NET ZERO ROADMAP
GH DISPLAY LTD

The Green Business Impact Programme is a collaborative effort led by Cambridge City Council, South Cambridgeshire District Council, Huntingdonshire District Council, the Cambridgeshire and Peterborough Growth Hub and the Cambridgeshire & Peterborough Combined Authority.

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This document has been completed by Jenny Wilton on behalf of PECT and the Green Business Impact Programme. For advice and guidance on the information contained within the report please call 01733 568408 or email greenbusinessimpact@pect.org.uk

EXECUTIVE SUMMARY

GH Display Ltd are a leading custom exhibition stand builder and custom display manufacturer.

They are facing challenges to reduce their energy consumption and carbon emissions to continue their path to net zero.

As part of their commitment to Net Zero, they are already operating out of a well insulated building and have installed LED lighting throughout. They have a large solar PV system, with a storage battery, already installed on the roof of the main building. In addition, they have made lots of improvements with regard to material waste reduction in the factory and are working very closely with suppliers to ensure that as much incoming material as possible is itself manufactured sustainably.

An assessment of GH Display Ltd's carbon footprint revealed that the majority of CO2e emissions are from Scope 2 emissions, specifically electricity.

In order to further reduce their Carbon Footprint, they are looking at adding additional solar panels to the existing system, switching the main heating system to low energy electric heating and eventually adding an additional solar PV system to the roof of the new building. They are also intending to find out more about energy generation via wind turbines and are looking to replace older manufacturing equipment with more energy efficient equipment when practical.

In addition they also have a plan to switch to renewable HVO diesel for all existing company owned vehicles. This is along with various other improvement activities documented in the associated Action Plan.

The intention is to implement these improvements over the next 5 years and following are illustrations of key activity milestones and potential CO2e savings, as well as a more detailed explanation of the buildings and organisational activities.

They are committed to exploring all available opportunities, including grants, relevant implementations, and policies, to reach their net zero carbon goals and embed net zero targets into their long term business strategy, including forward financial planning for the installation of improvements.

ASSUMPTIONS, CAVEATS & CALCULATIONS

- Building use has been estimated using the opening and closing times provided by the organisation.
- Most data has been provided remotely by the beneficiary, but some information was collecting during a site visit.
- All calculations are based on annual utility usage provided by the organisation, unless otherwise stated. Data provided has not been 3rd party verified.
- Where verifiable data is not available, a pro-rata extrapolation method has been used to estimate the data. This means using figures from another comparable time period to fill the gap.
- The Emissions Statements presented in this document include the key energy emission sources for which the organisation has provided data. An emissions statement is a means of expressing the environmental impact of resource consumption and is presented as tonnes of carbon dioxide equivalent (tCO2e) to account for the impacts of all seven Kyoto Protocol gases. Both current and predicted Emissions calculations use Defra's most recently published Greenhouse Gas Conversion Factors conversion factors (June 2023). https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023
- Emission sources have been categorised according to the World Resources Institute's (WRI's) greenhouse gas protocol methodology - https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf
- With regard to Scope 2 emissions, we have used the location-based methodology as outlined in the GHG Protocol. Under this methodology, all emissions are reported using standard emissions factors as released by the UK Government annually. https://ghgprotocol.org/sites/default/files/Scope2_ExecSum_Final.pdf
- This document focusses on Scope 1 & 2 emissions, based on data provided by the organisation, and Scope 3 emissions have been considered only where deemed material and where the information has been provided to us.
- Current GHG Protocols for reporting scope 2 location based emissions require us to quote the usual scope 2 emissions for electricity supply for green tariffs. Consequently, emissions will be reported calculated as usual for electricity usage.
- Any claims made regarding emissions and / or costs savings in the future are dependent on the organisation implementing the improvements suggested in this document and we understand that priorities may change based on business performance and priorities.

COMPANY DETAILS AND ACTIVITIES

Location: Bullock Road, Washingley, Cambs, PE7 3SJ

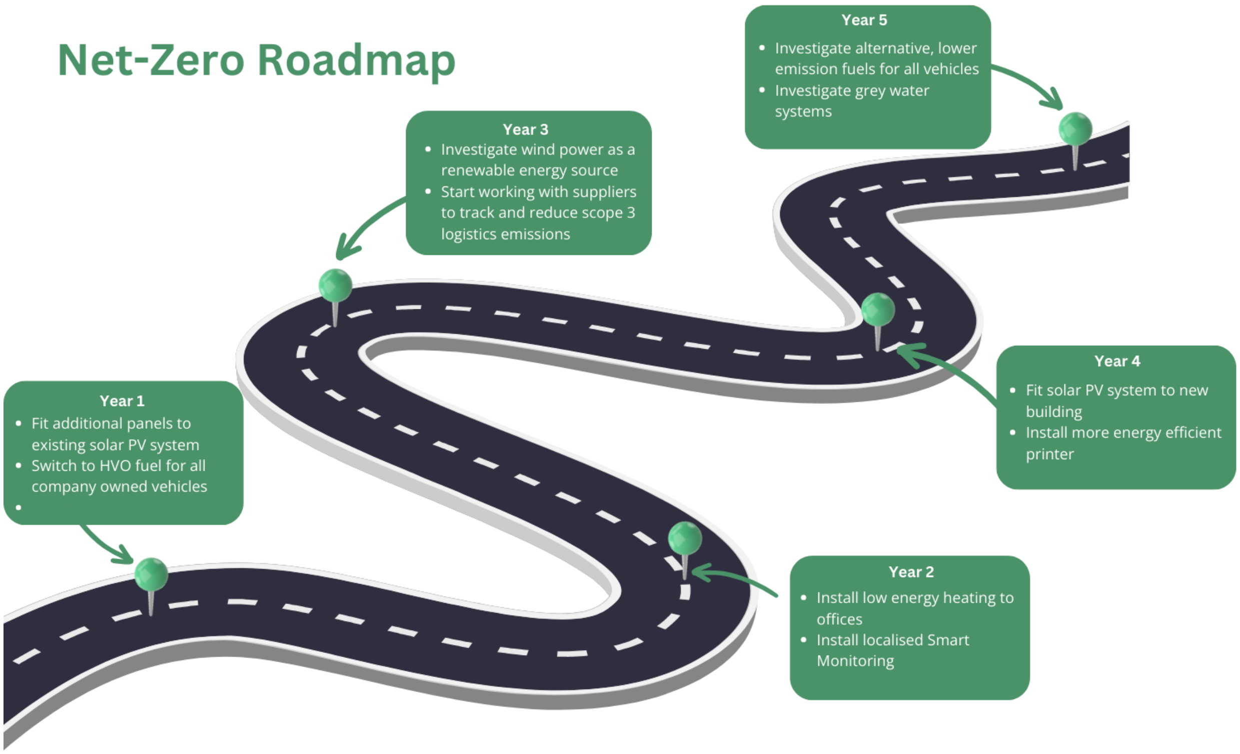
The largest energy usage on site is electricity, for manufacturing equipment, office equipment and lighting. The biggest electricity usage on site is thought to be manufacturing equipment.

There are several printing machines onsite and lots of other electrical manufacturing equipment, such as cutting machines, drills and painting equipment.

Some deliveries to customers are made via 3 company owned vans, and the estimated annual mileage for these is around 77,000 miles per year.

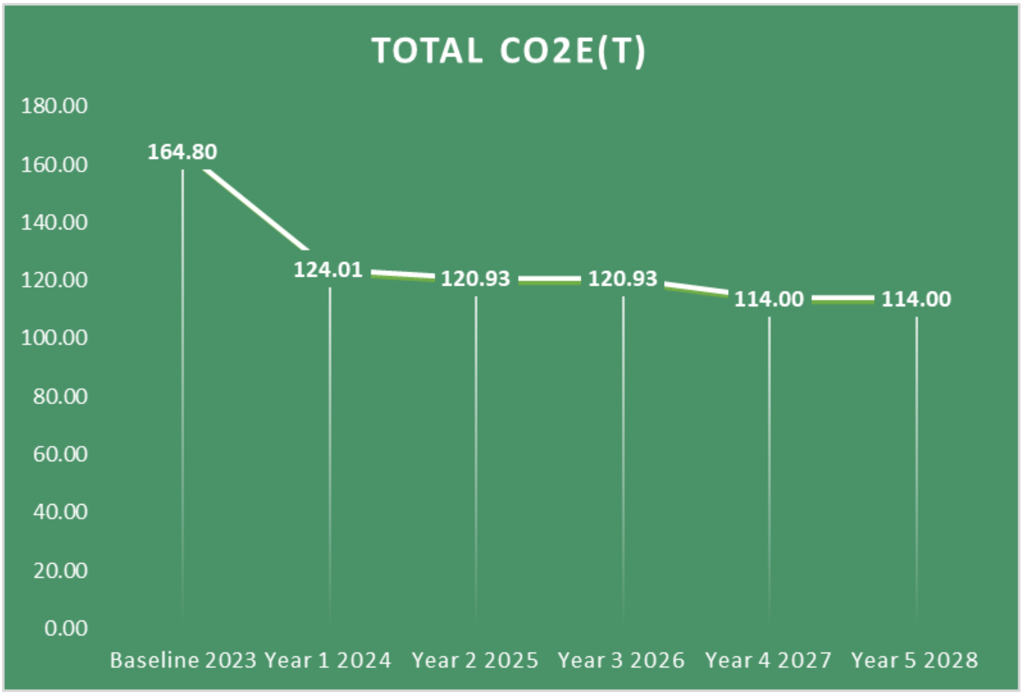
NET ZERO ROADMAP

Key improvement activities in GH Display Ltd's Net Zero Plan are shown below.



