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The contribution of offsite manufactured homes to solving London's housing crisis



Planning Committee
August 2017

Holding the Mayor to
account and
investigating issues that
matter to Londoners

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The Planning Committee's role is to scrutinise the detail of the London Plan, the Mayor's use of his planning powers and the strategic planning challenges facing London.

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Nicky Gavron AM

Chair of the Planning Committee



It is universally acknowledged that London faces a housing crisis. We are all aware of the complexity of the challenge, but we are simply not building enough homes.

To reach the 50,000 homes London needs as a minimum each year, an innovative approach to delivering new homes is vital. We need a change of mindset, collaboration between the construction and housing sectors, and bold political leadership. The last time we were anywhere near that target was in the early 1970s. Loved or loathed, the ‘prefabs’ and system-built blocks of the past contributed significantly to supply. While the use of these technologies fell out of favour, London’s record since has been one of consistent failure to meet housing demand.

Today’s offsite manufactured homes are characterised by their high quality, precision engineering, digital design and eco-efficient performance, truly twenty-first century homes. Construction within a factory environment achieves quality control that ensures fast builds and lengthy lifespans. The wide range of homes offsite now produces can meet London’s complex housing needs, in terms of the variety of demand and sites. Once delivered to site they can be up in a matter of days or weeks, a vital advantage given the acute scale of demand London faces.

The Mayor identifies housing as his single biggest priority, but offsite also provides wider opportunities to meet London’s strategic challenges. The Farmer Review has highlighted the skills challenge an ageing construction workforce and Brexit pose for housebuilding. Offsite manufacturing offers the opportunity for ambitious job creation; it has the potential to be a new industrial sector for the UK, which London’s demand could stimulate. Making homes in this way produces significant environmental benefits, from reduced deliveries, traffic and dust in construction to an outstanding energy performance. It also offers residents significant reductions in bills, removing many from fuel poverty.

But, the sector must be galvanized to fully harness these benefits. I have pursued extensive engagement across the housebuilding and housing industries. It is clear with strong political leadership, the offsite sector is poised to achieve a step-change in delivery, but it needs co-ordinated continuity of demand, along with land, policy and funding.

The Mayor is ideally placed to respond to this call to action. The Mayor has resources in GLA and TfL landholdings, a record £3.15 billion of funding, established partnerships with London’s local authorities and housing associations, and extensive autonomy over the policy guidance of the London Plan and other strategies. The Mayor is about to revise these and he has already signalled his willingness to encourage offsite – this is the moment to lead. This report offers a call to action and recommendations as to how offsite manufacturing’s full potential contribution to solving our housing crisis can finally be realised. I urge the Mayor to take up the challenge.

“It is clear with strong political leadership, the offsite sector is poised to achieve a step-change in delivery”

Summary

London needs 50,000 new homes per year to meet its growing needs. Despite recent improvements in housing output, traditional housebuilders and developers continue to deliver between 50 and 60 per cent of what the Mayor wants for London.

In the short to medium term, London's construction industry is facing the need to deliver increased supply in the face of future labour shortages as the construction sector ages, and rising costs of materials.

There are now some very encouraging signs that a more positive future for housebuilding in London is emerging in the form of the potential of offsite manufactured housing. The Government has recently started to stimulate the growth of this sector through a variety of policy and funding programmes.

In London, the Mayor is signalling his support for the OSM sector through his Affordable Homes Programme and Innovation Fund is designed to encourage innovative ways of delivering affordable housing in London.

We are now at a point where many favourable conditions are aligning to prove the case that OSM can bridge the gap between what the traditional house-building industry can deliver and what London needs.

What is OSM housing and its past contributions

Offsite manufactured housing (OSM) is an umbrella term for a system of house building that relies on individual components being 'manufactured' in a factory, transported to a site and mostly, or entirely, completed and assembled on location.

Offsite construction allows most construction phases to be undertaken simultaneously. While site preparation, foundations and utility connections are being prepared, whole completed housing units are being built in a factory ready for final assembly and finishing in situ.

OSM has played a significant role in meeting some of the country's most severe housing challenges for more than 70 years – especially in the post-war period and in the 1960s when it helped to propel house building to the highest level ever recorded in the country. Over 425,000 homes were built in 1968 alone, and much of this was substantially manufactured offsite.

Once again, as in the 1960s, housing is high up on the political agenda.

OSM housing today – and why it is suitable for London

The last 50 years have seen tremendous advances in the quality and performance of OSM housing. Today's homes are unrecognisable from those 'prefabs' that are embedded in the memory of many.

They are now 'precision-manufactured' homes that can offer an increased level of consistency and quality control and additional benefits in terms of speed of delivery, cost efficiencies and safety on site. Furthermore, an industry-wide move towards more offsite work could make a career in the construction sector more attractive to young people.

Designing for manufacture is increasingly assisted by technology, namely Building Information Management (BIM) software. Digital construction enables the high quality that distinguishes offsite manufactured housing from its prefab predecessors.

OSM offers a route to delivering homes that can be built to higher sustainability standards, with potential advantages in terms of build quality, speed of delivery, construction health and safety, energy-in-use, whole-life carbon footprint, and reduced transport pollution.

The sector's positive contribution is not limited to the production and performance benefits alone. OSM homes are now a viable potential alternative for any development site, at a range of densities that can adapt to a range of local priorities.

These features make this housing particularly relevant, and uniquely suited, to the housing challenges faced in the capital where it is vital that we 'sweat' all available land assets, irrespective of the difficulties presented, to meet London's housing need.

While not a panacea, OSM will be critical in bridging the gap between the numbers of new homes the traditional construction industry can deliver in London and the level of housing need that is anticipated in the next 20 years.

Moving production from the construction site inside to a factory environment has many other benefits, especially in attracting a new demographic to the industry and diversifying the workforce. Being able to offer professional 'careers' in a permanent place of work should help the industry attract a broader pool of talent - especially women and young people.

It could also help tackle London's long standing strategic priorities – for example the need to deliver affordable housing quickly, meet carbon reduction targets, tackle fuel poverty, and unlock stalled, difficult to develop or currently unviable sites.

Furthermore, manufacturing homes for London could assist a national economic strategy. Although London will continue to be a real engine room for the national economy, there is a strong case for a more balanced economy

where the regions support London's growth ambitions – by making homes for London - and that in turn supports the regional economies.

Issues, barriers and challenges for London today

Failures to invest in, and push on with, OSM have resulted in an over-reliance on the traditional approach. In other countries conditions exist that ensures OSM fulfils a much greater proportion of new housing.

There are many reasons why OSM has failed to take off in England:

- To date there has not been the volume of demand and continuity of supply to justify the up-front capital investment needed to build the plant to manufacture the product.
- Traditional funding and financing models are not geared to the requirements of OSM where there is a need for greater 'upfront' finance and where smaller manufacturers can access credit at the risk levels involved.
- There is very little guidance anywhere that applies specifically to OSM housing, and this may be reinforcing the slow pace of adoption by local authority elected members and technical officers.
- Innovation is a feature of OSM and this has led to a plethora of designs and systems bringing with them issues of intellectual property rights that often challenge the conditions required by manufacturing in volume and is a deterrent to contractors and lenders. Furthermore, the absence of OSM specific design codes and standardisation is holding back the development of the sector.
- The full advantages of OSM depend on scale and continuity of demand. Few institutions are large enough to achieve this critical mass, but London lacks collaborative partnerships that can deliver at the scale required.
- Existing housing partnerships, or indeed organisations such as the G15, that might offer the basis of collaborative partnerships have yet to demonstrate a successful approach in London.

For many stakeholders, there is an understandable degree of nervousness surrounding OSM. This approach to building requires a different way of doing business, of funding and delivery, and few developers, commissioners and lenders are ready to take the plunge which could help create the break through to enable OSM to realise its full potential.

The Mayor is in an ideal place to deliver this leadership and there are a number of steps he could take to galvanise the delivery of more OSM housing in London.

Recommendations on how the Mayor can galvanise the sector

The Mayor is best placed to break through the barriers preventing a wider adoption of this approach to house building. He can do this through his role in providing pan- London leadership; supporting the OSM sector through strategic policy direction; and, potentially providing land and backed by his significant funding resources. Few other leaders have this scope of power and responsibility.

The Mayor needs to, when revising the London Plan and his strategies:

- Provide a clear and strong leadership role in the development of awareness of OSM's potential. He needs to consider how best to promote the sector and to foster the confidence the industry and housing providers need.
- Critically examine all of his strategies and guidance to see if there are any policy barriers to wider adoption of OSM, or if there are areas where he can encourage the use of OSM to achieve wider strategic objectives.
- Work towards defining and adopting a Manufactured Housing Design Code to drive a more standardised and aggregated demand profile which can be delivered by a range of technologies and supported by the full range of Mayoral strategies including land and planning.
- Announce a further round of his Innovation Fund that is specifically focussed on OSM that would reflect the particular funding needs to support OSM developments.
- Look at the potential of using GLA-owned land, particularly TfL owned land, to stimulate the OSM sector and should actively work to stimulate partnerships and facilitate continuity of demand on land beyond his direct control.
- Set up a London-specific OSM led procurement framework. The key objective would be the attraction of a sufficient number of developers and contractors capable of delivering housing using a range of OSM led solutions and which are suitable for the variety of sites and typologies and all the specific challenges that exist in London.
- Set up an independent panel of experts charged with advising on the range of areas indicated above with particular reference to financial due diligence.

