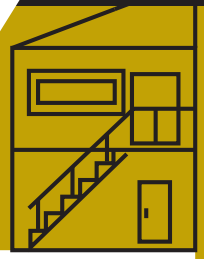
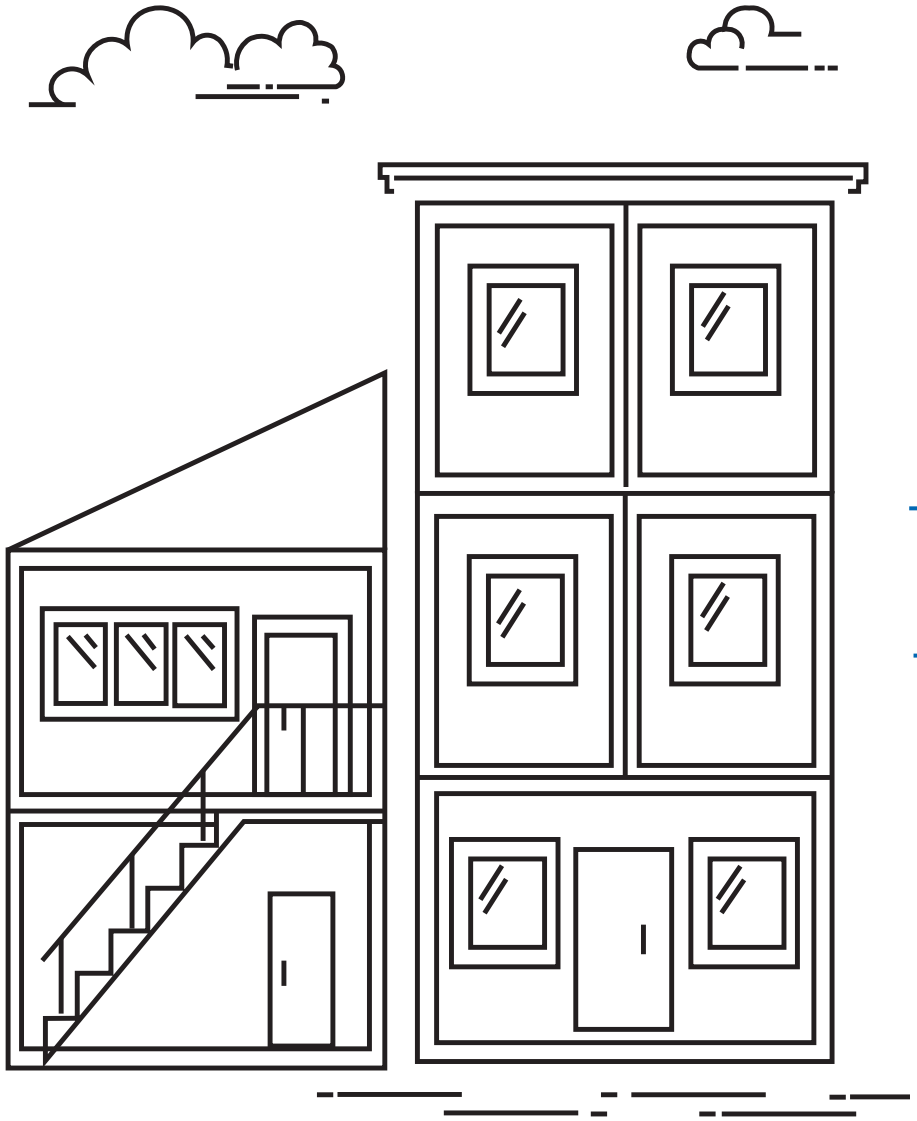
Building Design 2029

Predicting trends for the future



Glen Dimplex
HEATING & VENTILATION

The current landscape



Population growth and densification in our cities are driving change within the building industry. When these issues are combined with rising temperatures and more extreme weather events, the result is an increased need for more housing and air conditioning within the urban environment. For example, the **UK Government has recently declared that all new buildings will be required to be net zero carbon by 2050[1] and gas free by 2025[2]**. Additionally, there will be a need for an extra 340,000 new homes each year in England until 2031 to meet demand[3]. The lifecycle impact and energy performance of these new buildings need careful consideration if we are to meet our demanding energy and carbon reduction targets. While suitable dwellings need to be constructed for residents' needs, they also need to comply with more stringent legislation, e.g. EU nearly Zero Energy Buildings (nZEB) and UK building regulations Part L, as we continue to look for ways to achieve a more sustainable future.

The Building industry needs to meet societal changes and expectations, as well as changing legislation, by addressing new approaches to products, technology and construction in regard to new build properties in the UK.

This e-book will look at how the building industry can meet societal changes and expectations, as well as changing legislation, by addressing new approaches to products, technology and construction in regard to new build properties in the UK. It has a strong focus on sustainability, and comments on how the building industry can adapt and drive change towards 2029.

1 https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law
2 https://www.telegraph.co.uk/news/2019/02/21/end-gas-hob-government-advisers-say-new-homes-should-gas-grid/
3 https://www.independent.co.uk/news/uk/home-news/housing-homeless-crisis-homes-a8356646.html

Introduction

Globally, buildings and construction account for 36% of global final energy use and 39% of energy-related carbon dioxide (CO2) emissions[4]

Across the European Union (EU) energy consumption in buildings is the largest user of energy from all sectors in Europe[5]. The European 2050 roadmap aims to reduce energy use, and **CO^2 equivalent (CO2e) emissions, by at least 80% by 2050 compared to 1990 levels**. It is vital that our buildings become more efficient and minimise their impact on the environment. This includes all aspects, such as manufacturing, transport, the building fabric, use of energy and end of life. The use of fossil fuels for heating is one of the most significant energy users, which is why the UK in particular, though the Future Homes Standard is looking for a cleaner non fossil fuel alternative.