MILESTONE CO2 REDUCTION TARGETS

From the improvements identified in the 5-year action plan, estimated emissions savings have been calculated for each year and the milestone reduction is shown below. The percentage reduction over the 5 years is estimated at 31%, if all of the improvements detailed are implemented.



Nb. All calculations have been made using Defra's published Greenhouse Gas Conversion Factors (June 2023). Any changes in GHG Protocol and calculation methods will not be reflected here and it is recommended that these figures be updated on an annual basis. If calculating methods for scope 2 emissions change for green tariffs (location based), these figures will reduce. Targets have been set by an absolute reduction target method, which compares absolute figures in the target year to the baseline year. An emissions statement is a means of expressing the environmental impact of resource consumption and is presented as tonnes of carbon dioxide equivalent (tCO2e) to account for the impacts of all seven Kyoto Protocol gases.

Potential decarbonisation activities have been identified with the organisation management team and the dates agreed to at the present time. All improvement activities will be dependent on financial availability based on the organisation's business performance and future priorities.

If wind turbines for renewable energy generation and a replacement, lower energy printing machine are installed it is likely that further CO2e reductions are possible, but these are not included in these figures.

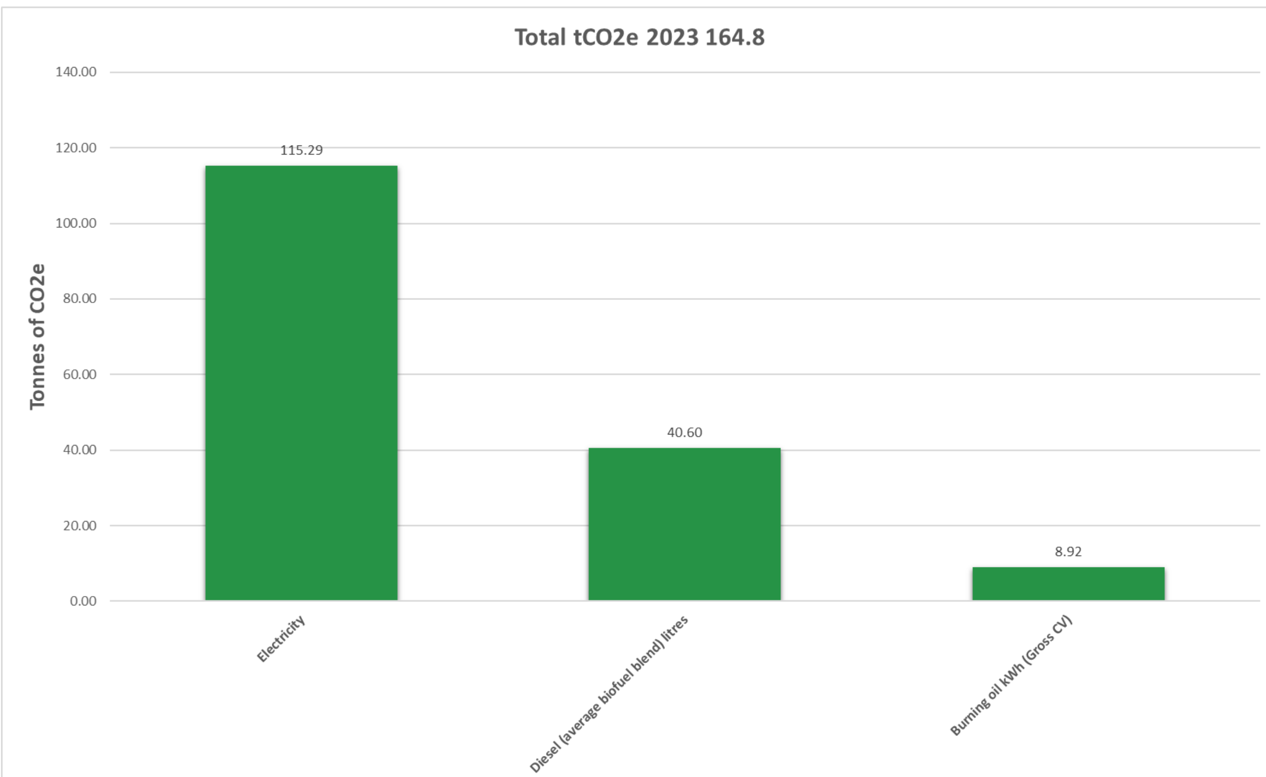
CURRENT USAGE AND EMISSIONS

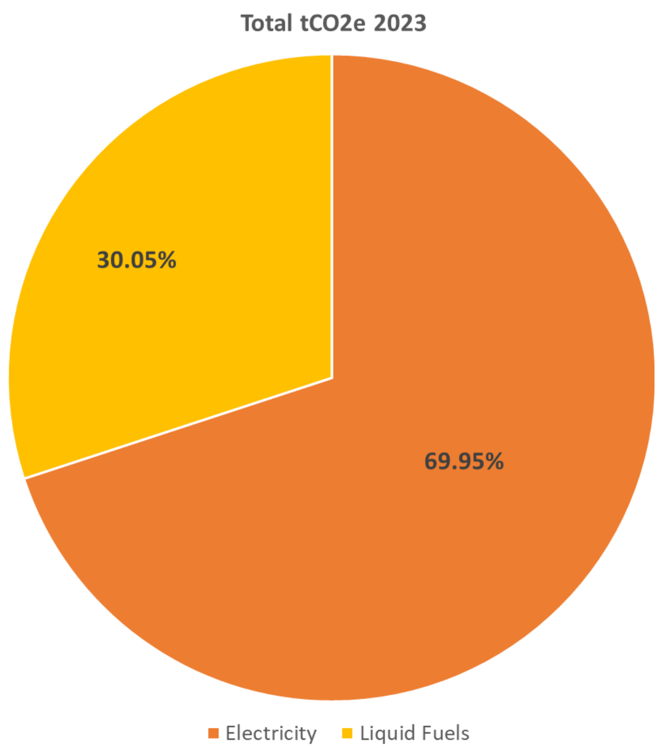
An overview of the current annual usage figures and calculated CO2 equivalent emissions are detailed in this section. Emissions are measured in tonnes of carbon dioxide equivalent (tCO2e) per year.

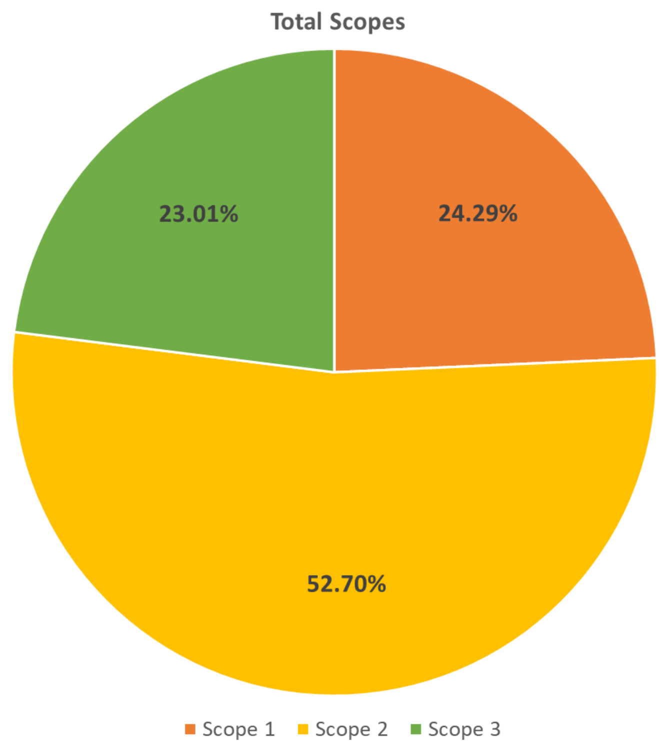
Baseline data – actual usage

2023 actual usage data		
Category	**Resource**	**Units used**
Electricity	Electricity: UK kWh	419,440
Liquid Fuels	Burning oil kWh (Gross CV)	29,891
Diesel vehicles	Vehicle mileage: Miles	83,375
Battery electric vehicles	Vehicle mileage: Miles	28,346

Total tonnes of CO2e calculated for GH Display Ltd is 164.8 tonnes per annum. This is predoniantly from Scope 1 and Scope 2 emissions as scope 3 emissions have only been calculated for emissions associated to the distribution and production of gas and electricity.







