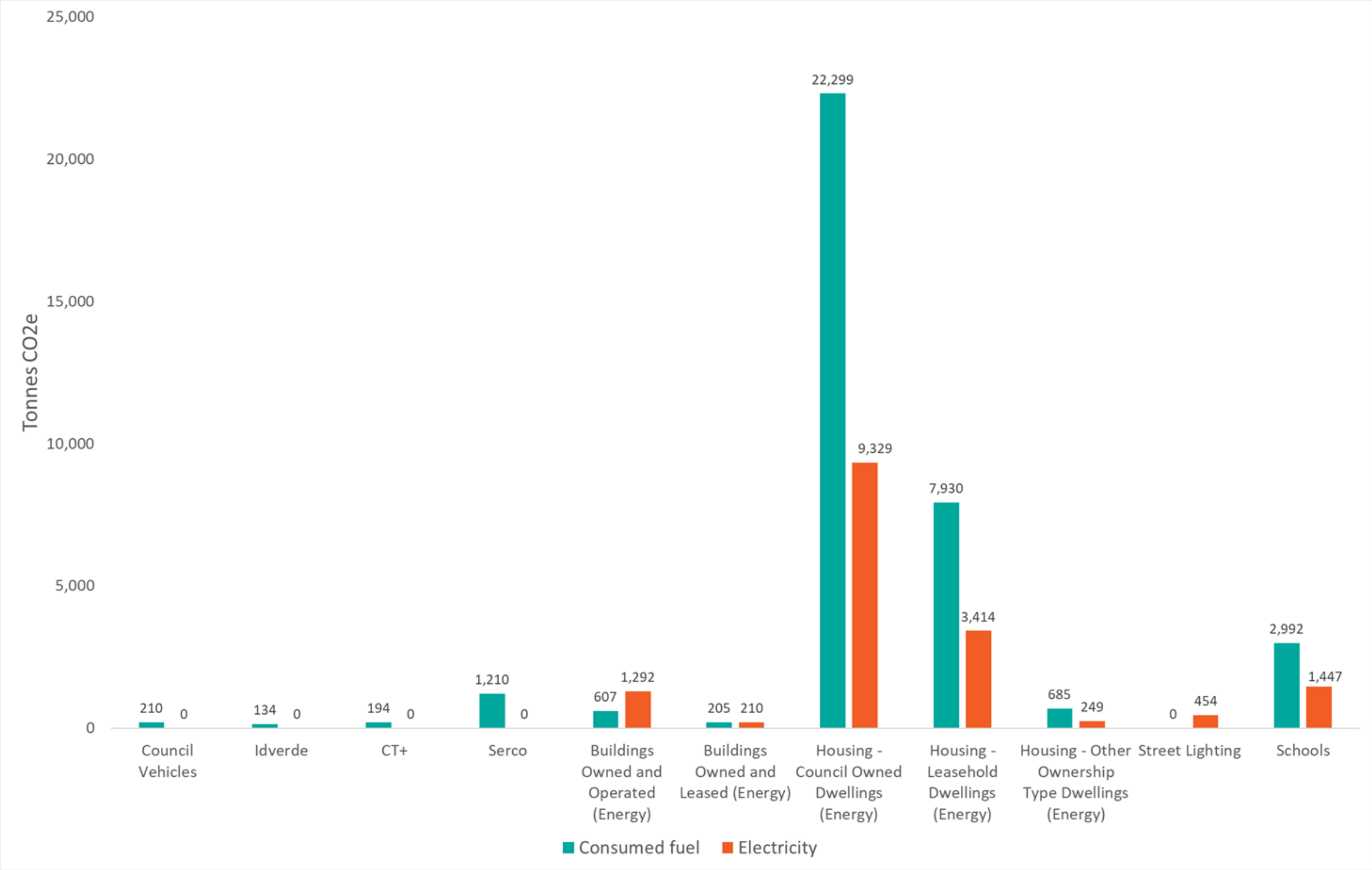


Figure 1-4 presents emissions from other elements of the council's Scope 3 emissions, including procured goods and services, staff commuting and water consumption.

The emissions from procured goods and services are substantial, totalling over 63,000 tonnes CO_2e (for a breakdown of the sources of these emissions, see Table 4-8 in A.1.1.4). However, this element of the footprint should be considered an estimate only, for two reasons:

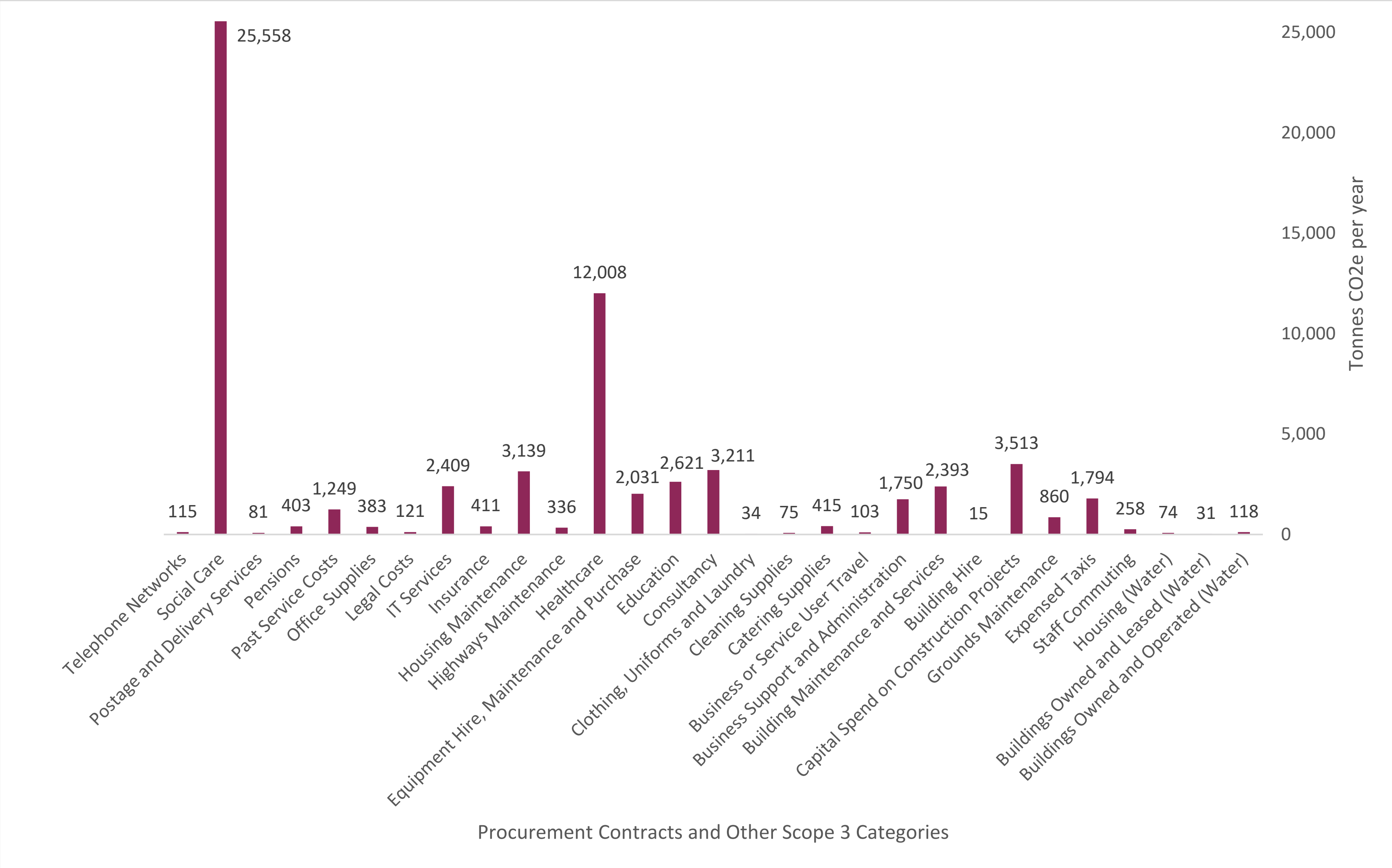
- Firstly, the procured goods and services emissions assessment is based on the council's spend in a variety of categories, for which emission factors provided by the government are less precise.
- Secondly, the procurement categories covered are the result of a broad categorisation of a large procurement dataset of spend on goods and services. It is possible that there are some mis-categorisations or instances of double counting, or there may be additional categories of expenditure that are not included.

Nevertheless, the analysis still provides important insight into the hot-spot areas within H&F’s supply chain that should be priority areas for emission reductions, as well as giving an indication of the scale of the emissions from procured goods and services.

The largest component of supply chain emissions arises from the procurement of health (12,008 tonnes CO_2e – 19% of all procurement) and social care services (25,558 tonnes CO_2e – 40% of all procurement). It is important to understand that the reason these sources dominate the footprint is not due to these procurement categories having a relatively high emissions intensity, rather it is due to these two procurement categories being by far the largest elements of the council’s procurement spend. Outside of procured goods and services, the council’s provision of taxi and ambulance journeys to and from council services represents an important source of emissions that the council may be able to reduce. There was no data available on business travel, and therefore the emissions associated with this have not been included. Business travel might constitute a noteworthy amount of emissions, particularly if flights are taken, and it is recommended that a system is introduced for monitoring this going forwards.

Covid-19 has had a dramatic impact on all aspects of life. While it remains to be seen what the ‘new normal’ will look like, we can be sure that there will be permanent changes to things like working patterns (e.g. more working from home and meetings held virtually). We expect that in the long term this will help reduce H&F’s footprint. However, future assessments may need to consider the carbon impact associated with home working set-ups, and carbon accounting advice in this area is likely to emerge as more organisations begin to factor this into their carbon reporting.

Figure 1-4: Scope 3 Emissions Categories (excluding social housing)



1.2 Emissions Included in Reduction Pathways

The overall footprint for the council of 127,178 tonnes CO_2e per year is comprised of elements that are more and less controllable by the authority, and of things that are controllable in different ways. 'Scope 3 categories'—whose emissions fall *exclusively* into scope 3, like procurement—have been excluded from the emissions reduction analysis (except staff commuting, which is considered to be 'influenceable'.) The scope 3 portions of other emissions categories like social housing, which have emissions which fall into scopes 1, 2 and 3, are included.

The emissions that have been excluded account for 65,251 tonnes CO_2e per year. These emissions have been excluded because they are associated with the provision of services and products from third-party organisations. They can be controlled through procurement processes to an extent, but primarily rely on the actions of service and product suppliers. They should not be ignored, but they are addressed more meaningfully through a green procurement process than through an action plan for change.

The remaining 61,927 tonnes CO_2e are those emissions that can primarily be addressed through an action plan. They comprise some challenging elements, such as the electricity emissions of social housing tenants and staff commuting, as well as areas of direct control such as own fleet. This portion of the footprint is the basis for the emissions reductions section that follows.

1.3 Additional Emissions Categories

Waste management services

An additional emissions category for consideration concerns the management of waste collected from H&F residents. This has not been included in the Scope 1-3 summary above for two reasons:

1) Whilst the council has an influence over how waste is managed, the quantities and types of waste managed are to a large extent the responsibility of residents. It is therefore useful to present waste as a separate emissions category; and
2) Emissions from waste can be considered in terms of direct emissions associated with the processing of waste, but also in terms of benefits derived from recycling materials. Including recycling impacts shows an emissions saving, which is difficult to capture in a conventional Scope 1-3 breakdown.

Figure 1-5 shows a breakdown of emissions from waste management. These figures have been produced using Eunomia's inhouse waste footprinting tool, and data on H&F's waste management from WasteDataFlow.