In this eBook, Glen Dimplex Heating and Ventilation in collaboration with Dr. Stephen Finnegan, lecturer in Sustainable Architecture at the University of Liverpool, discusses five predictions that will have a dramatic impact on the building and design industry over the next ten years.

In his Spring Statement in March 2019 Chancellor Phillip Hammond announced a Future Homes Standard with the end of fossil fuel heating by 2025

4 "2018 Global Status Report - Towards a zero-emission, efficient and resilient buildings and construction sector | World Green Building Council." [Online]. Available: https://worldgbc.org/news- media/2018-global-status-report-towards-zero-emission-efficient-and-resilient-buildings-and. [Accessed: 22-May-2019].

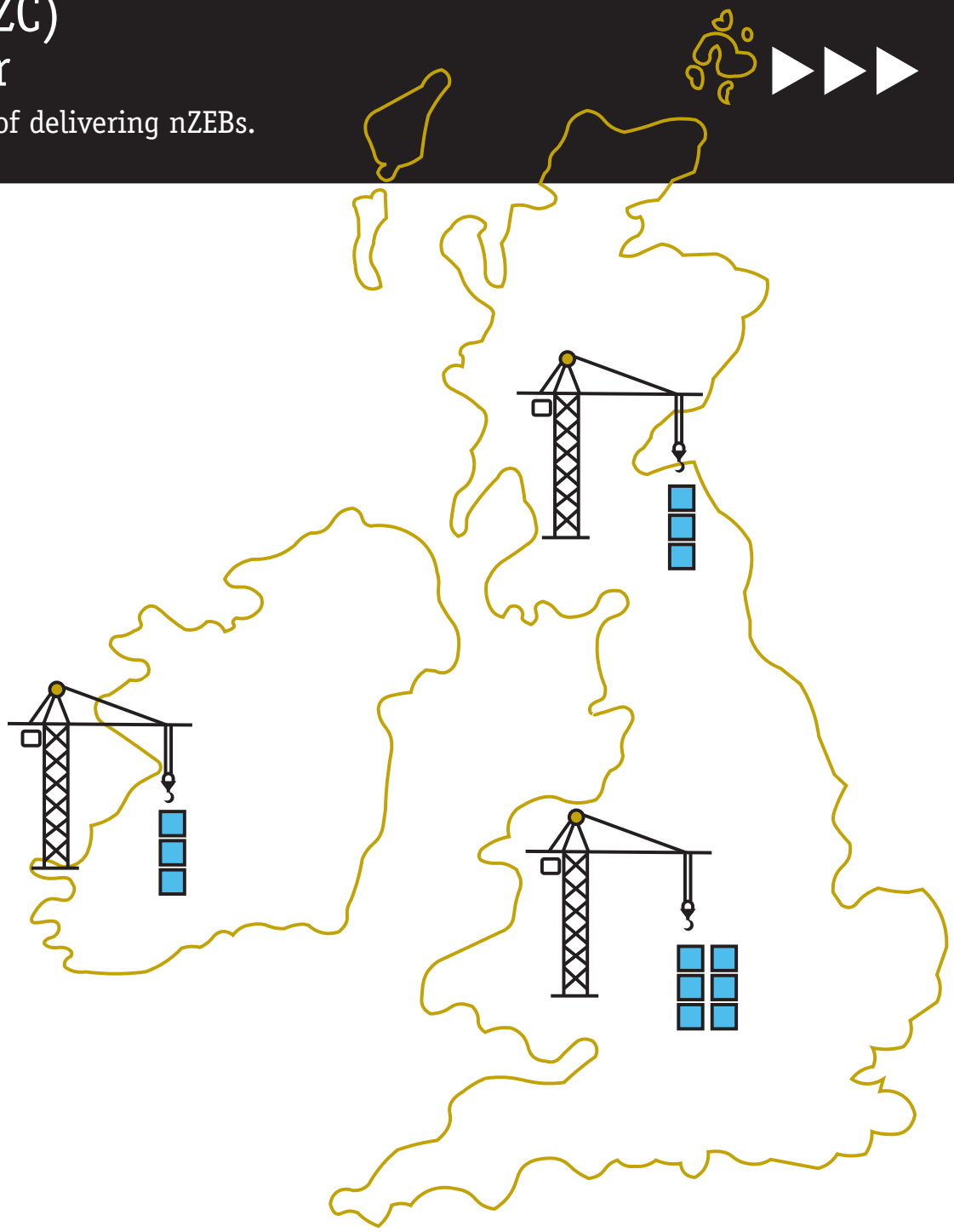
5 R. Moschetti, H. Brattebø, and M. Sparrevik, "Exploring the pathway from zero-energy to zero-emission building solutions: A case study of a Norwegian office building," Energy Build., vol. 188–189, pp. 84–97, Apr. 2019

Prediction one: Net Zero Carbon (NZC) and nZEB will become more popular

Building to net zero carbon standards provides one method of delivering nZEBs.

UK

It is likely that nZEB buildings will, in the short term, lead the way and act as the forerunner to the creation of more sustainable buildings, providing time for the industry to transition to the more stringent Net Zero Carbon (NZC) standards.



As building regulations become tighter and residents seek to live more sustainably, the construction industry needs to build comfortable, affordable, high-quality homes with ultra-low energy use and excellent indoor air quality. These are all outcomes which a Net Zero Carbon (NZC) and nZEB building strive to achieve.