Recommendations

Leadership

Recommendation 1

The Mayor needs to provide a clear and strong leadership role in the development of awareness of OSM's potential. He needs to consider how best to promote the sector and to foster the confidence the industry and housing providers need.

Strategic guidance

Recommendation 2

The Mayor should critically examine all of his strategies and guidance to see if there are any policy barriers to wider adoption of OSM, or if there are areas where he can encourage the use of OSM to achieve wider strategic objectives.

Throughout this direction and guidance, the issue of ensuring OSM provides a high-quality solution must be emphasised so that recent improvements in the performance of the sector are maintained, recognised and valued by the public and housing providers.

Recommendation 3

The Mayor should work towards defining and adopting a *Manufactured Housing Design Code* building on emerging government construction strategy thinking in the UK and also what is currently being developed in Australia. The code should be developed in conjunction with designers, manufacturers and housing providers and specify the key rules for a 'Design for Manufacture and Assembly' approach to London housing.

The design code should be branded as a Mayoral 'kite mark', supported by suitable warranty providers' to promote its use. It would drive a more standardised and aggregated demand profile which can be delivered by a range of technologies and systems and which is fully recognised by the funding and valuation sectors. The use of such a London design code should be incentivised by the full range of Mayoral strategies including land and planning.

Funding

Recommendation 4

The Mayor should announce a further round of his Innovation Fund that is specifically focussed on OSM. This would reflect the particular grant profiles required to support OSM developments, potentially underwrite projects and act as a spur to capacity building in the OSM industry.

Mayoral funding support might even extend to financial assistance with capital funding where appropriate.

GLA owned land

Recommendation 5

The Mayor should look at the potential of using GLA and especially TfL-owned land to stimulate the OSM sector. OSM homes are quick to build and quick to generate rent. The Mayor may wish to review his strategy for housing on GLA sites in this respect, and for TfL owned land that may be particularly suitable for OSM if the sites are constrained and prove challenging for traditional construction.

The Mayor should actively work to stimulate partnerships and facilitate continuity of demand on land beyond his direct control.

Recommendation 6

The Mayor should set up a London-specific fully pre-qualified OSM led procurement framework. The key objective would be the attraction of a sufficient number of developers and contractors capable of delivering housing using a range of OSM led solutions and which are suitable for the variety of sites and typologies and all the specific challenges that exist in London.

This procurement framework would also ensure the implementation of the Mayor's wider objectives, including housing quality and space standards through the application of a new London Manufactured Housing Design Code.

The Mayor should also set up an independent panel of experts charged with advising on the range of areas indicated above with particular reference to financial due diligence, design and planning, market-making, and engineering and technical expertise.

1. Introduction

Key findings

- London needs 50,000 new homes per year to meet its growing needs. Despite recent improvements in housing output, traditional housebuilders and developers continue to deliver between 50 and 60 per cent of what the Mayor wants for London.
- In the short to medium term, London's construction industry is facing ever greater challenges to deliver increased supply because of potential labour shortages.
- There are now some very encouraging signs that a more positive future for housebuilding in London is emerging in the form of the potential of offsite manufactured housing. The Government intends to stimulate the growth of this sector through a variety of policy and funding programmes.
- In London, the Mayor is signalling his support for the OSM sector through his Affordable Homes Programme and his Innovation Fund, which is designed to encourage innovative ways of delivering affordable housing in London.
- We are now at a point where many favourable conditions are aligning in terms of proving the case that OSM can bridge the gap between what the traditional industry can deliver and what London needs.

London's housing shortage

- 1.1 London needs 50,000 new homes per year to meet its growing needs.¹ The last time we were anything near that target was in the early 1970s.² Since then, the capital's record has been one of consistent failure to meet housing demand.
- 1.2 Despite recent improvements, traditional housebuilders and developers continue to deliver between 50 and 60 per cent of what the Mayor wants for London. There is a growing consensus that building in the way we have been doing historically is not an option if we need to bridge the gap between housing demand and supply.
- 1.3 Furthermore, the short to medium term future of London's construction industry is facing challenges to delivering increased supply. Construction has entered a technical recession but faces significant cost inflation pressures. Materials costs are rising on global markets, but the depreciation of sterling has also added around 6-8 per cent to prices.³
- 1.4 The Farmer Review highlighted that census data suggests the UK construction industry is due to lose 620,000 domestic workers to retirement by 2026.⁴ As that review highlighted, given these significant challenges to construction capacity, it is time to 'Modernise or Die'.⁵
- 1.5 A chronic undersupply of homes has had a dramatic impact on the affordability of housing in London across all tenures. In 1997, house prices in London were on average four times the annual earnings of the average worker. By 2016, Londoners could expect to pay 12 times their annual earnings to buy a home and, of the ten least affordable local authorities in the country, seven were in London.⁶
- 1.6 In the rented sector things are just as unaffordable. An estimated 400,000 Londoners in the private sector "constantly struggle to pay their rent or are falling behind."⁷ In the social rented sector average rents have increased by around 60 per cent in the ten years to 2016.⁸
- 1.7 The consequence is rising overcrowding and homelessness. Last year over 8,000 people slept rough for at least one night on the streets of London. And there is increasing use of temporary accommodation. Nationally, the annual cost of temporary accommodation rose by 43 per cent in the last five years.⁹ In London there are more than 54,000 households in temporary accommodation – including 90,000 children¹⁰. It has been estimated that the likely cost of providing such housing in 2014/15 was close to £663 million.¹¹
- 1.8 London's housing problems are unique in England but are not unassailable.¹² There are now some very encouraging signs that a more positive future for housebuilding in London is emerging in the form of the potential of offsite manufactured housing.

Offsite manufactured housing (OSM)

- 1.9 Offsite manufactured housing (OSM) is an umbrella term for a system of house building that relies on individual components being ‘manufactured’ in a factory, transported to a site and mostly, or entirely, completed and assembled on location.¹³
- 1.10 Post-war, there have been varying degrees of support and advocacy in Government, and the wider industry, for a larger contribution from manufactured homes using OSM. And now the momentum is beginning to build again for a variety of mutually supportive reasons:
- The modern product delivers far more than a much needed home – it is high quality and delivers on a range of sustainability standards
 - We have a growing number of examples of where this kind of housing is delivering on the ground – internationally, nationally and recently here in London
 - Government policy, and more importantly, funding programmes are now being tailored to encourage the innovation and speed of delivery that characterises OSM¹⁴
 - Interest in the rented sector is on the rise in London and both public and private sector developers are attracted to the counter-cyclical nature of ‘build to rent’, the financing of which is attracted to the delivery of the fast rental stream that OSM enables
 - The Mayor has the power to co-ordinate funding, strategic policy direction and the leadership role to drive through innovation in housing delivery.
- 1.11 There is now a real and positive impetus building from the top. The recent Housing White Paper recognises that some firms are increasing their use of these (offsite construction) methods, but we need to go further. We will promote more modular and factory built homes.
- 1.12 The Government intends to stimulate the growth of this sector through the Accelerated Construction programme and the Home Builders’ Fund. This will create new opportunities for the use of modern methods of construction to encourage investors into the sector and give current suppliers confidence to expand into the housing market. It will also support the delivery of high quality, energy efficient homes through these programmes.¹⁵
- 1.13 Furthermore, the Government intends to support: measures to ensure finance is readily available across a range of methods of construction including OSM; how the operation of the planning system is working for OSM developments; working with local areas who are supportive of this type of manufacturing to deliver growth, provide jobs, and build local housing more quickly; and the

opportunities for offsite firms to access innovation and growth funding and support for them to grow.¹⁶

- 1.14 In London, the Mayor is signalling his support for the OSM sector. As part of the Affordable Homes Programme, the Mayor’s Innovation Fund is designed to encourage innovative ways of delivering affordable housing in London. Innovation could include OSM as construction innovation in itself, new ways of structuring financial investment, and new accommodation for homeless households.¹⁷
- 1.15 There are welcome signs too, that some of the passionate advocates of OSM are realising that greater awareness needs to be developed through an exemplar demonstration of the sector’s potential. One such exciting example is ‘HomeWorldExpo’ that is now seeking to build a partnership to promote a residential development model of mixed use and tenure that will be an exemplar of offsite construction to prove the deliverability of OSM.¹⁸ Such an example could be on a site in London, which could then be developed and become permanent.
- 1.16 We are now at a point where many favourable conditions are aligning in terms of proving the case that OSM can bridge the gap between what the traditional industry can deliver and what London needs.
- 1.17 This report looks at the final few actions needed to realise the OSMs sector’s potential to rise to London’s housing challenge.

