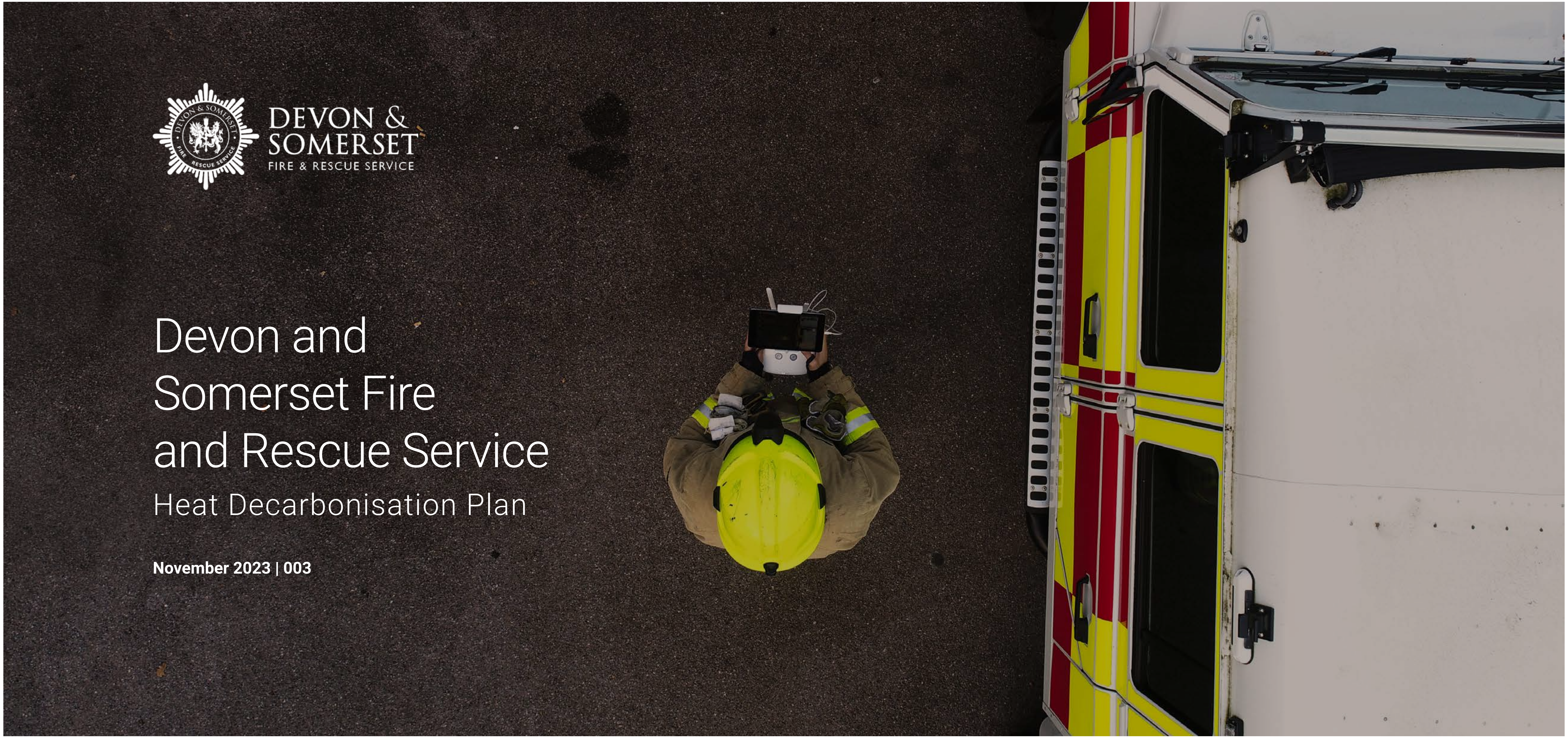
Heat Decarbonisation Plan Approval

Throughout the HDP creation process, regular meetings were with the project team, including the Net Zero Consultant managing the project, as well as Aimee Lee (Category Manager, Procurement), Nigel Harvey (Property Manager, FM, Special Projects), David Lang (Head of Estates), and any technical specialists as and when needed. This allowed for review of the progress of the project against the proposed programme to Salix, and has ensured that the report is complete and signed off well in advance of the 28th March 2024. The inclusion of members from across various roles within the Service has meant that the interventions identified have been communicated to the necessary people, allowing for the correct approval, and subsequent discussions and approvals for any interventions that progress to project.

The milestone for the initial draft was met, with feedback given to allow for further revision of the report based on the Service's needs, and the specific quality assurance feedback rating. This HDP has been approved as relevant and applicable by Aimee Lee, Nigel Harvey and David Lang, and will guide the route for the Service to start the works to reach Net Zero within an aspirational yet realistic timeframe.

Signed: ……………………………………………………

Date: …………………11/01/24…………………………………..



DEVON & SOMERSET FIRE & RESCUE SERVICE

Devon and Somerset Fire and Rescue Service

Heat Decarbonisation Plan

November 2023 | 003

AtkinsRéalis

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3.0	Final edit	OR	SR	SC	DG	21-11-2023

SAFETY

INTEGRITY

COLLABORATION

INNOVATION

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Glossary of Terms

- ASHP - Air Source Heat Pump
- BEMS – Building Energy Management System
- BMS – Building Management System
- BSE - Building Services Engineering
- Building fabric – The physical components and materials that make up a building's envelope, including walls, roofs, floors, and cladding, which collectively determine the building's structure integrity, thermal performance, and weather resistance
- Decarbonisation (Built Environment) - The process of reducing or eliminating carbon emissions associated with construction, operation, or maintenance of buildings and infrastructure, typically through sustainable design, energy efficiency measures, and the adoption of low-carbon technologies
- DESNZ - Department of Energy Security and Net Zero
- DHW – Domestic Hot Water
- DNO – District Network Operator
- FM - Facilities Management
- GHG - Green House Gases
- HDP - Heat Decarbonisation Plan
- HVAC - Heating, Ventilation, and Air conditioning
- KPIs - Key performance indicators
- kWh - Kilowatt hour
- LCSF – Low Carbon Skills Fund.
- LED - Light Emitting Diode; type of lighting
- LPG - Liquified Petroleum Gas
- M&E – Mechanical & Electrical
- MEP – Mechanical, Electrical, and Plumbing
- NZC - Net Zero Carbon
- PSDS – Public Sector Decarbonisation Scheme
- PV - Photovoltaic
- Quick wins - Interventions that are easy, fast, and economical to implement.
- Retrofit – The process of enhancing or upgrading existing buildings, infrastructure, or systems to improve energy efficiency, sustainability, and functionality. Often done through incorporating innovative technologies and design principles.
- Salix finance - non-departmental public body, wholly owned by the Government administering funds on behalf of the Department for Energy Security and Net Zero
- SBTi – Science Based Targets initiative
- tCO2 - One Tonne of Carbon Dioxide
- UK-GBC - UK Green Building Council

Executive Summary

Meeting the UK Government's target for Net Zero Carbon emissions will involve a major transformation of existing buildings, transport and energy infrastructure. This transformation will impact every sector of the economy and will be shaped by national policy and regional resources.

Devon and Somerset Fire and Rescue Service has commissioned AtkinsRéalis to develop a roadmap to achieving Net Zero across thirteen sites listed in Appendix A. This report has been funded by the Salix Low Carbon Skills Fund. The purpose of this plan is to assist the Service in achieving its aim to be Net Zero by 2030, in line with the Service's Environmental Strategy. This report considers three scenarios, decarbonisation by 2030, 2040 and 2050, with focus given to 2030 in line with the Service's target. This report predominantly focuses on the decarbonisation of heat and for the purposes of this analysis, Net Zero Carbon has been defined as:

"The carbon emissions associated with operational energy consumption across the estate are zero or negative on an annual basis. The majority of fuel and power is supplied from on-site and off-site renewable energy sources, with any remaining carbon balance offset."

Existing energy and heating technologies

Barnstaple – Heating is provided by 2 Dokum Boilers (2010) serving all but the drying room, with an Ideal Mexico boiler serving the drying room (2015). All boilers are in fair condition. DHW is provided by 2 indirect heated cylinders installed in 2022 so are in good quality.

Bridgwater – Heating is provided by 2 Potterton boilers in good condition (2020), with DHW provided by an indirect LTHW cylinder with Solar Thermal support, powered by a Gloworm system boiler (also 2020).

Chelston Vehicle Workshop and Stores - Heating for the main building is currently provided by Vaillant gas boiler, installed 20 years ago, along with distribution pipework and emitters. Domestic hot water is provided by a direct gas fired water heater, installed 20 years ago, as well as a zip boiler serving the canteen which is 5 years old.

Crownhill – Heating is provided by 2 Broag Remeha Quinta Pro 90 boilers (2011), with pipework well beyond design life (50+years). DHW is provided by a gas water heater. POU showers and 3 zip water boilers.

Danes Castle – Heating is provided by Combined Heat and Power (CHP) with 2 Ideal IMAX boilers in backup (14 years), in moderate condition. DHW is provided by a Calorifier serving the wider building, with two zip boilers serving the kitchen area.

Exmouth – Heating is provided by 3 Vaillant boilers which are 22 years old, and in poor condition. DHW is provided by an indirect cylinder (also 22 years and in poor condition), an electric shower and 3 zip water heaters.

Fire Service Headquarters - Heating for the site is provided via 2 boiler houses. Boiler house 1, serving buildings Devon House and Somerset House, features 2 95kW gas boilers installed in 2020. Boiler house 2, serving building East Devon House, and features 2 50kW gas boilers installed in 2004. All distribution pipework and emitters are over 25 years old. Domestic hot water from boiler house 1 is provided by a 25-year-old indirect cylinder with solar PV support and 2 back up immersions. Domestic hot water from boiler house 2 is provided by a 25-year-old direct gas fired water heater.

Greenbank – Heating is provided by 2 Remeha Quinta boilers (17 years) and are near technical end of life. DHW is provided by an indirect cylinder (18 years, near technical EOL), and a zip boiler serving the kitchen.

Middlemoor – Heating is provided by 3 gas boilers (13 years old, fair condition). A Senertec HKA g S1 CHP feeds into a 700l buffer vessel, backed up by 2 Ideal Imax Gas Boilers. DHW is provided by a LTHW Calorifier, and 2 zip heaters, all 13 years old.

Paignton – Heating is provided by 2 Hamworthy gas boilers, (3 years, good condition), with DHW provided by an indirect cylinder and 4 POU showers. Whilst the units themselves are in good condition, distribution pipework and emitters are well beyond technical EOL (50+years).

Taunton – Heating for the main building is currently provided by 2 Hamworthy gas boilers. Domestic hot water is provided by a 25-year-old indirect cylinder. All boilers were renewed 5 years ago but most of the distribution pipework and emitters are 50+ years old.

Torquay - Heating for the main building is currently provided by 2 gas fired boilers, renewed 8 years ago, and a combi boiler which is over 25 years old. Domestic hot water is provided by the combi boiler, a gas fired water heater (25 years old), 7 electric showers and 3 zip boilers. Most of the distribution pipework and emitters are over 50 years old.

Yeovil - The boiler house on site was rebuilt in 2006 and the main boiler was replaced a few years later in 2009. The 2 smaller boilers were replaced in 2016; since then, one of these boilers has broken down with a leak inside and has therefore been isolated. Around 70% of the distribution pipework and emitters were replaced 17 years ago, the remainder being over 50 years old. Domestic hot water is provided by an indirect calorifier, 2 electric showers and a zip water boiler serving the kitchen.

Implementation

The strategy applied is a 'whole building' approach which involves reducing the demand for energy before decarbonising the heating, ventilation and cooling (HVAC) equipment and installations.

Reduction in demand is achieved by; implementing energy saving behaviour change, improving the thermal performance of existing buildings; improving the control and operation of HVAC systems and replacement of existing equipment with higher efficiency alternatives. The replacement of fossil fuel HVAC systems are then considered for replacement with low carbon alternatives, generally in the form of heat pumps. To support the replacement of fossil fuel with electricity, the strategy seeks to strengthen on-site renewable generation, typically by installing solar PV arrays on suitable roof areas.

Implementation of all interventions in this plan indicates a potential reduction in the baseline consumption of 83%, from 2,763,371kWh to 446,828kWh. If interventions are implemented by 2030, accounting for 6.5% inflationary increases in energy prices, it is predicted that the Service will save £440,598 per annum on utility bills by 2030. Capital cost estimates for delivering this HDP for by 2030 is £6,751,193 over 7 years. By 2040, costs may rise too £7,501,325 and £8,197,877 by 2050.

Cost of Interventions	Total
2030	£6,751,193
2040	£7,501,325
2050	£8,197,877

2030 predicted annual cost savings after implementation of the interventions

Utility	Predicted Annual Spend in 2030 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2030 Without Install (annual 6.5% inflation)	Saving (£)
Electricity	£195,171	£364,388	£169,218
Gas	£0	£271,380	£271,380
		Total Saving	£440,598

2040 predicted annual cost savings after implementation of the interventions

Utility	Predicted Annual Spend in 2040 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2040 Without Install (annual 6.5% inflation)	Saving (£)
Electricity	£366,362	£684,007	£317,645
Gas	£0	£509,418	£509,418
		Total Saving	£827,062

2050 predicted annual cost savings after implementation of the interventions

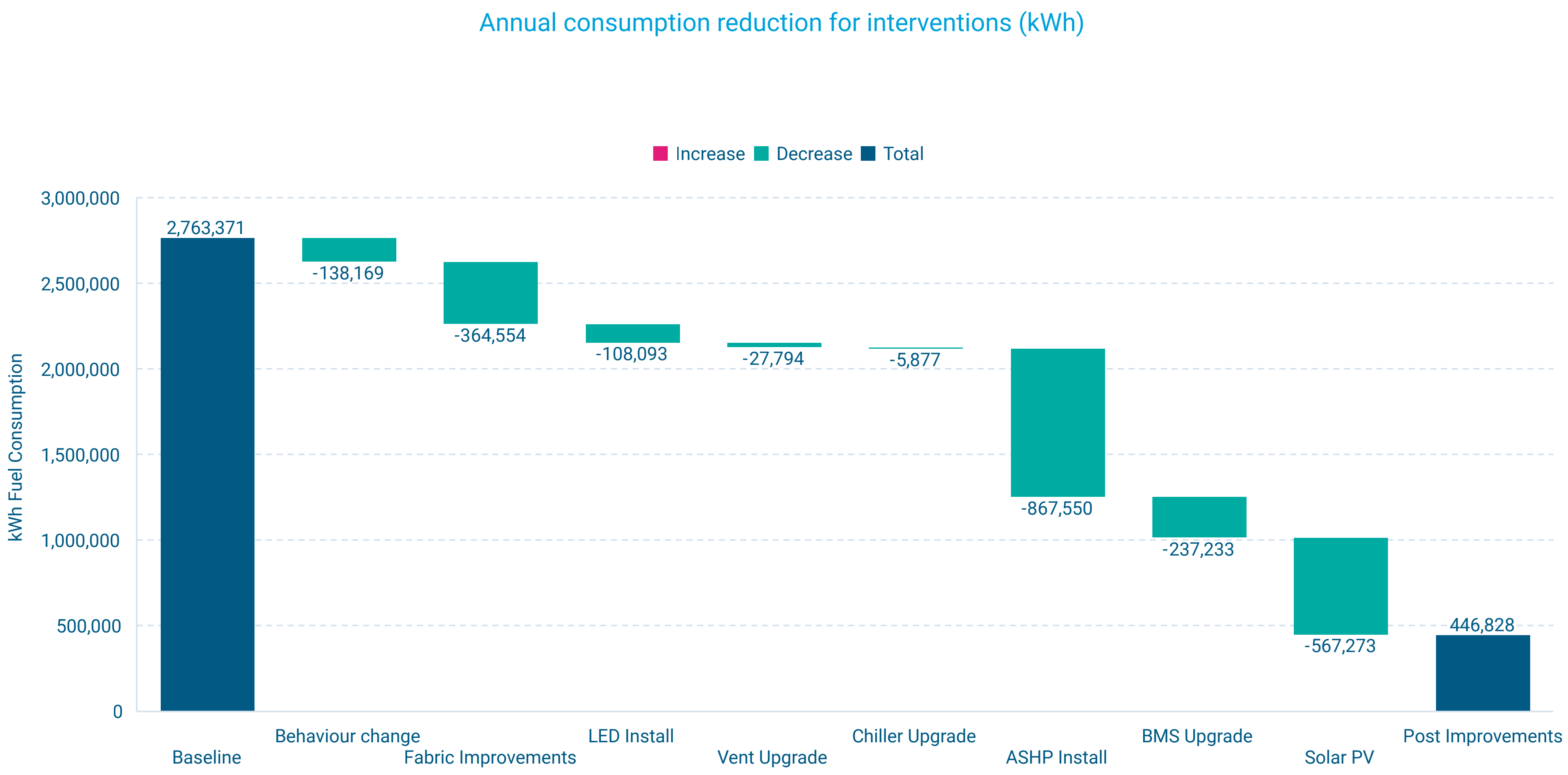
Utility	Predicted Annual Spend in 2050 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2050 Without Install (annual 6.5% inflation)	Saving (£)
Electricity	£687,713	£1,283,975	£596,263
Gas	£0	£956,247	£956,247
		Total Saving	£1,552,510

Through implementation of this heat decarbonisation plan, there is potential for carbon emissions to be reduced from 513CO_2e to 23tCO_2e, It should be noted that the decarbonisation calculations here allow for the ongoing decarbonisation of the national grid. – Without grid decarbonisation the value would be 86tCO_2e.

The interventions are highlighted next:

- Behaviour change – Improving energy saving behaviour i.e. turning lights off, keeping windows shut, promoting friendly energy saving competitions across shifts.
- Building fabric thermal insulation – improved insulation, such as infilling any voids in walls where possible, and double glazing.
- LED lighting – Light emitting diode lighting, these lights are up to 80% more efficient than traditional lighting.
- Fans, Motors, and Pumps – More efficient pumps can reduce the load on electricity, with the potential for heat recovery from fans in areas with existing heat i.e. kitchens.
- Building Energy Managing System (BEMS) and Energy Metering – These integrated systems allow for remote control and management of all services within a building, allowing for the setting of heating rules for plant to follow.
- Heat pumps (ASHP) – These are electrically powered heating sources with an efficiency of typically 3, meaning for every 1 unit of power in, 3 units of heat out are achieved, allowing for more efficient, low carbon heating.
- Solar Photovoltaics (PV) – Panels made of cells from a semi-conducting material, which when sunlight hits them generates a flow of electricity.

The national grid continues to decarbonise by using more renewable technologies, this will further reduce the carbon emissions. As the carbon emissions do not reach Net Zero in either scenario, there is the opportunity to offset any remaining carbon by considering investment into off-site solar PV and large-scale wind turbines, or through purchasing “green electricity”, moving to an 100% REGO (Renewable Energy Guarantee Origin) backed electricity contract to reach a Net Zero Carbon status.



The impact of each intervention mentioned overleaf is shown on the above waterfall graph. There is a reduction in consumption from the baseline of 2,763,371kWh to a post improvement values (all recommendations installed and integrated) consumption of 446,828kWh.

Approaches and additional recommendations that should be considered to support delivery and drive efficiency into Net Zero programmes include:

- Implementing fast-track "quick wins" for carbon reduction e.g. LED lighting.
- Securing capital funding to support carbon reduction e.g. grant schemes operated by Salix Finance.
- Undertaking Life Cycle Costing of capital proposals to ensure whole life value of investments is considered.
- Realising wider community benefits for carbon reduction through adopting a social value framework for delivery of a Net Zero Carbon programme.
- Undertaking feasibility studies to ensure that solutions allow future flexibility and adaptability.
- Measuring the co-benefits of interventions, e.g. air quality, positive impacts on staff and building users for talent attraction, wellbeing and quality of construction.

Sites can be prioritised in several ways. Priority sites can be determined through looking at total carbon saved, through prioritising sites with end-of-life systems that are in need in replacement, or through site specific funding available.

1. Introduction

Devon and Somerset Fire and Rescue Service covers the entirety of both counties, spanning 83 fire stations including retained and wholetime stations, three technical vehicle workshops and stores facilities.

This report focuses on the decarbonisation of 13 sites within the building stock (forming the 'estate' within this report), those that were deemed to be the greatest opportunity for energy reduction, with a primary focus on decarbonising the heat source and allowing for operation of a low carbon, resource efficient estate. These sites were chosen due to their high energy usage and intensity, approximately 50-60% of fuel consumption across the entire service, and follow below:

- Barnstaple
- Bridgwater
- Chelston
- Crownhill
- Danes Castle
- Exmouth
- Greenbank
- Middlemoor
- Paignton
- Fire Service Headquarters
- Taunton
- Torquay
- Yeovil

The Service is in the early stages of their journey towards Net Zero, with a target of 2030, however have already taken steps towards meeting this goal. EV chargers are being installed across the estate, with LED rollout also occurring. Five of the sites also already have small scale PV installation, as well as a behavioural improvement campaign being rolled out through energy posters, and the ambition to send consumption data to sites. Of note, the Service Headquarters is included within the report, with this effectively being composed of three smaller buildings, combined with a shared lobby, necessitating differing interventions for each section of the building.

...Through implementation of this heat decarbonisation plan, there is potential for carbon emissions to be reduced from 513CO$_2$e to 23tCO$_2$e...

Scope

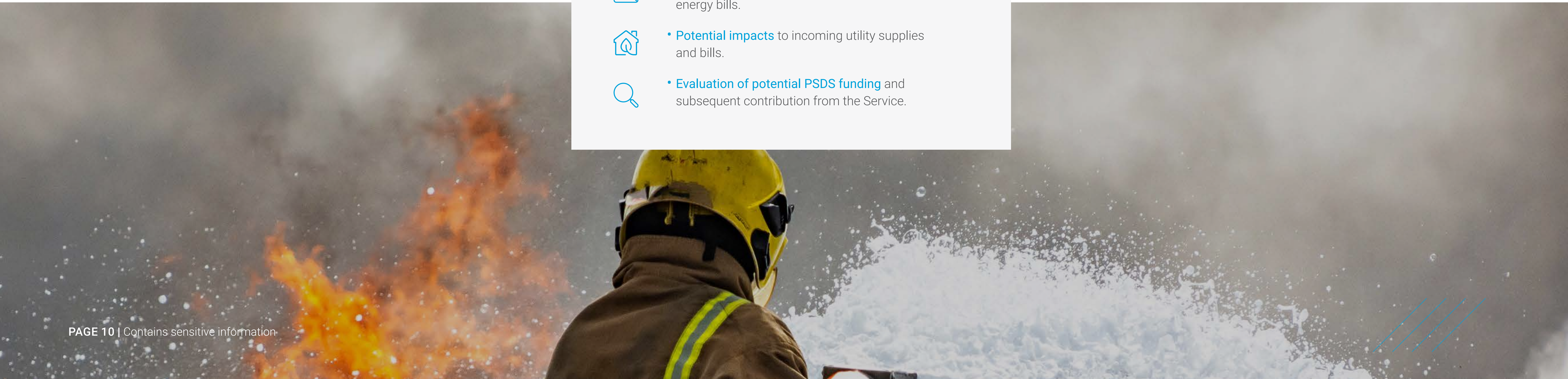
AtkinsRéalis have been appointed by Devon and Somerset Fire and Rescue Service (the Service henceforth) to produce a roadmap for thirteen sites to achieve Net Zero Carbon emissions, with particular attention being paid to decarbonising the heat source.

The agreed key **deliverables** for the Service's commission are as follows:

- Detailed proposal for the recommended/preferred Net Zero Carbon implementation plan.
- Prioritised options for maximising carbon reduction potential whilst delivering a cost effective and value for money solution.
- Estimated savings, capital costs, return on investment and payback.
- Provision of methodology applied to all calculations and details of any assumptions made.
- Review of existing documentation, including energy bills.
- Potential impacts to incoming utility supplies and bills.
- Evaluation of potential PSDS funding and subsequent contribution from the Service.

Site audits were undertaken and reports prepared for each site. The site auditors collected data on the existing building condition; existing equipment and services; and identified effective ways of decarbonising the site. This site audit report information was used to create an excel spreadsheet which contains energy saving calculations associated with introducing the proposed carbon saving measures at each site.

