Carlisle City Council
Report to Executive

Report details

Meeting Date:	21 February 2022
Portfolio:	Finance, Governance & Resources
Key Decision:	Yes
Policy and Budget Framework	Yes
Public / Private	Public
Title:	Heat Decarbonisation Plan
Report of:	Director of Governance & Regulatory Services
Report Number:	GD 12/22

Purpose / Summary:
Carlisle City Council developed its Local Environment (Climate Change) Strategy in August 2020 and have subsequently committed to achieving net zero carbon emissions for sites within their operational control. The City Council has taken significant steps to reduce their emissions and are now looking to target further reductions through their building stock and heat usage to ensure to ensure the UK Government 2050 ambition is met.

A Heat Decarbonisation Plan (HDP) is the starting point in looking at how we improve the energy efficiency of our portfolio and the Executive is asked to approve this report.

Recommendations:
The Executive is asked:

1). To approve a Heat Decarbonisation Plan for its operational buildings portfolio, and

2). To delegate responsibility to accept the grant funding to the Corporate Director of Governance and Regulatory Services following consultation with the Portfolio Holder for Finance, Governance & Resources.

Tracking

Executive:	21st February 2022
Scrutiny:	
Council:	

1. Background

1.1. In August 2020 Carlisle City Council developed its Local Environment (Climate Change) Strategy and is currently aiming to achieve net zero by 2037. All areas of the Council's operations will be reviewed and actions taken to reduce carbon emissions.

1.2. In September 2019 the Council was successful in securing funding through phase 2 of the Public Sector Skills Fund to produce a Heat Decarbonisation Plan (HDP).

1.3. A HDP focuses on identifying carbon reduction measures, with a specific focus on the decarbonisation of heat. The plan describes the current position with the portfolio's energy use and its plans for reducing/or decarbonising its energy use.

1.4. The plan outlines what has been done already, what it is currently doing and what it plans to do in the future. The plan explains what actions are going to be taken, the timescales and the intended outcomes.

2. Proposals

2.1 The HDP reviewed 11 operational properties:

- The Civic Centre
- Bousteads Grassing Depot
- Carlisle Crematorium
- Old Town Hall & Tourist Information centre
- Old Fire Station
- 6-24 Castle Street
- John Street Hostel and Annexe
- Water Street Family Centre
- Bitts Park Depot
- Cemetery depot
- Cemetery Garden Links

2.2 Energy performance comparison was undertaken and, although as stated in the report, comparison with other public buildings is difficult, superficial analysis indicates that the Council's portfolio is inefficient, being higher than the sector average for electricity and higher than the sector average for gas when measured by the Carbon Trust Energy Efficiency in Public Buildings Methodology 1999.

2.3 The report provides advice on how improvements can be made and also identifies 8 priority actions for improvement of the Council's energy management practices along with associated costings, savings and payback periods.

2.4 In total if the Council was to implement all 8 priority actions it is estimated that the Council would save £391,842 p.a.in energy costs with the associated savings of 553.88 tonnes of CO2 and 1,412,843 KWH p.a.

2.5 The total cost of these measures is estimated at £2,047,840 which would give a 5-year payback period. We would caution that these figures require further detailed examination before final budget costs could be provided but they do give an estimate of the potential savings available.

2.6 Having a HDP opens up opportunities to bid and hopefully secure further Government funding.

2.7 We have already submitted a bid for further grant funding under Phase 3 of the Public Sector Decarbonisation Scheme where we are seeking £1.87m to undertake the works identified in the plan. If successful a match of up to £177,000 would be required from the City Council; exact match will not be known until a grant offer is forthcoming however it would be funded from the Property Services earmarked reserves and/or existing base budgets.

2.8 If successful, the funding rules require the work to be undertaken during the 2022/23 financial year.

2.9 In the event that the funding bid is unsuccessful the Council would seek to implement the recommendations but over a longer term by the use of existing resources as part of the planned maintenance regime for the portfolio or when subsequent funding opportunities arise.

3. Risks

3.1 Failure to implement the recommendations of the HDP would impact on the Council's aspiration to reach net zero by 2037.

4. Consultation

4.1 Consultation has been undertaken with the Health & Safety Manager and the Policy Communications Manager.

5. Conclusion and reasons for recommendations

5.1 The HDP is small step on the journey to net zero. It sets out opportunities for the Council to reduce its energy consumption and associated emissions. Approving the HDP offers the opportunity to apply for funding to undertake the recommended improvements and improve the environmental performance of our operational portfolio.

6. Contribution to the Carlisle Plan Priorities

6.1 Delivering the Local Environment (Climate Change) Strategy by reducing emissions from the City Council estate and operations.

Contact details:

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Appendices attached to report:

- Heat Decarbonisation Plan

Note: in compliance with section 100d of the Local Government Act 1972 the report has been prepared in part from the following papers:

- None

Corporate Implications:

Legal

The Council has a fiduciary duty to properly manage its assets and the implementation of the recommendations contained in the report will help the Council achieve its climate change aspirations.

Property Services

Contained within the main body of the report

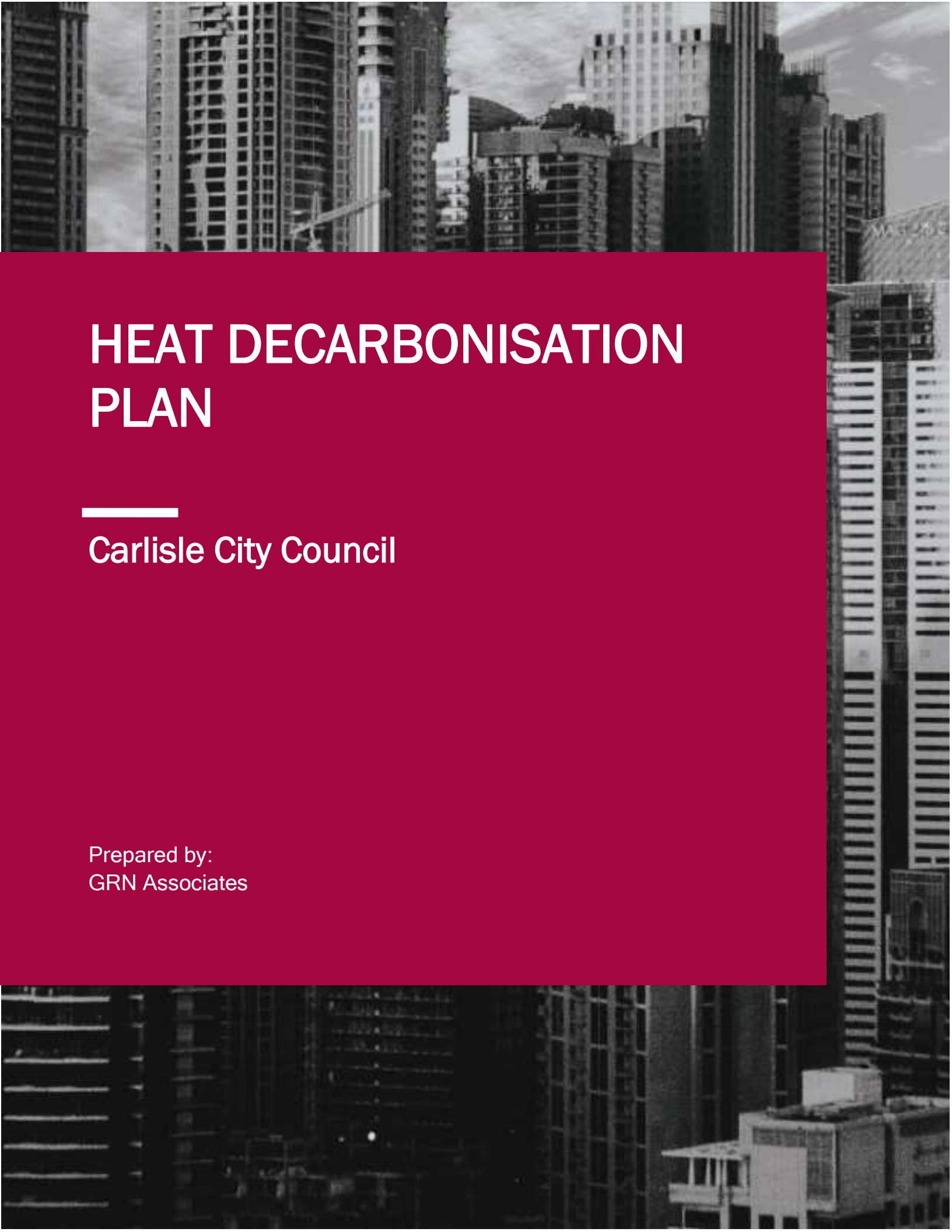
Finance

In order to fully implement the measures outlined in the Heat Decarbonisation Plan a cost of £2,047,840 would be incurred. This would generate savings in the region of £391,842. An application has been made under Phase 3 of the Public Sector Decarbonisation Scheme for funding of £1.87m towards the cost of full implementation. If successful, the balance of funding could be met from existing property enhancement budgets / earmarked reserves. Any implementation of enhancements would need to be added to the capital programme as improvements to the assets.

