In partnership with:

KOPE

MAKE uk MODULAR

GREENER, BETTER, FASTER: MODULAR'S ROLE IN SOLVING THE HOUSING CRISIS

makeuk.org

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ABOUT MAKE UK MODULAR

Make UK Modular is the voice of modular housing – the most advanced form of construction in the United Kingdom.
Make UK Modular was founded in December 2021 and has grown to include Ilke Homes, L&G Modular Homes, Top Hat, Laing O'Rourke, Vision Modular Systems and Stelling Properties.

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CHAIR'S INTRODUCTION

I had been in housebuilding for nearly 40 years when it became clear to me that the industry had not changed in terms of productivity and methodology of build since I entered it. Instead, I saw new challenges arising from the supply chain.

I became chair of modular manufacturer Ilke Homes in 2018 and found I wasn't alone in wanting to see change. Several other pioneering providers emerged, who recognised the challenges facing the sector and the need to create a better, sustainable method of producing the homes the country needs. From this, our trade body Make UK Modular was formed.

This report, the first of its kind, lays out where the modular housing industry is today, and where it is going. It has pulled together comprehensive data from all of Make UK Modular's members plus a wide range of external stakeholders.

From this, two clear pictures have emerged. First, modular has arrived in the UK. Second, modular is growing, and growing rapidly. We now know that nearly £1 billion of private finance has put in place the capacity to deliver more than 20,000 homes per annum by 2025. This is without the sort of government support packages commonly seen in other manufacturing industries such as automotive, wind energy, and aerospace.

The benefits of modular have been talked of for years. This report demonstrates that they have firmly arrived with modular delivering some of the highest quality, greenest, most energy efficient housing in the country at unprecedented speed.

However, there are still barriers which slow our progress and delay these much-needed benefits. We now need government to accelerate delivery and ensure the viability of the investment made and the jobs created by removing the remaining barriers holding the industry back. This report explains how government can do this and support modular without additional public spending.

Government must capitalise on this investment and capacity. It will not have this opportunity again. It is my hope that this report demonstrates not only how far the sector has come but will help government and industry to ensure the housing of the future is built today.

Dave Sheridan
Chair of Make UK Modular

FOREWORD

The UK housing market has been in crisis for over 30 years. The total number of new houses built each year has not kept pace, leaving an imbalance between supply and demand.

The UK government has recently taken radical measures to try and solve this problem by introducing new legislation that speeds up planning applications and cuts red tape, but more is required. The vast majority of these measures are still focused on building houses in the same way as we have done for the last 100 years.

This report makes clear that modular construction is one of the key solutions taking centre stage to address the housing crisis. Even though this building concept has been around since the 1800s, it has taken a long time to become mainstream.

However, in recent years we have seen a resurgence, driven by government and industry strategy, as well as advancements in technology and a rise in institutional investment. Innovation within the sector is shaping its own path too, with KOPE sharing a similar vision as to where the industry needs to go to help improve the built environment.

Modular construction looks set to play an increasingly important role in the UK housing sector as we look to meet the demand for new homes across the country. Several modular house builders have surfaced and entered the market over the last few years, challenging the status quo of the traditional house builders.

The overall outlook is extremely positive and we are confident modular will play a huge part in helping to resolve the issues around housing. At KOPE, we are focused on helping those intent on making a difference.

Whilst the new era of digitization offers immense benefits for the construction industry, the environment, and the economy; the barrier to entry is high and widespread adoption is still low. In the modular sector, we see natural partners who are also trying to transform the housing sector.

The writing has been on the wall for some time now and we find ourselves at a tipping point where these new approaches to design and build must now be embraced by the industry. KOPE aims to give everyone in our sector the ability to embrace modular and offsite construction. As this report illustrates, modular has made huge strides in recent years and is now in a position to have a transformative effect on UK housing.

The sector is now well placed to create a more sustainable and repeatable construction industry, while empowering the people aiming to address our housing crisis, therefore allowing future generations to grow and thrive.

Mark Thorley
Co-Founder & CEO, KOPE

EXECUTIVE SUMMARY

Widescale change in the way in which we build new homes at scale has not been seen in the UK for generations. Technological advances have transformed areas of life including transport, entertainment, retail and consumables, but until recently housebuilding had been slow to innovate. That is now changing with the advent of a new generation of factory-built modular homes.

POISED FOR GROWTH

Modular housing, the production of entire homes in factories as 3D modules, has matured rapidly in the last 5 years – more than doubling its output despite the Covid-19 pandemic. In 2022, one in every 60 new homes in the UK will be built entirely in a factory – that's over 3,300 new homes, providing somewhere to live for an estimated 8,000 people. Make UK Modular members (who account for about 70% of the market) are on track to expand output by 400% and produce more than 10,000 homes by 2025.

Capacity is in place to deliver in excess of 20,000 new modular homes per annum by 2025. This would grow England's housing supply by 10% and cut the output gap on the government's housing target by 20%.

FASTER, BETTER, LOWER COST

Factory engineering means modular homes can be built to consistently high standards, for competitive costs, at speed, and delivered to sites with hugely reduced disruption. Modular homes are typically built 50% faster and reduce waste by 90% compared to traditional build.

JOBS AND PRODUCTIVITY

Modular factories create jobs where they are most needed, and then deliver houses and apartments to where they are most needed. Up to 65% of modular's workforce are in manufacturing jobs, not construction, allowing modular to rapidly expand its workforce. Building in a factory has driven up productivity by over 40% compared to traditional on-site construction.

CHEAPER TO HEAT, BETTER FOR THE PLANET

Modular homes are the greenest new homes being built at scale in the UK – green to build, green to live in. Modular is building homes in the top energy performance bracket, which can save an average household up to £800 a year in energy bill savings – a 32% reduction on the average new-build home, and a 55% reduction on the average UK home.

Modular tower blocks are built with 45% less whole-life embodied carbon, while modular houses can be built with up to 82% less whole-life embodied carbon.

INVESTING IN R&D AND INNOVATION

A new, innovative industry, modular accounts for up to 30% of all R&D spending in the construction of buildings sector. Nearly £1 billion of overall investment into modular is helping to level up the nation – supporting dozens of new factories and creating nearly 3,000 new jobs.

OPPORTUNITIES FOR GROWTH THROUGH A SUPPORTIVE POLICY FRAMEWORK

There is a huge opportunity to be grasped. Private investment has been substantial and the modular sector does not require new financial support from government to fulfil its potential. There are a small number of strategic, effective government policy decisions which can act as a catalyst to help build self-sustaining momentum. In the process, skilled jobs will be created the quality of new homes will be improved, the carbon footprint of our new homes will shrink and their energy efficiency will increase as modular expands.

This report looks at the areas where government should move to support growth and innovation. This includes expanding the role of modular in affordable housing provision, offering fast-track planning, prioritising modular and green homes in land allocation and raising energy efficiency standards for new housing. Collectively, these changes would drive up standards, while offering pipeline security for modular producers and helping the industry to scale up.

By working with the sector, government can deliver the UK's much needed homes: greener, better, faster.

PART ONE CHALLENGES

1.1 BRITAIN'S HOUSING CRISIS

Housing supply has not kept pace with demand

Britain's housing crisis has been a generation in the making. The UK has not delivered enough housing for decades and supply has failed to keep up with demand.

The 2010s had the lowest private-sector completions of any decade since post-war rationing ended in the 1950s. This is despite rocketing house prices which have increased by over 370% since 1998. The average home is now priced at 7–8 times the average salary, up from just 4 times the average salary in 1998.[1]

The rising cost of housing has pushed up rental prices across England by 40% since 2005 (46% in London), pricing many first-time buyers out of buying, worsening their access to good homes and taking money out of the economy.

