HOME ELECTRICAL INFRASTRUCTURE OF THE FUTURE

How Net Zero is changing the electrical foundations in our homes

October 2021

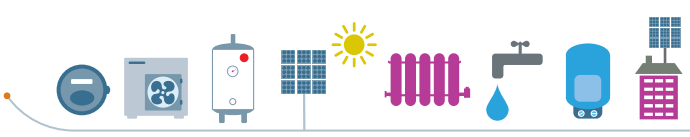
Introduction

Home electrical infrastructure of the future – how Net Zero is changing the electrical foundations in our homes:

In this report we discuss how the UK Government's commitment to achieving Net Zero by 2050 may impact the homes we currently live in and future homes.

The three following topics have been selected as discussion points; We highlight the current situation, the issues surrounding the current situation, what can be done to overcome these issues, what needs to be in place to make this happen and who benefits.

1. Mandatory Electrical Safety Inspections
2. Three Phase supply to homes
3. The Domestic Energy Centre



1. Mandatory electrical safety inspections

- **Make sure homes are ready for changing electrification needs**
- **Reduce current and future fire risk**

The UK Government has set ambitious targets for achieving Net Zero by 2050, with a target to reduce the UK's emissions by at least 68% by 2030, compared to 1990 levels.

Globally we are in need of Low-Carbon Technologies (LCTs) to achieve our targets: Low-Carbon Technologies refer to all measures and methods designed to reduce the use of fossil fuels such as oil, coal and gas (which give off a lot of CO_2 and NOx when burned) by replacing them with renewables. Low-Carbon Technologies are an integral part of the energy transition.

To ensure these Low-Carbon Technologies can be embraced we must ensure our domestic electrical wiring is safe 'mandatory electrical safety inspections' will be crucial to cross-tenure housing.

Currently the new UK Regulations require *landlords* to have the electrical installations in their properties inspected and tested by a person who is qualified and competent. At an interval of at least every 5 years. From 1 April 2021 the Regulations apply in all cases where a private tenant has a right to occupy a property as their only or main residence and pays rent. This includes assured shorthold tenancies and licences to occupy.

This is a positive change however all homes within the UK will be affected by the electrification upgrades and are therefore in need of an inspection and test in addition to those mentioned above.

Electrical Safety First (ESF) have authored a report on "Future Ready Homes":

Recommendations from ESF report: *"Government should introduce a common, cross-tenure, housing standard for electrical safety which includes mandatory, five-yearly, electrical safety checks for all homes in all parts of the UK."*

"Central Government and energy suppliers should launch free services including electrical checks to support the electrical safety of vulnerable consumers as we transition away from gas."

Distribution Network Operators (DNO) must be contacted in advance of Low carbon technology installations, via the Electricity Network Associations (ENA) application form for Heat Pumps, Electric Vehicle charge points, battery storage i.e. Tesla Powerwall's and Solar PV to be able to provide the power capacity from the service cable. Early terraced and semi-detached housing can have looped LV services between the two homes, these looped services need to be removed if Low Carbon Technologies (LCTs) are added to the homes. The DNOs remove looped LV services for free. By advising the host DNO this ensures the LV network is fit for purpose, safe, secure, and the sustainability of the electricity network by ensuring connections are fit for purpose, compliant with the technical and legal requirement in the UK. Without this underlying knowledge of installations, the network can become overloaded, unbalanced and unexpected demands can be placed on these resources, which could also pose safety issues.

See the ENA link below regarding more detail on connecting to the Energy networks:

CLICK HERE

This registration of Low Carbon Technology installations is another key driver for mandatory electrical inspections. As those systems that have NOT been registered in the past with the host DNO will be picked up over time.

One of the primary reasons for these applications not being submitted is the time delay in getting approval. The lack of resources is causing significant delays taking up to 2-3 months. All DNOs are addressing the "turn around" or SLA time, some DNOs are now running semi-automated systems which provide short response times for applications.

To enable these changes investment and planning will be required, the UK Government will need to adopt and mandate policy changes and enforce these new measures. UK Wiring Regulations will need updating to reflect the policy changes.

An increased availability of certified inspectors and installers will be needed to cope with increased demand.

Additional educational resources will be required to support the increase of certified inspectors and installers.

The entire supply chain from raw materials, Manufacturers and distribution will need to prepare for demand. Investments in all areas of staffing and resources.

