Liverpool City Region Combined Authority LCRCA
Heat Decarbonisation Plan
Supporting Document
LCRCA

Rev No	Comments	Author	Checker	Date
0.1	DRAFT	O.Riley		17/02/23
2	Final Issue	OR	FM	04/04/23

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Executive Summary

A Heat Decarbonisation Plan (HDP) has been undertaken for selected buildings operated by Liverpool City Region Combined Authority (LCRCA). The HDP was grant-funded by the Low Carbon Skills Fund (LCSF) and produced in accordance with guidance from Salix Finance Ltd, the non-profit organization loan provider. The buildings in scope are:

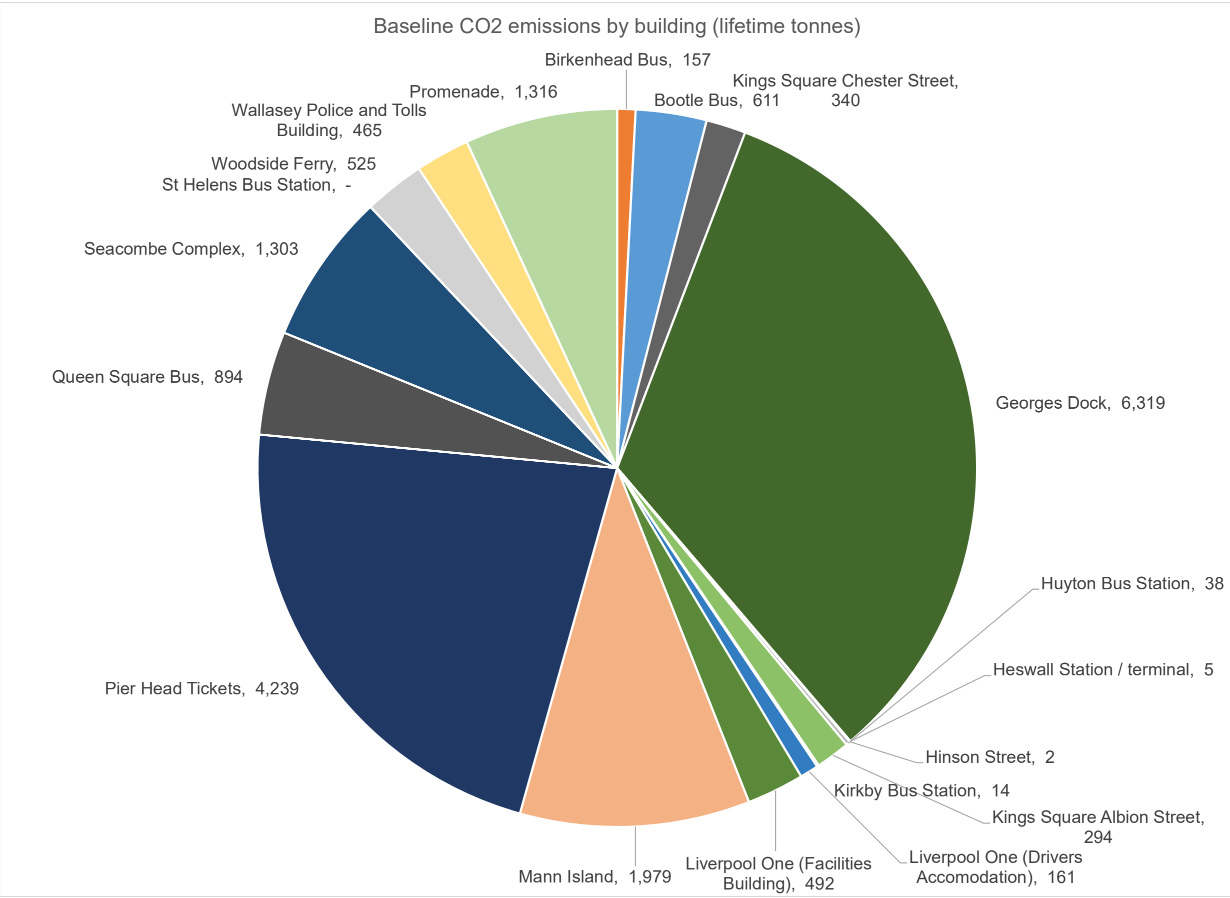
- Birkenhead Bus Station
- Bootle Bus Station
- King's Square Chester Street
- King's Square Albion Street
- George's Dock
- Heswall Bus Station
- Hinson Street
- Huyton Bus Station
- Kirkby Bus Station
- Liverpool One (Driver's Accommodation)
- Liverpool One (Facilities Building)
- Mann Island
- Pier Head Tickets
- Queen Square Bus Station
- Seacombe Complex Ferry Terminal
- Woodside Ferry Terminal
- Wallasey Police and Tolls Building
- Promenade Ventilation Station

These buildings vary widely in style, age and usage but are generally independently served with space heating and hot water provisioned by decentralised gas-fired boilers. There are also some sites using process gas. Electricity is used for lighting, appliances, and to supply a number of air-conditioning units for some sites. Energy usage data for the year 2022 was provided for the portfolio.

Energy type	Annual Consumption (kWh)	CO_2 emissions (tonnes)
Gas	2,429,946	444.7
Electricity	7,525,416	1,119.3

Baseline emissions for the portfolio for reference year 2024 are estimated as **1,564 tonnes CO_2 p.a.**

CO_2 emissions over the 30-year lifetime considered are estimated as 19,166 tonnes CO_2.



Opportunities were identified across all buildings to reduce emissions through energy efficiency, low carbon heat and renewables. **The HDP identifies the following decarbonisation options:**

- **Fabric: External Wall Insulation** – proposed for Hinson Street and Wallasey Police and Tolls Building which does not appear to have an open cavity.
- **Fabric: Double Glazing** – Chester Street, Hinson Street, Huyton Bus Station, and Albion Street would be suitable. **Secondary Glazing –** Woodside Ferry Terminal would be suitable due to the listing status of these buildings.
- **Fabric: Floor** – no opportunities deemed cost-effective.
- **ASHP** – displacing gas use on site through externally mounted ASHPs to 10 of 19 buildings.
- **WSHP –** opportunities to displace gas use on site through installation of WSHPs have been identified to Pier Head Ticket Office, Seacombe Complex Ferry Terminal, due to their location at the banks of the river Mersey and significant gas usage.. A positive lifecycle business case is indicated, but there are additional considerations precluding their direct proposal at this stage. The feasibility of these options should be established, followed by a full options appraisal comparison.
- **Heat Recovery –** there is an opportunity to extract heat from the George's Dock vent shaft via an ASHP to serve the building. A similar opportunity has been identified at the Promenade ventilation shaft to serve Seacombe Ferry Terminal and possibly buildings in the vicinity have been identified. However, further validation work would be required to progress the idea. Therefore, ASHPs are considered the core decarbonisation strategy for Seacombe Ferry Terminal.
- **DHN.** A heat network called Merseyheat by Peel NRE is under construction which initially will connect to buildings around Stanley, Trafalgar, and Collingwood Docks, providing low carbon heat from a water-source heat pump. It is envisaged that this network will be expanded to the vicinity of George's Dock. While not an immediate proposal, it is recommended that these avenues are explored fully before determining a decarbonisation pathway.
- **PV** – Birkenhead Bus Station, Chester Street, Heswall Bus Station, Hinson Street, Huyton Bus Station, Albion Street, Kirkby Bus Station, Liverpool One (Facilities Building), Pier Head Ticket Office, Queen Square Bus Station, Wallasey Police and Tolls Building and Promenade Ventilation Station appear suitable for installation of PV panels. This is particularly advantageous where the electrification of heat leads to an increase in overall electrical demand.

We have flagged some impediments to heat pump integration, the most significant being:

- Suitable space available to locate an ASHP at Bootle Bus Station, Hinson Street is to be confirmed.
- Concerns regarding noise from ASHP due to potential space available for locating the unit on the roof of Liverpool One (Facilities Building) being in close proximity to the Hilton Hotel. Further investigation is required to determine if the distribution system at sites where 'low temperature' heat pumps have been proposed are appropriate / adequate to be served by heat pumps.

The budget costs for each measure have been estimated using benchmarks from comparable projects. The energy operational cost and carbon emissions have been assessed using tariff data provided and Green Book methodology.

The simple payback has been calculated where relevant. The lifetime CO_2 saving and cost of CO_2 abatement in £/tonne has been assessed using methodology prescribed by Salix for its capital grant mechanism Public Sector Decarbonisation Scheme (PSDS), future rounds of which this scheme may be eligible for. Note, it is good practice to apply Building Cost Indices as shown at Appendix C through the lifetime development of the project

It is estimated that the proposed package of decarbonisation measures could save 41% of CO_2 emissions over a lifetime of 30 years at a capital cost of 5,301,592. This is equivalent to a lifetime cost of carbon of £683 / tonne CO_2 saved.

Seven sites have boilers which can be considered 'end of life'; and hence eligible for PSDS. No heat is needed at Heswall Bus Station, Kirkby Bus Station and Promenade Ventilation Station.

For PSDS eligible sites the proposed package of decarbonisation measures could save 46% of CO_2 emissions over a lifetime of 30 years at a capital cost of £3,638,867. This is equivalent to a lifetime cost of carbon of £572 / tonne CO_2 saved.

The following next steps are recommended:

- Feasibility study and options appraisal of Seacombe Complex and Pier Head WSHP opportunity and the DHN connection at St George's Dock.
- Utility applications and liaison to establish connection and reinforcement costs.
- Design development including building 'heat-pump ready' optimisation using a hydraulic digital twin.
- Preparation of application for upcoming round of PSDS.

A summary of the proposed measures at portfolio level is as follows. The following capital cost estimates have been based on benchmarks for similar projects. The operational cost savings estimates are solely energy usage variation. The lifetime cost per tonne has been calculated as the full capital cost estimate divided by the Total direct carbon emissions saved over the lifetime of the project, using the plant lifespans/persistence factors identified in by Salix[1].

