Mitsubishi Electric Guide to Operational Carbon in New and Existing Buildings

Information Guide 83

Mitsubishi Electric Guide to Operational Carbon in New and Existing Buildings

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This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today.

This guide accompanies a series of seminars, all of which are CPD certified.

Contents

Background

In 2019, the UK government established a global precedent by setting a legally binding target to achieve Net Zero national greenhouse gas emissions[1] by 2050. The whole UK economy is impacted by this target, from industry to transport and finance. The national goal requires every sector to reduce its carbon footprint, including the built environment.

In some ways, the UK is progressing toward its 2050 Net Zero objective. The Climate Change Committee (CCC) oversees and advises the government on carbon reduction policies and progress. It reported in June[2] 2023 that UK emissions have been falling steadily over the last three decades. We are also 'likely' to have met our most recent carbon budget (the third), which ran from 2018 to 2022, although final figures will not be available until 2024.

However, the CCC warned that the UK cannot rely on past success to carry it into a low-carbon future. A considerable proportion of progress has been due to the 'greening' of our electricity generation as the UK shifted away from coal and increased wind generation. This cannot continue to be the only driver. Therefore, carbon reduction targets for all sectors will become more challenging in the next carbon budget.

The CCC notes: "If we exclude emissions from electricity supply, which have driven the bulk of the reductions (since 2014) emissions fell by only 36 $MtCO_2e$ to 360 $MtCO_2e$, an average reduction of over 1.2% per year."

If the UK is to stay within its next carbon budget (which ends in 2030), then the average carbon reduction rate must reach at least 4.7% per year. This four-fold increase in the carbon reduction rate means that we cannot rely on decarbonising electricity generation alone. The CCC highlights that in the built environment, the rate of carbon reduction "needs to accelerate by a factor of two or three."

Several mechanisms are being used to drive improvements in building carbon performance. For example, the Building Regulations Part L (2021) sets lower carbon targets for new buildings than in previous years.

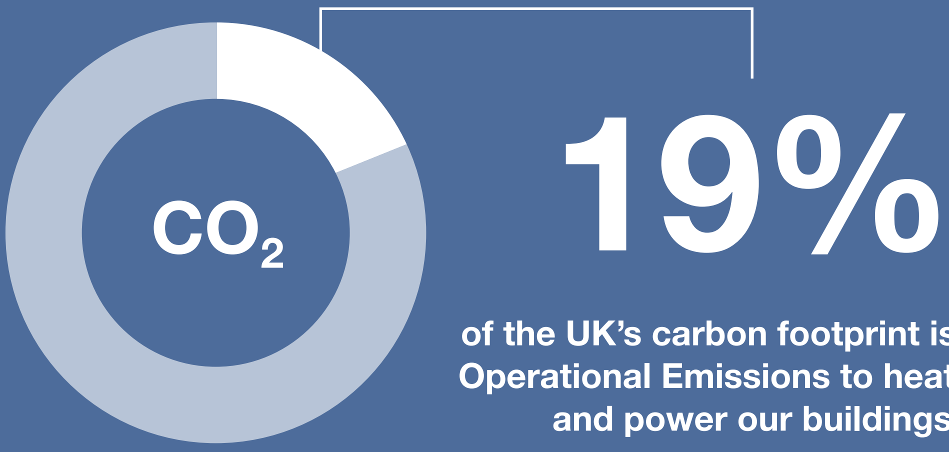
One of the main challenges for the sector is that buildings generate emissions throughout their lifetime. They account for significant embodied carbon, generated during the construction process and in the manufacture, transportation and installation of equipment installed in buildings. (See the Mitsubishi Electric CPD Guide to Embodied Carbon for further insights).

And buildings are also responsible for operational carbon produced during a building's use phase. Some of these may be direct emissions, such as burning fossil fuels such as gas or oil on-site for heating and hot water. In addition, there are indirect operational emissions created when electricity used in the building is generated from fossil fuels. The UK Green Building Council (UKGBC)[3] states that 19% of the UK's carbon footprint is from operational emissions produced from energy used to heat, cool and power buildings.

The CCC notes that the next decade will be a crucial period in which we decarbonise buildings, but the UK is currently 'off track' for switching from reliance on gas for heating and hot water. In addition, the government must focus on delivering new policies for optimising building energy efficiency.

Building owners and managers face some uncertainty around what government policies might be introduced in the future as several are still being shaped and finalised. However, as the government focuses on reducing carbon emissions from the UK's built environment, we can expect to see an increased focus on switching to electricity for heating and hot water and a renewed drive to improve the energy efficiency of new and existing buildings.

This Guide aims to help readers understand how these issues relate to operational carbon in the built environment and why it is a significant element of the UK's journey to Net Zero 2050.



of the UK's carbon footprint is from Operational Emissions to heat, cool and power our buildings

Understanding and measuring operational carbon in the built environment

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With the spotlight turning to carbon reduction from buildings, it is important to understand some terms to grasp what is being measured.

Whole Life Carbon (WLC)

Refers to the carbon emissions associated with a building across its whole life cycle, from construction to operation, maintenance, and demolition.

Embodied Carbon

Is included in WLC and refers to emissions arising from the manufacture, transportation and installation of the materials and products in a building. This includes the carbon emissions from the use of materials such as steel, concrete, and glass, as well as the embodied carbon of equipment such as air handling units, electrical wiring, and ductwork.

Operational Carbon

Is also part of a building's whole life carbon footprint. It includes emissions produced in the building, for example, from the combustion of on-site gas boilers. These are known as direct emissions.