The detailed calculations are represented in tabular and graphical format throughout this report.



2. Definition of Net Zero

Definition

The built environment has been identified as one of the most significant contributors to global GHG emissions, accounting for 39% of annual emissions worldwide.

From a UK perspective, the built environment is accountable for approximately 25% of the country's GHG emissions. Operational energy GHG emissions contribute for about 75% of the UK-built environments' GHG emissions, with emissions from gas boilers identified as the primary contributor. The remaining 25% of GHG emissions are associated with embodied carbon emissions during construction.

The UK Government agreed upon the net-zero pledge in 2019 in response to the Intergovernmental Panel on Climate Change (IPCC) report published in 2019. This report highlighted that the world is on track to overshoot the Paris Agreement's 1.5°C limit before 2050, which would have catastrophic consequences for humanity. Hence, to combat this issue, the UK Government published world-leading emergency climate goals under the Climate Change Act 2008 and Carbon Budgets Orders, which set legally binding pledges to reduce UK net GHG emissions from 1990 levels by:

68%	78%	100%
Net Zero by 2030	Net Zero by 2035	Net Zero by 2050

Net Zero Carbon has a range of definitions. This section aims to provide clarity on the definition of Net Zero Carbon. It may be defined differently depending on the application of the term nationally, to the built environment, or in its application to a particular estate portfolio. The relevant definitions are reviewed below to set the context for how the framework definitions are applied to the Service's estate.

In this report we have used the widely accepted definition provided by the Science Based Targets initiative (SBTi). The SBTi defines and promotes best practice in science-based target setting to support corporates in setting net-zero targets that are aligned to meet societal climate goals. Its focus is to accelerate companies to halve emissions before 2030 and achieve net-zero emissions before 2050.

To reach net-zero at a corporate level, organisations must deeply reduce emissions and counterbalance the impact of any emissions that remain. The SBTi Net-Zero Standard defines corporate net-zero as:

- **Reducing scope 1, 2, and 3 emissions to zero** or a residual level consistent with reaching global net-zero emissions or at a sector level in eligible 1.5°C-aligned pathways; and
- **Permanently neutralising any residual emissions** at the net-zero target year and any GHG emissions released into the atmosphere thereafter.

2. Definition of Net Zero

In accordance with the GHG Protocol, GHG emissions scopes 1, 2 and 3 are defined as:

Scope 1: Includes direct emissions (gas and oil) from sources owned/controlled by the organisation;

Scope 2: Comprises indirect emissions from the organisation's purchase of electricity energy; and;

Scope 3: Is an optional reporting category and is all other indirect emissions that result from activities within the organisations but not sources owned or controlled by it.

To help develop a shared understanding of what Net Zero Carbon means for the construction sector, the UK Green Building Council (UK-GBC) published a framework definition that encompasses three further scopes: construction; operational energy and whole-life.

The formal UK-GBC definitions of Net Zero for each scope are given below.

Net Zero Carbon – Construction
(for new buildings and major renovations):

"When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy."

Net Zero Carbon – Operational Energy
(for all buildings in operation):

"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A Net Zero Carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balancing offset."

All sites within this scope of works fall into the Operational Energy definition of Net Zero, as all stations, workshops and stores are currently in operation. With the wholetime stations being 24/7 usage, the operational Carbon of the sites is the most important current factor to the Service.

Net Zero Carbon – Whole Life:

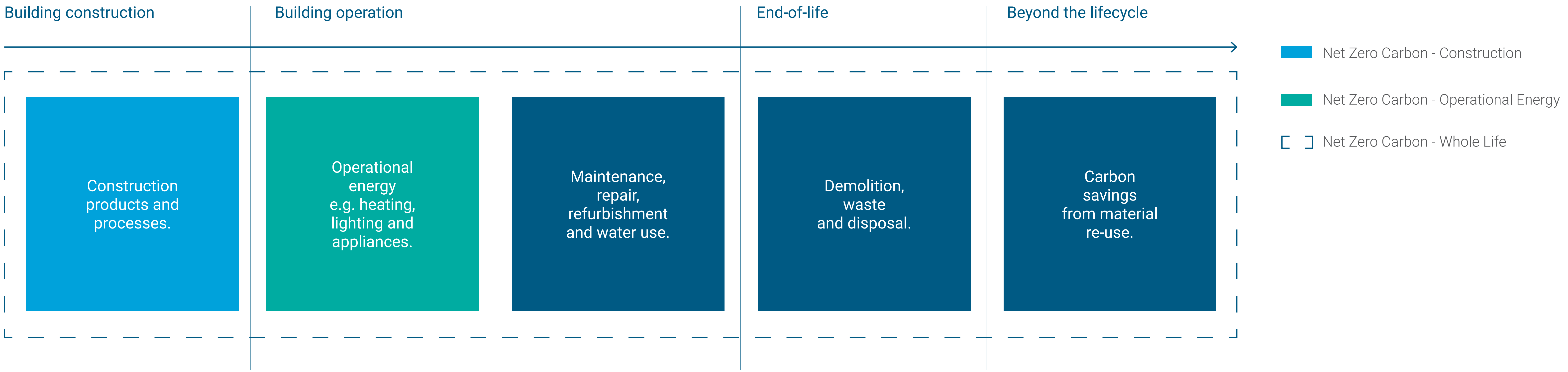
"When the amount of carbon emissions associated with a building's embodied and operational impacts over the life of the building, including its disposal, are zero or negative."

Due to the extensive usage of the sites mentioned above, maintenance, repair and refurbishment are constantly ongoing to ensure all stations are safe and operational, with these activities captured within the whole life carbon stage of the sites. This is picked up through embodied carbon of new materials and emissions from the refurbishment works themselves.

From a UK perspective, the built environment is accountable for approximately 25% of the country's GHG emissions.

Figure 1.

UK-GBC framework definition of Net Zero Carbon buildings



This framework helps to identify the practical steps that can be taken to reduce emissions at each stage of the building lifecycle:

1. **Construction:** At the construction stage, materials with low or zero "embodied" carbon should be selected. On-site construction impacts can be reduced by using local suppliers of materials and by reducing waste.

2. **Operational Energy:** Reducing operational carbon should begin with reducing energy demand through correct operation of the building, high standards of insulation; energy-efficient lighting, plant, and equipment; and effective building controls. The remaining energy demand can be satisfied by using a decarbonised source (changing from fossil fuels to electricity), by using renewable energy technologies e.g. solar photovoltaic (PV) panels and by offsetting any remaining demand by using "green" electricity.

3. **Whole Life:** Designing buildings to be flexible for adaptation to changes in use and for disassembly at end of life supports whole-life carbon reductions. Effective maintenance and management practices will ensure that operational carbon savings are maintained.

Devon and Somerset's aspiration of Carbon Neutral or Net Zero by 2030 within their Environmental Strategy refers to emissions from activities, covering fleet, building usage both in existing buildings and new building schemes, and waste. This report seeks to help the Service with benchmarking their existing operational energy usage and associated carbon emissions.

In this report we look to reduce emissions associated with operational energy and therefore define Net Zero Carbon for the Service's estate as:

> "The GHG emissions associated with operational energy consumption across the estate are zero or negative on an annual basis. The majority of fuel and power is supplied from on-site and off-site renewable energy sources, with any remaining carbon balance offset."

The modelled scenarios and Net Zero Carbon tool identify operational carbon emission savings alone for the thirteen sites. The calculations exclude assessment of:

- **Embodied carbon** associated with new construction, major refurbishment, and on-going operational maintenance activities.
- **Transport** – replacement of fleet with Ultra-Low Emission Vehicles (ULEVs) and provision of charging/refuelling infrastructure for ULEVs.
- **Emissions associated with end-of-life** scenarios, for example demolition.

Figure 2.

Map of sites

3. Net Zero Roadmap Framework

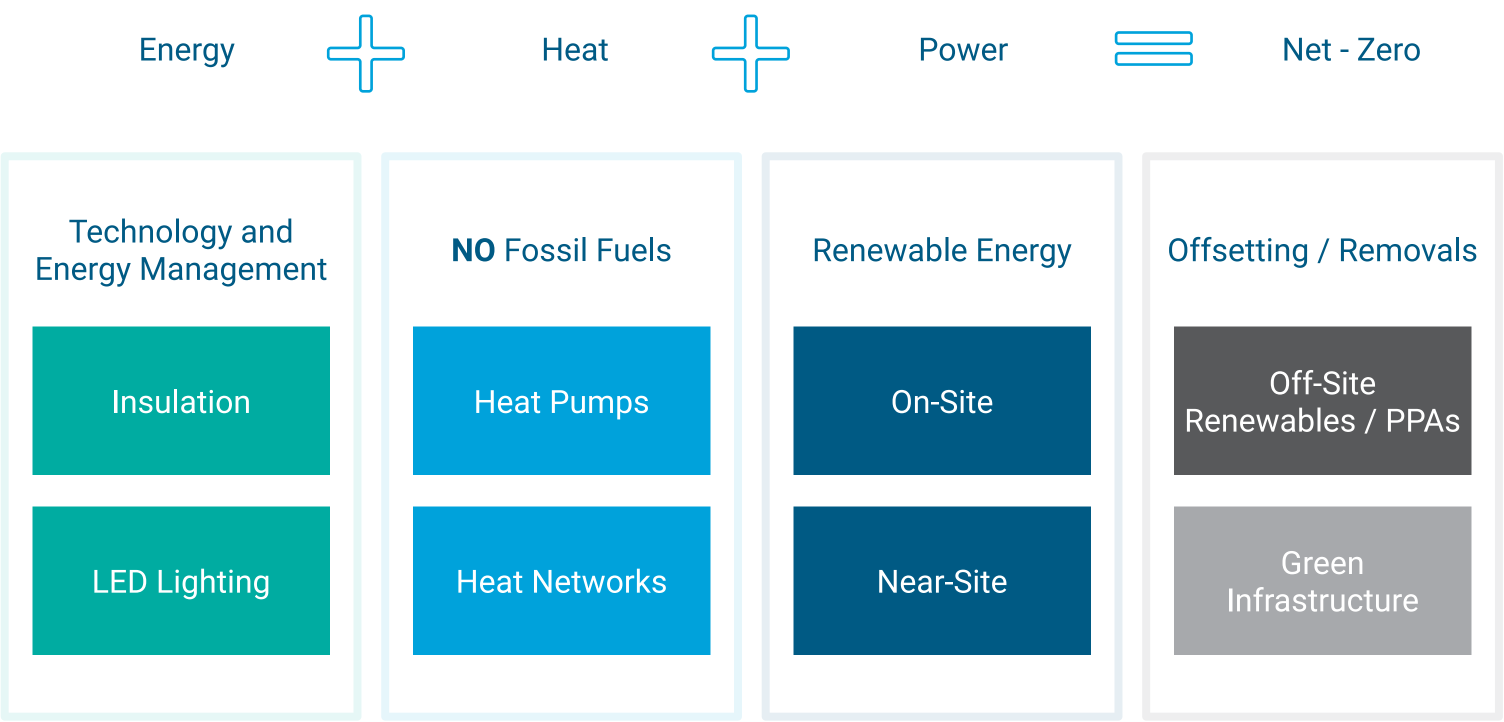
Following the definition of Net Zero Carbon introduced above for the Service sites in this report, we can identify three key elements of this roadmap:

1. **Energy Efficiency: Increasing energy efficiency by reducing demand** is achieved through a range of approaches, including improved energy management practices (e.g. conducting regular energy audits); introducing behavioural change programmes (e.g. encouraging building users to operate the building efficiently) and replacement of equipment with more energy efficient equipment (e.g. replacing older lighting systems with LEDs). Demand is also reduced by improving controls to operate the building in a more efficient manner.
2. **Heat: Decarbonising heat.** The main alternatives to fossil fuel heating are heat pumps and low-carbon heat networks. These technologies need to progressively replace the existing fossil fuel heating plant across the estate.
3. **Power: Increasing renewable energy supply.** There are a range of renewable energy technologies that can be used to generate clean power. Solar photovoltaic (PV) panels are an established technology that can be readily installed on roofs across the five buildings to generate carbon-free electricity from the sun.

The diagram below shows how all these element's link together and identifies what Net Zero means in practice for buildings.

Figure. 3

Process towards Net Zero Carbon buildings



The following approaches and technologies have been recommended. These key interventions are discussed in more detail in the following sections.

- Behaviour change.
- Building fabric thermal insulation.
- LED lighting.
- Fans, Motors, and Pumps.
- BEMS and Energy Metering.
- Heat pumps.
- Solar PV.

4. Building Information

Building Information

The selection of buildings in the Service, included in the proposal, comprises of thirteen sites. Of the thirteen sites, 11 are Fire Stations, one (Chelston) being one of the Service's workshop facilities and only supplies/stores facility, as well as the Service Headquarters (SHQ) also being included, which is a standalone building as part of the wider HQ site.

The SHQ usage spans standard office hours, with the 'building' being composed of three smaller blocks, Devon House, Somerset House and East Devon House. Much of the administration, estate management and wider service control is run out of this site. Chelston Workshop and Stores operating hours are also standard office hours (8am-5pm), with the site consisting of the office building, warehouse and vehicle workshop, where the service fleet are maintained and managed throughout the year.

The wholetime fire stations are running 24/7 often with multiple shifts within the station and are crew occupied for this entire period. These sites typically consist of a main office block, with an attached appliance bay where the vehicles are kept. There are variations in the usage of the appliance bays, mainly regarding heating, however the service confirmed that heating was being phased out across the estate, with frost protection remaining.

The majority of sites have Trend IQ4 BMS controls on the heating and hot water, including Barnstaple, Bridgwater, Crownhill, Danes Castle, Exmouth, Greenbank, Middlemoor, Paignton, Boilerhouse 1 of SHQ (Devon and Somerset House), Torquay and Yeovil. Bridgwater DHW is controlled through a local timeclock system, with Chelston's heating and hot water also controlled by Local Timeclock. SHQ Boilerhouse 2, providing heat and hot water to East Devon House, is controlled by a Drayton DC1100 Optimise Controller, whilst the Admin Building at Torquay is controlled by a Local Programmable Controller. As a result of the types of controls in place, there are no energy monitoring portals for data download or reporting.

> The sites are occupied by the Service and the Service is responsible for the energy consumed within the buildings. The Service report on the carbon usage annually. The site list follows:

Table 1.

Site list

Site Name	Construction	Total Consumption (kWh)	Area (m^2)	Annual Elec (kWh)	Annual Gas (kWh)	Total kWh/ m^2	tCO_2e
Barnstaple Fire Station	1964	209,642	1,500	64,050	145,592	140	39
Bridgwater Fire Station	1964	131,600	1,081	46,692	84,908	122	25
Chelston Vehicle Workshop and Stores	2003	161,787	1,301	59,110	102,677	124	30
Crownhill Fire Station	1954	257,000	1,211	93,128	163,872	212	48
Danes Castle Fire Station	2009	177,413	806	63,053	114,361	220	33
Exmouth Fire Station	2001	124,987	1,152	47,607	77,380	108	23
Greenbank Fire Station	2006	179,904	975	55,445	124,459	185	33
Middlemoor Fire Station	2010	244,843	1,153	57,246	187,597	212	45
Paignton Fire Station	1972	100,630	495	33,296	67,334	203	19
Service HQ	East Devon/Somerset 2001-2010 Devon c1800	398,347	2,227	77,995	320,351	179	74
Taunton Fire Station	1972	267,906	2,126	72,835	195,071	126	50
Torquay Fire Station	1957	247,121	1,638	78,532	168,589	151	46
Yeovil Fire Station	1962	262,191	1,283	85,250	176,941	204	49

Total floor area was determined using data provided by the Service and cross referenced with floor plans.

The following data was provided by the Service:

- **Asset list** – including names, addresses, building floorplans and main heating source (summarised in Appendix A).
- **Energy data** – records of electricity, gas and other fossil fuel consumption associated with the asset list.
- **Information on recent energy improvement** projects which have already been undertaken or are proposed.
- **Current Display Energy Certificates** – This is only for Danes Castle, other values are from lapsed certificates.
- **Planned alterations** to the building stock which should be considered as part of the heat decarbonisation exercise (advised no changes).
- **Other supporting information**, including high-level information about previous projects.

The energy consumption data for each site was provided in the format of monthly consumption data and half hourly meter readings. Data was provided to cover 2 whole years of consumption, with the date range being May 21-May 23. Access to half-hourly data and the ability to download reports from the varying sites gave an excellent indication of current energy usage, which formed part of the investigation in the onsite audits.

For the Service HQ, we extrapolated the electricity meter data according to the floorplan of the three buildings, as no submetering is available onsite. Gas data was taken from the dedicated gas meters in both the plantrooms that supply the three buildings.

The Service provided access to energy data for all sites. Because of this, no assumptions were made ensuring accuracy of the modelling and any forecast cost and energy savings.

The energy baseline data is summarised in the following graphs:

Table 2.

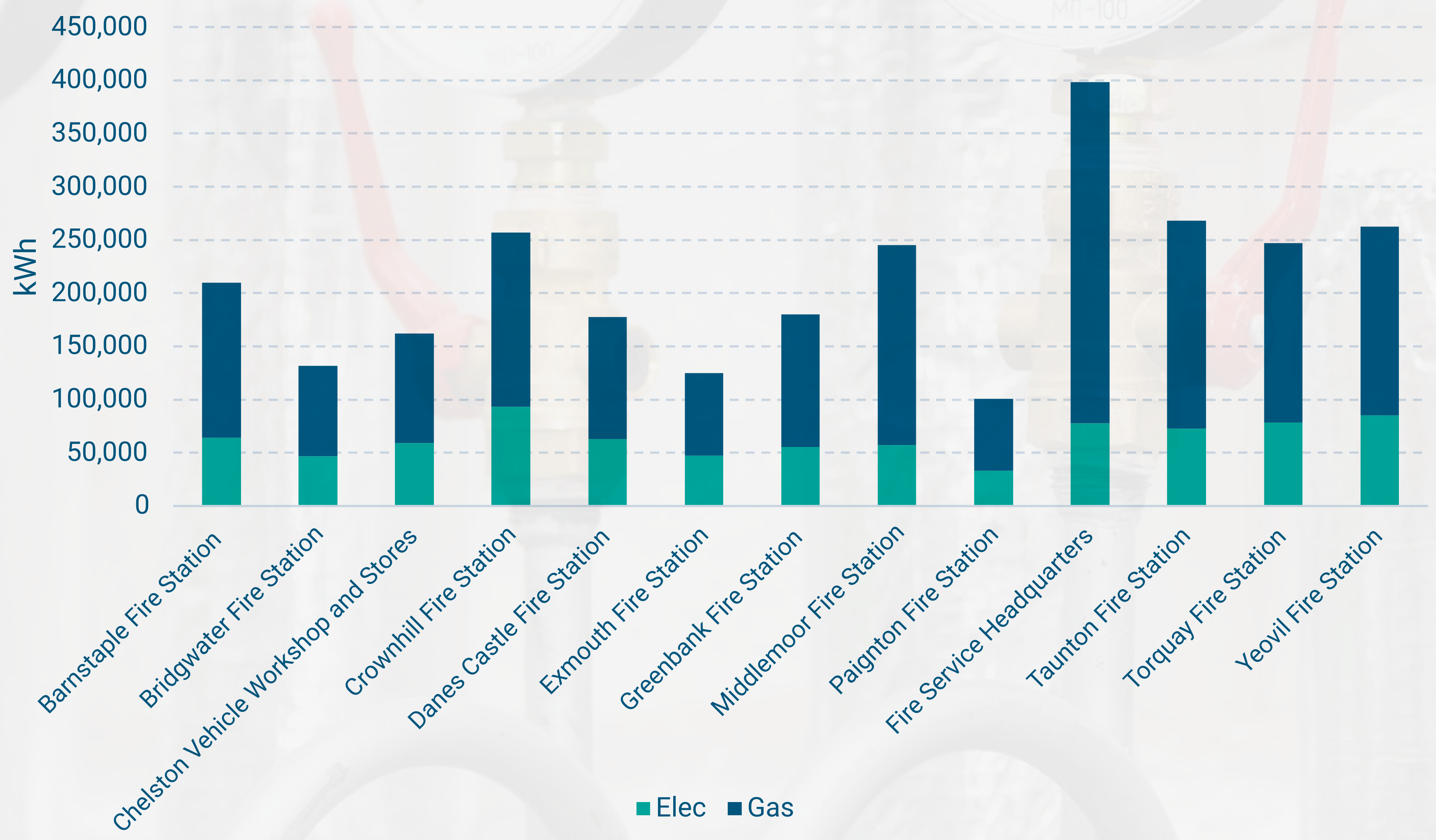
Annual energy consumption.

Fuel Type	Total kWh	tCO_2e	Annual Spend
Electricity	834,239	161	£220,175
Gas	1,929,133	352	£163,976
Total	2,763,371	513	£384,151

The Service's baseline consumption sits at 2,763,371kWh, or the equivalent of 513 tCO_2e per annum. Whilst gas makes up the majority of the consumption across the thirteen sites, spend for electricity far outweighs gas, highlighting the need to be aware of the potential for impact on the Service when looking to decarbonise heat through removing fossil fuels.

Figure 4.

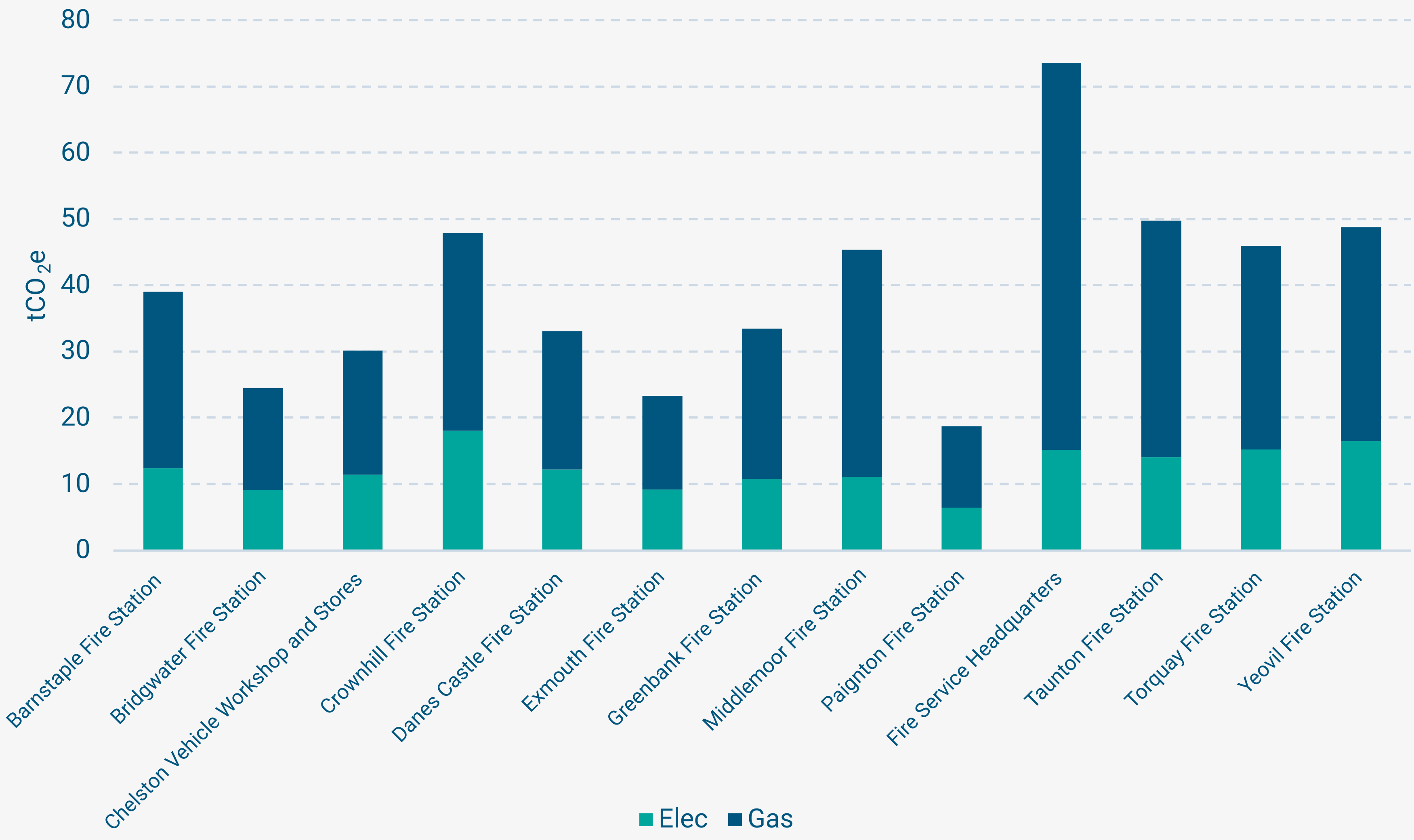
Total Annual consumption by site (kWh)



Figures 4 and 5 highlight that Gas consumption is the majority fuel consumption at the majority of sites (approximately 60-70%), all except SHQ, where gas accounts for a higher proportion of the mix. SHQ does also have the highest overall consumption, 398,347kWh, which is to be expected due to its much larger footprint across the three buildings, and the differing usage to the more typical fire stations. On the other end of the scale, Paignton has the lowest energy consumption, 100,630kWh total, with a mix of 67,334kWh gas and 33,296kWh elec, however the station does have a high energy usage intensity (EUI) of 203kWh/m^2.