Full portfolio

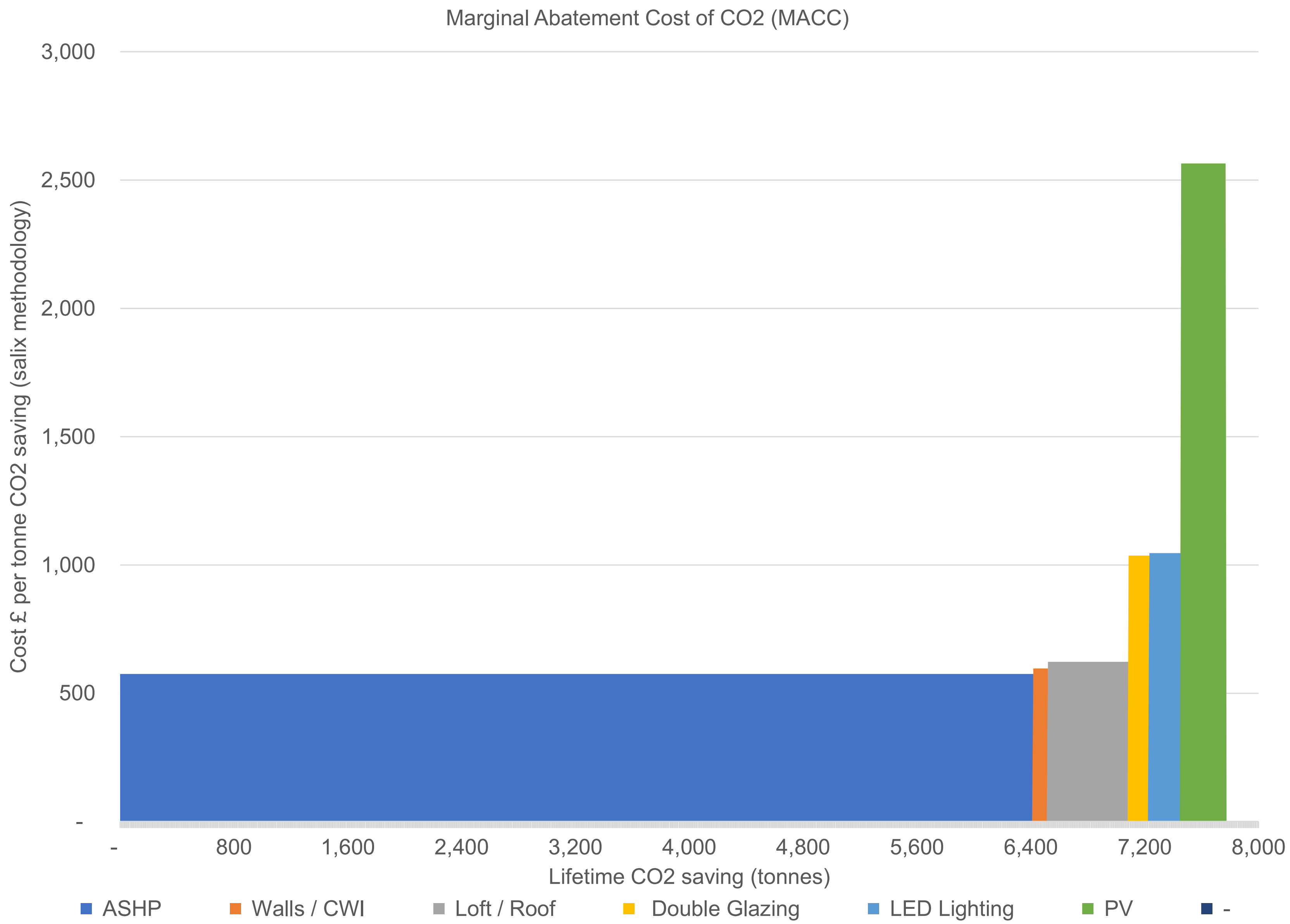
Baseline		Energy Eff..						Low Carbon Heat	Renewables		TOTAL PROJECT
		Fabric: Loft / Roof	Fabric: rooflights	Fabric: CWI	Fabric: Double Glazing	Fabric: Floor	LED lighting	ASHP	Solar PV	Solar Thermal	
Capital cost estimate (£)	£ -	£365,449	£-	£64,535	£150,741	£-	£229,466	£ 3,694,561	£809,081	£-	**£5,313,833**
Gas saving (kWh p.a.)	-	114,829	-	19,705	28,380	-	-	1,898,303	-	-	**2,061,218**
Electricity saving (kWh p.a.)	-	-	-	-	-	-	294,868	-721,538	421,601	-	**- 5,069**
Operational cost saving (£ p.a.)	£ -	£12,356	£-	£2,120	£3,054	£-	£103,204	-£48,281	£147,560	£-	**£ 220,013**
Simple payback on capital cost	N/A	29.6	-	30.4	49.4	-	2.2	N/A	5.5	-	**24.2**
Lifetime emissions (tonnes CO_2)	19,166	18,598	19,166	19,057	19,020	19,166	18,941	12,747	18,850	19,166	**11,386**
Lifetime emissions saving (tonnes CO_2)		567	-	108	145	-	225	6,419	315	-	**7,780**
Saving as % over baseline	0%	3%	0%	1%	1%	0%	1%	33%	2%	0%	**41%**
Lifetime cost £/tonne CO_2		644	-	597	1,037	-	1,022	576	2,565	-	**683**
Salix lifetime or persistence factor (years)		27	30	30	28	30	25	20	23	25	**30**

[1] Phase 3b Public Sector Decarbonisation Scheme (PSDS) Guidance October 2022, at https://www.salixfinance.co.uk/sites/default/files/Phase%203b%20PSDS%20Guidance%20Note%20v.4_0.pdf

Buildings with End of Life Boilers Only

Baseline		Energy Eff..						Low Carbon Heat	Renewables		TOTAL PROJECT
		Fabric: Loft / Roof	Fabric: rooflights	Fabric: CWI	Fabric: Double Glazing	Fabric: Floor	LED lighting	ASHP	Solar PV	Solar Thermal	
Capital cost estimate (£)	£ -	£-	£-	£-	£-	£-	£171,066	£ 3,242,133	£225,668	£-	**£ 3,638,867**
Gas saving (kWh p.a.)	-	105,099	-	-	-	-	-	1,597,725	-	-	**1,702,824**
Electricity saving (kWh p.a.)	-	-	-	-	-	-	-	-	-	-	**-**
Operational cost saving (£ p.a.)	£ -	£11,309	£-	£-	£-	£-	£-	£171,915	£-	£-	**£183,224**
Simple payback on capital cost	N/A	-	-	-	-	-	-	18.9	-	-	**19.9**
Lifetime emissions (tonnes CO2)	13,959	13,440	13,959	13,959	13,959	13,959	13,959	8,111	13,959	13,959	**7,592**
Lifetime emissions saving (tonnes CO2)		519	-	-	-	-	-	5,848	-	-	**6,367**
Saving as % over baseline	0%	4%	0%	0%	0%	0%	0%	42%	0%	0%	**46%**
Lifetime cost £/tonne CO2		-	-	-	-	-	-	554	-	-	**572**
Salix lifetime or persistence factor (years)		27	30	30	28	30	25	20	23	25	**30**

A useful visualisation is the simple portfolio-level Marginal Abatement Cost of Carbon (MACC) curve showing the CO_2 saving for each measure (X) plotted against the Lifetime cost of CO_2 (Y). This indicates the priorities for investment, along with the 'big ticket' progress items



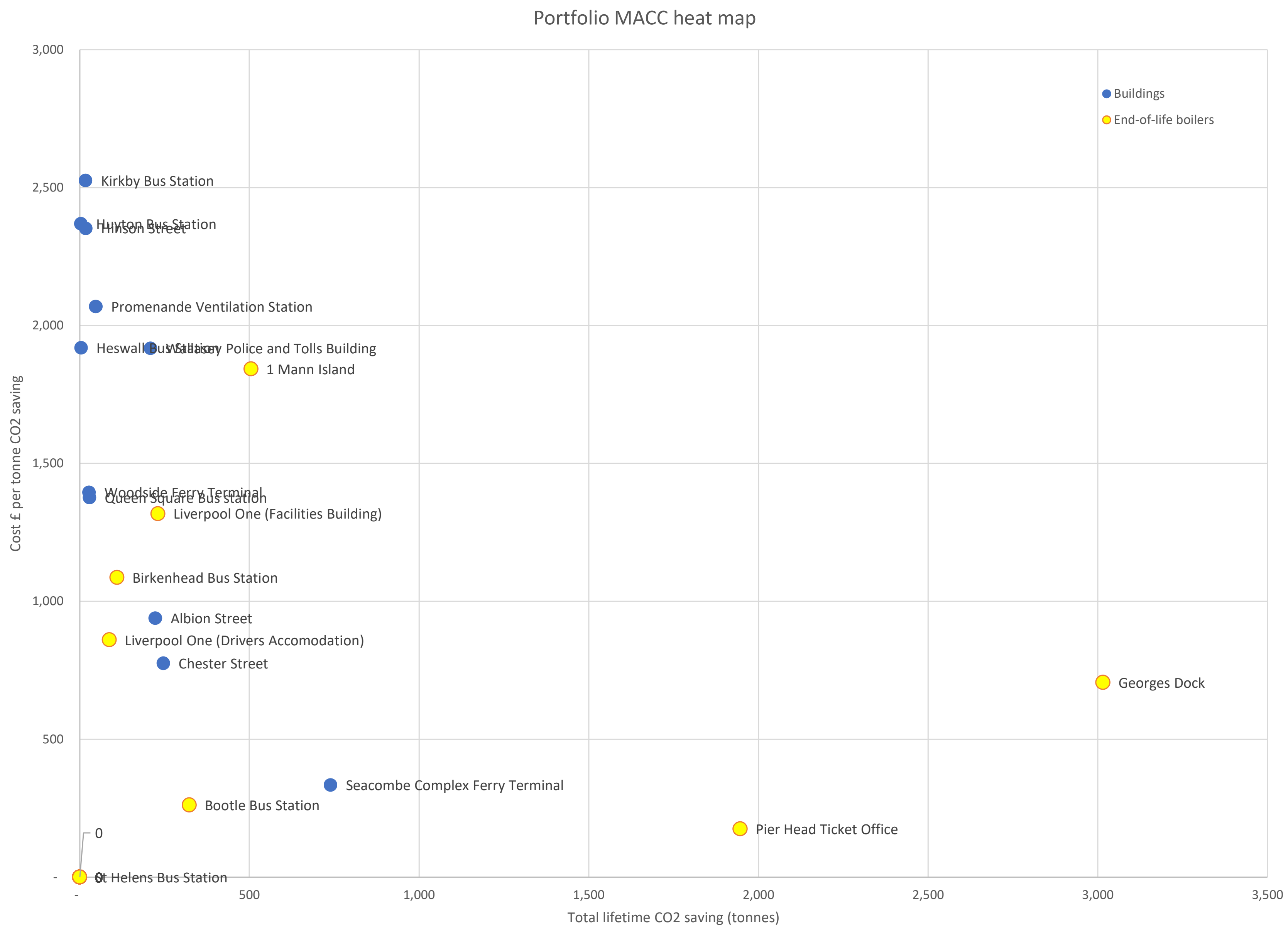
The breakdown of proposals by each building, showing the modelled energy and CO_2 changes by each stage of the energy hierarchy, is as follows.