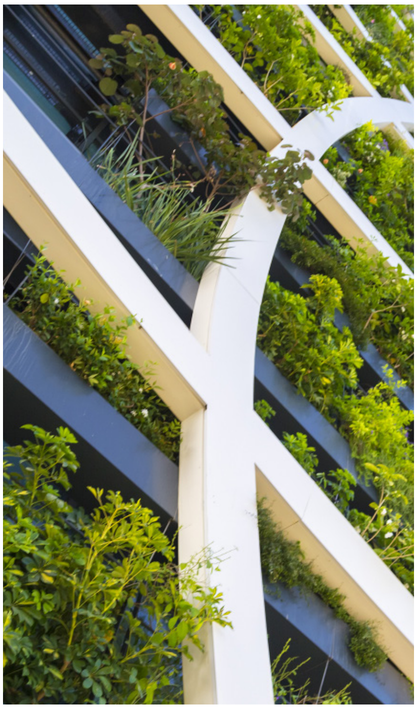
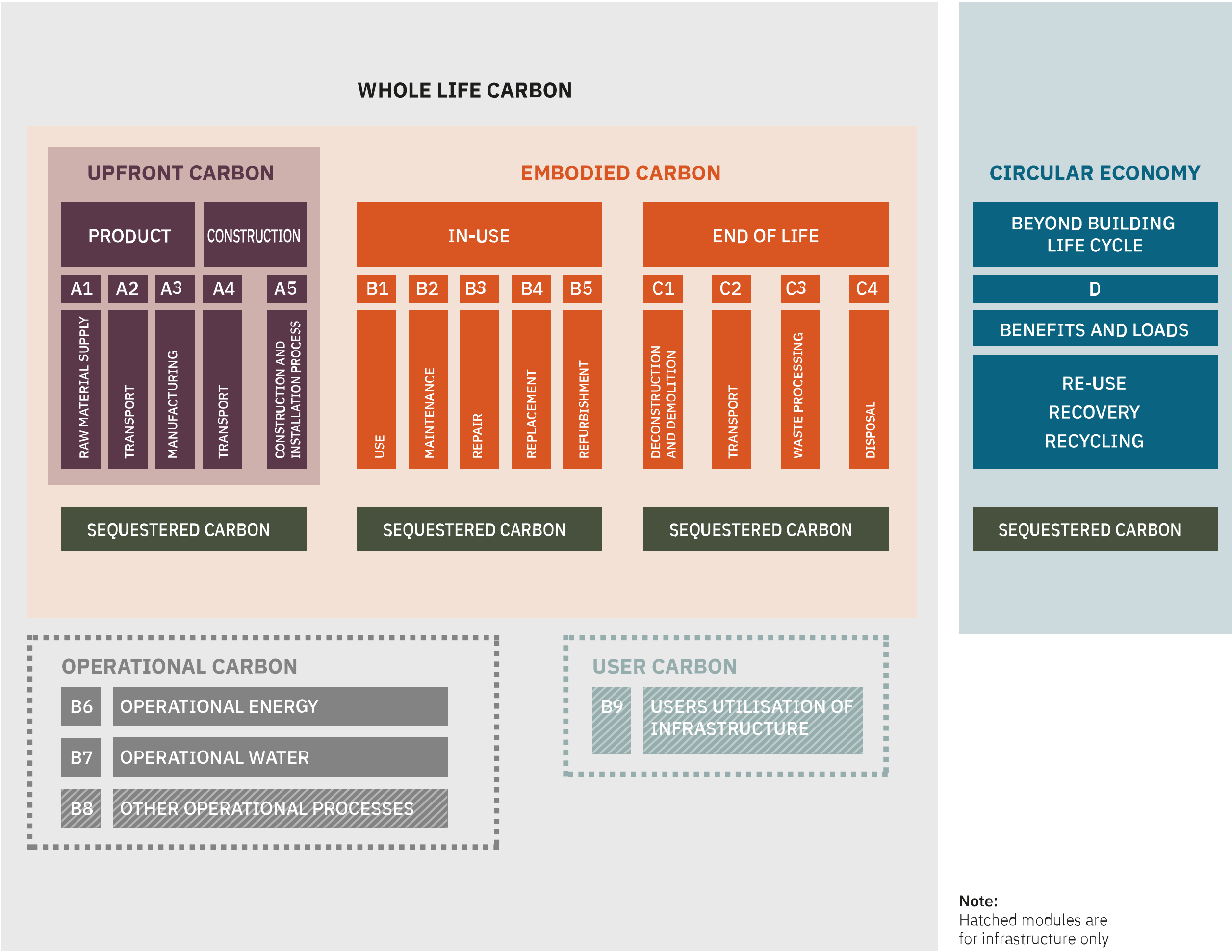


Diagram 1 below shows the relationship between whole life, embodied and operational carbon. It is taken from BS EN 15978 *(Sustainability of construction works. Assessment of environmental performance of buildings[4]. Calculation method).*

This approach to defining carbon across the lifetime of a building is widely applied, including by the Royal Institute of Chartered Surveyors (RICS) in its *Whole Life Carbon Assessment for the Built Environment*[5].

Diagram 1: Relationship between Whole Life, Embodied and Operational Carbon



Note:
Hatched modules are
for infrastructure only

Source: WLCN-LETI adaptation from BS EN 15978

Understanding and measuring operational carbon in the built environment

The RICS WLC Assessment also provides useful insights into the proportion of embodied and operational carbon that impact the whole life carbon of different types of building - as shown in Table 1 below.

Table 1: RICS WLC Assessment

		Spec office; Cat A fit out; central London	Warehouse shed with 15% office space, London	Residential block, basic internal fit-out, Oxford
Embodied Carbon Emissions	Carbon emissions to practical completion	35%	47%	51%
	Carbon emissions in use	32%	29%	18%
Operational Carbon Emissions	Operational emissions - regulated	18%	11%	24%
	Operational emissions - unregulated	15%	13%	7%

Figures from: Professional Statement on Whole life carbon assessment for the built environment (2017) and Sturgis Carbon Profiling

Operational carbon also includes indirect operational emissions. These are generally created by using electricity produced from fossil fuels. Indirect operational emissions are associated with ventilation, air conditioning, pumps and fans, and energy used for IT, for example. The UKGBC[6] highlights that 71% of the UK's built environment emissions are indirect operational emissions.

This figure highlights the important link between energy use and operational carbon. While the two figures are not precisely the same, they are closely related. Energy use in a building will undoubtedly impact its operational carbon footprint and should be regarded as an essential element of operational carbon reduction for building owners and managers.

Accurate measurement of energy use in a building is therefore essential. One reason is to track what is known as 'unregulated' energy use. Regulated energy use refers to equipment that is part of the design of a building, such as the HVAC systems. These are included in the building Energy Performance Certificate (EPC) calculations.

However, EPCs are an indication of potential building energy use. They do not take into account actual and unregulated energy use, which covers cooking appliances (for example, office microwaves), server rooms, and plug socket loads. This may seem insignificant, but unregulated energy can account for 50% of total energy use[7] in some types of building.

In 2020 the Better Buildings Partnership (BBP) surveyed 1,100 commercial properties, looking at self-reported energy data[8]. The BBP found that buildings with the highest EPC ratings (A and B) often use more energy than those with ratings as low as C, D or E. The BBP commented: “There is very little relationship, if any at all, between the Energy Performance Certificates and the actual energy usage of buildings.”

Awareness of all energy used in a building is therefore becoming more important because of its close association with carbon emissions. The commercial property market is looking for more accurate means of understanding building energy consumption. As CIBSE notes: “Target-setting using current Building Regulations Part L and EPCs cannot be relied upon to deliver energy and carbon savings.”[9]

This search for a more useful measurement has seen growing interest in Energy Use Intensity. EUI includes all energy use in the building - regulated and unregulated - as measured at the meter and set against the building floor area. It is measured as kWh/m^2.