Equality

None

Information Governance



HEAT DECARBONISATION PLAN

Carlisle City Council

Prepared by:
GRN Associates

Heat Decarbonisation Plan

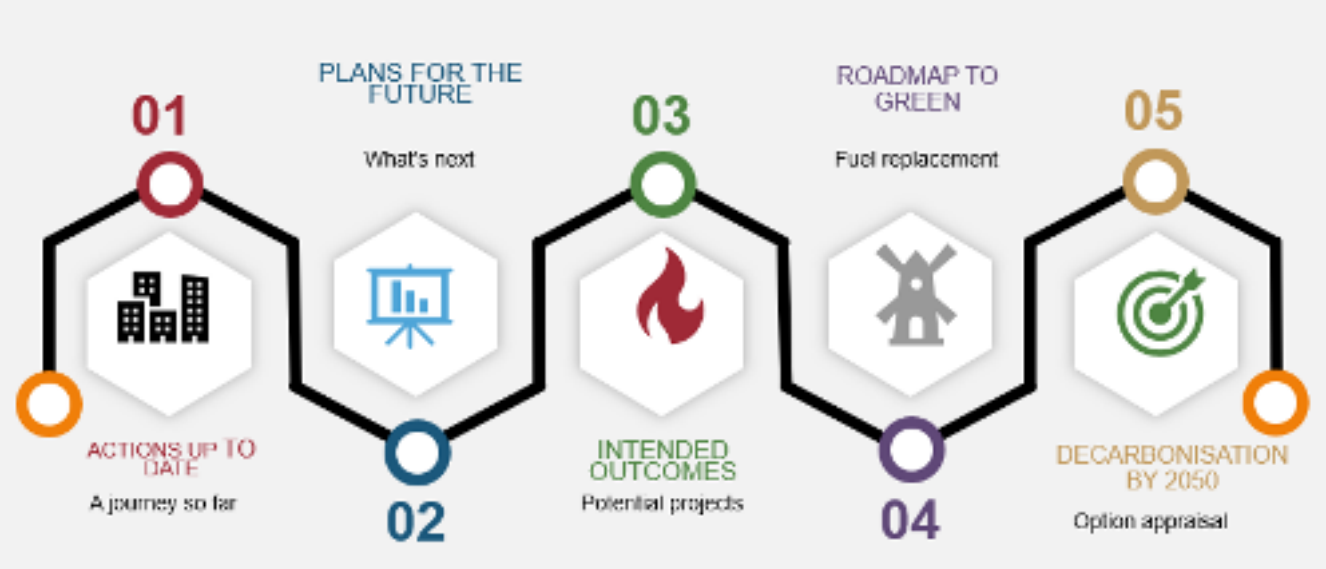
Executive Summary

Carlisle City Council has set up a Sustainable Strategy and has subsequently committed to achieving net zero carbon emissions for sites within their operational control. The City Council has taken significant steps to reduce their emissions and are now looking to target further reductions through their building stock and heat usage to ensure the 2050 UK's Climate Change Act ambition is met.

GRN Associates have been invited to help the City Council with a Heat Decarbonisation Plan (HDP) to support their ambition. This implementation plan focuses on identifying carbon reduction measures for buildings, with a specific focus on the decarbonisation of heat. This report has been prepared as part of the Low Carbon Skills Fund, funded by the Department for Business, Energy and Industrial Strategy.

The City Council, with GRN Associates' assistance, has already identified several carbon reduction projects which are implementation ready. Carbon reduction measures are considered across the estate, including consideration of use of smart technology and options for the decarbonisation of heat.

Commissioned by the City Council, GRN Associates have prepared this roadmap to enable a heat implementation plan to be developed for the main buildings and further support the journey to net zero. This HDP will support the City Council's ambition and provide a pathway for delivery of the 2037 target. This report summarises the work undertaken, with a focus on identifying carbon reduction measures for City Council buildings and supplies, as well as a carbon management strategy.



Analysis of options has identified projects and targets with the potential to save at least 40% of the City Council's baseline emissions through energy efficiency and renewable technologies. This is based on current technologies and conservative estimates of potential for conversion to electric heating and onsite renewable generation; actual potential may be higher. Any remaining emissions may need to be offset through carbon compensation or fuel switching. Overall, this will allow the City Council to reach a net-zero position by 2037.

1. INTRODUCTION

1.1 Heat Decarbonisation Plan overview

Carlisle City Council developed its Local Environment (Climate Change) Strategy in August 2020 and have subsequently committed to achieving net zero carbon emissions for sites within their operational control. The City Council has taken significant steps to reduce their emissions and are now looking to target further reductions through their building stock and heat usage to ensure the UK Government 2050 ambition is met.
GRN Associates have been commissioned to help the City Council with a Heat Decarbonisation Plan to support this ambition.
This decarbonisation plan focuses on identifying carbon reduction measures for buildings, with a specific focus on the decarbonisation of heat. This report has been prepared as part of the Low Carbon Skill Fund, funded by the Department for Business, Energy and Industrial Strategy which has been administered by Salix.

1.2 Journey to achieving heat decarbonisation

The UK has a 2050 net zero target and the public sector throughout the UK can make a major contribution to enabling our country to reach this target. The public sector can influence local communities and businesses and a starting point for that influencing role is to have in place a Heat Decarbonisation Plan (HDP) which demonstrates how the public organisation concerned is leading the way in their community.

The purpose of this HDP is to describe how the council intends to replace fossil fuel reliant systems with low carbon alternatives. To meet the challenge of net zero, organisations throughout the UK need to decarbonise their buildings. A HDP describes the current state of the City Council's energy use and its plans for reducing and/or decarbonising its energy use. The plan outlines what Carlisle City Council has already done, what it is currently doing, what it plans to do in the future. The plan explains what actions are going to be taken, over what timescales, and the intended outcomes.

The City Council has a number of buildings 11 of which have been included in this plan:

1. The Civic Centre
2. Bousteads Grassing Depot
3. Carlisle Crematorium
4. Old Town Hall and Tourist Information Centre
5. Old Fire Station
6. 6-24 Castle Street
7. John Street Hostel and Annex
8. Water Street Hostel
9. Bitts Park Depot
10. Cemetery
11. Cemetery – Garden Links

The City Council has invested in refurbishing and upgrading the sites over the years and has an ongoing maintenance and improvement programme for its property portfolio.

2. PROJECT SCOPE

2.1 Project Scope

This Heat Decarbonisation Plan encompasses sites within the operational control of the City Council. Sites have been identified through collection of data for natural gas and electricity and using Carbon Trust standardisation data for 6-24 Castle Street as no data was available.
In total 8 sites have been taken forward and included in the Council's Public Sector Decarbonisation Scheme #3, as they were included in the Grant Scheme for Category 2 and Category 3 measures. The reduced list of sites was based on the Grant Scheme eligibility and funding criteria where only low carbon heating solutions could be taken forward.

2.2 Baseline emissions

To develop the baseline carbon footprint for the portfolio being reviewed as part of this heat decarbonation plan, historic energy data (natural gas and electricity) has been gathered for each building/supply for the year from April 2018 to March 2019, pre-pandemic data which shows more accurate consumption.
From this data baseline emissions for the project have been calculated using the Department for Business, Energy & Industrial Strategy's (BEIS) 2020 greenhouse gas reporting conversion factors. Emissions have been defined as scope 1 and 2 as follows:

- **Scope 1**: These are direct emissions and can come from fuel combustion, owned vehicle fleet and fugitive emissions. For this project these relate to ***natural gas fuel use on site***
- **Scope 2**: These are energy indirect emissions and originate from electricity, heat, steam, and cooling purchased for own use. For this project these relate to ***purchased grid electricity***

2.3 Development of opportunities

Within this section, we have reviewed the feasibility for energy conservation measures and generating power on site and the opportunities for renewable energy technologies that may be appropriate to the City Council regarding heat decarbonisation. At this stage of the assessment process, we have considered the following systems as appropriate for consideration.

1. Wind energy
2. Solar photovoltaics
3. Solar thermal
4. Geothermal energy (including Ground source heat pumps)
5. Air source heat pumps
6. LED Lighting
7. Improved heating and ventilation control systems
8. Improved energy metering management and targeting systems

The following is a feasibility level review of the technologies and suggests how they could be applied to the City Council's decarbonisation plans.

Wind turbines

Wind turbines harness the power of the wind to produce electricity through circular motion. They can produce electricity without carbon dioxide emissions, and range in outputs from Watts to Megawatts.

There are two basic types of Wind turbine systems:

- Horizontal Axis Wind Turbine (HAWT)
- Vertical Axis Wind Turbines (VAWT)

Image 1: Wind Turbine Examples

The most common design of wind turbine has three blades mounted on a horizontal axis and the blades are free to rotate into the wind on a mast. The positioning of the turbines needs to be considered carefully not only to generate optimum energy but also because the blades of large units can present safety hazards to Aircraft and can provide noise issues if near occupied buildings. Smaller units may therefore have to be adopted, leading to multiple numbers. The

electricity can either link to a distribution network or charge batteries. However, batteries are expensive and have a life span of some 10-15 years.

The city centre sites are unlikely to be appropriate for wind generation due to the proximity of occupied buildings in the local area and the associated complexities of integrating wind generated electricity into the site grid. Dense town location would rule out any application of tall horizontal axis turbines therefore selection of appropriate units would be limited to relatively low mounted vertical axis solutions with low generating yields.

Whilst wind technology is a robust renewable solution that would produce relatively good energy yields based on the average site wind velocity, we do not consider wind generation to be appropriate for all of the sites with the exception of the Crematorium.

Advantages to the use of wind energy for the City Council Crematorium:

- Visual statement of sustainable energy credentials for the site,
- Low maintenance costs,
- Zero fuel cost to produce energy,
- Reduced carbon dioxide emissions.

Disadvantages to the use of wind energy for the Crematorium:

- Complex controls and mains synchronisation,
- Proximity to local occupied buildings.

Solar Photovoltaic

PV systems require only daylight, not direct sunlight to generate electricity (although more is produced with more sunlight). PV panels tend to work best when fitted to the top of roofs, due to fewer obstructions blocking sunlight. Photovoltaic cells can be incorporated into glass for atria walls and roofs or used as cladding or a rain screen on a building wall. They are particularly suited to buildings that use electricity during the day. Once installed they require little maintenance, although clearance of dust and bird droppings could be significant.

Image 2: PV panel examples

For the City Council, Photovoltaic cells (PVs) could provide a proportion of the buildings electrical load. PVs could in principle be implemented locally on a building-by-building basis or via a centralised farm.