Government and charity support for consumers to be able to afford inspections and upgrades

The primary objective is to improve safety in all domestic dwellings, updating older properties will be no small task as many will have their original wiring configurations, including a looped LV service cable to the adjacent house. Host DNOs remove looped LV services for free when connecting LCTs to the house.

There will be significant positive impact on the Electrical sector with but less so for the property owner; inspections and upgrades will need to be paid for. Government grants and support would be needed.

2.
Consider three phase electrical supplies to new homes

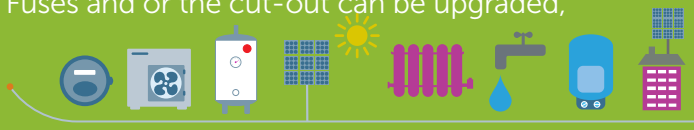
- Develop a rapid charging infrastructure for electric vehicles
- Enhance suitability for heat pumps and other electrification

At this time all DNOs (Distribution network operator) and IDNOs (Independant Distribution network operator) provide single phase LV supplies to UK domestic dwellings, except for WPD (Western Power Distribution), since Q4 of 2020 WPD have been providing three phase LV service cable and three phase cut-outs to all new builds or service alterations, it is up to the building owner if they make use of this facility. Across all DNOs larger buildings or multi occupancy buildings, are supplied with single phase from the grid. Single phase installations have been in use since the early in the 20th century. The UK Wiring Regulations date back to the late 1800's which were adopted by BSI as BS7671 in 1991 as a National standard for all UK electrical installations.

UK Wiring Regulations are not retrospectively applicable and therefore some very old electrical installations may still be in use today. There are no records for these domestic electrical installations, even now. These older installations will require testing, replacing and significant upgrades to cope with future electrical demands, and at significant cost.

The current model in the UK is for DNOs and IDNOs to run three phase LV mains cables in the pavement to tee off the main LV to each house with single phase and neutral LV service cables.

Depending on the age of the property and whether work has been carried out the electrical system of the building, LV single phase supplies to domestic properties are 230V nominal voltage, the DNO cut-out fuse can vary from 30A through to 100A depending on the age of the LV service. Fuses and or the cut-out can be upgraded, from the 30A – 60A to 80A or 100A but safety is paramount and knowing if the existing installation can cope is essential before works should be carried out. Hence why the host DNO / IDNO should be notified over the installation of LCTs.



A Report by WSP commissioned the Losses Group of the ENA predicts meeting Net Zero could see as much as a 40% increase in load on the LV network. For the UK network to cope with the demands of the future, installing homes with 3 phase LV supplies and three phase devices like a three phase 22kW EV changer and a three phase heat pump is one solution to provide more efficient output, consistent, reliable balanced supplies and more power. This would encourage homeowners with the uptake of solar, heat pumps and electric vehicles to name a few.

Western Power Distribution have been out to consultation on the use of three phase LV service cables of in Q3 of last year (2020) and the response was absolutely positive so in Q4 of 2020 they have changed their Business as Usual policy to ensure ***all*** New Build and Service alterations going forward would be a three phase LV service cable complete with three phase cut-out in a three phase flush mounted meter box.

Safety

The installation of three-phase supplies would enable the total load of the house to be distributed over three phases, giving each individual home greater capacity, and ensuring wiring is not overloaded and at risk from over-heating and thus fire.

EV's

Why don't all EV Charge at a high rate on home charging?

There are numerous reasons why different models of electric vehicles charge at different rates. These include the cost of OBCs (On-Board Chargers), the available space for the battery, and the faster you charge your EV, the more damage is done to the battery.

OBC rates vary from manufacturers to manufacturer, here are a few examples:

Nissan Leaf (older model): 3.6kW
Nissan Leaf (latest model): 6.6kW
Tesla Model S: 7.4 kW
Renault Zoe: 22 kW

Very few cars have an OBC of up to 22kW on AC, but moving forwards, car manufacturers are offering more and more powerful OBCs.

All the above listed cars can be charged using a single-phase supply but up to a maximum of 7.4kW, to benefit from the 22kW a three-phase supply would be required. See the table below for approximate timings for the different OBC capabilities using a large 90kWh battery:

OBC Size (kW)	Amps	Supply	Large Battery 90kWh
3.7 kW	16A	Single-Phase	24 Hours
7.4 kW	32A	Single-Phase	12 Hours
11 kW	16A	Three-Phase	8 Hours
22 kW	32A	Three-Phase	4 Hours

To summarise; A three-phase supply would allow consumers to charge their EVs (multiple cars per household) more rapidly, enabling households to gear up for a future when electric cars have longer-range and higher capacity batteries. (87% of charging connection events take place at home, with 8% at work, 4% at service stations, and 1% at 'destinations' such as shopping centres).