Building Name	Baseline			Energy Eff..				Low Carbon Heat				Renewables			
	Gas (kWh p.a.)	Elec (kWh p.a.)	Lifetime emissions (tonnes CO2)	Gas (kWh p.a.)	Elec (kWh p.a.)	Cumulative Lifetime Emissions (tonnes CO2)	Saving over Baseline (%)	Gas (kWh p.a.)	Elec (kWh p.a.)	Cumulative Lifetime Emissions (tonnes CO2)	Saving over Baseline (%)	Gas (kWh p.a.)	Elec (kWh p.a.)	Cumulative Lifetime Emissions (tonnes CO2)	Saving over Baseline (%)
Birkenhead Bus Station	19,553	64,220	157	19,553	48,807	145	7%	-	56,299	79	50%	-	13,554	47	70%
Bootle Bus Station	94,811	116,792	611	94,811	116,792	611	0%	-	149,713	288	53%	-	149,713	288	53%
Chester Street	61,983	4,137	343	45,750	1,655	259	24%	-	19,809	105	69%	-	7,056	96	72%
Georges Dock	835,965	2,234,765	6,319	730,866	2,201,243	5,775	9%	-	2,480,200	3,304	48%	-	2,480,200	3,304	48%
Heswall Bus Station	-	6,470	5	-	4,529	4	30%	-	4,529	4	30%	-	1,269	1	78%
Hinson Street	-	2,401	2	-	888	1	62%	-	888	1	62%	-	-20,839	(16)	937%
Huyton Bus Station	-	49,501	38	-	48,511	38	2%	-	48,511	38	2%	-	45,441	35	8%
Albion Street	53,563	7,494	300	34,869	2,998	201	33%	-	16,460	84	72%	-	3,707	74	75%
Kirkby Bus Station	-	18,699	14	-	18,699	14	0%	-	18,699	14	0%	-	-4,156	(3)	118%
Liverpool One (Drivers Accommodation)	24,181	36,887	161	24,181	29,510	156	3%	-	38,956	74	54%	-	38,956	74	54%
Liverpool One (Facilities Building)	62,289	193,567	492	62,289	181,953	483	2%	-	207,273	274	44%	-	190,978	261	47%
1 Mann Island	118,843	1,713,793	1,979	118,843	1,576,690	1,875	5%	-	1,624,418	1,475	25%	-	1,624,418	1,475	25%
Pier Head Ticket Office	683,977	625,855	4,239	683,977	588,304	4,211	1%	136,795	785,842	2,353	44%	136,795	706,492	2,294	46%
Queen Square Bus station	126,510	258,004	894	126,510	234,784	877	2%	126,510	234,784	877	2%	126,510	220,378	866	3%
Seacombe Complex Ferry Terminal	219,960	123,763	1,303	219,960	123,763	1,303	0%	-	214,282	565	57%	-	214,282	565	57%
Woodside Ferry Terminal	52,111	308,629	525	48,928	294,741	498	5%	48,928	294,741	498	5%	48,928	294,741	498	5%
Wallasey Police and Tolls Building	76,200	60,325	465	56,495	59,119	356	23%	56,495	59,119	356	23%	56,495	-73,048	257	45%
Promenade Ventilation Station	-	1,700,115	1,316	-	1,697,565	1,314	0%	-	1,697,565	1,314	0%	-	1,637,344	1,269	4%

The breakdown of proposals by each building, showing the modelled energy and CO_2 changes and cost implications, is as follows. The status of the site's boilers is also indicated, an important qualification measure for PSDS.

Building Name	Baseline				Decarbonisation Proposals									PSDS Qualification
	Gas (kWh p.a.)	**Elec (kWh p.a.)**	**Annual CO2 emissions (tonnes)**	**Lifetime emissions (tonnes CO2)**	**Capital Cost (£)**	**Gas saving (kWh p.a.)**	**Elec saving (kWh p.a.)**	**Annual Energy Saving (kWh)**	**Annual Cost Increase (£)**	**Annual Carbon Saving (tCO2e)**	**Lifetime Carbon Saving (tCO2e)**	**Lifetime cost of carbon £/tonne CO2 abated**	**Lifetime CO2 saving as %**	**End-of life Boilers?**
Birkenhead Bus Station	19,553	64,220	13	157	£119,314	19,553	50,666	70,219	£ 19,837.07	11.1	109.8	£1,087	70%	✓
Bootle Bus Station	94,811	116,792	35	611	£84,565	94,811	-32,920	61,890	-£ 1,320.50	12.5	322.9	£ 262	53%	✓
Chester Street	61,983	4,137	12	343	£202,882	61,983	-2,920	59,063	£ 5,647.47	10.9	247.7	£ 819	72%	✗
Georges Dock	835,965	2,234,765	485	6,319	£ 2,129,474	835,965	-245,435	590,530	£ 4,047.57	116.5	3,015.3	£ 706	48%	✓
Heswall Bus Station	-	6,470	1	5	£7,520	-	5,201	5,201	£ 1,820.37	0.8	3.9	£1,919	78%	✗
Hinson Street	-	2,401	0	2	£40,960	-	23,239	23,239	£ 8,133.77	3.5	17.4	£2,353	937%	✗
Huyton Bus Station	-	49,501	7	38	£7,228	-	4,060	4,060	£ 1,421.00	0.6	3.1	£2,369	8%	✗
Albion Street	53,563	7,494	11	300	£208,887	53,563	3,787	57,349	£ 7,088.67	10.4	225.8	£ 925	75%	✗
Kirkby Bus Station	-	18,699	3	14	£43,197	-	22,855	22,855	£ 7,999.25	3.4	17.1	£2,526	118%	✗
Liverpool One (Drivers Accommodation)	24,181	36,887	10	161	£75,003	24,181	-2,068	22,113	£ 1,878.00	4.1	87.2	£ 860	54%	✓
Liverpool One (Facilities Building)	62,289	193,567	40	492	£303,682	62,289	2,588	64,877	£ 7,608.18	11.8	230.5	£1,318	47%	✓
1 Mann Island	118,843	1,713,793	277	1,979	£929,447	118,843	89,375	208,218	£ 44,068.87	35.0	504.4	£1,843	25%	✓
Pier Head Ticket Office	683,977	625,855	218	4,239	£341,586	547,181	-80,637	466,544	£ 30,653.73	88.1	1,945.9	£ 176	46%	✓
Queen Square Bus station	126,510	258,004	62	894	£39,185	-	37,626	37,626	£ 13,169.24	5.6	28.5	£1,376	3%	✗
Seacombe Complex Ferry Terminal	219,960	123,763	59	1,303	£247,311	219,960	-90,519	129,441	-£ 8,013.79	26.8	738.7	£ 335	57%	✗
Woodside Ferry Terminal	52,111	308,629	55	525	£37,513	3,183	13,888	17,071	£ 5,203.39	2.6	26.9	£1,395	5%	✗
Wallasey Police and Tolls Building	76,200	60,325	23	465	£398,838	19,705	133,373	153,078	£ 48,800.64	23.4	208.0	£1,918	45%	✗
Promenade Ventilation Station	-	1,700,115	253	1,316	£97,240	-	62,771	62,771	£ 21,969.91	9.3	47.0	£2,069	4%	✗

The portfolio MACC heat map shows the CO_2 saving potential (X-axis) plotted against the cost-per-tonne lifetime CO_2 saving. The best opportunities are those to the bottom-right quadrant.



1. Project Overview

1.1 Portfolio Description

The sites considered form part of the Liverpool City Region Combined Authority (LCRCA), and consists of bus stations, ticket offices, offices, tunnel ventilation.

There are 18 individual buildings with a combined Gross Internal Area (GIA) area of circa 44,722 m^2.

1.2 Building Services Overview

For more details see Appendix B. The buildings can be characterised as decentralised (i.e., building-by-building) gas-fired boiler systems. Space heating is done by wet radiators with few exceptions.

Domestic Hot Water (DHW) via calorifiers either heated from the boiler circuit or direct gas-fired, with a few buildings having electrical Point of Use (POU). The buildings are a mixture of naturally and mechanically ventilated.

Cooling to some of the buildings is via chiller plant and a limited amount of reversible A/C units.

1.3 Baseline Energy and CO_2 Emissions

Data was provided for the year 2022. We have used 2024 as a project reference year (i.e., the first year savings are realised).

Energy type	Annual Consumption (kWh)	CO_2 emissions[2] (tonnes p.a.) using 2024 factors
Gas	2,429,946	444.7
Electricity	7,525,416	1,119.3

Baseline Scope 1 and 2 emissions for the Site were **1,562 tonnes CO_2 p.a.**

1.4 Energy Tariffs

The following all-in rates (ex-VAT) were provided, which have been used for analysis:

Energy type	Tariff (£/kWh)
Gas	0.085
Electricity	0.29

1.5 Site Masterplan Considerations

No significant masterplan considerations (e.g., demolition, re-development, or expansion) have been identified.

1.6 Existing or Concurrent Energy Efficiency and Low Carbon Projects

Solar PV arrays are installed on several buildings. See Appendix A for details.

1.7 Existing Heating Systems

For details on the existing heating and hot water plant for each building, which informs the strategy and sizing of replacement Heat Pumps and likely eligibility for 'end of life' criteria required for PSDS grant funding, see Appendix B.

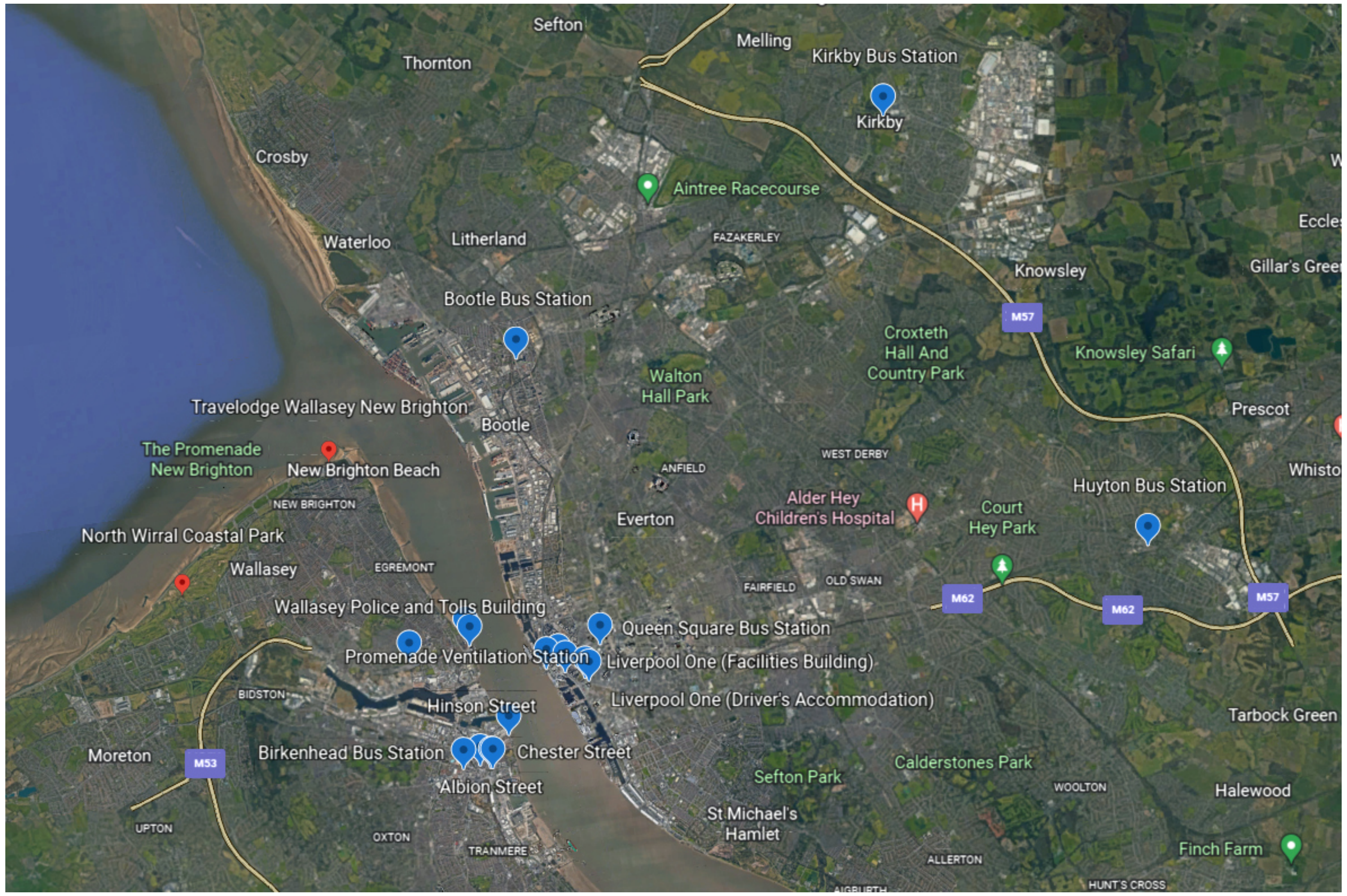
[2] Carbon factors source: Treasury Green Book: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal Notes: Electricity 'Grid Average' figures used throughout.