“OSM can bridge the gap between what the traditional industry can deliver and what London needs”

A note on the evidence base for this report

This report is the result of a detailed review drawing on case studies, site visits, a series of roundtables and an extensive call for evidence, it looks at the advantages of offsite manufactured housing to help solve the crisis in housing delivery, the reasons why early attempts to boost the sector have failed and what role the Mayor can play to catalyse the sector’s potential to meet his strategic housing and environmental objectives.

The evidence base used for this report is considerable:

- 37 stakeholders from across the industry and public sector submitted detailed written papers
- Site visits to five housing schemes that reflect many of the different approaches to OSM were made
- 13 separate meetings with 23 experts were held.

This evidence base is set out in full in Appendix 1.

2. Offsite manufactured housing

Key findings

- Offsite manufactured housing (OSM) is an umbrella term for a system of house building that relies on individual components being 'manufactured' in a factory, transported to a site and mostly, or entirely, completed and assembled on location.
- Offsite construction allows most construction phases to be undertaken simultaneously. While site preparation, foundations and utility connections are being prepared, whole completed housing units are being built in a factory ready for final assembly and finishing in situ.
- OSM has played a significant role in meeting some of the country's most severe housing challenges for more than 70 years – especially in the post-war period and in the 1960s when it helped to propel house building to the highest level ever recorded in the country. Over 425,000 homes were built in 1968 alone, and much of this was substantially manufactured offsite.

What is it?

“Whole completed housing units are being built in a factory ready for final assembly and finishing in situ”

- 2.1 Offsite manufactured housing (OSM) is an umbrella term for a system of house building that relies on individual components being ‘manufactured’ in a factory, transported to a site and mostly, or entirely, completed and assembled on location. Various terms are used to describe such a process, for example prefabrication, modular housing or precision manufactured homes.
- 2.2 Offsite manufacturing is distinguished from ‘traditional’ building methods that rely on ‘linear construction’, where each stage of construction takes place on site and must be completed in sequence before the next phase of building can take place. Offsite construction allows most of these phases to be undertaken simultaneously. While site preparation, foundations and utility connections are being prepared, whole completed housing units are being built in a factory ready for final assembly and finishing in situ.
- 2.3 OSM housing comes in many different forms. Generally, there are five main categories used to classify the various construction systems:
 - Volumetric or modular (three-dimensional units produced in a factory, fully fitted out before being transported to site and stacked onto prepared foundations to form dwellings)
 - Panellised (flat panel units built in a factory and transported to site for assembly into a three-dimensional structure or to fit within an existing structure)
 - Hybrid (volumetric units integrated with panellised systems)
 - Sub-assemblies and components (larger components that can be incorporated into either conventionally built or factory built dwellings)
 - Non-offsite manufactured element (innovative methods of construction used onsite and the use of conventional components in an innovative way).
- 2.4 Appendix 2 sets out further details and characteristics of different OSM approaches.
- 2.5 Even ‘traditionally built’ housing now contains some offsite manufactured components; the most commonly used being factory-manufactured roofing elements (truss-rafters) and pre-fabricated window units.¹⁹ Increasingly, whole units or pods like bathrooms and kitchens are being used in traditional homes, and there is a growing market in these ‘room’ components. However, these elements usually contribute no more than 10 – 15 per cent of the entire home as opposed to 60 – 90 per cent of what is now regarded as a true OSM house.²⁰

Its contribution in meeting past housing challenges

- 2.6 Many of us will still have memories of the post-war ‘pre-fabs’. OSM has played a significant role in meeting some of the country’s most severe housing challenges for more than 70 years.
- 2.7 At the conclusion of the Second World War, more than a million London homes had been destroyed or damaged. This, combined with the need to replace surviving slum housing, required a massive and concerted effort to replace these homes on a scale never before attempted:
 - The Emergency Factory Made Homes programme assured that 156,623 “temporary” prefabricated buildings were erected all over the UK between 1946-9.
 - Permanent non-traditional homes²¹ outside this programme delivered a further 450,000 new homes in the decade following the war.
- 2.8 These homes utilised the spare factory capacity and techniques for rapid assembly that were developed for the war industry, such as aircraft production. Despite being designed with an intended life-span of around ten years, many of these ‘pre-fabs’ continued to provide homes for decades. The Excalibur Estate in Catford, south east London was constructed between 1945 and 1946 and provided 187 pre-fabricated bungalows that were continually in use until a decision was made to demolish them in 2013.²²
- 2.9 Despite these post-war efforts, the nation’s housing crisis continued into the 1960s when “housing was back on the political agenda, and both major parties saw the need rapidly to expand housing output. Again, the traditional building industry could not cope, and governments in the early 1960s looked again for new methods. This time they went for industrial methods and, unlike the earlier non-traditional boom, it meant high-density, high-rise dwellings.”²³
- 2.10 Such industrialised, system built housing helped to propel house building to the highest level ever recorded in the country. Over 425,000 homes were built in 1968 alone, and much of this was substantially manufactured offsite.²⁴
- 2.11 Much of this ‘industrialised building’ was represented by the large panel method of construction, comprising factory-made pre-cast concrete floor and wall panels. These units arrived on site in their assembly sequence and were assembled with the aid of a crane.
- 2.12 Once again, as in the 1960s, housing is high up on the political agenda.

3. OSM housing today – and why it is suitable for London

Key findings

- The last 50 years have seen tremendous advances in the quality and performance of OSM housing. Today's homes are unrecognisable from those 'prefabs' that are embedded in the memory of many.
- OSM offers a route to delivering homes that can be built to higher sustainability standards, with potential advantages in terms of build quality, speed of delivery, construction health and safety, energy-in-use, whole-life carbon footprint, and reduced transport pollution.
- The sector's positive contribution is not limited to the production and performance benefits alone. OSM homes are now a viable alternative for any potential development site, at a range of densities that can adapt to a range of local priorities.

Refreshing the image of OSM

- 3.1 Today, OSM is no longer the domain of 'niche' architects and small manufacturers. There have been tremendous advances in the quality and performance of OSM housing (see below) and Berkeley Homes, for example, would not have spent five years developing their own OSM product if they didn't think their "Urban House" would be highly attractive to home buyers.²⁵
- 3.2 Furthermore, award winning architectural practices are now adopting OSM as part of their mainstream projects. Rogers Stirk Harbour + Partners' development in New Islington, Manchester, is just one example of this new enthusiasm for OSM. For this practice "in comparison [between] traditional schemes versus offsite... offsite wins hands down in every way."²⁶
- 3.3 The challenge for OSM is to get the product more widely accepted outside the more visionary or innovative designers, manufacturers and builders. There are, however, significant barriers to be overcome.
- 3.4 The "pre fabs" of the 1950s and "system built" housing of the 1960s and 1970s has left many with negative perceptions of offsite housing and so we now need to refresh the image of OSM.
- 3.5 The lasting legacy of past failures lingers, and remains an effective barrier to implementing OSM solutions for many authorities. The London Borough of Harrow is, even today, tackling the negative perceptions of OSM. It is still demolishing estates built in the 1960s using Resiform (an old panellised system) and is finding it challenging to present a persuasive case to tenants living in these homes that they should agree to move into homes that have not been built traditionally. Plans to use the former Civic Centre site as a meanwhile use with OSM were shelved due to the lasting negative perception of OSM.²⁷
- 3.6 The success of many, relatively small OSM projects, is however generating interest. Many affordable housing providers have gone as far as pilot projects to test the viability of using OSM – however the nature of small scale test projects cannot demonstrate the benefits that large scale production can bring. "Pilot schemes do not stack up as cost effective when compared to traditional construction which prevents developers, local authorities and registered providers from choosing this method of construction."²⁸
- 3.7 Furthermore, many authorities never get past the feasibility study phase and, faced with conclusions based on conservative assumptions, or recommendations from consultants not skilled in assessing OSM projects,²⁹ do not progress their interest further.³⁰

"Small scale test projects cannot demonstrate the benefits that large scale production can bring"

OSM today

- 3.8 The last 50 years have seen tremendous advances in the quality and performance of OSM housing. Today's homes are unrecognisable from those 'prefabs' that are embedded in the memory of many.