Solar PV Arrays

Under Engineering Recommendation G83 (see page 10), single phase connections currently restrict domestic export to 3.68kW AC of solar PV per phase on their rooftops, without seeking DNO permission, so three phase would allow up to three times this amount and allow for easier connections to heat pumps as the Government increasingly prioritises the decarbonisation of heat.

Heat Pumps and Underfloor heating

There are two main types of underfloor heating, electric underfloor heating, which is sometimes known as a dry system, and hydronic underfloor heating, which is also known as a wet system. Dry and wet underfloor heating systems are similar, both having their own pros and cons.

Electric Underfloor Heating (Dry):

The main drawback of electric underfloor heating as a whole house heating system for a large poorly insulated property can be the running cost. The cost of heating up an entire floor area with electric underfloor heating is generally more expensive than with wet underfloor heating.

The advantages of electric underfloor heating are:

- Ease of installation, hence it is often used in smaller well insulated properties or one or two rooms such as kitchen or bathroom in larger properties.
- Excellent heat output.
- A quick heating response time.
- Cheaper to install than a hydronic system.

The disadvantages of electric underfloor heating are:

- Potentially high running costs due to the 1kW of power to produce 1kW of heat.

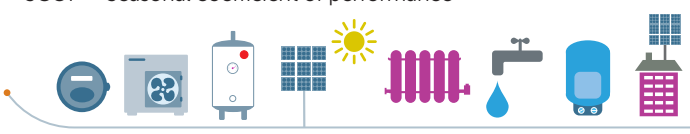
Wet Underfloor Heating (Hydronic):

Unlike a gas or oil boiler, which heats water to between 65 and 85°C, a heat pump generates hot water at around 40°C.

The advantages of wet underfloor heating are:

- Ground source heat pumps have a typical COP[1] of 3 i.e. 1kw of power in to 3kW of heat out. Air source heat pumps have an SCOP[2] this can vary depending on ambient outdoor temperature.
- 40% more efficient when running from a heat pump.

1 COP = Coefficient of performance
2 SCOP = Seasonal coefficient of performance



The disadvantages of wet underfloor heating are:

- Houses with microbore piping require a buffer tank and circulation pump otherwise the back pressure caused by the microbore tubing causes problems for the heat pump.
- Usually more complex and expensive to install.
- Systems can be retrofitted but due to the size of pipes further work to raise the floor may be required.

For hydronic UFH used in conjunction with a heat pump, both for domestic and commercial applications three phase offers the advantage of being able to offer a single larger heat pump than two separate units and frequently dispenses with the need to apply to the DNO to connect before initiating the install.