EUI is already recommended by organisations such as CIBSE[10] for modelling in-use energy performance. The UK Green Building Council’s Whole Life Carbon Roadmap also strongly recommends the adoption of EUI as a compliance approach within Building Regulations:

Understanding and measuring operational carbon in the built environment

"Building Regulations must shift from the notional building (i.e., hypothetical) comparison approach to in-use energy performance metrics (EUI, kWh/m^2/year) to drive an industry shift towards an outcomes-led design for performance approach."[11]

Perhaps one of the most important arguments in favour of the adoption of EUI as an efficiency measure is that it prevents reliance on our 'greening' electricity grid to decarbonise buildings. If UK buildings continue to use energy at the same rate and switch to electric heating as an alternative to gas, we cannot generate sufficient renewable energy to meet those requirements, putting the Net Zero 2050 target at risk.

Despite the UK's shift to renewable electricity generation, a significant proportion is still produced by burning fossil fuels, mainly natural gas but including some coal. Figures in Table 2 below are from the July 2023 *Digest of UK Energy Statistics (DUKES)*[12] produced by the Department for Energy Security & Net Zero (DESNZ). The data presented is the UK electricity in gigawatt hours (GWh).

Table 2: UK Electricity Production

Generator Type	2022 GWh Produced	% Of Total (rounded figures)
Gas	124,979	38%
Wind	80,268	25%
Nuclear	47,723	15%
Bioenergy	35,820	11%
Solar	13,283	4%
Other Fuels	7,765	2%
Hydro	5,640	2%
Coal	5,576	2%
Oil	2,211	1%
Total	**325,287**	

Table 2: Figures from DUKES table 5.1a Electricity Production: July 2023 report. Figures for wind and solar appear separately in Table 5.6)

UK electricity generation methods tie energy use in buildings to carbon emissions. Reducing our electricity consumption in buildings will result in a larger proportion of our electricity being sourced from low-carbon sources. However, increased electricity usage will lead to additional use of fossil fuel burning to satisfy increased demand.

Legislation and voluntary assessment schemes - driving operational carbon reduction

Despite their shortcomings, EPCs remain central to several government policies around building performance, particularly energy efficiency. The prime example is Minimum Energy Efficiency Standards (MEES).

The government is using this mechanism to drive higher energy efficiency in new and existing buildings. In 2021, the UK government expressed its intention to raise the minimum EPC rating for non-domestic buildings to B by 2030. If a commercial building does not achieve the standard, it cannot be leased or sold, impacting its asset value.

Given that the current minimum is E, many commercial buildings face the challenge of significant upgrades to meet the new standard. Property industry estimates are that in 2021, 60% of existing stock would not achieve a B rating and that landlords will have to invest in efficiency refurbishment at double the usual rate over the next seven years[13].

However, some clients are going beyond MEES requirements and working with industry organisations to develop workable definitions and targets for ‘net zero’ buildings. They are also adopting voluntary standards and more accurate measures of building energy use, particularly EUI.

Construction and property clients are examining the buildings they own or occupy in terms of corporate sustainability and ESG strategies. In addition, the new voluntary building rating schemes offer more accurate insights into building energy use, which is useful for estimating operating costs as well as carbon emissions.

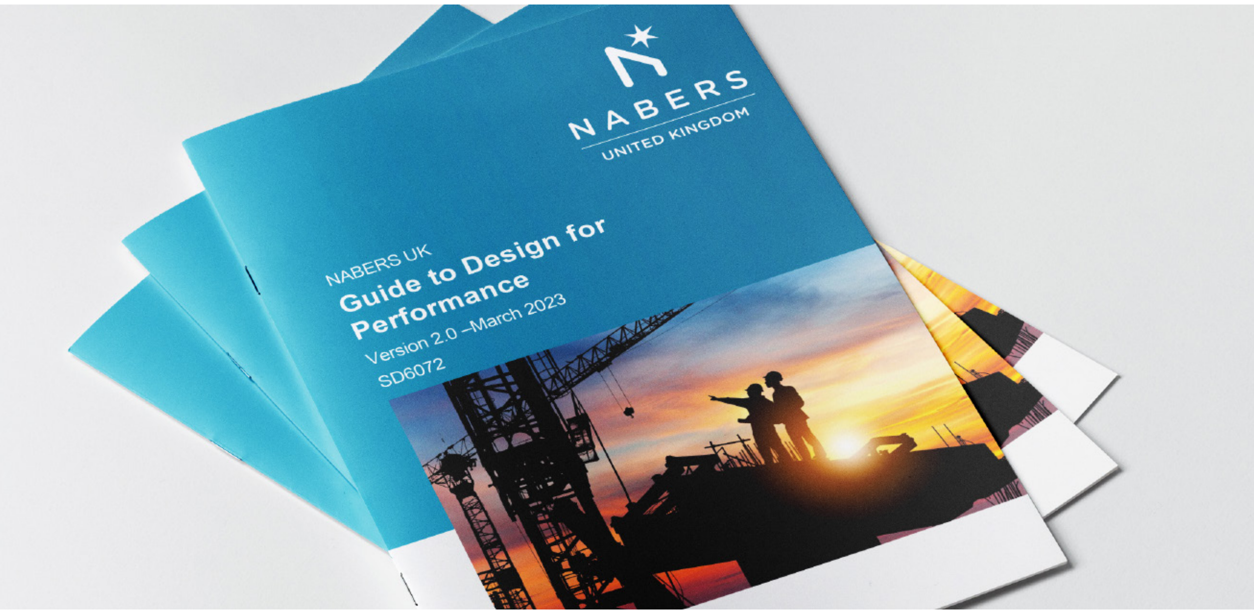
Legislation and voluntary assessment schemes - driving operational carbon reduction

One example is NABERS UK, first introduced in 2020. The scheme originates in Australia but has been developed in the UK via the *Design for Performance initiative*, led by the Better Buildings Partnership[14]. The assessment is delivered through BRE, and is backed by organisations such as CIBSE, RIBA, BSRIA and RICS, as well as BBP members who include property developers and managers such as Grosvenor, The Crown Estate and LGIM.

NABERS measures actual (metered) energy and provides a target at design stage and in-operation. NABERS requires energy measured as kWh per annum and kWh/m^2 (i.e., Energy Use Intensity). The annual measurement and rating of an office works by comparing the energy consumption of the building against a set of benchmarks developed using real-life data. Ratings are awarded as stars from 1 to 6. Grosvenor's Toronto Square office building in Leeds[15] was the first to be verified using NABERS UK Energy for Offices, achieving 4.5 stars.