NZC buildings will be required across the UK by 2050 with nZEB buildings required much sooner. The UK Green Building Council (UKGBC) is working closely with the UK Government to help shape the meaning of the 'net zero' terminology. The recently published UKGBC Net Zero Carbon Framework[6] provides the first clear path to achieving net zero carbon in both construction and operation. The operational carbon i.e. emissions from mechanical and electric (M&E) systems will come first followed by a requirement to also consider the construction (or embodied carbon) impact.

6 https://www.ukgbc.org/ukgbc-work/net-zero-carbon-buildings-a-framework-definition/

Prediction two: Modular build

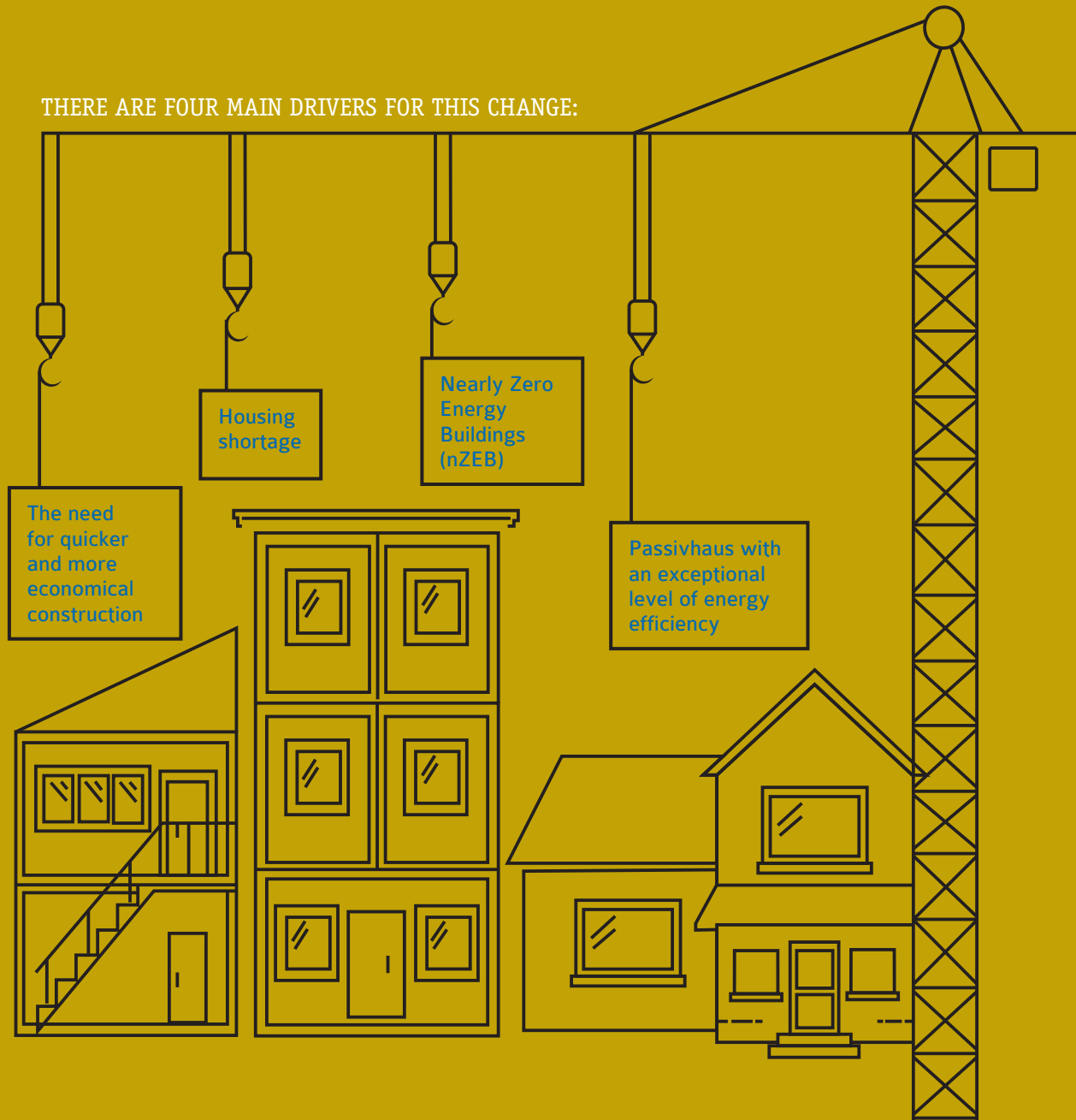
Modular homes are a way to deliver high-quality housing in a cost-efficient and timely manner

A modular house is often referred to as a 'prefabricated home'. It is built in sections within a factory and then assembled on-site in its new location. A modular house is subject to the same regulations and planning laws as more traditional builds.

Modular housing will develop at pace and very recently Homes England, Urban Splash and Sekisui House (the largest modular house building in Japan) have joined forces in a **£90 million initiative to building modular homes across the UK[7].**

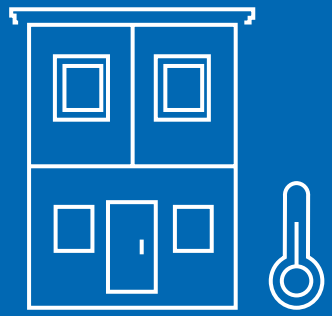
Modular homes take less time and labour to complete than traditional builds as much of the prefabricated unit is built off-site. A modular build can vary from simply the fabric of the building and much of the internal piping and ductwork. In the latter example, this means that technologies such as ventilation systems and heat pumps can be easily connected on site. Many modular builds even come complete with fully fitted bathrooms and kitchens.