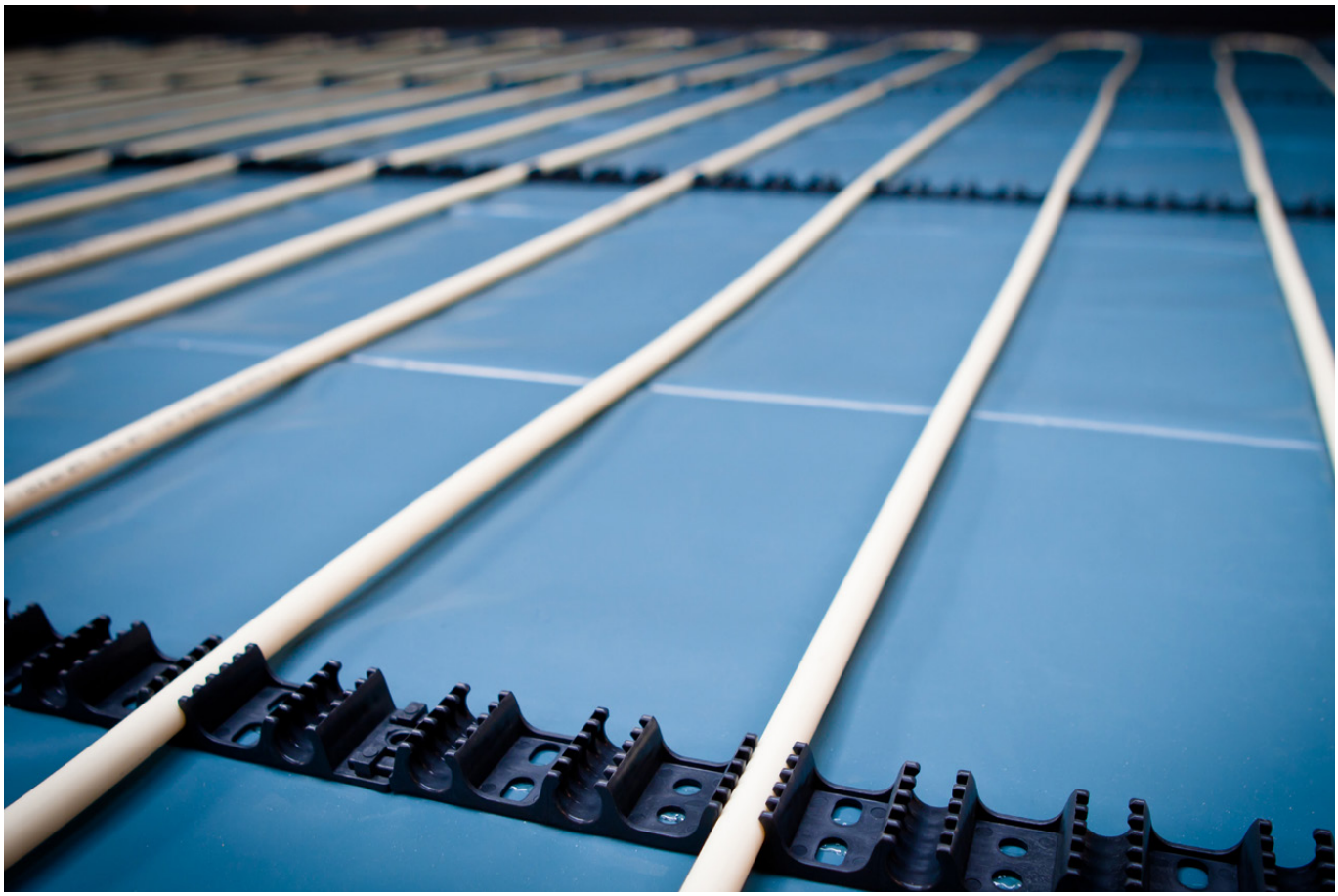
The distribution network operator (DNO) or Independent distribution operator (IDNO) is the company that owns and operates the power lines and infrastructure that connect the electricity network to the property, depending on what upgrades are being undertaken on the property will be dependent on who will be responsible to perform the upgrades to the supply, any electrical work carried out after the electrical meter on the property will be solely for the owners to foot the bill.

Government support will be needed to fund these upgrades. There will be significant positive impact on the Electrical manufacturing sector with but less so for the property owner; inspections and upgrades will need to be paid for. Significant Government grants and support would be needed.

There are approximately 1,000 businesses registered in England and Wales with competent persons for the installation of heat pumps, with the Government's target of 600,000 by 2028 this figure will need to be 40,000.

According to the CCC 'Sixth Carbon Budget report' 65% of consumers have no awareness at all about low carbon heating and only 5% describe themselves as being sufficiently knowledgeable.

This clearly highlights that consumers require education on such technologies, before they can even make an informed decision about future installations and upgrades.