The latest version of NABERS UK 2.0 was launched[16] in 2023 and can rate the base building, which looks at central services such as heating and cooling, lifts, and lobby lighting. In addition, a 'tenancy rating' considers energy used by office tenants, which typically includes lighting and power and, optionally, local air conditioning. There is also a third, whole-building rating which brings both elements together. The NABERS scheme is set up under a *Design for Performance* (DfP) agreement between the scheme administrator and the applicant (the building owner or representative). This is a contracted agreement to design, build, commission and operate the building to achieve a NABERS Energy for Offices rating of 4 stars or more.

The DfP Agreement allows developers, building owners and tenants to promote and market the expected energy performance of a new or refurbished office from the design stage. However, the contract is in place for several years until the building achieves a NABERS 'in operation' rating.



The role of building designers and operators

Although NABERS is becoming more widely used across the UK, it is important to note that there is currently no official definition of a net zero building. The UK government is working towards establishing this, and several organisations, including the Low Energy Transformation Initiative (LETI), CIBSE, BRE, RIBA and RICS have developed definitions[17] to help clarify issues for construction professionals.

Their definition of a *Net Zero Carbon - Operational Energy* asset is: “One where no fossil fuels are used, all energy use has been minimised, meets local energy use targets (kWh/m^2/pa) and all energy used is generated on or off-site using renewables that demonstrate additionality. Direct emissions from renewables and any upstream emissions are ‘offset’”.

In practical terms, achieving operational net zero begins with reducing energy use. For example, the UK Green Building Council has said that to meet the national Net Zero 2050 target, the office sector must achieve an average 60% reduction in building energy use. It refers to this target as ‘Paris-proof’ in reference to the Paris Climate Agreement of 2015.

The UKGBC set out proposed energy target milestones[18] for office buildings that are targeting net zero operational carbon:

Diagram 2: Energy Performance Targets for Buildings Targeting Net Zero Operational Energy

		Interim Targets			Paris Proof Target
Scope	**Metric**	**2020-2025**	**2025-2030**	**2030-2035**	**2035-2050**
Whole Building Energy	kWh$_e$/m^2 (NLA) / Year	160	115	90	70
	kWh$_e$/m^2 (GIA) / Year	130	90	70	55
	DEC rating	D90	C65	B50	B40
Base Building Energy	kWh$_e$/m^2 (NLA) / Year	90	70	55	35
	kWh$_e$/m^2 (GIA) / Year	70	55	45	30
	Nabers UK star rating	4.5	5	5.5	6
Tenant Energy	kWh$_e$/m^2 (NLA) / Year	70	45	35	35

NLA = Net Lettable Area GLA = Gross Internal Area

Reducing operational carbon - strategies

The UK Green Building Council defines a net zero carbon - operational energy building as: “When the amount of carbon emissions associated with the building’s operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset.”

Building owners looking to achieve operational net zero must therefore start with energy efficiency measures at the top of their list. This should include HVAC building systems as they are significant energy users. Whether a building owner is targeting a higher EPC rating, a NABERS score or simply wants to improve the energy performance of their building, a systems approach is key to success.

Decarbonise heating and hot water

Targeting operational net zero means removing the use of fossil fuels on-site as well as reducing EUI. Buildings are increasingly moving away from the use of any natural gas or oil for heating and hot water and switching to an ‘all electric’ approach.

Heat pumps are one of the most widely used alternatives to the gas or oil boiler, and they provide energy efficient electric heating, as well as meeting domestic hot water requirements. Modern commercial heat pumps can now deliver water temperatures up to 90ºC, so can be applied in buildings with significant hot water demands, for example, from showers and gymnasiums.

Make use of ‘waste’ heat energy

Modern HVAC equipment is energy efficient, but performance can be optimised further. The principle of heat recovery treats ‘waste’ heat as an energy source, taking heat energy ejected from one part of a building and applying it in another.

For example, this strategy can be used through mechanical ventilation with heat recovery (MVHR). Heat energy from air expelled by the ventilation system is transferred to incoming outdoor air before it enters the occupied space. This reduces the amount of heating required for incoming air, saving energy. The principle of heat recovery can also be applied in 4-pipe simultaneous heat pump systems, which use heat pump technology to boost the temperature of ejected heat and apply it to other parts of the building, or to meet domestic hot water requirements.

Heat recovery is also available on VRF systems, a useful solution for buildings requiring simultaneous heating and cooling. Distributing surplus heat from cooling operations (and vice versa) can result in energy savings of up to 30% over conventional systems[19]. On a larger scale, the heat recovery principle is also used in ambient heat loops. These can be particularly useful for mixed-use developments where heat extracted from office or retail cooling systems is transferred to on-site residences such as apartments using heat pump technology.

A commercial heat pump provides the heat source for the building (or buildings) and a heat network carries water at between 10ºC to 30ºC to each apartment which has a heat pump. These heat pumps use that energy source to provide space heating and hot water for each dwelling. An added benefit is that the heat network can act as a ‘heat sink’ for heat extracted from nearby shops, offices or gymnasiums. This heat energy reduces the load on the central chiller, saving more energy.

Reducing operational carbon - strategies

Use controls to monitor and manage energy use

Building controls are critical in helping building managers monitor and manage energy use. Given the growing requirement for data collection from many voluntary assessment schemes, data collection on building performance is vital for tracking performance over time. In addition, the ability to spot trends gives facilities and energy management teams the insights to take action where energy is potentially wasted.

CIBSE's TM54 (*Evaluating operational energy use at the design stage*) highlights the importance of planning control systems early in the design process: **"Often the controls strategy is not developed until late in the design when opportunities have been missed or it is unclear and too complex and does not sufficiently inform future occupiers on how to operate the building."**

The document points to five key areas to consider when planning a controls strategy:

- **Thermostat profiles** (setpoints and setbacks)
- **Implementation of variable temperature and volume**
- **Plant sequencing**
- **Hours of operation**
- **Zoning**

The data available from a modern building management system can be invaluable in tracking overall building energy use, as well as the performance of individual plant equipment. This can help building managers avoid unnecessary operation of equipment.