- 3.9 “Offsite construction offers a route to delivering homes that can be built to higher sustainability standards, with potential advantages in terms of build quality, speed of delivery, construction health and safety, energy-in-use, whole-life carbon footprint, and reduced transport pollution.”³¹

The environmental performance is outstanding

- 3.10 Manufacturers of offsite homes, such as SIG, have demonstrated a modern offsite building is typically outstanding in terms of energy, fire, and quality performance.³² Various commissioners of such homes have vouched for the benefits experienced by the tenants of such homes. The acoustic performance can be 200 per cent above building regulations³³ and thermal properties can be close to ‘Passivhaus’ standards.³⁴
- 3.11 ‘Passivhaus’ is a rigorous, voluntary standard for energy efficiency in a building that results in ultra-low energy buildings requiring little energy for space heating or cooling. These homes outperform energy use of traditional homes, reducing utility bills by up to 25 per cent, up to 80 per cent on gas bills and 30 per cent on water.³⁵

OSM has a small carbon footprint

- 3.12 Construction materials now make up around 50 per cent of a building’s entire carbon footprint.³⁶ As well as the improved environmental performance (as set out above), OSM housing can be carbon neutral. “Building in timber is carbon neutral, indeed these buildings sequester carbon - you can grow housing.”³⁷ Dalston Lane is the world’s largest cross-laminated timber building. It has been estimated that the building will save 2,400 tonnes of carbon compared to a concrete building of the same size. The embodied carbon is 2.5 times less than a concrete building. Overall, the structure of the building is carbon negative.³⁸

Transportation and waste are significantly lower

- 3.13 Traditional construction relies on significant numbers of vehicles to transport materials to site and heavy plant to build homes. OSM does not, and this is much appreciated by site managers³⁹ and the reduced impact of traffic movements, low levels of construction noise and improved local air quality are being noticed by the mainstream media. A recent report suggests that large development sites, with dozens of diesel generators and diesel powered machines, are major contributors to breaches of air quality standards. “A single excavator can produce as much pollution as 14 or 15 double-deckers”.⁴⁰
- 3.14 Additionally, vehicle movements for the delivery of materials are significantly lower.⁴¹ Current, site-based construction involves the delivery of all the materials on an individual basis to one-off sites. With OSM, “the quantities delivered are typically more than one building at a time, therefore maximising the efficiency of transport for the raw materials... This reduces the overall site construction traffic by 90 per cent.”⁴² For Karakusevic Carson Architects, buildings designed on a computer and built in a factory dramatically reduce

“Reduced impact of traffic movements, low levels of construction noise and improved local air quality”

the amount of waste needing to be removed from a site.⁴³ Some commentators estimate the reduction in waste is also 90 per cent.⁴⁴

Controlled production equates to high quality homes

“Properties built in a factory will have a higher level of quality control compared with a construction site, improving the performance of the building over time.”

- 3.15 Independent experts have highlighted the superior quality of the finished product over conventionally built housing. Factory production creates controlled conditions which reduce the variation that might otherwise be a consequence of building onsite in changing environments. “There are [simply] fewer opportunities for errors in the building process.”⁴⁵ Properties built in a factory will have a higher level of quality control compared with a construction site, improving the performance of the building over time. This improved performance from offsite techniques should translate into reduced energy and maintenance costs.⁴⁶

OSM delivers speed of construction and delivery

- 3.16 One of the immense advantages of OSM housing is the speed of delivery. Reductions in construction time vary, but evidence received from numerous OSM manufacturers and building companies shows these reductions can be impressive: “We can deliver sites at greater speed through modular construction - typically 30 per cent quicker than traditional construction.”⁴⁷ Up to 10 ILKE Homes can be installed onsite in a single day, the journey from installation to occupation then takes just two weeks. This results in a build programme of a medium size site that is six months faster than traditional construction.⁴⁸ Using data from a project in Wolverhampton, 825 modules were installed in 6 months – the construction period was reduced by an estimated 12 months.⁴⁹ With careful planning houses can be delivered onto ready prepared foundations at a rate of 4 or 5 per day, and can be ready to move into within 1 week.⁵⁰ Swan Housing Association has invested in its own factory, and estimate time savings to be between 50-60 per cent.⁵¹



Berkeley's Urban House in Kidbrooke: OSM reduces costs across the board

- ✓ Utility bills reduced – up to 80 per cent on gas bills and 30 per cent on water
- ✓ Starting prices for homes are £800,000 – £400,000 less than similar
- ✓ Units delivered in ten weeks compared to over 40 weeks using traditional methods – saving labour costs

Health and safety and working conditions are enhanced

- 3.17 Building sites are dangerous work places. There were 43 construction workers fatally injured in 2015/16 – three and a half times the rate of industry as a whole.⁵² The main causes of fatal injuries were falls from heights and being struck by moving vehicles or by falling objects. The nature of OSM reduces the

likelihood of injury considerably. Visits to sites under construction, managed by Waugh Thistleton Architects, showed that fewer workers are required on site, there are many fewer deliveries, there is less need for large construction plant and the number of crane movements are minimised.⁵³ Added to that, since most work is undertaken in carefully controlled factory conditions the OSM industry has a significantly better safety record.⁵⁴

- 3.18 Moving production from the construction site inside to a factory environment has many other benefits, especially in attracting a new demographic to the industry and diversifying the workforce.
- 3.19 “The stereotypical image of the construction workplace is pretty unappealing to younger generations: hard labour, bad weather, noise and dirt, limited opportunities to broaden experience and progress... While this might not be the reality, there is at least a grain of truth to it. So it’s hardly surprising we’ve got a skills issue.”⁵⁵
- 3.20 Being able to offer professional careers in a permanent place of work should help the industry attract a broader pool of talent - especially women and young people.

OSM requires much lower labour input

- 3.21 The traditional construction industry is relatively labour intensive, and as highlighted by the Farmer Review, the challenges posed by an ageing and declining labour force will only grow:
- The construction industry has failed to improve its efficiency of operation – productivity has stayed flat during the past two decades, while during the same period, the rest of the manufacturing sector increased its productivity by 50 per cent⁵⁶
 - The industry could see a 25 per cent decline in the available labour force within a decade as many experienced workers look to retire, with 700,000 new workers needed in the next five years
 - The current reliance on EU workers in London’s construction workforce
 - The construction industry skills shortage contributes to poor quality workmanship and results in project over-runs and budget over-spends.⁵⁷
- 3.22 One of the country’s biggest housebuilders has recognised this: “fundamentally, the construction industry has been doing some things the same way for hundreds of years. Historically, we had the labour ... But the challenge is different now.”⁵⁸
- 3.23 Moving to OSM offers the opportunity to dramatically reduce the labour input, both onsite and in the factory. Estimates of the reduced labour requirement vary, from 25 per cent (using timber frame construction)⁵⁹ to a significant 75 per cent reduction onsite using modular techniques as demonstrated by Vision Modular, an offsite manufacturer.⁶⁰ Bacton Estate

regeneration in Camden saw 24 homes made from cross-laminated timber built by only ten workers in ten weeks.⁶¹

Design Meets Manufacturing: The Opportunity of Technology

- 3.24 We have heard that designing for offsite from the outset is the key to successful and cost-effective development. Designing for manufacture is increasingly assisted by technology, namely Building Information Management (BIM) software.
- 3.25 BIM is 3D modelling software designed to facilitate collaboration, project and information management across the planning, design, construction and the management of buildings. BIM has been driven by central government in a bid to tackle unnecessary costs and “maintain the UK’s global leadership in digital construction”.⁶² The 2011 Government Construction Strategy established the requirement for Level 2 BIM collaborative 3D modelling on all government build projects from 2016 and in the 2016 budget, the Government announced its intention to develop and mandate BIM Level 3 across the construction industry.
- 3.26 Digital construction enables the high quality that distinguishes offsite manufactured housing from its ‘prefab’ predecessors. Collaborative modelling software enables ‘design to meet manufacturing’. Homes or their components can be designed for the precision factory based manufacturing offers, and such early integration of design and manufacture reduces errors, ensures perfect repetition and so lower costs to production. Level 3 BIM will extend consideration of costs from construction to the building’s entire life cycle, reducing ambiguity over maintenance.
- 3.27 BIM as digital construction has been welcomed by offsite providers as “a tangible mechanism to encourage the consideration of offsite solutions as early as possible in the project planning process”.⁶³
- 3.28 Lessons have been learned from the ‘painful process’ of adapting designs to OSM part way through a development.⁶⁴ Given that OSM needs to be ‘designed in from the start of the process’ BIM assists with the advanced planning at the design stage, and growing adoption of this approach can only assist the use of OSM in the future.

Design quality, construction materials and safety

- 3.29 In the light of the tragedy at Grenfell Tower, and pending the full findings of the Public Inquiry, it is clear that London's housing strategy needs to assure the public as well as the funding and insurance markets that only the highest quality housing will be acceptable via London's planning, building control and management regulatory process – especially in terms of fire safety. This should ensure that the emergence of a growing ‘precision manufactured’ element of London's housing delivery assures high quality and predictable technical solutions. These should meet the most stringent structural, fire and related life safety engineering tests and be prone to fewer site of the

“Digital construction enables the high quality that distinguishes offsite manufactured housing from its ‘prefab’ predecessors”

installation failure risks or specification divergence that are features of fragmented supply chains and price led procurement.

- 3.30 The Mayor's support for 'growing' an offsite precision manufacturing sector should be contingent on the demonstration that OSM solutions are being developed that meet or exceed accepted standards and regulations, including and especially fire safety. The Mayor needs to work with Government to support any emerging single accreditation/warranty standard that may be adopted for the OSM sector and which addresses technical compliance requirements.
- 3.31 The Mayor should therefore review GLA, London Borough and Registered Provider procurement practices for housing construction to ensure that selection is based on best outcomes not the lowest price.

Why is OSM especially suitable for London?

“OSM homes are now a viable alternative for any potential development site, at a range of densities that can adapt to a range of local priorities.”