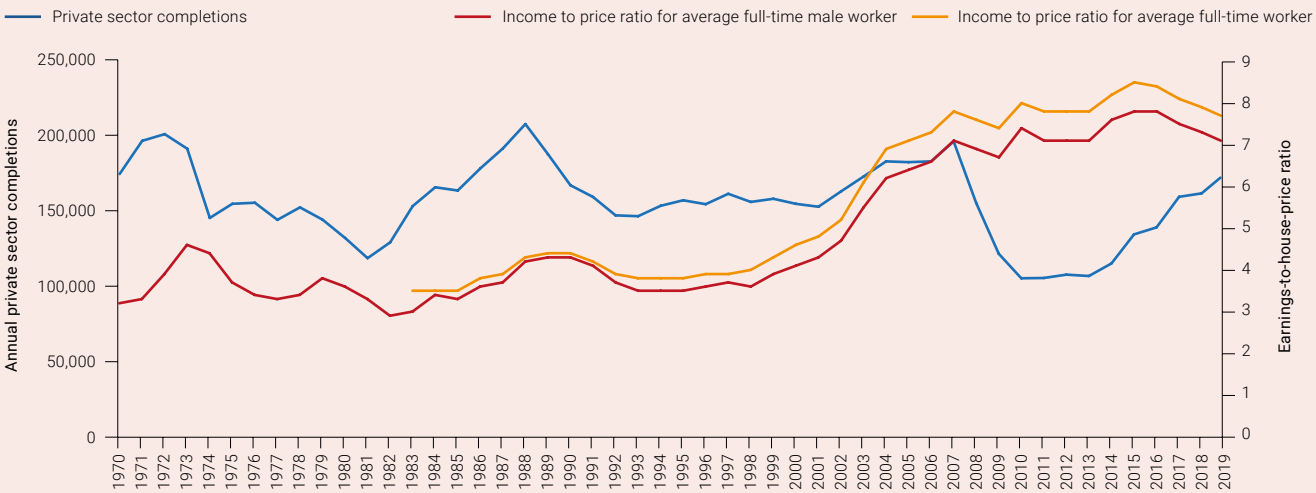
Despite this enormous clamour for housing, the housebuilding industry has been unable to ramp up supply. In no other sector has the marketplace failed so dramatically to meet such high demand.

As such, the government will almost certainly fail to meet its target of building 300,000 homes a year by 2025. Even in the public sector, Homes England missed its 2021–22 affordable homes delivery target by 21.5% and its overall completions target by 15%.

The housebuilding industry is fundamentally struggling to deliver across all sectors and tenures.

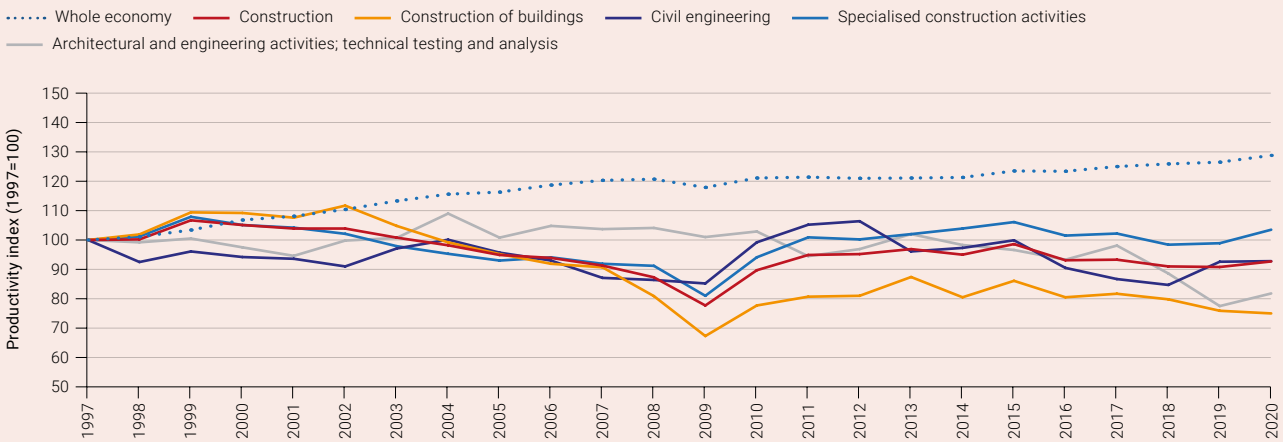
There are both demand- and supply-side explanations for the housing affordability crisis, but on the supply-side traditional construction faces several structural constraints.

Figure 1: Private sector housing completions and house prices to earnings ratio, 1970–2020



Source: Department for Communities and Local Government; ONS; Stephen Merrett, Owner-Occupation in Britain (London, 1982); UK Government – for full details, see endnote 2

Figure 2: Productivity growth in construction industries, compared with the whole economy (output per hour worked, 1997 to 2020, indexed to 1997)



Source: 'Productivity in the Construction Industry, UK: 2021', ONS, 19 October 2021

i) A shortage of labour and a fragmented workforce

The construction sector has an aging and shrinking workforce:

- 55% of construction workers are aged over 40.
- The sector will lose over 500,000 workers (around 25% of the workforce) in the next 10–15 years through retirement alone.
- Employment in the sector already fell by over 120,000 between Q4 2019 and Q1 2022.

This chronic and worsening shortage of skilled construction labour is a major constraint on its capacity to deliver. And it will get worse. Remedying this will require fundamental change to the labour model underpinning housebuilding.

The labour-intensive, on-site work in traditional building also hampers the speed of building. It takes approximately six to nine months to build and fit out the superstructure of a single home on site. The technology behind building has barely changed for decades.

In addition, it is also a highly fragmented industry, with over 40% of construction workers self-employed. Traditional construction, with its itinerant workforce and constrained labour supply, has come to depend on layers of sub-contracting, which can have the side effect of diluting control and responsibility, creating variable quality and increasing precarity for workers.

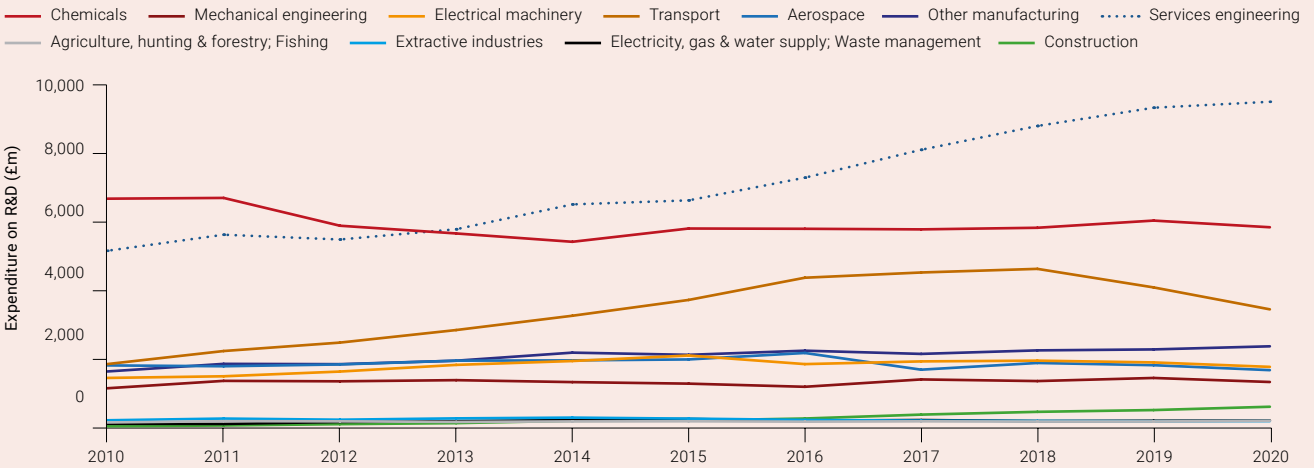
ii) Stubbornly low productivity

Construction is one of the least productive sectors of the UK economy – falling behind both services and manufacturing. Construction of buildings is actually less productive now than it was 25 years ago.

iii) A lack of innovation

Progress on both labour and productivity is limited by a lack of innovation, research and development. The construction industry has historically spent far less on research and development (R&D) than almost every sector, bar industries and utilities. Construction invested just 6% of what services invested in R&D in 2020, and half of the lowest-spending manufacturing sub-sector. This means it is failing to develop new ways of building and driving up efficiency.

Figure 3: Expenditure on R&D performed in UK businesses (constant prices, 2010 to 2020)



Source: 'Business Enterprise Research and Development', ONS, 19 November 2021 (accessed 27 July 2022).