The negative numbers indicate areas where emissions are saved through the reuse and recycling of waste. These arise from the recycling of:

- Paper/card (1,979 tCO_2e savings);

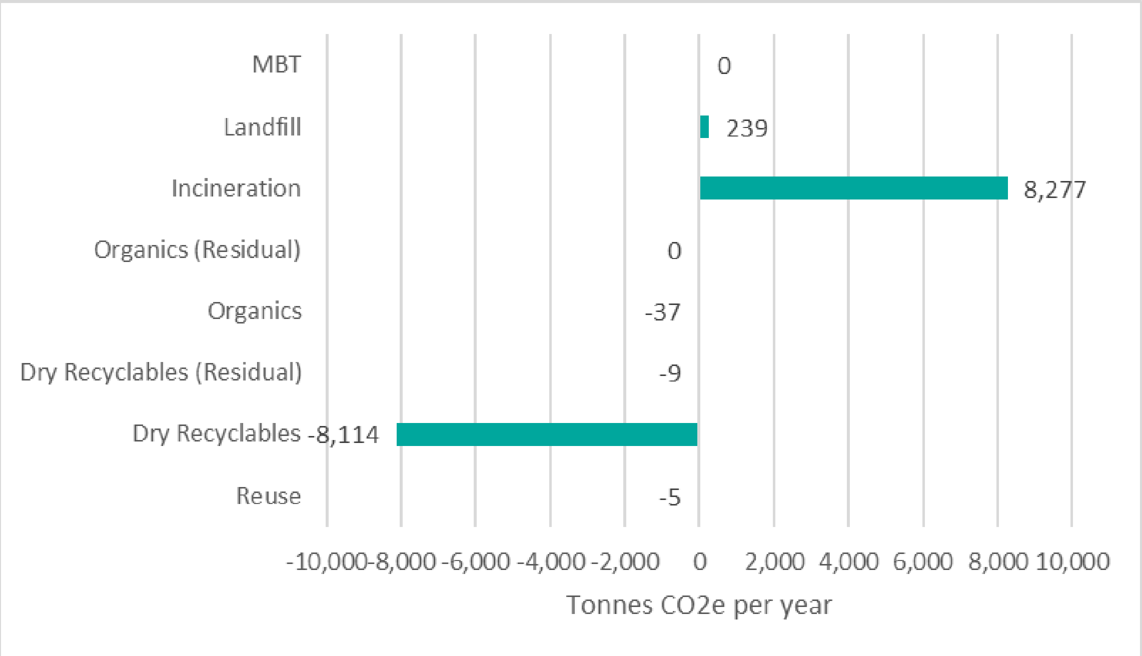
- Glass (519 tCO_2e savings);
- Ferrous metals (548 tCO_2e savings);
- Non-ferrous metals (1,116 tCO_2e savings);
- Plastics (1,193 tCO_2e savings);
- Textiles (2,704 tCO_2e savings); and
- Electricals (53 tCO_2e savings).

These figures are calculated using the assumption that the recycled materials displace the use of virgin materials for new products, and incorporate emissions produced during the recycling processes.

Positive numbers indicate where emissions are generated – primarily through Mechanical Biological Treatment (MBT) and the subsequent incineration of the output material from this process.

It is not possible to address opportunities for reducing emission from waste in detail within the scope of this report. However, some opportunities are apparent. It would be advisable to minimise the quantities of plastic, food waste and textiles being sent for incineration, as these deliver the majority of the carbon emissions. In addition, further work to increase the recycling rate will help avoid emissions from virgin materials (where virgin materials are displaced).

Figure 1-5: Emissions from Waste Management



Emissions from H&F's Pension Portfolio

The carbon audit also reviewed available data regarding emissions associated with H&F's pension portfolio.

The data and insight provided for the audit showed that there is already a proactive strategy in place to direct the council's pension investments to support sustainable activities. Some carbon footprinting has been undertaken by pension providers and reported to H&F, and this footprinting covers approximately half of the pension portfolio. The outcomes show where the council is invested in lower carbon portfolios, an emission saving has been made relative to investing in a 'business as usual' portfolio.

The footprint associated with approximately half of H&F's pension portfolio totals 30,000 tonnes[5]. It is recommended that further carbon assessments are undertaken on the rest of H&F's portfolio and opportunities to further prioritise low carbon investments are prioritised.

[5] Derived from analysis from Trucost on H&F's LGIM MSCI World Low Carbon fund.

2.0 Emission Reduction Pathways

To achieve Net Zero emissions Hammersmith and Fulham will need to reduce emissions as far as possible, and then compensate for remaining emissions by investing in carbon balancing projects.

This Carbon Audit has evaluated how reductions can be achieved, assessed possible decarbonisation pathways, and estimated the size of the remaining footprint in 2030.

As already identified, there are 61,927 tonnes CO_2e per annum that the council can address through an action plan, and 65,251 tonnes CO_2e that can be addressed through green procurement or are completely beyond council control. The emissions reduction pathways address the former portion of emissions, which comprises:

- Energy consumption (gas and electricity) in the corporate estate and social housing portfolio
- The council's owned and leased vehicle fleet (including refuse vehicles, which are all contracted from Serco)
- Purchase and production of electricity
- Employee commuting

Given the Net Zero target of 2030, the emissions reduction assessment has been conducted using existing, established technologies and interventions. Approaches that may not yield results or technologies that are unproven (for example hydrogen heating) have not been included. The key interventions modelled are shown in Table 2-1.

Table 2-1 Overview of the Carbon Reduction Measures Modelled and where they can be Applied

Measure	Description	Applicability
Energy efficiency	Reduction of energy consumption in buildings (e.g. through insulation)	Buildings: domestic and commercial/industrial
Low carbon heating	Installing air source heat pumps in buildings to provide low carbon heat	Buildings: domestic and commercial/industrial
Green energy tariff	Switching to green energy procurement that has been produced by renewable energy sources	Electricity in buildings, electricity for electric vehicles
Solar PV	Installing rooftop solar PV arrays to generate low carbon electricity	Buildings: domestic and commercial/industrial
Electrifying transport	Transition the council's fleet of owned vehicles, and the vehicles it leases, to electric	Vehicle fleet

Measure	Description	Applicability
Lower carbon commuting	Encourage a shift from car use to working from home, active travel, and public transport	Commuting

These measures have informed three emission reductions scenarios from 2020 - 2030. Each scenario varies the extent to which each measure can be implemented, and when the measures can be implemented. The scenarios are shown Figure 2-1 and the underlying assumptions described in Table 2-2.

Figure 2-1: Emission Reduction Pathways

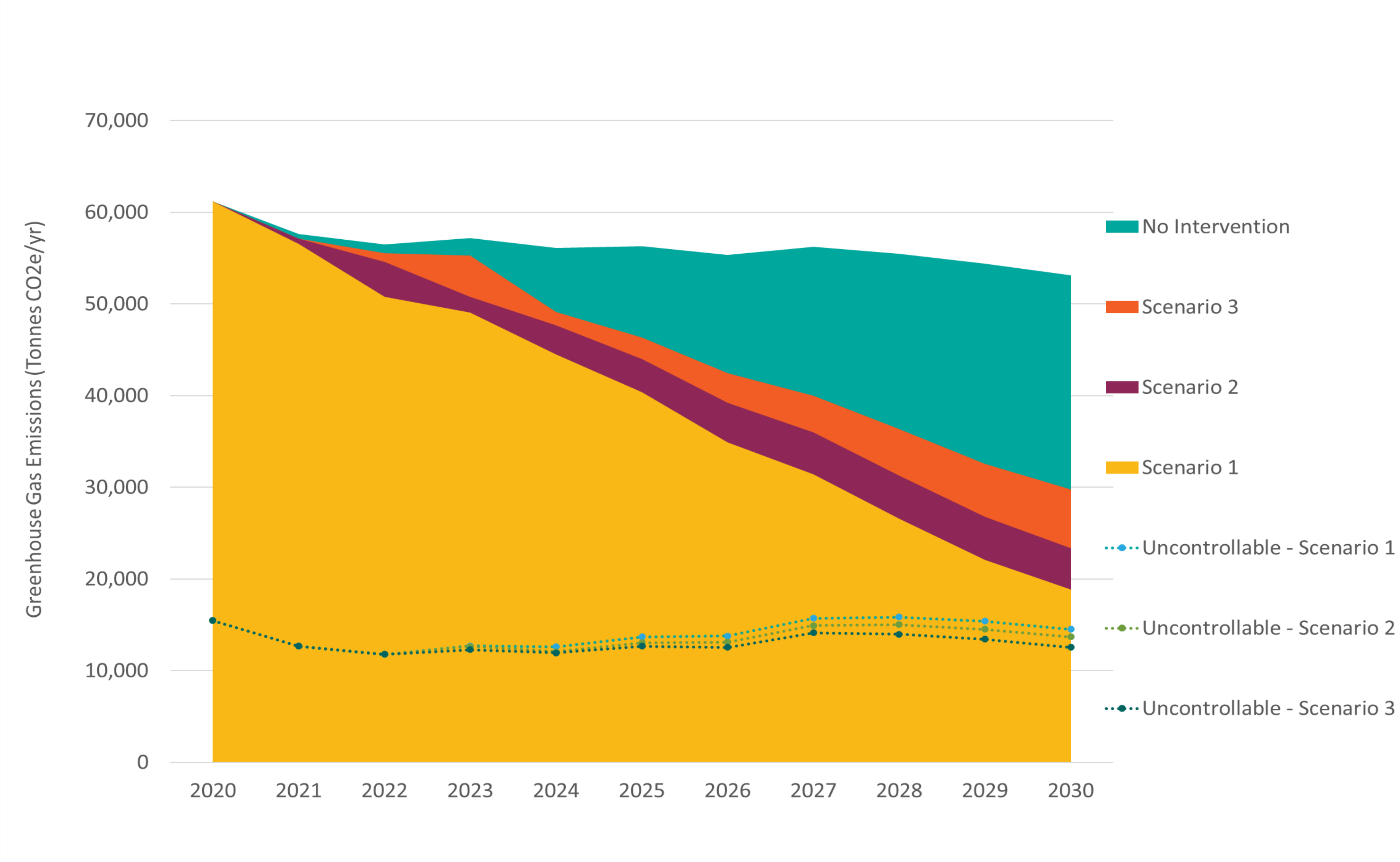


Table 2-2: Emission Reduction Pathway Explanations

Intervention	Green Business As Usual	Orange Scenario 3 [Lower Ambition]	Purple Scenario 2 [Higher Ambition]	Yellow Scenario 1 [Close to Ideal]
Summary of Pathway	Emissions reduce in line with grid decarbonisation, but no other low carbon interventions are made	There are significant limitations to implementation of measures and there are delays to implementation	Measures are largely enacted, but not in full, they are enacted earlier on, but often take longer to complete	Most measures are able to be fully implemented, and are enacted relatively early
Energy Efficiency		Applied to: 59% of Domestic Dwellings 80% of Commercial Buildings Negligible investment possible in current four-year asset management horizon	Applied to: 77% of Domestic Dwellings 90% of Commercial Buildings Moderate investment possible in current four-year asset management horizon	Applied to: 90% of Domestic Dwellings 100% of Commercial Buildings Significant investment possible in current four-year asset management horizon
Air Source Heat Pumps		Applied to: 56% of Domestic Dwellings 70% of Commercial Buildings Negligible investment possible in current four-year asset management horizon	Applied to: 75% of Domestic Dwellings 90% of Commercial Buildings Moderate investment possible in current four-year asset management horizon	Applied to: 88% of Domestic Dwellings 100% of Commercial Buildings Significant investment possible in current four-year asset management horizon
Green Tariff		Green Tariff procured in 2024	Green Tariff procured in 2023	Green Tariff procured in 2022
Solar PV		No arrays constructed	Half possible arrays constructed (2.9 MW). 5-year lead in	Maximum arrays constructed (4.7 MW) 5-year lead-in

Intervention	Green Business As Usual	Orange Scenario 3 [Lower Ambition]	Purple Scenario 2 [Higher Ambition]	Yellow Scenario 1 [Close to Ideal]
Transport Electrification		50% of vehicles replaced in initial programme, with additional 20% in later years	75% of vehicles replaced in initial programme, with additional 10% in later years	100% of vehicles replaced in initial programme
Improved Commuting		40% of possible car journeys changed Changes take 3 years to commence	70% of possible journeys changed Changes take 2 years to commence	100% of possible journeys changed Changes take 1 year to commence

Residual Emissions

The dashed lines in Figure 2-1 indicate the emissions that the council are likely to find it more challenging to influence, specifically those derived from electricity consumption in social housing. This is because tenants select their own electricity tariffs, and it cannot be guaranteed the electricity source will be renewable. These emissions fluctuate as the grid carbon factor changes, and as heating systems are transferred from gas boilers to heat pumps (which consume electricity). There are multiple lines as the difference in heat pump roll out affects the electricity consumption of residents. Emissions below the lines can be assumed to be largely the responsibility of tenants. Emissions above the lines are assumed to be the responsibility of the council, and in 2030 represent the footprint that will need to be offset for the council to achieve Net Zero.