Scope 1 emissions are direct emissions from the activities of an organisation or under their control, including fuel combustion on site such as gas boilers and fleet vehicles.

GH Display Ltd's scope 1 emissions are from the oil fired boilers, which provide space and water heating and from company owned, diesel vehicles.

Scope 2 emissions are indirect emissions from electricity, steam and heat purchased and used by the organisation. Emissions are created during the production of the energy and eventually used by the organisation. BEVs emissions are also categorised as Scope 2.

GH Display Ltd's scope 2 emissions are mainly from electricity usage across the buildings and their biggest energy usage is thought to be from manufacturing operations. They also have a BEV (Battery Electric Vehicle). Currently localised energy monitoring is not in place to monitor any specific equipment or manufacturing areas.

They have not yet switched to a green tariff. Current GHG Protocols for reporting scope 2 location based emissions require the organisation to quote the usual scope 2 emissions for electricity supply, even when on a green tariff. This is because the power supplied from the National Grid is generated via various different sources and the proportion of generation from renewable sources varies from day to day. Link here to see daily electricity generation mix - https://grid.iamkate.com/

Although using the Location Based method for calculating scope 2 emissions means that currently no reduction in emissions are reported, signing up to a Green Tariff is helping to drive the industry towards more renewable energy sources.

Scope 3 emissions are indirect emissions from activities of the organisation often occurring from sources that they do not own or control, such as emissions associated with energy source production & distribution, waste, water consumption and the organisation's supply chain. Business travel in vehicles that are not directly owned by the organisation are also classified as scope 3.

GH Display Ltd's reported scope 3 emissions are from electricity and gas generation & distribution, Water and waste emissions are not high and there is already a focus on waste reduction across the organisation.

Scope 3 emissions generated by the organisation's supply chain are outside the scope of this document, but they are intending to focus on measuring these emissions within the next 5 years.

Actual calculated emissions by scope - breakdown

2023	Scope 1	Scope 2	Scope 3	Total	Percent
Electricity	0.00	86.86	28.43	115.29	70%
Liquid Fuels	40.03	0.00	9.48	49.52	30%
Total	**40.03**	**86.86**	**37.92**	**164.80**	**100%**

ELECTRICITY USAGE

Existing Energy Efficiency Measures

As previously mentioned, the organisation have already fitted a solar PV system (with battery) to the roof of the main building and have fitted LED lighting throughout.

To further reduce energy usage, they have pledged to:

- Install local smart meters to track electricity usage for different areas and specific manufacturing equipment, allowing for better monitoring and management of energy consumption.
- Get half hour data for smart meters in order to be able to look for unnecessary out of hours energy usage
- Replace old equipment or electric appliances with more energy-efficient options and / or refurbished options when they come to the end of their useful life.
- Ensure that lights, equipment, and plug sockets are switched off when not in use.
- Initiate a close down procedure for all lighting, equipment and heating system
- Use smart plugs and / or sockets in order to better manage out of hours usage.
- Maintain a culture of energy consciousness among staff, continually monitoring and improving energy usage practices.

Using smart plugs is likely to reduce electricity usage by at least 10%, which should result in further CO2e(t) savings.

Green Tariff

GH Display Ltd are currently not a green tariff scheme, but are looking to switch to one at next contract renewal. Although using the Location Based method for calculating scope 2 emissions means that currently no reduction in emissions are reported, signing up to a Green Tariff is helping to drive the industry towards more renewable energy sources.

LIGHTING

The building already has LED lighting fitted, with motion sensors in all relevant areas.

RENEWABLE ENERGY GENERATION

GH Display Ltd are keen to expand their existing solar PV system in year 1.

Calculations have been carried out that predict that up to 15559kWh per year could be saved by 40 additional solar panels fitted to the existing system on the main building. Estimated savings are shown below and include an emissions reduction of 4.28tCO2e. Batteries have not been included in these calculations, as at the time of writing there are issues with the configuration of the existing solar PV system, but this will be considered in the future if there are people using electricity in the building frequently outside of working hours.

Estimated savings - expansion on existing solar PV system			
Additional savings from new panels	Additional cost savings	Estimated payback (years)	CO2e (t) saving
15559	£ 3,133.56	7.55	4.28

They are also planning to fit an additional solar PV system to the new building in year 4. Calculations have been carried out that predict that up to 25,000kWh per year could be saved by this system. Estimated savings are shown below and include an emissions reduction of 6.93tCO2e.

Solar PV - Additional panels on west roof of the new building						
Possible additional system size (based on roof area)	Estimated annual generation	Estimated cost (March 2024)	Estimated savings from solar (kWh/year)	Estimated cost saving	Estimated payback (years)	CO2e (t) saving
20	17440	£ 26,000.00	13467	£ 2,712.20	9.59	3.70

Solar PV - Additional panels on east roof of the new building						
Possible additional system size (based on roof area)	Estimated annual generation	Estimated cost (March 2024)	Estimated savings from solar (kWh/year)	Estimated cost saving	Estimated payback (years)	CO2e (t) saving
20	16310	£ 26,000.00	12441	£ 2,505.55	10.38	3.42

Solar PV - Additional panels on east & west roof of the new building						
Possible additional system size (based on roof area)	Estimated annual generation	Estimated cost (March 2024)	Estimated savings from solar (kWh/year)	Estimated cost saving	Estimated payback (years)	CO2e (t) saving
40	33750	£ 52,000.00	25196	£ 5,074.47	10.25	6.93

Calculations carried out based on current hours of operation and more detailed calculations may need to be carried out once formal proposals have been received from potential suppliers. Solar PV prices quoted as at July 2024 and based on an average price of £1,300 per kWp. Energy cost saving based on current cost of electricity for the organisation. Payback is based on the solar system installation size to cover the size of suitable roof space. Although the performance of any solar system cannot be guaranteed with certainty due to the variability of the amount of sunlight from year to year, the calculation of estimated generation is based on industry-standard methodologies.

In order to have a solar PV system in an area supplied by UKPN (UK Power Networks - the National Grid) a licence is required. This will ensure that there will be no issues with the grid's capacity to handle solar PV installations in the area. GH Display Ltd are aware of this and will check before installation and ensure that all relevant permissions are sought and approved. A full survey of the roof will also be carried out to check its suitability before any installation is planned.

In addition, they are keen to investigate wind generation as another source of renewable energy and will fit additional renewables in this form if deemed financially and technically viable.

Once half hour data is available for the building, it will be possible to gain more accurate estimates of the amount of generated energy from renewable sources that is likely to be used in the building.

KPIS

GH Display Ltd are already monitoring monthly usage for electricity, via their utility bills.

They already have smart metering installed and will be arranging for half hour data reporting, which will be beneficial in order to more closely monitor electricity usage, including identification of equipment left on outside of working hours. They are also hoping to have separate energy metering for the manufacturing areas and specific manufacturing equipment, so that energy usage can be more closely monitored and analysed.

They are keen to ensure that business mileage continues to be tracked in order to accurately calculate direct / indirect transport mileage and will also be able to more closely monitor vehicle fuel usage when they switch to HVO for all company vehicles. In addition they are considering monitoring driving efficiency using telematics.

Although outside the scope of this document, they are also planning more accurate waste measurement and segregation in order to facilitate waste reduction activities.

As previously mentioned, the organisation have recognised that it would be good to start developing a method for measuring scope 3 Upstream and Downstream emissions within the next 5 years. Collecting data will enable the identification of improvements to reduce these emissions over time.

Longer term, GH Display Ltd are looking to start measuring supply chain data, such as distances travelled for incoming products and other purchased items.

BUILDING DETAILS & FABRIC OF THE BUILDING

There are 4 buildings on site:

Unit 1, where the team carry out their work (office, print and manufacturing). This unit is well insulated and the windows are all double glazed and in good repair. Consequently there is likely to be minimal heat loss through the fabric of the building. In order to further reduce heat loss and solar gain, the organisation are intending to fit heat reflecting blinds to all windows and doors and draft excluders where necessary. This will further reduce heat loss and therefore CO_2e emissions and cost.

Unit 2 is used for storage. This unit has no insulation, but it is not heated.

Unit 3 is also used for storage only and although very basic (no insulation) it is not heated.

Unit 4 is the newest unit with excellent insulation throughout.

HEATING & COOLING SERVICES

Space and water heating for the offices is provided via an oil fired boiler. There are TRVS fitted to radiators currently and the system is managed via a timer

They are keen to switch to low energy electric heating in year 2 - either wall mounted heat pump units for both heating and cooling of the building, or an infrared heating system. Both types of heating, if well maintained and used correctly, are typically between 2 and 3 times more efficient than gas or oil fired boilers, but it is important to ensure continued efficient operation.