South Facing roofs of the portfolio could be considered for locating photovoltaic cells, however careful consideration would be required to securely position panels at the roof to limit the risk of damage during heavy storms. It may be possible to integrate the PV panels into the roofing material if it was due a replacement (i.e roof tiles).

The export of solar PV generated power to the local site electricity network will be subject to further consideration during design development should this solution be considered feasible for progression. Small ground based solar arrays could be appropriate where open areas exist such as at the crematorium.

Consideration should also be made to the appropriate G99 protection of each solar installation to ensure synchronisation with the mains power.

Advantages to the use of solar photovoltaics for the estate:

- Low maintenance
- Unobtrusive operation however there can be reflectivity issues
- Highly visible
- Possible to export excess electricity to the grid
- Does not compete for land space with other uses
- “Free” energy following the initial capital cost
- Integration with battery storage to harness more generation onsite

Disadvantages to the use of solar photovoltaics:

- Capital cost of technology is high
- Dictates roof design regarding optimum orientation and maintenance access
- Relative cost per kW installed is high
- Low electrical output only some 10% of solar Array rating is averaged over the year.

Solar thermal hot water

Solar thermal technologies generate domestic hot water from the sun’s energy through the use of solar collectors. The sun’s heat energy is accumulated by the solar cells, and then water is pumped through these, thus heating the water. The heated water is then used indirectly to generate hot water for use in the building. These systems tend to be incorporated on a roof space, so that they are clear of obstacles, as obstructions on the roof can have an effect on the solar cell array.

Image 3: Solar Thermal examples

There are two main types of Solar Thermal system:

- Flat panel and

- Thermal vacuum tubes.

Vacuum tubes are more efficient and work in cloudier conditions but are generally more expensive. The Solar thermal hot water could act as the primary heating source with an additional form of heater within to supply additional heat when solar heat is not available. This will allow for some free hot water (excluding pumping energy) and hence reducing the primary energy requirement.

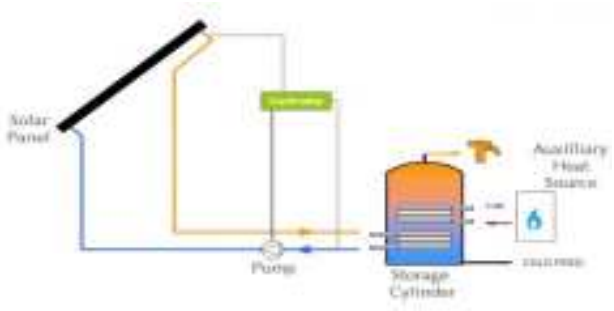


Image 4: Solar Thermal Schematic

Advantages to the use of solar thermal:

- Low maintenance
- Unobtrusive operation
- Highly visible statement if on view
- Zero cost to produce energy

Disadvantages to the use of solar thermal:

- Dictates roof design with regard to the orientation and future maintenance access
- Large thermal store system which will require plant space
- Careful design required to minimise legionella risks
- Need to ensure system is correctly designed and installed and not oversized to prevent pressurisation of system and failure.

Ground source heat pumps

Ground source heat pumps (GSHPs) use the renewable resource of heat which is stored in the ground. GSHPs transfer heat from the ground into a building to provide space heating and/or preheat hot water; they can also be reversed so that heat from a building is placed into the ground to provide cooling during the summer months. Under the surface, the ground tends to be at a constant temperature throughout the year and is approximately between 10 to 16 degrees Celsius at 2 metres.

There are two basic types of ground source heat pump systems:

- Open loop heat pump
- Closed Loop heat pump

A closed loop installation consists of plastic piping which is buried in the ground and connected to a heat pump. A mixture of water and antifreeze is passed through the looped pipes where it absorbs heat from the ground. This fluid then flows into an electrically powered heat pump, comprising a compressor and heat exchangers, before discharging back to the ground. There

are three types of ground loop; they are vertical loop, horizontal loop and slinky loops and all of these require areas of land for ground works. Slinky and horizontal loops are buried approximately 1-2m into the ground. Vertical loops require bore holes to be drilled deep into the ground (usually between 15m and 100m).

In an open loop heat pump system, ground water is withdrawn from an aquifer through the supply well and pumped into a heat exchange device, where it acts as a heat source in the heating or cooling process. Once the ground water is withdrawn from the supply well, it will be pumped through a piping system where it will pass through various control devices, monitoring equipment, instrumentation, and a heat exchanger before being returned to the ground. Typically, heat is exchanged between the building's circulation water and the extracted ground water before returning the ground water to the aquifer.

Closed loop systems circulate fluid through tubing laid in horizontal trenches or in vertical boreholes which are filled with an antifreeze mixture. By applying additional energy input in the form of electricity, it is possible to raise the temperature of the source heat to the temperature required.

Applicability for the City Council

If a ground source heat pump is selected for the estate, it may be possible to provide a form of heating or cooling that is renewable or carbon neutral by driving the heat pumps by electricity from renewable energy sources such as solar photovoltaics.

Heat pumps perform optimally if they are required to provide constant low-grade heat accordingly any building thermal emitters placed on this system would be designed to operate at lower temperatures. The heat pump would need to be supplemented by LPG gas or district heating to provide domestic hot water as the heat pump may not be able to generate hot water to the desired temperature of 65^0C efficiently.

Advantages to the use of ground source heat pumps:

- Both open and closed loops systems are unobtrusive and vertical systems occupy a small surface area,
- Low on-going costs for closed loop system,
- Ground source heat pumps are proven technology,
- Reduced energy consumption over an air-cooled heat pump,
- Reduced Carbon Dioxide emissions over an air-cooled heat pump,
- Limited maintenance requirements.

Disadvantages to the use of ground source heat pumps:

- Horizontal closed loop systems require extensive site area,
- Vertical systems are expensive to install due to the cost of the boreholes required and high risk of disturbing ground around buildings. Usually needs extensive ground survey.
- Increased design complexity to integrate into the building services installation,
- Heat pump efficiency (cop) is very dependent on temperature rise outside to inside. If differential is high then COP drops off dramatically.

System is site and building specific. Site investigation will be required to finalise design.

Air Source Heat Pump

Air source heat pumps (ASHPs) work in a very similar way to Ground source heat pumps, except they draw heat from the air.

There are two basic types of air source heat pump systems:

- Variable Refrigerant Flow system (VRF) – 3 pipe or 2 pipe
- Air to water source heat pump

A 3 pipe VRF heat pump system is capable of simultaneously providing heating and cooling to different zones within a building. The energy consumption performance is good with very high efficiencies and competitive installation costs when compared to more traditional chilled water-cooling systems operating with air to water heat pumps.

An Air to water heat pump circulates water through pipework system rather than refrigerant gas. They are generally less efficient than a 2-pipe VRF system due to the additional stage of heat transfer in the system. The cooling capacity available is low compared to VRF but this would not propose a significant problem in a modern and well insulated building. Unlike the 2 pipe VRF system, the air to water system has to be in heating or cooling mode and therefore cannot heat and cool at the same time.

A 2 pipe VRF heat pump system is capable of providing either heating and cooling at any one time.

A 3 pipe VRF heat pump system has excellent performance in terms of energy consumption and would be a suitable technology to provide heating and comfort cooling across the site.

Advantages to the use of Air source heat pumps for the buildings:

- Relatively low capital cost for technology
- Widely used technology. Known installation techniques to local market.
- Proven technology
- Lower capital costs than ground source heat pumps.
- Demands Less physical area than the GSHP alternative.
  Less Risk than ground source systems.

  System can now be purely renewable as some new heat pump alternatives can produce higher water temperatures suitable for Domestic hot water.

Disadvantages to the use of Air source heat pumps across the estate:

- Coefficient of performance (COP) lower than for ground source systems COP will depend on temperature rise and outside temperature.
- Higher on-going running cost
- External space required – either on roofs or ground adjacent to buildings.

- No commercially available system at present uses zero Global Warming Potential (GWP) refrigerants which are suitable for high rise buildings as the zero GWP refrigerants are all flammable.

Low Carbon Technology	Selected for HDP	Comments
Wind Technology	Yes	Only suited for the Crematorium, due to its midterm decarbonisation strategy
Solar Photovoltaic	Yes	Solar intensity would provide good yields. This would primarily feed to the local grid, with low building demand during the day.
Solar Thermal	No	Common technology, good solar yields. Could provide a good option for hot water generation.
Geothermal Energy (GSHP)	No	High capital cost and complexity reduces attraction.
Air Source Heat Pump (ASHP)	Yes	Very suitable to the buildings with both Heating & Cooling mix. Low capital cost.

Table 1: Renewable Technology Summary Table

Building #	Site	ASHP	PV	Wind
1	Civic Centre	YES		
2	Boustead Depot	YES	YES	
3	Crematorium		YES	YES
4	Town Hall			
5	Old Fire Station	YES		
6	Castle Street	YES		
7	John Street	YES		
8	Water Street	YES		

3. BASELINE EMISSIONS

3.1 Energy usage data

Consumption data has been provided for natural gas and electricity across the seven buildings within the scope with Castle Street usage estimated. High level cost data associated with these supplies has been provided. From this data, average current prices across supplies have been assumed as follows:

- Natural gas: 3 p/kWh
- Electricity: 18.5 p/kWh

The City Councils gas cost is low at present and the future increased energy costs could be particularly significant in the light of current world events.

3.2 Emissions baseline

The table below summarises the main energy types used at the City Council and their relative importance. An assumption for electricity and gas was used for the Castle Street building as no historical data was available.

Utility	Purchased Energy		Cost		CO_2 emissions
	kWh/year	%	£/year	%	tonnes
Grid Electricity	3,064,919	53	551,686	87	714
Natural Gas	2,750,830	47	82,525	12	505
Total Energy	**5,815,749**		**634,210**		**1,219**

3.3 Forecast emissions

Due to the current Energy Conservation Measures and work ongoing across the estate to manage energy more effectively, it is estimated the forecast energy usage for 2022 and associated emissions will be as illustrated in table below.

