BUILDINGS ENERGY AND CARBON DIOXIDE EMISSIONS REVIEW

Saltash Town Council

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Contents

Introduction

Up Energy was instructed to assist Saltash Town Council in assessing their buildings, to assist in moving those buildings towards a net zero position. The subject buildings were visited and surveyed on 1 February 2024 with follow up energy data supplied via email.

Methodology

For this early approach to net zero, the route taken was to assess the buildings using the methodology set out for Energy Performance Certificates (EPC). This standardises building energy consumption and CO2 emissions, based on the building type, for a theoretical average user.

The EPC route is often a good starting point. To provide more realistic results, some of the EPC conventions were not followed, as these are sometimes worst-case assumptions, that from experience, are not always accurate, even in older buildings.

EPCs look at the following aspects of buildings:

- Fabric
- Heating
- Cooling
- Auxiliary (fans and pumps)
- Lighting
- Hot water
- Equipment[1]

Results have been reported under the above areas of energy consumption, based on the buildings as they are currently. Building upgrades and improvements have then been considered, to reduce energy where possible. At this stage, budgets, payback and priorities have not been considered, as this would require a more detailed and in-depth approach.

Buildings Analysis

Each building has been analysed and the results set out below. The EPC (energy performance certificate) energy consumption values have been reported and then compared with the actual energy consumption. A CIBSE Guide F benchmark for 'Good Practice' has also been added.

The CIBSE benchmarks do not always fully align with the building type. The Maurice Huggins Room, for example, is akin to office use, however it's not a full-time occupied office with computer equipment and desks etc. It's more of an ad-hoc space for various users, however a benchmark for this does not really exist. Other buildings do not fully align either, with perhaps the library being the closest to a 'standard' building.

Maurice Huggins Room

Building summary

Assumed to be constructed in the mid 1960's with no thermal upgrades since, other than the double glazing. Heating is via simple, electric panel heaters. Lighting is LED with manual controls. Hot water use is likely very low and uses an electric, point of use water heater with small storage. Occupants using the building on the day had laptops with them but generally, equipment levels appear to be low. There is a small kitchen facility.

Calculations

The EPC methodology gives the following results.

End use	kWh/m^2	Proportion of energy use
Heating	262	84.5%
Cooling	0	0%
Auxiliary	0	0%
Lighting	13	4.3%
Hot water	12	3.7%
Equipment	23	7.5%

The above data has been compared with the actual use, as well as the CIBSE Guide F 'office – naturally ventilated, cellular' benchmark.

Metric	EPC methodology	CIBSE benchmark	Actual consumption
Annual energy use kWh/m^2	310	112	95
Annual total energy use kWh	11,159	4,032	3,405

Energy consumption is very low and well below that indicated by the EPC methodology and the CIBSE benchmark. This is most likely due to occupancy patterns and lower equipment energy use than the assumed $23kWh/m^2$.

The table below shows the CO_2 emissions associated with the actual energy use.

Emissions kg CO_2 (electricity)	Emissions kg CO_2 (mains gas)	Emissions kg CO_2 total	Emissions kg CO_2/m^2
705	0	705	19.6

Library

Building summary

Assumed to be constructed in the early 1960's with some replacement double glazing on the main façade. The rear extension is mentioned as added in the early 1990's, when Building Regulations would have imposed improved performance standards. The building is heated via an efficient mains gas boiler and radiator system.

The 1992 extension does have roof mounted fans, which appear to be manually operated and for extract purposes, though it is believed these are not operated and thus excluded from the model. Lighting is LED with manual controls in the main public areas and reception desk and a mixture of compact and linear fluorescent in the staff areas.

Hot water use is again likely low, with an electric, point of use heater with small storage. There is some computer equipment and tea making facilities.

Calculations

The EPC methodology gives the following results.