Figure 5.

Total Annual Carbon emissions by site (tCO_2e)



Removing SHQ, the highest consumers of energy are Crownhill, Middlemoor, Taunton, Yeovil and Torquay, each with a similar energy split. In terms of EUI, Paignton, Crownhill, Danes Castle, Middlemoor and Yeovil all have values above 200kWh/m^2 which is significantly high, and at a baseline level provide a good priority for energy usage reduction.

Figure 6.

Gas, electric and total consumption by site (kWh)

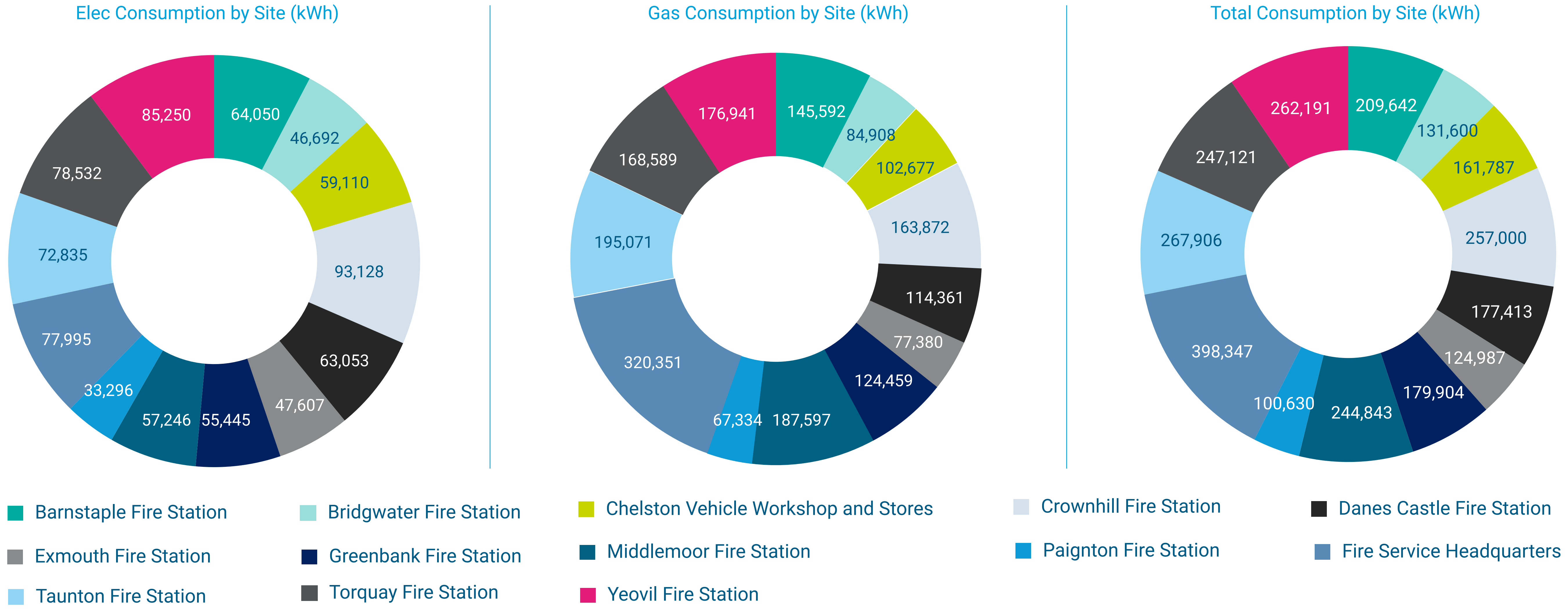
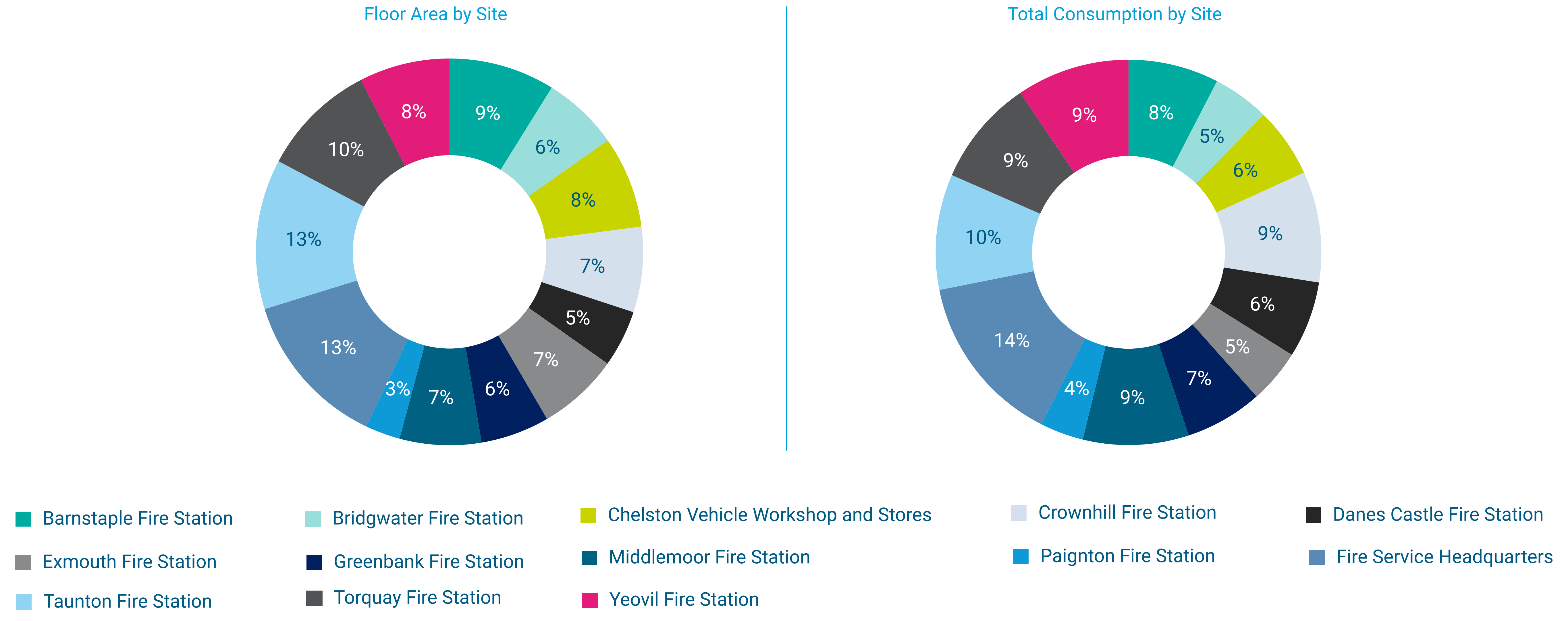


Figure 7.

Floor area and Consumption by site

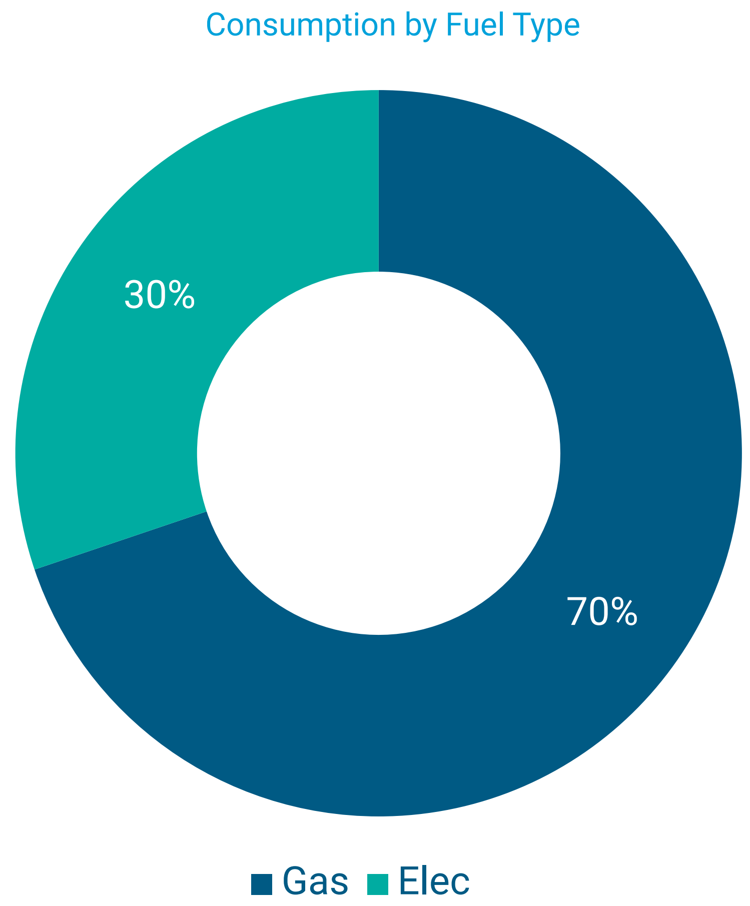


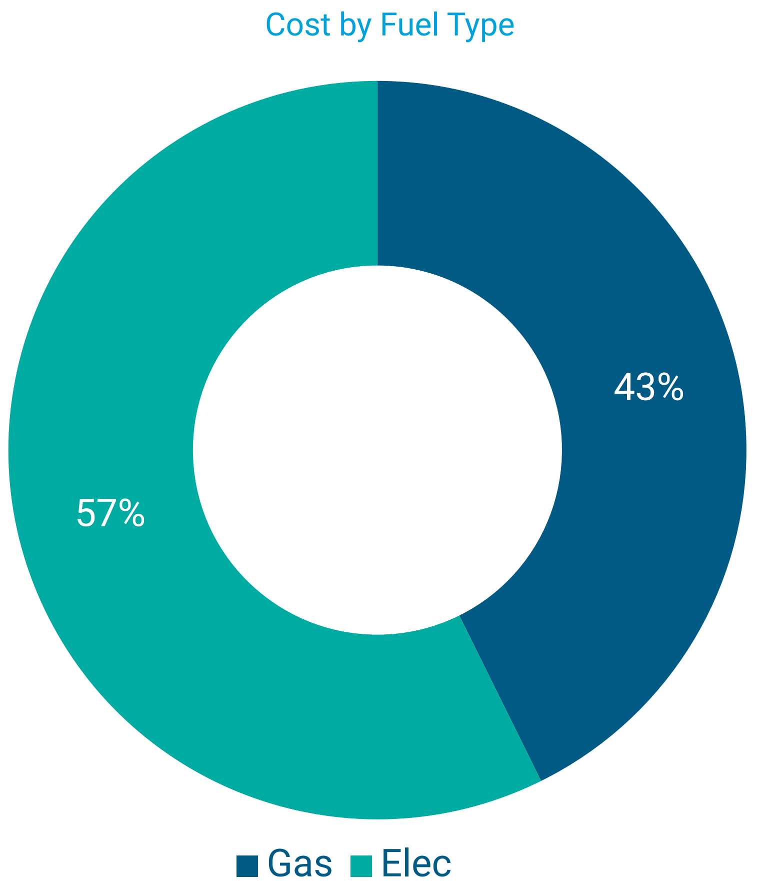
SHQ is the highest consumer of energy across the estate, with 14% of the total consumption at 398,347kWh (Figure 6/7) which is almost directly in line with its 13% coverage of the floor area of the estate. As previously discussed, and in line with all other sites in the estate, gas accounts for the majority of this consumption, with an overall gas consumption of 320,351kWh compared to electricity's 77,995kWh.

Compared to their footprint, Crownhill, Middlemoor, Yeovil, Danes Castle, Greenbank, SHQ, Torquay and Paignton all consume a higher proportion, but this is relatively negligible, in the magnitude of 1-2%. Taunton and Chelston both consume a lower proportion of the split than their relative footprint, with Chelston this would be expected due to the differing site usage over a large footprint, and for Taunton this is likely due to the larger footprint of the site compared to most of the other stations.

Figure 8.

Fuel consumption and cost by fuel type, all sites.



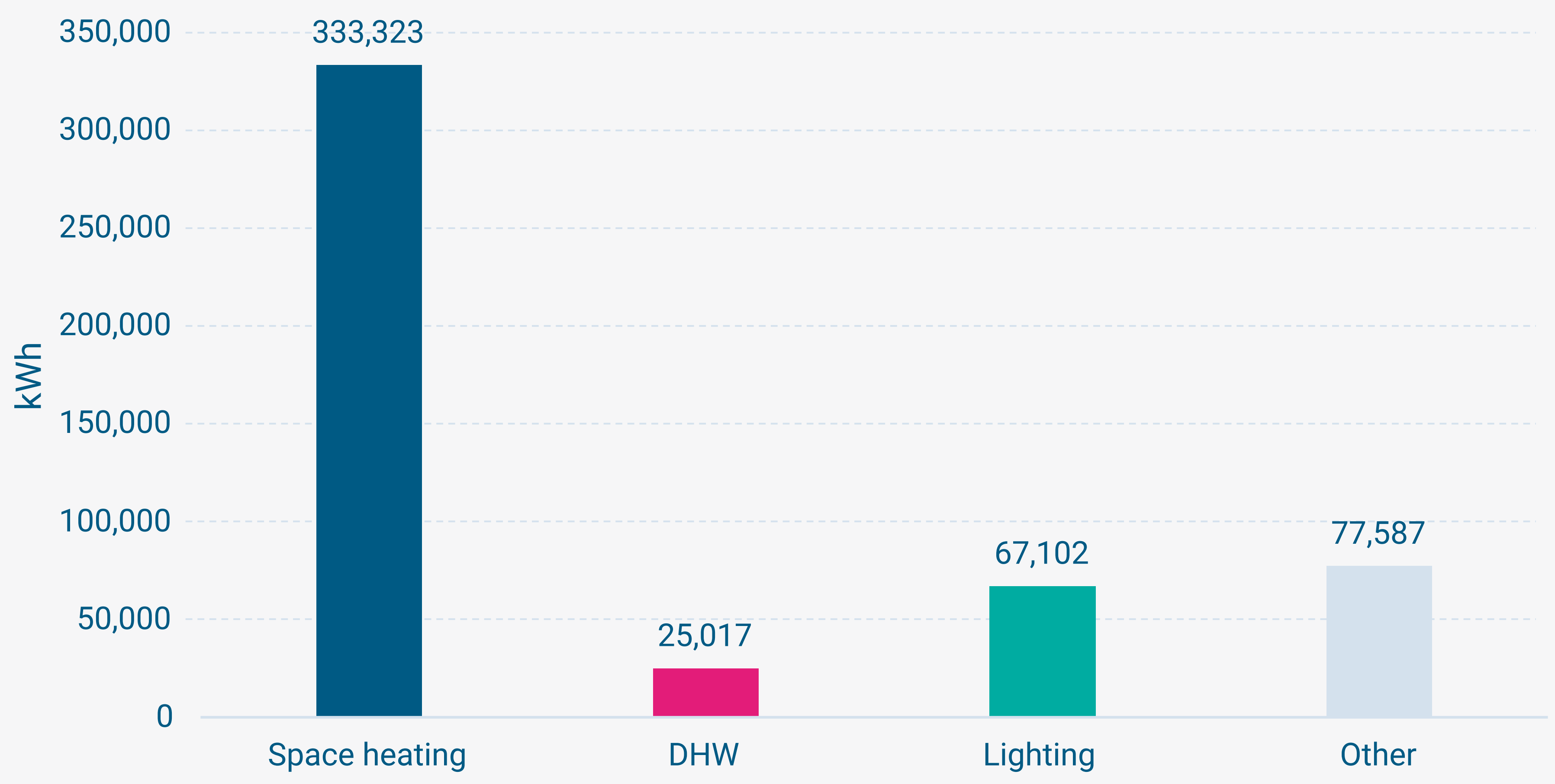


All sites have a higher gas consumption than electricity consumption and overall, gas consumption accounts for 70% (Figure 8) of the overall consumption evidencing the need for decarbonisation, however electricity accounts for 57% of the total cost, highlighting the need to focus on onsite production and movement away from the grid. Detailed costs for individual site spend on both Gas and Electric are found in the Appendix G.

This large reliance on fossil fuel (70% of total consumption), offers a good opportunity for decarbonisation through electrification of the heating and Domestic Hot Water (DHW) systems. There is no oil or Liquified Petroleum Gas (LPG) consumption across these thirteen sites, with efforts made already on the aforementioned sites to reduce reliance on the grid through PV arrays.

Figure 9.

Combined on-site energy consumption



Baselined data highlights space heating as the highest cause of consumption across the thirteen sites, with a calculated 333,323kWh yearly. 'Other' elements such as ventilation i.e. extract fans in appliance bays, and general electric consumption i.e. computers etc, as well as other gas usage such as kitchens, accounts for 77,587kWh, with lighting at 67,102kWH. This evidences the fact that heating should be priority for decarbonisation.

Display Energy Certificates (DEC)

Since July 2015, it has been a requirement that a DEC is produced for all non-domestic public buildings which have a useful floor area of 250m^2 or above and meet certain criteria with the aim to raise public awareness of energy use and to inform visitors to the energy use of a building.

DEC's must be prominently displayed in the entrance to the building. The DEC is based on actual energy consumption and includes the benefit of any on-site renewable technologies. It provides an 'operational rating' on a scale of A to G, with 'A' being the most efficient and 'G' being less efficient (similar to domestic white goods energy labelling). The score gives a comparative rating, assessing the consumption against industry benchmarks for a particular type of building.

The DEC also shows the associated annual CO_2e emissions. For buildings between 250-1000m^2 a DEC is valid for 10 years and those above 1000m^2 are valid for 1 year. A DEC is also accompanied by an Advisory Report which gives recommendations for improving the energy performance of the building (e.g. upgrades to the building fabric or services, and opportunities for the installation of low and zero carbon technologies).

DEC ratings are available for most public buildings, apart from those which are exempt and those which are not visited by the public. DEC operational ratings for each building were provided by the Service and if missing were found on the government DEC database. The typical operational rating score for a public building is 100. This typical score gives an operational rating band of "D". Buildings with lower band ratings (E-G) offer a greater "potential" for energy savings.

Table 3.

Display Energy Certificates for the thirteen estate.

Site	Postcode	DEC
Barnstaple Fire Station	EX31 1PA	C
Bridgwater Fire Station	TA6 5JT	B
Chelston Vehicle Workshop and Stores	TA21 9JH	B
Crownhill Fire Station	PL5 3AN	E
Danes Castle Fire Station	EX4 4LP	D
Exmouth Fire Station	EX8 2NR	C
Greenbank Fire Station	PL4 7JQ	C
Middlemoor Fire Station	EX2 7AP	C
Paignton Fire Station	TQ3 2SH	N/A
Service Headquarters	EX3 0NW	E
Taunton Fire Station	TA1 2LB	B
Torquay Fire Station	TQ2 7AD	C
Yeovil Fire Station	BA20 1JF	E

5. Resources

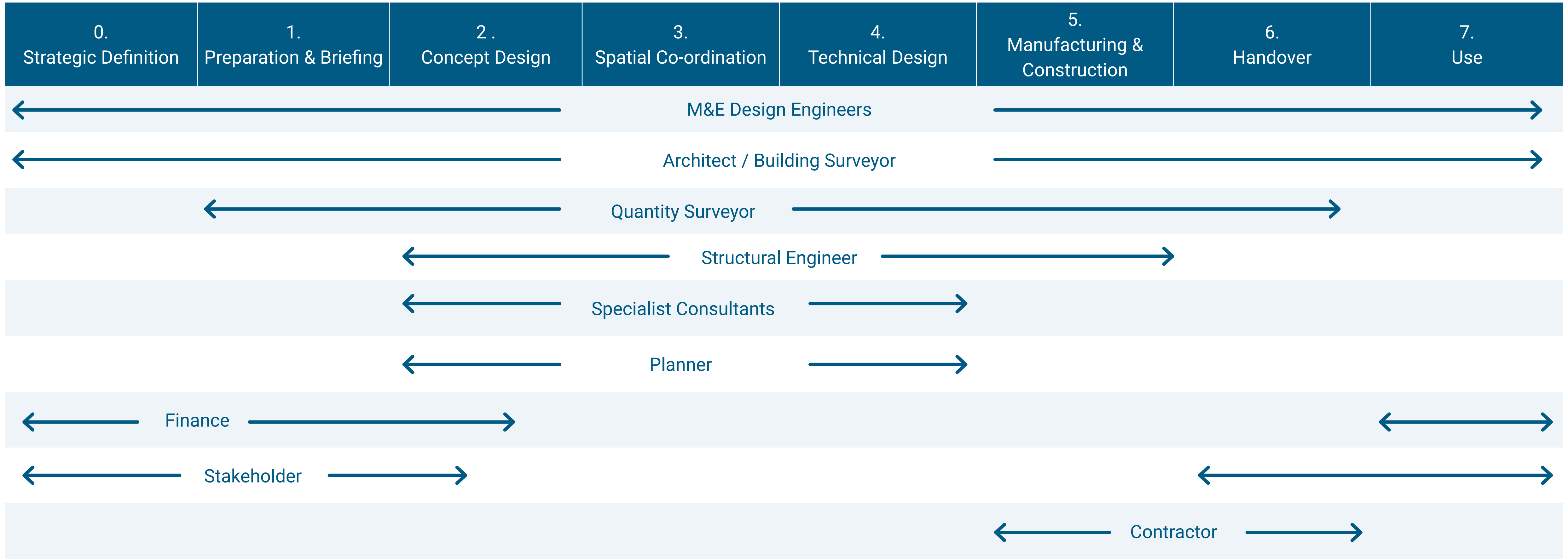
The Devon and Somerset Fire and Rescue Service Estates Department, specifically Nigel Harvey (Property Manager, FM, Special Projects) will be responsible for overseeing the implementation of the decarbonisation plan for the estate.

Aimee Lee is Category Manager overseeing procurement and contracts for Estates and Environmental and thus is lead for any purchasing and projects undertaken across the sites.

The Estates Department are appropriately qualified, experienced, and trained to manage the required works, however additional external human and financial resources will be required to deliver the retrofit interventions, such as specialist consultants and contractors. These required resources for the project are illustrated in the following figure against the RIBA plan of work stages. The additional resources required will depend on the funding available which will determine the project scope, and would be highly dependent on how the works are packaged i.e. site by site, individual packages per intervention, or one overall package across the estate. It would be expected that if all interventions were to be pursued for an individual site, this could take an expected 2-3 years, however with multiple projects ongoing this timeframe could be kept from expanding across the estate i.e. these programmes would overlap and not stack, allowing for completion of all projects by the 2030 targets.

Figure 10.

Plan of work stages



Internally, it would be expected that a dedicated project manager from the estates team would average a days work a week for the period of construction, to liaise with the primary contractor and specialist consultants. Support from the wider estate team would be necessary throughout a project lifespan, however the majority of the work would be picked up by the main contractor.

6. Previous & Existing Efficiency Projects

The Service has been proactive in implementing energy saving measures across parts of the estate. The most recent energy saving projects are listed in the tables below.

Table 4.