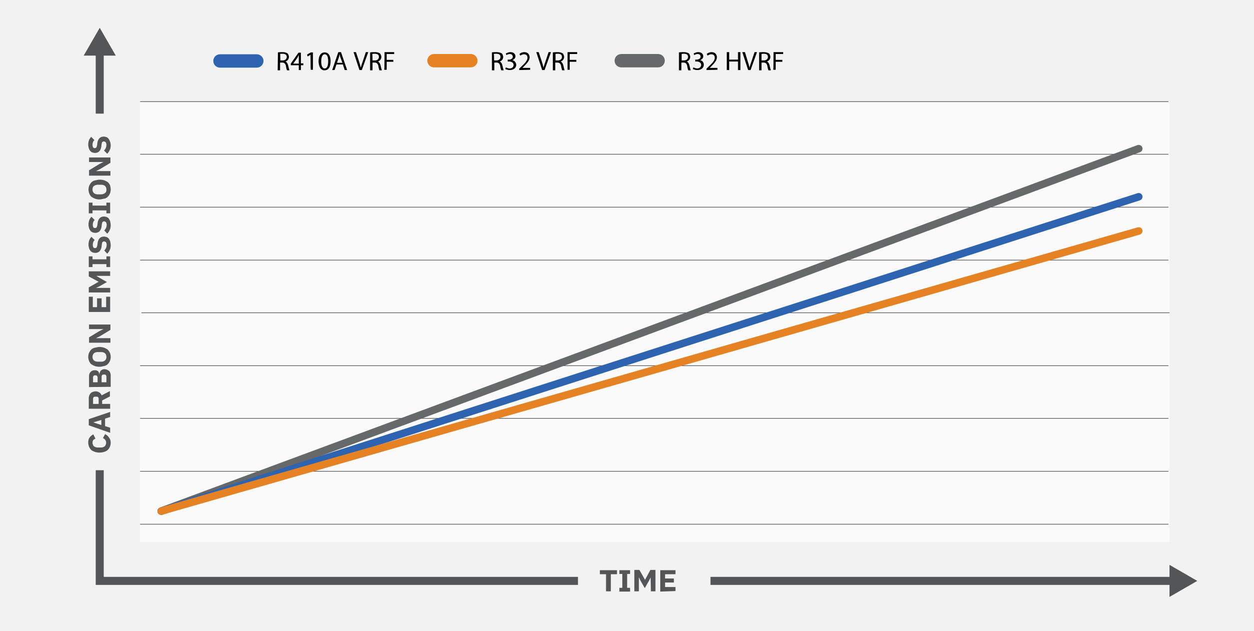
Specify HVAC equipment to achieve carbon objectives

One of the most challenging aspects of the focus on the whole life carbon of buildings is its impact on the specification process. For example, highly energy efficient equipment may have a higher embodied carbon footprint than an alternative which uses more energy in the long term, affecting the building's operational carbon.

Some important questions for specifiers include, at what point does the equipment's operational efficiency outweigh higher embodied carbon? Or how long does a high-efficiency product with high embodied carbon have to operate before its WLC balances against a lower-efficiency product with lower embodied carbon? In addition, there are grid emissions to consider as the UK increases its renewable generation over time.

The importance of these considerations can be shown with some straightforward examples. Let us start by looking at a comparison between Mitsubishi Electric R410A Variable Refrigerant Flow (VRF), R32 VRF and R32 Hybrid VRF (HVRF) solutions – in combined heating and cooling modes. In our analysis, we will base our calculations on two potential scenarios. The first scenario assumes a fixed grid emissions factor, implying a constant grid over time. The second scenario considers grid emissions that improve progressively. For this, we have used values from the UK Greenbook[20].

Diagram 3: Operational Carbon (Fixed Grid)



(Diagram 3: Scenario 1: A fixed grid emission factor). See box out for a note on our graphs.

Reducing operational carbon - strategies

The graphs in these examples are compiled using information on the operational carbon and efficiency performance of Mitsubishi Electric systems. The X and Y axes are generalised for Time and Carbon to illustrate the impact of operational carbon. Exact figures would depend on the actual performance of the system, which is unique to each building.

Assumptions for charts (excluding the grid emissions charts)

- SEER and SCOP has been taken from the Mitsubishi Electric City Multi VRF and Hybrid VRF Seasonal Efficiency Explained brochure.
- Power consumption in cooling and heating mode have been extracted from the associated product fiches.
- Number of hours in each temperature bin calculated according to EN14825.
- Grid emission factor for electricity taken in accordance with UK Greenbook and shown as decreasing over time.
- Embodied carbon values used for Whole Life Carbon calculations taken from published Mitsubishi Electric TM65 mid-level calculations.
- Site added refrigerant based on a nominal 50m pipe run between the outdoor units and branch controller, and then a further 150m total from the branch controller to the indoor units.

As we had expected, in Diagram 3 a notable trend emerges, indicating a sustained upward trajectory in operational carbon across all three systems. This trend exhibits a near-linear progression over time. This observed increase can be largely attributed to the consistent grid emissions factor that we have assumed in this example.

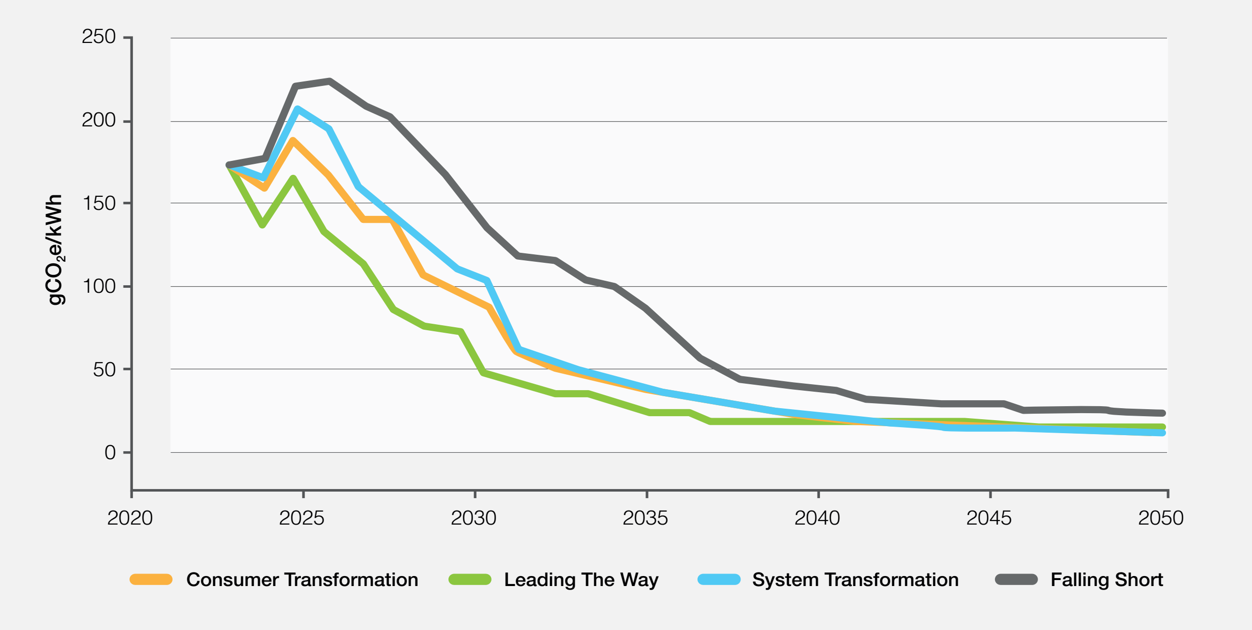
Looked at in more detail, this observation prompts further reflection on the role of external variables and the long-term implications they have on our sustainability objectives and decision-making processes.