End use	kWh/m^2	Proportion of energy use
Heating	216	82.8%
Cooling	0	0%
Auxiliary	2	0.9%
Lighting	21	8.1%
Hot water	2	0.6%
Equipment	20	7.5%

The above data has been compared with the actual use, as well as the CIBSE Guide F 'library' benchmark.

Metric	EPC methodology	CIBSE benchmark	Actual consumption
Annual energy use kWh/m^2	261	145	137
Annual total energy use kWh	113,365	63,017	59,402

Energy consumption is well below that indicated by the EPC methodology and close to the CIBSE benchmark.

The table below shows the CO_2 emissions associated with the actual energy use.

Emissions kg CO_2 (electricity)	Emissions kg CO_2 (mains gas)	Emissions kg CO_2 total	Emissions kg CO_2/m^2
2,584	8,445	11,029	25.4

Guildhall

Building summary

Assumed to be constructed in the late 18th century, with no obvious thermal upgrades, other than access to the loft showed the roof had been insulated with PIR boards between the rafters. Glazing is single and other than the roof, opaque elements are assumed to be uninsulated.

The building is heated via an efficient mains gas boiler and radiator / convector system. There is a modern, efficient comfort cooling split system in the top floor office.

The loft houses an air handling unit, of which performance details are unknown. It appears to provide ventilation to the guildhall and top floor office. There are additional extract fans around the building, though staff advise some are not used.

Some lighting has been upgraded to LED. There are PIR occupancy sensors to automate switching in some rooms. In general, lighting is fluorescent.

Hot water is provided by electric storage heaters. A more modern, better insulated version is installed in the cleaner store. There is some computer equipment in office areas, along with tea making facilities.

Calculations

The EPC methodology gives the following results.

End use	kWh/m^2	Proportion of energy use
Heating	184	68.1%
Cooling	1	0.5%
Auxiliary	10	3.8%
Lighting	29	10.6%
Hot water	7	2.6%
Equipment	39	14.5%

The above data has been compared with the actual use, as well as the CIBSE Guide F 'town hall' benchmark.

Metric	EPC methodology	CIBSE benchmark	Actual consumption
Annual energy use kWh/m^2	270	222	138
Annual total energy use kWh	107,432	88,356	55,006

Energy consumption is well below that indicated by the EPC methodology and the CIBSE benchmark. This is most likely due to occupancy patterns and lower equipment energy use than the assumed 39kWh/m^2.

The table below shows the CO_2 emissions associated with the actual energy use.

Emissions kg CO_2 (electricity)	Emissions kg CO_2 (mains gas)	Emissions kg CO_2 total	Emissions kg CO_2/m^2
3,666	6,713	10,379	26.1

Isambard House

Building summary

The building has undergone a significant, recent refurbishment, with a new extension. Thermal upgrade information has been taken from the design drawings, which was also explained on the day, by a council representative. The walls, floor, roof and windows / doors have all been improved / replaced to meet modern standards. Some u-value calculations were undertaken to determine the performance.

There is an efficient mains gas boiler with underfloor heating. There is mechanical extract ventilation for toilets and the kitchen area.

Lighting is LED throughout with some PIR occupancy sensors to automate switching. Hot water is provided by a combination boiler and electric, point of use heaters with small storage. There is some small power and domestic style food preparation equipment.

Calculations

The EPC methodology gives the following results.

End use	kWh/m²	Proportion of energy use
Heating	75	53.8%
Cooling	0	0%
Auxiliary	3	1.9%
Lighting	8	5.5%
Hot water	41	29.2%
Equipment	13	9.5%

The above data has been compared with the actual use, as well as the CIBSE Guide F 'community centre' benchmark.

Metric	EPC methodology	CIBSE benchmark	Actual consumption
Annual energy use kWh/m^2	140	147	37
Annual total energy use kWh	26,701	28,018	7,137

Energy consumption is well below that indicated by the EPC methodology and the CIBSE benchmark. This is most likely due to the fact the building is yet to be fully occupied for a year.