- 3.32 During this review, numerous experts have stressed how OSM can deliver for London – and this has been confirmed by site visits to a number of developments that demonstrate how OSM adapts to a variety of challenging circumstances.
- 3.33 OSM's positive contribution is not limited to production and performance benefits alone. It is suitable for all tenures, but with particular financial suitability for the rental sector. We have seen many examples of both public and private-sector developers being attracted to the counter-cyclical nature of rental homes and the delivery of a fast rental stream that OSM enables.
- 3.34 OSM homes are now a viable alternative for any potential development site, at a range of densities that can adapt to a range of local priorities. These features make this housing particularly relevant, and uniquely suited, to the housing challenges faced in the capital where it is vital that we 'sweat' all available land assets, irrespective of the difficulties presented, to meet London's housing need.

OSM is lighter and requires considerably less obtrusive foundation preparations

- 3.35 The absence, or substantial reduction in the use, of concrete and steel in OSM construction make these buildings significantly lighter than traditional approaches. Typically, OSM homes are 20 -25 per cent of the weight of 'conventional' buildings.
- 3.36 These weight reductions are significantly advantageous on sites where deeper and more intrusive foundations make the site unviable for traditional designs, for example those with infrastructure tunnels below, next to main railway routes or heavily contaminated sites:
- The architects of Bacton Low Rise were able to build right up to the embankment of the main West Coast rail line without compromising the safety and integrity of the retaining walls of the

railway, as the building is 75 per cent lighter than a conventional approach.

- The architects of Dalston Lane were able to construct the largest cross-laminated timber building in the world directly over a safeguarded Crossrail 2 tunnel given the 80 per cent reduction in weight. This also increased the housing density, allowing an additional two storeys to be included in the design which would have been impossible, or unviable, with a concrete building.
- The ILKE Homes development in Gallions Reach required only small concrete foundation pads rather than conventionally deep foundations that would have proved expensive and technically challenging on the contaminated site.



Dalston Lane in Hackney: Low weight enables higher density

- ✓ A fifth of the weight of traditional construction enables building to be sited over safeguarded Crossrail 2 tunnels
- ✓ High sound insulation protects residents from adjacent Overground railway line
- ✓ Low weight enables greater height and density

Small and infill sites become viable, with less impact on residents

- 3.37 Small and 'infill' sites abound in London, but are normally surrounded by existing homes. As set out above, OSM has much lower construction impacts in terms of noise, vehicle movements and faster build times. All of these advantages make OSM particularly suitable for the capital, and particularly in terms of increasing densities on existing housing estates.
- 3.38 In terms of infill sites, the potential opportunities can be considerable. Barnet Council, for example, indicated that up to 1,000 homes could be delivered on infill sites across its borough. In Brent over 1,100 empty garages could be suitable for conversion to new homes. Boroughs such as Harrow, Greenwich and Lambeth have all either delivered or identified capacity for over 150 homes on infill sites.⁶⁵
- 3.39 Less disruption to residents will make acceptance of infill development and estate intensification considerably more acceptable. London has capacity for at least 100,000 homes on infill sites⁶⁶, and many of these are currently unviable for development through conventional means.

OSM is suited to intensification and increasing density

- 3.40 The London Plan encourages mixed use development and it is likely that the next review will also focus on co-locating employment and residential uses. OSM has the potential to be ‘installed’ over existing buildings or even added on top of blocks of flats. One idea, launched in 2016, enables modular homes to be built on stilts above car parks. The homes are designed to almost ‘Passivhaus’ status (see paragraph 3.10), with a highly insulated timber frame pod. They will sit beneath a solar-panelled roof which will provide 90 per cent of the homes’ energy.⁶⁷



Bacton Low Rise in Camden: Suitable for immensely constrained sites with reduced impact on existing residents

- ✓ Low number of delivery loads minimised disruption for residents
- ✓ Lighter building weight suitable for sites next to operating railway
- ✓ CLT has also enhanced liveability- close to Passivhaus standard

OSM can provide temporary uses on stalled sites

- 3.41 There are many potential housing sites in London that are not delivering the new homes the capital requires. Often these sites are temporarily ‘stalled’ through funding problems, or have been earmarked for development as part of a wider regeneration strategy that is phased over many years. OSM enables these sites to be used almost immediately. PLACE Ladywell is one such example. The site, on the former Ladywell Leisure Centre, will ultimately become part of a larger regeneration scheme, however it is being used now for much needed homes, after which it will be deconstructed, moved and reconstructed elsewhere in the borough. The modules have been designed to be moved five times to other sites.

Superior energy performance and the impact on reducing fuel poverty

- 3.42 London suffers disproportionately from fuel poverty. Fuel poverty is a large and growing problem in the capital, affecting over a million Londoners, including around 300,000 children. The number of London households unable to afford to heat their homes increased by 26 per cent between 2012 and 2014 to more than 348,000 homes.⁶⁸ There were over 4,000 excess winter deaths in the capital in 2014/15, with between 30-50 per cent believed to be attributable to cold homes.⁶⁹

- 3.43 As set out above, OSM homes outperform energy use of traditional homes, reducing utility bills by up to 25 per cent, up to 80 per cent on gas bills and 30

“OSM homes outperform energy use of traditional homes, reducing utility bills by up to 25 per cent, up to 80 per cent on gas bills and 30 per cent on water”

per cent on water. The London Borough of Lewisham estimates annual energy bills of £300 per home in the Ladywell development, as opposed to costs in excess of £2,000 for traditional homes.⁷⁰ Encouraging more OSM housing would significantly assist the Mayor's Fuel Poverty Action Plan which aims to help Londoners get out of fuel poverty and put London on a path to zero carbon by 2050.



PLACE Ladywell in Lewisham: OSM is suitable for temporary or stalled sites

- ✓ Site utilised for four years and designed for removal to another site
- ✓ Use for temporary accommodation reduces costs to local authority
- ✓ Fast construction time enables quicker generation of rent income
- ✓ Homes exceed the minimum space standards by 10 per cent

OSM is particularly suitable for rented accommodation

3.44 OSM housing is particularly suitable for rented accommodation. Reduced construction time means homes are occupied sooner, and rents begin to flow quicker.⁷¹ The pressures on London boroughs' temporary accommodation budgets has spurred innovation; the London Borough of Lewisham's PLACE Ladywell scheme is a good example of this (see further details in the case studies, Appendix 3). Construction on the site began in November 2015 and the majority of residents had moved in by August 2016. The speed of construction in Lewisham has helped to deliver the rents needed for the scheme to pay for itself in seven to ten years through rent and reductions in temporary accommodation payments to the private rented sector. The council says it will save £140,000 a year simply through not paying to house these families in low quality temporary accommodation. This aspect of OSM is particularly relevant for London where, last year, authorities spent around £650 million on temporary accommodation.

3.45 To date, replacing temporary accommodation in the private rented sector has been a spur to the OSM sector, but now we are seeing increasing evidence that all parts of rental market are looking at OSM in a positive light. The Mayor is encouraging the Build to Rent sector as a form of development that will boost the delivery of new homes in London. During this review, our dialogue with investors indicates that this may be particularly suitable for OSM housing.

3.46 Boroughs too are viewing Build to Rent positively:

- Build to Rent is more affordable than market sale because there are lower barriers to entry. Where a deposit is required it is in the

region of £1,000 to £2,000 against the average deposit of £80,000 for a first time buyer

- There are too few major developers – encouraging this tenure brings new entrants into the development market
- Build to Rent speeds the delivery of developments, as they are not tied to sales rates.⁷²

Conclusions

- 3.47 It is now increasingly recognised that aspirations to ramp up housing delivery to the levels Government and the Mayor believe are necessary appears to be physically impossible using traditional methods.⁷³
- 3.48 While not a panacea for London’s housing crisis, OSM will be critical in bridging the gap between the numbers of new homes the traditional construction industry can deliver and the level of housing need that is anticipated in the next twenty years.
- 3.49 It could also help tackle London’s long standing strategic priorities – for example the need to deliver affordable housing quickly, meet carbon reduction targets, tackle fuel poverty, and unlock stalled, difficult to develop or currently unviable sites.
- 3.50 So why have previous attempts to make OSM ‘mainstream’ failed?

4. Issues, barriers and challenges for London today

Key findings

- In other countries, OSM fulfils a much greater source of new housing.
- There are many reasons why OSM has failed to take off in England:
 - There is degree of nervousness surrounding OSM. This approach to building requires a different way of doing business.
 - There has not been the volume of demand and continuity of supply to justify building factories to manufacture the product.
 - Few institutions are large enough to achieve this critical mass, but London lacks collaborative partnerships that can deliver at the scale required.
 - There is very little guidance anywhere that applies specifically to OSM housing, and this may be reinforcing the slow pace of adoption.