1.2 MEETING NEW CHALLENGES

Raising supply is not the only challenge facing housebuilding. The UK has set ambitious net zero targets for housebuilding. We now face an enormous cost of living crisis, driven by high energy prices. And both sides of the political spectrum are keen to 'level up' the country to drive growth and employment in low-growth areas.

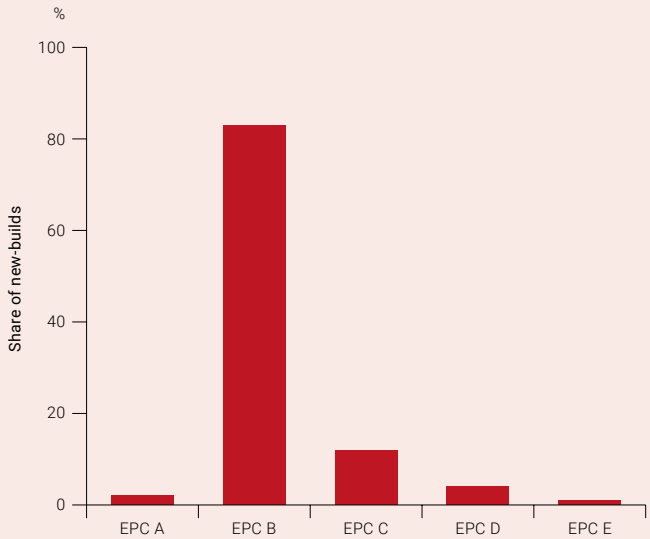
i) Achieving net zero

To achieve net zero, the government has set a target of reducing emissions associated with heat and buildings by 98–100% by 2050, with interim reductions of 25–37% by 2030 and 47–62% by 2035.[3] This will need to be achieved through increasing the energy performance of new buildings, building homes with a far smaller carbon footprint, and using low-carbon fuels and heating.

These changes have long been needed. Britain is known as the 'cold man of Europe' – with among the highest rates of fuel poverty and one of the oldest and least energy efficient housing stocks in Europe.[4] Building warmer, more efficient modern housing is going to be key to changing this.

UK housing is not building in the highest Energy Performance Certificate band – 80% of new homes are in band B and only 2% are in band A.

Figure 4: All new-build homes by Energy Performance Certificate band, Q2 2021



Source: Lucie Heath, 'Only 2% of New Homes Meet Top Energy Efficiency Standard', Inside Housing, 29 July 2021 (accessed 18 July 2022).

These band B homes will need to be retrofitted over the coming years to increase performance. It is expensive and technically challenging for traditional builders to build drastically more efficient homes, which may further push up prices, constrain supply and increase issues over labour supply.

Yet, the need for change has never been more acute. Fuel prices are skyrocketing in 2022, making energy one of the biggest contributors to the UK's cost of living crisis. The energy price cap has already nearly doubled since autumn 2021.[5] As the cheapest energy is that which we don't use, the best way to reduce energy bills for households in the long-term is to make more energy efficient homes.

A three-bedroomed EPC A family home is estimated to cost 32% less to heat than an equivalent EPC B home. This translates to a saving of up to £800 a year based on Q2 2022 prices.

ii) Supporting growth

All political parties want to see growth spread across the country so that all regions enjoy prosperity, employment and good housing. Traditional housebuilding requires labour to be based near building sites, but building often takes place in high-demand, high-growth areas where the demand for new jobs is lower and wages are already high. This constrains its capacity to deliver, while also creating an itinerant labour force often pulled away from low-growth areas, further preventing those places from levelling up. It is therefore not helping to reduce regional inequality.

These issues are not new or unknown. Yet improvement has proven elusive. Something is needed to disrupt the market and challenge the housebuilding industry to scale up delivery and radically alter the way it makes houses.

PART TWO
MODULAR, THE TIME IS NOW

"Houses were traditionally constructed in little pits in muddy fields but here it's clean and perfect and, in terms of the engineering of what's going on, it's so fantastically accurate."

Kevin McCloud MBE, designer, and presenter of Channel 4's Grand Designs, on a visit to Make UK Modular member TopHat's factory

2.1 WHAT IS MODULAR?

The UK's rapidly maturing modular housing industry has a crucial role to play in tackling the enormous challenges facing the housebuilding sector. Modular offers a radical departure from traditional building – it is a market disruptor, driving up standards and investing hundreds of millions of pounds in research, development, and innovation.

Modular houses are built on assembly lines in factories. Once finished, they are transported to the site, installed, commissioned and turned over to the owner. This means everything happens in a slick, highly productive factory setting, where quality control is improved. Under shelter and off-site, the buildings are produced in clean environments unaffected by the weather. Building can happen at pace and at night to speed up delivery. The technical term for this sort of building is 'Category 1 Modern Methods of Construction' – meaning that it uses pre-manufactured components and builds houses at scale in factory settings (it is also sometimes called 'volumetric modular' or '3D modular', because it combines premanufactured components to form complete, 3D modules in the factory).

Now that modular manufacturers are doing this, it seems striking that this hasn't been the norm for longer. After all, you wouldn't have Rolls Royce build a car for you on your driveway – we all recognise how inefficient that would be, and of course no one would build a car in the rain. Yet we've normalised spending hundreds of thousands of pounds on an asset which has been constructed in a muddy field for months on end, in all weather. Now, modular is proving that this doesn't need to be the case.

This shift in approach from on-site construction to off-site manufacturing is simple enough to describe, but it represents a fundamental change for housebuilding. It is because modular has shifted building off-site, because it uses a manufacturing model, and because of its hundreds of millions of pounds of investment that it is able to solve the issues which have long haunted the traditional construction industry.

Modular housing is enabling the building of new houses and apartments at scale, with inspiring design. Today, it employs cutting edge technology for construction and living, while creating the most sustainable British buildings developed at scale. By building factories in areas of low economic activity, modular manufacturers create thousands of secure, stable jobs across all regions – no more itinerant labour force, precarious employment

models and sub-contracting. Shifting to manufacturing also helps bypass the labour market constraints which stymy growth in traditional building.

All construction projects are a balance between cost, time and quality. Traditional construction is unable to generate major efficiencies in speed and quality, let alone both simultaneously. Instead, it tends to focus and compete principally on cost. Forty years of this model has left little room for further efficiency in this space. Modular inverts this approach by driving major efficiencies in build time and quality.

Industrialisation is driving up productivity in housebuilding (which is over 40% higher for modular), while innovation is producing better products.

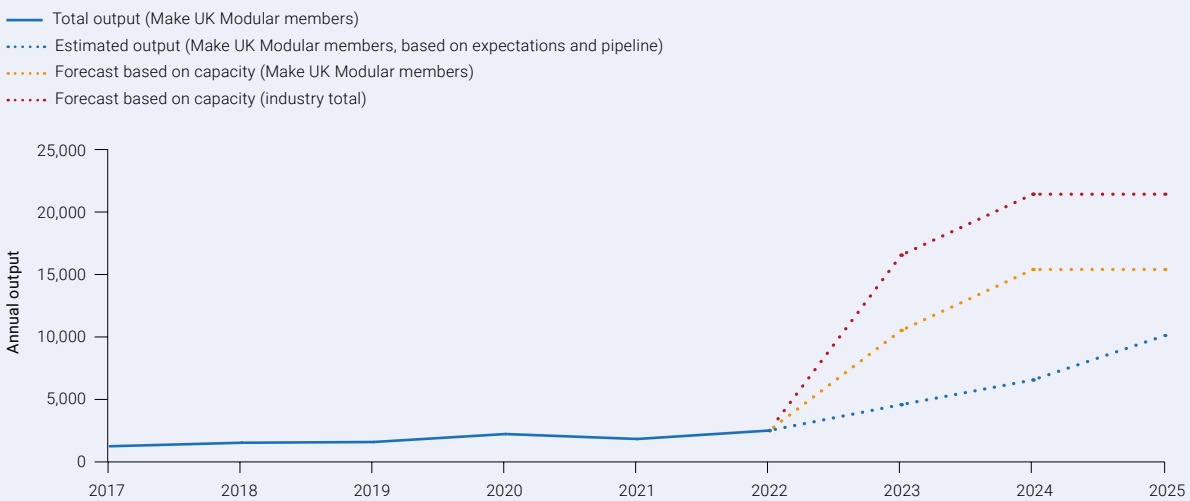
Because they are built with all the efficiency of a factory setting and transported to the building site, where they are craned onto place in a matter of hours and fully installed within days, modular homes are faster to build – with houses built in just 1 to 2 weeks and the whole build time reduced by about 50%. The assembly line means that modular makes homes with the precision-engineering, quality control and productivity of the manufacturing sector. Snagging and defect rates are lowered through the continuous improvement processes found in all manufacturing industries.