The reason that the electricity emissions of tenants are included in this analysis, is because by shifting from gas to electric heating in social housing, the council is reducing emissions overall, but increasing emissions associated with electricity consumption. This trade-off needs to be captured and understood to properly reflect the situation.

Residual emissions in 2030 are primarily associated with buildings that cannot be retrofitted and/or have heat pumps installed, indicating that the domestic retrofit and heat pump programme is the most critical element of success for achieving Net Zero. Residual emissions are explored in greater detail in Table 2-3.

Table 2-3: Residual Emissions

	Green Business As Usual	Orange Scenario 3 [Lower Ambition]	Purple Scenario 2 [Higher Ambition]	Yellow Scenario 1 [Close to Ideal]
Total Residual Emissions in 2030 (Tonnes CO_2e)	**53,144**	**29,781**	**23,368**	**18,859**
Residual Emissions Outside of Authority Control		**12,534** Of which: 3,435 is domestic electricity for heating 9,099 is domestic electricity for appliances	**13,700** Of which: 4,601 is domestic electricity for heating 9,099 is domestic electricity for appliances	**14,497** Of which: 5,398 is domestic electricity for heating 9,099 is domestic electricity for appliances
Residual Emissions In Authority Control (Tonnes CO_2e)		**17,246** Of which: 16,362 is domestic gas for heating 646 is commercial transport 238 is personal transportation for commuting	**9,668** Of which: 9,125 is domestic gas for heating 321 is commercial transport 222 is personal transportation for commuting	**4,361** Of which: 4,155 is domestic gas for heating 0 is commercial transport 206 is personal transportation for commuting

Overall, the pathways show there is substantial potential for Hammersmith and Fulham to reduce its annual carbon emissions. The analysis that informs each pathway is based on a core set of low carbon interventions. The following sections explains the technologies and approaches that have been applied in the reduction modelling, and the rationale for their inclusion. A variety of case studies are also included to illustrate how other local authorities have taken action in these areas.

2.1 Energy Efficiency in Buildings

Energy efficiency measures help reduce demand for heat, minimise the power requirements of new heating systems and reduce long term costs. Improving energy efficiency in buildings is an important precursor to installing low carbon heating solutions.

The energy efficiency measures included in the emissions reduction analysis are insulation (cavity wall and loft) and draught exclusion for homes, and insulation, double glazing on windows and thermostatic control for commercial and industrial buildings. The analysis assumes a base starting position of the national average, so for example the proportion of dwellings across the country with double glazing is used to determine the proportion of dwellings in H&F with this installed. The gap between this and full installation is then the amount of potential change (and therefore impact) available.

In practice, the most appropriate set of energy efficiency measures— for example, the type of insulation (cavity wall, internal wall, external wall, and various forms of loft insulation) and whether double glazing is required —will depend on the building fabric, layout, and other considerations.

The buildings considered in this analysis are: the 16,889 residential properties owned or part-owned by the council, various commercial and industrial buildings and schools operated by the council (including its offices), and a vehicle depot.

The impact of the measures on these buildings is taken from the National Energy Efficiency Database as follows:

- Residential buildings: 35% energy demand reduction
- Non-residential buildings: 30% energy demand reduction

When implementing this element of the reduction strategy it will be necessary for buildings to be reviewed on a case-by-case basis to establish the most appropriate energy efficiency measures. The measures included in the modelling are not necessarily exhaustive, and building surveys may reveal additional activities that would help further reduce energy consumption.

The council will have different degrees of control over different buildings. For example, of the 16,889 residential properties, 71% are owned by the council and likely to fall under its direct control, meaning that council has clear responsibility to implement upgrades to the building fabric. However, the remaining 29% of buildings fall under other types of ownership/leasehold model, and the council may not have final say over changes to the building.

There are two factors that will determine how many buildings will be able to be retrofitted:

- Whether the authority can control the installation; and
- Whether it is actually possible to install energy efficiency measures in the building.

Our analysis varies both of these factors to provide a realistic variation that the council may encounter. These variations are shown in Table 2-4.

Table 2-4: Potential for Energy Efficiency Measures: Domestic

	Scenario 3	Scenario 2	Scenario 1
Access to direct control (e.g. rented)	100%	100%	100%
Access to uncertain control (e.g. leasehold)	25%	50%	75%
Building suitability for retrofit	75%	90%	97%
Overall stock that can be changed	59%	77%	90%

In the commercial and industrial buildings sector, it was assumed that the council has total control over all buildings, both owned and leased.

A final consideration to be made when reviewing the particular requirements of individual buildings is the importance of maintaining a safe and comfortable internal temperature in light of the increasing frequency of extreme heat events. Modelling these requirements is complex, and falls beyond the scope of what is possible to analyse within this report. Understanding these requirements is likely to be most effectively achieved by considering the fabric of individual buildings during retrofit planning. The needs of individual buildings, and future climate trends, may mean additional building energy efficiency or cooling requirements are required that have not been considered in this report.

Case Study: Energy Performance Contracts, Peterborough City Council

- PCC agreed an innovative 'energy performance contract' to install £7.5m worth of energy efficiency upgrades in its leisure buildings, admin offices, schools and car parks (private financing was permitted under the contact)
- Upgrades included new building management systems, air handling units, lighting systems, combined heat and power units, and pool filtration systems.
- It is expected to save £10.1m over 10 years, and the contract stipulates that if the council does not make energy bill savings, the contractor pays.

Carbon Savings

- ✓ The improvements are expected to generate over 934 MWh of electricity savings and around 2.14 GWh of gas savings per annum (equivalent to approximately 620 tonnes of CO_2e).

2.2 Decarbonising Heat in Buildings

Once insulated, to further reduce their carbon emissions buildings must use heat sources that produce no greenhouse gases, meaning fossil fuel systems must be replaced with low carbon alternatives. It is often the case that insulation measures are critical to facilitate low carbon heating technologies being installed.

The UK government has identified heat pumps as the most widely applicable technology to achieve building heat decarbonisation.[6] Heat pumps work by capturing energy from the air, ground, or water and transferring this to buildings, using electricity to drive this process. The use of electricity as the power source enables heat pumps to operate with zero emissions, as long as the electricity is renewable.

For the purposes of forecasting reduction opportunities, it has been assumed that air source heat pumps (ASHPs, heat pumps that absorb heat from the surrounding air) are implemented across the building portfolio. When compared to ground or water source heat pumps, ASHPs are often the most suitable for retrofit as in most cases they do not require substantial engineering works. As in the Energy Efficiency in Buildings section, the scenarios assume a variation in the numbers of buildings for which these measures can be installed, as shown in Table 2-5.

[6] Committee on Climate Change (2019) *Net Zero Technical Report*, May 2019, https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf

Table 2-5: Potential for Heat Pump Installations: Domestic

	Scenario 3	Scenario 2	Scenario 1
Buildings retrofitted (from Table 2-4)	59%	77%	90%
Building suitability for heat pump installation	95%	97%	98%
Overall stock that can be changed	56%	75%	88%

When moving to implementation, it will be necessary for H&F to review the most suitable renewable heat source for each individual building for cost effectiveness, technical applicability and carbon reduction potential. In some instances, it may be that ground or water source heat pumps are more suitable than air source heat pumps. Centralised energy solutions may be most appropriate for larger buildings and blocks of flats, and there may also be opportunities for heat networks to be installed, which provide efficiency savings and could be powered using heat pumps.

Further, where heat pumps are installed, it may also be necessary to alter radiator systems (to those with larger surface areas) so that the lower-temperature output of heat pumps does not reduce the ability to heat buildings to required temperatures. For this reason, it is even more critical that H&F review heating upgrade options from a 'whole building' perspective.

It should be noted that these recommendations are made without consideration of potential changes to future building regulations, which may or may not impact upon the feasibility of the building heating measures, and other measures, presented in this report.

Case Study: Energy Performance Contracts, Peterborough City Council

- A new heating system in a council owned sheltered housing property in Maidenbower, West Sussex
- They installed a 70kW water source heat pump to replace the two existing boilers, alongside a brand-new backup boiler, a new radiator programme and a complete plant room upgrade
- A project of this size will earn c£8,000 per annum in Renewable Heat Incentive payments for 20 years, and the fuel cost saving will be approximately 10%

Carbon Savings

- ✓ The improvements are expected to generate over 934 MWh of electricity savings and around 2.14 GWh of gas savings per annum (equivalent to approximately 620 tonnes of CO_2e).

2.3 Procuring Green Electricity

Energy consumers can switch to ‘green’ electricity tariffs, offered by energy companies who buy certificates showing that this electricity has come from renewable sources, or procure electricity directly from renewable power installations. Theoretically, increasing demand for this type of tariff raises the price of renewable certificates, thus boosting investment in low carbon energy sources and driving further grid decarbonisation.

Purchasing electricity through a green tariff will make a substantial contribution to reducing emissions when using a market-based system of carbon reporting.[7]

2.4 Solar PV

H&F may also invest in its own renewable generation capacity. This would have several benefits:

- Installing renewables is a very visible demonstration of low carbon ambitions;
- Overall electricity consumption from the grid would decrease; and

[7] The GHG Protocol requires two forms of carbon reporting when renewable energy is purchased. The ‘location-based’ method uses a grid-average emissions factor for electricity reporting. The ‘market-based’ method uses the carbon intensity of your specific energy tariff. When purchasing a green energy tariff, electricity emissions can be considered to be zero in the market-based reporting method.

- Carbon emissions would fall as a result.[8]

For the purposes of this analysis, it has been assumed that rooftop solar PV arrays are the only renewable energy generation technology appropriate for H&F. Not all properties have roofs that are suitable for solar PV: smaller residential properties must have a roughly south facing, slightly sloping roof. The method used to determine a total number of eligible roofs in the H&F estate is detailed in Section A.1.2.3., finding that there is the potential for the production of approximately 5,984 MWhr per year of electricity.

Within the emission reduction forecasting model, it is assumed that when using either procured green electricity, or self-generated green electricity, emissions from electricity consumption are zero.

The modelling has assumed that electricity generated by installed PV is consumed by the council's commercial properties. In reality there are a number of potential ways in which this electricity could be consumed, one option being direct consumption by social housing tenants, creating additional impact in an area the council has very limited control over. This approach may be interesting for the council and could be explored in more detail as part of ongoing work.

[8] When using a green tariff for all of H&F's electricity consumption and using the market-based method for carbon accounting (see footnote 8), production of solar PV may not contribute to a reduction H&F's own emissions because these are considered zero. However, under the location-based method, emissions would be reduced because the electricity purchased from the grid, and the associated emissions, are reduced.