The table below shows the CO_2 emissions associated with the actual energy use.

Emissions kg CO_2 (electricity)	Emissions kg CO_2 (mains gas)	Emissions kg CO_2 total	Emissions kg CO_2/m^2
1,134	3,820	4,954	26.0

Longstone Depot

Building summary

It is understood the main building has been extended vertically but the date of this is unknown. Access to the loft was available and insulation is present. The windows have been upgraded to double glazing. It is assumed the remainder of the fabric is uninsulated, based on age. The workshop is unheated and as such, the fabric standards are not relevant.

Heating demand is generally low with electric panel and night storage heaters in the office with a small, fanned electric heater in the toilet. The lighting is LED with a compact fluorescent in the stairwell.

Hot water use is likely very low, supplied by electric, instantaneous point of use heaters. There is some computer equipment with tea making facilities.

Calculations

The EPC methodology gives the following results.

End use	kWh/m^2	Proportion of energy use
Heating	74	67.3%
Cooling	0	0%
Auxiliary	<1	0.4%
Lighting	14	12.5%
Hot water	2	1.4%
Equipment	20	18.5%

The above data has been compared with the actual use, as well as the CIBSE Guide F benchmark. For this building, the benchmark has been calculated based on part office, part workshop. There is no guidance for a local authority workshop but there is a MoD option, which has been used.

Metric	EPC methodology	CIBSE benchmark	Actual consumption
Annual energy use kWh/m^2	110	56	20
Annual total energy use kWh	9,431	4,816	1,759

Energy consumption well below that indicated by the EPC methodology and the CIBSE benchmark, again, likely due to intermittent occupancy and less than typical operational temperatures in the office.

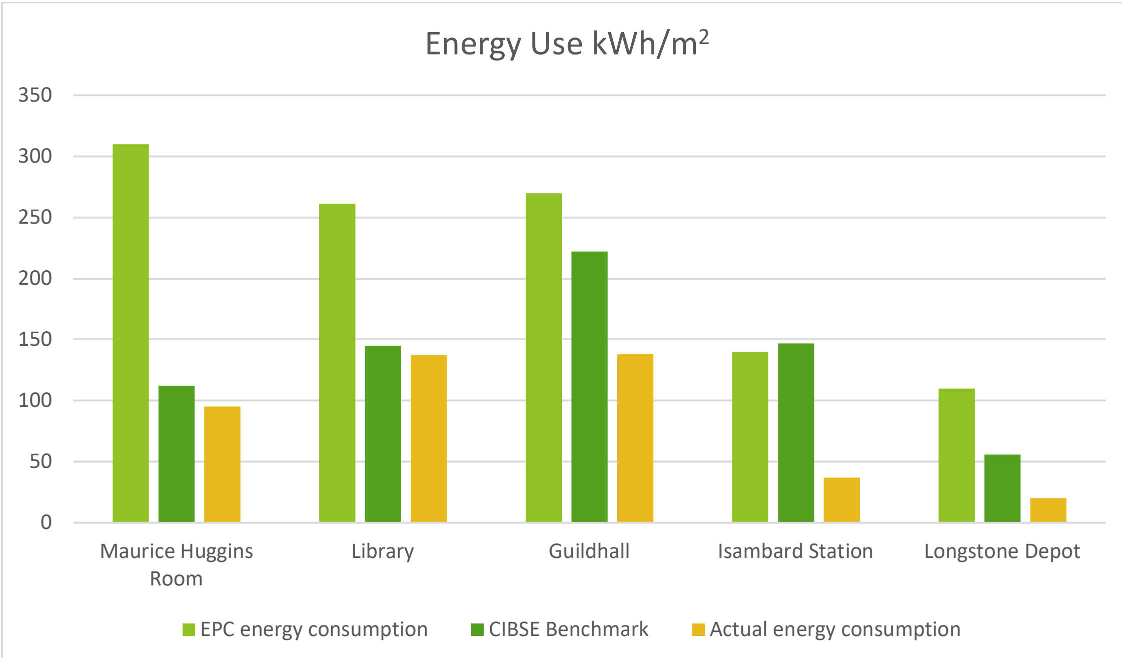
The table below shows the CO_2 emissions associated with the actual energy use.