Utility	Purchased Energy		Cost		CO_2 emissions
	kWh/year	%	£/year	%	tonnes
Grid Electricity	2,838,456	56	525,114	88	661
Natural Gas	2,381,830	44	71,445	12	442
Total Energy	**5,220,286**		**596,569**		**1,104**

The unit costs for electricity in calculating savings are 18.5 p/kWh for electricity and 3p/kWh for gas. No CCL is applicable. The gas price can be expected to double when contracts are renewed over the next four years. Electricity could increase by 20% to 30% but here an average 5%/pa based on BEIS[1] predictions have been used.

4. HEAT DECARBONISATION STRATEGY

4.1 Energy Performance Indicators

Energy performance indicators give a measure of activity-based energy use, which can be compared with equivalent benchmarks. Energy consumption benchmarks are published in Good Practice Guides for different buildings and some processes. For a particular site, the performance indices are modified to take into account building occupancy, size, activities, location and weather (degree days). The lower value indicates best practice.

Actual Performance calculated as annual kWh/m2 of floor area using method adopted in Carbon Trust Publication energy efficiency in public buildings. This publication was first printed in 1999 and electrical consumption in office establishments have grown mainly due to the use of computers, air conditioning and higher levels of lighting. However, it is still useful to compare energy consumption and intensity across the estate.

Energy - SEC in KWh/m2

Comparison of Site Energy Consumption with Benchmark Information from ECG54

Benchmarking Data

Property	Gas kWh/m2	Electric kWh/m2	Total kWh/m2	Comments
Civic Centre	68.7	188.8	257.5	Sector average
Bousteads Grassing Depot	101.5	178.4	279.9	About sector average
Carlisle Crematorium	1940.1	404.6	2344.6	High due to process load
Old Town Hall & Tourist Information Centre	171.1	31.1	202.2	High heating low electricity
Old Fire Station	70.4	272.0	342.5	High electricity due to ducted air system
6-24 Castle Street	0.0	0.0	0.0	No figures – used benchmark
John Street Hostel & Annexe	148.6	48.2	196.8	High heating low electricity
Water Street Hostel	69.8	203.9	273.6	High electricity
Bitts Park Depot	2.1	0.0	2.1	Lack of m2 figures
Cemetery	0	0	0	Lack m2 figures
Cemetery - Garden Links	0	0	0	Lack m2 figures

[1] BEIS Energy Price Forecast

The City Council appears to have opportunities to improve, being higher than the sector average for electricity and higher than the sector average for gas. It is dangerous to make straight comparisons especially with the various mix of buildings. The benchmarking data is based on 1990 data and it would be expected that the energy use was much lower in the newer buildings. There is a high number of computers, air conditioning and lighting load in the City Council. This is reflected in the SEC. There is scope for improvement at all the sites.

SEC in cost/m2

Cost comparison £ per m2/annum	Cost£/m2	Cost£/m2	Cost£/m2	Notes
Property	**Gas**	**Electricity**	**Total**	
Civic Centre	2.7	6.7	9.5	
Bousteads Grassing Depot	4.1	6.0	10.0	
Carlisle Crematorium	77.6	14.3	91.9	most costs are related to cremation
Old Town Hall & Tourist Information Centre	6.8	1.7	8.5	
Old Fire Station	2.8	9.6	12.5	
6-24 Castle Street	3.0	30.8	33.8	Estimated
John Street Hostel & Annexe	5.9	10.6	16.6	
Water Street Hostel	2.8	7.2	10.0	
Bitts Park Depot	0.1	1.2	1.3	
Cemetery			0	No floor area
Cemetery - Garden Links			0	Mainly greenhouses

The total energy cost varies from £1.3 to £10.6 per m2 per site. The larger the site the lower the unit cost should be.

4.2 Energy efficiency

Building fabric is the first item for consideration when looking at energy efficiency in buildings. Adopting a 'fabric first' approach to both new building design and building retrofit will involve first considering and maximising the performance of building components and materials to make the building as efficient as possible. Options for mechanical and electrical building services and systems should then be considered to further improve efficiency and reduce carbon emissions. Elements to be considered include levels of insulation, airtightness, solar

gain/passive solar design, potential for natural ventilation and the thermal mass of the building fabric.

Equipment	Age	General condition	Est. date for next upgrade
Site Heating – Civic Centre	3 Remeha 160kW boilers and electric instantaneous water heaters feeding floors of tower. New 3 pipe electric heat pumps/comfort cooling system on ground and partial A/C to first floors	Boilers are new and in Good condition, but boiler controls and heating systems need upgrading. Toilet ventilation systems are inefficient. Within the basement the heating pipe work is all unlagged and wastes energy, after being stripped out during flooding repairs. This will be very difficult and costly to reinsulate. Heating in tower is mainly by radiant panels and fan boosters with a few air coil units on the 9th floor	2021/22
Site Heating - Bousteads Grassing Depot	Garage area is served by three heating systems: Direct fired gas radiant heaters, a ducted air heater fed by a waste oil fired burner. Low pressure hot water radiators in some areas fed from a single Ideal Evomax 80kW boiler. The office/ bothy area is heated by a LPHW system fed	LPHW Boiler in good condition but controls are basic. Waste oil heater should not be used. The overhead gas heaters need replaced. The office bothy area boiler is in good condition, but the pipework insulation needs replaced in some areas and the controls are basic.	2021/22

	by a separate ideal Evomax 80kW gas fired boiler		
Site Heating – Carlisle Crematorium	A new ideal Evomax boiler is used as back up to the waste heat generated by the crematorium incinerators.	Boiler is new and rarely operated.	2021/22
Site Heating- Old town hall and tourist information	The 110kW Remeha eco LPHW Boiler which feeds LPHW radiator system is in reasonable condition located in basement. Controls are basic	The building is a listed building which limits options. New controls should be considered.	2021/22
Site Heating- Old Fire Station	The plant room and Ground floor heating systems have been refurbished	Some first-floor room heating needs thermostatic valves fitted.	2021/22
Site Heating 6-24 Castle Street	The site has not been occupied for some time and the existing 2 module 100kW Wessex LPHW boilers are very old. The controls are basic	The heating needs replacement and new controls fitted.	21/22
Site Heating John Street Hostel and Annex	The 100kW ideal Evomax boiler feeds LPHW radiators. DHW is supplied by a 60kW Hamworthy direct fired water heater. The Annex is older and is heated by a new 30kW Worcester LPHW	The boiler is efficient and in good order. The controls and metering need updating.	21/22

	boiler which also supplies a domestic DHW cylinder		
Water Street Hostel	The site is heated by two Viessman 60kw LPHW boilers feeding a hot air supply and underfloor heating and A DHW cylinder	The equipment is all in good condition. The controls and metering could be upgraded.	21/22
Bitts Park Depot	The main building is heated by a single 40kW Volkera LPHW boiler and radiators	The boiler is in good condition and fairly new. The boiler is only used infrequently. The controls could be upgraded	21/22
Cemetery Depot	The main office/bothy area is heated by both wall mounted direct fired gas heaters, and electric panel heaters. Both are on is some areas. DHW is by electric instantaneous water heaters	The controls are basic. The heating is not controlled. The gas heaters should be decommissioned and removed.	21/22
Garden Links	The site has two small boilers. One very old Ideal Mexico2 boiler feeds the greenhouse area. The office area and hot house are fed by a newer 30kW Worcester boiler. DHW is supplied by an electric zip Aquapoint3	The main greenhouse boiler is very old and needs to be replaced. The controls are basic and need upgrading.	21/22

	instantaneous water heater		
Site Lighting all areas	Very old to new	Some LED lighting installed at most sites but mainly old fluorescent lighting. Old sodium lighting in Bousteads grassing's garage depot is very inefficient	2021/22

4.3 Electrification of heat

Heating and hot water are responsible for a significant proportion of City Council's greenhouse gas emissions, and current on-site renewable and low-carbon heating levels are low. Therefore, opportunities for conversion of heating to renewable or low carbon sources should be considered as part of the Heat Decarbonisation Plan.
Delivery of low carbon heating is complex, particularly given the scale of gas heating within the existing buildings. It is expected that the shift to low carbon heating can be achieved by installing intelligent heating solutions at the earliest possible time across the portfolio. This is expected to involve a combination of heat pumps and solar water heating with the potential for small scale district heating having a role in the city centre and potentially within regeneration schemes. Where conversion of heating is not feasible, energy efficiency measures will be carried out.

4.4 Heat networks

Supplying heat from a centralised plant via a heat network is a solution that works well in areas of concentrated demand and can offer significant carbon savings, particularly where lower carbon fuels and sources of waste heat to be used.

Heat networks can use various sources of heat, including heat from biomass and biogas fuelled boilers, heat pumps and energy from waste facilities. Additional value and efficiency can be achieved through using combined heat and power (CHP) solutions which convert a fuel to heat and power simultaneously.

Most heat networks currently use gas as their primary fuel source. However, once the network of pipes supplying end-users is in place then generation technologies may be changed over time, switching the heat network to lower carbon fuels such as Hydrogen.

For heat networks already planned that will utilise natural gas such as CHP, consideration should be given to future, low carbon fuel sources such as Hydrogen. Low carbon sources of fuel also need to be considered for future heat networks.

The following sections provide an overview of the main technology options that are currently available for a heat network and ones that have been explored during the feasibility study for a district heating scheme in Carlisle city centre.

Cogeneration/Combined Heat and Power

Good quality CHP producing both power and heat (cogeneration) is a well-established technology enabling the efficient use of primary energy and a cost-effective way of reducing carbon emissions. However, the ongoing growth of wind and solar power generation and associated decarbonisation of the electricity grid will reduce the frequency with which the operation of good quality CHP saves carbon. Natural gas is still greener than grid electricity at present and will be for the foreseeable future.