Case Study: Banister House Solar, Hackney

- The UK's largest social housing community energy scheme.
- Solar panels installed on 17 of the blocks of flats that make up Banister House.
- Raised £142,000 for the scheme with Hackney Council, Repowering London, Banister House Solar and Hackney Energy.
- Trial with Verv to enable residents to generate, store and trade their own community energy

Carbon Savings

✓ 38 tonnes of CO_2 saved annually.

Community Benefits

- 14 young people took part in a 30-week paid work experience programme to learn about the co-operative business model and fitting energy efficiency measures.
- Sharing clean energy at affordable prices.

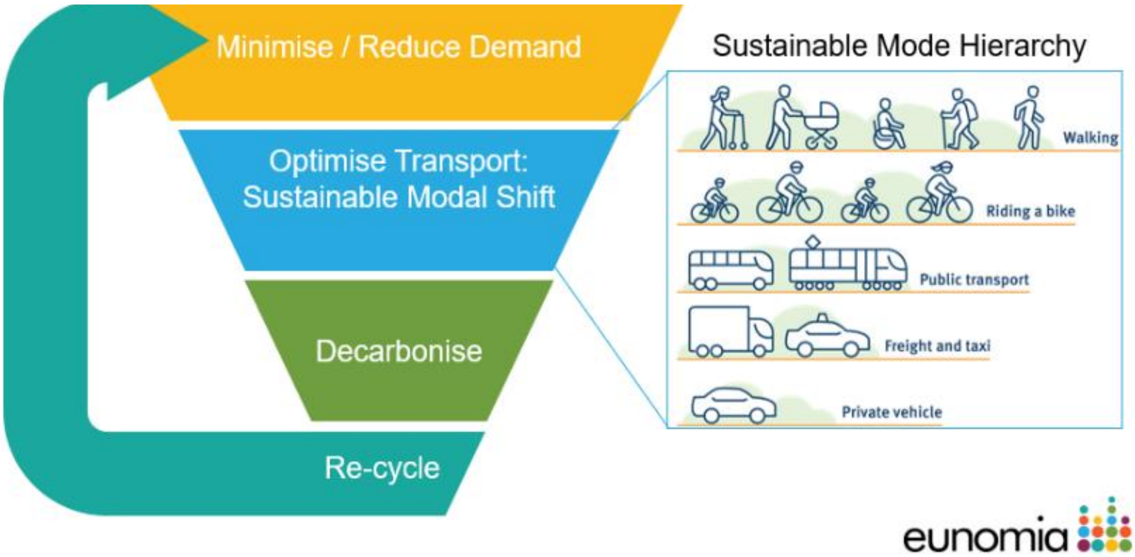
2.5 Electrifying Commercial Transport

Commercial transport includes refuse collection, estate management and the provision of a variety of other services. It is responsible for 1,747 tCO_2e (3%) of H&F's corporate carbon footprint (and 2,163 tCO_2e including scope 3 emissions; 2% of the total footprint). There are several ways to reduce this contribution, and the ideal order of action should be informed by the Travel Hierarchy which is shown in Figure 2-2. In the first instance opportunities to reduce demand for vehicles should be pursued, followed by shifts to active travel modes (walking and cycling) where appropriate, and could allow H&F to save money by reducing the number of vehicles required.

Once travel reduction has been achieved, H&F's fleet must be converted to low carbon vehicles to reduce carbon emissions as far as possible. The electric vehicle market is developing quickly, and alternatives to petrol/diesel can be found for cars, vans and buses, however there are not yet electric alternatives for all vehicle types.

Within our reduction modelling, the low carbon shift included for commercial vehicles is electrification. It has been assumed that the council will have optimised the fleet make-up to a reasonable extent already. Given that it is unlikely all vehicles will have viable electric replacements, none of the scenarios assume 100% electrification, and leave some residual emissions.

Figure 2-2: Travel Hierarchy



For commuting, our modelling assumes some shifts to active travel (as this is likely to be more feasible for commuting), as well as some journeys changing to electric vehicles. Similarly to commercial vehicles, the scenarios assume that not all journeys are completely 'green' in any scenario, and some residual emissions remain even in the highest ambition scenario.

Vehicles can be replaced in a rolling fashion, as they near the end of their lives. Electric vehicles have substantial embodied carbon footprints (the greenhouse gases that were emitted during the production of the vehicles themselves—not modelled in this work), and it is therefore critical from an environmental perspective to minimise embodied emissions by replacing fossil fuel vehicles at the appropriate point. However, it has been noted that the authority has ambition to electrify the fleet by 2022, and this has formed the foundation of modelling.

An important consideration for transitioning to electric vehicles is the required charging infrastructure. Some smaller cars may be able to share a charging point, with smart scheduling in combination with rapid charging devices allowing service delivery to remain largely unchanged. In other cases, like buses and electric refuse collection vehicles (eRCV), it may be more applicable to install one charging point per vehicle and charge overnight. In addition, it be necessary to undertake a large-scale upgrade of electricity infrastructure at vehicle depots to enable potentially hundreds of vehicles to be charged.

The best charging infrastructure set-up must be determined by a more detailed analysis of H&F's fleet requirements and the infrastructural constraints at depots. The costs associated with these changes depend on the charging infrastructure implemented and this analysis goes beyond the scope of this work. Estimates for the infrastructure costs per vehicle have been derived from similar case studies.

Case Study: Electric Vehicle Roll Out, Nottingham City Council

- Goal of converting 22% of fleet to Ultra Low Emission Vehicles by 2022
- Have achieved 50 ULEVs, including electric street sweepers, refuse collection vehicles cars and vans
- Some sources suggest electric refuse collection vehicles have a 10-year life span—to a petrol vehicle's seven

Carbon and Cost Savings

- ✓ A current Euro 6 diesel engine RCV generates 27 tonnes of CO_2 each year. That's 270 tonnes of CO_2 over the lifespan of an electric bin lorry that would be saved by switching.
- ✓ The fuel savings for each vehicle will be about £10,000 per year, on top of the cheaper maintenance costs saving an additional £6,000 per year.

2.6 Decarbonising Commuting

The carbon emissions of H&F's employees' commuting are estimated as 258 tCO_2e per year. This is a small contribution, however encouraging reductions in employee carbon emissions is an important way to demonstrate ambition and empower alternative stakeholders to contribute to wider decarbonisation efforts. Supporting the reduction of commuting carbon emissions through promoting active travel may be preferable because of the health and cost co-benefits that brings, but ride sharing, public transport and e-scooters also have much lower carbon footprints than driving and can be used to reduce the carbon footprint of commuting.

Due to a lack of H&F-specific staff commuting data, a generic London dataset was used to reach the emissions estimation of 258 tCO_2e per year. Carbon reductions were modelled by estimating that 50% of those that currently drive to work could switch to other low carbon alternatives.

Case Study: Beat the Street active travel game, Colchester Borough Council

- A two-week program which rewarded local residents with points and prizes for exploring the town on foot or by bicycle
- In total, more than 13,000 residents took part, running, walking and cycling almost 100,000 miles over the seven weeks

Social Benefits

- ✓ The proportion of people reporting as inactive (doing 0-30 minutes of exercise in the past week) decreased from 12% to 8%
- ✓ The proportion of adults walking or cycling for travel for 10 minutes or longer, on five or more days in the past week, increased from 65% before Beat the Street to 68% immediately after

2.7 Potential Challenges to Implementation

There is substantial opportunity for H&F to achieve emission reductions through each of the actions described above. However, there will also be many challenges to overcome, and it is important that the council be aware of these during this planning stage. These challenges are summarised in Table 2-6; where challenges cannot be overcome, emissions will continue, falling into the category of the council's footprint that will need to be offset from 2030 to achieve the Net Zero goal.

Table 2-6: Potential Challenges to Implementation

Low Carbon Action Area	Potential Challenges
Building Energy Efficiency and Heating	Installing energy efficiency measures is likely to cause disruption to building use in the H&F portfolio. There may be periods where buildings cannot be used during retrofit works and alternative properties will have to be identified. Within the social housing portfolio, necessary consent will be required from residents to proceed with retrofit works. In addition, where social housing exists alongside leasehold dwellings in buildings, the necessary consent of other residents will also be required. The necessary low carbon heating solutions will vary by building; some technologies are not appropriate for certain buildings. For example, ASHPs may not be suitable for larger buildings, where GSHPs or connection to a heat network may be more appropriate. Some solutions require more substantial building work, such as Ground Source Heat Pumps or Heat Networks. The necessary work may cause wider disruption to local transport networks and local amenities.
Green Electricity	Installation of on-site generation via Solar PV may involve invasive building works, but this is unlikely to be a major challenge. More complex energy procurement, for example entering into Power Purchase Agreements, may require coordination with other purchasers and take time to reach agreements.
Vehicle Fleet	The extent of vehicle electrification may be limited by: - The required mileage per charge of vehicles and the technical constraints of current electric vehicles - The extent of charging infrastructure required to service the fleet - The availability of suitable electric replacements for larger vehicles such as trucks and buses With regard to larger vehicles, it is likely that a greater variety of options for alternative fuel replacements will be available in the coming years. These may be electric, or hydrogen fuel may become more widely adopted for larger vehicles.

Low Carbon Action Area	Potential Challenges
Commuting	Decarbonising commuting may be limited by the availability of low carbon public transport, and there may always be some need for private, fossil fuelled vehicle travel. The commuting requirements of officers may not be suited to low carbon transport types, depending on where officers live and the availability of alternative transport modes.

2.8 Additional Considerations

2.8.1 Embodied Carbon

As well as the 'operational' carbon emissions considered in this report, all new technologies and infrastructure include embodied carbon emissions – i.e. emissions produced during their production. These emissions would be accounted for in the scope 3 emissions of future council emission assessments. Given the need to upgrade infrastructure to reduce, and where possible eliminate, operational carbon emissions, it is inevitable that there will be an increase in embodied carbon emissions delivered through the measures suggested in this report. However, to minimise these emissions as far as possible, it is recommended that existing assets are used to the end of their operational lifespan, where this is compatible with H&F's 2030 deadline. For example, fossil-fuel vehicles should not be prematurely retired if they have useful lifespan left. There will be trade-offs between maximising the lifespan of some assets, and the necessity of making infrastructure upgrades, and in these instances there will need to be a degree of judgement exercised by H&F.

2.8.2 Behaviour Change

The emission reduction modelling undertaken for this report has focussed on the impact of technology changes and upgrades to infrastructure. It may also be possible to reduce emissions by achieving behaviour change amongst officers, members and residents. These actions may include things like turning off lights, or turning down thermostats. These types of action have not been included within the modelling, as the potential to achieve them is difficult to estimate, and their potential impact is likely to be of a lower order of magnitude than changing physical infrastructure. However, it is a limitation of this research, and should behaviour change be achieved in any substantial manner, it may reduce the scale of implementation required by the council.

3.0 Carbon Balancing

The measures implemented by 2030 will not reduce H&F's carbon emissions to zero. Under the Orange (lower ambition) scenario there will be a residual carbon footprint (not including emissions from domestic electricity for accounting reasons) of 20,681 tCO_2e, Purple (high ambition) 14,269 tCO_2e, and Yellow (close to ideal) 9,760 tCO_2e—any residual footprint must be balanced for H&F to be Net Zero by 2030.[9]

Carbon balancing/offsetting (these terms can be used interchangeably) involves paying a third party to sequester greenhouse gases (broadly, to use plants or soil to absorb carbon dioxide from the atmosphere and store it), or to not emit carbon emissions that would have been produced without the payment.

Given the Borough's location, there is little space for meaningful sequestration activity within H&F land beyond a small amount of tree planting in urban areas or parks. Instead, it is likely that H&F will have to invest in carbon offsetting projects outside of the Borough to balance the residual footprint in 2030.