Emissions kg CO_2 (electricity)	Emissions kg CO_2 (mains gas)	Emissions kg CO_2 total	Emissions kg CO_2/m^2
2,584	8,445	11,029	25.4

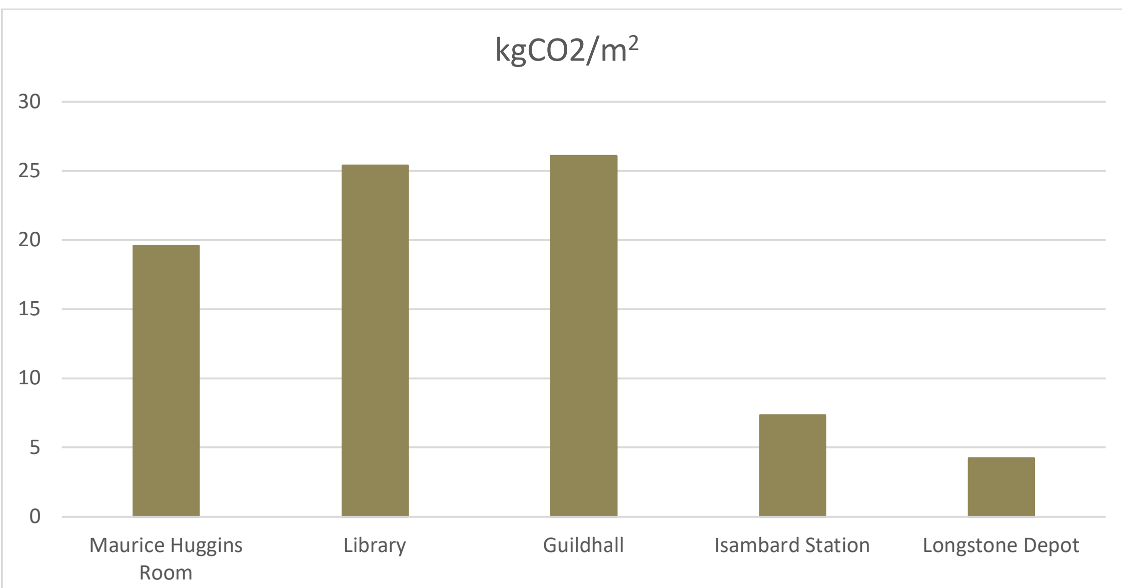
Summary

All buildings consume low amounts of energy compared with the EPC methodology and the CIBSE Guide F benchmarks for 'good practice'. EPCs generally overestimate energy consumption and the CIBSE benchmarks are not fully representative of these buildings, as they don't all fall in to a set category, apart from the library. Reduced opening hours and occupancy levels will drastically impact energy consumption if heating patterns are set to match that lower occupancy.

The chart below shows the performance of each building.



The chart below shows the CO_2 emissions associated with each building.



Upgrades

It is generally best to take a fabric first approach to reducing building energy consumption, which in turn reduces the carbon dioxide emissions. Once the building has been improved to reduce consumption, building services efficiency is generally the next approach, with renewable energy then used to further reduce electricity drawn from the grid.

There will be numerous approaches to improving the buildings but for each one, improvements across all parts of the building have been considered and analysed. It is beyond the scope of this early stage project to run upgrades one at a time, so complete building upgrades have been considered, to see what may be required to reduce CO_2 emissions, in order to move towards net zero.

The tables below, for each building, show potential upgrades. The reduction in energy for the various end uses (heating / cooling / auxiliary / lighting / hot water / equipment), as predicted by the EPC methodology, has been applied to the actual consumption to show the overall energy reduction.