To maintain the efficiency of the heating system, they have pledged to:

- Implement a regular maintenance schedule where relevant for. Regular servicing ensures that heating systems operate at peak efficiency, reducing energy consumption and extending their lifespan.
- Regularly inspect of the property to identify any sources of draughts, such as gaps around windows, doors, and other openings.

In addition they will begin researching possible Smart Building Managements Systems in order to efficiently and effectively manage heating & cooling throughout the whole building. Through the use of a BMS, along with fitting thermostats to each room / area, individual room temperatures could be set and adjusted as required. This could also ensure that rooms are adequately heated prior and during use and turned off when not in use, thus saving energy. Sensor controls could also be introduced to identify when rooms are empty so that the heating can be switched off and external temperature sensors could be used to automatically adjust the heating set points of the system (to maximise efficiency). This is an evolving area of technology and new innovations are coming onto the market, so GH Display Ltd will revisit this periodically and look to install when financially viable.

TRANSPORT

The second highest emissions for GH Display Ltd are caused by their direct transport and mainly from diesel vehicles used for logistics, accounting for 40.60tCO2e per year.

In order to significantly reduce transport emissions, they have committed to switching all vehicles to HVO fuel as soon as practical.

This could reduce CO2e emissions by an estimated 36.52tCO2e per year. When completed, this transition would represent a total percentage reduction of nearly 90% from the current transport emissions footprint.

	Total CO2e(t)
Current Diesel fuel	40.60
Biodiesel HVO fuel	4.08
Estimated Saving	36.52

Diesel CO2e figures based on vehicle mileage. HVO CO2e figures based on equivalent estimated fuel volumes.

In addition, it has been recognised that some fuel efficiencies could be achieved via driver behaviour and incentives and the organisation are intending to investigate the introduction of telematics systems to all vehicles to enable the availability of data to facilitate an increase in efficiency.

Telematics systems can report on the fuel economy of specific vehicles. Typical figures from the Energy Saving Trust suggest that through better scheduling, higher productivity and increased vehicle utilisation, operating costs can fall 10%. By covering fewer miles, reducing speeding and improving driving style, fuel use and CO2 emissions can be cut by 15%.

Other technologies may be available in the coming years to improve driving efficiency. These may include technologies to improve aerodynamics and reduce vehicle drag, so GH Display Ltd will continue to research and implement any reasonable options when financially viable.

OTHER MATERIAL FACTORS

There is some manufacturing waste, including timber and there are ongoing initiatives to reduce waste already in place. In addition, GH Display Ltd will start measuring waste volumes in more detail. Tracking the amount of waste generated by the organisation now will help to assess where reductions could be made in the future. They have also pledged to continue monitoring innovations with regards to environmental sustainability in their industry, so that switching to more sustainable items can be continued when available and financially viable.

Supply chain.

Although not yet included in their carbon footprint, the organisation have already pledged to look into measuring the impact of their supply chain within the next 5 years. They will also be looking at reducing their impact by focussing on more sustainable products, sourced from more local suppliers.

Waste management

To help reduce their overall environmental impact, the organisation are keen to:

- Continue, where possible, choosing products and supplies that have minimal packaging and are made from sustainable materials.
- Where possible, continue to favour suppliers who use recycled materials in their packaging and products.
- Where possible, collaborate with brands that have strong environmental credentials. Many such brands offer take-back schemes for packaging, which can further reduce waste.
- Work with local electrical equipment reuse organisations to avoid as much electrical waste being discarded as possible
- Introduce dedicated bins for recycling different types of waste such as paper, plastic, glass, and metal, which will help to identify the types of waste being generated, which in turn can help identify opportunities for waste reduction.
- Reduce Single-Use Plastics, by transitioning to eco-friendly, biodegradable, or reusable alternatives for items like plastic bottles, cups, and bags.
- Educate staff about the importance of waste reduction and proper waste disposal, including displaying informational materials in the organisation to raise awareness and encourage sustainable practices.

Water consumption reduction

GH Display Ltd are looking to:

- Where possible, replace existing faucets with low-flow models to reduce water flow without compromising performance.
- Regularly inspect plumbing for leaks and repair them promptly to prevent water wastage.
- Ensure that all water systems and equipment are well-maintained and operating efficiently.

- Educate both staff and clients on the importance of water conservation. Display signage in the organisation to promote water-saving behaviours.

The call to reduce emissions related to cloud storage has gained momentum in the last year, so GH Display Ltd are intending to start measuring their digital emissions footprint within the next year or so and then monitor this with a view to reducing amount of cloud storage used, or move to a supplier that uses renewable energy to power server systems.

POLICY, GOVERNANCE & EMBEDDING THE PLAN

GH Display Ltd already have an Environmental Sustainability policy, and they are keen to generate a sustainable procurement policy and a sustainable travel policy and once generated, review these policies annually, updating them with any new Net Zero initiatives.

As previously mentioned, having separate metering for the heavy energy usage areas of the building is likely to drive more sustainable practices, such as ensuring equipment and lights are off when not needed.

Keeping up to date with industry initiatives will help to ensure that any improvements with regard to waste management and energy consumption (specialist equipment) are maximised.

They are also committed to registering with an independent Accreditation service in order to maintain momentum with their Net Zero journey and this will help to raise credibility as an environmentally sustainable provider and increase competitiveness in the marketplace. This is likely to lead to further CO2e savings, typically around 10%.

Several activities to aid with embedding Net Zero practices within the organisation and the building will also be introduced:-

- Organising relevant training for employees, including adding Net Zero training to induction processes and procedures, utilising funded support programmes that offer training.
- Appointing one or more Green Champion(s) to be responsible for sustainability/energy management, which will be very beneficial to raising awareness and maintaining momentum.
- Adding the Net-zero action plan to all management meeting agendas and updating it regularly with progress to help ensure that momentum is maintained.
- Adding the sustainability actions and targets that have been agreed and detailed in this document to the strategic business plan and updating these regularly, to help to ensure that net zero and environmental sustainability is considered in all strategic business decisions.

STRATEGIC BUSINESS BENEFITS

For GH Display Ltd, the strategic business benefits of committing to decarbonisation targets and implementing the improvements detailed above are:-

- ✓ Cost savings from energy usage reduction
- ✓ Long term cost savings from vehicle fuels
- ✓ Retention of key customers
- ✓ Reputational advantage over competitors for the business
- ✓ Reputational advantage for sourcing / retaining customers and staff

RISK MANAGEMENT

The main risks for GH Display Ltd for the delivery of this Net Zero Roadmap are financial, as large capital investments are required to significantly impact their CO2e emissions.

There may also be other short term financial risks with regard to the implementation of the long term plan.

It is hoped that Government grants may be available in the future, to help the organisation fulfil their Net Zero plans, but in the absence of this, it is important that financial planning for Net Zero improvements is incorporated into annual budget plans.

There are currently no legal requirements for an SME organisation to be reporting their carbon emissions. However, large organisations are required to have an ESOS Energy Usage Audit carried out by a qualified professional and are also already required by SECR to annually report their environmental impact. It is likely that these requirements will begin to filter down to SMEs and smaller organisations for the government to be able to meet national Net-Zero targets, so planning early for this will reduce the risks of non-compliance in the future.

In the meantime, organisations that would like to supply larger businesses are more likely to win contract bids if they have a fully defined path to Net Zero. Additionally, many consumers now report that they prefer to buy from / deal with environmentally sustainable businesses and employees report that they prefer to work for organisations that are committed to environmental sustainability.

Therefore there could be commercial risks associated with not implementing decarbonisation activities and also issues with employing good quality employees.

COMMUNICATION AND STAKEHOLDER ENGAGEMENT

This document details a 5 year plan for GH Display Ltd to reduce their carbon footprint in order to support the journey to Net Zero by 2050. As such extracts from this document could be used to communicate to customers and other key stakeholders their commitment to Net Zero.

APPENDIX 1 - ACTION PLAN

GH Display Ltd's full Action Plan spreadsheet has been sent with this document.

APPENDIX 2 - HALF HOUR DATA ANALYSIS & SMART BUILDING MANAGEMENT

Half hour data shows electricity readings for every half hour during each 24 hour period. It can therefore be used to identify electricity usage outside of working hours, enabling savings to be made by switching off equipment left on unnecessarily. This can be requested from your electricity supplier if you have a smart meter fitted. Regularly reviewing Half Hour data will allow progress towards improved energy efficiency to be monitored.

Smart building management system (BMS), incorporating relevant sensors to control lighting & heating, and smart sockets to allow the central control of all electricity usage. Smart sockets can be centrally (and remotely) controlled and provide real-time energy consumption data for any device that are plugged into them. This provides immediate insights into which devices or appliances are consuming the most power, enabling facility managers to make informed decisions about their usage patterns.