Because of the way they are made, modular homes can be built with far less embodied carbon – nearly 50% less for high-rise tower blocks, and up to 82% less whole-life embodied carbon for low-rise homes. Modular providers are building the most energy efficient homes on the market and can deliver them routinely; it is no surprise that the first company to build zero-bill homes in the UK is a modular manufacturer.

Modular is currently producing over 3,300 homes a year – one in every 60 homes, providing new houses for an estimated 8,000 people to live in. Our membership (who account for about 70% of the market) will produce 2,500 homes this year and its output has doubled since 2017. But modular manufacturers have the capacity to go further. Our members estimate that by 2025, they will be building over 10,000 homes a year – or about 5% of the current level of housebuilding. But capacity is in place across the whole industry to deliver double this, more than 20,000 homes per annum by the mid-2020s. This would equate to one in every 10 homes built in the UK and would cut the output gap on the government's housing target by 20%.

This capacity has been put in place by close to £1 billion of private investment, which funds start-up costs, including factory setup and R&D. We estimate that the entire modular sector could deliver over 20,000 new homes a year by the mid-2020s, providing a 10% uplift on the current housebuilding levels.

Figure 5: Make UK Modular – member output with forecasts and capacity



Source: Make UK Modular member data

2.2 BUILDING MORE HOMES, AND FASTER

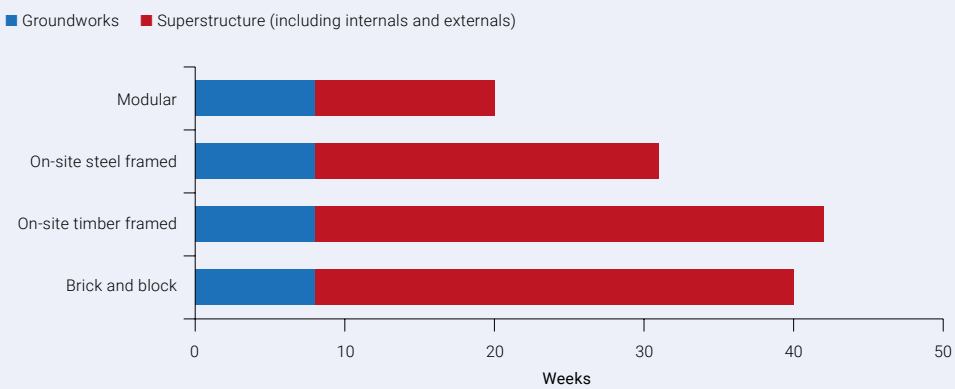
KEY STATISTICS

- The UK has not delivered enough housing for the last 50 years. The 2010s had the lowest private-sector completions since rationing ended in 1954.
- House prices have increased by over 370% since 1998. The average home is now priced at 7–8 times the average salary, twice the mortgage multiplier and up from just 4 times the average salary in 1998 when house prices in every region were at or below the standard mortgage multiplier.
- This unaffordability is worst in London but prices are now far above the average mortgage multiplier in every region.
- Rental prices have risen by 40% since 2005 (46% in London), pricing many first-time buyers out of the market and taking spending money out of the economy.
- Despite this, the housebuilding industry has chronically failed to ramp up supply. In no other sector has the marketplace failed so dramatically to meet such high demand.
- As such, the government will probably fail to meet its target of seeing 300,000 homes built a year by 2025.
- Homes England missed its 2021–22 affordable homes delivery target by 21.5% and its overall completions target by 15%.
- There is a way of speeding up delivery and adding more houses: it is modular.
- Modular has doubled its output in the last five years and is on track to increase by 400% by 2025. It is delivering 1 in every 60 new homes in the UK now, and Make UK Modular members will be building over 10,000 homes a year by 2025.
- Capacity is in place today to deliver more than 20,000 new modular homes per annum by 2025. This alone would close 20% of the gap between current output and the 300,000 target; it would increase housing supply by 10% a year. This will grow as the industry expands and taps into economies of scale.
- Modular homes are faster to build: modular manufacturers can make a home in the factory in less than two weeks, a saving of up to 95% over traditional build (which builds the superstructure of a house in 6 to 9 months).
- Because they are made off-site, modular homes can be built while groundworks are completed on site; this adds further to the huge time saving across the development.
- In many cases, the total time it takes to complete on a site, including groundworks, is halved or reduced even further because of these savings.

Modular homes are delivered faster: they take just two weeks to assemble in a factory and a few days to install on site, saving 6 to 9 months of superstructure work compared to an on-site, traditional build. In traditional building, the build process is sequential: groundworks have to be completed before superstructure, which must be done before internals. By building off-site, modular homes can be manufactured *while* groundworks are finished, further shortening the overall build time.

Overall build time can be reduced by as much as 50% compared with traditional construction.

Figure 6: Build times (in weeks) by method of build



NB: groundworks time is indicative and will vary by site.
Source: member data, combined with Paul Cartwright, Emmanuel Moulinier and Fran Nowak, SmartLIFE Site Management: Final Report (Watford, 2008), pp. 21, 42, 57 (figs 29, 76, 108).

2.3 BUILDING GREENER HOMES

KEY STATISTICS

- Modular housing delivers 40 to 45% whole-life embodied carbon reductions in high-rise developments and can reduce whole-life embodied carbon in low-rise developments by up to 82% (with an over 90% reduction in upfront embodied carbon in low-rise, timber-framed housing). It is cutting housing's carbon footprint.
- Modular reduces building waste by 90% thanks to the efficiency of factory production.
- Modular manufacturers are also delivering thousands of homes in the top energy performance band (EPC A); they could switch to producing only EPC A homes in just 2 to 3 months thanks to the assembly line process.
- An EPC A home uses far less energy and costs up to 60% less to heat against the average current new-build home (EPC B). For a three-bedroomed family home, this is estimated to save 32% on the cost of energy – equating to a saving of up to £800 a year in Q2 2022 prices.
- Modular is going further than this, with many of our members producing homes which outperform even the EPC A rating. Five years of R&D has allowed Ilke Homes to produce the UK's first ever Zero Bills homes, which are so energy efficient they cost nothing to heat and power.
- Modular can do this easily and inexpensively – it costs just a few thousand pounds extra to upgrade a modular home from EPC B to EPC A, and just a 10% uplift in build costs to produce a home with extremely low energy bills.
- Compared with a standard EPC B home, the added cost of buying an EPC A modular home could pay for itself within as little as 2 years, depending on the cost, while upgrading to a higher performance, very low bill modular home would pay for itself within 4 to 6 years at current prices.
- Building homes with very low embodied carbon would cost only £3,000 to £5,000 extra in some cases.
- If modular reaches capacity by the mid-2020s, it could add 20,000 new EPC A homes a year – or 10% of the market.
- Yet currently only 2% of new building is at EPC A level – on-site builders struggle to make these efficiency savings and are not future-proofing our housing. All those homes being built to lower standards now will need to be altered to make them more energy efficient later this decade.

Decarbonisation

Modular homes possess far less embodied carbon. In 2022, an academic study of Vision Modular Systems' modular high-rise development in Croydon found that it contained 40 to 45% less embodied carbon than an equivalent building built using traditional methods.

For low-rise buildings, these savings are greater. One of our members produces low-rise homes with just 18% of the whole-life embodied carbon of the average new home being built today, already surpassing RIBA's 2030 targets for the residential building sector. Some manufacturers who produce low-rise homes using timber (one of the building materials with the least embodied carbon) calculate upfront carbon savings to be over 90% on traditional build.

In one case study, it cost just £3,000 extra to make a modular home zero-carbon (and £5,000 extra for an apartment), whereas achieving this through traditional building methods would be prohibitively expensive for clients.