Maurice Huggins Room

Building upgrade	Standard
Insulate external walls	U-value 0.25
Insulate flat roof	U-value 0.16
Solar PV	2.5kW

The above upgrades would reduce heat loss and generate electricity on site, to help offset grid electricity consumption. When applied to the current energy use, the calculations show a revised annual consumption of -3,924kWh.

Library

Building upgrade	Standard
Insulate original external walls	U-value 0.25
Insulate original mono-pitch roof	U-value 0.16
Replace single and older double glazing	U-value 1.60 (g-value 0.50)
Upgrade fluorescent lighting to LED	95 lm/W
Solar PV	26kW

It was noted during the site visit, that the building is or may be in the process of being listed. This may reduce the upgrades available, however the above should be achievable without altering the building character.

The above upgrades would reduce heat loss and generate electricity on site. Replacing the main façade glazing would give an opportunity to potentially reduce the g-value, which impacts the amount of solar gain that passes through the glass. Solar gain is beneficial in that it provides free heat, however on a heavily glazed façade, it can cause occupant discomfort through overheating. With the above upgrades applied to the current energy use, the calculations show as -19,263kWh.

Guildhall

Building upgrade	Standard
Install low-e secondary glazing	U-value 2.00
Upgrade fluorescent lighting to LED	95 lm/W

The building is listed so upgrades opportunities may be more limited. The above upgrades would reduce heat loss a little and cut lighting energy. When applied to the current energy use, the calculations show a revised annual consumption of 5,863kWh.

Isambard Station

No upgrades have been suggested for this building, given the very recent refurbishment. It could benefit from solar PV, if allowed, and could be considered for an air source heat pump to replace the gas boiler, at some point.

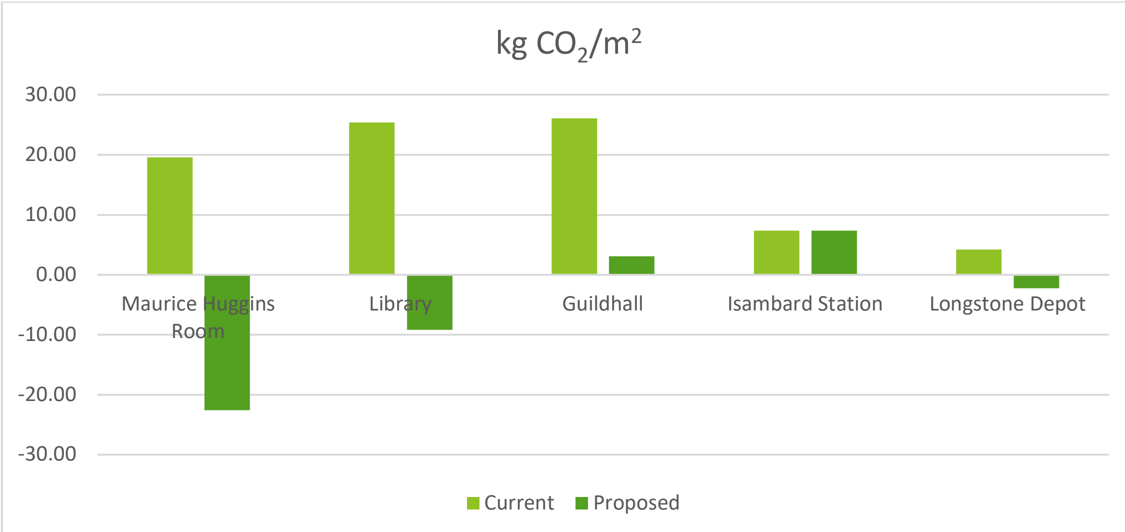
Longstone Depot

Building upgrade	Standard
Insulate external walls (office building)	U-value 0.25
Increase roof insulation	U-value 0.16
Insulate internal floor over unheated store	U-value 0.25
Solar PV	2.25kW