1.8 Summary Schedule of Buildings

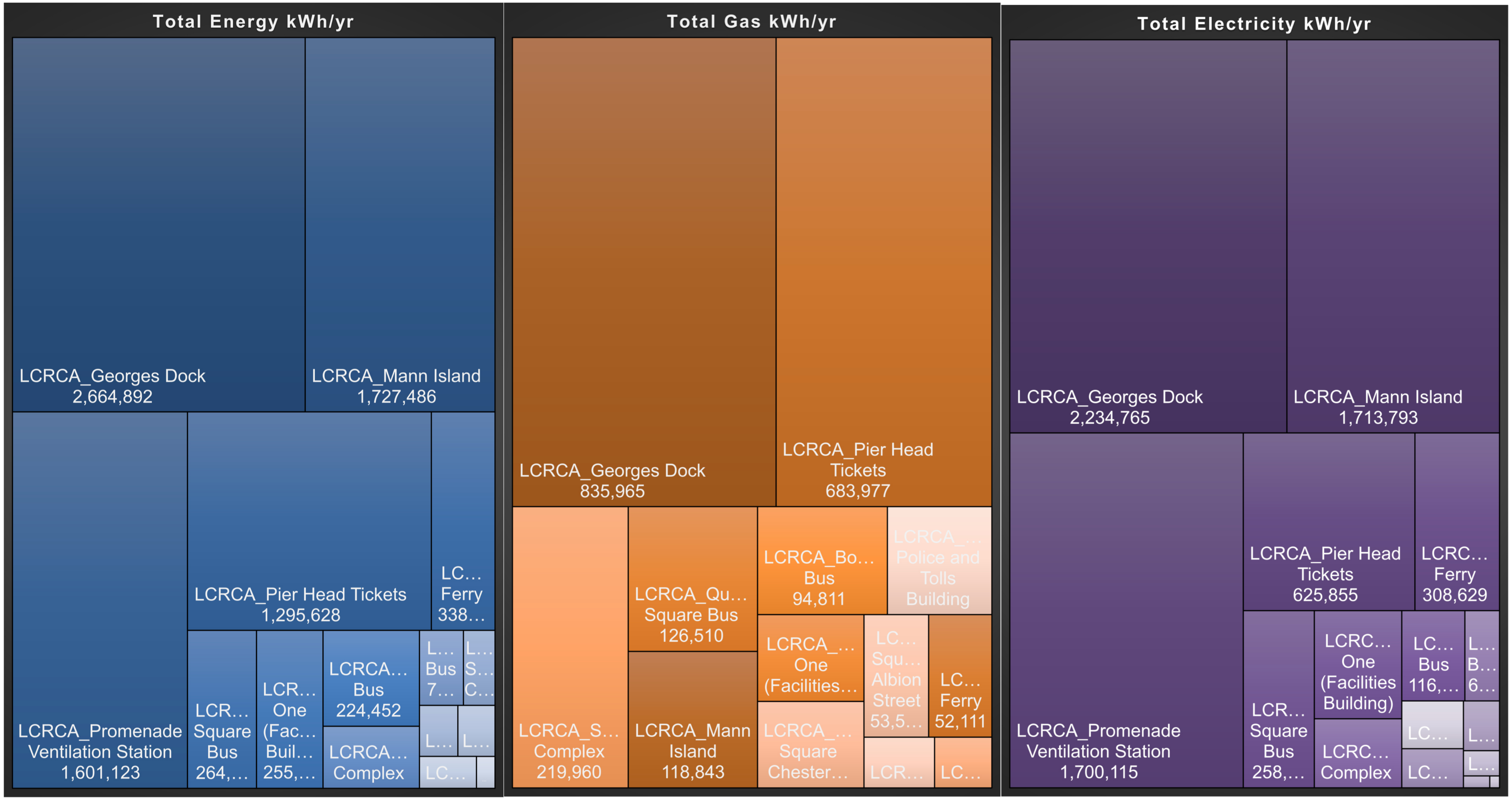
For more details see Appendix B.

Ref	Building name	Storeys	Build date (approx.)	GIA (m2)	DEC
2	Birkenhead Bus Station	2	1990	134	None
5	Bootle Bus Station	1	1970	225	None
9	Chester Street	2	1979	462	None
12	Georges Dock	4	1934	7,846	G
13	Heswall Bus Station		1990	7,974	None
14	Hinson Street	2	1970	1,260	None
15	Huyton Bus Station	1	1990	101	None
18	Albion Street	2	1979	830	None
19	Kirkby Bus Station		2015	101	None
23	Liverpool One (Drivers Accommodation)	1	2010	225	None
24	Liverpool One (Facilities Building)	1	2010	225	None
26	1 Mann Island	13	2010	15,631	None
31	Pier Head Ticket Office	2	2010	3,028	None
34	Queen Square Bus station	2	1990	808	None
36	Seacombe Complex Ferry Terminal	1	1933	1,880	C
52	Woodside Ferry Terminal	1	1980	957	None
53	Wallasey Police and Tolls Building	1	1971	635	None
55	Promenade Ventilation Station	1	1970	252	None

1.9 Building Location



1.10 Portfolio Energy Use Visualisation



2. Heat Decarbonisation

2.1 Scope of Assessment

This plan has been produced following a successful Low Carbon Skills Fund (LCSF) bid to assess potential decarbonisation options and will support the organisation in identifying and prioritising the investment required to deliver on reduction targets for the carbon emissions within its responsibility.

The scope of carbon emissions considered include:

Scope 1: emissions generated locally from fossil fuels.

Scope 2: indirect emissions generated elsewhere related to the local consumption of electricity and heat.

Scope 3: emissions – outside the scope of this work.

2.2 Approach

The HDP methodology included consultation with the organisation, collection of desktop data and site survey. Energy conservation measures have been identified and outline feasibility explored, with any issues highlighted to be concluded. Capital cost estimates have been made, based on benchmarks for similar projects.

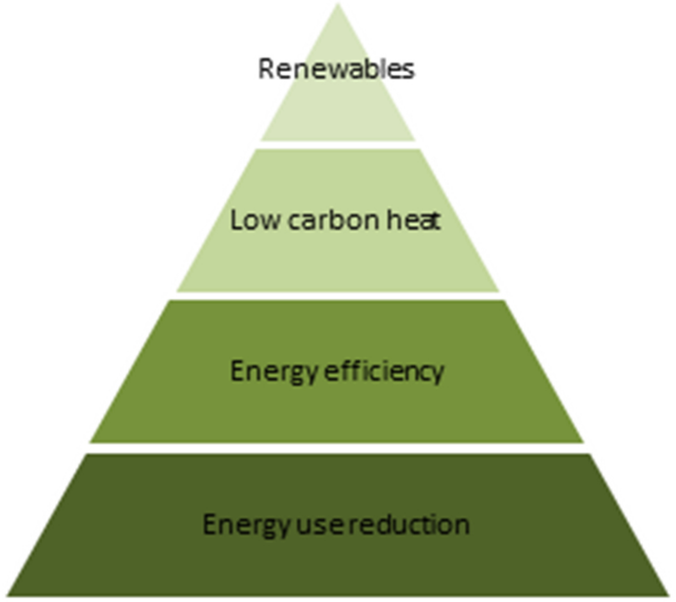
This plan has been developed based on the review of the energy consumption and carbon footprint of building/buildings, desktop data as well as site surveys to assess the opportunities and constraints, the condition of the building fabric, existing heating systems and existing domestic hot water systems.

2.3 Budget Cost Estimating Methodology

Cost estimates are based on benchmarks for similar projects recently taken to tender and should be considered as budget estimates.

2.4 Prioritisation of Opportunities using the Energy Hierarchy

The proposals within this plan have been based on the energy hierarchy shown below.



Energy use reduction measures targets energy wastage and inefficient practices via simple steps such as resetting of time clocks and temperatures, upgrading systems controls and good energy housekeeping by staff, students, visitors, and contractor.

Energy efficiency step includes material improvements to building fabric and services equipment, such as fitting variable speed pumps or "two port" control of mechanical services, as well as building fabric improvements.

Low carbon heat option primarily considers the use of heat pumps to switch fossil fuel to electricity – preferably from onsite renewables, or a dedicated renewable PPA, or as a backstop from the grid. District heating is also considered where viable.

Renewables should be implemented where possible on site. Given the potential increase of overall electrical demand due to electrification of heat, onsite renewable electricity generation projects can reduce the impact on local and national electrical infrastructure and the need for reinforcement.

2.5 Specific Considerations

2.5.1 Building Suitability for Heat Pump Conversion

For sites where DHW generation is independent of the main heat source, e.g., minimal point-of-use type, 'low-temperature' heat pumps sized to meet the site peak Space Heating demand and to ensure adequate flow temperature have been proposed. In this instance, upgrades to the distribution system might be required.

If a significant DHW loads is present, we propose a concept using 'high temperature' heat pumps able to produce up to 80ºC. NB: we advocate that at the design stage it is aspired to reduce the flow temperatures, to improve heat pump efficiency.

A high-temperature WSHP system would be facilitated by a 'cascade' arrangement.

Most buildings on site exhibit heat pump conversion potential in a relatively straightforward manner without significant alteration to existing internal heat distribution systems. Some impediments to heat pump integration have been flagged, the most significant being:

- Suitable space available to locate an ASHP at Bootle Bus Station and Hinson Street is to be confirmed.
- Concerns regarding noise from ASHP due to potential space available for locating the unit on the roof of Liverpool One (Facilities Building) being in close proximity to Hilton Hotel.
- Further investigation is required to determine if the distribution system at sites where 'low temperature' heat pumps have been proposed are appropriate / adequate to be served by heat pumps.

2.5.2 WSHP

The lowest-risk and most straightforward way to decarbonise these buildings' heating would be to convert each gas boiler system to an equivalent, high-temperature ASHP.