Energy saving projects undertaken

Completed:		
Yeovil	PV 12.32kW	2019
Torquay	PV 3.17kW, 3.84kW, est.23kW	2011, 2011, 2023
Middlemoor	PV 2.72kW	2008
Danes Castle	PV est 2.8kW	2009
Bridgwater	PV 11.8kW	2017
Various sites	Some sites have had full LED upgrade as a rollout programme is being undertaken by the Service's in-house Electrician.	Multiple

Planned for 2023 and beyond:	
Site:	Works Description:
Various Sites	EV Charging Ports are currently planned to be rolled out across various sites in the estate, with some of these works already being undertaken. Whilst transport carbon is outside of the scope of this report, it is important to be aware of additional electrical loads resulting from other decarbonisation interventions.

Surveys have been undertaken at all sites to assess potential for fabric improvements, LED upgrades, solar PV, controls upgrades and to assess the practicality of introducing low carbon heating within the buildings.

7. On-Site Opportunities

This section of the report provides an overview of the technologies considered to be most relevant to the decarbonisation of the 13 sites, in line with the three key elements:

Energy Efficiency: Increasing energy efficiency by reducing demand.

Heat: Decarbonising heat.

Power: Increasing renewable energy supply.

Stage 1 – Energy Efficiency

Behaviour Change

Behaviour Change and Internal Policy is the first step in energy demand reduction and is a key driver in facilitating and embedding an energy saving culture. An effective behaviour change policy focuses on internal policy, culture, and changing everyday behaviour to improve efficiencies. Behaviour change interventions are generally the least financially intensive and therefore represent quick wins. As a behaviour change scheme is usually undertaken across the full estate, this will have far reaching benefits across all of the Services properties.

Energy Conscious Organisation (EnCO) provides a good framework for this initiative which should be explored. The EnCO process analyses the current position of the organisation in terms of energy awareness and performance and provides a framework / programme to drive change and deliver energy savings.

Behavioural change in individuals can be targeted through teaching aids, face-to-face learning, energy roles and rewards for good practice. EnCO highlights various steps that can be implemented to facilitate behaviour change that can be applied to all members of the Service.

- Making it visual helps us remember. Implementing posters around the station can act as a regular reminder of the Service's energy initiatives and the benefits this can bring, with poster packs seen on site during the audits. Expanding these into posters showing specific conversions i.e. X amount of time a light is left on is X kg of CO_2eq would help building users to visualise the savings being made.
- It is recommended that day and night shift Energy Champions are appointed to raise awareness and lead the change programmes. People respond best to face-to-face interaction which can be met through the role of an Energy Champion. An Energy Champion can model the attitudes and behaviours the Service is seeking to influence, and can lead by example in encouraging their peers to follow suit.
- Where the building user base is composed of various teams/shifts, competitions can be ran and encouraged covering on-shift energy saving, boosting engagement with one another in a healthy manner, and potentially speeding up any energy saving gains. This could be applied at an inter-station level also, with leader boards for most energy consumption reduction month on month.
- 'Lunch and Learns', where specific information and advice is shared from the Energy
- Establish incentives and recognition programs to acknowledge and reward individuals or teams that consistently demonstrate energy-efficient behaviours. Recognising their contributions can boost morale, promote healthy competition, and reinforce the importance of sustainable practices. Incentives can range from monetary rewards to additional paid time off or other non-financial incentives that align with the Service's policies and resources.

Behavioural change highlights that the Service's most important asset for the delivery of reducing carbon is its' people. Raising awareness and increasing knowledge and skills through a behaviour change programme will be crucial to the next steps towards decarbonisation.

Building Fabric Opportunities

Improving the existing fabric thermal performance is a key factor of energy demand reduction and has interdependencies with the delivery of the M&E interventions and in particular, the installation of heat pump systems. Increasing insulation and improving U-values reduces the heat loss from a building, which saves energy, and also improves thermal comfort. There are a range of different building fabric insulation types, including; cavity wall insulation, internal or external wall insulation, loft insulation, flat roof insulation and floor insulation. From a technical perspective, improving building fabric performance is a cornerstone to any energy efficiency programme.

The benefits of improving building fabric performance are summarised below:

- Passive,
- Low maintenance,
- Long life,
- Low failure rate.

However, implementation can be complex and disruptive and implementation projects do not tend to produce quick economic paybacks. As such, fabric improvement programmes are only considered appropriate for sites where there is a clear commitment to the longer-term future of the building.

Replacing older single-glazed windows with double, or triple-glazing which will reduce heat loss. The payback periods for replacement windows are relatively long in comparison to other carbon reduction measures due to the high installation costs. The benefits of replacement windows include the potential for improved ventilation and natural daylight, which can reduce lighting energy consumption when combined with lighting control upgrades.

Cavity wall insulation is used to reduce heat loss through a cavity wall by filling the air space with material that inhibits heat transfer. This immobilises the air within the cavity (air is still the actual insulator), preventing convection, and can substantially reduce space heating costs. Without extensive surveying it's difficult to determine the presence of cavity walls and why it is important to complete inspections before embarking on insulation programmes. Recommendations in this project have been based on building cues.

Sites that are recommended to benefit from increased double glazing are Barnstaple, Crownhill, and parts of Devon House, c20%. Investigation into cavity fill is recommended for Bridgwater, Crownhill, Barnstaple, Paignton, Taunton, and the potential for Somerset and East Devon house, however we believe there to already be a good amount of insulation in these buildings already. Investigations into internal dry lining is also recommended to Devon House.

> We would recommend investigating Devon House's roof to assess the volume of pitch roof insulation in the void due to the age of the building, pitched roof insulation to Taunton, with flat roof insulation recommended for Yeovil, Torquay, Paignton and Barnstaple.

LED Lighting

LED lighting technology has developed rapidly in the last decade, delivering significant energy savings in use compared to fluorescent, sodium, and metal halide lamp types.

A further programme of LED lighting replacement across the sites would represent a "quick win" for reducing energy demand and operational costs. An LED upgrade involves replacing less efficient lighting systems with higher efficiency LED luminaires and, where possible, incorporating improved controls. LEDs are a highly efficient lighting technology and typically have a longer life than older lighting technologies. Due to their increased efficiency, LEDs also emit less heat.

LED is known as a "quick win" because implementation is quick, and the consumption reduction realised immediately. As highlighted in Table 5, the Service has begun to make progress in upgrade light fittings to LEDs. LED upgrades are still recommended for the majority of sites, with upgrades and installation for 90% of the lights recommended in Chelston, Torquay, Barnstaple and Crownhill. The sites with full LED, so no recommendation, are Danes Castle, Exmouth, Middlemoor, and Paignton.

If the Service were to undertake a lighting upgrade for the 13 sites and replacement to LED, this would cost an estimated £336,414, saving 108,093kWh per annum, or 21 tCO_2eq.

Fans, Motors, and Pumps

Heating, ventilation, and cooling (HVAC) plant is used to distribute air, and hot and cold water within a building, to provide a comfortable and healthy environment.

Integral to these distribution systems are fans, motors, and pumps. Developments in fan, motor and pump technologies mean that new, more energy-efficient technologies and improved control systems are available that can reduce electricity consumption in buildings.

Ventilation throughout the sites is generally by local extract fans, typically wall extracts and toilet extracts. Ideally controlled supply and extract systems with a heat recovery facility are the optimum solution for an energy efficient solution, however this is not always practical when extract fans are remote and there are site limitation for installation of such systems. Some sites, such as Greenbank, already utilise Mechanical Ventilation Heat Recover (MVHR) in the mess rooms to capture excess heat from cooking, and we would recommend expanding this across all sites. Air quality sensors would also be recommended in the appliance bays to control fume extracts where these are not already in place. For Chelston, we would recommend MVHR installation in toilets and offices.

BMS and Energy Metering

Building Management Systems (BMS) are integrated systems for monitoring and controlling energy-related building services. These systems control and monitor heating, ventilation and air conditioning systems, lighting, and power systems.

A BMS provides real-time remote monitoring and integrated control of plant and equipment. A BMS can also monitor modes of operation, internal and external environmental conditions, and energy use. Hours of operation and set points can be adjusted to optimise performance and comfort. For larger buildings, or sites with multiple buildings, the integration of systems operated through a BMS, provides enhanced control with the potential to achieve significant energy savings. Metering is a key component of effective energy management and a BEMS can monitor utility meters as well as sub-meters for electricity and heat.

All sites have localised Trend BMS systems on the majority of boilers, with some local timeclock control on the hot water systems. We would strongly recommend upgrading to a new, remotely managed BMS that gives the Service the ability to set parameters controlling the heating i.e. what temperatures it turns on and off, as well as allowing for interrogation of plant where it is believed to be over/under worked. There are many remote BMS systems, some that are capable of integrating to trend, and some that would necessitate full switchover, which allow the user to view the entire estate, schematics of the heating systems, rules in place, and remotely trigger heating systems on and off. This also allows for reporting of the plant usage, an element vital for understanding the Service's energy usage.

If the BMS system is upgraded to allow for complete remote control and managing across the estate, an estimated 237,233 kWh could be saved yearly, or 44tCO_2eq – This would call for an investment of £428,280.

Stage 2 - Heat

Heat Decarbonisation

Currently, the main alternative to fossil fuel heating is heat pump technology. Where viable, these technologies will need to progressively replace the existing fossil fuel heating plant across the Service's estate. There are limited water sources, waste heat, heat recovery or energy from waste opportunities within the estate boundaries and air source heat pumps are the most viable form of heat pump. ASHP technology is summarised below.

Air Source Heat Pumps (ASHP) –These can be Air to Air or Air to Water arrangements. Previously, only Air to Water technology was supported for Government funding but recently Air to Air has been approved for funding.

ASHP (air-water) systems operate with the greatest efficiency when delivering a low flow temperature (<55°C). They can operate at 65°C to satisfy domestic hot water demands (requiring stored water at 60°C) with an associated decrease in seasonal efficiency. They can also operate at 80°C when a 2-stage arrangement is used and can be installed as a direct replacement for existing boilers serving heating systems which operate with higher flow temperatures (80°C). As expected, there is a further associated decrease in efficiency for these systems.

ASHP (air-air) heat pumps have predominately been used in offices and retail buildings in the past but are becoming more common in other types of buildings due to the lower installation costs and space requirements when compared to air-water heat pumps They also offer the added benefit of cooling operation when in reverse cycle operation. These systems are more commonly known as VRV or spit air conditioning systems.

Figure 11.

Simplified diagram of an Air Source Heat Pump

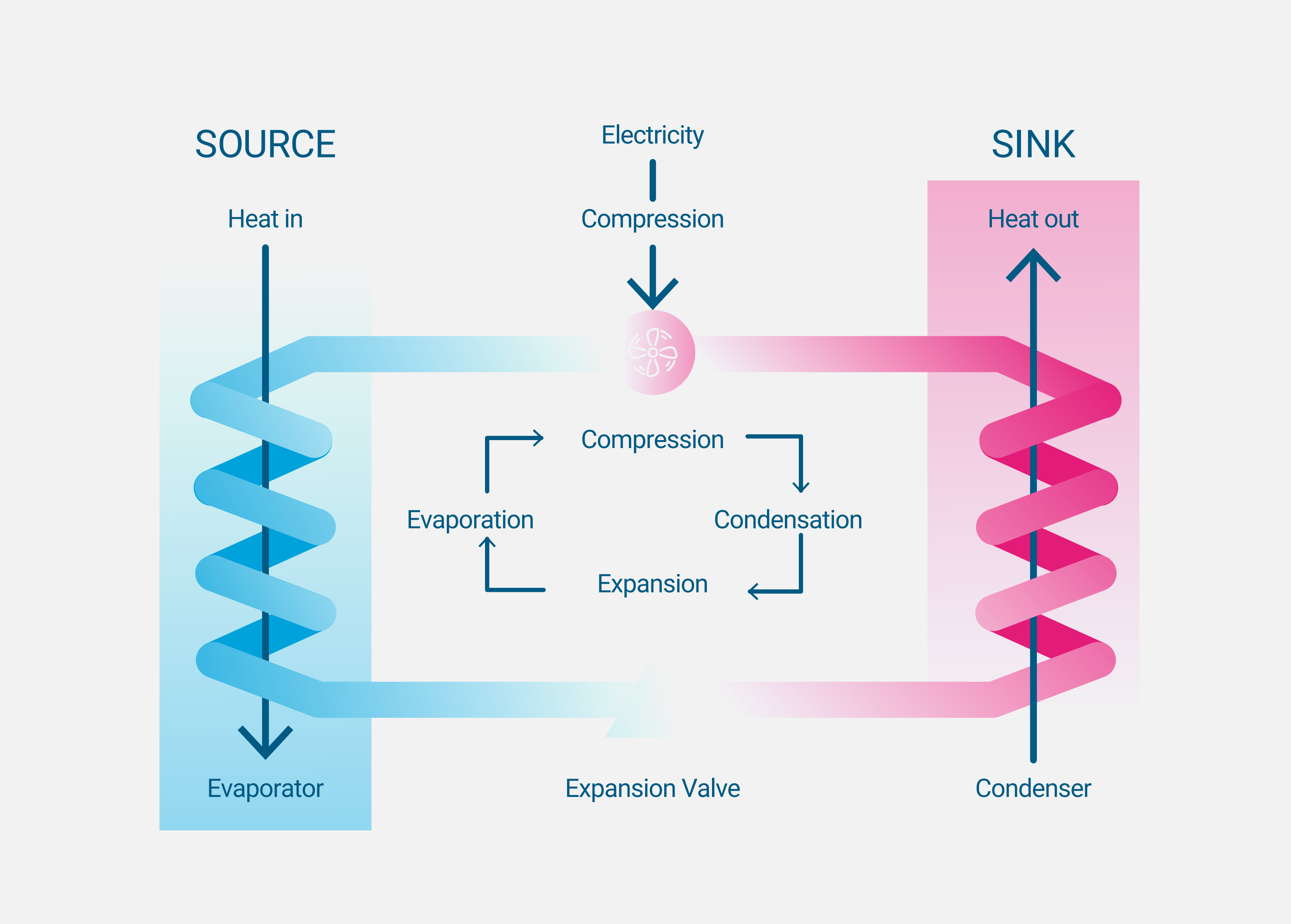


Image source: Heat Pump Association

https://www.heatpumps.org.uk/consumers/heat-pump-technical-information/the-vapour-compression-cycle/

Ground Source Heat Pumps (Open loop) – These systems require an aquifer (large body of underground water) or lake/river. These systems have a higher efficiency than air source heat pumps as the water provides a more consistent temperature low grade heat source and in winter conditions, these systems continue to operate without the need to operate "defrost cycles".

Ground Source Heat Pumps (Closed loop) – Whilst these systems operate using a more consistent heat rejection temperature (below ground temperatures of 8-12°C), these systems are significantly more expensive to install than air source heat pumps. The increase in seasonal efficiency is generally not large enough to offset the additional installation costs. These systems could be considered for any projects where an ASHP solution is not likely to be viable due to noise considerations, or where efficiency is paramount, and funding is available.

The proposed decarbonisation solutions for the thirteen sites are ASHPs with a combination of air to air and air to water systems.

The main challenges with the implementation of ASHPs include:

- **Heating system operating temperatures** and heat emitter sizes – existing gas and oil heating systems tend to operate at higher temperatures than most heat pumps. Although there are now heat pump manufacturers which can match existing temperatures for retrofit boiler applications, this comes at the cost of a much lower system efficiency. For most low temperature heat pump installations, full or part system replacements are necessary, which has implications on cost and additional project considerations.
- **Increased electrical draw** on the grid from the enhanced electrical intake needed to run a complete heating system. Even if no upgrade is needed, permission to connect is still necessary, and any site may need to have the incoming capacity upgraded through work and cost with the local DNO, which itself can incur delays to programme. Early engagement with DNO is vital to understand the need for any capacity upgrade to allow for early resourcing and planning.
- **Heating system water treatment** – chemical inhibitors are added to heating system water to prolong the life of the equipment. With a change of equipment and operating temperatures this regime will need to change.
- **Noise from air source heat pumps** – heat pump systems may operate overnight/early hours of the morning. Acoustic enclosures or screens may be required in residential areas and planning is usually required.
- **Outside space required for the air source heat pump** condensers and internal plant room space for additional buffer vessels is required. In general, ASHPs are much larger than the boilers they will be replacing. The table below gives a comparison of the size and weight differences for a 50kW boiler and a 50kW heat pump.
- **If large quantities of domestic hot water are required** over a short time frame (e.g. station kitchens, showering facilities etc.) There is likely to be a requirement for water to be stored at 60°C. ASHPs which can generate water at 65°C will be required. Consideration should be given to providing local point of use electric water heaters where this is practical.
- **Gas and oil boilers** are repaired promptly through established FM supply chain arrangements. ASHPs are a relatively new technology and heating companies will need to re-skill service engineers and the industry will need to develop new supply chain partners to ensure required components are easily available.
- **ASHP systems run wholly off of electricity,** and will likely be the largest consumer of electricity on site. Due to the large draw on the electrical supply to a site, it is imperative to understand the local DNO (District Network Operator) capacity, as well as understanding individual sites electrical supply capacity, and volume of use. For example, a large ASHP may require an upgrade to the supply to a site, or a full upgrade to the cable running all the way back to the substation. Once ASHP installation has been decided on as the low carbon heating solution, early engagement with the local DNO would be necessary, to ensure any upgrades are known and implemented ahead of time. Further detail is given in Section 10.

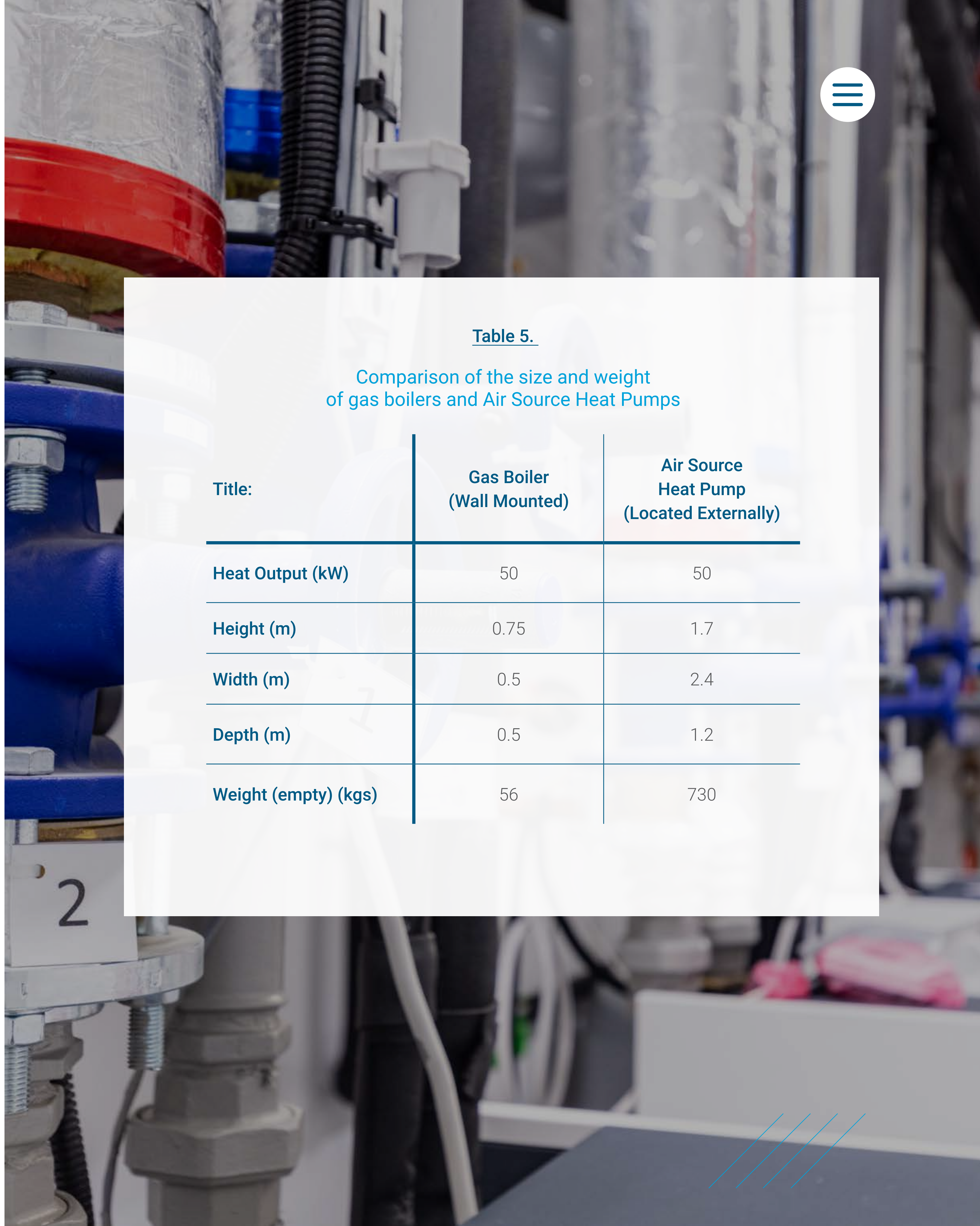


Table 5.

Comparison of the size and weight of gas boilers and Air Source Heat Pumps

Title:	Gas Boiler (Wall Mounted)	Air Source Heat Pump (Located Externally)
Heat Output (kW)	50	50
Height (m)	0.75	1.7
Width (m)	0.5	2.4
Depth (m)	0.5	1.2
Weight (empty) (kgs)	56	730

The following conventions have been adopted when assessing the option for decarbonising the heat source within the thirteen sites:

Table 6.

Prioritisation when assessing options of heat source decarbonisation

Item:	Description:
Priority 1:	**For sites with obsolete heating installations** Replace entire heating system (heat source and distribution/emitters) with an ASHP solution using low temperature distribution. Domestic hot water provision to be provided by the ASHP (boosted by electrical immersions) for properties with sufficient demand (determined by Domestic Hot Water System (DHWS) consumption monitoring). Where DHWS demand does not require the provision of centralised storage, point of use electric water heaters are recommended.
Priority 2	**For smaller sites with obsolete boilers/distribution systems** Install ASHP or split DX/VRV replacement installation and electric point of use water heaters.
Priority 3	**Sites with obsolete boilers but fair condition distribution** Retain distribution and emitters and install an ASHP solution to match the existing high temperature distribution. Domestic hot water provision to be provided by the ASHP for properties with sufficient demand (determined by DHWS consumption monitoring). Where DHWS demand does not require the provision of centralised storage, point of use electric water heaters are recommended.
Priority 4	**For sites with new boilers and installations and old DHWS** Retain heating system. Domestic hot water provision to be provided by ASHP for properties with sufficient demand (determined by DHWS consumption monitoring). Where DHWS demand does not require the provision of centralised storage, point of use electric water heaters are recommended.
Priority 5	**For sites with new boilers, installations and DHWS in fair condition** Defer to end of HDP programme and review new technologies available before commencing decarbonisation. If no preferable technology is available, install an ASHP solution to match the existing high temperature distribution. Domestic hot water provision to be provided by the ASHP for properties with sufficient demand (determined by DHWS consumption monitoring). Where DHWS demand does not require the provision of centralised storage, point of use electric water heaters are recommended.

Using the above prioritisation (Table 6), combined with building information gathered from the site audits, the following conventions have been recommended for heating systems across the thirteen sites:

Bridgwater fire station

Heating for the main building is currently provided by 2 Potterton gas boilers which were installed as part of a boiler house refit in 2020, and thus are in good condition.

Domestic hot water is provided by an indirect LTHW twin Coil Cylinder with Solar Thermal support, powered by a Gloworm system boiler, also installed as part of the 2020 refit, with new internal distribution pipework installed 1 year ago.

The proposed heating solution would be to replace the gas boilers with an ASHP air to water solution to serve the building. A Medium Temperature (MT) ASHP would provide enhanced efficiency, assuming the heating can be satisfied at 65°C, however if not then a High Temperature (HT) solution can be implemented. ASHP (air to water) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas. The existing distribution pipework will be retained as it is new and in good condition.

Heating to the appliance bay is provided by LTHW unit heaters served from boilers noted above. It is recommended that separate electric radiant heating, interlocked with roller shutter doors, is installed. Radiant Heating refers to infrared panels that heat objects and people through radiant heat, however do not heat the air, allowing for higher efficiencies. This also means that 'hot air' is not lost when the roller doors open. As the system is only 3 years old and unit heaters are already interlocked this is a low priority.