Future Energy Scenarios (FES)[21] represent a range of different, credible ways to decarbonise our energy system as we strive to meet the 2050 target. The annual Future Energy Scenarios sketch out four possible futures for the UK's energy system until mid-century.

The carbon intensity of electricity generation in the UK has fallen significantly as we have reduced coal-based generation and increased our use of renewables. In summary, power sector carbon emissions are expected to fall rapidly in the early 2020s in all scenarios.

However, some of these scenarios reach the ambition quicker than others and, although Net Zero is our main goal, significant work will be needed alongside this to continue to provide safe, reliable and affordable energy for all, including a more centralised and strategic approach to network planning. It is challenging to predict the precise scenario, hence we have multiple options, as shown in Diagram 4.

Diagram 4: CO_2 Intensity of Electricity Generation

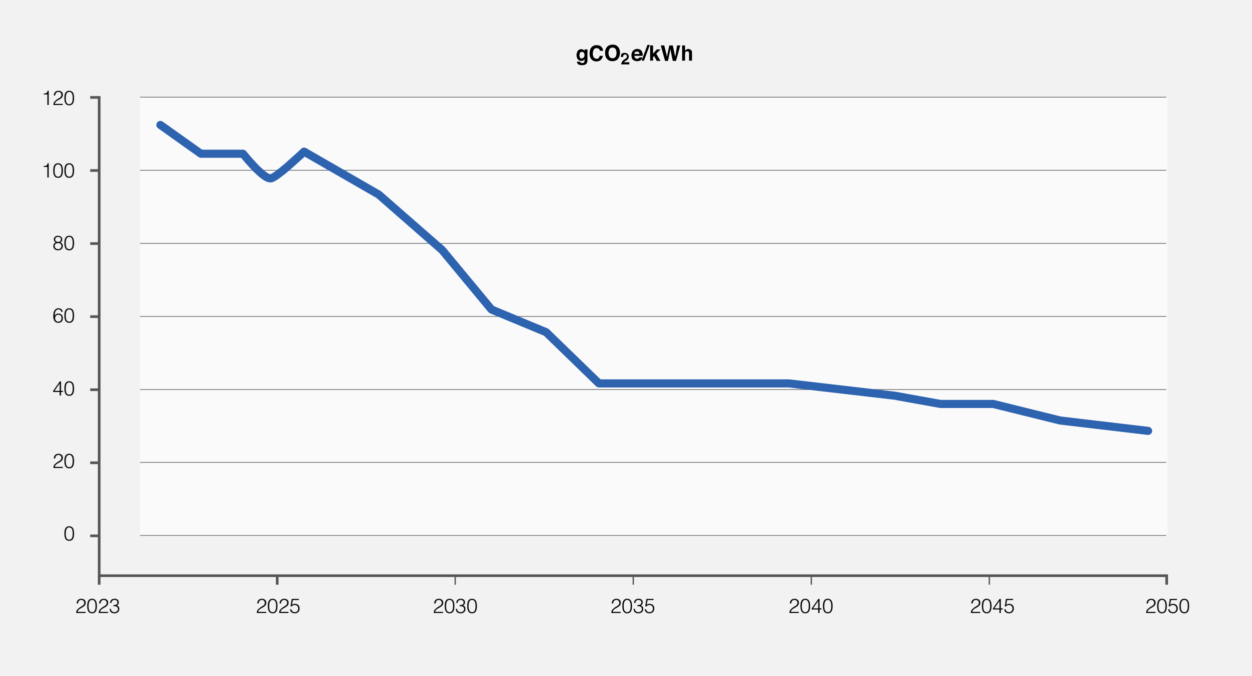


(Diagram 4: Figures showing future CO_2 intensity of electricity generation, excluding negative emissions from BECCS (gCO_2/kWh) – 2022 Future Energy Scenarios Document

Reducing operational carbon - strategies

For the purpose of our worked examples, we have used values from UK Greenbook which also show reducing emissions as the UK grid switches to renewable electricity generation over time. It follows a similar trajectory as those shown in the Future Energy Scenarios.