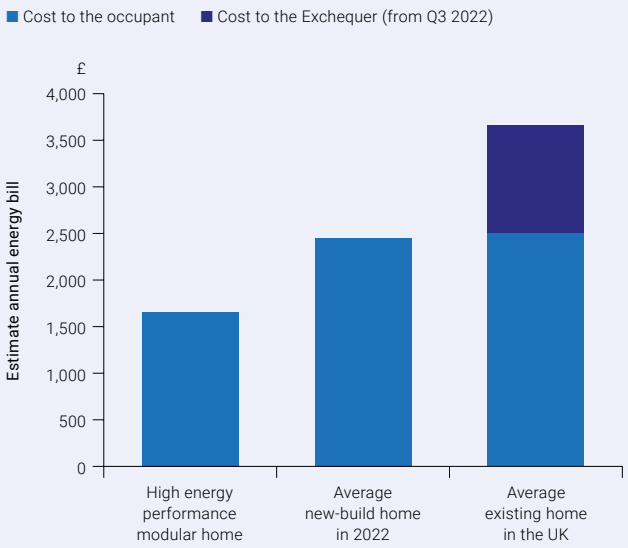
Energy performance and energy bills

Modular's factory-based production system allows manufacturers to easily produce homes that fall into the top energy performance banding (EPC A). Many modular manufacturers produce EPC A homes already. They could easily switch production to entirely EPC A homes.

Currently only 2% of all new homes are at EPC A level, but if modular were to reach capacity by the mid-2020s it could be adding 20,000 new EPC A homes a year – or 10% of the market. An EPC A home costs 20 to 60% less to heat (and thus would be expected to make a similar emission saving) than an EPC B home (which is what most builders are currently producing).

An average, three-bedroomed family home is estimated to cost 32% less to heat if it is EPC A rated than if it is EPC B rated – equating to a yearly saving of up to £800 in Q2 2022 prices.

Figure 7: Annual energy bill for 3-bedroom home with 4 occupants (upper estimate, adjusted for Q2 2022 prices)



NB: left-hand bar is for an EPC A home.
Source: Fuel Cost Prediction Tool (2017) by the Lenders consortium – see endnote 6

As modular can deliver these homes routinely, it can therefore drive progress on decarbonising our new housing stock, reducing emissions and slashing energy bills.

> Five years of research and development has allowed Ilke Homes to go further and produce the UK's first ever Zero Bills homes, which are so energy efficient they don't cost a penny to run.

In going above and beyond minimum standards, modular manufacturers are saving residents and the government from having to expensively retrofit these homes in the future; by contrast, all those homes being built to lower standards now will need to be altered at substantial cost to make them more energy efficient in the next 10–20 years.

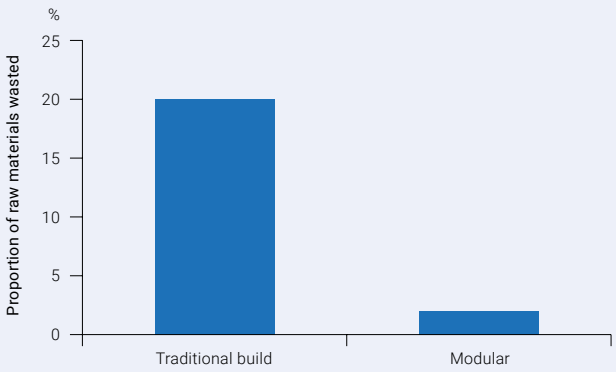
Moreover, upgrading a modular home from EPC B to EPC A often costs just a few thousand pounds – enough to install an air source heat pump or solar panelling. Even producing very highly efficient homes around the top of what our members can do involves only a 10% uplift in costs. At current energy prices, these changes would pay for themselves in as little as 2 years for the EPC A upgrade (depending on the type of heat pump used), or 4 to 6 years for the upgrade to an even more advanced home with very low bills, providing huge savings across the lifetime of the property, while avoiding any retrofitting costs.

These enormous efficiency gains are only possible right now because these homes are modular. This is not a costly experiment. These houses are built and are being sold on the open market as you read this.

Reducing waste

Modular manufacturers produce 90% less waste during building than traditional builders, generating just 1 to 2% of waste during the build process. This is because of the efficiency of the factory setting.

Figure 8: Proportion of raw materials wasted during a build



Source: Make UK Modular member data in combination with Emily Williams, 'Embodied Carbon and Construction', Savills, 23 April 2021 (accessed 18 July 2022).

2.4 BOOSTING PRODUCTIVITY IN HOUSEBUILDING

Modular housebuilding is over 40% more productive in terms of hours worked per m^2 built than traditional brick and block/timber-framed on-site building. It takes a modular manufacturer 7 to 9 hours of labour per m^2 to build the superstructure of a house, compared with 12 hours per m^2 for both brick and block and on-site timber-framed methods. This is unlocked through the efficiency gains of the factory's assembly line system.

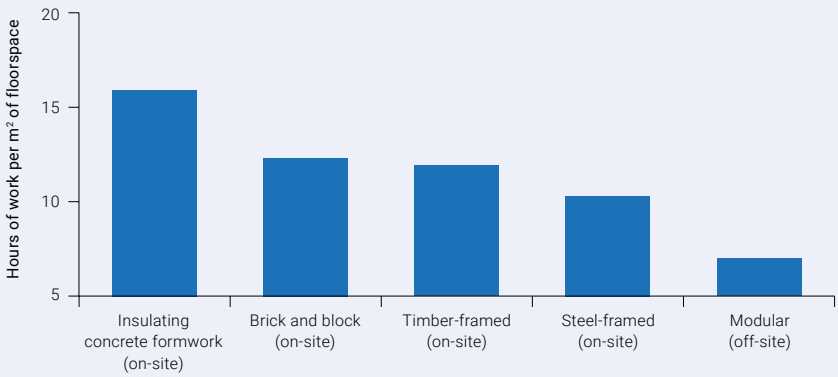
These gains have been fostered by nearly £1 billion in private investment by modular manufacturers. They have spent an estimated £200m on research and development over the last five years – which accounts for between 10 and 30% of all R&D spending by all building construction companies in the same period (including developers of commercial, education and healthcare buildings), despite our members accounting for 1% of the residential market alone.

This investment has allowed modular manufacturers to develop working assembly lines off-site. This reduces the scope for human error in the building process by allowing tasks to be divided, routinised and repeated – driving up consistency and increasing productivity. Many modular providers are introducing robotics into their factories as they scale up unlocking the potential for even greater efficiency gains.

There are other benefits too. The assembly line process and off-site location allow manufacturers to increase the energy efficiency of a building in ways which are challenging for on-site builders. Lack of exposure to the weather and bypassing site access requirements during the superstructure assembly reduces the scope for delays and inefficiencies, while modular's assembly line means building a modular home produces 90% less waste than traditional building.

By raising the bar in terms of productivity, efficiency savings, quality of product, energy performance, and speed while still delivering a marketable product, modular manufacturers are able to use competition to drive up standards across the board – they are gradually encouraging other types of builders to rise to their challenge. They are at last making competition drive improvement in UK housing.

Figure 9: Efficiency: Hours of work per m^2 of floorspace



Source: Make UK Modular member data in combination with Paul Cartwright, Emmanuel Moulinier, Tarwinder Saran, Oliver Novakovic, and Karen Fletcher, SmartLIFE – Lessons Learned (Watford, 2008), pp. 19, 39, 56, and planning documents – see endnote 7

2.5 SUPPORTING GROWTH IN THE REGIONS AND SOLVING CONSTRUCTION'S LABOUR CRISIS

KEY STATISTICS

- Modular manufacturers have built over 40 factories in post-industrial provincial towns or cities. Make UK Modular members alone have directly created over 2,000 jobs; if their factories were operating at capacity, this would rise by over 50%.
- Modular workers live close to their factories, demonstrating how modular creates locally rooted employment, bringing stable and secure jobs and nearly £700m of investment to low-growth, low-employment areas, while driving up productivity.
- Construction has an ageing and shrinking workforce: employment in the sector fell by over 120,000 between Q4 2019 and Q1 2022
- Traditional building will lose over 500,000 workers (around 25% of the workforce) in the next 10–15 years
- Modular solves this problem because it does not rely on traditional construction skills – some of our members report 50 to 60% of their workforce are in manufacturing jobs, on assembly lines, with very few in construction trades.
- Most entrants do not need to build up years of training and formal qualifications – removing a major barrier to housing growth.