Conventional practice (by national governments or companies) has been to purchase carbon credits from projects in other countries. This means the UK has a very small number of carbon balancing projects, and little governance around how organisations should carbon balance in the UK. However, international carbon balancing is unlikely to be 'best practice' for local authorities over the next decade. There are two reasons for this:

1) International rules governing carbon balancing are changing, and are likely to make it easier to carbon balance in the UK; and
2) Local authorities will want to deliver maximum benefit for UK residents from their carbon balancing payments, rather than send that money abroad.

Therefore, H&F may want to begin thinking about how it can start building a carbon balancing programme that would support UK projects. This could involve supporting:

- Existing carbon balancing projects in the UK like those participating in the Woodland Carbon Code or the Peatland Code, which involve restoring and managing woodland or peatland in such a way that carbon dioxide is sequestered; or
- Residents to decarbonise their homes, for example by (part-) funding the installation of low carbon heating systems like heat pumps or installing insulation. Several factors must be considered like the 'additionality'[10] of such a programme and how many carbon credits it could plausibly claim, however there are also diverse co-benefits like helping drive the decarbonisation agenda within

[9] These values do not include the Scope 3 emissions from procured goods and services, as these largely fall outside the council's control.
[10] Offset funding brings additionality when it is shown the project would not have happened without it.

the Borough, as well as helping residents save fuel costs and live in more comfortable homes. This would be a new approach to carbon balancing in the UK and would require research and development; or

- Novel offsetting approaches in the UK like re-wilding (the restoration of natural habitats, allowing species to return) or sustainable agricultural practices like agro-forestry, whereby trees and produce are grown together to enhance carbon dioxide uptake and slow soil degradation. The use of such approaches to produce carbon offsets is new and requires further research; the extent of carbon sequestered, costs, additionality considerations, and other co-benefits are not yet fully clear and further development funding is required.

Table 4-6 shows indicative costs of carbon balancing residual carbon emissions totalling 5,000, 10,000 and 20,000 tCO_2e in 2030 (approximately the scale of offsetting required under the three scenarios modelled in this report). Three pricing scenarios are presented: where offsetting a tonne of CO_2e costs £3 (the approximate current international carbon credit price), £10 (the approximate current UK carbon credit price) and £81 (HM Treasury's central estimate for a carbon price in 2030). Depending on the scenario, balancing costs will total in the range £10,000s to £1,000,000s.

4.0 Estimated Costs

The scale of infrastructure upgrades required to meet H&F's Net Zero goal is substantial and the costs associated with achieving this transition can be presented in multiple ways.

This analysis is split into three sections:

1) **Total capital costs**. This section outlines the capital costs required under each of the three scenarios modelled. These costs take into consideration the capital and installation costs of the modelled measures, and can be thought of as the 'up-front cost' of achieving Net Zero. These can, of course, be funded through borrowing, spreading costs over time, but the full costs are presented here for clarity.
2) **Net capital costs**. It is fair to assume that over the next decade investment would still be required to maintain buildings and replace vehicles and other infrastructure. This will therefore comprise some of the funding for the proposed low or zero carbon changes. Comparing these 'business as usual' estimated costs with the expenditure on technologies required for the Net Zero transition enables identification of the potential funding gap, or 'net capital costs'.
3) **Operational savings**. This section is concerned with the savings associated with operating the implemented measures compared to the business as usual situation, for example the saving in heating associated with energy efficiency measures, or the saving in fuel costs from moving to cycling from driving. These operational savings are assessed qualitatively to indicate their likely scale and the beneficiaries. Where they accrue to the council it is possible to quantify these to an extent and this is provided in the analysis.

This section addresses all of the eight measures identified in the analysis, but each has a different cost and saving dynamic. The broad picture is presented in Table 4-1. As can be seen there are two measures that do not have capital costs associated with them: Implementation of a green tariff; and encouraging a shift in commuting behaviour. As these do not have capital costs associated with them, they are not included in the subsequent capital cost analysis.

All of the measures have the potential for operational savings for either the council or other stakeholders, and therefore all of these are considered in the operational savings assessments.

Table 4-1 Measures Included in Cost Assessments

Measure	Is there a capital cost to the council?	Is there a potential operational saving for the council?	Is there a likely operational saving for other stakeholders?
Energy Efficiency - Domestic	✔ Included in cost modelling	✘	✔
Energy Efficiency - Commercial	✔ Included in cost modelling	✔	✘
ASHP – Domestic	✔ Included in cost modelling	✘	?
ASHP – Commercial	✔ Included in cost modelling	?	✘
Green Tariff	✘ Excluded from cost modelling	?	✘
Vehicle Electrification	✔ Included in cost modelling	✔	✘
Solar PV	✔ Included in cost modelling	✔	?
Commuting shifting to active travel	✘ Excluded from cost modelling	✘	✔

Following the sections considering capital and net costs, an assessment of potential ongoing costs associated with carbon offsetting are presented to complete the costs analysis.

In line with the objectives of this report, all sets of costs are intended to be initial estimations to guide the initial stages of H&F's Net Zero planning. Further detailed assessments will enable these costs to be refined. Indeed, many of the short-term recommendations within the action plan in Table 1-1 focus on receiving quotations from suppliers to refine cost estimations.

4.1 Total Capital Costs

The three scenarios modelled lead to different capital costs to H&F. This depends on the level of ambition and technical feasibility of implementation, and hence the quantities of equipment and infrastructure that need to be purchased and installed. The total cost of investment required until 2030, including capital and installation costs of each scenario, is shown in Table 4-2. Four measures are presented for each scenario. These are:

- **Commercial buildings** – commercial energy efficiency and commercial low carbon heating combined
- **Domestic housing** – domestic energy efficiency and domestic low carbon heating combined
- **Commercial transport**
- **Solar PV**

The two measures excluded are green tariff and commuting change as neither of these incur a capital expenditure.

The Business-as-Usual costs are calculated based upon the replacement of each boiler and commercial vehicle, once within the time period, corresponding to a lifetime of roughly 10 years.

Table 4-2: Estimated Total Capital and Installation Costs by Scenario

Scenario	Measure	Estimated Capital and Installation Cost	Estimated Total Capital and Installation Cost for each scenario
Scenario 1 – Yellow [Close to ideal]	Commercial Buildings	£25 million	£303 million
	Domestic Housing	£259 million	
	Commercial Transport	£19 million	
	Solar PV	£7 million	
Scenario 2 – Purple [Higher Ambition]	Commercial Buildings	£22 million	£259 million
	Domestic Housing	£221 million	
	Commercial Transport	£16 million	
	Solar PV	£3 million	

Scenario	Measure	Estimated Capital and Installation Cost	Estimated Total Capital and Installation Cost for each scenario
Scenario 3 – Orange [Lower Ambition]	Commercial Buildings	£17 million	£196 million
	Domestic Housing	£165 million	
	Commercial Transport	£13 million	
	Solar PV	£0 million	
Business-as-Usual	Commercial Buildings	£4 million	£58 million
	Domestic Housing	£43million	
	Commercial Transport	£11 million	
	Solar PV	£0 million	

4.1.1 Scenario 1

This Scenario has the highest level of ambition and involves implementing each measure in full and enacting relatively early. The required capital spend on equipment and installation is shown in Figure 4-1.

Domestic and Commercial Buildings

Purchasing and installing energy efficiency improvements and ASHP's in the domestic housing stock is by far the largest cost to H&F, approaching £38 million per year between 2025 and 2027. This equates to energy efficiency measures and ASHPs being installed in just over 2,000 homes per year. These costs are high primarily because of the large number of households that would need to be retrofitted and have ASHPs installed.

The costs on these measures only commence in 2023, reflecting the fact that the current 4-year asset management horizon is fully planned already. It has been assumed that there is nonetheless some flexibility towards the end of this window, in 2023.

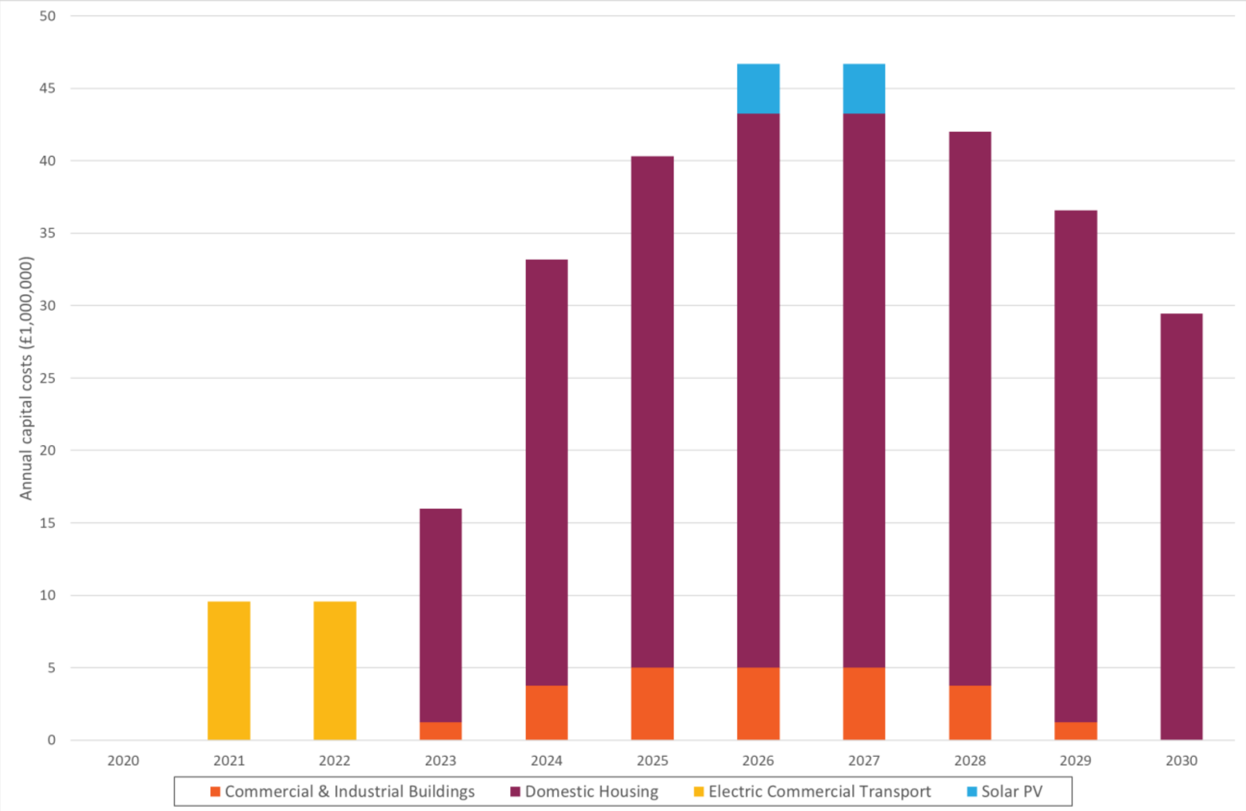
Solar PV

In 2026 and 2027, solar PV arrays are installed at full capacity on both the domestic and commercial housing stock.

Commercial Fleet

The entirety of the vehicle fleet is electrified and charging infrastructure installed as per the council's target of 2022, leading to significant up-front spend.

Figure 4-1: Capital and Installation Costs in Scenario 1



4.1.2 Scenario 2

In the moderate ambition level modelled in Scenario 2 and shown in Figure 4-2, the overarching patterns in investment is similar to Scenario 1, except with lower costs (and lower GHG emissions reductions).

Domestic and Commercial Buildings

The majority of investment is required for the purchase and installation of energy efficiency retrofits and ASHPs in H&F domestic housing stock. This commences in 2023 towards the end of the current asset management horizon, and is concentrated towards the latter years of the decade. The retrofitting of commercial buildings for energy efficiency, and subsequent installation of ASHPs follows a similar path.