Passivhaus is a performance standard that can be achieved with a variety of construction techniques and materials to address various construction methods in different climates around the world. Using modular build techniques is an excellent way to meet the standard, but to achieve nZEB, designers, architects and builders will need to adopt a fabric first approach.



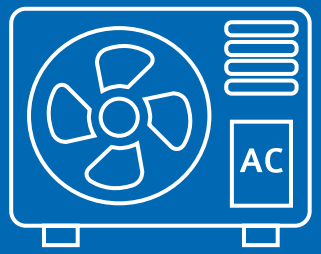
7 https://www.insidermedia.com/insider/northwest/urban-splash-secures-55m-investment-as-japanese-housebuilder-enters-uk-mark

The approach



16-24°c

30-40W



40-60%
of peak power

Essentially, the modular build approach looks to the fabric of the building to reduce energy losses before any other technologies are factored in. In fact, residential homes can be 'super-insulated' to dramatically reduce both heat gains and losses, leading to environments that can **maintain temperatures of 16-24 degrees Celsius all year round** without any heating requirements. However, consideration must also be given to the environmental impact of the material. For example, virgin concrete achieves performance targets but could be considered non eco-friendly. Whereas Structurally Insulated Panels (SIPs) or Cross Laminated Timber (CLT) structures are potentially more sustainable, providing the same U-Values as concrete. This can meet the efficiency targets of nZEB, and is ideal for modular construction.

Of course, an airtight modular build will require ventilation if it's to be a comfortable environment for its residents, and that means more than opening a window. MVHR systems filter out stale air and replace it with fresh air. Additionally, they can achieve this with **very low electricity consumption of 30-40 Watts** and the recovered heat can be used to maintain a comfortable temperature throughout the building.

As the government moves away from gas and towards net zero emissions by 2020, heat pumps alongside MVHR systems are an ideal way to meet these targets as well as nZEB. While Passivhaus modular builds have minimal energy requirements, heat pumps can provide energy when needed — meeting both primary energy and reduced carbon targets. Indeed, the government's Clean Growth Strategy suggests heat pumps as a way to decarbonise how we heat our homes[8]. The world economic forum has identified air conditioning in hot climates as a significant problem. **In Mumbai and New Delhi, AC accounts for 40-60% of peak power.** With the population growing, by 2050, there are expected to be more than 1 billion units in India. This is predicted to be a major factor in India's emissions rising to 25% of the global total by 2025[9]. A 20-year national cooling action plan is in place as alternative low energy solutions are sought.

8 http://www.biee.org/wpcms/wp-content/uploads/BEIS_The_Clean_Growth_online.pdf
9 https://www.weforum.org/agenda/2019/05/india-heat-cooling-challenge-temperature-air-conditioning/