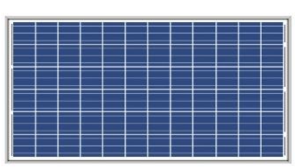
Smart plugs can be considered for key equipment in order to more closely manage out of hours usage. These can often be centrally (and remotely) controlled and provide real-time energy consumption data for any devices that are plugged into them.

APPENDIX 3 - RENEWABLES

Solar

Photo Voltaic cells (PV) convert energy provided by the sun into electricity. There are two main types of solar cells found in most solar arrays, Monocrystalline and Polycrystalline, but more recently, Thin-Film solar cells have entered the market. Each cell has certain advantages and disadvantages, but the core differences are:

Mono – these are the most efficient cells used in solar panel arrays (achieving efficiencies over 20%), due to their single cell structure, and work well in lower light conditions. Additionally, the panels have a solid black finish, which some find more aesthetically pleasing. These panels do come with a higher cost compared to;



Poly – these panels are cheaper to produce than the mono cells, but are less efficient (around 15-17%), due to their multiple cell structure. They still perform well and offer a good return on investment. The arrangement of cells within each panel gives the panel a blueish hue.

Thin-Film – these panels are cheaper than the mono panels and as they are made of a flexible material. They are light weight, portable and can be placed on most surfaces. Designs for these panels have been adapted for buildings with large, glazed facades, as they can generate electricity well, even at lower light conditions. However, the film is less efficient than the poly cells (around 11%) and are better suited for buildings where standard panels are difficult to install.

As the cost of solar PV has dropped significantly since they first entered the market, most installations now would consider Mono panels as they are the more efficient of the two, and the price difference is now negligible. Improvements in design now also allow for high capacity panels to be installed, upwards from 350W.

For large installations, such as solar farms, poly panels may be recommended as the larger surface areas allows for adequate energy generation, while the cheaper cost helps to keep the installation costs lower.

For high rise buildings without sufficient roof space, thin film panels are best suited as they can be placed on most surfaces. Additionally, buildings with weaker roofs or roof spaces that are not suitable to house a large panel array would also benefit from the thin film panels due to their lightweight design.

Wind Turbines

Wind across the UK varies significantly by region, but there is some wind across all parts of the UK. Wind has the potential to offer a good source of renewable energy, but the installation of a wind turbine is complex and there are a wide variety of factors that need to be considered before pursuing this as an option. These do include how much wind blows through the area, and how high does a turbine need to be placed to avoid turbulence from buildings, trees, or other structures.

Turbines operate most efficiently when there is continuous wind at over 6-7 m/s. The higher a turbine is placed, the easier it is for winds to reach these speeds as they are not impacted by turbulence and other tall standing objects, trees, buildings, etc. However, the higher the pole for the turbine, the higher the cost and difficulty in installing the turbine, including planning permission. To understand whether this technology is suitable for the site, it is recommended that an MCS certified installer carries out a series of tests, including wind speed tests, to determine if an installation is possible, and what size turbine would be available.

As an example, a 10kW solar PV system would generate approximately 8-9,000kWh per annum, subject to sun levels, costing around £9,000 – so the ratio is 1-1; £1 cost for every 1kWh produced. A 10kW wind turbine would produce around 22,000kWh, but cost around £40,000 – so the ratio is doubled, £2 cost for every 1kWh produced.

The main difference is that solar is best during summer, whereas wind is all year round so there is better opportunity to utilise more of the energy. However, most business operate during the day while the sun is shining, whereas wind could blow at any time, even at night when the business does not need the energy. If a wind system is considered, it would be worth considering battery storage as well.

While wind systems can be installed at roof level, these often do not perform as expected, and there are only a handful of locations where this system would operate effectively.

Battery Storage

Whichever renewable option is chosen, one of the biggest challenges for renewable energy generation is the difference between times when energy is generated and when it is used. For most domestic settings, energy from solar is generated during the day when the house is empty, and energy is used at night when there is no generation, whereas most businesses operate during daylight hours and therefore often do not benefit from the same energy shifting, particularly during winter months when daylight hours are shorter.

However, wind energy is sporadic with wind blowing throughout the year and throughout a day. While wind is typically better during winter, there is still wind throughout the year. The complication however, is there is no control over when the wind blows. As such, energy shifting does become more attractive when the storage is coupled against a wind system.

There are a variety of battery types, each offering different energy profiles and solutions. Lithium-ion batteries are the most common battery storage type and often come with 10-year warranty. A battery system's longevity is rated in cycles, so the life of the system depends on how frequently the system is cycled – one cycle is equivalent to one period of discharge and recharging of the battery. The deeper the discharge, before it is recharged again, the shorter the lifespan. On average, most systems are rated for around 3,000 - 10,000 cycles so how long the battery system lasts for in years, is improved if the system is operated as efficiently as possible, to maximise the lifespan.

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For renewables, providing the UK Energy Grid can receive export energy, excess energy can be exported back into the Grid and the generator receives a fee per kWh that is exported. This falls under the Smart Export Guarantee. These rates will vary between different energy companies but the average price per kWh is around 15p/kWh exported. However, the cost paid per kWh often exceeds 24p/kWh (at time of writing). Therefore, capturing the excess generated energy within a battery storage system to be used on site offers a greater cost saving than exporting to the Grid.

It is important to note that solar and wind systems have a 20-25 year lifespan while the current battery system only has around 10-12 years. As such, the battery system will have to be replaced at least once throughout the lifetime of the total system. This will significantly increase the life-cycle cost of this type of arrangement and needs to be factored in. As a result, shifting the energy is best placed where the system can be used all year round. This does limit the application with some solar arrays, as the need for shifted energy in winter is reduced, further impacting the return on investment.

The size of the system should be determined by the energy demand of the building. This could be based on the load the battery needs to support, or with renewables, outside of renewable generating periods understanding how much additional energy needs to be shifted. This should be carried out by an installer when selecting the system. Additionally, it is important to consider all changes to the building first before installing or seeking the assessment. For example, switching from gas to a GSHP will shift energy demand from gas to electricity, thus increasing the electricity demand, impacting on the size of the battery storage needed. This is similarly the case for businesses looking to expand electric fleets.

Where the system is being used as support, rather than strict energy shifting, and the electricity is charged a variable rate, such as day and night rates, the battery storage system can be charged by the night, when the rate is lowest, and discharged the energy during the day when the rate is highest. This helps to balance the costs when utilising the technology in this way.

APPENDIX 4 - HEATING & COOLING

When providing heat to a building, there are a number of low carbon, low energy heating options to consider. However, the most efficient system needs to match the building in terms of fabric and design, as well as being fit for purpose by matching the use of the building.

When considering future options for a building, it is also important to consider the source of energy for the building. For buildings that use oil or gas to provide space heating, the process is carbon intensive due to inefficiencies within the heating process. Switching to an energy source with lower carbon emissions or improved efficiencies will help the reduce the carbon footprint of activities on site.

The best alternative option to move away from fossil fuels is to switch to electricity, as electricity can be generated from renewable sources. However, it should be noted that there is currently a large price difference between the cost of electricity and fossil fuels. This is likely to change as the UK transitions away from fossil fuels, but there is no clear pathway how, or when, this will happen.

Switching to electric, therefore, will offer good carbon savings, but financial savings may be limited and, in some cases, may even be negative. This can be offset by the reduced cost of servicing and better longevity of systems, but that will depend on the maintenance schedule of existing systems against the difference in cost.

Heating options:

- Ground Source Heat Pump (GSHP) / Air Source Heat Pump (ASHP)
- Air conditioning
- Infrared heating

Cooling options:

- Air conditioning
- Evaporative coolers, natural ventilation systems or green building alterations

The heating options will reduce the amount of energy used and associated carbon.

Ground Source or Air Source Heat Pumps

Heat pumps use latent heat from an external source through a heat exchanger to provide low carbon heating to a building. Ground source heat pumps (GSHP) source this heat through the ground (or water), where air source heat pumps (ASHP) source this heat from the air. Obtaining heat from the air has a difference in performance compared to obtaining heat from the ground. This is because the air temperature fluctuates continuously and at times where peak heat is needed, the air is at its coldest. In these situations, an ASHP system will use more electrical energy to 'boost' the temperature. As the ground temperature is more stable, only changing by a few degrees as whole seasons change, a GSHP system is the more efficient of the two.

However, while more efficient, the installation of a GSHP is more complex and carries a much greater installation cost in comparison to an ASHP. To extract enough latent heat from the ground, GSHPs require long lines of pipe to be run through the ground, so the refrigerant can pick up the heat needed. To lay these pipes there are two options, depending on the available space, and type and condition of the soil / ground.

1. Where there is enough space and the condition of the ground is suitable, the cheapest option is to dig out a long trench that is roughly 2m wide and 1.5m deep. The size / length of the trench will depend on the type of pipe configuration, size of plant, and type and condition of soil in which it is buried.
2. Where space is limited or the ground is not suitable for trenching, boreholes need to be dug to lay the piping vertically. This increases the costs of installation significantly and multiple holes may need to be dug, depending on the size of the system.