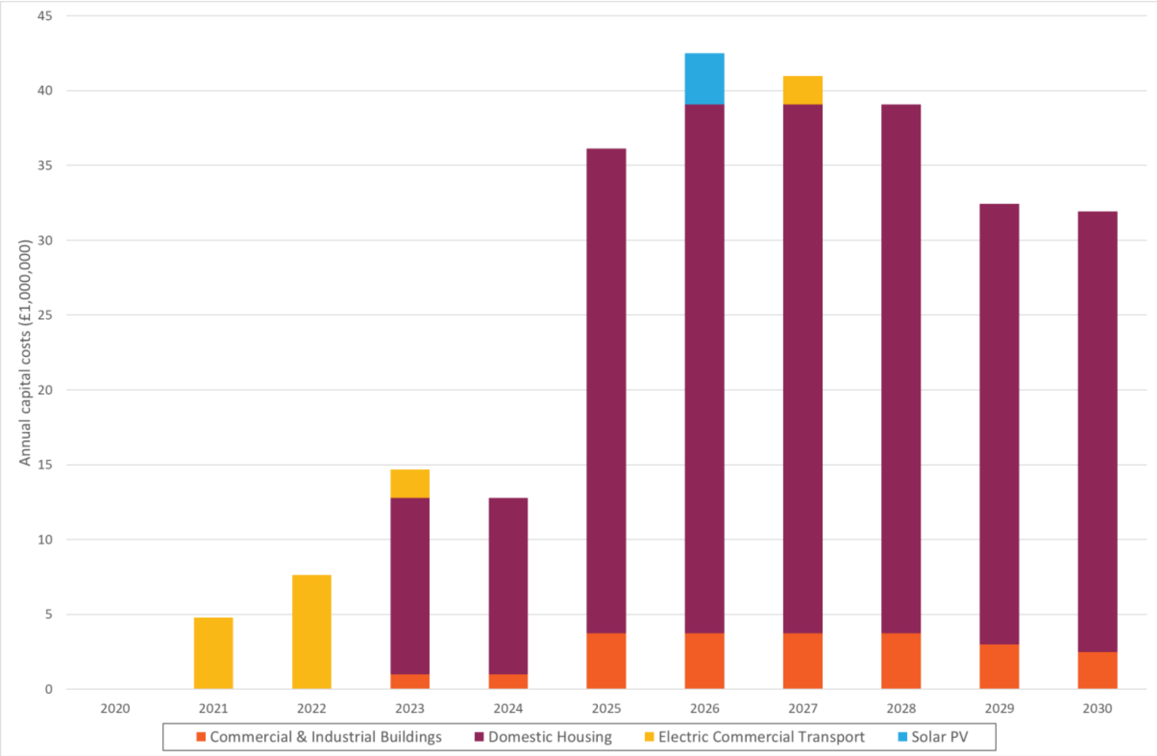
Solar PV

Here there is installation of Solar PV in 2026 – the scale is less than Scenario 1.

Commercial Fleet

The bulk of the investment required to electrify H&F commercial vehicle fleet and install charging infrastructure is taken in 2021 and 2022 reflecting the current target of 2022, with some overspill into 2023. For those vehicles that cannot be electrified, there is additional purchase of newly available vehicles later in the decade.

Figure 4-2: Capital and Installation Costs in Scenario 2



4.1.4 Scenario 3

Scenario 3, shown in Figure 4-3, has low ambition and opportunity for change, and as a result the capital costs and costs of installation are relatively low. None of the years would require an investment greater than £30 million, and until 2024 no investment greater than £5 million would be required.

Domestic and Commercial Buildings

It is assumed in this scenario that there is no scope to invest in the current four-year asset management horizon, and the subsequent investment follows a gentle curved profile.

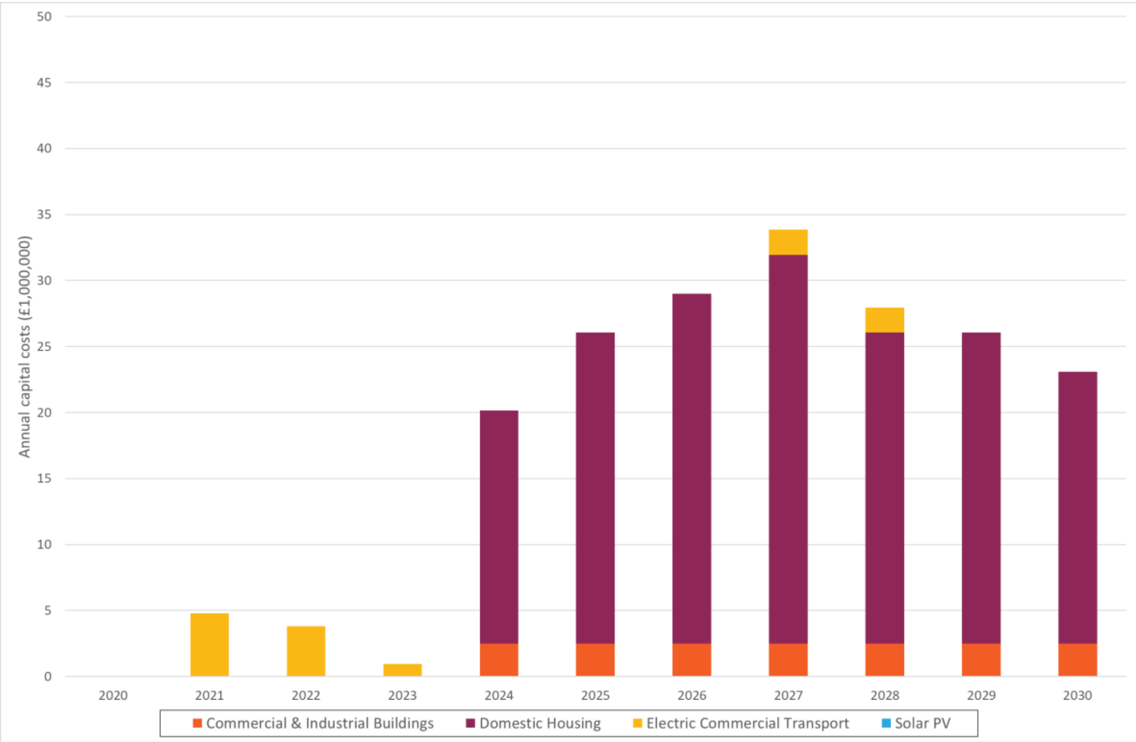
Solar PV

There is no solar PV installed in this scenario.

Commercial Fleet

The bulk of the investment required to electrify H&F commercial vehicle fleet is taken in 2021 and 2022 reflecting the current target of 2022, with some overspill into 2023. For those vehicles that cannot be electrified, there is additional purchase of newly available vehicles later in the decade.

Figure 4-3: Capital and Installation Costs in Scenario 3



4.2 Net Capital Costs (Comparison to Business-as-Usual)

Whilst there will be upfront capital costs associated with implementing the necessary low carbon technologies, it should be recognised that not all this spend is additional. This section presents an estimate of the 'net capital costs' of decarbonising the council's activities by comparing to a business-as-usual scenario.

Estimates for the total capital cost of each scenario in comparison to a 'business-as-usual' case are displayed in Table 4-3 below. The business-as-usual scenario assumes:

- Buildings would have boilers replaced with fossil fuel versions; and
- Vehicles would be replaced with fossil fuel versions.

The cost difference for capital and installation is the difference between each scenario and the business-as-usual case, taken from Table 4-2. The total (gross) capital costs are included as a comparison.

Table 4-3: Estimated Difference in Costs in Comparison to Business-as-Usual

Scenario	Net Capital Costs[11]	Total Capital Costs
Scenario 1	£245 million	£303 million
Scenario 2	£202 million	£259 million
Scenario 3	£138 million	£196 million

[11] Net capital costs: Capital & Installation Cost minus Business As Usual Capital Spend

4.3 Operational Savings

It is important to consider that whilst the costs in Table 4-2 include upfront capital requirements, over the longer-term there is potential for the council to reap savings due to reduced energy and maintenance costs. Calculating these accurately is extremely challenging given the potential for energy costs to change over time, and the relative efficiencies of different technologies to shift over time. However, Table 4-4 provides an indication of where savings may be generated over time, based on current market dynamics. We recommend that the potential savings from recommend measures are assessed in detail as part of the council's financial planning for the Net Zero agenda.

Table 4-4: Potential Savings from Low Carbon Measures

Measure	Potential Operational Savings	Beneficiaries of Savings
Commercial energy efficiency	Energy efficiency measures in isolation would deliver a saving to the council with regard to energy spend due to reduced fuel/power consumption associated with operating heating systems. Energy efficiency measures tend to require minimal upkeep and therefore the savings are not reduced.	Council
Commercial low carbon heating	The costs of running a heat pump compared to conventional heating depend on the extent to which a building is insulated and the relative prices of electricity and heating fuels. In broad terms the costs are currently of the same magnitude so no saving is anticipated in the short term, but should the council generate its own electricity or similarly reduce the cost of electricity this would provide a saving.	Council
Domestic energy efficiency	Similar to commercial buildings, energy efficiency measures would deliver energy cost savings if implemented in isolation due to reduced fuel/power consumption to reach the same temperatures. Alternatively, in fuel poor households it may lead to an increase in mean temperatures instead of a fuel saving as they were previously unable to pay for adequate heating.	Residents of domestic dwellings
Domestic low carbon heating	As for commercial low carbon heating, the operational costs are currently largely similar, but will change in future as prices change.	Residents of domestic dwellings

Measure	Potential Operational Savings	Beneficiaries of Savings
Vehicle electrification	At present the operational costs of electric vehicles are lower than for fossil-fuel counterparts due to the cost of fossil fuels for transportation compared to electricity (in part due to fuel duty). Should the council generate its own electricity, this would be amplified. It is also anticipated that maintenance costs for electric vehicles will be noticeably lower than for fossil-fuel equivalents due to the removal of combustion from within the vehicle, which should also reduce operational costs[12].	Council
Solar PV installation	Based on savings on electricity bills, the installation of solar PV is likely to re-coup costs over the mid to long term (circa 15 years). Whether this saving is reaped by the council depends on who derives the benefit on the installed solar capacity – tenants, other organisations such as schools, or the council's own buildings or electric fleet.	Depends on recipient of energy

An initial analysis of the potential operational savings ***to the council*** was conducted based on a comparison of the energy and maintenance costs of the new technologies against the equivalent costs in the business-as-usual case. This is shown in Table 4-5. The net capital costs are shown for comparison.

Table 4-5: Operational Savings for the Council

Scenario	Net capital costs	**Net operational savings** Positive **values are net savings, cumulative over the next decade**
Scenario 1	£245 million	£11.2 million
Scenario 2	£202 million	£8.1 million
Scenario 3	£138 million	£4.6 million

[12] For example, see https://www.edfenergy.com/electric-cars/maintenance

The analysis shows that operating and maintaining low carbon technologies is less costly than for their fossil fuel equivalents. These costs are small compared to the capital expenditure needed to implement them, but they are not insignificant. These cost savings are, however, concentrated in commercial transport, which for example in Scenario 1 would achieve a saving of roughly £7 million up until 2030. This is due to the reduction in costs associated with fuel, and lower Vehicle Excise Duty.

It should be noted that in estimating these cost differences, we have not assumed any future price of carbon associated with ongoing emissions. Should such a price be implemented, this will substantially improve the business case for implementing the measures identified in this report. The offsetting costs presented in section Table 4-6 serve to illustrate potential ongoing costs associated with residual emissions based on a range of future carbon prices.