However, Water Source Heat Pumps (WSHP) should be considered given that they offer significant efficiency advantages, and a large body of water is in close proximity to suitably sized gas users Pier Head Ticket Office, Seacombe Complex Ferry Terminal. A simple analysis indicates it could provide a favourable lifecycle business case over ASHP (for more details see Appendix B).

The WSHP approach offers the following advantages over ASHP:

- Improved COP and lower energy running costs
- Lower electrical peak demand
- No need for outdoor heat rejection plant
- Lower noise
- Opportunity to provide comfort cooling (climate adaptation consideration)

However, these are bespoke solutions in which technical challenges would need to be overcome, with pipework run from the building to the river and either a civil works installation to abstract/inject water or a submerged heat exchanger array. A feasibility study should be undertaken to establish the technical viability of the proposals including modelling of the water source, establish the necessary consents/permissions and their likely outcomes, and undertake an options appraisal to compare to the ASHP.

2.5.3 Hybrid Gas-Electric Systems

It is possible to design 'hybrid' systems where gas-fired boilers are retained in conjunction with HPs to take the baseload, the advantages over full electrification being that significant proportion of decarbonisation can be achieved through much smaller HP plant, which may become a constraining factor e.g., due to electricity supply.

However, only full electrification of heat at each building has been considered, the rationale being that this alone offers a true net zero carbon pathway, and consequently qualifies for support under most recent Public Sector Decarbonisation Scheme (PSDS) eligibility rules.

2.5.4 Heat Networks

The Mersey Heat network is currently under construction by Peel NRE and will serve the docklands area and the vicinity of several buildings in the study. The website[3] invites queries for potential new connections. Further work is required to assess the feasibility of connection and whether it offers an advantage in carbon, cost, or any other factor (e.g., plant space). Much would depend on the proposed heat supply technology, which is unknown.

The existing heating is based on a 'decentralised' model i.e., where each building has its own heat plantroom. There are opportunities to cluster the buildings, and therefore centralising the heating system, in groups such as:

- George's Dock, Mann Island and Pier Head Ticket Office.
- Heat recovery from Promenade Ventilation Station, with temperature being boosted to the desired figure to serve Seacombe Complex Terminal and possibly buildings in vicinity.

The advantages of such an approach are:

- Diversity of heat demand profile means that reduction in installed peak can be realised over the additive building peaks.
- ASHPs need to be located outside, but also with adequate free area around them (e.g., 1m). Hence footprint does not scale linearly with capacity; it is more efficient to group installations.

Further study would be necessary to determine feasibility and life cost/benefit comparison with the decentralised approach proposed here.

2.5.5 Site Electrical Infrastructure and suitability to support heat pumps

For details of site electrical infrastructure and upgrades to the incoming supply required to support the heat pump proposals for each building, see Appendix B.

2.5.6 Resilience

A pre-design-stage peak heat demand estimate based on high-level heat loss calculations has been assumed. These have been cross-checked against installed boiler capacity and in all cases are comparable with a slight reduction as expected due to the proposed fabric upgrades.

Heat pump sizing at this stage has assumed that multiple units would be used to achieve the rated capacity with no additional resilience. This is considered acceptable if using units with multiple compressors, which can operate at partial duty in the event of a compressor failure. At design stage we would recommend more detailed discussion and study of resilience including the provision for temporary plant should it be required during full overhaul of equipment or replacement.

2.5.1 Maintenance

Maintenance costs have not been modelled at this stage. A qualitative consideration of maintenance implications id given in Appendix D – Maintenance Considerations for Decarbonisation Technologies

[3] https://www.merseyheat.co.uk/for-developers

3.1 Summary Proposals by Building

The below table summarises the heat decarbonisation measures proposed for each building.

	Energy Use Reduction	Energy Eff..					Low Carbon Heat	Renewables	
Building Name*	**Optimisations**	**Roof**	**Walls**	**Glazing**	**Floors**	**LED Lighting**	**Heat Pump**	**Solar PV**	**Solar Thermal**
Birkenhead Bus Station	✓	✗	✗	✗	✗	✓	✓	✓	✗
Bootle Bus Station	✓	✗	✗	✗	✗	✗	✓	✗	✗
Chester Street	✓	✓	✗	✓	✗	✓	✓	✓	✗
Georges Dock	✓	✓	✗	✗	✗	✓	✓	✗	✗
Heswall Bus Station	✓	✗	✗	✗	✗	✓	✗	✓	✗
Hinson Street	✓	✗	✓	✓	✗	✓	✗	✓	✗
Huyton Bus Station	✓	✗	✗	✓	✗	✓	✗	✓	✗
Albion Street	✓	✓	✗	✓	✗	✓	✓	✓	✗
Kirkby Bus Station	✓	✗	✗	✗	✗	✗	✗	✓	✗
Liverpool One (Drivers Accommodation)	✓	✗	✗	✗	✗	✓	✓	✗	✗
Liverpool One (Facilities Building)	✓	✗	✗	✗	✗	✓	✓	✓	✗
1 Mann Island	✓	✗	✗	✗	✗	✓	✓	✗	✗
Pier Head Ticket Office	✓	✗	✗	✗	✗	✓	✓	✓	✗
Queen Square Bus station	✓	✗	✗	✗	✗	✓	✗	✓	✗
Seacombe Complex Ferry Terminal	✓	✗	✗	✗	✗	✗	✓	✗	✗
St Helens Bus Station	✓	✗	✗	✗	✗	✗	✗	✗	✗
Woodside Ferry Terminal	✓	✗	✗	✓	✗	✓	✗	✗	✗
Wallasey Police and Tolls Building	✓	✗	✓	✗	✗	✓	✗	✓	✗
Promenade Ventilation Station	✓	✗	✗	✗	✗	✓	✗	✓	✗

3.2 Implementation Plan

3.2.1 Salix Application Timeline

Previous Salix application processes have indicated a project delivery timescale of twelve months from grant award to completion for the Single year schemes and up to three years for those projects accepted as Multi-year schemes. A simple typical timeline is shown below.

Activity	Milestone Timescale (months)
Complete feasibility works	Minus 6 months to Month 0
Submit Application to Salix	Month 0
Partner concludes design	Month 6
Salix conclude Technical Review period	Mont 6
Grant award	Month 6
Conclude Procurement	Month 9
Commence on Site	Month 12
Commissioning complete and PC achieved	Month 18
Salix Financial close	Month19
12 months post PC Salix Measurement and Verification reporting commences (for 36 months)	Month 30 – Month 66

The following is a suggestion based on our observations of the site constraints and options feasibility.

3.2.2 Quick Wins and Short-term measures (0 - 1 years)

- Building Fabric

As a first phase of work, upgrading the building fabric such as cavity wall insulation (CWI), loft insulation, and window upgrades from single pane to low emissivity double glazed windows. This will improve the thermal envelope of the buildings.

- Solar PV – opportunities should be progressed immediately to maximise CO_2 benefit
- Building Energy Management System (BEMS)

Along with the fabric improvement works, it would be recommended to install a centralised Building Energy Management System (BEMS) for building energy controls such as heating, lighting, and meter readings. By incorporating these systems in a centralised system and undertaking some dedicated optimisations within each building with feedback sensors can realise a further energy saving.

This BEMS system should be open protocol to avoid future limitations and ensure end user flexibility to enhance the system through its lifetime

- Preliminary Works

Works during, years 0 to years 1, would be the planning stage and preliminary works for heat pump integration such as,

- Feasibility studies for GSHP and WSHP potential, establishing technical viability, determining consents needed and de-risking design assumptions.
- Detailed design of the heating decarbonisation solutions, ideally using a hydraulic digital twin to optimise existing building solutions.
- Application for connection to the District Network Operator (DNO)
- Potential funding applications. It is recommended that the Public Sector Decarbonisation Scheme portal be monitored for announcements of further funding rounds and an application be prepared
- including other future funding streams Building control and planning
- Project team appointment and system detailed design
- Associated electrical infrastructure upgrades to facilitate heat pump connection.
- Necessary ground works and construction of heat pump base and/or structural works to roof space dependant on the buildings' strategic masterplan moving forward.
- Plantroom connection points
- During this time future resilience measures could be implemented such as mechanical and electrical stab-in points for emergency heat and electrical generation connection, should a catastrophic failure ever occur.
- Monitor emerging technologies for new opportunities or new heat pump iterations

3.2.3 Medium-term (within next 5 years)

- Solar Thermal

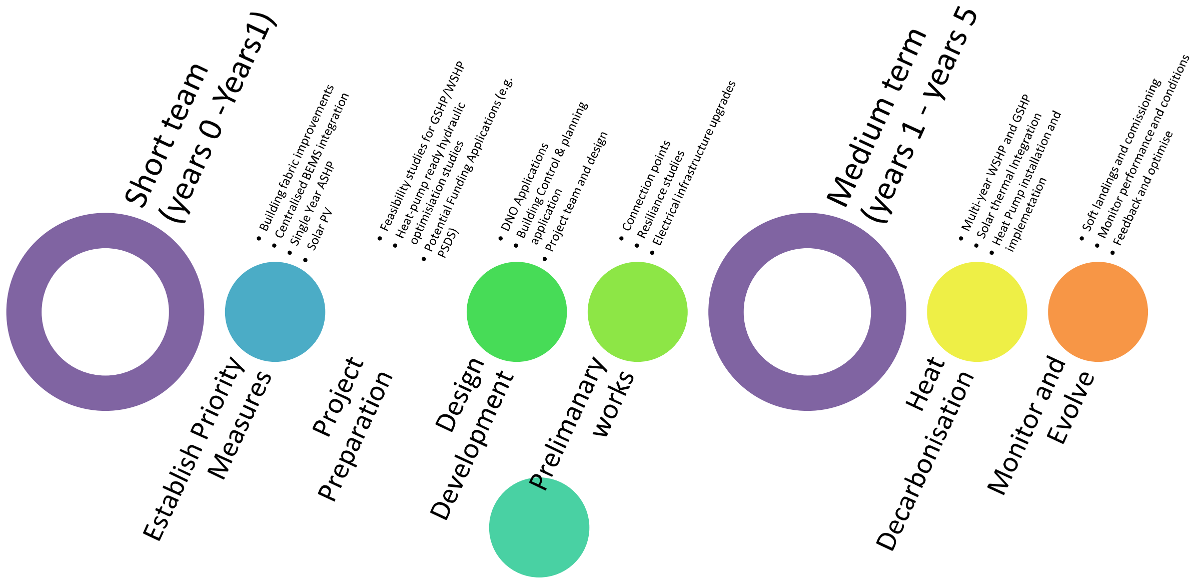
As the second phase of work, year 1- year 5, the introduction of the Solar Thermal systems can be integrated to offset part of the buildings' energy use

- Battery Storage

It is recommended Solar PV be integrated with battery storage to provide flexibility.

- Heat Pump implementation

In this second phase of work the selected heat pump technology or new emerging technologies identified, is implemented, integrated, and is assimilated into the site.