As such, GSHP are best suited for buildings with wide open space available to them or a water source and would not typically be recommended for buildings in built-up urban areas with hard ground in their immediate surroundings.

ASHPs in contrast are very easy to install, as the plant can be installed externally, and depending on size could either be attached to the building or within a purpose built cage / housing (to prevent tampering or damage).

Sizing of the units and the installation is vital in achieving the most effective and efficient solution. Typically, it is recommended that heat pumps are sized to accommodate between 60-80% of the buildings total heat load. This allows the heat pump to operate at its most effective whilst providing most of the heat needed for the building over the colder season.

Modern buildings or buildings that are well insulated require less energy to heat as the building's thermal performance minimises how much heat is lost through the building fabric. These are ideal for heat pumps as the building will retain most of the heat energy released within, and an 80% load will provide enough energy to heat the building comfortably.

For older or more 'porous' buildings where retaining heat is problematic, a secondary heating system may be required to top-up or boost heating levels on the coldest days. The heat pump will still provide the baseload so for most days, this would be adequate, but on the coldest days a secondary system will increase the heat load to maintain an adequate internal temperature.

This is known as a 'Hybrid' heating system and would typically utilise a small, fossil fuel boiler, to be used to provide heat only on days where it is needed most, minimising the carbon emissions for the heating system overall.

The reason for this is that heat pumps are Low Temperature Heating Systems (LTHS). Standard boilers and central heating systems operate at temperatures between 60°C and 90°C. Heat Pumps operate at temperatures between 30° and 45°C with some systems being able to reach up to around 60°C or 65°C if conditions allow, although this makes them less efficient. Due to this drop in temperature, a GSHP / ASHP cannot replace an existing boiler system directly, as the 'standard' distribution of heat is not suitable for such low temperatures.

The delivery system will, therefore, need to be designed accordingly:

1. Underfloor heating. This is the optimal solution for delivery of heat through a LTHS, as it provides the largest surface area to heat a room and the thermal mass of the floor manages and radiates the heat slowly throughout the day. This is, however, the most expensive retrofit solution and is best designed

at new build to keep costs low. It is also only beneficial in buildings where heat is continuously needed for several hours.

2. Low temperature radiators. Due to the low heat output, a low temperature radiator needs to be sized accordingly to the room and heat requirements. A drop of 20°C in output temperature would require an increased emitter surface of 30 to 40 percent to provide the same heat output. Where an existing ‘wet’ system is in situ, the size of piping may also need to be adapted to ensure loss of temperature through the pipes is reduced wherever possible. The increase in emitter size could either require larger radiators or the installation of more radiators in a room.
3. Air blowers. GSHP and ASHPs can be adapted to blow hot air throughout different rooms, the same way an air conditioning system would deliver heat. Most air conditioning systems operate using ASHP technology in this way. This option is typically suggested for buildings that do not already have a ‘wet’ system, less efficient buildings, or buildings that also require cooling.

For buildings that solely use electrical heating where there is no existing ‘wet’ system to provide central heating throughout the building, introducing a ‘wet’ system, either through underfloor heating or radiator type heating will further increase installation costs.

Heat pumps were eligible to receive Renewable Heat Incentive (RHI) payments but this scheme was closed to non-domestic systems in March 2021, and will be closing to domestic installations in March 2022. The UK Government is set to release grants for ASHP and for GSHP towards the installation of heat pumps under the Boiler Upgrade Scheme (BUS). This will run for three years until 2025 and is limited to sizes under 45kWth.

Air Conditioning / ASHP

Air conditioning is typically used to cool buildings or areas. However, some air conditioning systems contain air source heat pumps so the process can be reversed, and heat can be delivered into a building. In winter, the system extracts latent heat energy from the external air through a heat exchanger, delivering the warm inside through an internal unit. During the summer months, the process is reversed where the latent heat inside the room is removed and expelled externally, leaving cooler air inside.

Modern heat pumps use heat recovery technology to further improve efficiencies, particularly during winter months. Using an air-to-air heat pump is an efficient method to deliver heat into a building. To find an air conditioning system that is more environmentally friendly and energy-efficient, you should check the energy efficiency ratio (EER). This is the ratio between the cooling capacity, in British Thermal Units (BTU) per hour, and the power input, in watts. The higher the EER, the more energy-efficient the air conditioner. The addition of using the technology to cool the premises will increase the amount of energy used overall, but the improved efficiencies in heating will offset the increased energy for cooling. However, it is still strongly recommended that cooling is not used unless absolutely necessary.

It is also likely that these systems will not fall part of the Boiler Scheme Upgrade (BUS) and will therefore not be eligible to receive any grants or subsidised funding, although it is worth keeping an eye on new Government funding schemes.

Infrared Heating

Infrared heaters are electric heating panels that can be installed very easily in most places. They work off the principle of radiative heating, which heats thermal mass directly (floors, walls, tables, even people) which absorbs the heat energy and radiates it back out into the room. This provides a more uniform method of heating that does not rely on air temperature to deliver the heat.

Convection heating works by heating the air, which is a poor conductor of heat. As the air heats up, it rises to the ceiling and gradually sinks as warmer air moves above it. Additionally, warm air always seeks to escape to colder environments, so gaps in building fabric or opening of doors / windows allows the warm air to escape, requiring additional energy to heat the incoming colder air back to required temperatures.

There are three types of heating panels available, Short Wave, Medium Wave (picture left) and Long Wave (picture below). The variances in wavelength allow the panels to perform in different settings. Short Wave panels are intense high heat systems ideal for external settings such as patios. Medium Wave panels are medium heat, ideal for high ceilings or warehouse settings with a high degree of air movement. Long Wave panels are low heat systems, ideal for office or domestic settings.

Infrared is adept at zonal heating, where heating is only needed for an individual working within an area, this could be a workstation in a warehouse or factory, and not whole building. Infrared can also be used to provide space heating, for example in domestic/office settings, by warming the thermal mass of the room/building. While this method of delivery takes longer to heat compared to the zoned heating, as the room will need to warm up first, the process still uses much less energy compared to a standard convection system and can deliver the same level of thermal comfort.

For buildings with problematic heating areas, such as desks near windows, reception desks by front doors, etc or where heat retention is difficult, infrared is ideal as secondary heat source. The process of heating, as described above, means the panel can warm the individual directly using minimal energy without continuously fighting the loss of heated air through opened doors or windows.

For buildings that require dynamic heating, such as sports halls, changing rooms, etc., where heat is only needed for short periods or different heating requirements are needed by different user groups, infrared heating offers a versatile heating option that can sit alongside the existing heating system. Where heat is needed for only 1-2 hours and then not needed again, IR panels can be attached to push button timers where groups or staff can turn the system on to run for 1-2 hours. Once complete, the system switches off and no energy is wasted trying to heat the whole room.

Subsequently, if the heat for the room is needed for several hours, the existing system can then be used. This allows for a much more adaptive heating system that meets the heating needs of the building in a range of different scenarios.

Alternative Cooling

As a general principle, air conditioning units use 1kW of electrical energy to remove / generate around 3-4kW of thermal energy. The larger the temperature difference, the worse this efficiency becomes. Air conditioning systems can still therefore, consume a significant amount of energy, especially where cooling was not present before and is an added electrical load. In buildings where cooling is needed for specific reasons, such as process, servers, etc. AC systems should be considered as they are best at controlling the temperature and maintaining required temperatures.

For all other buildings where cooling is being considered, there are low energy alternative options available, each with its own advantages and disadvantages.

Fans

Ceiling fans are the cheapest and easiest to install. Also known as destratification fans, they work by pulling the air up into the ceiling, moving air around and into the building, and through the process of evaporation, the skin is cooled as the air moves over it.

Desk fans work similarly by moving air around but bladeless fans are extremely efficient and effective at moving air around a room to create the same effect but are an expensive purchase.

Evaporative coolers

Evaporative coolers work off the principle of evaporation, to cool the air as it is blown around, and these systems work in conjunction with a water source. As the water evaporates, cooling the air, the cooled air is then blown around the room. These coolers are very efficient and work well on warm dry days. However, it is not possible to set a temperature and the cooling effect is only as good as the level of humidity.

When the air is humid, there is a saturation of water in the air which prevents more water from evaporating. In these conditions, the units do not cool an individual down as much. This is where an air conditioning unit does have an edge. Additionally, these systems require open windows as the cool air is water heavy and with closed windows, will lead to moisture building on surfaces and eventually damp.

Hot Water

Switching from a fossil fuel system to an electric system changes how heat is delivered into the building. Most fossil fuel systems provide both heating and hot water, either through a combi boiler or a more traditional water tank system. Depending on the electric heating system chosen, the supply of hot water will need to be assessed.