As highlighted in Table 4-5, there will also be savings accrued to other stakeholders, but these have not been quantified as they are far less certain.

4.4 Offsetting Costs

Indicative costs of offsetting under different price and residual emissions scenarios are shown in Table 4-6. These costs will be borne annually for any emissions that cannot be reduced by the council, and act as an incentive to reduce as far as possible.

Table 4-6: Estimated Costs of Carbon Balancing Per Year

		Price per tonne of carbon balanced		
		£3 (approximate current international carbon credit price)	£10 (approximate current UK carbon credit price)	£81 (HM Treasury central estimate for carbon costs in 2030)
Tonnes carbon to be balanced each year	5,000	£15,000	£50,000	£405,000
	10,000	£30,000	£100,000	£810,000
	20,000	£60,000	£200,000	£1,620,000

A.1.0 Technical Appendix: Assumptions and Methodology

A.1.1 Baseline Carbon Footprint

A detailed breakdown of H&F's carbon footprint is given in Table 4-7.

Table 4-7: Breakdown of H&F's Carbon Footprint by Category, Sub-category and Scope

Category	Subcategory	Scope 1	Scope 2	Scope 3
		Tonnes CO2e/year		
Council Owned Vehicles	**Council Vehicles**	210	0	51
Council Vehicle Subsidiaries	**Idverde**	134	0	32
Council Vehicle Subsidiaries	**CT+**	194	0	46
Council Vehicle Subsidiaries	**Serco**	1,210	0	288
Utilities	**Buildings Owned and Operated (Energy)**	607	1,292	388
Utilities	**Buildings Owned and Leased (Energy)**	205	210	76
Utilities	**Housing (owned) - Communal Areas (Energy)**	0	0	0
Utilities	**Housing - Council Owned Dwellings (Energy)**	22,299	9,329	5,104
Utilities	**Housing - Leasehold Dwellings (Energy)**	7,930	3,414	1,838
Utilities	**Housing - Other Ownership Type Dwellings (Energy)**	685	249	148
Utilities	**Street Lighting**	0	454	107
Utilities	**Buildings Owned and Operated (Water)**	0	0	118

Category	Subcategory	Scope 1	Scope 2	Scope 3
Utilities	**Buildings Owned and Leased (Water)**	0	0	31
Utilities	**Housing (Water)**	0	0	74
Other Council Travel	**Staff Commuting**	0	0	258
Other Council Travel	**Expensed Taxis**	0	0	1,794
Utilities	**Schools**	2,992	1,447	731
Procurement	**Grounds Maintenance**	0	0	860
Procurement	**Capital Spend on Construction Projects**	0	0	3,513
Procurement	**Building Hire**	0	0	15
Procurement	**Building Maintenance and Services**	0	0	2,393
Procurement	**Business Support and Administration**	0	0	1,750
Procurement	**Business or Service User Travel**	0	0	103
Procurement	**Catering Supplies**	0	0	415
Procurement	**Cleaning Supplies**	0	0	75
Procurement	**Clothing, Uniforms and Laundry**	0	0	34
Procurement	**Consultancy**	0	0	3,211
Procurement	**Education**	0	0	2,621
Procurement	**Equipment Hire, Maintenance and Purchase**	0	0	2,031
Procurement	**Healthcare**	0	0	12,008
Procurement	**Highways Maintenance**	0	0	336

Category	Subcategory	Scope 1	Scope 2	Scope 3
Procurement	**Housing Maintenance**	0	0	3,139
Procurement	**Insurance**	0	0	411
Procurement	**IT Services**	0	0	2,409
Procurement	**Legal Costs**	0	0	121
Procurement	**Office Supplies**	0	0	383
Procurement	**Past Service Costs**	0	0	1,249
Procurement	**Pensions**	0	0	403
Procurement	**Postage and Delivery Services**	0	0	81
Procurement	**Social Care**	0	0	25,558
Procurement	**Telephone Networks**	0	0	115

The assumptions made and methods used to estimate H&F's baseline carbon footprint for each sector are detailed in this section. With the exception of procurement, the emissions for each category are calculated using the UK Government's 2019 set of conversion factors for advanced users.[13]

A.1.1.1 Energy in Buildings: Residential

Three separate methods were considered for calculating the electricity and gas consumption of residential properties in the Borough's portfolio.

Method 1: The breakdown of H&F housing by property type (house, maisonette, flat etc.) was provided. The average floor area of these properties was estimated using data from the Mayor of London's Datastore.[14] Government statistics for average gas and

[13] Department for Business, Energy & Industrial Strategy *Conversion factors 2019: full set (for advanced users)*, accessed 15 July 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/847122/Conversion-Factors-2019-Full-set-for-advanced-users.xls

[14] London Datastore *Average Floor Area by Borough*, accessed 14 July 2020, https://data.london.gov.uk/average-floor-area-by-borough/

electricity consumption per m^2 for different property sizes[15] were used to calculate the average energy consumption for each property type, which were summed to give total values for residential electricity and gas consumption.

Method 2: The EPC value of some residential properties in the H&F residential property portfolio were provided, which were assumed to extrapolate to the whole portfolio. Average energy consumption per property values were found for each EPC band from government statistics[16], which were multiplied by the number of properties in each band to find the final gas and electricity consumption values.

Method 3: BEIS publish 'experimental' data on electricity and gas consumption by postcode[17], and data on the location (i.e. postcode) of H&F properties was provided. This can be summed across all properties to estimate a total energy consumption

Method 3 was ultimately excluded because it was deemed that, within a postcode, possible variation in property size and type is too great for an average energy consumption to be reasonably be applied to all properties. However, an initial calculation through this method suggests that it returns a similar result to the other two, validating all three approaches.

Methods 1 and 2 methods were chosen as they offer a replicable approach. However they also rely on their own assumptions which may change in time. Methods 1 and 2 give very similar results and so there is a reasonably high level of confidence in the values produced; we recommend that H&F consider all three approaches if repeating this analysis in future.

A.1.1.2 Energy in Buildings: Schools

Electricity and gas consumption data for some schools was provided for the audit. Future assessments may consider looking at schools in further detail to ascertain clearly what is in and out of scope.

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[15] Department for Business, Energy & Industrial Strategy *National Energy Efficiency Data Framework (NEED): Energy Performance Certificate Analysis*, accessed 14 July 2020, https://www.gov.uk/government/publications/energy-trends-december-2017-special-feature-article-domestic-energy-consumption-by-energy-efficiency-and-environmental-impact-2015

[16] Department for Business, Energy & Industrial Strategy *National Energy Efficiency Data Framework (NEED): Energy Performance Certificate Analysis*, accessed 14 July 2020, https://www.gov.uk/government/publications/energy-trends-december-2017-special-feature-article-domestic-energy-consumption-by-energy-efficiency-and-environmental-impact-2015

[17] Department for Business, Energy & Industrial Strategy *Postcode level electricity statistics: 2018 (experimental)*, https://www.gov.uk/government/statistics/postcode-level-electricity-statistics-2018-experimental

A.1.1.3 Commuting

Commuting modes and distance data were not provided. These were estimated using the total number of full time-equivalent staff (provided), average commuting distance and mode in London[18], and an assumption that staff work from home one day a week, to produce totals for person.km travelled per mode per year. These were then converted to carbon emissions values using standard conversion values.

A.1.1.4 Procurement

Carbon emissions associated with procured goods and services were estimated to provide an indication of the scale of their contribution with respect to Scopes 1 and 2 sources, and are given in Table 4-8.

This estimation was achieved by converting the amount paid for these goods and services to carbon emissions values using conversion factors from the Department for Environment, Food & Rural Affairs/ Leeds University[19] (cleaning supplies, mobile phones), the Department for Environment, Food & Rural Affairs[20] (buildings/ grounds/ highways maintenance, rented buildings, business support and administration, business travel, catering, clothing, consultancy, education services, equipment hire/ maintenance/ purchase, healthcare, insurance, IT services, legal services, office supplies, pensions, postal and delivery services, social care), and HM Government[21] (capital spend on construction).

Total procurement spend data was provided to Eunomia by H&F. Eunomia sorted the data into the following emission categories using their best judgement. The judgement used in this process, combined with the use of spend-based emission factors, means our assessment of emissions arising from procured goods and services can only be considered a best estimate.

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[18] Department for Transport *Modal comparisons (TSGB01)*, https://www.gov.uk/government/statistical-data-sets/tsgb01-modal-comparisons

[19] University of Leeds, and Department for Environment, Food & Rural Affairs *Data download consumption emissions 1997-2017*, https://www.gov.uk/government/statistics/uks-carbon-footprint

[20] Department for Environment, Food & Rural Affairs *Table 13 - Indirect emissions from the supply chain*, https://www.gov.uk/government/statistics/uks-carbon-footprint

[21] HM Government *Environmental reporting guidelines: including Streamlined Energy and Carbon Reporting requirements*, https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance

Table 4-8: The Scope 3 Emissions from Procured Goods and Services

Category	Subcategory	Emissions (tonnes CO2e/year)	Spend (£/year)
Building Hire	Rental and leasing services	15,076	64,166
Building Maintenance and Services	Services to buildings and landscape	2,393,028	9,744,557
Business or Service User Travel	Road Transport	102,693	132,398
Business Support and Administration	Office administrative, office support and other business support services	1,749,525	9,754,921
Capital Spend on Construction Projects	Construction	3,513,081	7,169,554
Catering Supplies	Other food products	414,586	432,977
Cleaning Supplies	Disinfectants, polishes, other cleaning materials, some pest controls	75,476	2,805,160
Clothing, Uniforms and Laundry	Wearing apparel	34,110	50,481
Consultancy	Computer programming, consultancy and related services	3,210,886	18,197,177
Education	Education services	2,621,113	15,727,893
Equipment Hire, Maintenance and Purchase	Machinery and equipment n.e.c.	2,030,620	3,631,884
Grounds Maintenance	Services to buildings and landscape	859,515	3,500,000
Healthcare	Human health services	12,008,331	48,187,754

Category	Subcategory	Emissions (tonnes CO2e/year)	Spend (£/year)
Highways Maintenance	Services to buildings and landscape	336,419	1,369,918
Housing Maintenance	Services to buildings and landscape	3,139,031	12,782,331
Insurance	Insurance, reinsurance and pension funding services, except compulsory social security & Pensions	410,532	2,299,691
IT Services	Computer programming, consultancy and related services	2,409,313	13,654,392
Legal Costs	Legal services	121,249	1,261,201
Office Supplies	Office administrative, office support and other business support services	383,346	2,137,443
Past Service Costs	Office administrative, office support and other business support services	1,248,588	6,961,818
Pensions	Insurance, reinsurance and pension funding services, except compulsory social security & Pensions	402,823	2,256,511
Postage and Delivery Services	Postal and courier services	81,037	231,622
Social Care	Social care services	25,558,227	88,234,017
Telephone Networks	Mobile phone account	114,711	707,630

A.1.1.5 Energy in Buildings: Commercial and Industrial / Commercial Transport / Street Lighting

The relevant electricity and/ or fuel consumption data were provided for: buildings in the corporate estate (including the Linford Christie Stadium); the commercial vehicle fleet; and street lighting. These were converted to associated carbon emissions values using standard emissions intensity values.

A.1.2 Carbon Reduction Measures: Modelling Assumptions

The assumptions and methods used to estimate the potential for carbon emissions reductions are given in more detail here. The measures described can be implemented up to 2030 at different rates; this is reflected in the different forecast scenarios.

A.1.2.1 Energy Efficiency: Domestic, C&I and Schools

For energy efficiency measures, a baseline situation of the national mean was assumed.