Due to the intermittency of wind and solar generation, there will still be occasions across the year when 'flexible' thermal generation is required and, from an energy efficiency and carbon perspective, could be best met by good quality CHP. Good quality CHP can therefore still have a role in district heating both micro and large scale, particularly when integrated alongside electric batteries, electrical heating and thermal stores. Digital technology can then be used to balance supply and demand to optimise operation, energy efficiency and carbon savings.

Another consideration is that, as green gas production such as hydrogen enrichment increases and further decarbonises the gas grid, the substitution of the resulting lower-carbon gas in CHP could make this option increasingly cost competitive for achieving heat decarbonisation at scale. There are 20% hydrogen ready gas turbine solutions already available which could run initially on natural gas and then be used with no modification with 20% hydrogen/natural gas mixture in the future without modification.

Heat pumps / Low grade heat recovery

Heat pumps use electrical input and a refrigeration cycle to upgrade low temperature heat from sources such as the air, ground and water to levels required for the end use. Heat pumps are a mature technology readily available throughout the UK. However, some solutions may contain more novel elements, which would come with greater risk around deliverability, efficiencies and proportion of heat that can be achieved.

With any heat pump solution, the form of refrigeration used to raise heat to a temperature appropriate for interconnection with the heat network will need to be a consideration, both in terms of cost and environmental impact.

The key challenges around use of heat pumps in heat networks are generally around the source of heat and corresponding availability, impact on the quantity of heat that can be provided, the efficiency of the heat generated and the cost implications. The efficiency of a heat pumps is normally stated as the Coefficient of Performance (COP).

$$COP = \frac{Heat\ output\ (kW)}{Electrical\ power\ input\ (kW)}$$

There are various sources of heat locally in Carlisle that could be connected to a heat pump, which are outlined in the following sections.

Water source heat pump – river

Year-round availability of heat may not be consistent, as river temperatures reduce during winter, so viability of heat extraction at reasonable COPs will decrease.

Other key environmental considerations around the viability of a river source heat pump include Environmental Agency requirements around extract and discharge and associated impact on temperature on the river, which may impact viability and/or scale.

Low-grade heat recovery – Data Centres

Recovery of heat from industrial processes can provide a stable and clean (in terms of complexities around filtration being removed) form of low-grade heat. A heat-pump can be connected into the existing heat network system recovering heat from a suitable source.

Data centres with cooling heat rejection within proximity to a heat network can also be potential sources for heat recovery. This provides a relatively stable source of low-grade heat throughout the year.

Similar to data centre heat recovery, cooling tower heat recovery can recover the heat rejected to atmosphere. However, in instances where generation is associated with chilled water demand for space cooling, the availability of heat therefore far more seasonal, with greatest generation during summer when heat loads are at their lowest.

Sewage heat recovery

Domestic hot water is used then flushed down drains, injecting heated water into the sewage system. The average temperature of sewer networks in the UK is in the order of 10-20°C, which is capable of providing a stable source of low-grade heat year-round.

Green Gas Certificates

The UK policy on decarbonisation of the gas network is still developing, with options around injection of biomethane and development of hydrogen networks ongoing. Current available options for reduction of CO_2e content of gas include Green Gas Certificates, which can be purchased as an approach to offsetting natural gas used in a heat network.

4.5 Hydrogen

A potential future alternative to burning natural gas for heating would be the use of hydrogen as a fuel. Unlike natural gas, hydrogen does not produce carbon dioxide on combustion. Polyethylene pipes that are increasingly used in gas distribution networks can safely transport hydrogen, but this is not the case for the entire gas network and new hydrogen transmission

pipelines would be required to deploy hydrogen at scale. Changes would also be required to appliances at the points of end use.

Large-scale hydrogen production typically falls into one of three categories: electrolysis, steam methane reforming (SMR) or as a by-product from chlor alkali plants or refineries, with the first two being capable of generating significant volumes of hydrogen.

While hydrogen is technically capable of supplying heat to buildings, there is still significant testing and development required before this could be deployed at scale. For the purpose of this heat decarbonisation plan it is not currently considered a viable option but is one that the City Council may wish to consider in the future. There may also be potential to test this technology at smaller scale via pilot schemes.

5. HEAT DECARBONISATION MEASURES

The City Council is reasonably efficient but has scope for further improvement. There are few forced ventilation units and only some air conditioning. The energy costs are relatively high at present due to poor control.
Some of the older buildings are draughty and poorly insulated and the heating systems are basic, with simple controls. The computer and lighting systems are poorly controlled in some areas. There is scope to achieve energy savings through a combination of good housekeeping, better control and further integration of energy efficient practices and equipment.
The largest energy use is the building lighting, computer systems and space heating. The main scope for savings, include raising staff awareness, improving targeting and monitoring of energy usage, controlling energy usage in the numerous heating and lighting systems. Consideration should be given to replacing the old fluorescent lighting in most areas with new LED fittings and removing excess lighting from all areas.
The heating controls and boilers should be upgraded where appropriate. The City Council depots are poorly insulated and vastly over heated. The main office Civic Centre building has no thermal insulation on 90% of the heating pipework within the basement. The building is of 1960's design and is poorly insulated. There may be scope to install small CHP micro grid systems and renewable energy sources such as solar although these need further investigation.

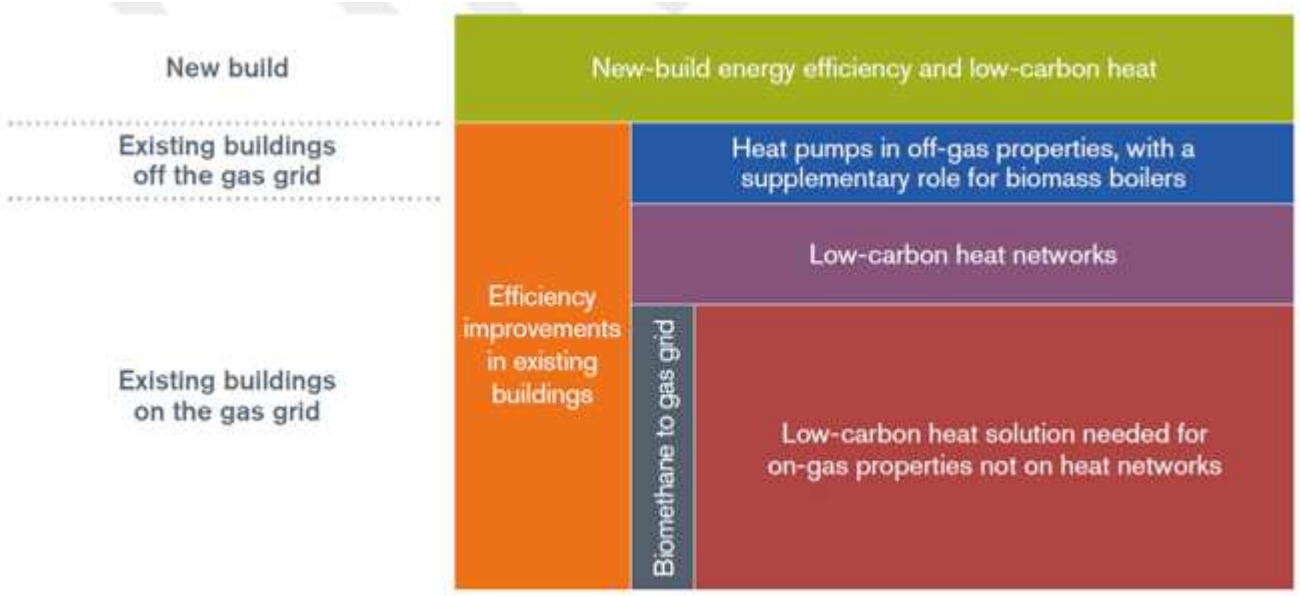


Diagram 2

5.1 Summary of the portfolio

The objective of this HDP is to highlight the most important activities that the Local Authority could undertake to reduce carbon dioxide emissions, energy and costs. The site specific objectives were discussed with Stuart Burns who was the site contact during the survey.

To meet the UK's Net 2050 target, emissions from public sector estate will need to be near zero and the Clean Growth Strategy sets out that public sector emissions will be halved by 2032 compared to a 2017 baseline in order to meet the Fourth and Fifth Carbon Budgets.

In this study a 'whole building' approach has been undertaken to decarbonise the heating system and highlighted energy conservation measures which, when implemented, should reduce on site energy demand.
As per the above Diagram 2, which has been published by Climate Change Committee, efficiency improvements in existing buildings are a 'non regret' option and therefore this Heat Decarbonisation Plan provides a roadmap to reducing the heat demand in the first instance, before a heating replacement for a more low carbon option.

Civic Centre

This consists of a 11-storey office building in the center of Carlisle, completed in 1964 with a total floor area of 12043m^2. The building houses the council office staff and the council chambers. The building exterior is poorly insulated, built with concrete panels. The windows are single metal frames but are fully opening and are not airtight. The site was flooded in 2015, the basement and ground floors were badly damaged during the flood. They have been totally refurbished including new interior fabric, new air conditioning and lighting. The rest of the building is need of upgrading with perimeter overhead radiant panels along with some fan assisted heaters fed from the main boiler house.

The heating system to the rest of the building consists of three new Remada 160kW LPHW boilers which replaced the boilers damaged in the flood. The heating pipe insulation has been removed throughout most of the basement after the flood and has not been replaced. This could cost circa £45k to replace, and the heat losses are probably higher than the actual building heating load. The BMS is in the process of being upgraded. Lighting above the first floor is mostly old fluorescent 4x18W panels.

The only forced ventilation is a central toilet extract system which runs down the centre of the building in a services duct. DHW is mainly supplied by local electric instant hot water units.