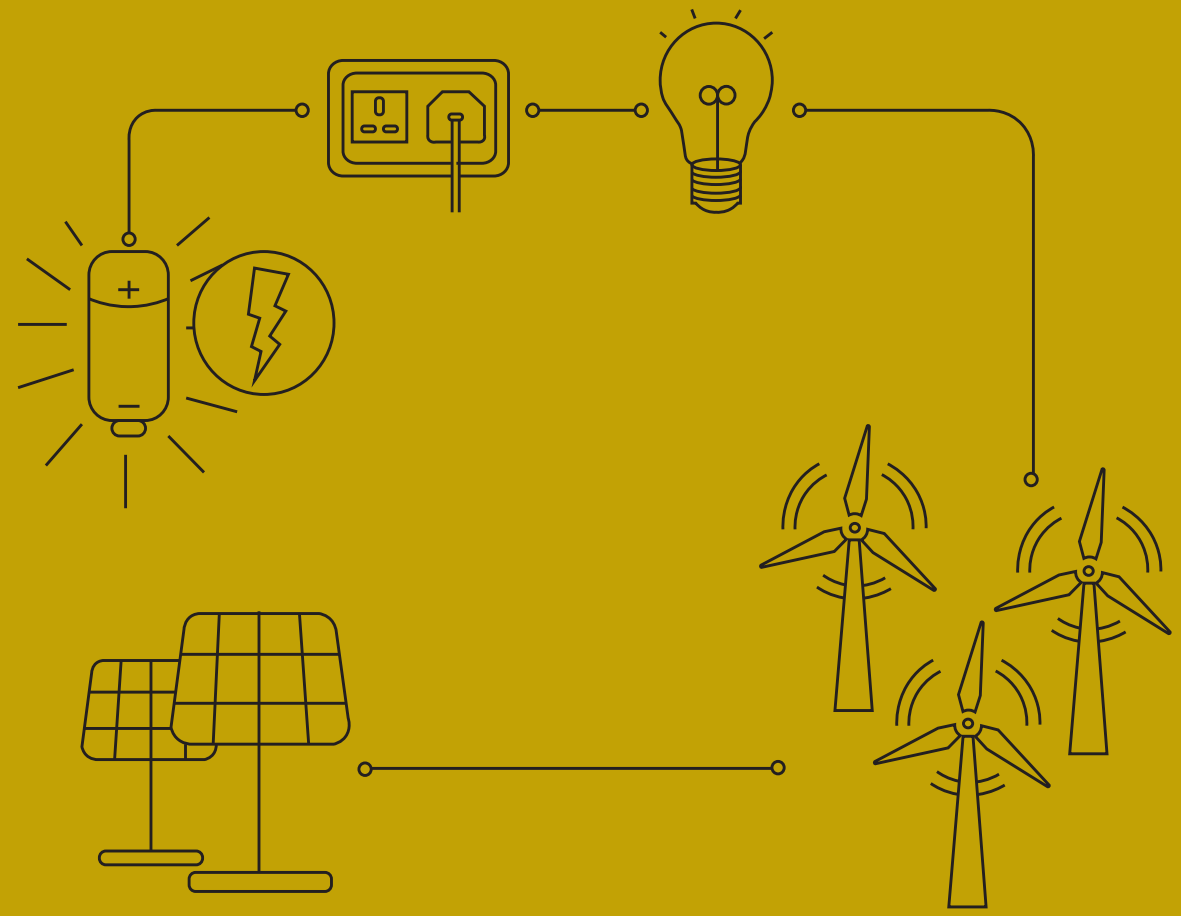
Prediction three: Renewables

Renewable energy provides the means to generate electricity without harmful greenhouse gas (GHG) emissions

As the population continues to grow, and despite improvements in energy efficiencies, there will clearly be a requirement for more energy, not less. For the EU and UK to meet the nZEB and Net Zero Carbon (NZC) targets, more of our energy will need to come from renewables. However, **renewables such as wind and solar power are an intermittent source of energy when compared to more traditional methods of electricity generation.**

Battery storage is a great solution for reducing dependence on the grid at peak times of the day. For instance, switching to an Economy 7 or 10 tariff - when most electricity is consumed from the grid in the evening at non-peak times - is considerably cheaper than other times of day. Having a battery installation means that electricity can be purchased at these cheaper times and stored for use when prices rise. Combining artificial intelligence (AI) and automating the system allows this to happen seamlessly and without any intervention. Battery technology can (and over time will) easily form part of the modular build for all future homes.

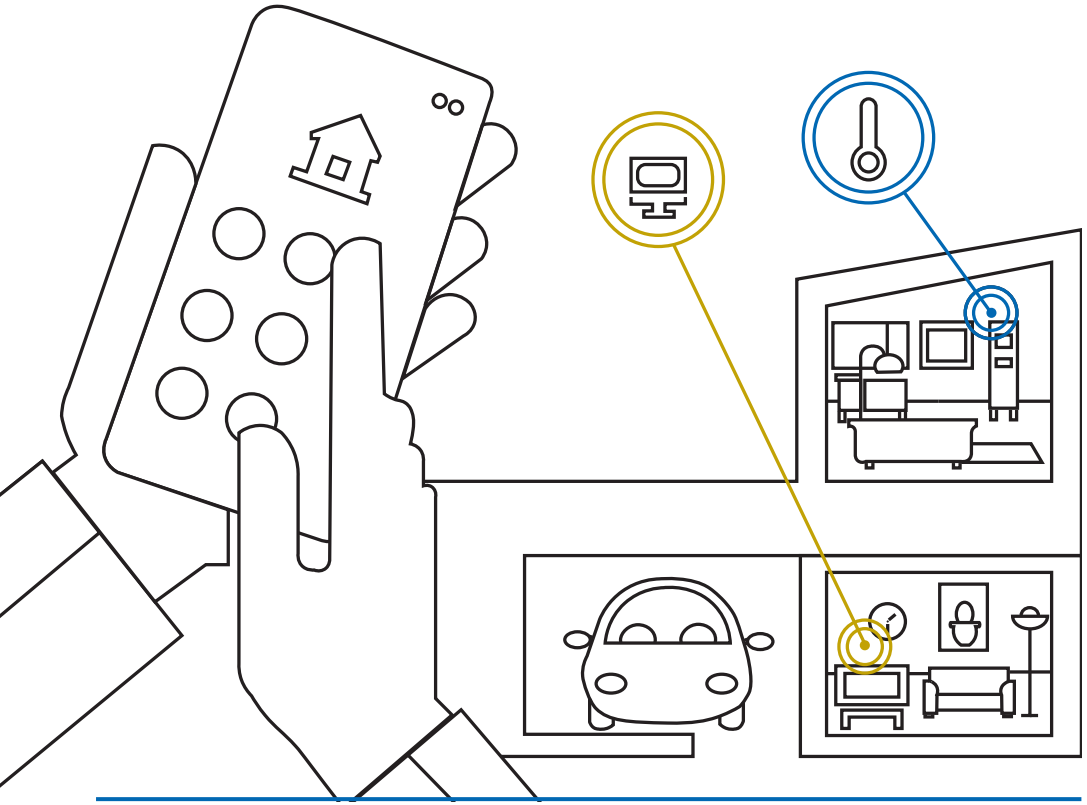
Combining photovoltaics with battery technology is where buildings start to become more independent of the grid and really start to achieve NZC standards. As outlined in the Energy Performance of Buildings Directive (EPBD), the little amount of energy required by an nZEB building should be covered by renewable sources, produced on-site or nearby. Furthermore, solar photovoltaics, which produce electricity on-site, do not contribute to primary energy as the electricity doesn't need to be transported. Using Mechanical Ventilation with Heat Recovery (MVHR) systems and heat pumps alongside renewable technology not only achieves net zero emissions and nZEB, it can also reduce the energy costs of running the building to near zero for its residents. This is an ideal solution for tackling fuel poverty in social



As the Committee on Climate Change (CCC) states, the UK can end its contribution to global warming within 30 years by setting an ambitious new target to reduce its greenhouse gas emissions to zero by 2050

Prediction four: The growing influence of technology

Technology is an essential requirement in maintaining air-quality and comfortable temperatures within an nZEB home



"We can design buildings to nZEB and NZC standards but ultimately, it's down to the occupants to ensure that they remain as energy efficient as possible."