The DHWS could be decentralised but as a HT or MT ASHP is proposed it makes sense to retain the centralised DHWS to serve showers and local DHWS. POU electric water heaters are proposed in remote locations to reduce losses from long runs of DHWS pipework.

Crownhill fire station

Heating for the main building is currently provided by 2 Broag Remeha Quinta Pro 90 boilers installed in 2011, with pipework well beyond its design life at 50+ years old.

Domestic hot water is provided by an Andrews gas water heater, 4 POU electric showers and 3 zip water boilers.

The proposed heating solution would be to replace the existing boilers and distribution pipework with an ASHP air to air Variable Refrigerant Flow (VRF) system. ASHP (air to air) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas.

Heating to the appliance bay is provided by LTHW Unit Heaters served from boilers noted above. It is recommended that separate electric radiant heating, interlocked with roller shutter doors, is installed.

It is proposed that the DHWS is decentralised, replacing the central gas fired calorifier with POU electric water heaters and electric showers. This will decarbonise the system and reduce losses from long runs of DHWS pipework.

Using the above prioritisation (Table 6), combined with building information gathered from the site audits, the following conventions have been recommended for heating systems across the thirteen sites:

Danes Castle fire station

Heating for the main building is currently provided by Combined Heat and Power plant backed up with 2 Ideal IMAX Gas Boilers, all 14 years old in reasonable condition.

Domestic hot water is provided by a LTHW Calorifier which serves the whole building and two zip water boilers serving the kitchen/canteen.

As the existing boilers are approaching end of life, the proposed heating solution would be to replace these with a ASHP (Air to Water), whilst retaining the distribution pipework and emitters as these are not end of life. A Medium Temperature (MT) ASHP would provide enhanced efficiency, assuming the heating can be satisfied at 65ºC, however if not then a High Temperature (HT) solution can be implemented. ASHP (air to water) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas.

Heating to the appliance bay is provided by three Unit Heaters served from boilers noted above. It is recommended that separate electric radiant heating, interlocked with roller shutter doors, is installed.

DHWS could be decentralised but as a HT or MT ASHP is proposed it makes sense to retain centralised DHWS to serve showers and local DHWS. Remote locations to have POU electric water heaters to reduce losses from long runs of DHWS pipework.

Barnstaple fire station

Heating for the main building is currently provided by 2 Dokum Boilers (2010) serving 90% of building which are in a reasonable condition, and a 2015 Ideal Mexico boiler serving the drying room.

Domestic hot water is provided by 2 indirect cylinders, installed less than 1 year ago. The proposed heating solution for the main building would be to replace the gas boilers with an ASHP air to water solution to serve the building. A Medium Temperature (MT) ASHP would provide enhanced efficiency, assuming the heating can be satisfied at 65ºC, however if not then a High Temperature (HT) solution can be implemented. ASHP (air to water) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas. The existing distribution pipework will be retained as it is in good condition and not end of life.

Heating for the training hub is currently provided by 3 electric fan convectors serving the office, 2 electric radiant fire heaters serving approximately 50 square meters (15 years old), and a 2017 combi boiler serving approximately 70 square meters (6 years old). Domestic hot water is provided by POU electric showers and the combi boiler.

The proposed heating solution for the training hub is to replace the existing combi boiler with a small ASHP air to water Variable Refrigerant Flow (VRF) system. In addition to this it is recommended that the electric fires and electric fan convector are replaced for improved efficiency and served from the new ASHP.

Heating to the appliance bay is provided by Unit Heaters served from boilers noted above. It is recommended that separate electric radiant heating, interlocked with roller shutter doors, is installed.

The DHWS could be decentralised but as a HT or MT ASHP is proposed it makes sense to retain the centralised DHWS to serve showers and local DHWS. POU electric water heaters are proposed in remote locations to reduce losses from long runs of DHWS pipework.

Using the above prioritisation (Table 6), combined with building information gathered from the site audits, the following conventions have been recommended for heating systems across the thirteen sites:

Exmouth fire station

Heating for the main building is currently provided by 3 Vaillant boilers which are 22 years old, and in poor condition.

Domestic hot water is provided by a LTHW indirect cylinder (also 22 years old), an electric shower and 3 zip water boilers.

The proposed heating solution would be to replace the existing boilers and distribution pipework with an ASHP air to air Variable Refrigerant Flow (VRF) system. ASHP (air to air) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas. Where the heating for Exmouth is also supplying heat to the conjoined Ambulance station, this would mean a full switch out of VRV emitters in the ambulance unit also (air conditioning units) to provide heating and cooling. It is advised that this solution would need to be a combined project from the Service and the Ambulance Service due to the complete removal of the original heating system.

Heating to the appliance bay is provided by a gas fired unit heater. It is recommended that separate electric radiant heating, interlocked with roller shutter doors, is installed.

It is proposed that the DHWS is decentralised, replacing the central gas fired calorifier with POU electric water heaters and electric showers. Where the DHW is decentralised, and the LTHW heater removed, this would also call for POU heaters and electric showers in the Ambulance station. This will decarbonise the system and reduce losses from long runs of DHWS pipework.

Greenbank fire station

Heating for the main building is currently provided by 2 Remeha Quinta boilers which are 17 years old and thus near to EOL.

Domestic hot water is provided by an indirect cylinder (18 years old) and a zip boiler serving the kitchen.

As the existing boilers are approaching end of life, the proposed heating solution would be to replace these with a ASHP (Air to Water), whilst retaining the distribution pipework and emitters as these are not end of life. A Medium Temperature (MT) ASHP would provide enhanced efficiency, assuming the heating can be satisfied at $65^{o}C$, however if not then a High Temperature (HT) solution can be implemented. ASHP (air to water) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas.

Heating to the appliance bay is provided by LTHW unit heaters served from boilers noted above. It is recommended that separate electric radiant heating, interlocked with roller shutter doors, is installed.

The DHWS could be decentralised but as a HT or MT ASHP is proposed it makes sense to retain the centralised DHWS to serve showers and local DHWS. POU electric water heaters are proposed in remote locations to reduce losses from long runs of DHWS pipework.

Using the above prioritisation (Table 6), combined with building information gathered from the site audits, the following conventions have been recommended for heating systems across the thirteen sites:

Middlemoor fire station

Heating for the main building is currently provided by 3 gas boilers which are 13 years old. A Senertec HKA g S1 CHP feeds into a 700l buffer vessel, backed up by 2 Ideal Imax Gas Boilers. Domestic hot water is provided by a LTHW Calorifier and 2 zip water boilers, all 13 years old.

As the existing boilers are approaching end of life, the proposed heating solution would be to replace these with a ASHP (Air to Water), whilst retaining the distribution pipework and emitters as these are not end of life. A Medium Temperature (MT) ASHP would provide enhanced efficiency, assuming the heating can be satisfied at 65ºC, however if not then a High Temperature (HT) solution can be implemented. ASHP (air to water) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas.

Heating to the appliance bay is provided by 3 unit heaters served from boilers noted above. It is recommended that separate electric radiant heating, interlocked with roller shutter doors, is installed.

The DHWS could be decentralised but as a HT or MT ASHP is proposed it makes sense to retain the centralised DHWS to serve showers and local DHWS. POU electric water heaters are proposed in remote locations to reduce losses from long runs of DHWS pipework.

Paignton fire station

Heating for the main building is currently provided by 2 Hamworthy gas boilers. Domestic hot water is provided by a LTHW indirect cylinder and 4 electric POU showers. All boilers were renewed 3 years ago but most of the distribution pipework and emitters are 50+ years old.

The proposed heating solution for the main building would be to replace the existing boilers and distribution pipework with an ASHP air to air Variable Refrigerant Flow (VRF) system. ASHP (air to air) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas.

The appliance area features redundant under floor heating which is no longer working. Electric radiant tubes (possibly oil filled) have since been fitted to provide heating to the area and these are 15 years old. It is recommended that new separate electric radiant heating, interlocked with roller shutter doors, is installed.

It is proposed that the DHWS is decentralised, replacing the LTHW indirect calorifier with POU electric water heaters (showers are already electric). This will decarbonise the system and reduce losses from long runs of DHWS pipework.

Using the above prioritisation (Table 6), combined with building information gathered from the site audits, the following conventions have been recommended for heating systems across the thirteen sites:

Taunton fire station

Heating for the main building is currently provided by 2 Hamworthy gas boilers. Domestic hot water is provided by a 25 year old indirect cylinder. All boilers were renewed 5 years ago but most of the distribution pipework and emitters are 50+ years old.

The proposed heating solution for the main building would be to replace the existing boilers and distribution pipework with an ASHP air to air Variable Refrigerant Flow (VRF) system. ASHP (air to air) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas.

Heating to the appliance bay is provided by 2 direct gas fired unit heaters. It is recommended that new separate electric radiant heating, interlocked with roller shutter doors, is installed.

It is proposed that the DHWS is decentralised, replacing the LTHW indirect calorifier with POU electric water heaters and showers. This will decarbonise the system and reduce losses from long runs of DHWS pipework.

Torquay fire station

Heating for the main building is currently provided by 2 gas fired boilers, renewed 8 years ago, and a combi boiler which is over 25 years old. Domestic hot water is provided by the combi boiler, a gas fired water heater (25 years old), 7 electric showers and 3 zip boilers. Most of the distribution pipework and emitters are over 50 years old.

The proposed heating solution for the main building would be to replace the existing boilers and distribution pipework with an ASHP air to air Variable Refrigerant Flow (VRF) system. ASHP (air to air) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas.

Heating to the appliance bay is provided by 2 direct gas fired unit heaters. It is recommended that new separate electric radiant heating, interlocked with roller shutter doors, is installed.

It is proposed that the DHWS is decentralised, replacing the LTHW indirect calorifier with POU electric water heaters, retaining the existing electric showers. This will decarbonise the system and reduce losses from long runs of DHWS pipework.

Using the above prioritisation (Table 6), combined with building information gathered from the site audits, the following conventions have been recommended for heating systems across the thirteen sites:

Yeovil fire station

The boiler house on site was rebuilt in 2006 and the main boiler was replaced a few years later in 2009. The 2 smaller boilers were replaced in 2016; since then, one of these boilers has broken down with a leak inside and has therefore been isolated.

Around 70% of the radiator system was replaced in 2019 but these are not operating effectively as the offices and 1st floor are overheating whilst there are complaints of the ground floor being too cold. Around 70% of the distribution pipework and emitters were replaced 17 years ago, the remainder being over 50 years old. Domestic hot water is provided by an indirect calorifier, 2 electric showers and a zip water boiler serving the kitchen.

The proposed heating solution for the main building would be to replace the existing boilers and distribution pipework with an ASHP air to air Variable Refrigerant Flow (VRF) system. ASHP (air to air) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas.

The appliance bay currently features redundant under floor heating and is currently heated by LTHW unit heaters served from the boilers above. It is recommended that new separate electric radiant heating, interlocked with roller shutter doors, is installed. This is high priority due to problems with the existing installation which has led to complaints from users that the space is cold in winter.

It is proposed that the DHWS is decentralised, replacing the direct gas fired calorifier with POU electric water heaters and electric showers (2 already installed), in order to decarbonise the system. This is high priority as there are problems with the existing installation.

Fire Service Headquarters

Heating for the site is provided via 2 boiler houses. Boiler house 1, serving buildings Devon House and Somerset House, features 2 95kW gas boilers installed in 2020. Boiler house 2, serving building East Devon House, and features 2 50kW gas boilers installed in 2004.

All distribution pipework and emitters are over 25 years old. Domestic hot water from boiler house 1 is provided by a 25 year old indirect cylinder with solar PV support and 2 back up immersions. Domestic hot water from boiler house 2 is provided by a 25 year old direct gas fired water heater.

The proposed heating solution for both sets of buildings would be to replace the existing boilers and distribution pipework with an ASHP air to air Variable Refrigerant Flow (VRF) system. ASHP (air to air) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas. It is also recommended that controlled ventilation (MVHR) is installed to prevent opening of windows and uncontrolled heat loss.

It is proposed that the DHWS is decentralised, replacing the existing calorifiers with POU electric water heaters and electric showers. This will decarbonise the system and reduce losses from long runs of DHWS pipework.

Using the above prioritisation (Table 6), combined with building information gathered from the site audits, the following conventions have been recommended for heating systems across the thirteen sites:

Chelston Vehicle Workshop and Stores

Heating for the main building is currently provided by Vaillant gas boiler, installed 20 years ago, along with distribution pipework and emitters.

Domestic hot water is provided by a direct gas fired water heater, installed 20 years ago, as well as a zip boiler serving the canteen which is 5 years old.

The proposed heating solution for the main building would be to replace the existing boilers and distribution pipework with an ASHP air to air Variable Refrigerant Flow (VRF) system. ASHP (air to air) solutions are extremely efficient with typical seasonal efficiencies of around 400%. They are also modular and allow for excellent zoning and control of different areas. It is also recommended that controlled ventilation (MVHR) is installed to prevent opening of windows and uncontrolled heat loss.

Th warehouse is heated by electric radiant heating (10 years old) and the workshop is heated by gas fired unit heaters (20 years old). It is recommended that separate electric radiant heating, interlocked with roller shutter doors, is installed in the workshop.

It is proposed that the DHWS is decentralised, replacing the indirect calorifier with POU electric water heaters and electric showers.

Stage 3 - Power

Solar PV

Solar PV is a renewable energy technology which operates by absorbing the sun's energy and converting it into electricity. A solar PV panel is assembled from individual photovoltaic cells grouped together in modules. These modules are mounted together on a panel and the panels can be connected to form an array. The electricity generated by solar PV is Direct Current (DC), whereas building appliances typically operate from an Alternating Current (AC) supply. Therefore, an inverter is installed alongside the system to convert electricity from DC to AC.

As displayed in the Previous & Existing Projects section, the Service has made good progress on Solar PV installations, with seven arrays across 5 sites within this 13-site collection. As highlighted in the Building Information section, despite being a much lower proportion of the energy mix, the cost for electricity to the Service was far higher than gas, without the estate-wide switch to electrical heating.

To support the wide-scale electrification of heating outlined in this report, it is recommended that Solar PV is installed across the estate, with wholly new installations at Crownhill, Barnstaple, Exmouth, Greenbank, Paignton, Taunton, SHQ and Chelston, as well as additional PV on those sites with existing installations. Based on our calculations, Crownhill stands to benefit the most from a PV installation with a potential 578m^2 of south facing roof available for PV. Barnstaple, Greenbank, Taunton would then be recommended as the focus point.

3,282m^2 of roof has been highlighted for potential Solar PV arrays across all thirteen sites, and we would highly recommend expanding the PV arrays currently onsite on Bridgwater, Danes Castle, Middlemoor, and Yeovil. Torquay has a potential 300m^2 available for flat roof PV installation in addition to the existing works, however it has been raised that there are no current plans to expand the array. These installations would produce in the ~567,273kWh of electrical generation per year, at an estimated cost of £667,380. The projected carbon emission savings and costs for installation have been provided in further detail in Appendices C and D.

Table 7.

Solar PV opportunities and electric generation, if installation was to occur without additional storage

Site Name	Area available for additional/new solar PV	Rating of Solar Panels (kWp)	Electrical generation from solar panels (kWh)	Cost of solar panel installation
Barnstaple Fire Station	400	80	68,000	£80,000
Bridgwater Fire Station	100	20	17,000	£20,000
Chelston Vehicle Workshop and Stores	298	63	53,193	£62,580
Crownhill Fire Station	578	116	98,260	£115,600
Danes Castle Fire Station	200	42	35,700	£42,000
Exmouth Fire Station	100	21	17,850	£21,000
Greenbank Fire Station	400	80	68,000	£80,000
Middlemoor Fire Station	200	40	34,000	£40,000
Paignton Fire Station	206	41	35,020	£41,200
Fire Service Headquarters	100	21	17,850	£21,000
Taunton Fire Station	300	63	53,550	£63,000
Torquay Fire Station	300	60	51,000	£60,000
Yeovil Fire Station	100	21	17,850	£21,000
Total	3,282	667	567,273	£667,380

Should Solar PV be considered, further investigations by specialist Solar PV consultants and structural engineers must be undertaken to determine the extent of roof suitable for PV arrays, which will ultimately determine the magnitude of electrical generation that can be produced. It must be noted that due to the potential modular system build construction, further structural consideration may be required. Post Solar investigation, we would potentially recommend feasibility of battery storage capacity to deal with excess, however due to the low payback for battery storage it is not a recommendation of this report. Payback for Solar PV batteries typically sits at around 20+ years without taking into account any DNO connection and onsite integration, however with the rising cost of electricity this is reducing, and could provide a more attractive opportunity in the future.

8. Report Findings

This Heat Decarbonisation Plan outlines a scenario for achieving Net Zero by 2030 in line with the Services targets, but also 2040 and 2050 to allow the Service to understand alternative routes. An assumption has been made that funding and expenditure will be equally spaced throughout these periods. Also, future utility pricing is based on a 6.5% inflation rate and future installation costs based on 20% inflation every 10 years (Table 12).

Tabulated results from the modelling and calculations are included in Appendix B, C, D and E. The results are graphically portrayed in the following section. The graphs illustrate that the identified decarbonisation measures discussed in this report alone will not enable the buildings to reach Net Zero Carbon. There may be new technologies that come to the market or decarbonisation of the National Grid faster than that indicated by the Government. These scenarios would facilitate quicker decarbonisation and a closer approach to Net Zero Carbon. The Service could also consider carbon offsetting measures through off-site solar PV and large-scale wind turbines. Alternatively, moving to an 100% REGO (Renewable Energy Guarantee Origin) backed electricity contract would support zero carbon energy.

Table 8.

Estimated cost of interventions by scenario

	Cost of Install				
Interventions	2030	2040	2050	tCo_2 Saving without Grid Decarbonisation	Cost per ton saved (2030)
Behaviour Change	£2,881	£3,201	£3,499	26	**£112**
Fabric Upgrades	£1,051,418	£1,168,242	£1,276,722	67	**£15,746**
LED Install	£336,414	£373,793	£408,503	21	**£16,094**
Htg & DHW Upgrade	£3,449,820	£3,833,133	£4,189,067	153	**£22,481**
PV Install	£667,380	£741,533	£810,390	110	**£6,084**
BMS Upgrade	£428,280	£475,867	£520,054	44	**£9,724**
Chiller Upgrade	£60,000	£66,667	£72,857	1	**£52,791**
Vent Upgrade	£755,000	£838,889	£916,786	5	**£140,469**
Total	**£6,751,193**	**£7,501,325**	**£8,197,877**	**427**	**£15,808**

From Table 8 it is evident that Heating and DHW upgrade has the highest costs associated with interventions, £3,449,820, but also the highest carbon savings at 153 tons. PV install is a fraction of the price of the heating upgrade, yet is predicted to make over 2/3rds as much saving through intervention at 110 tons, so if cost is a prohibitive factor, PV install and fabric upgrade measures are predicted to supply almost as much carbon saving as heating upgrade, for around half of the cost.

BMS upgrade across the estate is also highly recommended, for a relatively low cost of £428,280 there is the potential to save 44 tons of carbon through advanced monitoring and control of heating.

Figure 12.

Consumption and Carbon emission reductions

Figure 12a.

Total Consumption Change (kWh)

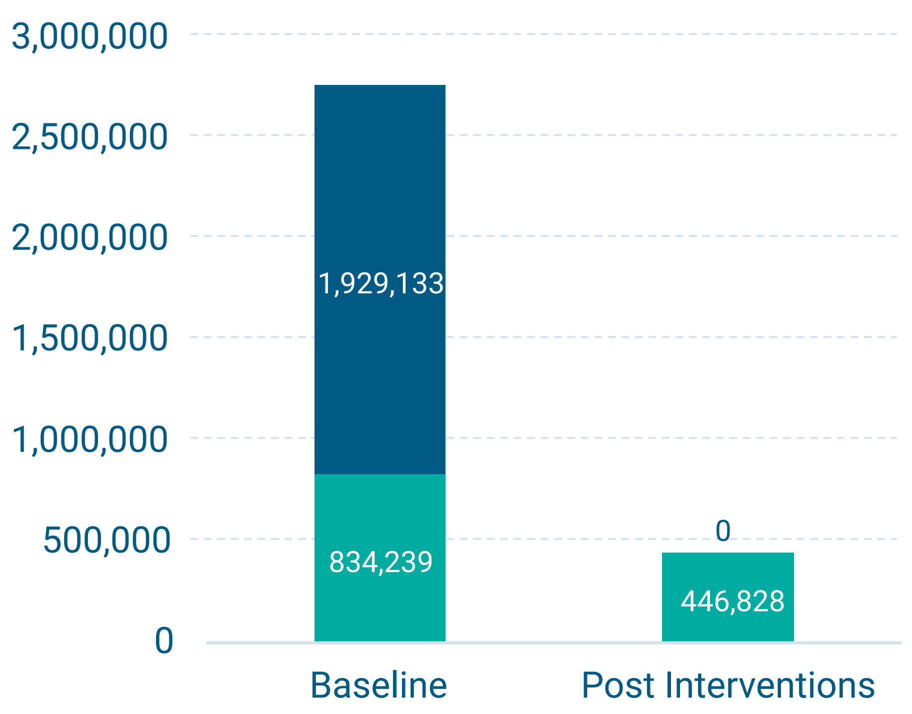


Figure 12b.

Total Consumption Change (tCO_2e)

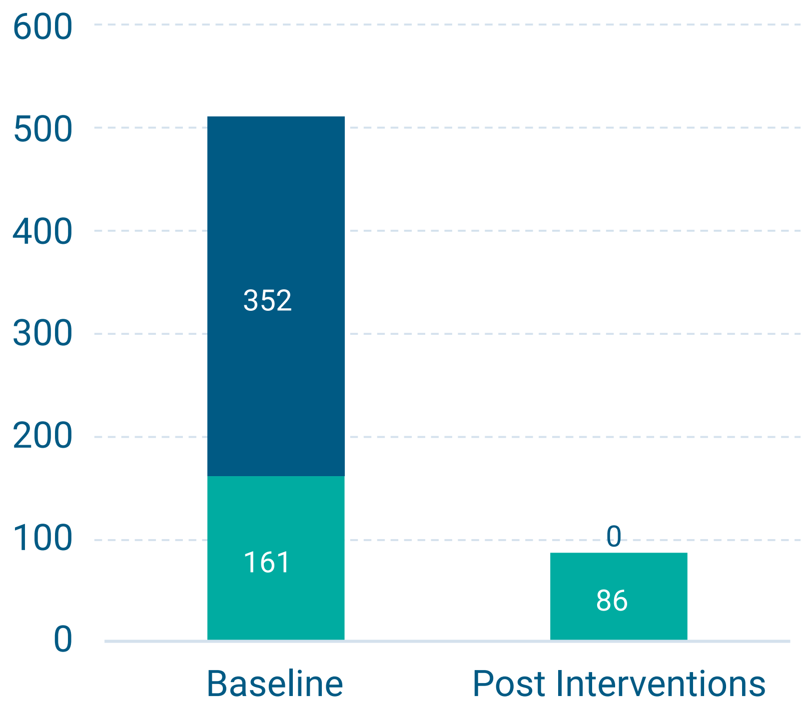
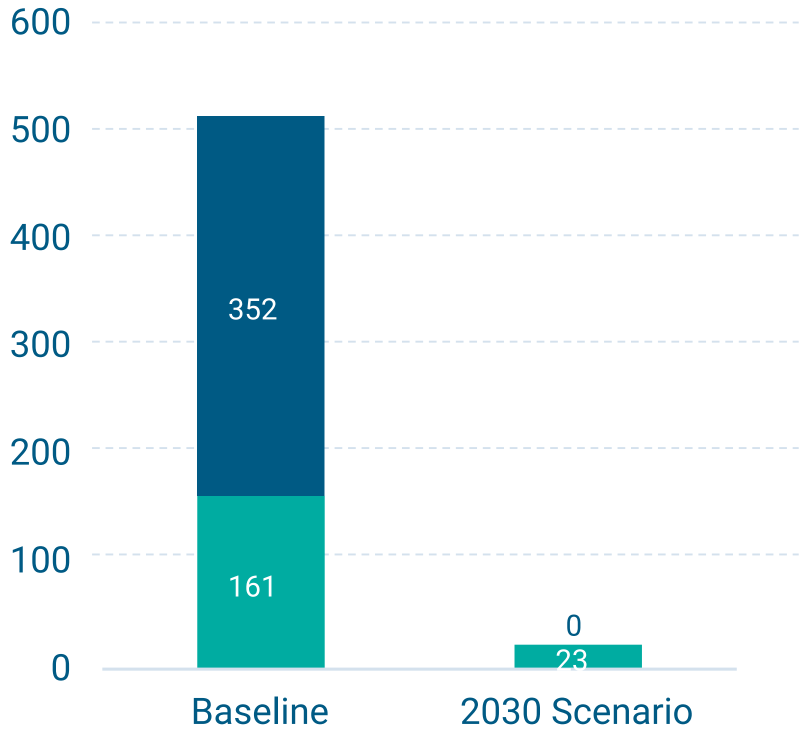


Figure 12c.