“In other countries conditions exist that ensures OSM fulfils a much greater source of new housing”

- 4.1 While the modern OSM product incorporates cutting edge technology, the concept is not new.
- 4.2 But, failures to invest in, and push on with, OSM have resulted in the over-reliance on the traditional approach, whereas in other countries conditions exist that ensure OSM fulfils a much greater source of new housing. Japan has a well-developed OSM housing market with the potential for high performance and has established strong housing brands.⁷⁴ In Tokyo alone, 140,000 new homes are delivered each year through OSM.
- 4.3 There are many reasons why OSM has failed to take off in England.
Delivering economies of scale requires volume and continuity of demand
- 4.4 Perhaps the biggest challenge to overcome is the one faced by any kind of industrialised activity. OSM, like all manufacturing processes, requires both volume and continuity of demand to justify the up-front capital investment needed to build the plant to manufacture the product.⁷⁵ With these two conditions in place prices will fall and confidence in the product will rise. Neither of these conditions have been in place to date, and so the economies of scale have never been achieved.
- 4.5 There is currently limited capacity in the OSM industry, with only a few large factories in England. The industry will not expand without assurances of a consistent pipeline over a number of years. According to an officer from the London Borough of Newham, one offsite manufacturer they were working with was looking for a 15 year guaranteed supply, which the council were unable to provide.⁷⁶
- 4.6 However, recent developments suggest that industry confidence is growing and major investment decisions are being made:
 - L&G are investing in a 550,000-square-foot factory near Leeds, intended to be “the largest modular homes construction factory in the world”⁷⁷
 - Berkeley Homes has a target of building 10-15 per cent of all its houses using prefabricated techniques in the short to medium term.⁷⁸
 - China National Building Material Company is reported to be investing in a £2.75bn joint venture with a UK housing association to build six factories that can produce 25,000 homes a year by 2022.⁷⁹
- 4.7 Not all projects require such a scale of output to make building a factory viable. Swan Housing Association, which owns 11,000 homes in Essex and London, has agreed a deal for factory space near Basildon, Essex. It is planning to use the factory to build at least 500 homes for market sale by 2022, although the total number built could be much higher than that. In the long-

term, Swan will also look at selling the manufacturing services to other providers.⁸⁰

“There is a smaller pool of lenders willing to finance OSM development than enjoyed by traditional builders”

- 4.8 It was made clear by many stakeholders that the ownership or leasing of production capacity guarantees advantages for house builders: control over quality, precision engineering, asset management and the full benefit of cost savings.
- 4.9 OSM housing opens up a wide range of STEM⁸¹ employment opportunities, specifically to groups that have not been attracted to traditional construction work, such as women, and across a whole range of skill levels which should be more attractive to young people in a way that differs from ‘traditional’ house building. There is potential for demand for homes to fuel employment opportunities in the rest of the country. London’s demand for homes could stimulate job growth and rebalance the national economy. This is something the Mayor may wish to discuss with Government for London to play a leading role in an emerging national industrial strategy.
- 4.10 We recognise that most factories producing OSM housing have been and will be outside London where sites are cheaper, but there is no reason to believe London-based factories are not viable. However, there may currently be scope for London-based factories at waterside sites, such as the Old Oak and Park Royal Mayoral Development Corporations and Barking Riverside, which may offer further cost reductions and environmental benefits. Should the volume of production increase to the levels London needs, then unit costs will fall, making transportation costs a bigger proportion of overall value. This is when London factories might begin to become feasible.
- 4.11 Land is scarce; however, there may be circumstances under which the temporary leasing or licensing of existing factory or warehouse space becomes viable for temporary manufacturing.

Funding OSM developments and financing mortgages

- 4.12 OSM housing requires an alternative funding model to traditional construction. Unlike traditional construction, OSM requires a larger proportion of finance at the early stages of the construction process as the manufacturer requires detailed designs and other upfront costs in order to begin to manufacture the product. The suppliers obviously need to have the factory in which to build the units. Even for a small production run, start-up costs can reach more than £500,000.⁸² Many small manufacturers do not have access to this level of debt funding.⁸³
- 4.13 Lenders are unaccustomed to the front-loaded nature of the finance needed for OSM so may be unwilling to lend the whole amount, or attach a higher level of risk and interest to the sum, making it more expensive. Generally this means there is a smaller pool of lenders willing to finance OSM developments than enjoyed by traditional builders.⁸⁴
- 4.14 This is especially a challenge for offsite manufacturers, most of which are SMEs. Around 80 per cent of these companies find it very difficult to directly

“The paucity of strategic guidance is clearly an obstacle to realising the sector’s potential to deliver”

secure funding from high street banks due to a lack of confidence or a track record of successful borrowing.⁸⁵ The situation is compounded by the absence of organisations prepared to undertake ‘due diligence’ for manufacturers seeking to borrow.⁸⁶ Members of the Build Offsite Property Assurance Scheme (BOPAS) reported that accessing finances through ‘Tier 1’⁸⁷ constructors is therefore necessary, and this adds to their costs.

- 4.15 However, due to the speed of construction OSM units may be rented or sold quicker than traditional build. Therefore the overall length of time for which finance is needed should be reduced.
- 4.16 Concerns have been raised about the availability of mortgage financing for OSM homes. In the past there has been some caution lending money for these products due to the historically poor track record of OSM in terms of durability. In forming a view about non-standard approaches, mortgage lenders will want to know about the warranties available on particular products, and to take a view on the suitability of the property as mortgage security. Lenders will also want to consider the expected design lifespan of the property and the extent to which a viable market might develop for properties of a particular product.⁸⁸
- 4.17 However, the introduction of BOPAS, an assurance scheme for accredited OSM housing, provides a guarantee to mortgage providers that OSM homes will last for 60 years.⁸⁹ Many have suggested that the true lifetime of OSM products is significantly longer. There are suggestions that BOPAS will now work towards guaranteeing OSM products for 100 years in order to dispel the myth that 60 years is the life span of the product.⁹⁰ According to the Council of Mortgage Lenders (which represents 97 per cent of the assets of the UK mortgage market), a recognised quality standard such as BOPAS is crucial in instilling confidence in the sector. The creation of BOPAS to overcome this issue is also encouraging evidence of the OSM sector’s maturation, suggesting the industry can come together and work with the Mayor.

Planning and other strategic policy issues

- 4.18 There is very little guidance anywhere that applies specifically to OSM housing, and this may be reinforcing the slow pace of adoption by local authority elected members and technical officers. Even recent guidance, dating from 2014 is relatively silent:
- The Mayor’s Housing Strategy makes one fleeting reference to OSM – but as a vehicle for small to medium constructors to enter the London housing market⁹¹
 - The Housing Supplementary Planning Guidance, which superseded the London Housing Design Guide, makes no mention of the use of OSM in setting design standards for new homes⁹²
 - The Sustainable Design and Construction Supplementary Planning Guidance similarly has no reference to OSM, despite the sector’s

significantly improved environmental performance (as set out in chapter 3).⁹³

- 4.19 The paucity of strategic guidance, or even encouragement for the sector, is clearly an obstacle to realising the sector's potential to deliver the scale of new homes London needs.
- 4.20 As the Ladywell scheme demonstrates, OSM projects can be suitable for location on 'meanwhile' sites and designed for relocation to other sites at a future date. But these schemes require temporary planning permissions. Temporary planning permissions, often for periods of five to seven years, impact on viability as more frequent moves of homes to other sites add costs. Longer temporary permissions, which are rarely given consent, are needed, and awareness of the particular OSM requirements for temporary permissions needs to be raised. At present, building regulations require conventional (more costly) foundations if a building is to be on site for more than two years.
- 4.21 The planning system often makes it a requirement to use local labour as part of a development. The OSM process means that more of the unit is completed offsite so there needs to be a mechanism for recognising this.⁹⁴ However, there is evidence that, where there is a need for onsite assembly, local labour can be recruited, trained and used consistently on various projects.⁹⁵

Absence of a 'design code' for OSM

- 4.22 Innovation is a feature of OSM and this has led to a plethora of designs and systems bringing with them issues of intellectual property rights that often challenge the conditions required by manufacturing in volume. Manufacturing is assisted by standardisation and interchangeable components that reduce costs and provide more certainty in the event of needing to change suppliers and manufacturers if companies unexpectedly fail. When this occurs 'intellectual property' is often lost and it is difficult to substitute with another product.
- 4.23 However, OSM-specific design codes are notable by their absence, and this is holding back the development of the sector.
- 4.24 This situation is not confined to this country. Work is currently underway in Australia where group of builders, designers, suppliers, developers, industry associations, academic institutions and government is trying to change this. Together, they have formed the Modular Construction Codes Board, which they have tasked with producing a code of practice or a handbook for the modular building industry.
- 4.25 The Code will address areas of design for performance, design for manufacture and assembly and regulatory guidance. The code aims to provide direction for architects and engineers about areas such as structure, services, façade, architecture, materials, safety, durability and logistics.⁹⁶

"The full advantages of OSM depend on scale and continuity of demand"

4.26 Crucially, this approach does not seek to compete or replicate National Construction Codes, but will provide guidance about strategies to manage the challenges which arise when designers move away from traditional building methods that are often without recognised or widely known guidance.