Technology is already being used extensively within our homes. **Google Home, Alexa and Nest are all familiar names to most housing residents and many already choose to control their heating, lighting or security cameras** with these devices or the Internet of Things (IoT) as they can be referred to. However, nZEB buildings have a definitive technology requirement to remain nearly zero energy, unlike more traditional builds.

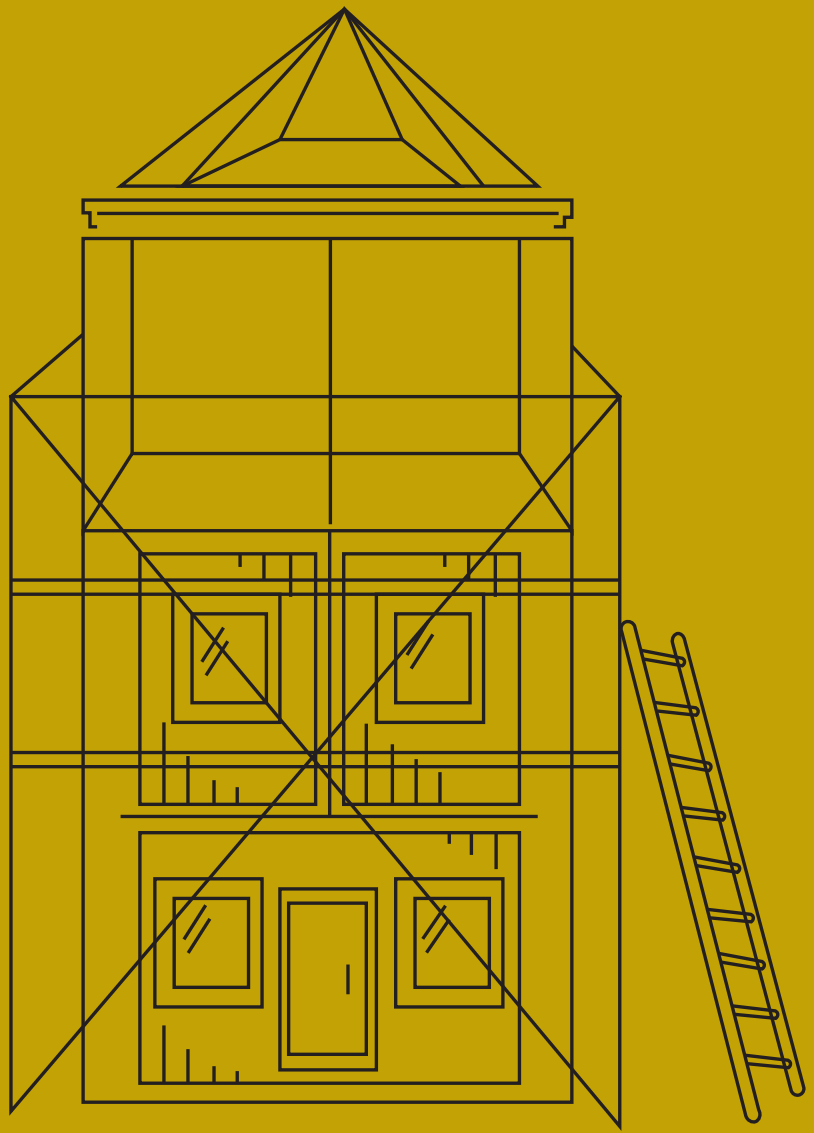
Maintaining a constant and comfortable temperature within an nZEB building requires smart controls that monitor the temperature and sense when a window or door is left open. For example, the technology used within the dwelling needs to be controlled automatically for the required level of comfort to be achieved. Maintaining the efficiency of the system requires more than human judgement — how much ventilation, cooling or heating is required should be decided through intelligent controls and sensors linked wirelessly together.

Additionally, a modern smart meter can monitor the electricity usage of individual appliances as well as linking to renewable sources such as photovoltaics and battery storage technology. AI will play an important part in leveraging this. Estimating how much energy a household requires at different times of the day and balancing this with the best time to buy electricity from the grid, and when to rely on stored electricity, can be a very complex process. Linking renewables to the grid with AI can overcome these complexities.

However, the efficiencies of an nZEB building can be disrupted if residents do not use it correctly. While energy efficiency can be controlled with the technology, it also requires a change in mindset from residents. Indeed, most construction companies provide training and education for new residents on how to get the most out of their home and the benefits that nZEB can provide. Some have also found that signing residents up to 'energy efficiency programmes' and providing performance data each month also helps them to become more accustomed to their nZEB homes.

Prediction five: The environmental impact of products

Reducing the environmental impact of housing stock boils down to more than just energy efficiency



There are many factors to consider when designing a sustainable and environmentally friendly home. Energy efficiency within the home tends to be front of mind but every product within the dwelling contributes to its lifetime environmental impact. Construction materials, for instance, should be sourced locally, manufactured using sustainable methods and disposed of correctly at the end of their life, as well as having minimal effect on the environment during their use. An Environmental Product Declaration (EPD) is an independently verified and registered document that communicates transparent and comparable information about the lifecycle and environmental impact of products[10]. In the construction industry, more suppliers are publishing an EPD for their products, but using these in isolation isn't enough according to BRE[11]. It recommends using a building lifecycle assessment (LCA) and BREAAM UK New Construction 2018 framework fully embraces this. The aim of the framework is to enable and encourage the construction industry to rise to the challenge of further reducing the environmental impact of buildings.