Appendix A – Portfolio Level Additional Analysis (1.5º Hub)

3.3 High Level Summary

Overall Impact	VALUE
Sum of Total area (m2)	42,574
Sum of Loft insulation (kWh)	91,863
Sum of Cavity wall insulation (kWh)	15,764
Sum of Rooflights (kWh)	-
Sum of Double glazing (kWh)	22,704
Sum of LED saving (kWh)	287,889
Sum of Increase Capacity kVA	3,358
Sum of Heat Pump Gas Reduction (kWh)	1,898,303
Sum of Heat Pump Electrical Demand (kWh)	- 721,538
Sum of PV contribution (kWh/annum)	421,601
Sum of PV contribution (kW peak)	571

3.4 Total; Capital PSDS Potential

#	LCRCA
END OF LIFE BOILERS (Y/N)	

	Column Labels		
	N	Y	Grand Total
Sum of TOTAL CAPITAL	£ 1,318,520	£ 3,983,072	£ 5,301,592

3.5 Building Area

ENTITY	LCRCA

Row Labels	Sum of Total area (m2)
Birkenhead Bus	134
Bootle Bus	225
Georges Dock	7,846
Heswall Station / terminal	7,974
Hinson Street	1,260
Huyton Bus Station	101
Kings Square Albion Street	830
Kings Square Chester Street	462
Kirkby Bus Station	101
Liverpool One (Drivers Accomodation)	225
Liverpool One (Facilities Building)	225
Mann Island	15,631
Pier Head Tickets	3,028
Promenade	252
Queen Square Bus	808
Seacombe Complex	1,880
St Helens Bus Station	-
Wallasey Police and Tolls Building	635
Woodside Ferry	957
Grand Total	**42,574**

3.6 Fabric Improvements

ENTITY	LCRCA

	Sum of Loft insulation (kWh)	Sum of Cavity wall insulation (kWh)	Sum of Rooflights (kWh)	Sum of Double glazing (kWh)
Birkenhead Bus	-	-	-	-
Bootle Bus	-	-	-	-
Georges Dock	84,079	-	-	-
Heswall Station / terminal	-	-	-	-
Hinson Street	-	-	-	-
Huyton Bus Station	-	-	-	-
Kings Square Albion Street	3,299	-	-	11,656
Kings Square Chester Street	4,485	-	-	8,501
Kirkby Bus Station	-	-	-	-
Liverpool One (Drivers Accomodation)	-	-	-	-
Liverpool One (Facilities Building)	-	-	-	-
Mann Island	-	-	-	-
Pier Head Tickets	-	-	-	-
Promenade	-	-	-	-
Queen Square Bus	-	-	-	-
Seacombe Complex	-	-	-	-
St Helens Bus Station	-	-	-	-
Wallasey Police and Tolls Building	-	#####	-	-
Woodside Ferry	-	-	-	2,546
Grand Total	**91,863**	**#####**	**-**	**22,704**

3.7 Lighting Improvements (LED)

ENTITY	LCRCA

Row Labels	Sum of LED saving (kWh)
Birkenhead Bus	15,413
Bootle Bus	-
Georges Dock	33,521
Heswall Station / terminal	1,941
Hinson Street	1,512
Huyton Bus Station	990
Kings Square Albion Street	-
Kings Square Chester Street	-
Kirkby Bus Station	-
Liverpool One (Drivers Accomodation)	7,377
Liverpool One (Facilities Building)	11,614
Mann Island	137,103
Pier Head Tickets	37,551
Promenade	2,550
Queen Square Bus	23,220
Seacombe Complex	-
St Helens Bus Station	-
Wallasey Police and Tolls Building	1,207
Woodside Ferry	13,888
Grand Total	**287,889**

3.8 Infrastructure Changes

ENTITY	LCRCA

Labels	Sum of Agreed Capacity with Supplier (MIC) kva	Sum of highest MD kva	Sum of Headroom kva	Sum of Increase Capacity kVA
Birkenhead Bus			0	-60
Bootle Bus	125	26	99	0
Georges Dock	450	497	-47	267
Heswall Bus Station	13.2	13.2	0	0
Hinson Street			0	37
Huyton Bus Station	0		0	-4
Kings Square Albion Street	0		0	0
Kings Square Chester Street	0		0	0
Kirkby Bus Station	0		0	-60
Liverpool One (Drivers Accomodation)			0	0
Liverpool One (Facilities Building)			0	10
Mann Island	1300	795	505	0
Pier Head Tickets	300	147	153	0
Promenade	800	599	201	-81
Queen Square Bus	100	51	49	-19
Seacombe Complex	150	61	89	0
St Helens Bus Station				
Wallasey Police and Tolls Building	0		0	81
Woodside Ferry	0	102	-27	0
Grand Total	**3238.2**	**2291.2**	**1022**	**171**

3.9 Heat Pump Benefits

ENTITY	LCRCA

Row Labels	Sum of Heat Pump Gas Reduction (kWh)	Sum of Heat Pump Electrical Demand (kWh)	Average SCOP
Birkenhead Bus	19,553	- 7,492	
Bootle Bus	94,811	- 32,920	
Georges Dock	730,866	- 278,957	
Heswall Station / terminal	-	-	
Hinson Street	-	-	
Huyton Bus Station	-	-	
Kings Square Albion Street	34,869	- 13,463	
Kings Square Chester Street	45,750	- 18,155	
Kirkby Bus Station	-	-	
Liverpool One (Drivers Accomodation)	24,181	- 9,446	
Liverpool One (Facilities Building)	62,289	- 25,321	
Mann Island	118,843	- 47,728	
Pier Head Tickets	547,181	- 197,538	
Promenade	-	-	
Queen Square Bus	-	-	
Seacombe Complex	219,960	- 90,519	
St Helens Bus Station	-	-	
Wallasey Police and Tolls Building	-	-	
Woodside Ferry	-	-	
Grand Total	**1,898,303**	**- 721,538**	**- 2.63**

3.10 Heat Pump Capacity

ENTITY	LCRCA

Row Labels	Sum of Heat Pump System Capacity (kW)
Birkenhead Bus	11
Bootle Bus	43
Georges Dock	507
Heswall Station / terminal	-
Hinson Street	-
Huyton Bus Station	-
Kings Square Albion Street	34
Kings Square Chester Street	45
Kirkby Bus Station	-
Liverpool One (Drivers Accomodation)	17
Liverpool One (Facilities Building)	66
Mann Island	397
Pier Head Tickets	85
Promenade	-
Queen Square Bus	-
Seacombe Complex	86
St Helens Bus Station	-
Wallasey Police and Tolls Building	-
Woodside Ferry	-
Grand Total	**1,290**

3.11 Solar PV Peak Generation

ENTITY	LCRCA

Row Labels	Sum of PV contribution (kW peak)
Birkenhead Bus	58
Bootle Bus	
Georges Dock	
Heswall Station / terminal	4
Hinson Street	37
Huyton Bus Station	4
Kings Square Albion Street	17
Kings Square Chester Street	17
Kirkby Bus Station	29
Liverpool One (Drivers Accomodation)	
Liverpool One (Facilities Building)	22
Mann Island	
Pier Head Tickets	108
Promenade	82
Queen Square Bus	20
Seacombe Complex	
St Helens Bus Station	
Wallasey Police and Tolls Building	173
Woodside Ferry	
Grand Total	**571**

3.12 Solar PV Contribution

ENTITY	LCRCA

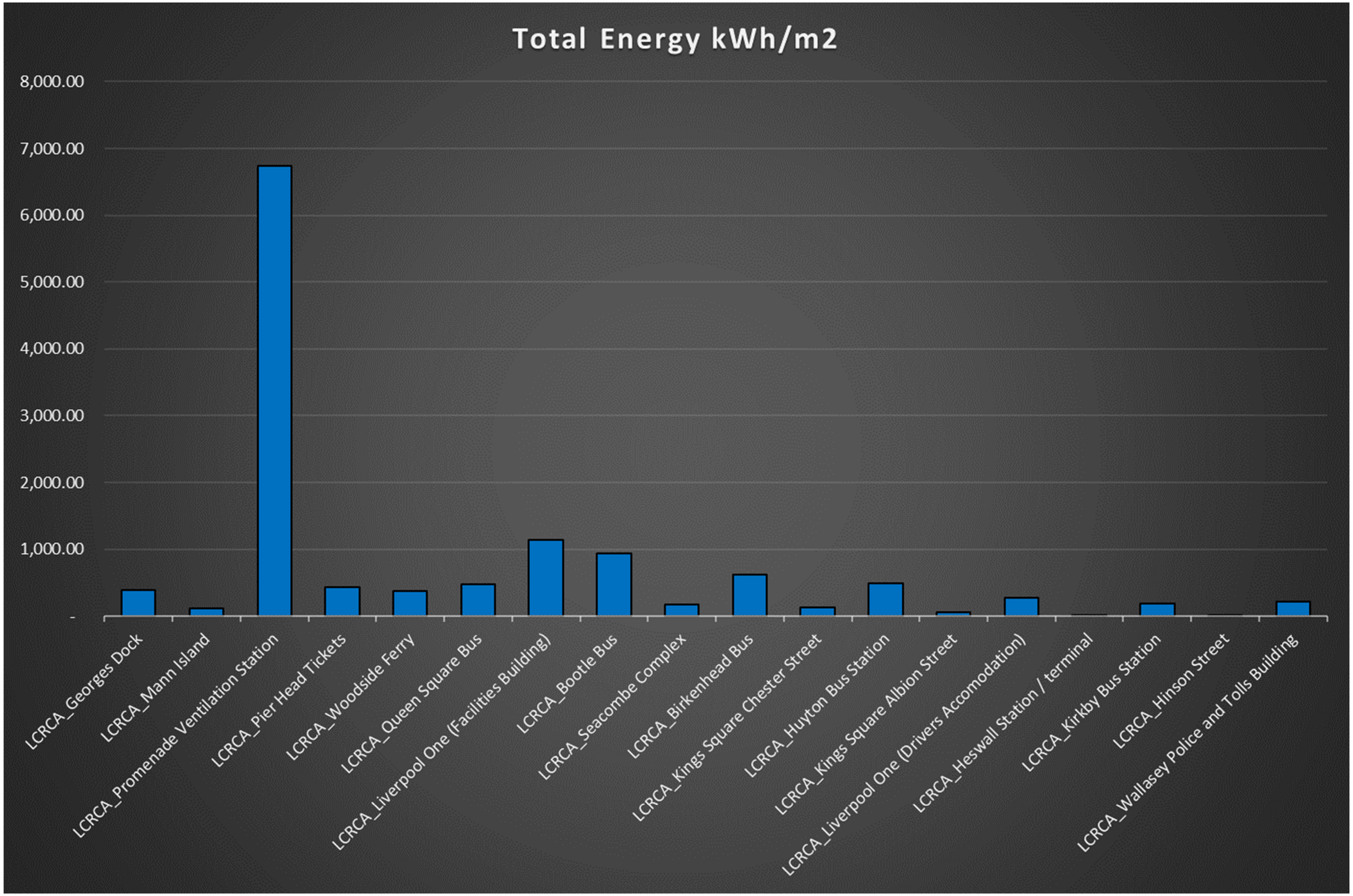
Row Labels	Sum of PV contribution (kWh/annum)
Birkenhead Bus	42,745
Bootle Bus	
Georges Dock	
Heswall Station / terminal	3,260
Hinson Street	21,727
Huyton Bus Station	3,070
Kings Square Albion Street	12,753
Kings Square Chester Street	12,753
Kirkby Bus Station	22,855
Liverpool One (Drivers Accomodation)	
Liverpool One (Facilities Building)	16,295
Mann Island	
Pier Head Tickets	79,350
Promenade	60,221
Queen Square Bus	14,406
Seacombe Complex	
St Helens Bus Station	
Wallasey Police and Tolls Building	132,166
Woodside Ferry	
Grand Total	**421,601**