Shifting to electric heating that does not utilise a 'wet' central heating system will completely remove the ability to heat water within the same system. If the switch is to a heat pump that will continue to deliver heat through the existing 'wet' system, then it is possible to include hot water as part of this system. However, heat pumps are low temperature systems which are most efficient producing temperatures around 45°C. Hot water needs to be maintained at levels over 55°C, with most systems maintaining around 60-65°C to remove the risk of bacteria, such as legionella.

Including hot water within a heat pump system does have an impact on the overall installation. The heat pump will need to be sized accordingly, increasing the size of the system and adding to overall installation costs. Additionally, the need to heat the water to these temperatures will affect the efficiency of the system as well. A such, it may be worth considering separating the hot water system to an electric system.

Where large volumes of water are needed, the District Hot Water (DHW) network can be maintained by replacing / installing a large electrically powered immersion water tank. This is ideal for sites that use hot water for process, washdowns, etc. or have shower facilities or high staff numbers. For buildings where hot water use is minimal, point of use water heaters can be considered. These are small 10-15 litre tanks installed under or close to kitchen and/or bathroom sinks.

Where hot water is rarely used, thought could also be given to an instant hot water tap. These do not store water and provide instant hot water by rapidly heating water as the tap turns on. These are very efficient systems and are ideal for locations that do not require hot water in any significant volume.

APPENDIX 5 - TELEMATICS AND DRIVING PRACTICES

Achieving lower fuel use as a result of lower mileage is just one of the benefits of telematics. In addition, systems can report on the fuel economy of specific vehicles.

In one study of company car drivers, a telematics system identified a 50% difference in fuel economy being achieved in identical cars over similar journeys. Much of the excess fuel use was down to driving style, including excessive speed and harsh acceleration.

By having more accurate, vehicle-specific data, a company can quickly identify where action needs to be taken, such as with driver training. Furthermore, by improving fuel economy and reducing time spent idling, a business can ensure it reduces its total carbon emissions.

Telematics can ensure managers know where vehicles are being driven and how they are being used. This may benefit the business in a number of ways. Automatic mileage updates can be received by managers or suppliers, such as leasing companies, to enable proactive servicing and timely replacement of vehicles. In addition, tracking systems are able to identify a vehicle's location, so the right vehicle and employee can be sent to the closest job. Furthermore, typical journey patterns can be monitored and reviewed to establish the most efficient route.

Telematics could help automate manual and time-consuming processes, such as timesheets, to make them more accurate and reduce paperwork. The system will automatically log vehicle use and location along with the start and end of the working day. This information can then be imported into payroll systems.

Typical figures suggest that through better scheduling, higher productivity and increased vehicle utilisation, operating costs can fall 10%. By covering fewer miles, reducing speeding and improving driving style, fuel use and CO_2 emissions can be cut by 15%.

A vehicle tracking system isn't just a one-box solution, as it can provide a myriad of reports and charts that can go into minute detail or just provide a graphical overview of key issues related to fleet use. If fleet managers choose wisely, they will have absolute clarity on their fleet. Choose poorly and information will be irrelevant, too detailed to use or in such great volumes that any benefit is lost in a sea of figures.

The data that a telematics system can provide comes from three key sources. The first is from GPS data, which calculates location and speed, the second is from a direct link to the vehicle that delivers information on any aspect of performance it is collecting, which can include oil temperature and even whether doors are open. Third, some systems have sensitive instruments that measure g-force to identify harsh braking, steering and acceleration.

Extracts from A Guide To Telematics from the Energy Saving Trust - https://www.energysavingtrust.org.uk/sites/default/files/Telematics.pdf

APPENDIX 6 - BUILDING MANAGEMENT SYSTEMS

Through the use of a BMS, along with fitting thermostats to each room / area, individual room temperatures could be set and adjusted as required. This could also ensure that rooms are adequately heated prior and during use and turned off when not in use. Sensor controls could also be introduced to identify when rooms are empty so that the heating can be switched off and external temperature sensors could be used to automatically adjust the heating set points of the system (to maximise efficiency). This is an evolving area of technology and new innovations are coming onto the market, so it is worth revisiting this periodically.

The Heat Network Efficiency programme recommends the installation of a building management system for heating. Whilst it is difficult to offer specific energy savings from implementing such a system, our experience is that having central control and good quality data on a heating system can:-

Give the building manager oversite as to how the system is running so that they can assess performance and make changes, remotely if required

- Make it easier to identify errors and issues in the system
- Highlight potential maintenance requirements
- Monitor how hard the system is working – if a heating system is overworked, it will not last as long
- Give the ability to centrally control when heating is on in specific areas, thus saving energy
- Allow multiple systems to be tied together
- Enable alerts for when the heating is on when it doesn't need to be
- Identify conflicting systems in operation – for example air-conditioning on when heating is on
- Reduce the amount of physical resource required to manage and maintain the system

Modern BMS can link to scheduling systems and automatically control heating in function rooms based on bookings, which may also be beneficial for parts of the heating system in this building.

Smart building management system (BMS) can also incorporate relevant sensors to control lighting, and smart sockets can be added to allow the central control of all electricity usage. Smart sockets can be centrally (and remotely) controlled and provide real-time energy consumption data for any device that are plugged into them. This provides immediate insights into which devices or appliances are consuming the most power, enabling facility managers to make informed decisions about their usage patterns.

Smart plugs can be considered for key equipment in order to more closely manage out of hours usage. These can often be centrally (and remotely) controlled and provide real-time energy consumption data for any devices that are plugged into them.

APPENDIX 7 - LIGHTING

Traditional lighting, such as fluorescents or high intensity discharge lights used in floodlighting use a significant amount of energy to produce light, but a large proportion of that energy is converted in heat which is wasted. Additionally, the light generated is omni-directional, meaning the light is scattered in all directions, and only around 30-40% of the light generated is focused on the target area. To compensate, most light fittings include reflectors to help reflect as much of the light as possible towards the target area.

LED lighting, however, uses around half the amount of energy to produce the same level of light (referred to as LUX), and produces significantly less heat making the system more efficient. Additionally, due to how the systems are developed, a larger proportion of the LUX generated is focused towards the target area, which aids in reducing the amount of energy needed to achieve the same / similar LUX levels.

Lighting is inherently a very inefficient way to use energy. As such, the most efficient light is one that is not switched on. Manually controlling lighting is ideal, however, in a public space where limitations to fully engage with users to ensure lights are controlled properly exist, the use of sensors can help to manage lighting and ensure it is used as efficiently as the system allows.

There are two sensor types that can be employed to individual lights or lighting circuits:

- Movement (PIR) sensors are well known and typically used in toilets, kitchens, etc., any area where movement is minimal, but lighting is needed when the area is occupied. These are set to timers, so lighting is on for as long as there is movement. Once the room is unoccupied, lighting will remain on until the timer ends.

- Light (LUX) sensors are less known but are especially useful sensors in bright areas that receive a good amount of natural light. LUX sensors measure the amount of light within an area and adjust the amount of artificial light to only use as much as is necessary. This minimises the amount of energy used when a light system is switched on.

Conducting an internal review of how lighting is used, and then installing appropriate controls is strongly recommended. This should consider:

- Lights near windows or areas of high natural lighting that could be altered
- Lights in low movement areas

Use natural light to provide the baseload of LUX, with the additional needs provided by artificial light. Lights that are near windows which receive natural light are prime areas for this. Often, lights are switched on to account for part of the room that is not near windows, while the lights near windows may not need to be on. Using LUX sensors on these prime light sources ensures lighting is balanced across the room, using various levels of artificial light where required.

Areas, such as kitchens, toilets, entrances, etc., which require light as people move through them but are accessed less than 50% of an entire day are prime areas for sensor lighting. Timers can also be adjusted to manage how quickly lights turn off.

Please note that mechanical lighting helps control how lights are used once switched on, but all lights will still require manual control in switching them off at the end of the day, unless smart controls are in place to manage this automatically.

APPENDIX 8 - IMPROVING THE FABRIC OF THE BUILDING

Building fabric refers to the materials and structure of a building and includes the walls, windows, doors, roof, floor, etc. Different materials have different insulative properties and insulation is added to all facets of a building to improve thermal efficiency by reducing / slowing the dissipation of heat through the materials. Insulation is designed to limit conduction and radiation of heat through the different layers of building fabric. Insulation also helps to seal gaps that air would otherwise escape through.

When retrofitting older buildings to reduce the energy demand, focusing on the building fabric first helps to ensure that heating systems within the building operate efficiently. However, building fabric is often the costliest element of improvement and while all improvements help to minimise the loss of heat, not all areas carry enough energy savings to warrant the cost in terms of payback.

It is also vital during any planning of such work that ventilation is also considered as improvements to the insulative properties of a building must also incur improvements to the ventilation of the building. Where insulation is added without adequate ventilation, buildings become hotter, leading to increased risk of condensation and damp developing. Managing the ventilation with the improvements ensures the appropriate level of air flow is achieved to minimise this risk from developing.