Building factories and creating jobs where they are needed

Because modular housing is constructed off-site, it decouples the location of the actual housebuilding from the location of housing demand – it is possible, therefore, to base a factory and create jobs where they are needed (in low-growth areas), while still building houses and then shipping them to be installed in high growth areas. This is the essence of levelling up – spreading growth around the UK and providing opportunities for low-growth regions. Modular manufacturers have built factories in post-industrial towns or cities, providing a boost to manufacturing and employment locally:

- Make UK Modular members have directly created over 2,000 jobs
- If their factories were operating at full capacity, they could increase this by over 50%.

Modular factory workers live close to their place of employment – in one case, 95% live within a three-mile radius. In another the average distance travelled to work is 10 miles. They are bringing local employment benefits and creating stable jobs.

Solving the housebuilding labour crisis

The chronic, worsening shortage of skilled construction labour is a huge challenge to the sector, with 25% of its workforce expected to retire within 10–15 years. Modular housing helps tackle this problem because it relies not on traditional construction skills, but on manufacturing labour. Some of our members report that 50 to 60% of their workforce are in manufacturing jobs, on assembly lines. Usually, only a minority are in skilled trades. Rather than cannibalising the existing shrinking construction labour force, modular therefore pulls new entrants into the industry while bypassing the labour and skills shortages that are constraining traditional builders.

Upskilling and reskilling the workforce

Modular produces good jobs: some skilled tradespeople are still needed for supervision and some specific aspects of builds, while modular has created highly skilled engineering, design and technical roles through its R&D programmes. Even outside these positions, factory floor workers are supported by training, apprenticeships and upskilling programmes. One member (Legal & General Modular Homes) runs a Modular Academy, delivering 68,000 hours of training a year.

Modular is therefore making it easier for people in low-employment areas to gain entry to a new line of stable, secure and productive work – future jobs supporting the green economy. It is upskilling workers and supporting new high-skilled jobs too.

Diversifying the workforce

By reducing the dependency on a narrow labour market, modular can draw from a wider labour pool and diversify its workforce. There is more to do in this space, but it is already showing improvements on construction. The average age of a modular factory's workforce is

nearly 40, whereas construction's workforce is older (with an average of nearly 43).

Some 16% of our members' workforce are women, compared with less than 1% of on-site workers in traditional construction. By providing new jobs in research, design and management, our companies are also attracting women into the sector at senior levels – the only one of our members who is required to declare gender pay gap data revealed that women in their company were paid 20% more than men in the most recent report.

Bringing jobs in house

The assembly line process requires a fundamentally different labour model. Modular manufacturers need to employ shopfloor staff full-time, permanently, and in-house. 80 to 100% of our members' workforces are on PAYE contracts and the average working hours are standard, full-time ones. This creates stable, long-term employment for workers at all pay grades allowing people to access mortgages, start families, and put down roots.

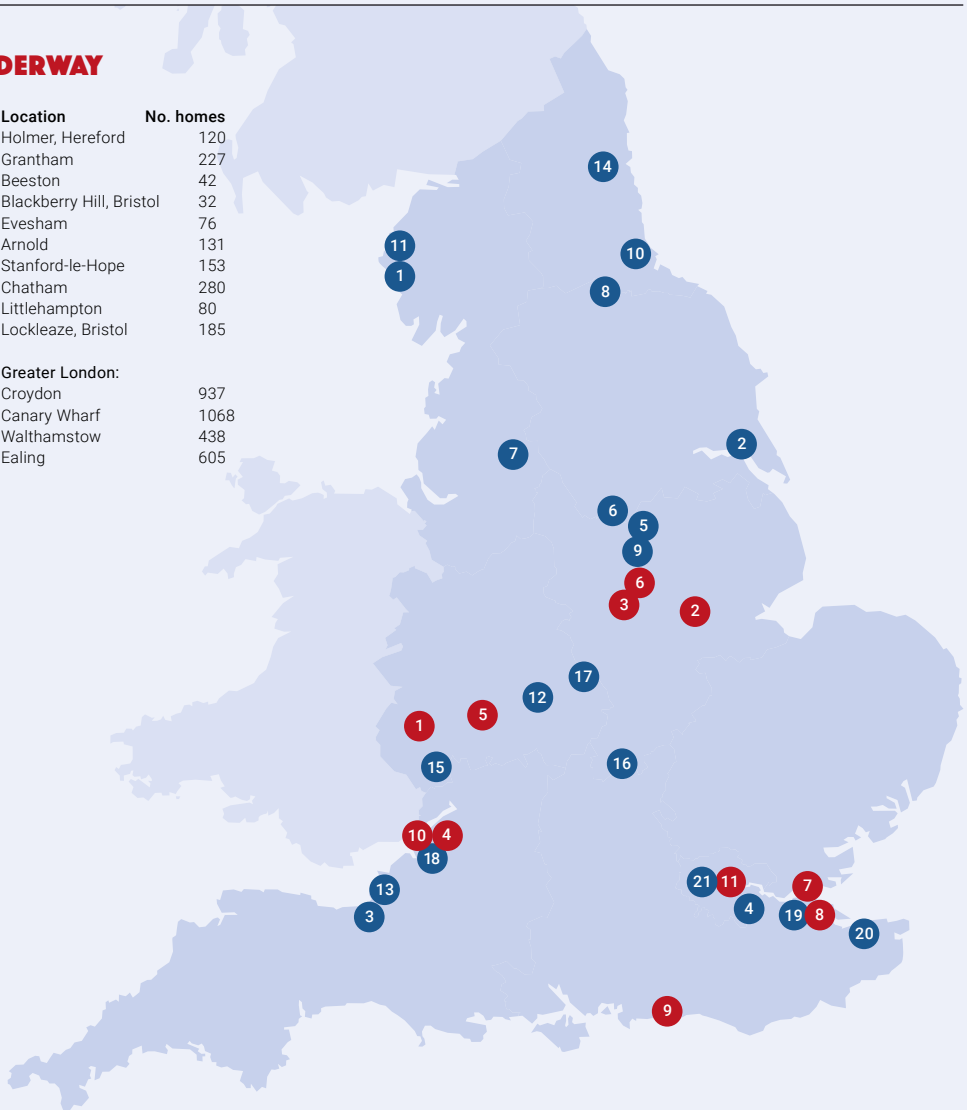
Figure 10: Map of modular housing sites

COMPLETE

	Location	No. homes
1	Egremont	26
2	Hull	16
3	Bridgewater	30
4	Swanley	47
5	Shirebrook	19
6	Chesterfield	10
7	Bolton	22
8	Darlington	17
9	Mansfield	10
10	Hartlepool	31
11	Whitehaven	18
12	Stratford on Avon	35
13	Highbridge	123
14	Newcastle	22
15	Drybrook, Forest of Dean	57
16	Tattenhoe	40
17	Rugby	38
18	Bristol	77
19	Chatham	20
20	Canterbury	386
21	Greater London:	
	Wembley	158
	Wembley	450
	Wembley	802
	Lewisham	611
	Streatham	32
	Wembley	580
	Wandsworth	89
	East Acton	306
	Croydon	546
	Islington	257
	Ealing	115
	Ealing	379
	Gants Hill	321
	Lewisham	825
	Bermondsey	250

UNDERWAY

	Location	No. homes
1	Holmer, Hereford	120
2	Grantham	227
3	Beeston	42
4	Blackberry Hill, Bristol	32
5	Evesham	76
6	Arnold	131
7	Stanford-le-Hope	153
8	Chatham	280
9	Littlehampton	80
10	Lockleaze, Bristol	185
11	Greater London:	
	Croydon	937
	Canary Wharf	1068
	Walthamstow	438
	Ealing	605