Total Consumption Change by 2030 with Grid Decarbonisation (tCO^2e)



■ Gas ■ Elec

Figure 12a, b and c show the reduction in consumption after implementation of all recommended technologies, moving from 2,763,371kWh (513 tons) to 446,828kWh (86 tons) according to today's grid makeup. The 2030 scenario, 11c highlights how much of a role grid decarbonisation is to play in further decarbonisation, bringing the final consumption to 23tCO_2e.

Figure 13.

Intervention's scenario Net Zero by 2030

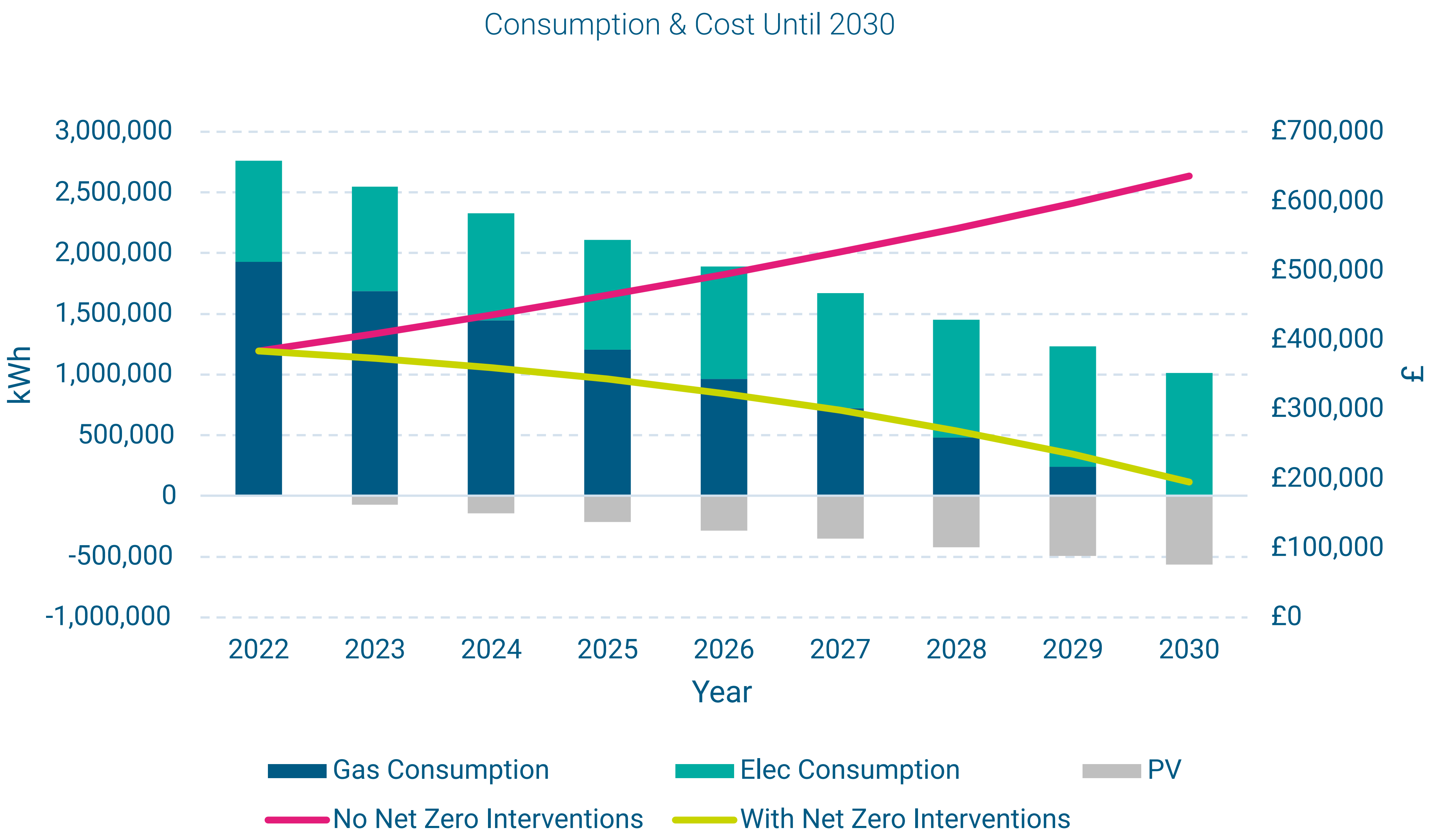


Figure 14.

Intervention's scenario Net Zero by 2040

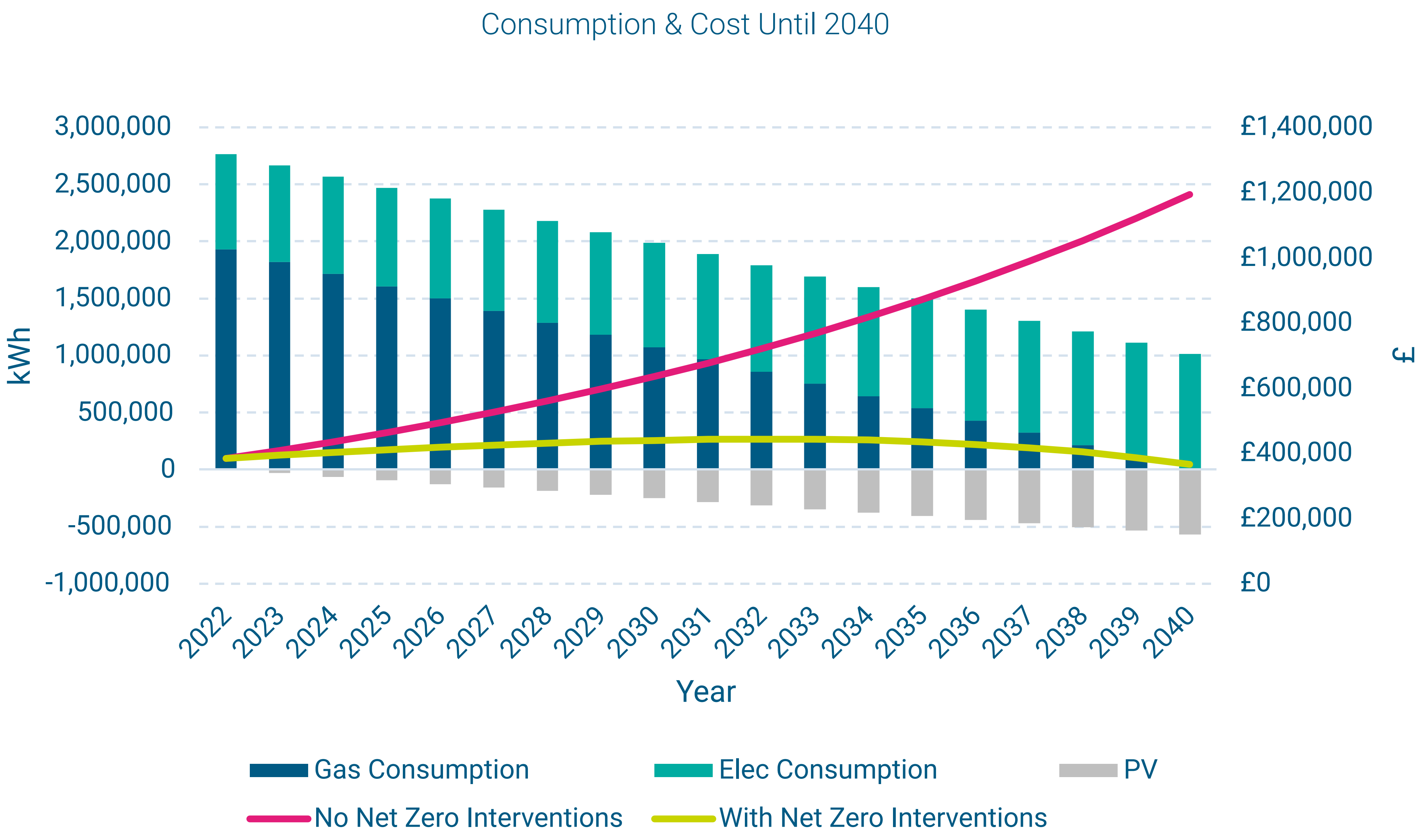
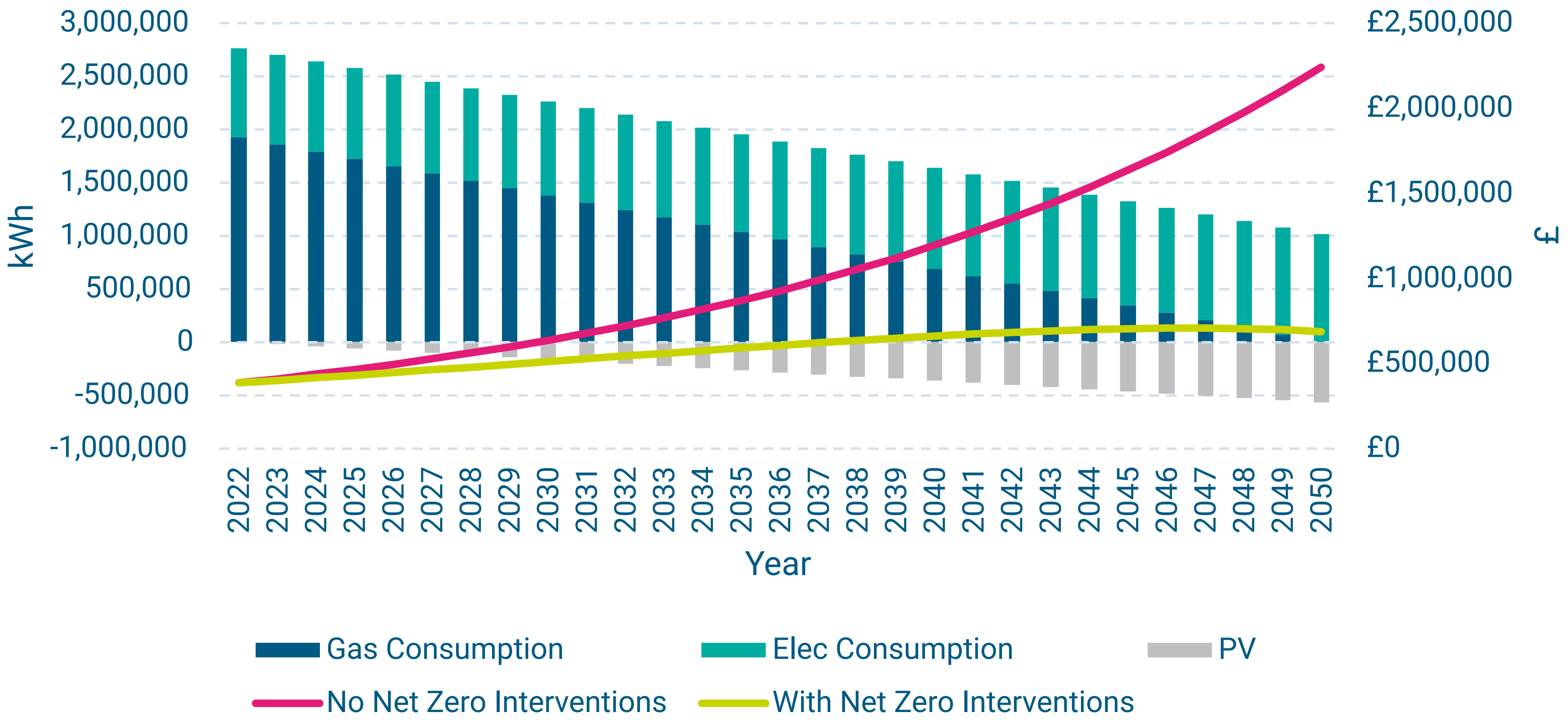


Figure 15.

Intervention's scenario Net Zero by 2050

Consumption & Cost Until 2050



Figures 13-15 show how consumption and energy costs would fall if all interventions were to be installed at an even rate to 2030, 2040 and 2050. It also highlights how energy costs to each scenario would increase when we factor forecast energy price increases based on a 6.5% per annum increase. Whilst costs for decarbonisation by 2030 are high for the short time frame, this would allow for lower operating costs for the service far quicker than other scenarios, with these costs also being estimated lower overall.

Figure 16.

Annual consumption reduction for interventions (kWh)

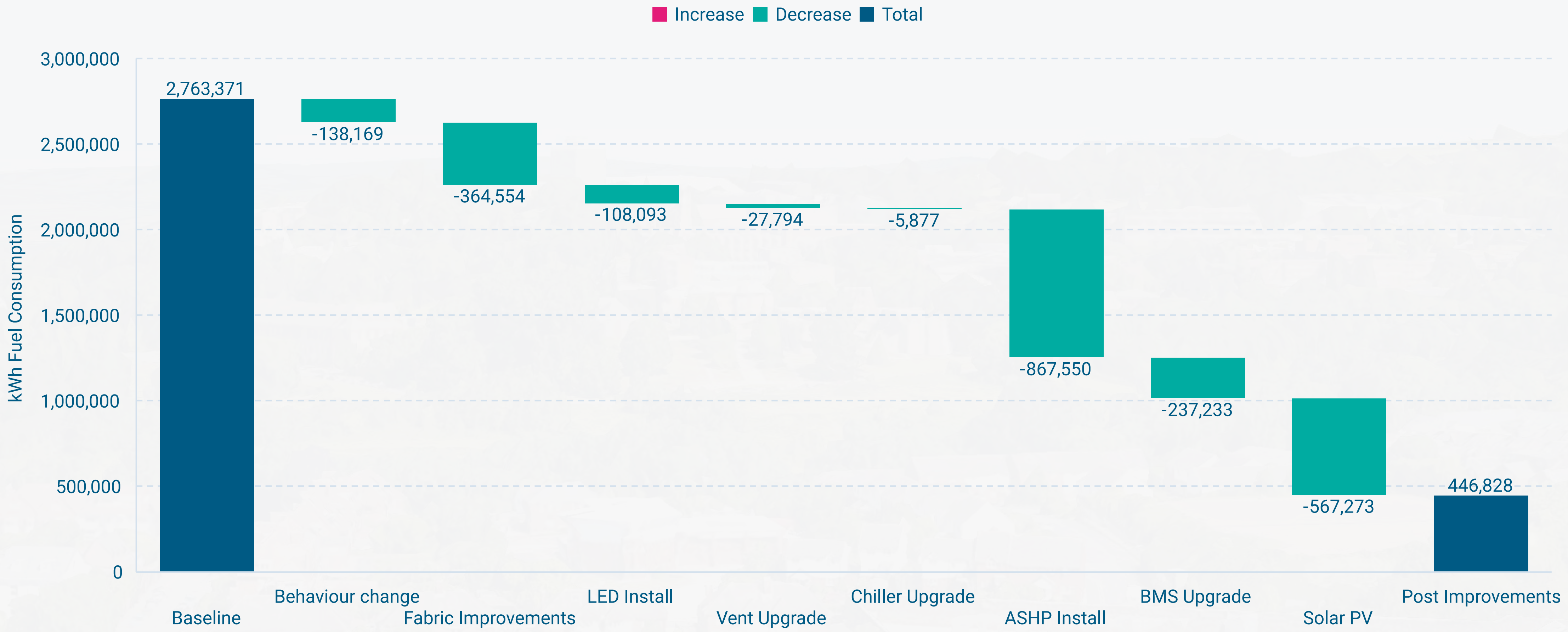


Figure 16 shows the reduction in consumption after implementation of all recommended technologies, moving from 2,763,371kWh (513 tons) to 446,828kWh (86 tons) according to today's grid makeup. Figure 15 further highlights this, with a complete removal of gas resulting from the interventions. Allowing for decarbonisation of the grid (by using more renewable technologies to generate electricity, as outlined in the DESNZ tables for valuation of energy in use and GHG emissions for appraisal), a reduction from 513 tCO_2 to 23 tCO_2 can be seen due to implementation of recommended measures by 2030. The greatest energy saving comes from ASHP install as highlighted in Figure 14, with PV install in second.

Table 9a.

Predicted annual cost savings after implementation of the interventions, using 2030 predicted spend with inflation

Utility	Predicted Annual Spend in 2030 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2030 Without Install (annual 6.5% inflation)	Saving (£)
Electricity	£195,171	£364,388	£169,218
Gas	£0	£271,380	£271,380
		Total Saving	£440,598

Table 9b.

Predicted annual cost savings after implementation of the interventions, using 2040 predicted spend with inflation

Utility	Predicted Annual Spend in 2040 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2040 Without Install (annual 6.5% inflation)	Saving (£)
Electricity	£366,362	£684,007	£317,645
Gas	£0	£509,418	£509,418
		Total Saving	£827,062

Table 9c.

Predicted annual cost savings after implementation of the interventions, using 2050 predicted spend with inflation

Utility	Predicted Annual Spend in 2050 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2050 Without Install (annual 6.5% inflation)	Saving (£)
Electricity	£687,713	£1,283,975	£596,263
Gas	£0	£956,247	£956,247
		Total Saving	£1,552,510

Tables 9a ,b and c indicates the predicted annual cost savings after implementation of the interventions for the 2030 scenario. Individual site breakdowns are found in the appendices, Appendix H. When predicting the annual spend on utilities an allowance has been made for inflationary rises in energy costs at 6.5% inflation each year.
If interventions are implemented by 2030, it is predicted that the Service will save £425,747 per year 2030. This is highlighted in Figure 11 with the yellow trendline compared to the red No Interventions assumed yearly spend.

Table 10.

Payback periods for each intervention according to 2030 Scenario

Cost of Install					
Interventions	2030	Elec kWh Saving	Gas kWh Saving	Cost of Saving (today's rates)	Payback (yrs)
Behaviour Change	£2,881	41,712	96,457	£19,208	0.2
Fabric Upgrades	£1,051,418	20,836	343,718	£34,715	30
LED Install	£336,414	108,093	0	£28,528	12
PV Install	£667,380	567,273	0	£149,716	4
Controls Upgrade	£428,280	68,243	168,990	£32,375	13
Cooling Upgrade	£60,000	5,877	0	£1,551	39
Vent Upgrade	£755,000	27,794	0	£7,336	103
Total	£6,751,193	387,410	1,929,133	£266,223	25

Table 10 shows the payback periods for each intervention using today's rates, which have been predicted through a Simple Payback calculation. This is calculated by dividing the initial cost of the retrofit by the energy savings per year. Typically, interventions with the shortest paybacks are assumed to be the most cost effective. It must be noted that with inflation of energy prices, shorter payback periods will be seen, due to an increased annual energy spend saving. It's also worth taking note that due to some interventions likely to be paying back concurrently, the full payback time will be quicker than highlighted above.

Due to increasing annual energy spend, electrification of heating and DHW do not provide a payback, and therefore have been left out of this calculation.

9. Next Steps

This initial plan (and supporting data analysis) has been produced to enable it to be updated over time, as budgets are identified, projects completed and new technological advancement in energy efficient and low carbon heating technologies identified. This plan needs to be communicated widely across the Service.

Prioritisation of sites in the route to 2030

One outcome from this plan is that the required investment in existing buildings to decarbonise to meet the Services climate goals has the potential to be prohibitive the date of the preferred scenario (£6.7mil by 2030). As explained above, in addition to the costs identified in this report, the Service needs to consider the required organisational, management and staff resources and associated costs.

It is important that future capital new build/major extensions/refurbishment projects and capital repair and maintenance projects are dovetailed into opportunities identified in this Heat Decarbonisation Plan and vice-versa. For example, if a window replacement project is being completed and the building has scaffolding installed, then PV could also be included.

One approach that the Service could take is to focus for next steps on the 'worst offenders' SHQ, Crownhill, Taunton, Torquay and Barnstaple, based on most carbon saved through intervention. Tackling these five sites would achieve a carbon saving of 229tCO_2e. Further, nine of the sites, highlighted overleaf in the funding section, are viable for PSDS application, allowing for funding of decarbonisation efforts, and should be investigated to allow for efficient use of existing funds to maximise savings.

In terms of the cheapest projects to undertake if cost is indeed prohibitive, the top five sites would be Paignton, Exmouth, Chelston, Greenbank and Bridgwater but there are lower carbon savings here.

Table 11.

Carbon Reduction opportunities across the estate

Site	Floor Area (m^2)	Total Carbon Saved (tCO_2e)	Cost of Interventions
Barnstaple Fire Station	1,500	39	£1,110,915
Bridgwater Fire Station	1,081	22	£371,429
Chelston Vehicle Workshop and Stores	1,301	30	£333,760
Crownhill Fire Station	1,211	51	£443,304
Danes Castle Fire Station	806	22	£404,198
Exmouth Fire Station	1,152	16	£312,144
Greenbank Fire Station	975	30	£354,939
Middlemoor Fire Station	1,153	23	£455,793
Paignton Fire Station	495	19	£230,166
Fire Service Headquarters	2,227	52	£940,148
Taunton Fire Station	2,126	44	£623,548
Torquay Fire Station	1,638	43	£762,553
Yeovil Fire Station	1,283	36	£408,294

Funding Options

At the time of completing this plan, the Department for Energy Security and Net Zero announced a further funding round, Public Sector Decarbonisation Scheme (PSDS) Phase 3C, with up to £230 million available in 2024/25. The previous round (Phase 3b) of PSDS was administered by Salix Finance and closed in September 2022, with 3C application completed on November 10th. An additional year of funding has now also been granted by the Department, allowing for projects to deliver across two financial years.

A summary of the main criteria for the Phase 3c scheme is outlined below:

1. Applicants must have and be using a fossil-fuelled heating system.
2. The heating system in question should be coming to the end of its useful life.
3. Applications must include a measure to decarbonising heating with a low carbon heating source in each building included in the application. This new low carbon heating system, alongside the energy efficiency measures installed, must meet the heat demand of the original end of life fossil fuel heating system.
4. Applicants can include energy efficiency measures and other enabling works where they reduce the heat or electrical demand of the building being heated by the proposed low carbon heating measure. Energy efficiency measures funded through the PSDS will be capped at 58% of the total grant value.
5. The funding provided to save a tonne of direct carbon (tCO_2e) over the lifetime of the project must be no more than £325 (the Carbon Cost Threshold (CCT)), which is automatically calculated by the Support Tool in the Grant Application Form.
6. Phase 3c funding is primarily for capital works, however external consultancy and management fees may be included. Existing employee costs or any costs previously incurred cannot be included.
7. Reasonable enabling and ancillary works may be included in the application, provided they are directly linked to the core technologies being installed, and these will be reviewed to confirm value for money.
8. Individual applications can be to any value and there is not an upper cap. However, Applicants must demonstrate that they can deliver within the funding timescales.
9. Applicants must either own the building that the funding is being used to upgrade or have a long-term lease arrangement, where the tenancy agreement places the responsibility for operation and maintenance of the building services on the Applicant.
10. Applicants must contribute the cost for a like-for-like replacement at a minimum of 12% of the total project costs - like-for-like costs over 12% should still be contributed by the Applicant in full.
11. To sharpen the scheme's focus on heat decarbonisation, there is a maximum proportion of the grant value that can be claimed for energy efficiency. This maximum proportion will be set at 58% of total grant value for each application.
12. All projects must be complete by 31 March 2026. Funding is not available for projects that cannot deliver to this timeframe, and projects which do not complete before this completion date will be liable for any project costs incurred after this date.