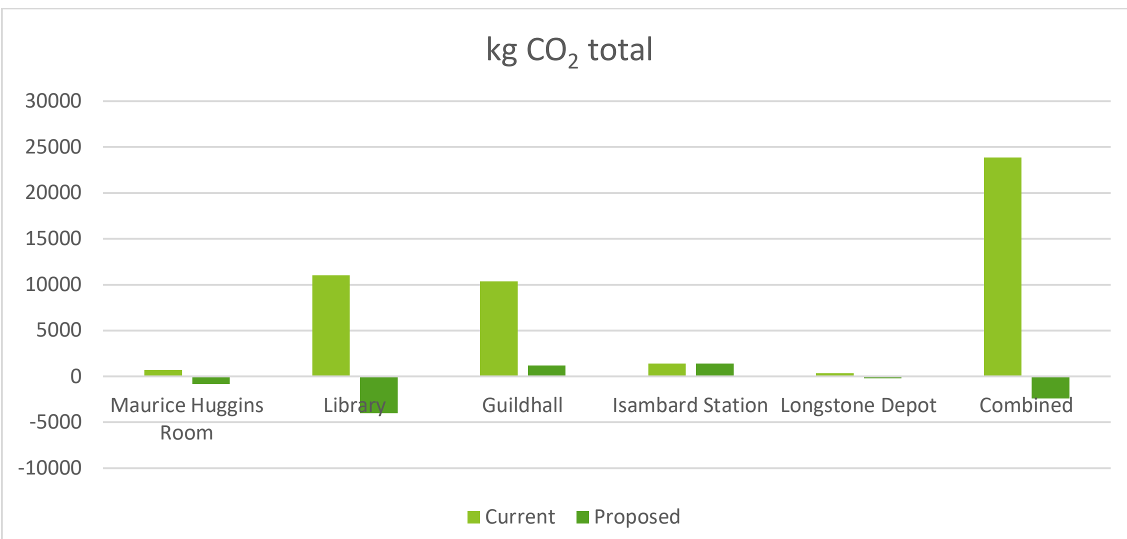
The above upgrades would reduce heat loss and generate electricity on site, to help offset grid electricity consumption. When applied to the current energy use, the calculations show a revised annual consumption of -947kWh.

Conclusion

The below table shows the carbon dioxide emissions for the buildings as they are and following the proposed upgrades listed.



And the chart below shows the overall portfolio emissions, before and after the listed upgrades.



The total, current portfolio building emissions shows as 23,875 $kgCO_2$ per annum.

The total, proposed portfolio building emissions shows as -2,384.93 $kgCO_2$ per annum.

The Isambard Station building energy use is assumed to increase but that is the best insulated building amongst the five. There are further opportunities to reduce energy use, including increasing insulation levels beyond those listed, insulating ground floors, improved lighting controls, heat pumps and additional solar PV. Some upgrades are not suited to all buildings and the payback on some may rule them out, thus further investigation would be required.

Further considerations

Achieving net zero emissions is a complex assessment of an organisation and as well as the energy consumed in the building, primary energy factors may also need consideration. This is the energy associated with production and delivery, to the point of use. The source of electricity, from the supplier may also impact the analysis.

As well as buildings, other fuels such as those used in passenger vehicles for business travel, or other vehicles, including plant and grounds maintenance, are also included within the scope of organisational CO_2 emissions.

https://www.nationalgrid.com/stories/energy-explained/what-is-net-zero

Building information was collected on site visually, with some questions asked of staff where available. The surveys were not invasive and therefore levels of insulation, where not visible, are based on the building age. Research has been done in to building services and their efficiencies, and reasonable estimates made in the absence of manufacturer data. The predicted figures above are estimates only and may vary significantly if building occupancy and user behaviour changes.