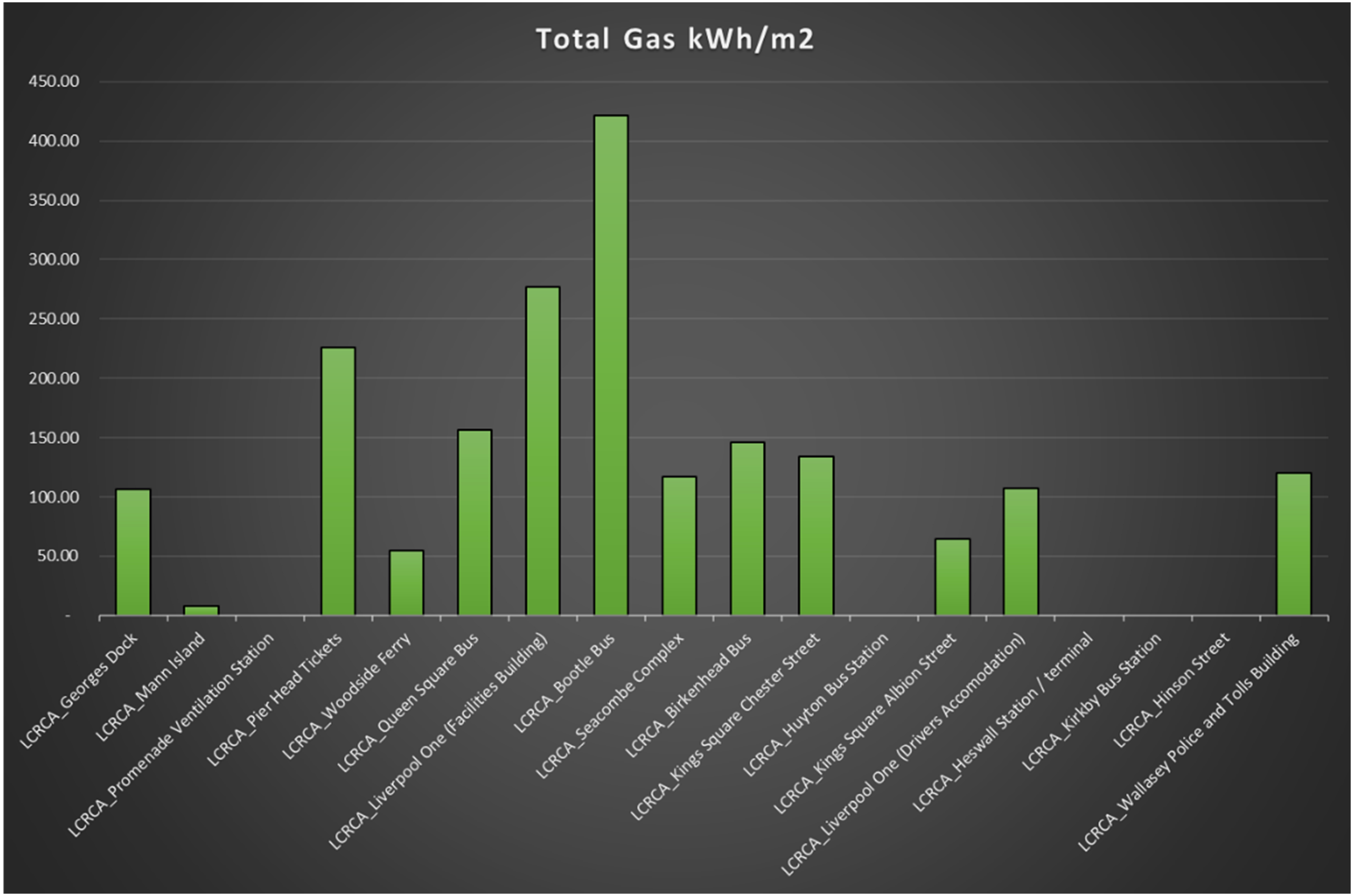
3.13 Solar Thermal Contribution

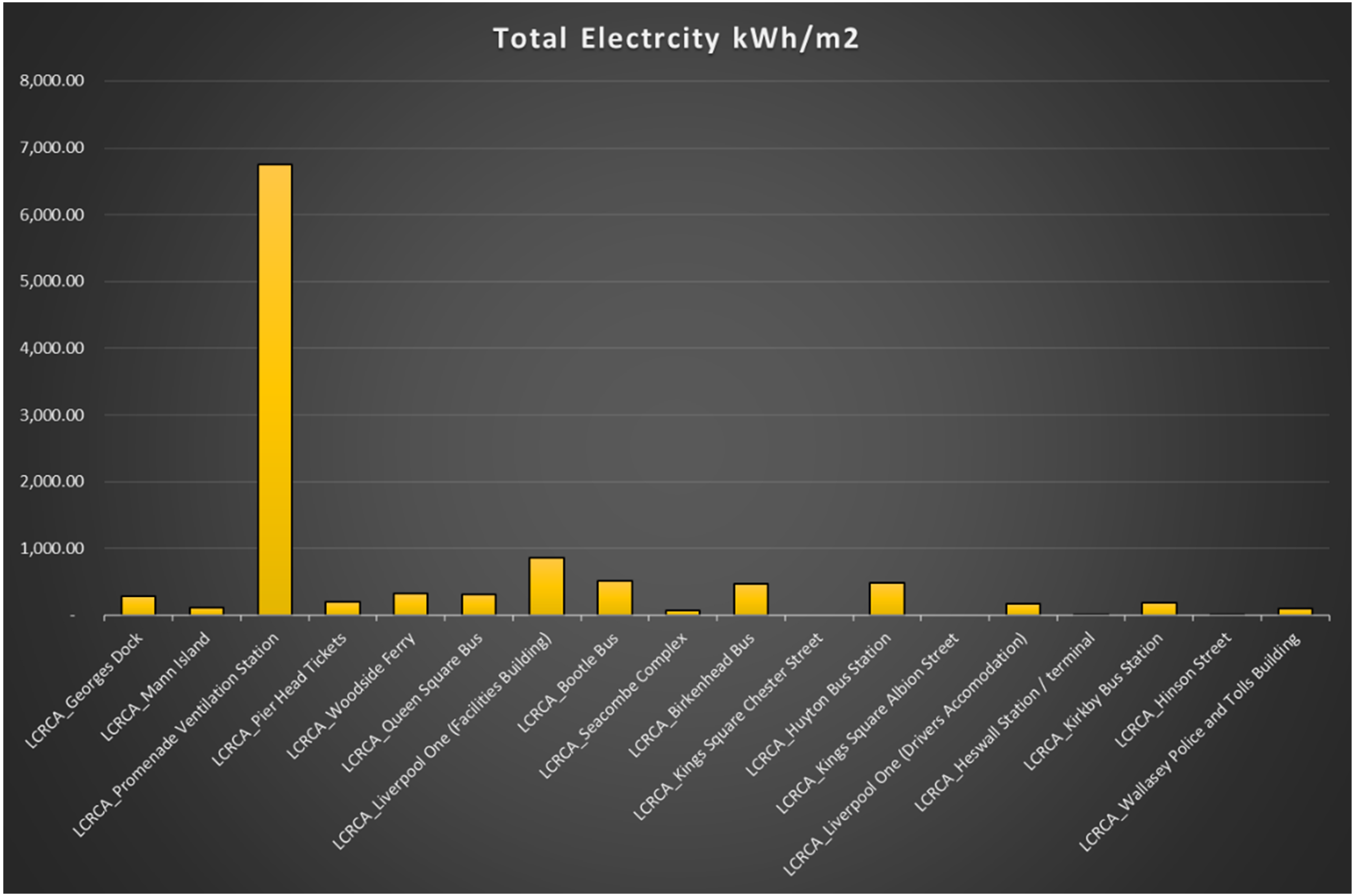
ENTITY	LCRCA

Row Labels	Sum of Solar Thermal (kWh)
Birkenhead Bus	-
Bootle Bus	-
Georges Dock	-
Heswall Station / terminal	-
Hinson Street	-
Huyton Bus Station	-
Kings Square Albion Street	-
Kings Square Chester Street	-
Kirkby Bus Station	-
Liverpool One (Drivers Accomodation)	-
Liverpool One (Facilities Building)	-
Mann Island	-
Pier Head Tickets	-
Promenade	-
Queen Square Bus	-
Seacombe Complex	-
St Helens Bus Station	-
Wallasey Police and Tolls Building	-
Woodside Ferry	-
Grand Total	**-**

3.14 Energy Intensity (kWh/m²)




Total Gas kWh/m2
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
-
LCRCA_Georges Dock
LCRCA_Mann Island
LCRCA_Promenade Ventilation Station
LCRCA_Pier Head Tickets
LCRCA_Woodside Ferry
LCRCA_Queen Square Bus
LCRCA_Liverpool One (Facilities Building)
LCRCA_Bootle Bus
LCRCA_Seacombe Complex
LCRCA_Birkenhead Bus
LCRCA_Kings Square Chester Street
LCRCA_Huyton Bus Station
LCRCA_Kings Square Albion Street
LCRCA_Liverpool One (Drivers Accomodation)
LCRCA_Heswall Station / terminal
LCRCA_Kirkby Bus Station
LCRCA_Hinson Street
LCRCA_Wallasey Police and Tolls Building



Total Electrcity kWh/m2
8,000.00
7,000.00
6,000.00
5,000.00
4,000.00
3,000.00
2,000.00
1,000.00
-
LCRCA_Georges Dock
LCRCA_Mann Island
LCRCA_Promenade Ventilation Station
LCRCA_Pier Head Tickets
LCRCA_Woodside Ferry
LCRCA_Queen Square Bus
LCRCA_Liverpool One (Facilities Building)
LCRCA_Bootle Bus
LCRCA_Seacombe Complex
LCRCA_Birkenhead Bus
LCRCA_Kings Square Chester Street
LCRCA_Huyton Bus Station
LCRCA_Kings Square Albion Street
LCRCA_Liverpool One (Drivers Accomodation)
LCRCA_Heswall Station / terminal
LCRCA_Kirkby Bus Station
LCRCA_Hinson Street
LCRCA_Wallasey Police and Tolls Building