Diagram 5: UK Declining Grid Factor

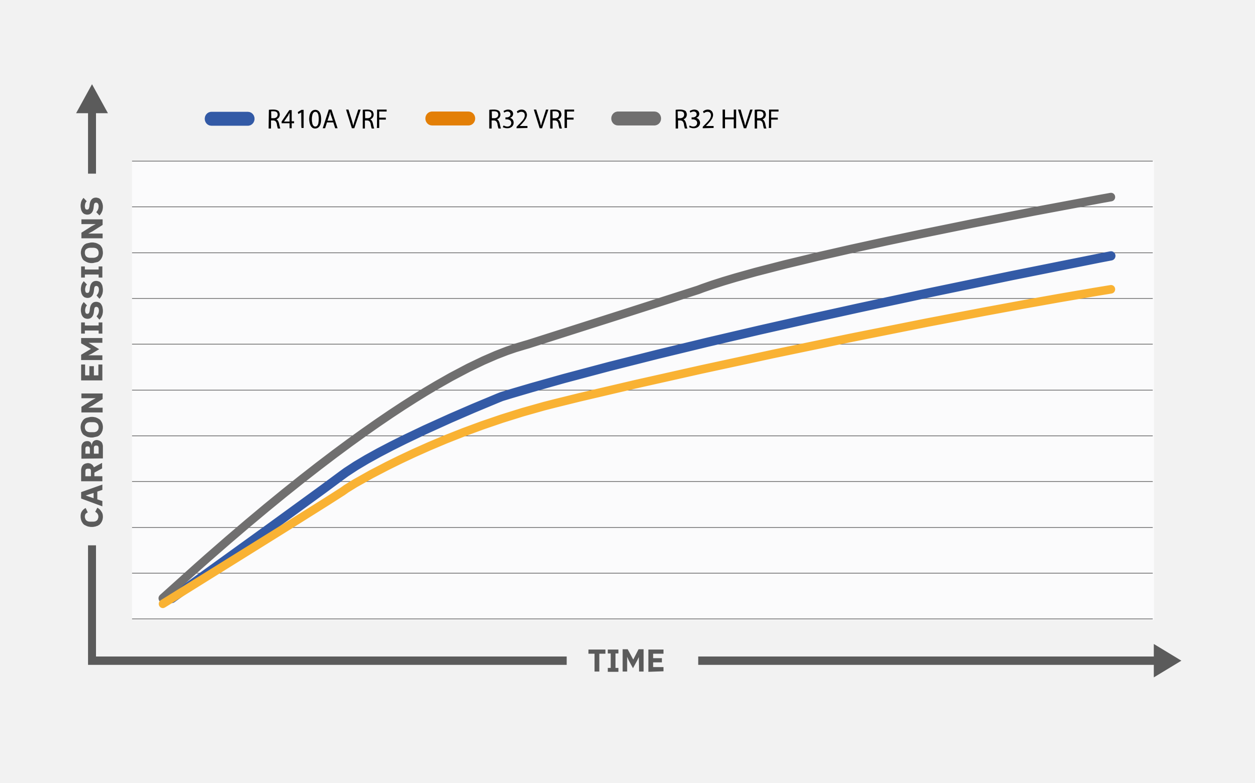


(Diagram 5: UK declining grid factor from the UK Greenbook)

If we apply this to our comparison of technologies, we are factoring in a grid that undergoes a gradual improvement over time. The operational carbon for each system appears quite similar at the start, although at the end of the fifteen-year lifespan we see that the R32 VRF solution shows the lowest operational carbon. The R32 HVRF solution maintains its position as the highest operational carbon approach across the fifteen-year lifespan and the R410A VRF solution continues to sit between both solutions.

By considering a grid that exhibits gradual improvement over time, we introduce a dynamic element into our analysis. At the outset of our fifteen-year lifespan assessment, the operational carbon profiles of each system are close in appearance. However, as we progress through the years, a significant divergence becomes evident. Notably, the R32 VRF solution emerges as the frontrunner, with the lowest operational carbon by the end of the projection. In contrast, the R32 HVRF solution maintains its position with the highest operational carbon. The R410A VRF solution occupies an intermediate position between the two.

Diagram 6: Operational Carbon (cleaning grid)



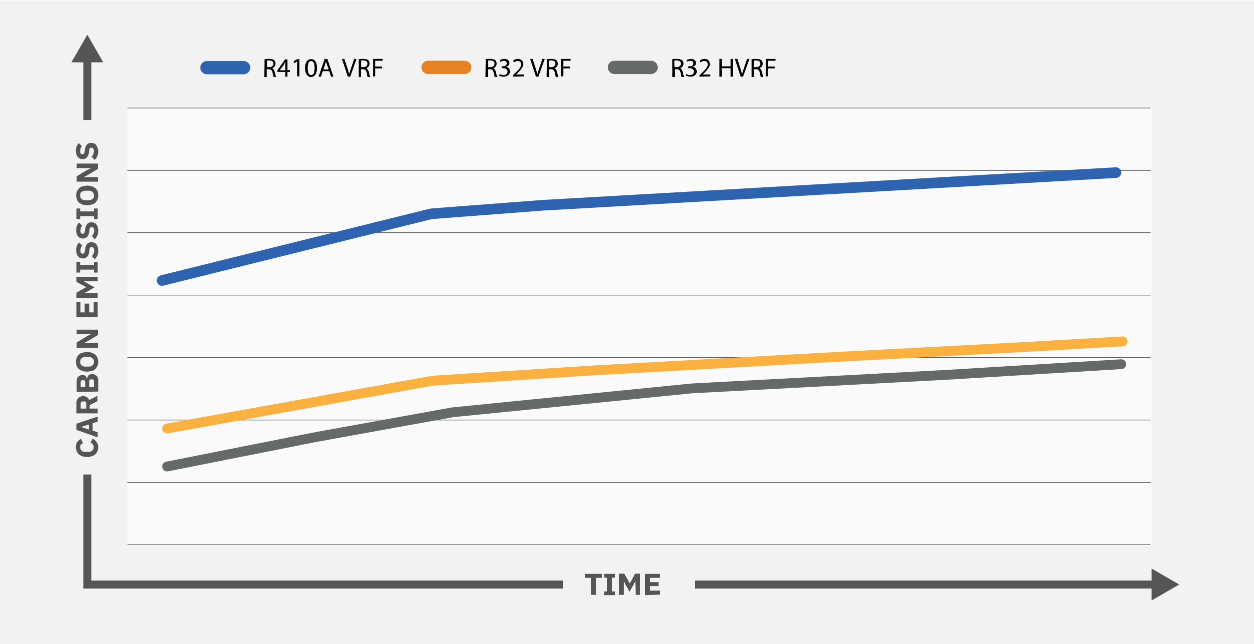
(Diagram 6: Impact of the UK's greener grid over time)

As we look deeper into the charts, we observe a direct correlation between the declining grid carbon factor and operational carbon. Notably, the impact becomes evident around year twelve as the operational carbon starts to level off (Diagram 6).

When viewed from a whole life carbon standpoint, this approach offers a different insight however. To offer a comprehensive view, in Diagram 7 we have included the calculated embodied carbon of these systems using published CIBSE TM65 data for the indoor units, outdoor units and branch controllers, and have also incorporated site-added refrigerant into the calculations for this example.

Reducing operational carbon - strategies

Diagram 7: Whole Life Carbon (cleaning grid)