Domestic

The average annual savings potential in kWh of cavity wall insulation, loft insulation and draught excluders were found from the National Energy Efficiency Database[22], showing that in an average dwelling these measures would cumulatively reduce heat consumption by 3.5MWh per year—35% of heat consumption

In lieu of more accurate information, it was assumed that 100% of the of the properties owned by the council that fall under its direct control can be accessed to make these interventions where relevant (63% of the portfolio), while only 50% of properties with other leasehold and shared ownership models can be accessed.

C&I and Schools

Approximate energy saving reductions (%) brought about by insulation, double glazing and thermostatic control in non-residential buildings were taken from a report by Building Futures and Sustainability East[23]. This was assumed to be applicable to the entire C&I and school building stock's energy consumption, to arrive at gas consumption savings values, giving a reduction of 30% of energy consumption per m^2.

A.1.2.2 Air Source Heat Pumps: Domestic, C&I and Schools

The electricity input needed by a heat pump was found by dividing the average gas consumption of a house (as estimated in Section A.1.1.1) by a typical coefficient of performance (CoP) of an ASHP of 3.2.

For **domestic** properties, the same assumptions were made when assessing the total number of properties that are eligible to have ASHPs installed as in Section A.1.2.1.

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[22] Department of Energy and Climate Change *Energy Efficiency Statistical Summary*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/65598/6918-energy-efficiency-strategy-statistical-summary.pdf

[23] Building Futures, and Sustainability East *Retrofitting: A guide for non-residential buildings*, accessed 14 July 2020, https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/building-futures/retrofitting-a-guide-for-non-residential-buildings.pdf

The same method was used to convert gas consumption figures for **non-residential properties** to electricity consumption (using the same CoP of 3.2.)

The electricity use could then be multiplied by the carbon factor for the electricity consumed in operation to determine emissions. In the case of solar PV generated electricity or electricity obtained from a tariff this is nil, but otherwise it was set as the grid carbon factor projection for the year concerned. This can then be used to compare with emissions from gas and oil boilers.

A.1.2.3 Solar PV

A breakdown of the residential properties by type (flat, house, maisonette etc.) in the H&F estate was provided; it was assumed that only those properties owned fully by the council are suitable for solar PV installation. An average of 15 flats per block was assumed, which is in concordance with England-wide data.[24] The proportion of residential (25%) and C&I (40-80%, average of 60% was assumed) roofs that are suitable for panels was taken from London-specific data[25], giving an estimate of the total number of residential (1,179) and C&I (50) solar PV systems.

Residential roofs are assumed to use standard 4 kWp systems; due to a lack of data on roof sizes of C&I buildings, average capacity of five times the residential figure were assumed. Assuming an annual capacity factor of 10%, generation of a standard residential roof-mounted 4 kWp solar PV system is approximately 3,500 kWh (with C&I systems producing five times this.)

A.1.2.4 Electrifying Commercial Transport

It was assumed that the entire H&F fleet will be EVs by 2030, and that the total person.kms travelled will not change in that time. Total fuel consumption for both diesel and petrol was provided by H&F. The total vehicle.km travelled by the council's fleet was estimated from these data using fuel efficiency averages for refuse (4 mpg) and commercial vehicles (27 mpg).

The kWh/vehicle.km travelled across all vehicles was taken as an average of 1.12 from industry data[26], and this value was used to calculate the total electricity in kWh that would be needed to power an electric fleet. The emissions savings are the difference between the carbon dioxide emitted when burning diesel and petrol (taken from

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[24] Office for National Statistics (2010) *English Housing Survey*, accessed 15 July 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6748/2173483.pdf

[25] Greater London Authority (2011) *Decentralised energy capacity study*, accessed 15 July 2020, https://www.london.gov.uk/sites/default/files/de_study_phase1.pdf

[26] See https://insideevs.com/news/340380/mercedes-benz-delivers-first-10-eactros-electric-trucks/ and https://www.mercedes-benz.co.uk/vans/en/e-vito-panel-van/technical-data

standard government conversion values[27]) in vehicle engines and that emitted when produced electricity (which is modelled as nil under a green electricity tariff).

A.1.2.5 Low Carbon Commuting

It was assumed that a maximum of 50% of those who currently commute to and from work by car can switch to other modes of transport, and that those who switch move equally to bus, train, London Underground, bicycle and walking. The emissions associated with those modes of transport are taken from government statistics.[28]

[27] Department for Business, Energy & Industrial Strategy (2019) *Greenhouse gas reporting: conversion factors 2019*, accessed 18 September 2019, https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

[28] Department for Business, Energy & Industrial Strategy (2019) *Greenhouse gas reporting: conversion factors 2019*, accessed 18 September 2019, https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

A.1.3 Carbon Reduction Measures: Costing Assumptions

The analysis comprised two strands:

- Capital and installation costs; and
- Operational costs (and savings)

Each of these is addressed for each measure as follows.

A.1.3.1 Energy Efficiency: Domestic, C&I and Schools

The energy efficiency improvements modelled in the emissions reduction pathways used a combination of wall insulation, loft insulation and draft proofing. The average **capital and installation** cost per household and per m^2 were calculated for each energy efficiency measure. For wall insulation a combination of cavity, solid, and party cavity insulation was assumed to be installed in the building stock whilst for loft insulation a combination of insulation at the joists and rafters was assumed. The cost estimates for each of these measures were based upon assumptions used in BEIS energy efficiency modelling,[29] and were calculated to be £6,600 per household and £82 per m^2.

The **operational costs and savings** associated with the measures were assessed based on the reduced demand for heat associated with these measures as discussed in A.1.2.1. The actual operational costs of the measures themselves were assumed to be close to nil due to the minimal maintenance required.

A.1.3.2 Low Carbon Heating – Air Source Heat Pumps: Domestic, C&I and Schools

For **capital and installation costs**, the average costs of an ASHP were calculated on a per household and per m^2 basis. This includes the equipment cost of the ASHP, any upgrades that would need to be made to the distribution system, and costs of installation.

The cost of equipment was calculated by taking the median from a range of sources. It was assumed that each room in a house would require either a large or ventilated radiator. The costs of installing the heat pump and radiators were estimated using literature sources and our own internal low carbon heating experts. The total 'one off' costs were calculated to be £10,830 per household and £129 per m^2.

For **operational costs**, the maintenance costs assume that units would be checked by a professional installer once every 3 – 5 years. To calculate the ongoing energy costs, the annual electricity consumption from the emissions reductions modelling was combined

[29] BEIS (2017) *What does it cost to retrofit homes?*, accessed 19 August 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/656866/BEIS_Update_of_Domestic_Cost_Assumptions_031017.pdf

with the standard commercial and domestic electricity costs. The ongoing costs were calculated to be £437 per household per year and roughly £7 per m^2 per year.

A.1.3.3 Electrifying Commercial Transport

H&F provided a breakdown of their commercial fleet, which were then assigned to vehicle category types such as cars, large vans, or refuse vehicles, amongst others. For each vehicle category, typical purchase costs of fossil fuel vehicles in each category and their electric equivalents were researched and from which the total **capital costs** of the fleet in each case calculated. A range of costs were researched for the capital costs of charging infrastructure. It was assumed that one charging point would be needed per large vehicle (e.g. bus) and only 80% of small vehicles would require charging points. The modelled cost of a large overnight charging point was £18,000 and a small charging point £2,000.[30,31]

For **operational costs**, the costs of commercial vehicles were assumed to include annual maintenance costs of £0.035/km and costs arising from fuel or electricity consumption.[32]

A.1.3.4 Solar PV

In order to estimate the **capital costs** of installation of solar PV panels across H&F's commercial and housing stock, the capital costs of a standard 4kW solar array were used. Assuming 4 hours of sunlight per day, the anticipated solar capacity of the array was calculated, from which a cost per MWh of electricity generation was estimated.

For **operational costs** it was assumed that the maintenance costs of the solar PV panels would be minimal, and there were no energy costs resulting from their use.

A.1.3.5 Low Carbon Commuting

The costs of a change to lower carbon commuting is a cost born by H&F employees rather than a cost to H&F specifically, and as such any costs arising from this measure have not been incorporated into the results.

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[30] Lajunen, A., and Lipman, T. (2016) Lifecycle cost assessment and carbon dioxide emissions of diesel, natural gas, hybrid electric, fuel cell hybrid and electric transit buses, *Energy*, Vol.106, pp.329–342

[31] *The Costs of Revving Up the Grid for Electric Vehicles*, accessed 20 August 2020, https://www.bcg.com/en-gb/publications/2019/costs-revving-up-the-grid-for-electric-vehicles

[32] Earl, T., Mathieu, L., Cornelis, S., Kenny, S., Ambel, C.C., and Nix, J. (2018) Analysis of long haul battery electric trucks in EU, *Transport Environment*

A.2.0 Glossary

Term	Definition
'Business-as-usual' scenario	The emissions pathway that would most likely have been followed in the absence of a carbon reduction/offset project, also referred to as the 'baseline scenario'.
Carbon balancing (offset)	Carbon offsets (or balances) are the 'certificates' used for showing that payments or funds have led to carbon sequestration or reductions elsewhere. Carbon offsets are purchased through selected and verified carbon projects and can be purchased on a voluntary basis or to meet regulatory requirements.
Carbon dioxide (CO_2)	The most emitted greenhouse gas, carbon dioxide is a by-product of industrial processes, burning fossil fuels and land use changes, and is absorbed by plants and oceans.
Carbon dioxide equivalent (CO_2e)	A metric used to compare the emissions from the various greenhouse gases on the basis of their global-warming potential. The CO_2e quantity of any greenhouse gas is the amount of carbon dioxide that would produce the equivalent global warming potential.
Carbon footprint	A carbon footprint is the total amount of greenhouse gas (GHG) emissions emitted by an organisation, event or product. For simplicity of reporting, it is often expressed in terms of CO_2e.
Carbon neutral/climate neutral/net zero	When a net carbon footprint is nil, because no greenhouse gases are emitted or because a measured amount of carbon released is offset with an equivalent amount sequestered or avoided.
Emissions factors	An emissions factor tells you how much CO_2e is created per unit of activity. For example, the emissions factor of taking the train is 0.0662kg of CO_2e per mile. Multiplying that by how many miles you travelled will give you the carbon footprint of that journey.[33] BEIS publishes an updated set of emissions factors each year.

[33] https://bulb.co.uk/carbon-calculator/glossary/

Term	Definition
Emission reduction pathway	A route to decarbonisation which can have varying levels of ambition. A more ambitious pathway will reduce more CO_2e but will likely come at a higher capital cost. Any remaining emissions will need to be offset.
Energy efficiency measures	Energy efficiency measures help reduce a building's demand for heat, minimise the power requirements of new heating systems and reduce long term costs. Some examples are insulation, double glazing and draft exclusion.
Green energy tariff	Tariffs offered by energy companies who buy certificates showing that this electricity has come from renewable sources. Theoretically, increasing demand for this type of tariff raises the price of renewable certificates, thus boosting investment in low carbon energy sources and driving further grid decarbonisation.
Greenhouse gas (GHG) protocol	GHG Protocol establishes comprehensive global standardised frameworks to measure and manage greenhouse gas (GHG) emissions from private and public sector operations, value chains and mitigation actions.[34]
Market-based system of carbon reporting	The 'market-based' system of carbon reporting uses the carbon intensity of your specific energy tariff. When purchasing a green energy tariff, electricity emissions can be considered to be zero in the market-based reporting method.
Scope 1 Emissions	Emissions from fuel consumed by the H&F estate, either from heating or owned vehicles.
Scope 2 Emissions	Emissions from electricity consumed by the H&F estate, including in buildings and street lighting.
Scope 3 Emissions	Indirect emissions that result from H&F activities. This includes: - Indirect emissions from Scope 1 and 2 activities, such as the transmission and distribution of electricity - Emissions from other H&F activities, such as water consumption, staff commuting, procurement, leased dwellings, etc.

[34] https://ghgprotocol.org/about-us