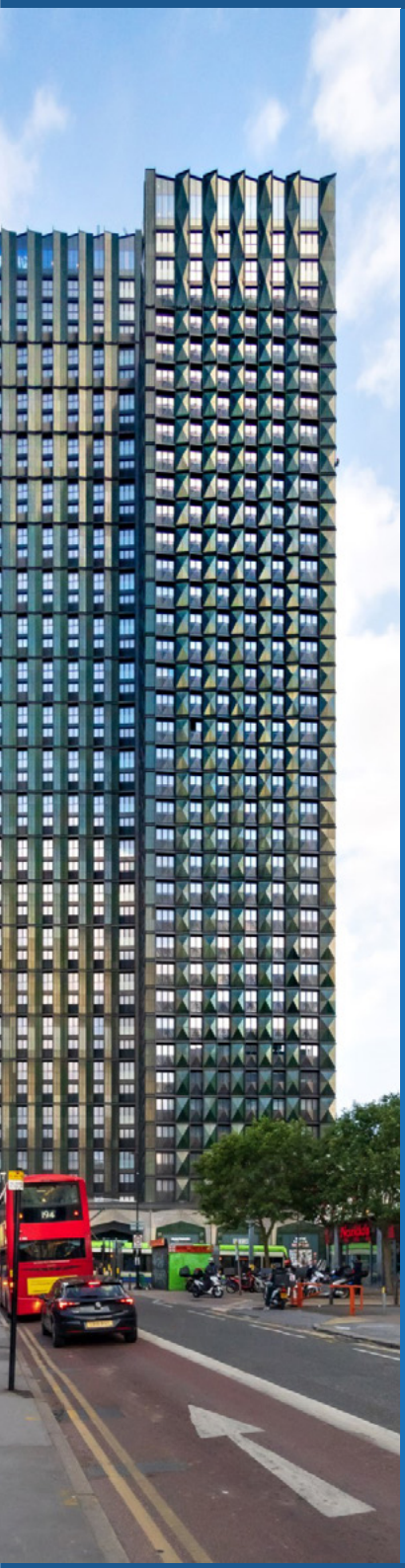
2.6 BUILDING BRITISH

The UK's modular industry is building some of the best modular houses in the world. Modular manufacturers are building houses which last, with lifespans comparable to or exceeding traditional build. They are building homes which are extremely energy efficient and have spent hundreds of thousands of pounds on safety testing, driving up quality.

Modular across the globe: In Japan modular is established and normal, but unlike British modular, the housing is not built to last and is often a cheaply produced solution. By contrast, some European countries have pioneered the development of modern, efficient and durable modular housing. It is popular in Scandinavia, Germany and the Netherlands, for example. Governments, consumers and builders in these countries have long recognised that modular housing is a good way of building homes and it is fast becoming a substantial part of their housing markets.

If the UK does not grow its domestic modular manufacturing sector, we may find foreign businesses stepping into the market. They know that modular will be a big part of the future of housebuilding and we are already seeing European, American, and Middle-Eastern companies entering this space. There is nothing inherently wrong with this – it brings investment, capital and jobs and increases our supply of good homes. But we feel that we should work to maximise the benefits of the modular revolution so that investment and profits are kept onshore and that British talent and businesses gain from the growth of modular.

British modular producers have the capacity to be world leaders in their field. They develop some of the best modular on the market and there is real potential for exporting designs and technology. Britain is world leading in exporting design, engineering, and construction management services. There is no reason why modular should not be part of this.



SPOTLIGHT: DRIVING GROWTH, DELIVERING VARIETY

- Data from KOPE shows that there are over 50 modular producers operating in the UK.
- Make UK Modular members will build over 2,500 homes in 2022 – one in every 80 homes built in the UK.
- They will double their 2017 output in 2022 (despite the pandemic's disruption).
- Since 2017 our members have delivered over 11,000 homes.
- We anticipate that they will be adding more than 10,000 homes a year by 2025 – that's one in twenty homes in the UK.
- Across the sector there is capacity in place to build more than 20,000 modular homes per annum by 2025.

Modular manufacturers are now operating in every major housing tenure. Over the last five years, 20% of new modular homes have been for private sale, 14% for affordable/social rent, 10% for shared ownership, 35% for private rental, and over 20% for student accommodation.

This partly reflects the great variety amongst manufacturers in terms of business models, housing types and materials. One of our members, for instance, builds mostly for the affordable/social renting sector; another almost exclusively for private sale. Another, Stelling, made headlines for building emergency accommodation for Ukrainian refugees.

Equally, one of our members (Vision Modular Systems) produces high rise towers; they have recently completed Europe's tallest modular building – in Croydon. Most of our other members produce homes below 11m in height (typically houses), providing a wide variety of models and typologies. Of those building low-rise houses, across the last five years 61% have been semi-detached, 34% terraced and 5% detached.

Because modular manufacturers have spent years and hundreds of millions of pounds on research and development, testing and design, they bring variety and competition to the marketplace. All modular manufacturers do certain things differently. Some build using steel framing; others use timber. Some make flats with concrete and steel. Modular manufacturers can produce housing which looks and feels just like a traditional home – with panelling styled like brickwork and real slate tiles. Others can make strikingly modern homes.

Likewise, they build for different price points and markets. They deliver homes of varying sizes and layouts to accommodate the needs and budgets of clients. Many modular homes fall in the top band of energy efficiency ratings – some manufacturers are going even further, anticipating uplifts in fabric performance; many are integrating renewables into typologies.

Modular is offering some of the best homes on the market today and it is growing. It is delivering a varied, competitive product that serves all major parts of the market. Indeed, it is the cutting edge of new housing. You won't find it in the Silicon Valley or Shanghai – you'll find it in Knaresborough and Croydon, in Corby and Lockleaze.

PART THREE
MODULAR: A QUALITY PRODUCT

Modular is delivering some of the best new homes in the country. On the back of hundreds of millions of pounds spent on research and development, its products have matured and it is delivering durable, accredited, adaptable homes with beautiful, award-winning designs, capable of being sold on the open market at full price.

- **Durability:** Modular manufacturers have worked to create homes with long lifespans. Like bricks and mortar, modular homes are built to last in perpetuity. All of our members use the Build Offsite Property Assurance Scheme (BOPAS) to provide the assurance (underpinned by warranties) to lenders that a property will be mortgageable for at least 60 years. As such, our members' modular houses have a *minimum* assessed durability of 60 years; in some cases, they have been assessed as having a longer minimum lifespan: 70 years or more for one member and 100 years or more for another.

- **Adaptability and accessibility:** If a home is going to be built to last for decades, it will need to be compatible with changes in the way its occupants use it – as households change in size, age and structure, and as different occupants move in, bringing new needs with them. Modular manufacturers recognise the importance of building homes that can be adapted to suit different needs and future changes of use. Many of them are now creating specifications which are designed to meet the optional adaptability and accessibility standards in the Building Regulations.

- **Accreditation:** All of our members are accredited with BOPAS and some of have NHBC accepts. The Build Offsite Property Assurance Scheme was launched in 2013 as the first systemic assurance process established to integrate modular and other MMC products into the mainstream of construction. It is the 'gold standard' for modular accreditation. The scheme is recognised by many principal mortgage lenders as providing the assurance they require (supported by warranty provision). This includes the minimum durability standard of 60 years outlined above. Modular providers also use a wide range of other accreditations. For instance, several of our members are ISO 9001 certified, which is the recognised international standard for quality management systems. Several also use the Local Authority Building Control (LABC) warranty. Other warranties used by members include NHBC Accepts, BuildZone Insurance, Checkmate, and BBA.

- **Mortgageability:** The best test of lender confidence in modular is whether builders can sell homes on the open market to buyers backed by standard mortgage providers. With a mature product and several years of trading, our members have found that they are fully able to do this. One member, for instance, has sold around 150 homes on the open market across the country at full market rate. They reported no issues with potential buyers accessing mortgage finance. Likewise, another member has sold nearly 200 homes at full market price; they have reported no issues with mortgageability and report that occupants were backed by 13 different lenders on one site alone. Finally, another member reported seeing no difference in buyers' ability to obtain mortgage finance compared with traditional

developments. Modular is therefore increasingly being backed by accreditation schemes which attest to its durability and quality. This is allowing buyers to acquire modular homes using mainstream mortgage products – essentially allowing them to buy modular just as they would if they were buying a traditional brick and block, on-site house.