BRE is a world leading, multi-disciplinary, building science centre with a mission to improve buildings and infrastructure, through research and knowledge generation.

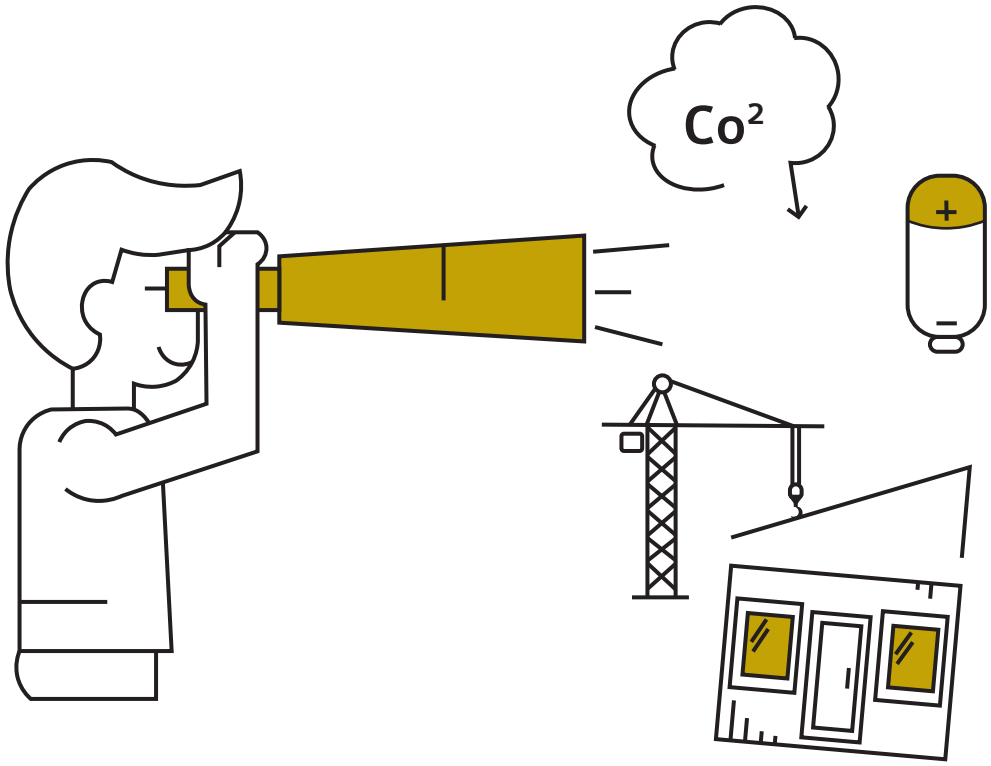
While there is no current government mandate concerning an EPD, the construction industry has much to gain from adopting this approach. Residents are increasingly concerned about sustainability and this could be used as a competitive advantage for building companies. Modular construction companies will need to take special notice of this as they are less limited to buying locally. It may be cheaper to source materials in Africa or the far east, but what due diligence checks are undertaken? What about ISO certification or CE marking? An EPD provides some level of approval by measuring the overall environmental impact. Maybe importing a product over such a vast distance is a poor environmental decision to make.

This presents an opportunity for modular build construction companies to find the right technology and material from local companies with a good EPD certification. Otherwise, it may seem conflicting to construct an nZEB building out of products that have a larger than necessary carbon footprint.

10 https://www.environdec.com/What-is-an-EPD/
11 https://www.breeam.com/news/breeam-why-building-lca/

What does 2029 look like?

Futuristic, space-age skyscrapers or understated eco-dwellings?



"Carbon reduction, climate change and energy efficiency may be the instruments of change, but homes must also be comfortable, affordable and healthy places to live."

While we cannot say for certain what the future holds, changes in legislation and residents' expectations all seem to point towards net zero emissions and nearly zero energy buildings which are comfortable, affordable and healthy spaces to live in. This is combined with population growth, increased urbanisation in our cities and a requirement for more, not less energy. The only possible solution to achieve targets and expectations is to combine the trends covered in this eBook. It seems that modular builds with their decreased construction time and high energy efficiency could be a very viable solution. **Additionally, we need to take advantage of renewable technology to avoid increasing CO2 emissions, reduce the depletion of natural resources, as well as ensure energy use is as efficient as possible.** Certainly, a zero-gas dependent housing stock looks very likely and using passive design principles to achieve nZEB and NZC for all new builds is the way to achieve these ambitions.

It's now possible to build a house digitally with design software and 3D printers. This means that homes could be made anywhere in the world and shipped to location for modular construction. **However, it is worth noting that materials and technologies will become under increased scrutiny for their environmental impact across their whole lifecycle as well as their cost, quality and suitability for the job.** Are we actually increasing lifecycle CO2 emissions with the mass uptake of particular sustainable technologies? The construction industry will need to stay ahead of the game in terms of evaluating and testing the many innovative construction materials coming on to the market.