The funding scheme criteria focuses on 'heat decarbonisation' and future PSDS funding rounds are likely to continue in this way. The three main points to highlight from PSDS phase 3c are:

1. The existing fossil fuel heating plant must be at the end of its working life and the project application must include a low carbon replacement.
2. PSDS grant funding will only cover the costs of decarbonising the heat within a building, over and above the costs of replacing the existing fossil fuel heating system on a like for like basis.
3. The grant will only fund the project to the value of £325/tCO_2 (the Carbon Cost Threshold (CCT) or below. The CCT relates to the carbon saved over the lifetime of the technology. Any costs above this must be met by the Service.

It is also important to note that whilst a project meets the schemes' criteria, it may not be successful due to PSDS funding limits. There has been extremely high interest in the previous rounds of this scheme, and the funding limit may be achieved within days of the scheme opening for applications.

To indicate what Salix funding may be available to the Service, the Phase 3c Salix criteria have been applied to the modelling results and proposed solutions for the thirteen sites (in a high level manner).

The calculations have given an indicative grant value and client contribution (minimum 12%) as shown below. It should be noted that the funding calculator only considers fossil fuel heating replacement, and not other enabling measures (fabric improvements, LED upgrade etc, nor OHP's/ contingencies). Three of the sites (Bridgwater, 2 of the buildings at SHQ, and Taunton) were unviable due to recent boiler installations, however in coming years may become viable, dependent on future PSDS criteria.

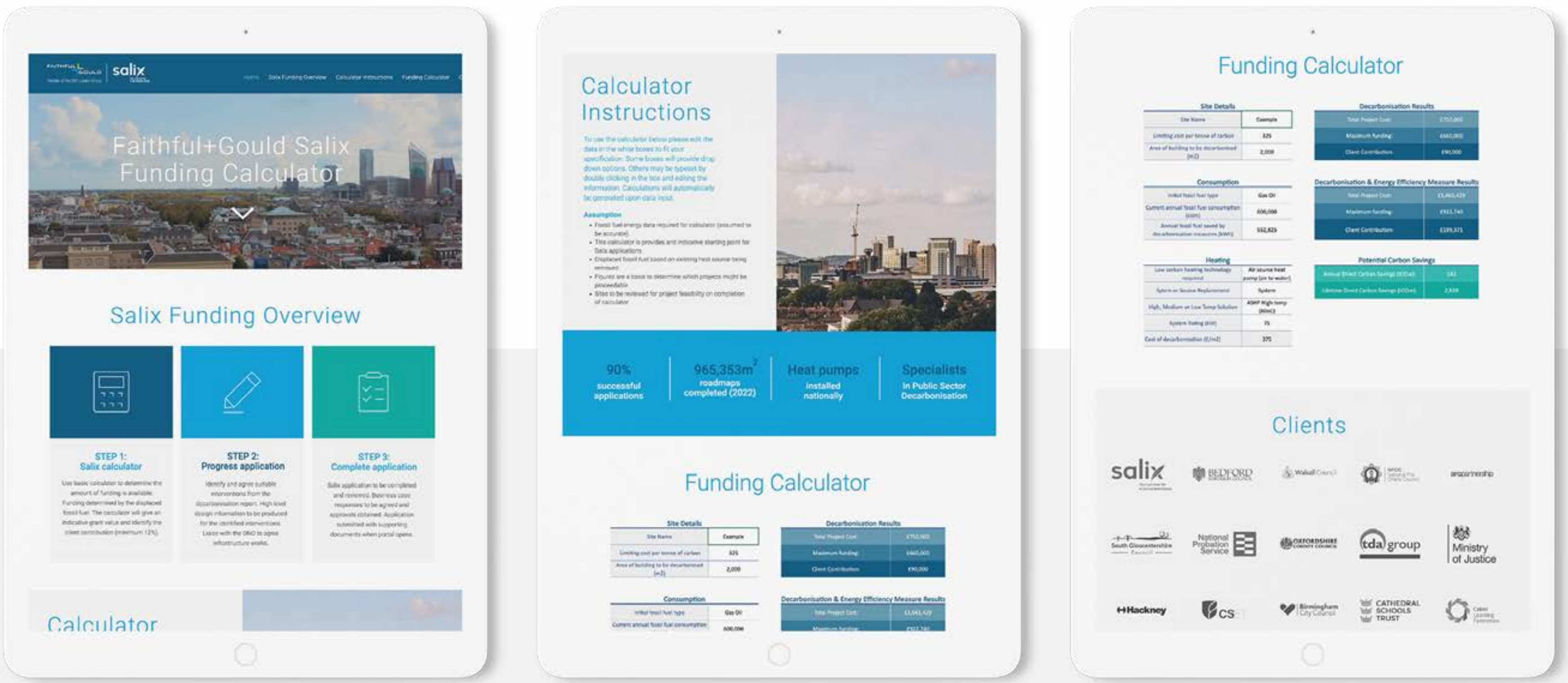


Table 12.

Salix funding calculator results for all viable sites (Boilers 10+ Years)

	Total Project Cost	Max Funding	Client Contribution
Torquay Fire Station (Admin Block)	£130,000	£55,000	£75,000
Middlemoor Fire Station	£340,000	£220,000	£120,000
Greenbank Fire Station	£330,000	£145,000	£185,000
Yeovil Fire Station	£335,000	£140,000	£195,000
Fire Service Headquarters - East Devon House	£350,000	£125,000	£225,000
Barnstaple Fire Station	£415,000	£155,000	£260,000
Crownhill Fire Station	£455,000	£196,000	£260,000
Danes Castle Fire Station	£440,000	£135,000	£305,000
Exmouth Fire Station (70%)	£400,000	£90,000	£310,000
Chelston Vehicle Workshop and Stores	£455,000	£120,000	£335,000

Looking at these results, Middlemoor Fire Station and Greenbank Fire Station provide the most appealing opportunity for Salix funding, due to a favourable ratio of funding available to expected client contribution.

High level budget costs for each intervention for each building is outlined in Appendix C. This information will provide the Service with the tools to make effective investment decisions.

Recommendation

The following actions are recommended as a short-term outline project plan, in line with potential PSDS application;

Undertake condition surveys of roofs and walls to establish current insulation levels and the suitability and economic viability for thermal improvements. Undertake pilot testing of cavity walls, as required. Undertake detailed life cycle costing exercises for the proposed measures, to establish value for money and consider this, alongside the benefits of the improved environment, and future proofing of the asset. When upgrading flat roofs and applying external wall insulation, the high capital cost requires careful consideration and would not be undertaken purely on the benefits of a reduced heat loss/energy saving, but may be considered on the basis of extending the life of the asset.

Undertake structural surveys of roofs to establish suitability for the installation of solar PV.

Undertake detailed analysis of solar PV by specialist /manufacturer.

Dependent on PV feasibility, undertake analysis of potential for battery storage on site.

Review domestic hot water use, ways to reduce demand, improve efficiency and options to replace with a low carbon alternative through feasibility.

Heat pump technology is key to decarbonisation, and are shown to provide the highest carbon saving across these sites. Early collaboration with supply chain and FM contractors is recommended to understand the current position, future developments and potential risks associated with deployment. There are arranged partnerships with heat pump manufactures which means preferable rates are given for heat pumps.

Early engagement with the Distribution network Operator (DNO) (National Grid, for the regions) for any potential projects is necessary, to understand current electrical capacity and any need for, and cost of, capacity upgrades.

Subject to the investigations above and funding availability, the following next steps are recommended:

The cost modelling undertaken in this report, identifies budget level costs for decarbonising the buildings. It is recommended that feasibility reports are undertaken and detailed cost models developed for individual projects prior to committing expenditure. As part of this work scope, AtkinsRéalis are undertaking these feasibility studies for Greenbank, Middlemoor and Yeovil, three sites with strong decarbonisation potential. Whilst this report provides a high-level overview of the three sites, we suggest the sites are taken to RIBA Stage 2 in order to de-risk delivery for the Service and provide 'off the shelf' and 'proceedable' projects. This will give the Service the backbone to a PSDS application for the chosen sites, allowing for these decarbonisation interventions to be undertaken through capital works.

The Service's most important asset in reducing carbon is its' people. Raising awareness and skills through a behaviour change programme and training should be prioritised. It is recommended that this measure is undertaken as an estate wide initiative.

In the medium to long-term, developments in hydrogen fuel could have significant potential to support emission reductions from buildings and transport. It is recommended that the Service initiates engagement with key stakeholders (e.g. Salix programmes) to stay abreast of latest developments as they emerge. AtkinsRéalis have strong relationships with Salix and DESNZ and can assist with this.

Ahead of works being undertaken, and whilst detailed feasibilities and programmes of work are put into place, it is recommended that the opportunity is undertaken to measure how energy is being consumed within the buildings. The high level calculations undertaken as part of the decarbonisation programme make industry based assumptions about where the energy is consumed within a particular type of building. However, depending on the type and amount of installed HVAC systems this can vary from building to building. Installing sub metering (permanent and/or temporary) will assist with the feasibility work and will make anticipated savings and payback calculation savings far more accurate. Domestic hot water consumption is of particular importance, as this can vary dramatically between buildings, even when they are the same "classification." Logging the times and amounts of consumed hot water for centralised systems will provide the information for a more accurately sized solution which is very important when selecting heat pumps. This will save on capital expenditure as using default design methodologies, based on industry standards is known to produce vastly oversized solutions in most instances.

Decarbonisation Delivery Plan:

It is recommended that Middlemoor and Greenbank Fire Stations are progressed as a priority into a Salix PSDS 3c funding application as Phase 1 of the Service's decarbonisation delivery plan.

This is due to the expected ratio of grant funding available to client contribution. To meet the eligibility criteria of the scheme, the project must use a whole building approach, so it is therefore recommended that Air Source Heat Pumps, BMS controls, Solar PV and lighting upgrades are included as part of the application.

Subject to funding success, designs will look to be initiated in April 2023 with works to start on site in February 2025, and an anticipated project completion date of March 2026. Table 13 below highlights the key milestones of the project and associated completion dates.

Table 13.

Indicative project programme for Phase 1 of the decarbonisation delivery plan

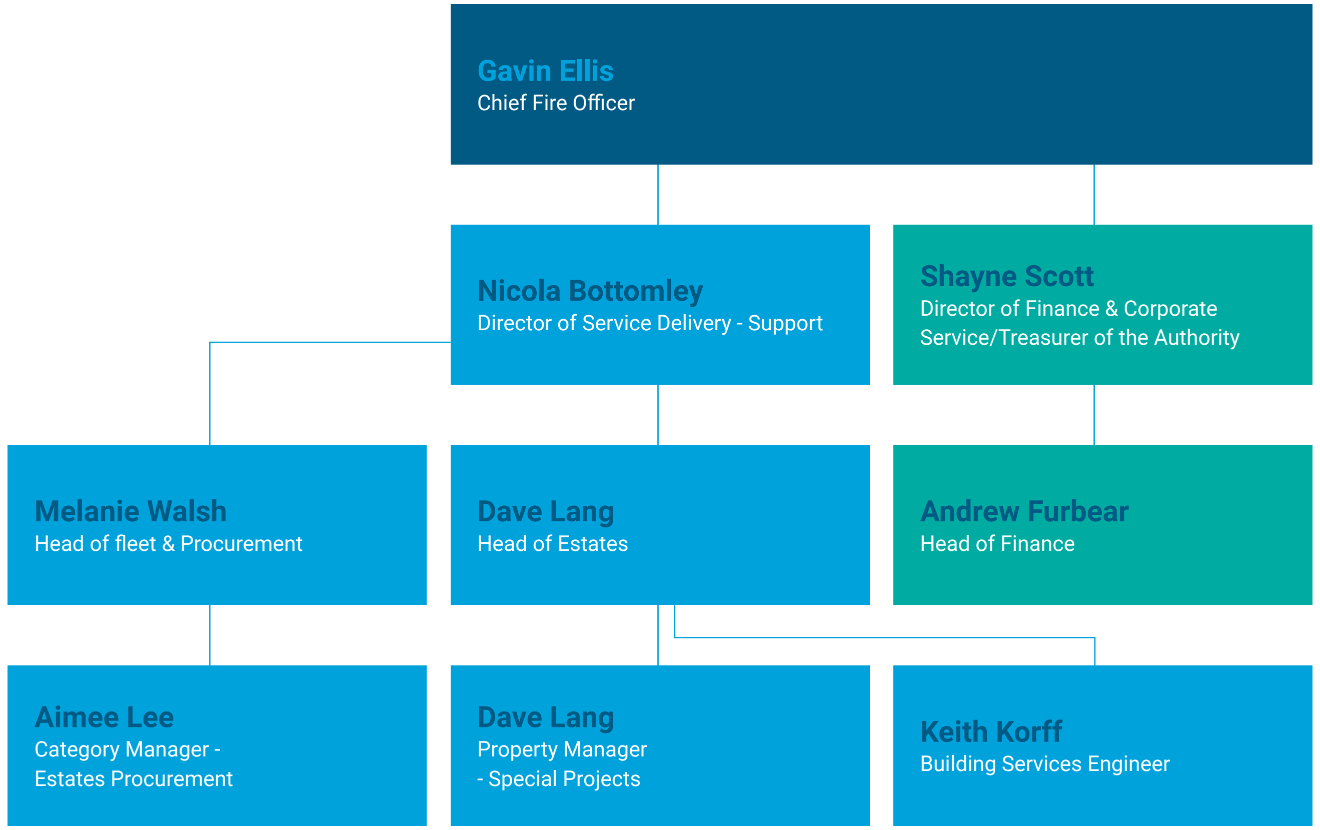
Milestone	Completion Date
Project Approval	01/04/2024
Designs Initiated	01/04/2024
Detailed Designs Complete	01/09/2024
Out to Tender	01/10/2024
Tenders Complete	01/12/2024
Orders Placed	15/01/2025
Works in Progress on Site	01/02/2025
Completed on Site	01/02/2026
Final Commissioning	31/03/2026
Completion Date (Step 4)	31/03/2026

A full programme for this work can be found separately.

The recommended works will require a high level of resource across a variety of disciplines. The project team will consist of internal personnel from the Service Estates Department and assisted by other internal supporting teams. The project team will be supported by the Chief of Fire Officer. A Project Sponsor will lead the projects, and is to work with project managers, property managers, procurement representatives, finance representatives and internal building service engineers. Selected based on previous experience of capital strategies, the project team will ensure the smooth delivery of the work, managing the entire process from procurement, commissioning of consultants, tendering for services through to project completion.

Figure 17.

Project organogram



To support the project team, the Service will contract the services of a consultant to act as the Professional Services Provider (PSP). In the pre-construction period of the project, a design team will be required consisting of Project Managers, Mechanical and Electrical Engineers, Architects, and Structural Engineers and Cost Consultants. Regular meetings should be held throughout the pre-construction phase, starting with kick-off meetings, site surveys, before entering fortnightly design team updates up until the project goes out to tender and a contractor is appointed.

The Service will comply with public sector procurement regulations in the procurement of requirements for the delivery of the PSDS project. The Service should seek to use either existing framework agreements (via direct award or further competition), or have the capability, capacity, and experience to undertake a full compliant tender process if necessary.

> The next phases of the Service's decarbonisation delivery planned should be initiated when internal funding becomes available, or in line with future rounds of Salix PSDS funding. It is recommended that workshops are undertaken to determine the priority sites that are to be delivered in the next phase. The delivery of future projects, including programme and resource requirements, is anticipated to largely mirror Phase 1.

10. Electricity Loading Capacity

Low carbon heating solutions will result in a reduction in fossil fuel consumption and an associated increase in electrical consumption for the site. A key consideration in planning for decarbonisation is whether there is available existing electrical capacity on site to support a change from fossil fuel to electric heating or if an increase in supply capacity is required, which will mean contacting the District Network Operator. The local DNO for the Service's regions is National Grid.

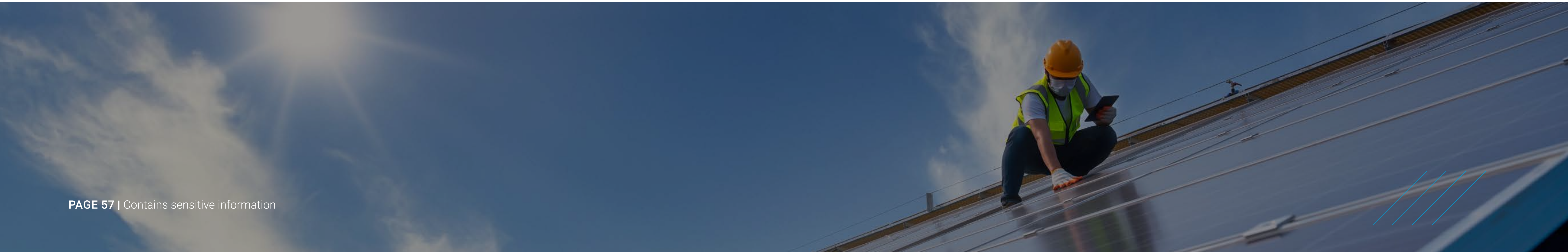
The power strategy firstly aims to reduce the site's electrical demand through a range of energy savings measures such as behaviour change, policy change, LED lighting upgrades, HVAC control upgrades and installation of solar PV (electrical generation to offset site electrical consumption). The existing site capacity will then need to be assessed against the final electrical requirement.

The existing site infrastructure will need to be surveyed to assess whether the site capacity will support the new electrical requirements of the site. It must be noted that, at this stage, an allowance has not been made to upgrade the existing electrical infrastructure. If a project is likely to proceed, then AtkinsRéalis will contact the Distribution Network Operator to establish grid constraint, making the DNO aware of any planned installations, and ensuring capacity upgrades are achieved within good time to ensure equipment is able to be commissioned once on site.

The Service has already undertaken some investigation with Joju Solar on site capacity in regard to EV charging points, and it is recommended that if these EV interventions were to go ahead and require a capacity upgrade, that this was packaged with an upgrade application for any decarbonisation works.

It should be noted that detailed storage of generated electricity has not been considered as part of this initial assessment, as current pricing indicates storage is not currently commercially viable, without external funding. As discussed, as detailed feasibility for PV generation is undertaken and an understanding of how much energy can be generated is gained, feasibility of battery storage can be undertaken for the chosen sites ahead of a full PSDS application.

For the purpose of this initial report, the potential for solar PV has been assessed as a high-level exercise by AtkinsRéalis, identifying suitable roof areas during the site surveys and using Google Maps to check orientation and to measure available roof space. Industry rules of thumb methods have been used to calculate the potential annual output for possible PV scenarios at each site, which have been included in the calculations. We are able to provide more detailed analysis/modelling of the PV opportunities to include daylight modelling, as and when required.



11. Supporting Information

Details of the building fabric elements for each site has been collected as part of the site audit and any potential for fabric upgrades were highlighted.

Energy savings from potential fabric upgrades have been included within the modelling and calculations using a simple steady state heat loss analysis. The U-Value of a surface is the measure of how well or how badly a component (a wall, a roof, a window, the floor) transmits heat from the inside to the outside. The slower or more difficult it is for heat to transfer through the component, the lower the U-value. Typical U values for various ages of buildings are included in table 14. Where potential improvements in U values have been highlighted by the surveyors, this has been calculated as a percentage improvement for the heat loss through that element. These percentage improvements have been applied to the "heat loss" element of the building's energy consumption. Heat losses through each element have been estimated using floor plans and Google Maps to estimate areas of walls, roofs and glazing.

Table 14.

Historical U-values from Building Regulations

YEAR	1965	1976	1985	1990	1995	2002	2006	2010	2013
Fabric	U-Value W/m^2.								
Walls	1.70	1.00	0.60	0.45	0.45	0.35	0.35	0.35	0.35
Floors		1.00	0.60	0.45	0.45	0.25	0.25	0.25	0.25
Pitched Roof	1.40	0.60	0.35	0.25	0.25	0.25	0.25	0.25	0.25
Flat Roof		0.60	0.35	0.25	0.25	0.16	0.25	0.25	0.25
Windows metal						2.20	2.20	2.20	
Windows all other						2.00	2.20	2.20	2.20
Window Area				0.15	0.23	0.25			
Pedestrian Door							2.20		
Entrance Doors							6.00	3.50	
Air Permeability[3]							10.00	10.00	

Notes

1. 2006 values are area-weighted average limiting standards (Part L2A). SBEM calculation required.
2. 2010 values are limiting fabric parameters (Part L2A). SBEM calculation required.
3. Air permeability units $m^3/(h.m^2)$ @ 50Pa.

12. Plans for the Sites

The Service has identified that there are no plans for major changes to the sites, with the only planned change being the rollout of EV charging across the estate.

It is hoped that elements of this report help the Service make decisions on the future of the thirteen sites within this plan, and steer Devon and Somerset Fire and Rescue Service to start on 'easier' decarbonisation efforts.

All proposed works relating to the provision of ASHPs will require planning approval through the Service's planning process. Around half of the sites are located within residential areas, so acoustic screening and other noise reduction measures are likely to be required. It is assumed that all relevant Planning Departments look favourably at low carbon projects, and therefore that planning complications will not be an issue. There should however be adequate planning times allowed within any proposed programmes of work.

> All works will be undertaken in accordance with local building regulations and appropriate industry standards.

13. Key challenges

There are number of barriers to a successful deployment of the HDP which are discussed below.

Table 15a. Financial barriers:

Item:	Description:
1	Availability of funding and budgets to undertake feasibility studies, bid for funding, the capital cost elements of work (including design fees). Determining that funding will be available throughout the plan.
2	Price security, risk of overspending, unforeseen costs (particularly when working in existing buildings), high levels of inflation within construction works, introducing new technologies.
3	Expenditure outside of project for consultancy, securing additional internal resources to deliver the projects.
4	Costs in this report should be regularly reviewed and increased in-line with inflation and up-to-date energy costs.
5	Potential high costs to upgrade electricity supply. A notional cost has been included for the implementation of heat pumps based on a typical 'new build'. However, as more property owners switch to low carbon technologies increasing electricity demand, it is likely to have an impact on the existing local electricity distribution network and increase the cost of an upgraded supply. This limitation may also delay implementation of the project.
6	Increased operational costs for implementing low carbon technologies (caused by gas and electricity pricing structure and higher servicing & maintenance costs.)

Table 15b. Organisational barriers:

Item:	Description:
1	Availability of resource to deliver, manage and monitor the performance of the plan.
2	Complex decision chains and routes to sign off proposals and timings to respond/bid for external funding opportunities.
3	Resistance to change when implementing behavioural change policies (top management support required.)
4	Lack of understanding and awareness of the plan and the requirement to decarbonise. The expectation that heat decarbonisation projects capital investment will result in future revenue savings.
5	Training requirements to be identified and supported time/funding.)

Table 15c. Delivery barriers:

Item:	Description:
1	Time to obtain required planning permission for heat decarbonisation works will need to be secured (e.g. the citing of external air source heat pumps, windows replacement, external wall insulation.)
2	Possible planning implications for listed buildings.
3	Possible delivery issues for proposed technologies (lack of available equipment/material due to Brexit/conflict across Eastern Europe/Russia.)
4	Lack of contractor knowledge in delivering low carbon heating projects (emerging technology.)
5	Lack of time/funding to facilitate monitoring and metering to provide ongoing feedback to secure the successful implementation of the plan. Feedback is vital to develop successful building solutions.
6	DNO delays due to lack of resource, unforeseen major upgrades needed back to substations which fall outside of project scope, but cause delay.

14. Concluding Remarks

The thirteen sites outlined in this report currently have a high dependence on fossil fuels for operational energy use, enhanced by the age of some of the sites i.e. Barnstaple, and the unique energy usage with the split between appliance bays and offices on the sites, especially notable at Chelston. As it stands, gas accounts for 70% (1,929,133kWh) of the 2,763,371 kWh total consumption across the thirteen sites.

In line with the Government's commitment to be Net Zero by 2050, and the Service's by 2030, the proposals within this report outline the major undertakings and projects that are required to remove fossil fuel usage across the estate by 2030, shifting to a reliance on renewable electricity, whilst also giving scenarios for 2040 and 2050. As highlighted, complete Net Zero will not be met by 2030, with the remaining emissions from electrical consumption needing to be offset for true Net Zero, The Service could consider carbon offsetting measures through off-site solar PV and large-scale wind turbines, as well as other traceable, local offsetting (known as insetting). Alternatively, moving to an 100% REGO (Renewable Energy Guarantee Origin) backed electricity contract would support zero carbon energy.