Bousteads Grassing Depot

This site is where the council transport is based. There is a garage and parking facilities. The site has two main buildings, The reception and garage area and the office and bothy areas. The garage area is heated by three different heating systems. An ideal Evomax 80 feeds radiators throughout the building. The controls are very basic. There is a very basic ducted warm air heating system from a waste oil heater fed from waste engine oil which is used to heat the garage workshop area. There is no information on the waste oil usage. There is also a number of direct fired radiant gas heaters in the workshop areas which are only used occasionally. The site has started converting the lighting to LED however, there are a number of old inefficient light fittings. This includes some 400W low bay sodium lighting in the garage area.
The office bothy area is heated by a second Evomax 80 boiler which is in reasonable condition but poorly controlled. The lighting is a mixture of new LED and old inefficient fluorescent fittings. The site has an expanse of roof area which could house a solar array to provide renewable low carbon electricity.

Carlisle Crematorium

The Carlisle Crematorium has a floor area of 679m^2. This consists of a main building dating from the 1950's and some outbuildings. The crematorium has one Main Building which is heated by the waste heat from the two body incinerators. There is a small chapel and incineration room and some side rooms and offices. The building is generally occupied from 8am to 5pm Monday to Friday. The lighting is mixture of old fluorescent fittings and new LED. There is a new ideal Evomax 80 boiler which has been installed as back up to the incinerator waste heat which is seldom used. The council are looking at decarbonizing the crematorium and changing to electric incineration from the existing gas fired units.

Old Town Hall and Tourist Information Centre

This building dates from the 16th century and was the original town hall. It is located in the main city square. It is now the tourist information center and has some shops and coffee shops located underneath the council building. The first floor houses the council activities. It has some meeting rooms but most of the area is taken up by the tourist information center. The building

is heated by a single 110kW Remeha LPHW boiler. Which was installed recently. The controls need updating and there is no energy metering. The lighting is a mixture of new LED and old fluorescent and tungsten halogen luminaries.

Old Fire Station

This building is a two-story building which used to be the old Victorian fire station. It is located in the town center close to the civic center. has been converted to an arts and music destination with arts gallery and small theatre. It has been leased to the new occupier on a ten-year lease. The occupier is responsible for the energy usage and costs. The ground floor and first floor of the building has been newly refurbished and is mainly heated from a new gas fired forced ventilation system. The rooms are heated by radiators. The system controls in the rooms could be upgraded and some of the room lighting is old and needs replacement.

6-24 Castle Street

This building is made up of a terrace of six buildings and was used by Cumbria University but has been handed back to the council. It is mixture of old Victorian and 1970's buildings which runs along the front of the street. It has a large number of small rooms and covers mainly two floors with a pair of three story and a small tower which has four floors at one end. The building is heated by 2 off Hamworthy gas fired 2 module Wessex boilers rated at 50kW per module (100kW per boiler). The boilers are each located at both ends of the building in basement boiler houses. The two boilers are very old and in poor condition and need replacement. The Controls are basic and need upgrading. There is no energy metering apart from the billing meters. The site Lighting is supplied by very old switch start fluorescent fittings which all need replacement. DHW is supplied by two off electric instantaneous water heaters.

John Street Hostel and Annex

This building consists of a relatively new main block attached to an old Victorian town house. Which is the annex. The buildings are in good condition. The Main building consists of a two story block of rooms which houses the residents. The building is heated by a 60kW ideal Evomax LPHW boiler feeding radiators. DHW is supplied by a separate 60kW Hamworthy instantaneous gas fired water heater. The Victorian annex is heated by a 30kW domestic boiler feeding radiators. DHW is supplied via small hot water cylinder fed from the boiler. The heating in both buildings is controlled by a control system which depends on wireless connection and batteries on valves and sensors. The system appears to be very unreliable and needs investigation.

Water Street Hostel

This building and plant are relatively new and consists of a two-story accommodation block with some side and common rooms and a reception office on the ground floor. Heating and DHW is supplied by 2 off 60kW Viesmann LPHW boilers. The boilers feed a ducted ventilation system and under floor heating. The lighting is supplied by downlighters in most areas. The light levels are poor and need upgrading. The controls and metering also need upgrading. The building has a number of submeters which are not connected.

Bitts Park Depot

This building is a storage work shed which is mainly unoccupied and unheated. It has a toilet and rest room which is heated by a small 30kW Vokera LPHW boiler. The lighting is all by old fluorescent fittings.

There are some old sodium floodlights. DHW is by small instantaneous electric water heaters.

Cemetery Depot

The cemetery depot consists of a small steel sheeted shed and a small stone building housing a rest room and toilet area. The shed is unheated and has some old fluorescent light fittings. The rest room is heated by both direct fired wall mounted gas heaters and electric panel heaters. The toilet area has electric panel heaters. The controls are manual and need upgrading. The radiant gas heaters should be removed.
The lighting is a mixture of new led and old fluorescent fittings which need upgrading. DHW is by small instantaneous electric water heaters.

Cemetery Garden Links

The Garden links consist of two heated greenhouses, a lean too glasshouse, a hot plant room with a small office and communal area. The old Victorian glasshouses are heated by an old and inefficient ideal Mexico boiler which is in very poor condition and needs replacement. The controls are basic and need upgraded. The office area is heated by a relatively new 30kW

Worcester gas fired boiler feeding radiators. This boiler also feeds some of the green house areas and hot plant room. The controls are basic. There is no metering. The lighting is mainly old t8 fluorescent batons which need replacement with Led units. The DHW is supplied by new electric instantaneous water heaters.

5.2 Energy conservation Measures

The following priority actions for improvement of the Councils energy management practices are recommended:

Priority 1	**Improve energy management structure and practices**			
Cost Saving £15173 pa	CO_2 Savings 36.9 Tonnes pa	Energy Savings 15927 kWh pa	Cost £ 10,000	Payback 0.75Yrs
Detail:	**Construct an action plan and energy strategy** The site surveys have identified a number of areas where energy consumption can be reduced and has either implemented, or plans to implement, a number of these measures over the following years. The City Council should now consider the construction of a formal action plan and strategy for achieving further energy savings. The action plan should be regularly updated with actions required through both management and technical measures. The recommendations made in this report should be used as the basis of the action plan and as a platform for further investigation. It is understood that a policy exists of specifying energy efficient equipment where possible, which is to be commended. Care should however be taken to ensure that the requirement for energy efficient equipment is integrated into all new build and refurbishment projects with consideration given to the life cycle energy costs rather than the initial capital purchase costs. **Form an Energy Programme Board/Working Group** Responsibility for energy management across the portfolio lies with the management in the Property Team in lieu of a dedicated Energy Team To assist this process an Energy Working Group could be formed with Energy Champion identified for each of the building or as appropriate. The working group should meet on a regular basis. The purpose of the WG, whose members could be co-opted from appropriate staff, should be to identify opportunities to reduce energy consumption and waste in general and monitor progress to date. The minutes of the meetings should be logged including any action either completed or required. In its formative stages the first main target should be to produce an action plan of all measures that have historically and are currently being considered for implementation that will reduce energy consumption. **Conduct regular reviews** Regular reviews of opportunities to reduce energy consumption are not currently completed. The Council should consider a regular review of both management and technical opportunities and should record all activities that will have an			

	impact on energy consumption and maintain a log of further areas for action. The reviews should be completed both during meetings of the energy working group and through regular site 'walks' to identify any poor practices and faults with any management or automatic control systems etc. These walks should be at least quarterly. Energy use should also be reviewed in all new and refurbishment projects. Project specifications should be reviewed to ensure that energy efficient equipment is specified. The findings of the reviews should be incorporated into the action plan to ensure that energy saving measures are implemented. The action plan should be regularly updated as the reviews are conducted and the results of the improved monitoring and targeting incorporated to identify achievements to date. **Improve awareness among staff** Levels of awareness of the need to conserve energy at senior management level are considered good at present. It is clear however that awareness requires improving among the staff to ensure that all lights and equipment is switched off when not required. See Priority's 2,3,4&5 below **Improve monitoring and targeting of energy use** Energy consumption is not manually or automatically checked and recorded from the main meters and sub meters. This should be carried out on a minimum of a monthly basis. Automatic systems will produce monthly reports and data down to every 15 minutes if necessary. This should be carried out and used to check billing and monthly consumption trends in order to identify waste and potential savings. In order to improve on the usage of this information, consideration should be given to further analysis based upon sub metering of the major energy users including the heating boilers, lighting, air conditioning and computer systems at each building. The City Council is aware that better targeting is possible but is limited by the availability of money, time, and trained personnel to complete these tasks. Once the parameters for energy performance are installed, the performance can then be targeted. Any fluctuations above expected performance can be checked to determine any relevant reasons such as failure of the controls, longer operating hours, severe weather etc. A simple spreadsheet system using a CUSUM based trending analysis in an excel spreadsheet or similar targeting automatic system could be used initially. See Priority 6 below **Publicise energy efficiency actions and achievements** Actions taken at each site to reduce energy consumption should be published via existing notice boards to assist in improving the levels of awareness in the site. Online energy data from M&T systems can be shown in real time on displays at each site. The City Council should publicise actions which can be used to show the organisation's green credentials. The recommended actions in this report should be used to assist in this process.
Rationale:	Potential energy savings at every building within the portfolio will be highlighted through the creation of a formal framework, increasing awareness and improved monitoring of the areas and levels of energy consumption. Savings are based on a typical 5% reduction in energy consumption. This would be achieved by switching off any lights, heating, air conditioning, kitchen, office or other

	equipment or appliances which were not required and closing windows and doors. This will require a culture change for some of the staff.
Risks:	Additional management time is required which may be seen as a distraction in the future if focus is not maintained Initial impetus must be maintained, and progress assessed on an ongoing basis to maintain and improve on the initial savings gained by the implementation of the appropriate recommendations.
Next Step:	1. Developing a Net Zero Carbon strategy for the estate in conjunction with commitment from the senior site management. 2. Develop and maintain an action plan that is reviewed on a regular basis. 3. Develop an energy budget and cost target. 4. Create an Energy Working Group and select Energy Champions. 5. Implement an active poster campaign. 6. Give energy conservation talks to employees. 7. Consider implementing energy conservation as part of staff employment terms and conditions similar to health and safety. 8. Include energy as part of staff induction training. 9. Publicising the site's performance as an aid to increasing awareness of the costs and benefits of reducing energy usage. 10. Collect specific information required. 11. Input of this information along with production to into a spreadsheet to determine the sites performance in a graphical manner to show how the site is performing. 12. Set base consumption figures and targets for improvement on this. 13. Completion of reviews of site energy performance and progress towards target. 14. Reassessment of target if required. 13. Review of current energy status and implemented energy saving Projects updating the action plan as required.