3.15 HEAT PUMP AND HEATING/DHW DETAILS

Entity	Building Name	Function	Quantity	Manufacturer	Model	Refrigerant Type	Heat Output (kW)	SCOP	Thermal Storage (litres) / Hot Water Calorifier (litre
MerseyTravel	Birkenhead Bus Station	**Heating**	1	Mitsubishi	Ecodan-PUZ-WM112YAA	R32	11	3.34	400
MerseyTravel	Birkenhead Bus Station	**Hot Water**	1		Electric Point of use				
MerseyTravel	Bootle Bus Station	**Heating**	1	Mitsubishi	CAHV-P500YB	R32	43	3.19	1,000
MerseyTravel	Bootle Bus Station	**Hot Water**	1		Electric Point of use				
MerseyTravel	Georges Dock	**Heating**	1	Mitsubishi	Climaveneta	R513A	207	3.36	7,000
MerseyTravel	Georges Dock		2	Airedale	KCE-150	n/a	150	n/a	n/a
MerseyTravel	Georges Dock	**Hot Water**	1		Electric Point of use				
MerseyTravel	Hinson Street	**Heating**	No Decarbonisation works						
MerseyTravel	Hinson Street	**Hot Water**	No Decarbonisation works						
MerseyTravel	Kings Square Albion Street	**Heating**	3	Mitsubishi	Ecodan-PUZ-WM112YAA	R32	11	3.34	100
MerseyTravel	Kings Square Albion Street	**Hot Water**	1		Electric Point of use				
MerseyTravel	Kings Square Chester Street	**Heating**	3	Vaillant	AroTHERM15	R410a	15	3.28	100
MerseyTravel	Kings Square Chester Street	**Hot Water**	1		Electric Point of use				
MerseyTravel	Liverpool One (Drivers Accomodation)	**Heating**	2	Mitsubishi	PUZ-HW85VHA	R32	9	3.48	Not Stated
MerseyTravel	Liverpool One (Drivers Accomodation)	**Hot Water**	1		Electric Point of use				
MerseyTravel	Liverpool One (Facilities Building)	**Heating**	2	Mitsubishi	CAHV-R450Y-HPB	R454C	33	3.57	700
MerseyTravel	Liverpool One (Facilities Building)	**Hot Water**	1		Electric Point of use				
MerseyTravel	Mann Island	**Heating**	3	Daikin	EWYT300B-SSA2	R32	300	3.42	5,000
MerseyTravel	Mann Island	**Hot Water**	1		Electric Point of use				
MerseyTravel	Pier Head Ticket Office	**Heating**	2	Mitsubishi	CAHV-P500YB-HPB	R32	43	3.54	2,000
MerseyTravel	Pier Head Ticket Office	**Hot Water**	1		Partially Electric Point of use, partially indirect from the ASHP's.				
MerseyTravel	Promenande Ventilation Station	**Heating**	0						
MerseyTravel	Promenande Ventilation Station	**Hot Water**	0						
MerseyTravel	Queen Square Bus station	**Heating**	0						
MerseyTravel	Queen Square Bus station	**Hot Water**	0						
MerseyTravel	Seacombe Complex Ferry Terminal	**Heating**	2	Mitsubishi	CAHV-P500YB	R32	43	3.19	1,000
MerseyTravel	Seacombe Complex Ferry Terminal	**Hot Water**	1		Electric Point of use				
MerseyTravel	Wallasey Police and Tolls Building	**Heating**	0						
MerseyTravel	Wallasey Police and Tolls Building	**Hot Water**	0						
MerseyTravel	Woodside Ferry Terminal	**Heating**	0						
MerseyTravel	Woodside Ferry Terminal	**Hot Water**	0						

Appendix C – Costs Indices

BCIS All-in TPI (Tender Price Index) provided as industry recognised, standard and good practice in respect of forecasting periodic price/cost fluctuations in Construction. BCIS collating, analysing, and reporting on national Construction price/cost trends and fluctuations to facilitate forecasted predicted market implications.

Formula used to calculate percentage price fluctuations between any two periods, such as base date to anticipated tender date:

(tender date index – base date index) / (base date index) x 100 = percentage tender price fluctuation

Example:

(tender 4Q2023 index 374 – base date 1Q2023 index 368) / (base date 1Q2023 index 368) x 100 = 1.63%

Projects with longer construction periods would also have applied additional price fluctuations to the mid-point of the anticipated construction period:

(construction mid-point index – tender date index) / (tender date index) x 100 = percentage construction price fluctuation

BCIS®

BCIS All-in TPI #101

The series contained on the page are as published on 02-Jan-2023

Base date: 1985 mean = 100 | **Updated:** 09-Dec-2022 | #101

			Percentage change		
Date	**Index**	**Equivalent sample**	**On year**	**On quarter**	**On month**
2Q 2021	331	Provisional	-1.2%	0.9%	
3Q 2021	339	Provisional	2.7%	2.4%	
4Q 2021	344	Provisional	4.9%	1.5%	
1Q 2022	349	Provisional	6.4%	1.5%	
2Q 2022	361	Provisional	9.1%	3.4%	
3Q 2022	366	Provisional	8.0%	1.4%	
4Q 2022	370	Provisional	7.6%	1.1%	
1Q 2023	368	Forecast	5.4%	-0.5%	
2Q 2023	370	Forecast	2.5%	0.5%	
3Q 2023	370	Forecast	1.1%	0.0%	
4Q 2023	374	Forecast	1.1%	1.1%	
1Q 2024	376	Forecast	2.2%	0.5%	
2Q 2024	378	Forecast	2.2%	0.5%	
3Q 2024	378	Forecast	2.2%	0.0%	
4Q 2024	382	Forecast	2.1%	1.1%	
1Q 2025	385	Forecast	2.4%	0.8%	
2Q 2025	388	Forecast	2.6%	0.8%	
3Q 2025	388	Forecast	2.6%	0.0%	
4Q 2025	390	Forecast	2.1%	0.5%	
1Q 2026	396	Forecast	2.9%	1.5%	
2Q 2026	399	Forecast	2.8%	0.8%	
3Q 2026	400	Forecast	3.1%	0.3%	
4Q 2026	403	Forecast	3.3%	0.8%	

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Appendix D – Maintenance Considerations for Decarbonisation Technologies

Within the LCRCA Decarbonisation Heat Plans we have proposed a range of technology to achieve a reduction in the carbon footprint of the various buildings. Principally these encompass:

- Enhancement of building fabric to reduce heat losses (a fabric first approach);
- Enhancement of BMS controls to optimise operation of existing systems
- Decarbonisation of the heat source by replacement of gas fired heat generators with:
  - ASHP's, supplemented by Solar HW generation in a small number of cases;
  - a secondary option of GSHP's in a small number of cases (subject to further investigative study), or;
  - District Heating if a viable scheme is available;
- Replacement of fluorescent lighting with LED lighting, including enhanced controls where appropriate
- Installation of Photovoltaic panels for supplementary power generation.

As with the existing installed systems, all of the above will require ongoing maintenance in order to deliver optimal performance. In the absence of accurate industry benchmark cost data, we have summarised below the general expectations against each item:

- <u>Building fabric:</u> Insulation and glazing: generally low maintenance encompassing periodic inspection, cleaning, and minor local repairs on as as-needed basis. Vacuum sealed glazed units may incur intermittent failure but early life failures should be covered by procurement of suitable warranty arrangements.
- <u>BMS system:</u> Following installation and seasonal commissioning to optimise system operation a BMS system will benefit from periodic (e.g., quarterly or half yearly) checks by a competent engineer to scrutinise alarm history and key trend plots in order to identify mis-operation (e.g., systems turned from auto to manual), failure of field devices, or sensor calibration drift. Commonly this periodic servicing is procured via a specialist but having a level of in-house skills can be highly beneficial for day to day optimisation. Centralised monitoring of multiple buildings is ideal, and modem links to allow system interrogation by an external specialist is optimal.
- <u>ASHPs:</u> Maintenance requirements will vary according to manufacturer and model but generally the periodic servicing of ASHP plant is required at a similar frequency to that for gas fired heat generation. An 'F' Gas certified engineer will be required to work on all systems / devices containing F-Gas refrigerant. Note that for heating only systems, monobloc ASHP have been selected where the refrigerant is all contained within the ASHP, factory installed.
- Renewable Energy Hub UK advises the following:

  The maintenance which general FM staff can perform to ensure the unit operates as intended is:

  - *Clean coils and fans (if necessary)*
  - *Ensure proper air flow is not impeded by debris (leaves, dust etc.)*
  - *Power off the unit and check / clean fan blades.*

  Before the winter (or summer if used for cooling) it is recommended to have the unit serviced by a specialist who will conduct a more advanced audit of the components and identify issues that could degrade the heat pump's performance. These checks will comprise of the following:

  - *Inspect filters, ducts, blower and indoor coil for dirt and other obstructions*
  - *Measure airflow is correct*
  - *Check refrigerant levels and pressure*
  - *Check all electrical contacts and ensure they are protected from the elements*
  - *Check for system leaks*
  - *Check reverse heating / cooling controls and verify they are operating as required*
  - *Lubricate moving belts, motors and check for damage / wear and tear*
  - *Check and test thermostat under normal operating conditions.*

- <u>Solar Thermal generation:</u> To remove /reduce legionella risk it is proposed to only use the solar thermal as a closed circuit pre-heat loop for the cold supply to the DHW calorifiers. There would not be a body of water sat there at below 60oC, only the coil in the cylinder, but a weekly pasteurisation should be programmed through the BMS. Maintaining cleanliness of the solar collector will assist with optimisation of performance.
- <u>GSHPs:</u> Maintenance requirements will vary according to manufacturer and model but generally the periodic servicing of GSHP plant is required at a similar frequency to that for gas fired heat generation. Renewable Energy Hub UK advises the following for a closed loop system:

  The main components applicable to a standard <u>closed loop</u> heat pump system that will need checking are:

  - *The electronics and control equipment*
  - *The water pump – the only moving item in the system*
  - *The compressor – if this unit fails it will have to be replaced as a whole as it is a sealed unit*
  - *Pipes and connectors (above ground)*
  - *Anti-Freeze / coolant fluid in the ground array – check for correct chemical mixture*

  As with all devices containing or designed to contain F-Gas refrigerants, an 'F' Gas certified engineer will be required to work on these components. In addition to this the larger commercial systems will be subject to more stringent maintenance requirements.

- <u>District Heating:</u> Typically, the maintenance of the centralised heat generation plant and network will sit with the system operator; and the building operator will hold responsibility for LTHW circulation within the building. Responsibility for the heat exchangers between the systems may vary according to individual contract, but it is not unusual for the Contract to require that the building operator maintains system return temperature within quite tight defined operational parameters with penalties attached to variances outside these parameters.
- <u>LED lighting:</u> Aside from lower energy consumption the transition to LED fittings is effectively mandated by the phasing out of fluorescent units. Lifespan for LED lamps varies with manufacturer but is generally estimated at circa 40-50% greater than fluorescents, but with this advantage is balanced out by it being common to replace complete LED fittings rather than just the lamps.
- <u>Photovoltaic panels:</u> Aside from occasional cleaning to maintain optimal performance these require minimal maintenance. Inverters and associated switchgear should be checked for correct operation and item changed out upon failure.