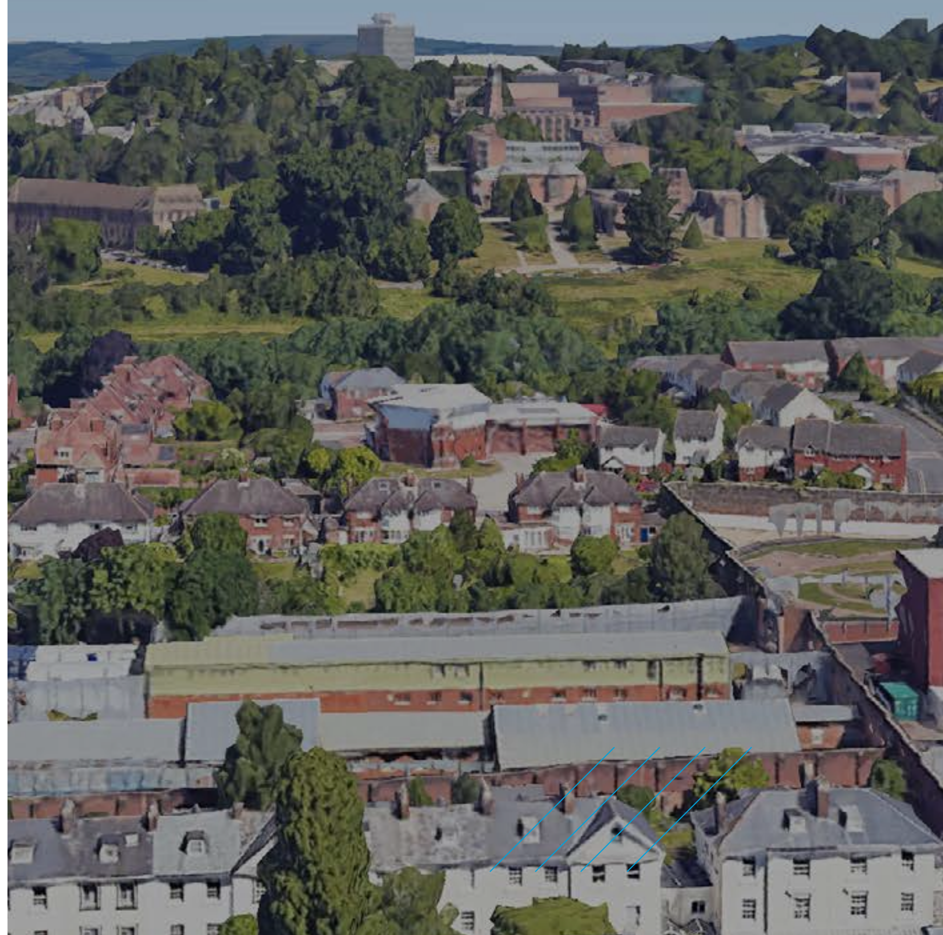
It is recommended that three key elements are implemented following this report. The Service must firstly seek to increase energy efficiency by reducing demand, before decarbonising the heat source and increasing renewable energy supply. Implementation of all measures would see a reduction in consumption to 446,828kWh, reducing carbon emissions from 513 tCO_2 to 23 tCO_2 by 2030. ASHP and Solar PV installation across the estate would have the highest reduction in consumption, reducing consumption by 867,550kWh and 567,273kWh respectively.

Implementing this Heat Decarbonisation Plan will have significant cost implications, estimated at £6.7 million if all measures are proceeded with. Despite this, this report has outlined the associated cost savings on utility bills that the Service would see because of increased efficiency and low carbon technologies, £266,223 if all interventions happened immediately with 2023 costs, and an increase to £440,598 per year from 2030, with an estimated quicker payback because of this.

Devon and Somerset Fire and Rescue Service should now use this report to put together a priority plan outlining the next steps on their Net Zero journey, with AtkinsRéalis involved in PSDS progression discussions. When looking at age and condition of the sites, and potential for carbon reduction, SHQ, Barnstaple, Taunton and Torquay are clearly the most favourable with the highest levels of carbon savings available.

> In terms for those PSDS viable sites if financial constraints are forecast to be an issue, it could be recommended that specific sites i.e. Middlemoor and Greenbank are chosen, with these calculated to provide the highest proportion of Salix funding.

Implementation of all measures would see a reduction in consumption to 446,828kWh, reducing carbon emissions from 513 tCO_2 to 23 tCO_2 by 2030...



Appendices

(Click title to go to relevant appendix)

DEVON & SOMERSET
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AtkinsRéalis

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Appendix A. Property List

Site	Postcode	EPC	Floor Area (m^2)	Lead Heat Source
Barnstaple Fire Station	EX31 1PA	C	1,500	Gas
Bridgwater Fire Station	TA6 5JT	B	1,081	Gas
Chelston Workshop and Stores	TA21 9JH	B	1,301	Gas
Crownhill Fire Station	PL5 3AN	E	1,211	Gas
Danes Castle Fire Station	EX4 4LP	D	806	Gas
Exmouth Fire Station	EX8 2NR	C	1,152	Gas
Greenbank Fire Station	PL4 7JQ	C	975	Gas
Middlemoor Fire Station	EX2 7AP	C	1,153	Gas
Paignton Fire Station	TQ3 2SH		495	Gas
Fire Service Headquarters	EX3 0NW	E	2,227	Gas
Taunton Fire Station	TA1 2LB	B	2,126	Gas
Torquay Fire Station	TQ2 7AD	C	1,638	Gas
Yeovil Fire Station	BA20 1JF	E	1,283	Gas

Appendix B. Existing and Final Fuel Use and Cost (Cost at today's energy prices)

Site	Total INITIAL Fossil Fuel consumption (kWh)	INITIAL Cost Of Fossil Fuel (£)	FINAL Annual Fossil Fuel Consumption (kWh)	FINAL Cost of Fossil Fuel (£)	INITIAL Annual Electricity Consumption (kWh)	INITIAL Cost Of Electricity (£)	FINAL Annual Electricity Consumption (kWh)	FINAL Cost of Electricity (£)
Barnstaple Fire Station	145,592	£12,375	0	£0	64,050	£16,904	2,361	£623
Bridgwater Fire Station	84,908	£7,217	0	£0	46,692	£12,323	41,932	£11,067
Chelston Vehicle Workshop and Stores	102,677	£8,728	0	£0	59,110	£15,601	95	£25
Crownhill Fire Station	163,872	£13,929	0	£0	93,128	£24,579	-13,495	-£3,562
Danes Castle Fire Station	114,361	£9,721	0	£0	63,053	£16,641	56,915	£15,021
Exmouth Fire Station	77,380	£6,577	0	£0	47,607	£12,565	37,464	£9,888
Greenbank Fire Station	124,459	£10,579	0	£0	55,445	£14,633	17,747	£4,684
Middlemoor Fire Station	187,597	£15,946	0	£0	57,246	£15,109	82,142	£21,679
Paignton Fire Station	67,334	£5,723	0	£0	33,296	£8,788	13	£3
Fire Service Headquarters	320,351	£27,230	0	£0	77,995	£20,585	111,204	£29,349
Taunton Fire Station	195,071	£16,581	0	£0	72,835	£19,223	27,470	£7,250
Torquay Fire Station	168,589	£14,330	0	£0	78,532	£20,726	16,715	£4,411
Yeovil Fire Station	176,941	£15,040	0	£0	85,250	£22,499	66,264	£17,489
Total	1,929,133	163,976	0	0	834,239	220,175	446,828	117,928

Appendix C. Cost of Implementation Measures

Site Name	Behaviour Change	Fabric Upgrades	LED Install	Htg & DHW Install	PV Install	BMS/Controls Upgrade	Vent Upgrade	Cooling Upgrade	Total
Barnstaple Fire Station	£220	£505,446	£54,000	£400,000	£80,000	£26,250	£45,000	£0	£1,110,915
Bridgwater Fire Station	£147	£22,652	£17,296	£249,310	£20,000	£17,025	£45,000	£0	£371,429
Chelston Vehicle Workshop and Stores	£182	£0	£49,438	£113,500	£62,580	£78,060	£30,000	£0	£333,760
Crownhill Fire Station	£289	£47,319	£43,596	£174,000	£115,600	£17,500	£45,000	£0	£443,304
Danes Castle Fire Station	£198	£0	£0	£292,000	£42,000	£12,500	£50,000	£7,500	£404,198
Exmouth Fire Station	£144	£0	£0	£213,500	£21,000	£20,000	£50,000	£7,500	£312,144
Greenbank Fire Station	£189	£0	£19,500	£200,250	£80,000	£12,500	£35,000	£7,500	£354,939
Middlemoor Fire Station	£233	£0	£0	£338,060	£40,000	£59,180	£60,000	£0	£581,633
Paignton Fire Station	£109	£70,107	£0	£60,000	£41,200	£6,250	£45,000	£7,500	£230,166
Fire Service Headquarters	£359	£0	£55,230	£549,940	£21,000	£133,620	£180,000	£0	£940,148
Taunton Fire Station	£269	£62,422	£17,858	£375,000	£63,000	£37,500	£60,000	£7,500	£623,548
Torquay Fire Station	£263	£273,322	£58,968	£262,500	£60,000	£25,000	£75,000	£7,500	£762,553
Yeovil Fire Station	£282	£70,150	£20,528	£221,760	£21,000	£22,075	£45,000	£7,500	£408,294
Total	£2,881	£1,051,418	£336,414	£3,449,820	£667,380	£428,280	£755,000	£60,000	£6,751,193

Appendix D. Carbon Saving of Implementation Measures (2022 Carbon Conversion Factors)

Site	tCO_2e Savings by Building (today's factors)									
	Behaviour Change	Fabric Upgrades	LED Install	Htg & DHW Upgrade	Additional Elec from Htg & DHW Upgrade	PV Install	BMS Upgrade	Vent Upgrade	Chiller Upgrade	Total
Barnstaple Fire Station	1.95	10.80	3.14	13.56	6.68	13.15	2.28	0.31	0.00	39
Bridgwater Fire Station	1.23	3.58	1.02	10.26	5.02	3.29	1.85	0.23	0.00	16
Chelston Vehicle Workshop and Stores	1.51	0.00	3.06	15.40	4.18	10.29	3.80	0.29	0.00	30
Crownhill Fire Station	2.40	6.28	4.56	20.34	5.92	19.00	3.42	0.45	0.00	51
Danes Castle Fire Station	1.65	0.00	0.00	17.85	8.41	6.90	3.04	0.78	0.24	22
Exmouth Fire Station	1.17	0.00	0.00	12.08	3.44	3.45	2.15	0.59	0.09	16
Greenbank Fire Station	1.67	0.00	1.51	19.42	9.11	13.15	2.99	0.27	0.11	30
Middlemoor Fire Station	2.27	0.00	0.00	29.28	13.73	6.57	4.22	0.71	0.11	29
Paignton Fire Station	0.94	5.64	0.00	5.76	1.80	6.77	1.19	0.16	0.06	19
Fire Service Headquarters	3.68	0.00	1.08	47.22	14.08	3.45	10.25	0.45	0.00	52
Taunton Fire Station	2.48	14.82	0.83	17.77	5.48	10.36	3.11	0.35	0.14	44
Torquay Fire Station	2.30	12.65	3.85	15.63	4.80	9.86	2.66	0.38	0.21	43
Yeovil Fire Station	2.44	13.01	1.86	16.65	5.10	3.45	3.09	0.41	0.16	36
Total Saving	25.67	66.77	20.90	241.22	87.76	109.70	44.04	5.37	1.14	427.06

Appendix E. Carbon Emission and Reduction – (Using 2030 Conversion factors that included estimated grid decarbonisation)

Site	Initial Carbon emissions from fossil fuel	Final Carbon emissions from fossil fuel (tCO_2e)	Initial Carbon emissions from electricity (tCO_2e)	Final Carbon emissions from electricity (tCO_2e)	Total Carbon Saved (tCO_2e)
Barnstaple Fire Station	27	0	12	0	39
Bridgwater Fire Station	15	0	9	2	22
Chelston Vehicle Workshop and Stores	19	0	11	0	30
Crownhill Fire Station	30	0	18	-1	49
Danes Castle Fire Station	21	0	12	3	30
Exmouth Fire Station	14	0	9	2	21
Greenbank Fire Station	23	0	11	1	33
Middlemoor Fire Station	34	0	11	4	41
Paignton Fire Station	12	0	6	0	19
Fire Service Headquarters	58	0	15	6	68
Taunton Fire Station	36	0	14	1	48
Torquay Fire Station	31	0	15	1	45
Yeovil Fire Station	32	0	16	3	45
Total	352	0	161	23	490

Appendix F. Fabric Installation Costs

Site Name	Wall	Roof	Glazing	Total
Barnstaple Fire Station	£40,388	£253,500	£211,558	£505,446
Bridgwater Fire Station	£22,652	£0	£0	£22,652
Chelston Vehicle Workshop and Stores	£0	£0	£0	£0
Crownhill Fire Station	£35,192	£0	£12,128	£47,319
Danes Castle Fire Station	£0	£0	£0	£0
Exmouth Fire Station	£0	£0	£0	£0
Greenbank Fire Station	£0	£0	£0	£0
Middlemoor Fire Station	£0	£0	£0	£0
Paignton Fire Station	£21,357	£48,750	£0	£70,107
Fire Service Headquarters	£0	£0	£0	£0
Taunton Fire Station	£28,542	£33,880	£0	£62,422
Torquay Fire Station	£19,822	£253,500	£0	£273,322
Yeovil Fire Station	£62,402	£7,748	£0	£70,150
Total	£230,355	£597,378	£223,685	£1,051,418

Appendix G. Monthly Energy Costs

Gas	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23
Barnstaple Fire Station	£1,267	£530	£424	£395	£377	£603	£920	£1,358	£1,844	£1,692	£1,470	£1,496
Bridgwater Fire Station	£854	£410	£258	£200	£213	£301	£376	£639	£1,110	£1,171	£863	£822
Chelston: DSFRS Vehicle Engineering	£794	£310	£200	£181	£166	£190	£300	£711	£1,713	£1,551	£1,377	£1,234
Crownhill Fire Station	£1,060	£844	£519	£444	£578	£706	£902	£965	£1,605	£1,453	£1,116	£1,263
Crownhill: Workshops	£174	£71	£48	£46	£45	£52	£21	£207	£503	£505	£394	£408
Danes Castle Fire Station	£844	£593	£495	£462	£420	£530	£620	£877	£1,332	£1,365	£1,103	£1,080
Exmouth Fire Station	£1,207	£854	£692	£528	£367	£504	£716	£722	£917	£1,014	£911	£964
Greenbank Fire Station	£1,010	£626	£546	£441	£498	£555	£570	£928	£1,688	£1,700	£1,057	£960
Middlemoor Fire Station	£1,321	£1,068	£864	£706	£691	£922	£1,359	£1,646	£2,033	£2,061	£1,714	£1,560
Paignton Fire Station	£646	£331	£217	£161	£156	£241	£322	£620	£806	£805	£685	£733
Fire Service Headquarters	£2,958	£1,466	£896	£995	£822	£1,578	£2,485	£3,583	£4,475	£1,770	£2,163	£4,039
Taunton Fire Station	£1,498	£748	£556	£478	£453	£622	£750	£1,202	£3,096	£3,116	£2,184	£1,878
Torquay Fire Station	£1,500	£890	£594	£470	£418	£657	£913	£1,235	£2,290	£1,921	£1,679	£1,762
Yeovil Fire Station	£1,544	£1,179	£819	£628	£566	£750	£906	£1,170	£2,110	£2,073	£1,600	£1,695

Appendix G. Monthly Energy Costs

Electric	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23
Barnstaple Fire Station	£1,146	£1,079	£941	£893	£883	£1,013	£1,103	£1,260	£1,449	£1,537	£1,174	£1,231
Workshops - Barnstaple	£204	£160	£76	£104	£45	£115	£184	£266	£565	£554	£462	£400
Bridgwater Fire Station	£1,093	£896	£737	£616	£773	£930	£1,036	£1,140	£1,337	£1,322	£1,172	£1,230
Chelston: DSFRS Vehicle Engineering	£1,150	£1,117	£969	£953	£956	£1,079	£1,212	£1,400	£1,604	£1,901	£1,554	£1,768
Crownhill Fire Station	£1,946	£1,806	£1,879	£1,780	£1,944	£1,939	£2,209	£2,202	£2,375	£2,402	£1,950	£2,061
Danes Castle Fire Station	£1,411	£1,338	£1,326	£1,265	£1,268	£1,282	£1,343	£1,454	£1,629	£1,617	£1,400	£1,566
Exmouth Fire Station	£1,278	£1,339	£1,242	£1,122	£1,058	£1,074	£1,452	£1,714	£2,043	£1,971	£1,787	£1,941
Greenbank Fire Station	£1,358	£1,196	£1,026	£1,087	£1,033	£1,081	£1,241	£1,349	£1,500	£1,465	£1,144	£1,322
Middlemoor Fire Station	£1,579	£1,641	£1,563	£1,536	£1,662	£1,641	£1,021	£795	£778	£820	£636	£1,384
Paignton Fire Station	£700	£692	£677	£628	£634	£679	£752	£778	£864	£862	£695	£797
Fire Service Headquarters	£11,383	£10,513	£10,188	£10,259	£10,256	£10,021	£10,985	£11,753	£13,394	£13,558	£11,601	£12,840
Taunton Fire Station	£1,596	£1,485	£1,329	£1,326	£1,354	£1,463	£1,615	£1,791	£2,056	£1,820	£1,672	£1,723
Torquay Fire Station	£1,929	£1,627	£1,643	£1,618	£1,416	£1,420	£1,670	£1,969	£1,996	£2,092	£1,610	£1,821
Yeovil Fire Station	**£1,623**	**£1,417**	**£1,230**	**£1,161**	**£1,205**	**£1,509**	**£2,020**	**£2,823**	**£3,239**	**£2,793**	**£1,944**	**£1,883**

Appendix H. Annual Cost Savings per Site for 2030, 2040 and 2050 scenario

Elec 2030

Site	Predicted Annual Spend in 2030 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2030 Without Install (annual 6.5% inflation)	Saving (£)
Barnstaple Fire Station	£1,031	£27,976	£26,945
Bridgwater Fire Station	£18,316	£20,395	£2,079
Chelston Workshop and Stores	£42	£25,819	£25,777
Crownhill Fire Station	-£5,894	£40,678	£46,572
Danes Castle Fire Station	£24,860	£27,541	£2,681
Exmouth Fire Station	£16,364	£20,794	£4,430
Greenbank Fire Station	£7,752	£24,218	£16,466
Middlemoor Fire Station	£35,879	£25,005	-£10,875
Paignton Fire Station	£6	£14,543	£14,538
Fire Service Headquarters	£48,573	£34,068	-£14,505
Taunton Fire Station	£11,999	£31,814	£19,815
Torquay Fire Station	£7,301	£34,302	£27,001
Yeovil Fire Station	£28,944	£37,236	£8,293
Total	**£195,171**	**£364,388**	**£169,218**

Gas 2030

Site	Predicted Annual Spend in 2030 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2030 Without Install (annual 6.5% inflation)	Saving (£)
Barnstaple Fire Station	£0	£20,481	£20,481
Bridgwater Fire Station	£0	£11,944	£11,944
Chelston Workshop and Stores	£0	£14,444	£14,444
Crownhill Fire Station	£0	£23,053	£23,053
Danes Castle Fire Station	£0	£16,088	£16,088
Exmouth Fire Station	£0	£10,885	£10,885
Greenbank Fire Station	£0	£17,508	£17,508
Middlemoor Fire Station	£0	£26,390	£26,390
Paignton Fire Station	£0	£9,472	£9,472
Fire Service Headquarters	£0	£45,065	£45,065
Taunton Fire Station	£0	£27,442	£27,442
Torquay Fire Station	£0	£23,716	£23,716
Yeovil Fire Station	£0	£24,891	£24,891
Total	**£0**	**£271,380**	**£271,380**

Appendix H. Annual Cost Savings per Site for 2030, 2040 and 2050 scenario

Elec 2040

Site	Predicted Annual Spend in 2040 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2040 Without Install (annual 6.5% inflation)	Saving (£)
Barnstaple Fire Station	£1,936	£52,516	£50,580
Bridgwater Fire Station	£34,381	£38,284	£3,902
Chelston Workshop and Stores	£78	£48,466	£48,388
Crownhill Fire Station	-£11,065	£76,357	£87,422
Danes Castle Fire Station	£46,666	£51,698	£5,032
Exmouth Fire Station	£30,717	£39,034	£8,317
Greenbank Fire Station	£14,551	£45,461	£30,910
Middlemoor Fire Station	£67,350	£46,937	-£20,413
Paignton Fire Station	£10	£27,300	£27,290
Fire Service Headquarters	£91,178	£63,950	-£27,229
Taunton Fire Station	£22,523	£59,719	£37,195
Torquay Fire Station	£13,705	£64,389	£50,685
Yeovil Fire Station	£54,331	£69,898	£15,567
Total	£366,362	£684,007	£317,645

Gas 2040

Site	Predicted Annual Spend in 2040 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2040 Without Install (annual 6.5% inflation)	Saving (£)
Barnstaple Fire Station	£0	£38,446	£38,446
Bridgwater Fire Station	£0	£22,421	£22,421
Chelston Workshop and Stores	£0	£27,113	£27,113
Crownhill Fire Station	£0	£43,273	£43,273
Danes Castle Fire Station	£0	£30,199	£30,199
Exmouth Fire Station	£0	£20,433	£20,433
Greenbank Fire Station	£0	£32,865	£32,865
Middlemoor Fire Station	£0	£49,538	£49,538
Paignton Fire Station	£0	£17,781	£17,781
Fire Service Headquarters	£0	£84,594	£84,594
Taunton Fire Station	£0	£51,512	£51,512
Torquay Fire Station	£0	£44,519	£44,519
Yeovil Fire Station	£0	£46,724	£46,724
Total	£0	£509,418	£509,418

Appendix H. Annual Cost Savings per Site for 2030, 2040 and 2050 scenario

Elec 2050

Site	Predicted Annual Spend in 2050 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2050 Without Install (annual 6.5% inflation)	Saving (£)
Barnstaple Fire Station	£3,634	£98,579	£94,945
Bridgwater Fire Station	£64,538	£71,864	£7,325
Chelston Workshop and Stores	£147	£90,977	£90,830
Crownhill Fire Station	-£20,770	£143,333	£164,103
Danes Castle Fire Station	£87,599	£97,044	£9,446
Exmouth Fire Station	£57,660	£73,272	£15,611
Greenbank Fire Station	£27,314	£85,336	£58,022
Middlemoor Fire Station	£126,425	£88,107	-£38,318
Paignton Fire Station	£20	£51,246	£51,226
Fire Service Headquarters	£171,154	£120,042	-£51,112
Taunton Fire Station	£42,280	£112,100	£69,820
Torquay Fire Station	£25,726	£120,868	£95,142
Yeovil Fire Station	£101,987	£131,208	£29,221
Total	£687,713	£1,283,975	£596,263

Gas 2050

Site	Predicted Annual Spend in 2050 After Install (annual 6.5% inflation)	Predicted Annual Spend in 2050 Without Install (annual 6.5% inflation)	Saving (£)
Barnstaple Fire Station	£0	£72,168	£72,168
Bridgwater Fire Station	£0	£42,088	£42,088
Chelston Workshop and Stores	£0	£50,896	£50,896
Crownhill Fire Station	£0	£81,229	£81,229
Danes Castle Fire Station	£0	£56,687	£56,687
Exmouth Fire Station	£0	£38,356	£38,356
Greenbank Fire Station	£0	£61,693	£61,693
Middlemoor Fire Station	£0	£92,990	£92,990
Paignton Fire Station	£0	£33,377	£33,377
Fire Service Headquarters	£0	£158,794	£158,794
Taunton Fire Station	£0	£96,694	£96,694
Torquay Fire Station	£0	£83,567	£83,567
Yeovil Fire Station	£0	£87,708	£87,708
Total	£0	£956,247	£956,247