Priority 2	**Ensure that ventilation and air conditioning is tightly controlled**			
Cost Saving £ 11,000 pa	CO_2 Savings 10.7 Tonnes pa	Energy Savings 50,000 kWh pa	Cost £12,000	Payback 1.1 yrs
Detail:	The City Council has a number of ventilation and air conditioning systems located at many of the sites. The systems are manually controlled or on simple time control. These systems should be tightly controlled and should only run when required. Air conditioning is very costly to operate. Typically, three times the cost of gas heating. The staff should be instructed to switch off the AC and ventilation when not in use or alternatively use personnel activated controls. Control of the sites ventilation and air conditioning systems using carbon dioxide levels to control ventilation rates should be considered. The heating should be interlocked with the air conditioning to ensure that both cannot be run together. It is estimated that The City Council has over 100 kW of cooling installed. Air conditioning was on in rooms which were unoccupied during the visit. The civic centre has some toilet extract systems which could be controlled to minimise ventilation costs.			
Rationale:	The City Council Air conditioning units draw an estimated average load of some 50 kW of electricity in total. The A/C units must not be switched on when the heating is on. If the Air conditioning is used, then the heating must be switched off to minimise cost and minimise carbon emissions. Rooms which are air conditioned			

	normally have high heat gains due to computers, office equipment and lighting which puts additional load on the air conditioning. This additional heat gain should be minimised. Printers etc can be located in separate un air conditioned side rooms. If the air conditioning is operated at 23C instead of 21C then the saving would be some 10% of the existing cooling cost. Existing A/C cost is estimated at 50kW x 3000hours x 22p = £33,000. This cost could easily double if not tightly controlled. Savings due to improved controls are: 10% of £33,000 = £3,300. Energy savings are 15,011 kWh, CO2 Savings are 2.7 tonnes Savings due to controlling ventilation load using personnel and Carbon Dioxide controls would be some 50% of the existing AHU running costs. This is due to the fact that if you reduce the fan motor speed by 20% then you reduce the fan motor power by 50%. A 50% saving in toilet ventilation fan running costs are 5kW x 3500 hours x 22p/kWh = £3850 per annum. The cost of new Variable speed drives and controls is estimated at £6 000 per AHU. The cost of upgrading 2 AHU's and extract fans Would be £12,000. Total potential savings would be £7,700
Risks:	The technical and commercial risks of updating the controls. Potential complaints by users.
Next Step:	1. Investigate cooling and ventilation control options in more detail. 2. If the outside temperature is less than 18C then open windows rather than switch on A/C units. 3. Ensure that heating and air conditioning is not on together 4. Reduce lighting load by switching off lights and fitting energy efficient fittings to reduce heat load on the air conditioning. 5. Use LCD monitors on computers to reduce heat gains. 6. Ensure air conditioning systems are well maintained and that time controls are set to switch off when rooms are unoccupied or fit personnel activated controls.

Priority 3	**Fit Automatic Metering Monitoring and Targeting system**			
Cost Saving £30,000pa	CO_2 Savings 73.8 Tonnes pa	Energy Savings 318533 kWh pa	Cost £ 60,000	Payback 2Yrs
Detail:	The City Council has a high energy bill but has very little visibility in how it is being used or where it is being used and how efficiently it is being used. Installing an automatic energy, carbon and cost management system has a number of advantages. 1 The City Council will be able to see clearly where the energy is being used and who is using it and how efficiently. 2 The City Council will be able to identify areas of waste and take action to reduce it. 3 The City Council will be able to allocate energy costs and carbon costs against each building and department. A league table will be automatically produces showing the highest and lowest users and their associated Key performance indicators (KPI's) 4 Once users know they are being monitored and compared with other users, this automatically reduces unnecessary consumption. 5 Real time energy display certificates can be produced for each building showing how they compare against benchmarks.			

	6 Energy budgets can be better allocated against users. 7 Energy saving projects can be identified and justified using the information produced. 8 The M&T system can be used to more easily specify new equipment using historical energy demand and power consumption. 8 The City Council's monthly carbon footprint can be calculated automatically.
Rationale:	The carbon trust trials showed that on average between 5% and 12% energy savings are made by implementing these systems Total potential savings in the City Council is estimated at some 10% of £303467 = £30,000 in total. Energy savings are 318533 kWh and 73.8 tonnes of CO2
Risks:	Cost and management time
Next Step:	1. Carry out detail Monitoring and Targeting study 2. Gather information on building/department allocated floor area and operating hours. 3. Install M&T System

Priority 4	**Rationalise and Upgrade Building Lighting**			
Cost Saving £30,000pa	CO_2 Savings 31.3 Tonnes pa	Energy Savings 136,363kWh pa	Cost £ 120,000	Payback 4.0Yrs
Detail:	The City Council has a high lighting load using many old fluorescent and tungsten halogen dichroic lamps. Many of these lights were on when not required during the day in areas with high levels of natural lighting. There are a number of tungsten and tungsten halogen lamps which should be changed to compact fluorescent lighting saving over 90% of the energy costs. Direct replacement 4watt LED lamps can now be purchased. The City Council lighting load is estimated at some 321kW in total split across the various sites. Critically assessing the number lamps and reducing the number of lamps to appropriate levels and fitting lighting controls such as timers and personnel activation in some areas will reduce the lighting costs dramatically. LED lights should be fitted in all areas with personnel activated controls fitted in low use and intermittently occupied areas. Led lights if properly specified and installed will last over 20 Years without replacement compared to continual replacement of fluorescent lamps. When fitting LED lighting it should be noted that equivalent fittings such as 600X 600 w replacements for 4 x 18w t5 lights or 2 X 28W Pl lights will probably give out almost twice the light which commonly leads to over lighting and complaints of too bright lights in the room. Check that appropriate Lighting replacements are fitted when replacing existing fittings.			

	Lighting is very expensive and should only be used where necessary. Appropriate light levels should be agreed, and the lighting controlled at that level. The light levels are very high in some areas compared to similar rooms in others. A picture hung on a wall, costs nothing to run. A light used for decorative effect has running costs which could be as high as £100 per year. Many lights are only on to light notice boards in already well- lit areas. Only light what you need to see and to appropriate levels.
Rationale:	The buildings have good day lighting giving high levels of natural light. Lux control could be carried out in some areas such as the work sheds and at windows. Adding personnel activated controls to the toilet areas and other intermittently occupied areas would save some £30 per annum per room. The dichroic spotlights should be replaced with LED lighting. Saving over 50% of lighting costs. The target loading cost saving is estimated as £34,071. Light fitting, lamp replacement and controls costs should be some £200,000. Although each area should be independently assessed. These are target values but should be achievable with more efficient lighting and improved control. Part of these savings could be achieved by better control of lighting by staff.
Risks:	Additional cost and operational disruption
Next Step:	1. Carry out detailed lighting survey to establish exact requirements. 2. Remove unnecessary lighting and rationalise lighting to appropriate levels in each area of the buildings. 3. Remove all tungsten and tungsten halogen lamps and replace with LED lamps. 4. Replace fluorescent fittings with LED fittings (also reduce number of fittings if appropriate). Led lighting gives out greater light per fitting than comparable fluorescent fittings 5. Fit lighting lux level control and personnel control to new fittings where appropriate.

Priority 5	**Replace gas heating with Heat pumps where possible**			
Cost Saving £ 30,000 pa	CO_2 Savings 92,5 Tonnes pa	Energy Savings 500,000kWh pa	Cost £800,000	Payback 26Yrs
Detail:	The City Council has a number of old boilers some in poor condition. Heat pumps should be considered where possible as part of the decarbonisation strategy.			
Rationale:	The Civic Centre heating system is very poor and inefficient. The boilers are in good condition, but the infrastructure and controls are old and in poor condition. The pipework is mainly uninsulated throughout the basement and the perimeter heating is very poor. The ground and first floors have already been converted to heat pump /AC units. The Castle street, Water street, John street, Garden link and Bousteads Grassing's depot should also be considered as they have existing boiler plant which could be converted to heat pumps. Where the existing systems feed			

	indirect DHW cylinders Phase change material heat storage could be used to store heat from the heat pump during the night and dispatch it when required during the day. This is worth some £30,000 per annum across the estate in cost savings for an installed cost of £800,000. Carbon savings would be some 92.5t/annum.
Risks:	Additional cost and operational disruption
Next Step:	1. Carry out a heating survey and provide a simple system specification. 2. Improve building insulation levels. 3. Consider upgrading the site controls at the same time

Priority 6		**Upgrade Heating Controls**		
Cost Saving	CO_2 Savings	Energy Savings	Cost	Payback
£23,521pa	72.5 Tonnes pa	392020 kWh pa	£ 65,000	2.8Yrs

Detail:	The existing building heating systems throughout the City Council buildings are poorly controlled. The heating could be improved by zoning some of the areas and repair existing zoning to allow the staff to remotely be able to monitor and alter temperatures and time schedules and control areas depending on occupancy. The heating in some areas is manually controlled, and in some areas or by simple time clocks and very old and obsolete Building Management Systems. Some areas are on continually unless switched off by staff at the boilerhouse. The controls are simple and basic in some areas relying on thermostatic valves which do not switch off the heating at night. New Zone valves could be fitted at appropriate areas allowing zoning to be implemented in the Civic Centre. New electronic distributed temperature monitoring and switching is now very cost effective.
Rationale:	We would recommend a remotely controlled system which could be operated from the estates office. Controllers at each building monitoring space temperatures. The zone temperatures could be adjusted as required or based on occupancy using occupancy sensors. Space heating is estimated at 70% of the gas bill. Savings in gas and electricity costs due to Improved controls would be some 20% of £117,606 = £23,521, 392.020 kWh and 72.5 tonnes of CO2. There would be additional electrical savings associated with the heating systems. Some areas will give quicker paybacks than others. Cost of upgrading controls is estimated at £65,000 across the estate.
Risks:	The technical and commercial risks of updating the controls. Potential complaints by clients.
Next Step:	a) Investigate heating and control options in more detail. b) Supply awareness training to occupants c) Instruct staff to switch off heating and close doors and windows in unoccupied areas.