- **Post-occupancy and remediation data:** As our members continue to gather data it is clear that remediation costs in many cases are negligible or small, and they expect rates of issues and remedy costs to be lower than traditional build. This is because of the precision engineering involved in the assembly line, where tasks are made routine and performed more efficiently than they would be in traditional build. The reduction in the use of external brick work also goes some way to removing many of the most common issues with building. The assembly line process also allows for quality control to be built into the erection of the building in more effective ways, while rectifying changes when they do arise can be done more cheaply and quickly due to the factory setting.
- **Quality of design:** Modular manufacturers understand the ideals set out in the National Design Code and integrates them into their developments. Modular is now producing some of the best new homes and places in the country and our members have won or been finalists for numerous industry awards (see Appendix 1).

PART FOUR CONCLUSION AND POLICY RECOMMENDATIONS

Modular has now arrived and is delivering greener, better homes, faster. It is driving up standards across the housebuilding sector and is poised to transform the market. There is no doubt that it will be a key player in housing provision in the UK. But barriers remain which we need the government to remove to unlock the full benefits of modular.

The following policy changes would require no additional spending by government but would help to grow modular so that it can drive up housing supply and lead the market transformation that housebuilding in the UK needs.

1. SUSTAINABILITY:
ENHANCE HOUSE-BUILDING SUSTAINABILITY BY INTRODUCING A MORE ROBUST COMMITMENT TO AND TARGETS FOR NET ZERO

To grow modular, realise its transformational benefits for the environment and deliver homes that are much cheaper to run, we want to see the government:

- Bring forward requirements for all new homes to perform at EPC A
- Adjust stamp duty rates based on energy efficiency and net-zero performance
- Require all for sale and to let homes to provide accurate data on energy bills
- Introduce a carbon trading scheme for new-build housing

2. SCALE:
DEDICATE AT LEAST 40% OF THE AFFORDABLE HOMES PROGRAMME TO MMC, AND AT LEAST 50% OF THIS TO MODULAR

Modular has the potential to grow – and it has put enormous capacity in place. But it is a new industry and it needs to grow to generate economies of scale that allow it to drive up competition and standards across the industry. We want government to

support modular manufacturers' pipeline security to this end. Government can do this at no extra cost by:

- Dedicating at least 40% of the Affordable Housing Programme (AHP) to modern methods of construction (including modular)
- Dedicating at least 50% of this share to modular (Category 1)
- Switching its Value for Money assessments from focusing on upfront costs to considering value across the whole life of a house

3. PLANNING:
CREATE A FAST-TRACK PLANNING ROUTE FOR NET-ZERO HOMES

Currently, modular has to navigate a planning system designed for traditional builders. It can be slow and add significant delays for modular manufacturers, reducing the time-saving benefits that modular can bring. We want government to help by:

- Providing a fast-track planning route for all net zero housing schemes; these should be prioritised for accelerated planning permission
- Guaranteeing modular homes parity with traditional build in all local plans

4. LAND:
GOVERNMENT TO REQUIRE A MINIMUM PERCENTAGE OF ITS LAND BANK TO BE ALLOCATED FOR MODULAR HOMES

In addition to supporting modular through the Affordable Housing Programme and planning, government can provide the certainty modular needs by helping it gain a steady supply of land. We would like:

- Government to require a minimum percentile of its land bank to be allocated to advanced modular housing (Category 1) and/or EPC A rated or low-carbon housing – or give priority or discounts to land used for low-carbon housing
- This percentile should be subject to a ratchet mechanism increasing year on year
- Government frameworks should mirror this ratchet with increased weighting towards modular housing in their scoring criteria

5. LEVELLING UP:
CREATE A MODULAR CAPACITY STRATEGY LINKING NEW FACTORY LOCATION, HIGH HOUSING DEMAND AREAS, AND LEVELLING UP PRIORITY REGIONS

- Government to create a modular capacity strategy working with combined authorities, freeports, transport hubs and other government agencies to ensure new factories are optimally located to maximise the associated employment and housing delivery benefits. This has already been done in the automotive and renewables industries.

NOTES

[1]Facts are cited in the Appendix, unless otherwise indicated.
[2]Department for Communities and Local Government, Table 502: 'Housing Market: House Prices from 1930, Annual House Price Inflation, United Kingdom, from 1970', February 2011 (accessed 21 March 2022); ONS, House Price Simple Averages: Table 23: 'Housing Market: Simple Average House Prices by New/Other Dwellings, Type of Buyer and Region, United Kingdom, from 1986', 14 July 2021 (accessed 21 March 2022); ONS, 'Average Gross Weekly Earnings, 1938–2021', October 2021 (accessed 21 March 2022); Stephen Merrett, *Owner-Occupation in Britain* (London, 1982), pp. 346–347; UK Government, Live Tables: Table 241: 'House Building: Permanent Dwellings Completed, by Tenure; United Kingdom Historical Calendar Year Series', 4 July 2019 (accessed 21 March 2022); ONS, 'House Building, UK: Permanent Dwellings Started and Completed', 19 January 2022 (accessed 21 March 2022).
[3]DBEIS, *Net Zero Strategy: Build Back Greener* (London, 2021), 136–137, 139, 146; DBEIS, *Heat and Buildings Strategy* (London, 2021), 161–163; 'Energy Efficiency of Housing in England and Wales', ONS, 23 September 2020 (accessed 18 July 2022).
[4]Association for the Conservation of Energy (Pedro Guertler, Jack Carrington and Antonia Jansz), *The Cold Man of Europe – 2015* (London, 2015).
[5]'What Is the Energy Price Gap and How High Will My Bills Go?', *BBC News*, 11 August 2022 (accessed 11 August 2022).
[6]Data derived from the Fuel Cost Prediction Tool produced in 2017 by the Lenders consortium (Nationwide Building Society, BRE, Energy Saving Trust, UCL Energy Institute, Principality Building Society, UK Green Building Council, Constructing Excellence in Wales, ARUP and Innovate UK): *EPC Mortgage Calculator* (accessed 6 June 2022). This was based on data from 40,000 energy consumers.
[7]Paul Cartwright, Emmanuel Moulinier, Tarwinder Saran, Oliver Novakovic, and Karen Fletcher, *SmartLIFE – Lessons Learned* (Watford, 2008), pp. 19, 39, 56; this showed that it took an average of 1,047 hours to build a 'brick and block' house on site 2 and 1,095 on site 3, 1,002 hours per house for timber-framing on site 1, 1,338 hours per ICF house on site 2 and 842 per steel-framed house on site 3. The report does not include average hours per m^2, but it is possible to work this out. There were 15 timber-framed houses on site 1, 20 brick and block houses on site 2 and 21 on site 3, 13 ICF houses on site 2, and 35 steel-frame houses on site 3. This makes it possible to calculate total man-hours per construction type per site. The report did not give the dimensions of the typologies used in the study, but it does explain which models were used on which site for each build method (*ibid*., pp. 4, 7, 9). Documents submitted for the planning application reveal the dimensions of each typology (A: 72m^2, B: 84m^2, B4: 99m^2, and E: 96m^2), which can then be multiplied against the given number of each typology per development – revealing the total floor area for each build method and site. Dividing the total number of hours by these figures reveals the productivity rates given in line here. It is worth noting that it took approximately 20% fewer man-hours per house to build a timber-framed house on-site, but it was more time-consuming to use steel framing and concrete. See also: 'Planning Application Documents: F/YR06/0194/F', *Fenland District Council* (accessed 27 July 2022). The relevant documents are: 3794-07 Rev C, Drawings 3794-08 Rev C, 3794-09 Rev C, and 3794-10 Rev C.

Make UK Modular is the voice of the modular housing sector. We exist to help modular housing scale up, provide expert advice about the sector's needs, foster collaboration to overcome political issues, and work with members to grow their businesses.

The UK needs more homes, and fast. It needs which are green to build. It needs homes which use less energy. It needs homes to be great quality and good value. And it needs new people to build them. It needs homes: greener, better, faster. It needs Modular.

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KOPE is accelerating the shift away from traditional construction by enabling the design, specification and procurement of offsite products and systems. KOPE grew from our consultancy Matterlab who focus on delivering simple solutions for complex problems at many of the leading construction organisations around the world. Over the years, the team have developed significant IP around automating a multitude of different processes with a strong focus on the benefits of offsite construction, particularly in the housing sector. Speak to us to find out more about how we can support your digital transformation and journey into industrialised construction.

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