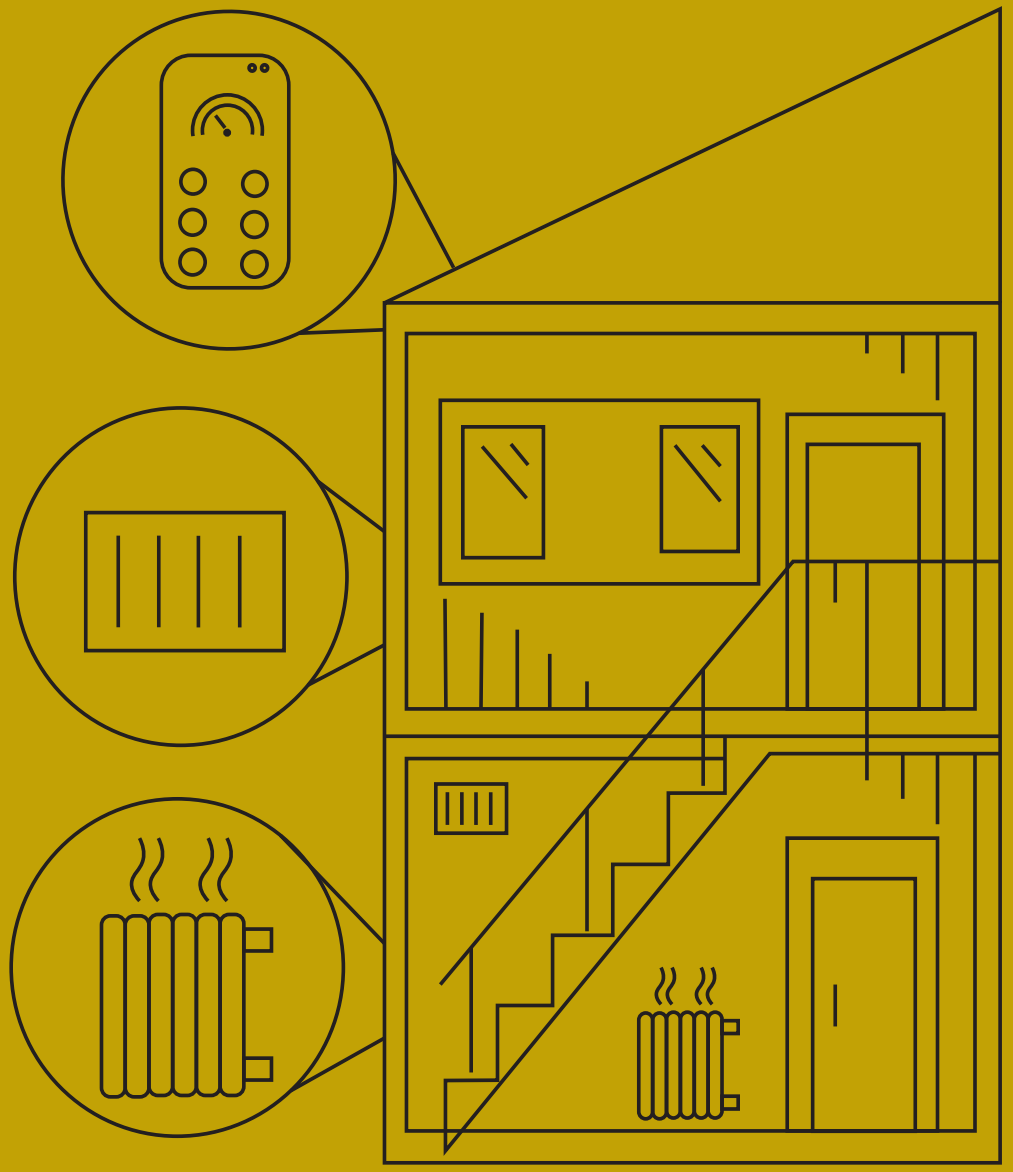
Without a doubt, our homes will increasingly be controlled via the IoT. Combining AI and machine learning with smart technologies allows buildings to learn about the energy needs of their residents, adjusting ventilation and temperatures much more efficiently than human intervention would do. Carbon reduction, climate change and energy efficiency may be the instruments of change when it comes to new and updated regulations. However, it mustn't be forgotten that homes should also be desirable, comfortable, affordable and healthy places to live. The building industry has the opportunity to embrace both angles and ensure that any homes built in the future can meet all of this criteria.

About Glen Dimplex Heating & Ventilation

Glen Dimplex Heating & Ventilation designs, develops and manufactures professionally installed heating and ventilation systems for residential and commercial buildings. It is a market leader in electric heating appliances in Europe and a leading player in decorative electric and gas fires and solid fuel stoves.

A division of the Glen Dimplex Group, the world's largest electrical heating business, Glen Dimplex Heating & Ventilation brings together a number of leading businesses within the sector, including: Dimplex, Xpelair, Valor, Redring, Creda, NOBO, Campa, Faber, and Ability, serving both UK and European markets. Products range from smart electric heating systems using the latest control and communication technologies, through to district heating networks - encompassing heat pumps, (some as part of water-to-water low temperature energy loops), MVHR systems, and a range of heat emitters such as fan coil units and fan-assisted hydronic radiators.

Headquartered in Southampton, England, Glen Dimplex Heating & Ventilation operates a policy of continuous investment in R&D. It operates a product design facility in the UK and has product category focused research teams with state-of-the art testing and evaluation in Ireland, and Europe.



About Dr. Stephen Finnegan

Stephen has 25 years+ of experience in sustainability in construction and operation, having previously worked for KPMG LLP, AEA Technology, Arup and the European Commission.

He currently works as a lecturer in Sustainable Architecture at the University of Liverpool and is actively involved with a number of UK professional bodies such as the UK Green Building Council (UKGBC). He has a number of academic publications relating to sustainable design, embodied carbon impact, life cycle planning and operation and has presented his research work in the US, India and across Europe at various international conferences and events. Stephen is currently supervising five Ph.D. students and has recently published a Taylor and Francis book entitled "New Financial Strategies for Sustainable Buildings".

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