Priority 7	**Install Solar Photovoltaic Panels on site**			
Cost Saving	CO_2 Savings	Energy Savings	Cost	Payback
£33,660 pa	35.19 Tonnes pa	127500kWh pa	£ 350,000	9.3 Yrs
Detail:	The council have a number of very large flat roofed areas and open grassed areas at the crematorium. There may be a possibility of mounting a large number of PV solar panels on the roofs and at the crematorium to provide electricity. These are becoming more attractive as costs fall and energy prices increase. It is estimated that there could be some 250kW of PV fitted across the estate. This could be attractive if grant funding was available and could be carried out in phases. Additional battery storage would increase carbon savings and the useful electricity harvested.			
Rationale:	The Crematorium, Garden Links and Bousteads Grassing's sites could probably house a large number of panels. Sized to match the best fit, demand and sun supply. Battery storage would improve the carbon savings			
Risks:	The technical and commercial risks of installing new plant.			
Next Step:	Investigate options in more detail, planning permission and grant approval. A feasibility study should be carried out.			
Relevant Publications:	n/a			

Priority 8	**Install Wind Turbine and Battery Storage at Crematorium**			
Cost Saving	CO_2 Savings	Energy Savings	Cost	Payback
£103,488 pa	165.8 Tonnes pa	559395 kWh pa	£ 500,840	4.8 Yrs
Rationale:	The Crematorium grounds could house a medium sized wind turbine some 100kW to 250kW and battery storage of some 300kW. The existing crematorium incinerators are gas fired. It is intended to decarbonise these in the future. If electric incineration is used, then there will be a very large demand for electricity at the site. The wind turbine will need to be sized to match the demand. Battery storage would average out the demand as it could be used to store electricity at night and at weekends and dispatch this electricity when required during the day to supplement the wind turbine and improve the carbon and cost savings			
Risks:	The technical and commercial risks of installing new plant.			
Next Step:	Investigate options in more detail, planning permission and grant approval. A feasibility study should be carried out.			
Relevant Publications:	n/a			

Priority 9	**Install Ultra Rapid and Rapid EV chargers**			
Cost Saving	CO_2 Savings	Energy Savings	Cost	Payback
£120,000 pa	35.19 Tonnes pa	127500kWh pa	£ 130,000	1.1 Yrs
Detail:	The council have a number of sites where Electric vehicle charging might be beneficial. The council is considering converting their vehicle fleet to electric and will need an EV charging network to make this possible. EV charging should be considered at the Boustead Grassings Depot and The Civic Centre. The crematorium car park should also be considered. Other sites such as swimming pools, leisure centres and Council owned car parks would be ideal locations. Converting to electricity from petrol or diesel will reduce the carbon emissions by up to 30% if using grid electricity to charge. If this was assisted by solar or wind then the savings would be higher. The installation of EV chargers could be funded by the savings. Current petrol and gas prices are around 27p/mile for a normal family car. The equivalent for a car charged at 22p/kWh is some 5p/mile If a battery were used to store the energy from wind or solar and dispatched when needed, then the EV charging could be free and carbon zero. If 6 off 22kW and 3 off 150 kW ultra-rapid 4 port chargers were installed across the estate, then the costs would be some £130k. If 10 vehicles were charged at 40kWh daily at 22p/kWh the cost savings could be in the region of £120,000 per annum. If gas fired CHP were considered, then this could be used at the three sites to supplement the site electrical supply and provide waste heat for the buildings. The electricity generated could allow the EV vehicles to be charged at an even lower cost of sum 2p/mile. The council could use this to generate income by charging cars at 22p/kWh.			
Rationale:	The Crematorium, Civic Centre and Bousteads Grassing's sites electrical connection could probably supply a number of chargers. Sized to match the best fit, demand and electrical supply. Battery storage would improve the carbon savings			
Risks:	The technical and commercial risks of installing new plant.			
Next Step:	Investigate options in more detail, planning permission and grant approval. A feasibility study should be carried out.			

5.3 Funding the delivery of heat decarbonisation

To date, the most common approach to funding energy projects has been for the City Council to fund through equity or debt through the internal reserves. To truly deliver the transition to the decarbonised estate, some options for funding aggregated projects through development of long-term strategic partnerships that combine public and private finance could be considered. In addition to these funding streams, the government has recently pledged nearly £2 billion of investment to reduce carbon emissions from industry and homes. The City Council should look at setting out, clear, innovative, and strategic plans for achieving decarbonisation of heat and look at options for obtaining investment, both through public funding and private investment.

Other typical funding mechanisms used by public sector to fund energy projects are outlined in the following sections. However, delivery of net zero is likely to require the exploration of innovative funding mechanisms.

Public Sector Decarbonisation Scheme

Funded by the Department of Business, Energy and Industrial Strategy, Salix has been working with public sector in England for over fifteen years. They have invested over £360 million in energy efficiency projects in English local authorities since 2004, saving English Councils over £71 million per annum.
Salix is able to fund energy efficiency projects across public sector estates, with over 100 energy efficiency technologies supported, including boilers, combined heat and power, insulation, LED and lighting upgrades. Salix offers grants through the Public Sector Decarbonisation Scheme.
Salix is continuing to work with clients to receive applications when you rounds are announced and are keen to work with organisations as they develop and deliver their heat decarbonisation plans. Salix also looks to build long term relationships by agreeing to fund projects over subsequent years as it was delivered under the PSDS#3.

Grants

Carlisle City Council has successfully applied for funding for a number of the projects identified in this report through the Low Carbon Skills Fund. This has been launched by the Department for Business, Energy, and Industrial Strategy (BEIS) who is allocating £1bn of grant funding for public sector decarbonisation. Projects are sought that align with the priorities of fighting coronavirus, backing business, unleashing innovation, and tackling climate change. The scheme will encourage green investment aligning with the Government's net zero and clean growth goals. There may be other grant funding available both locally and nationally, such as Local Growth Fund, Shared Prosperity Fund, and the Heat Network Investment Programme.

Procurement and route to market

The funding route and procurement strategy for delivery of the scale of low carbon projects required should be informed by early market engagement to help shape the requirements and plan the most appropriate route to market. This is particularly important where organisations are looking to procure innovative solutions, as early engagement with the market can help to shape solutions that maximise value and local benefits. This can then help to simplify the procurement process and is in line with Crown Commercial Service approach for commercial activities.

Frameworks

One example of a widely used framework is the Re:fit programme. This is a procurement initiative for public bodies wishing to implement energy efficiency measures and local energy generation projects on their assets, with support to assist in the development and delivery of the schemes. Measures implemented look to improve the energy performance of assets and thereby reduce carbon emissions, achieve guaranteed annual cost savings, and generate income for the authority.
The Re:fit framework is the framework of choice for public sector enabling change to be delivered at scale and pace. The framework uses a robust, flexible, and tested Energy Performance Contracting approach. Over 250 organisations have already engaged Re:fit and

over £180m of works have been procured across more than 1,000 buildings. This has resulted in savings in excess of 52,000tCO2 and £10m of energy costs each year. The current pipeline is over £91m and growing.
The framework provides a guaranteed 100% of the energy saving or generation (kWh) via a contractual agreement for the payback period of the project. This key feature helps to remove risk of failure with new developments, as well as protecting the client and their investment. Additional benefits include improvements to buildings' operational performance and comfort levels for staff, reductions in building-related complaints and maintenance backlogs and a boost to local investment through local job creation.
The new Re:fit 4 energy performance contracting framework has just been launched, running for the period up to April 2024. Public sector bodies can use the Re:fit framework to help accelerate the development and delivery of long-term capital programmes.

Investment

The challenge of achieving heat decarbonisation, meeting City Council needs, and maximising the benefits under current budget pressures means that a more commercial approach to delivery is likely to be required. This commercialisation might involve joint ventures, private finance, or other innovative funding mechanisms.

5.4 Final Summary

There is clearly a clear drive in City Council to tackle climate change and achieve net zero carbon within the estate's buildings. The opportunities identified through this study could help to drive this change.
GRN Associates recommend that Carlisle City Council implement a drive for energy efficiency through behaviour change, the setting of ambitious targets and implementing the energy efficiency measures highlighted within the report. This will help to reduce the overall consumption of buildings. Heating sources can then be either converted to electrical or low carbon sources and remaining power requirements supplied from green energy sources either via on-site renewable generation (e.g. solar PV) or REGO backed green power.
Monitoring of progress will also be key to City Council's success in achieving heat decarbonisation. Clear actions should be determined following from the analysis in this report. Monitoring and reporting of progress against these actions should be carried out within agreed timelines and continually assessed. This assessment should then feed into review and update of the action plan.