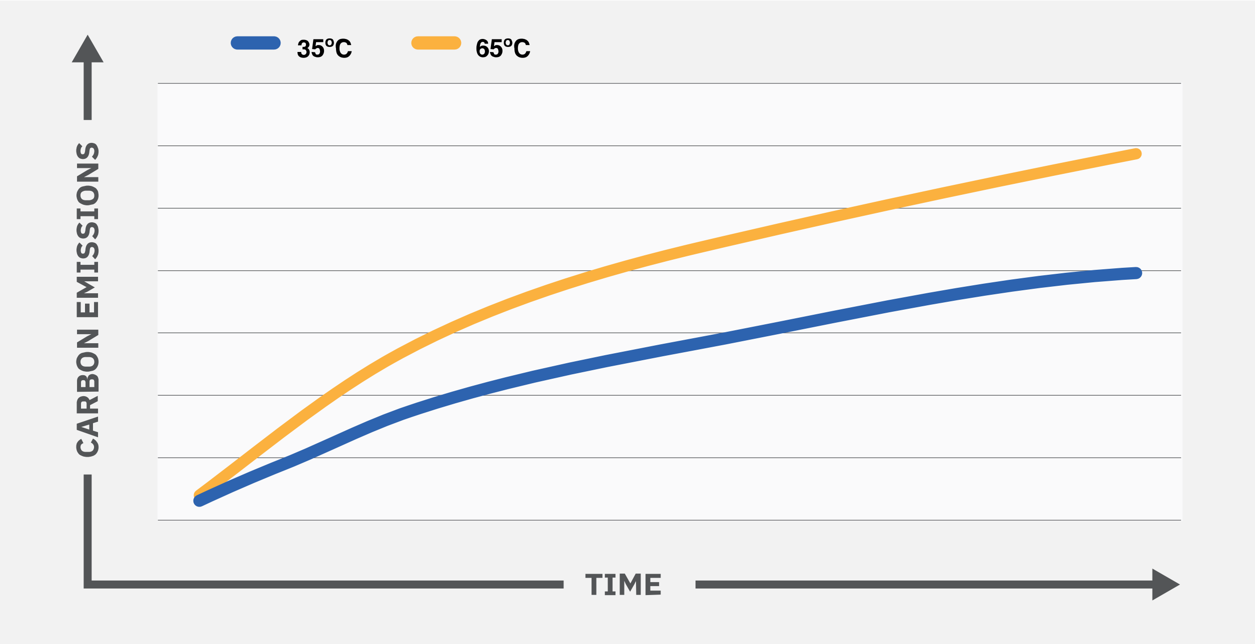


An examination of the graph highlights the critical importance of considering both operational and embodied carbon factors and underscores the significance of refrigerant type and quantity in the equation. In our previous analysis, where we solely focused on operational carbon, the R32 VRF solution initially seemed to have the lowest operational carbon. However, when we introduce embodied carbon and site-added refrigerant into the equation, a shift occurs.

It is clear that the R32 VRF solution, which had previously appeared favourable in terms of operational carbon, now exhibits a higher whole life carbon emissions impact. Conversely, the R32 HVRF solution emerges prominently with the lowest whole life carbon emissions impact. From year one, it establishes itself as the leader in this regard. On the other end of the spectrum, the R410A VRF solution consistently maintains the highest whole life carbon emissions impact throughout the entire lifecycle, largely due to its refrigerant type and quantity.

This analysis shows the significance of adopting a holistic approach when evaluating system choices, as it unveils how factors like refrigerant play a pivotal role in shaping the long-term sustainability and environmental impact of these systems. Other factors to take into account when specifying with operational carbon in mind include flow temperatures. Diagram 8 takes into account the progressively cleaner grid, while allowing for the effects of varying flow temperatures. This illustration is for a Mitsubishi Electric CAHV-P heat pump operating in heating-only mode.

Diagram 8: Operational Carbon (varying flow temperatures)



The trajectory of operational carbon echoes a familiar course, aligning with our prior illustration as it levels off in response to a cleaner grid. However, flow temperatures influence performance.

Notably, the lower the flow temperature, the lower the operational carbon. This dynamic becomes more pronounced as we work through the system's lifespan. The difference in operational carbon between different flow temperatures widens significantly over time. When we consider this scenario from a holistic, whole life perspective we find that we see the same trend.

In conclusion, although we have focused on operational carbon, these analyses highlight the critical impact that various factors can have. The choice of technology and system, grid emissions factors and flow temperatures each play a pivotal role in shaping the overall carbon footprint. In addition, we have also seen that when we consider the type and quantity of refrigerant this can further influence decisions. The findings highlight the need for a comprehensive evaluation, considering not only the initial stages of building and system operation but their entire life cycle.

Gaining a grasp of these subtleties empowers designers to make more educated choices regarding the systems and technologies that integrate into a project. This, in turn, enables them to align more effectively with the project's priorities, which will naturally differ from one project to another.

The future of low carbon buildings

In future, designers and building managers will have to balance operational carbon with embodied carbon to achieve the targets set for reducing the overall carbon footprint of buildings.

An important aspect of operational carbon is that occupant behaviour has a significant impact on the energy use intensity of a building. This ‘human factor’ makes it less predictable than complex embodied carbon calculations. In practice, it also requires building owners to work closely with tenants to agree on approaches to energy efficient building use.

Another uncertainty is what future legislation will require of building designers and operators. The uplift in MEES is expected but not yet definite. The government also has a Carbon Emissions (Buildings) Bill that started its journey through Parliament at the end of 2022. It will require whole life carbon emission reporting, among other things. The Bill is at the second reading stage, so has some way to go before adoption into law.

However, where the government takes its time, construction and property clients are forging ahead. For example, collective construction industry groups of clients and organisations have worked to introduce NABERS to the UK, and this is being delivered across a growing number of buildings. EUI, as a measure of efficiency, is also growing in importance.

There are other factors at play in the future of low carbon buildings. Technology is crucial, and it is becoming more likely that we will see batteries used alongside on-site renewables such as photovoltaics. Other potential developments include using water for thermal storage - dealing with heat as a form of energy which can be re-used to optimise efficiency.

And while carbon reduction is a long-term national policy, the UK must consider the effects of climate change, particularly in the form of hotter summers. This is happening across Europe, with Italy, Greece and Spain coping with temperatures up to 50ºC in some areas.

In the summer of 2022, the Spanish government set a lower legal limit for air conditioning systems to ensure the country would not experience power outages. The UK must consider how its existing building stock, constructed for a cool climate, will manage higher temperatures in the next decade.

> Building owners must be ready to meet the challenge of meeting carbon targets while tackling a changing climate. The work should start now because there are so many factors to consider. Buildings that adapt, become more sustainable, and provide good indoor environments will retain value. **Those that do not invest in innovative approaches are in danger of becoming stranded assets, losing value as they fall further behind rising targets.**

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To receive a CPD seminar on ‘Operational Carbon in New and Existing Buildings’, you can call your Mitsubishi Electric Regional Sales Office to arrange an in-house presentation of this information.

If you would like to receive invitations to future CPD events, please email **livingenvironmentalsystems@meuk.mee.com**

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Note: The fuse rating is for guidance only. Please refer to the relevant databook for detailed specification. It is the responsibility of a qualified electrician/electrical engineer to select the correct cable size and fuse rating based on current regulation and site specific conditions. Mitsubishi Electric’s air conditioning equipment and heat pump systems contain a fluorinated greenhouse gas, R410A (GWP:2088), R32 (GWP:675), R407C (GWP:1774), R134a (GWP:1430), R513A (GWP:631), R454B (GWP:466), R1234ze (GWP:7) or R1234yf (GWP:4). *These GWP values are based on Regulation (EU) No 517/2014 from IPCC 4th edition. In case of Regulation (EU) No.626/2011 from IPCC 3rd edition, these are as follows. R410A (GWP:1975), R32 (GWP:550), R407C (GWP:1650) or R134a (GWP:1300).

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