Absence of a collaborative partnership

4.27 The full advantages of OSM depend on scale and continuity of demand. Few institutions are large enough to achieve this critical mass, but a grouping of smaller suppliers might achieve this. London lacks collaborative partnerships within and between the public (Registered Social Landlords) and private sector. There are welcome signs of such partnerships emerging in other parts of the country:

- A consortium of north-west housing associations (Modular Allianz) led by Manchester City Council is hoping to drive higher uptake of offsite manufacturing by pooling demand to create a potential 500-home programme.
- The Central Housing Investment Consortium is a group of 85 Midlands based affordable housing providers that work together with the aim of securing efficiencies and savings through procurement of contracts, labour and services. It is actively seeking offsite manufacturers to join the consortium.

4.28 Existing housing partnerships, or indeed organisations such as the G15⁹⁷, that might offer the basis of collaborative partnerships have yet to demonstrate a successful approach in London.

4.29 OSM procurement frameworks are agreements put in place with a provider, or range of providers, that enable buyers to place orders for OSM services without running lengthy full tendering exercises. These frameworks enable buying in large volumes – and increasing volume is an essential part of any viable manufacturing process, including OSM housing. But there are limited examples of these. One such framework has been set up by LHC (originally London Housing Consortium) to provide regional lists of a range of suppliers. The London region framework has the smallest number of suppliers in the country. These are only suppliers and not exclusive to offsite.

4.30 The devolution of power from central government to a series of regional combined authorities represents a great opportunity for the Mayor to ensure a coordinated approach to how London's economic growth can be underpinned by strong relationships with the various metro mayors.

4.31 Although London will continue to be a real engine room for the national economy, there is a strong case for a more balanced economy where the regions support London's growth ambitions and that in turn supports the regional economies. It is clear that the level of housing and infrastructure required in the capital cannot be delivered through local resources alone and a strategic approach to creating national interconnected supply chains must be a priority.

4.32 The Mayor should commit to ensuring a strategic dialogue is developed with key regional combined authorities so that investment and capacity in their local economies can be developed in conjunction with an understanding of what potential demand for pre-manufactured housing and other construction products might arise. The skills needs for London may also be influenced by more assembly and logistics requirements to complement this approach.

Lack of strategic leadership in London

4.33 While there appears to be signs of strategic leadership emerging in the North and Midlands, to date there is little evidence of such a shift in London.

4.34 As set out above (paragraph 4.18), there is a paucity of relevant guidance contained in strategic documents produced in the capital. There are, however, welcome signs this may be changing.

4.35 The Mayor has secured £3.15bn from the Government to fund new affordable homes for Londoners. This funding is expected to support starts for at least 90,000 new affordable homes in London through to 2021.

4.36 As part of the funding package, the Mayor's Innovation Fund is designed to encourage innovative ways of delivering affordable housing in London. Innovation could include OSM itself, new ways of structuring financial investment and new accommodation for homeless households.

4.37 Crucially, the Innovation Fund specifically mentions OSM. However, the deadline for submitting an expression of interest was 13 April 2017 and many stakeholders may have been unable to submit bids given the complexity of delivering an OSM programme and the limited experience of many providers in this area.⁹⁸

Conclusions

4.38 For many stakeholders there is an understandable degree of nervousness surrounding OSM. This approach to building requires a different way of doing business, of funding and delivery, and few developers, commissioners and lenders are ready to take the plunge which could help create the breakthrough to enable OSM to realise its full potential.

4.39 While there are examples of successful and popular developments, many of these are small scale pilot projects. Nevertheless, they are beginning to change perceptions of the product. At a strategic level, more encouragement, guidance and help, covering financial, technical and organisational aspects, is needed to deliver the scale and continuity of demand that will enable OSM to demonstrate its potential.

4.40 The Mayor is in an ideal place to deliver this leadership and there are a number of steps that the Mayor could take to galvanise the delivery of more OSM housing in London. The next section looks at the steps the Mayor could take.

5. Recommendations for how the Mayor can galvanise the sector

Key findings

- The Mayor is best placed to break through the barriers preventing a wider adoption of this approach to house building.
- When revising the London Plan and his other strategies he needs to:
 - Promote OSM and to foster the confidence the industry and housing providers need.
 - Work towards defining and adopting a Design Code to drive a more standardised approach.
 - Announce funding that is specifically focussed on OSM.
 - Look at the potential of using GLA-owned land to stimulate the OSM sector.
 - Set up a OSM procurement framework

- 5.1 The Mayor is best placed to break through the barriers preventing a wider adoption of this approach to house building. He can do this through his role in providing pan- London leadership; supporting the OSM sector through strategic policy direction; and, potentially providing land and backed by his significant funding resources. Few other leaders have this scope of power and responsibility.

The Mayor must provide confidence and raise OSM's profile

- 5.2 OSM has its champions among architects, developers and some local authorities. They are convinced of the quality and performance of this type of housing and are delivering homes in ever greater numbers. However, a step change is required to re-imagine the product and to create sufficient volume of supply. That will need the commissioners of housing to “think OSM” from the start. A few London boroughs and some registered providers have taken this step but what is needed is for all of them to have the confidence to adopt OSM as an essential component of their housing strategies.
- 5.3 Awareness of the potential is still low in many boroughs. But, as this report has shown, there are now many excellent examples of new homes that have been delivered on the ground, both in London and elsewhere.⁹⁹ Local authorities and other housing providers, in the public and private sectors, need to be aware of this excellent work and the benefits OSM can, and does, deliver. The Mayor should lead and press the case for adoption of OSM much more widely across London.

Recommendation 1

The Mayor needs to provide a clear and strong leadership role in the development of awareness of OSM's potential. He needs to consider how best to promote the sector and to foster the confidence the industry and housing providers need.

Providing clear policy signals

- 5.4 OSM needs to be recognised as a vehicle that is capable of delivering on a wide range of Mayoral objectives that go well beyond its contribution to meeting housing targets. Increasing the numbers of OSM homes will also contribute to carbon reduction, energy efficiency, sustainable design and construction, combatting fuel poverty, reducing the public cost of temporary accommodation, as well as helping in the drive to secure appropriate increases in housing density.
- 5.5 The new Mayor is revising all the existing Mayoral strategies. When revising his strategies, the Mayor should consider how OSM can play a part in his overarching strategic objectives. Specifying performance levels through

planning and design requirements should give OSM a more equal playing field. For example:

- In the London Plan, and any related Supplementary Planning Guidance (SPG), the Mayor needs to ensure any barriers to OSM are removed and clear signals are given that OSM will be encouraged to play its full part in bridging the gap between current housing supply and London's needs. Following revision to the London Plan, the Mayor may wish to consider a new SPG dedicated to OSM. The Mayor should identify where OSM is particularly suitable for sites constrained by a variety of factors, how it can play a role in increasing density and intensification and its capacity to provide 'meanwhile' uses for stalled sites.
- In relevant sections of the document the Mayor should include, where appropriate, policy and/or text to reflect the strategic objectives covered in relevant strategies including those below.
- The Mayor might also consider setting a 'precision manufactured value' threshold for OSM content for housing schemes that developers would be encouraged to meet or exceed through any number of approaches. This may act as a 'market maker' to stimulate the sector further.
- In the Housing Strategy, the Mayor should review OSM's contribution across the whole sector, extending this beyond the current reference in the 2014 document, as an entry vehicle for small manufacturers. The strategy needs to send clear signals that: OSM can deliver on the Mayor's affordable housing agenda; tackle the soaring cost of homelessness and temporary accommodation; boost the supply of affordable rented homes London desperately needs; and reflect the industry consensus on the suitability of OSM for build to rent. He needs to amplify the welcome first signals set out in his Innovation Fund to encourage new ways of financial investment and new approaches to tackle homeless households.
- The Mayor's Innovation Fund already builds on the issues highlighted by the Farmer Review. Precision-manufacturing homes can offer an increased level of consistency and quality control and additional benefits in terms of speed of delivery, cost efficiencies and safety on site. Furthermore, an industry-wide move towards more offsite work could make a career in the construction sector more attractive to young people. The Mayor therefore expects to see an increasing number of bids that involve the precision-manufacture of new and affordable homes.¹⁰⁰
- In the Environment Strategy the Mayor should explicitly recognise: OSM's contribution to tackling climate change; sustainable design

and construction; reducing pollution, noise, construction waste and carbon (including a new policy on embodied carbon); and to increasing energy and water efficiency. Furthermore the links to achieving other strategic objectives that flow from the use of OSM, such as reducing fuel poverty, need to be explicitly recognised.

- In his Transport Strategy, the Mayor needs to recognise the positive contribution that OSM makes to the reduction of construction traffic movements and the associated impact on air pollutants, reduction of CO₂ and noise. He may also wish to review how his approaches to freight and river wharves can support the use of OSM in terms of transporting the materials needed for potential factories in London.
- The Mayor's Economic Development Strategy provides an opportunity to embed OSM as part of the capital's future economy. It should recognise that OSM is a new and emerging advanced manufacturing sector. Not only will it provide a new source of skilled industrial jobs (in digitalised construction) it will also be an essential part of the journey to a low-carbon and resource efficient economy. The Mayor may wish to consider using his planning and economic development powers to find sites for OSM factories in and around London. He should also ensure Londoners have the skills to take advantage of the employment opportunities that will arise.