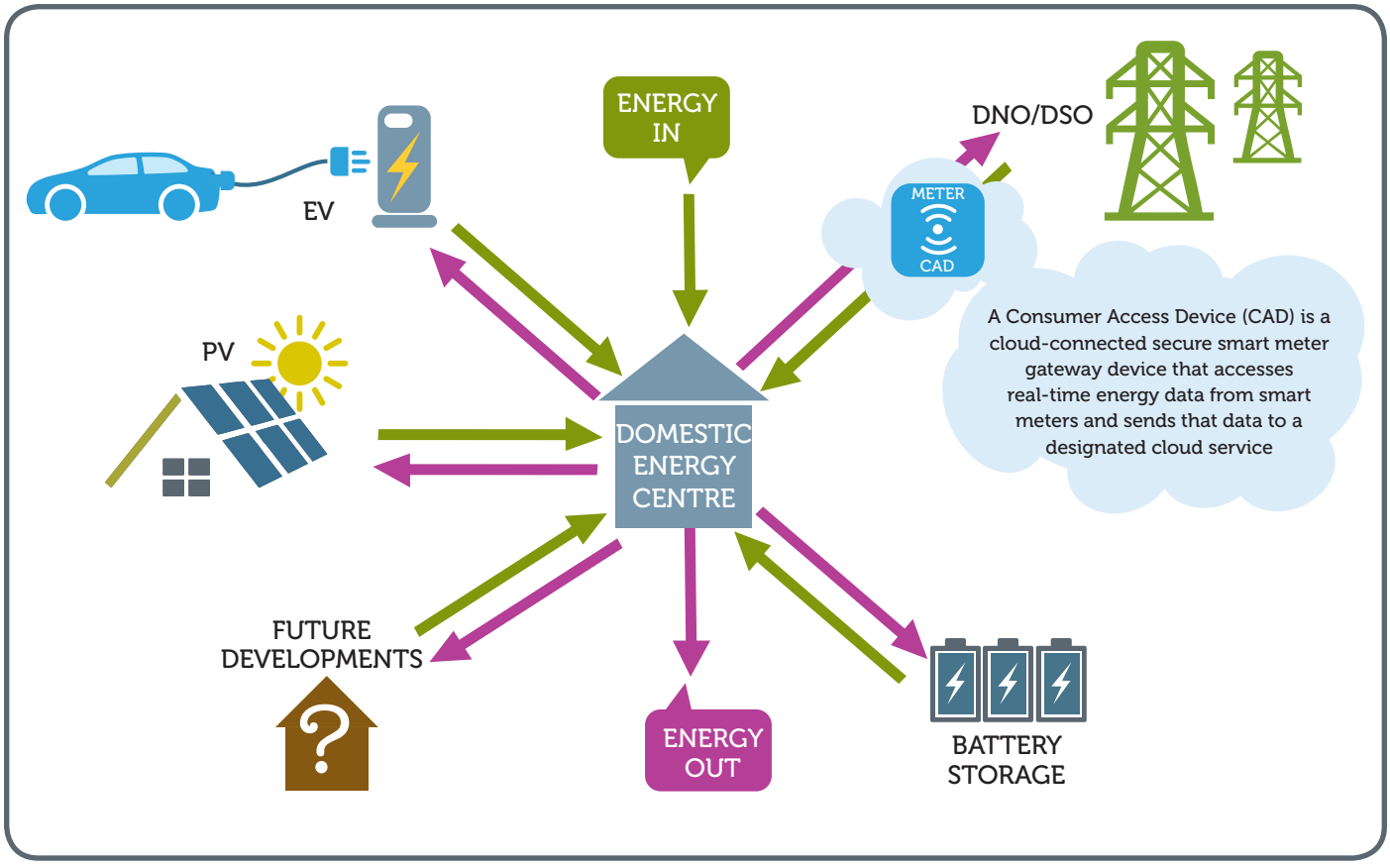
3.
Consumer units upgraded to a 'Domestic Energy Centre'

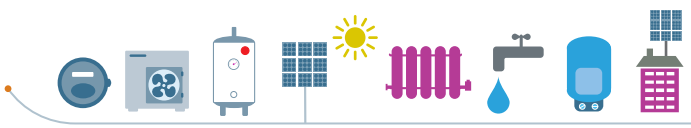
- Facilitate homes with renewable generation, battery energy storage, electric vehicle charging, increased levels of home automation and surplus electrical energy flowing into the grid.
- Ensure extra connection points and the associated circuit protection to accommodate the new functions.
- Ensure a single point of isolation for safety

With the increasing take-up of renewable technologies; electric vehicles; and smart technologies in a domestic installation, a need to consider safe and cost effective means to install these technologies is necessary.

The roll-out of smart metering is also expected to result in a further increase in demand for these technologies along with the need for greater interoperability, communications and data exchange. With the uptake of onsite generation, the need to provide onsite energy storage will also increasingly become vital.

The convergence of these different technologies into an existing domestic electrical installation needs to be handled in a safe and efficient manner. The current practice of each technology being installed separately to an existing installation leads to increased costs to the consumer, sometimes requiring the complete replacement of the customer distribution board (consumer unit). Even on occasions when consumer distribution boards are replaced, the future integration of new technologies is not normally considered which means that if the consumer decides to install another technology, the process may need to be repeated, each time costing the consumer. Similarly, for new builds, provision for future technologies should not be considered in isolation. There is installation interdependence between the smart meter, consumer unit, EV charging, controls for renewables, energy storage and Consumer Access Devices. These technologies all have





physical requirements in terms of space, access, and linkages to consider, and may even promote the use of DC distribution as a replacement for, or in parallel with, AC systems. The development of any one technology in isolation misses the opportunity to facilitate the needs of identified low carbon technologies and deliver economies in installation. Thinking in isolation may even create barriers for inclusion of other technologies.