When insulating a property, it is important to minimise any breaks within the insulation layer, these breaks are referred to as thermal bridging. This is where the materials of the building fabric allow heat to pass through material and circumvent the insulation. The best approach to insulating a building is to completely wrap the building. This offers the best performance, but comes at a significantly higher cost, particularly as a retrofit.

As warm air rises, ceilings are one of the largest areas of heat loss. Walls are another significant element as well, followed by ventilation, then windows, doors and floors. Ventilation is often a hidden cause of heat loss as the building needs to breathe in order to manage the internal environment, but as air changes, the heat generated internally is lost to the outside. As such, as building fabric improves, mechanical ventilation is often considered to manage the flow of air whilst utilising heat recovery technology to capture the heat and use it to warm incoming air.

In terms of improvements, costs vary significantly depending on what is needed. It is also important to note that walls, roofs and floors make up most of the building fabric. The ease to which insulation can be added impacts installation costs. As such, roof insulation is typically one of the easiest options and has a relatively good return on investment. Walls carry a range of complications and unintended consequences that need to be addressed both before and during installation. Floors are another challenging area, depending on the design and materials used.

Windows and doors are often a quick win, but the cost of glass is expensive and as these elements often make up the smallest proportion of the building's total fabric, often do not realise good energy savings, and do not payback within the products lifetime. However, improving windows and doors offers much in the way of improved thermal comfort for those using the building, making the changes more justifiable.

Roof insulation

Roofs can be insulated in one of two ways, referred to as a hot roof and a cold roof. A hot roof is where the insulation is added directly to the pitched ceiling. For a flat roof, the insulation is added above the rafters, immediately before the external element of the fabric. This is often seen as the most efficient option, but does carry a slightly higher cost. A cold roof is where the insulation is added above the ceiling, between the rafters. This is the same for a flat roof. This method can lead to some thermal bridging, which is why it is seen as slightly less efficient, but is the cheaper of the two. Overall, both options offer similar paybacks relative to the cost and energy saved.

For flat roofs, it is recommended to consider a hot roof over a cold roof as a better option for thermal performance and reducing / minimising potential for damp or condensation.

Wall insulation

Solid brick/stone walls offer a great opportunity for energy savings, but at added cost. There are two possible methods to use to insulate, external wall insulation and internal wall insulation. There are advantages and disadvantages to each option and these need to be assessed prior to any decision, and are based on the condition of the wall, whether there is any damp, building restrictions, etc. Overall, external wall insulation does have the potential to offer better performance, but will come at a much higher price, especially if the building is more than one storey high.

Cavity walls were more common and used almost entirely from the 1920's, but were not insulated until changes were made in the 1960's to improve thermal performance of buildings. It is possible to add insulation into a cavity wall, but it should be noted that the gap between the wall helps the building to breathe. Any changes can have effects on the overall performance of the building and must therefore only be conducted by a suitably qualified installer.

More importantly, however, is that with such a small gap (around 50mm), there is a limitation as to how much insulation can be added. Whilst adding insulation will improve the overall performance, it will not improve the wall comparable to modern standards. It is possible to add external or internal wall insulation, but, like solid brick walls, doing so creates another set of considerations that need to be assessed, plus will come at higher costs.

For more information, a very informative website that explains the process and considerations well is:

Insulating a Wall: What You Need to Know | Homebuilding

Floors

Insulating floors can be very tricky and will depend on the type of floor you have. Floors are often an area to consider last (after walls and roofs, and even glazing). However, it is still an area that needs to be assessed as part of a whole building approach. Insulating floors should also be considered where large renovation works are being undertaken that requires the floor to be dug up.

For more information on floor insulation:

Insulating Floors: What Insulation Do I Need? | Homebuilding

Glazing

Windows and doors make up the smallest element of a building's total fabric. However, improving windows and doors can make a significant difference to a building's thermal performance. Glass is the weakest point of thermal control as it is a very poor insulator. Additionally, depending on orientation, sunlight can enter through windows increasing solar gain and the temperature of rooms during the summer. Windows and doors also contribute to ventilation of a building, and improving these elements helps to reduce draughts and improve the air tightness of a building.

From a cost perspective, the difference in performance between double glazing and triple glazing is nominal, but the price difference is not. Triple glazing is significantly more costly and with reduced potential savings, will offer no payback at all. Replacing single glazing windows with triple glazing could be considered given the large differences in thermal performance, but this does need to be balanced against the performance of the overall building.

As such, triple glazing offers the best thermal performance, but the decision to switch to this type of glazing will need to be made against carbon performance and overall thermal comfort, and not against financial costs. Typically, unless you have single glazing windows, replacement of windows is only recommended when the existing units have failed and need full replacement. Ideally, 16mm+ glazing units should be chosen and it is recommended that windows are coated, which is now required within the building regulations, to reduce solar gain. You can fit air filled or argon filled double glazed windows – argon filled gives better heat loss results. A soft coat, low E film on the glass also further reduces heat loss. In fact it reflects heat away from the windows on both the outside (useful to reduce room temperature in summer) and on the inside (useful for keeping heat in).

Where windows don't need replacing but the rooms experience significant solar gain and are very hot in the summer, it is possible to help improve the performance of windows through the use of films. Window film is thin laminate film that is applied to the interior of the glass. The films can be treated in a variety of ways to offer different solutions to different building needs. Mostly, however, window films help to improve the thermal transmittance of glass by reflecting the suns heat (radiation) while still allowing light to enter a room. Films have been shown to reduce solar gain by around 85%.

Films come in a variety of opaqueness, from being clear to being completely reflective and with different tints, films can be applied to provide or meet different levels of aesthetics as may be required for the building.

Seals in windows and doors are known to fail with time due to expansion and contraction in heat, cold, and friction from opening and closing, etc. Seals are vital as they help prevent air leaking between the frame and the door or window. Annual checks should be conducted for all windows and doors across the building, as seals can be replaced easily and will help to reduce draughts and the unnecessary loss of heat.

It is important to note that if significant changes are made to the insulation of a building and heat loss is dramatically reduced, the heating system may become less efficient. This is because heating systems are specified based on the maximum energy required to heat a building on the coldest day of the year. A boiler capable of generating 30kWh of power per day, will not run as efficiently if the required power per day (after improvements) is halved.

Other useful links

Energy saving Trust

https://energysavingtrust.org.uk/energy-at-home/reducing-home-heat-loss/

https://energysavingtrust.org.uk/advice/windows-and-doors/

https://energysavingtrust.org.uk/advice/cavity-wall-insulation/

https://energysavingtrust.org.uk/advice/solid-wall-insulation/

https://energysavingtrust.org.uk/advice/floor-insulation/

https://energysavingtrust.org.uk/advice/roof-and-loft-insulation/

https://energysavingtrust.org.uk/advice/draught-proofing/

APPENDIX 9 - USEFUL LINKS

GOV.UK Energy Efficiency For Businesses website - https://businessenergyefficiency.campaign.gov.uk/

SME guide to Energy Efficiency - https://assets.publishing.service.gov.uk/media/5a80e7a340f0b62305b8dce7/DECC_advice_guide.pdf

UK Energy Regulator - https://www.ofgem.gov.uk/

Small business energy bills advice - https://www.citizensadvice.org.uk/consumer/energy/energy-supply/your-small-businesss-energy-supply/your-small-business-cant-afford-its-energy-bills/

EU Digital Emissions calculator - https://www.digitalcarbonfootprint.eu/

GHG Scope 2 Protocol update - https://ghgprotocol.org/sites/default/files/Scope2_ExecSum_Final.pdf

GHG Protocol Scope 3 guidance - https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf - Upstream and Downstream emissions guidance on page 29, section 5.3

Federation of small businesses - https://www.fsb.org.uk/

Industrial Energy Transformation Fund - https://www.gov.uk/government/publications/industrial-energy-transformation-fund-ietf-phase-3-spring-2024

Workplace charging points grant - https://www.find-government-grants.service.gov.uk/grants/workplace-charging-scheme-2

Energy Saving Trust Transport grants - https://energysavingtrust.org.uk/business/transport/funding/

Some useful tips here to reduce your digital emissions - https://sustainableict.blog.gov.uk/2023/04/27/three-steps-to-becoming-a-digital-superhero/

Current standards for carbon accounting including carbon neutral – these are costed:

https://www.iso.org/standard/43279.html

https://www.iso.org/standard/66453.html

https://www.bsigroup.com/en-GB/capabilities/environment/pas-2060-carbon-neutrality/

Science based target guidance and support:

Science Based Targets Initiative - https://sciencebasedtargets.org/

Online carbon calculators:

https://www.carbontrust.com/our-work-and-impact/guides-reports-and-tools/sme-carbon-footprint-calculator

https://smeclimatehub.org/start-measuring/

APPENDIX X - FURTHER SUPPORT

For further funded business support, contact the Growth Hub - enquiries@growthworks.uk