Therefore, to enable future take up of new technologies and to protect the consumer from costly rewires/replacements, a domestic energy centre that is designed to allow for future technological integration in a safe manner and at a minimal cost to the consumer is vital. The standard for distribution boards is under maintenance and will address issues around microgeneration and prosumer but is at a very early stage.

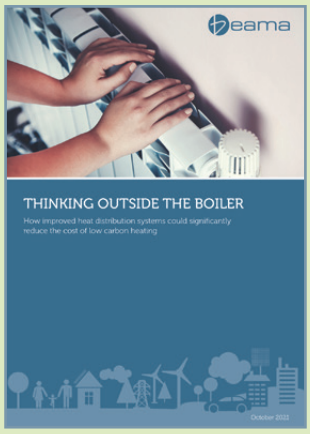
External stakeholders: For new builds and in the absence of regulatory drivers, the support of NHBC would be crucial. Any proposed alterations to designs to accommodate a domestic energy centre would need to be justified and will need to be seen as adding value for the customer. Changes to the UK Building Regulations would enforce these changes and ensure adequate space is created for a Domestic Energy Centre within the property. Equally for retrofits and new builds alike, the support of the electrical contracting fraternity would be necessary. Certsure, ECA, NAPIT, NICEIC, SELECT and the like will play an important role in driving the uptake of new technologies while ensuring appropriate training and qualifications are afforded to their members. The UK Wiring Regulations, BS 7671, would require updating to include the new technologies and be a catalyst for training and development of installers.

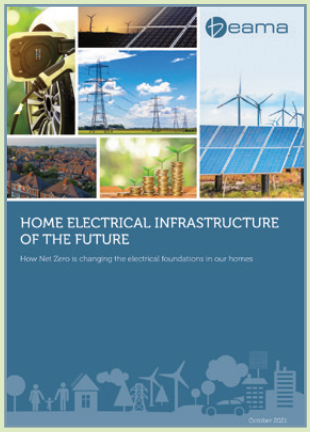
Regulating existing housing in the rented sector and new homes is more easily achievable however existing privately owned homes is a much greater challenge. Once such solution as mentioned in a podcast from David Cowburn @ NAPIT suggests that **'Consequential Improvement' as detailed in the UK Building Regulations may be a solution. 'Consequential Improvement'; if changes are being made anyway, then you're required to make specific changes. An example of this could be to upgrade not replace 'lie for like'. (Boiler Plus scheme was a working example of such a 'Consequential Improvement'.

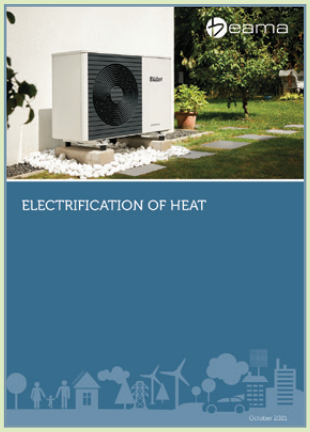
**UK Building Regulations: Part L2B / Section 6: Consequential improvement

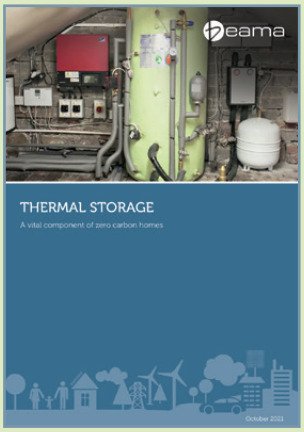
To read more, download the BEAMA *Net Zero by Design Main report and white papers*

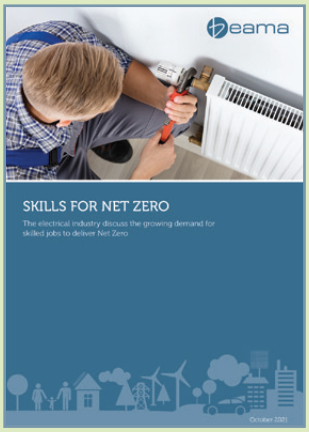
CLICK HERE











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