Recommendation 2

The Mayor should critically examine all of his strategies and guidance to see if there are any policy barriers to wider adoption of OSM, or if there are areas where he can encourage the use of OSM to achieve wider strategic objectives.

Throughout this direction and guidance, the issue of ensuring OSM provides a high quality solution must be emphasised so that recent improvements in the performance of the sector are maintained, recognised and valued by the public and housing providers.

Design guidance and protocols

- 5.6 Existing Mayoral guidance has not developed at the same pace, nor in time with, innovation in the OSM sector. This lack of guidance may be affecting the confidence of manufacturers and reinforce the slow pace of adoption by architects, developers, local authority elected members and technical officers.

- 5.7 The Mayor should build on the existing London Housing Design Guide but develop a set of standards the capital should adopt for OSM and effectively represent a Manufactured Housing Design Code. The design code would use 'Design for Manufacture and Assembly' principles that can define rules which still enable mass customisation of housing. This would include spatial planning criteria and a component standardisation 'catalogue' approach that can then be configured in multiple combinations as part of a project specific design response. These rules might define, for instance, how kitchens or bathrooms might be space planned and then fitted out, as well as broader critical dimension rules for storey heights, circulation and key room dimensions defined by ergonomics and furniture space planning. Such rules would reflect both national and London described space standards and other key qualitative standards.
- 5.8 This design code can then form the basis of how the broader offsite supply chain is able to respond with their own products and systems, all digitally enabled to harness greatest efficiencies and technical quality control. This approach could build on and leverage the work being done as part of Digital Built Britain's guidance document entitled: 'Delivery Platforms for Government Assets: Creating a marketplace for Manufactured Spaces.'

Recommendation 3

The Mayor should work towards defining and adopting a *Manufactured Housing Design Code* building on emerging government construction strategy thinking in the UK and also what is currently being developed in Australia. The code should be developed in conjunction with designers, manufacturers and housing providers and specify the key rules for a 'Design for Manufacture and Assembly' approach to London housing.

The design code should be branded as a Mayoral 'kite mark', supported by suitable warranty providers to promote its use. It would drive a more standardised and aggregated demand profile which can be delivered by a range of technologies and systems and which is fully recognised by the funding and valuation sectors. The use of such a London design code should be incentivised by the full range of Mayoral strategies including land and planning.

Funding

- 5.9 OSM has its own funding requirements that do not often sit easily with existing investment models that have been developed to support traditional construction approaches.
- 5.10 The Mayor has made a good start in recognising the need to incentivise funding programmes to OSM as seen, for example, where he has encouraged it in his Homes for London prospectus and tailored it in his Innovation Fund. But the industry has said it needs more. The Mayor should consider how his

funding role aligns with the needs of OSM, for example by re-profiling the release of grant earlier in the development process which reflects the 'front loaded' finance requirements that are a feature of OSM. He may also wish to review whether there is a role as an 'underwriter' for OSM in London. This would help to overcome the nervousness of banks and other investors and unlock the required stream of capital needed to support OSM. It might also provide support to production in periods of slow demand for homes.

Recommendation 4

The Mayor should announce a further round of his Innovation Fund that is specifically focussed on OSM. This would reflect the particular grant profiles required to support OSM developments, potentially underwrite projects and act as a spur to capacity building in the OSM industry.

Mayoral funding support might even extend to financial assistance with capital funding where appropriate.

Land: delivering volume and continuity of supply

- 5.11 Perhaps the biggest single obstacle working against OSM is that of guaranteeing sufficient volume of demand and a continuity of supply. An annual shortfall of 20,000 homes in London surely demonstrates that the potential demand is there. If manufacturers were assured this demand can be realised and funded then the market would respond.
- 5.12 The Mayor has already signalled his determination to fast-track more public land for development. TfL owns a 5,700 acre estate that includes land and properties with huge potential for creating the homes and jobs that London needs. These landholdings are beginning to play a vital role in meeting the Mayor's priorities to build affordable homes, while generating revenue for transport programmes.
- 5.13 TfL has a long-term development pipeline, aiming to deliver 10,000 homes across 300 acres, and there is no reason why OSM should not deliver a sizeable proportion of these homes with the right encouragement, especially on small and constrained sites.
- 5.14 Furthermore, there is much publicly owned land outside the GLA's control and the Mayor should look at ways of co-ordinating demand across all boroughs for OSM homes. One borough commissioning 100 homes per year might not provide the business case to expand production. But partnerships across a number of boroughs doing the same would stimulate supply. Similarly, partnerships to aggregate demand could be forged between boroughs, Registered Social Landlords and the private sector, as has been demonstrated outside London.

Recommendation 5

The Mayor should look at the potential of using GLA and especially TfL-owned land to stimulate the OSM sector. OSM homes are quick to build and quick to generate rent. The Mayor may wish to review his strategy for housing on GLA sites in this respect, and for TfL-owned land that may be particularly suitable for OSM if the sites are constrained and prove challenging for traditional construction.

The Mayor should actively work to stimulate partnerships and facilitate continuity of demand on land beyond his direct control.

More effective procurement

- 5.15 The Mayor needs to create two mechanisms to build confidence with clients and lenders. The GLA, currently, has no offsite specific delivery framework panel. What is required is a group of approved developers and contractors on which the GLA has carried out due diligence to ensure a pre-vetted and solid supply chain, possibly in conjunction with confirmed solutions that respond to the Design Code above.
- 5.16 Some of the contractors and developers will have their own factories and products; other developers and contractors will require matchmaking. This is a role for the Mayor.
- 5.17 This framework could encompass both 'developer led' models that are capable of providing turnkey solutions on public sites and also have a contractor led component which Registered Providers or private developers could use to buy OSM led construction solutions for use on land they control and which meets all necessary procurement governance rules. Key to being part of this framework will be a commitment to encouraging the replicability, compatibility and inter-operability of various OSM products and systems that respond to a new design code for London.
- 5.18 This, together with an expert panel, will accelerate and assist in overcoming risk averseness amongst lenders, enabling clients, including G15 housing associations and boroughs, to seek out approved developers and contractors. Many OSM manufacturers have limited capitalisation so anything that can assist in generating a predictable demand for OSM homes will give them confidence to maintain, and indeed increase, investment in their production capacity. The procurement framework can then be used by multiple client bodies acting as a 'brokerage' mechanism, matchmaking an emerging OSM sector with clearer routes to market either as vertically integrated models or through joint ventures and consortia.
- 5.19 Currently, there is insufficient knowledge and understanding of this sector (amongst investors and clients). Again, to give confidence, there needs to be an independent source of expertise. This needs to be an independent panel of experts which can cover the whole process and provide financial due

diligence, design and planning, market-making, and engineering and technical expertise. It could also advise on R&D and pilot projects. This will need an executive within the GLA and a non-executive advisory group.

Recommendation 6

The Mayor should set up a London-specific fully pre-qualified OSM led procurement framework. The key objective would be the attraction of a sufficient number of developers and contractors capable of delivering housing using a range of OSM led solutions and which are suitable for the variety of sites and typologies and all the specific challenges that exist in London.

This procurement framework would also ensure the implementation of the Mayor's wider objectives, including housing quality and space standards through the application of a new London Manufactured Housing Design Code.

The Mayor should also set up an independent panel of experts charged with advising on the range of areas indicated above with particular reference to financial due diligence, design and planning, market-making, and engineering and technical expertise.

Appendix 1 – Evidence base

Written submissions were received from:

OS-001	Barratt Developments PLC
OS-002	SIG
OS-003	Calfordseaden
OS-004	Willerby
OS-005	London Housing Consortium
OS-006	Network Homes
OS-007	Be:here
OS-008	Southern Housing Group
OS-009	Rogers Stirk Harbour + Partners
OS-010	63000 Homes
OS-011	MyPadHaus
OS-012	Premier modular
OS-013	LB Enfield
OS-014	Buildoffsite
OS-015	LB Harrow
OS-016	The Housing Forum
OS-017	Places for People
OS-018	Clarion housing
OS-019	Vision modular
OS-020	LB Haringey
OS-021	Council for Mortgage Lenders
OS-022	Peter Doherty
OS-023	BLP Insurance
OS-024	Berkeley
OS-025	National Housebuilding Council
OS-026	RICS
OS-027	Essential Living
OS-028	Andrew Pakes
OS-029	Swan Housing

OS-030	LB Hackney
OS-031	Pocket Living
OS-032	Waugh Thistleton Architects
OS-033	Laing O'Rourke
OS-034	Keepmoat Group
OS-035	Zohra Chiheb, Levitt Bernstein Architects
OS-036	Mary Hurst, First Home London

Site visits

Date	Location	Organisation
08/12/2016	PLACE/Ladywell	LB Lewisham
11/12/2016	Bacton Low Rise	Karakusevic Carson Architects
27/01/2017	Kidbrooke Village	Berkeley Group
07/04/2017	Pitfield Street and Dalston Lane	Waugh Thistleton Architects
10/05/2017	Gallions Reach	Ilke Homes

Meetings and interviews with experts:

Date	Organisation	Representative(s)
04/11/16	Cast Consultancy	Mark Farmer
22/02/17	Waugh Thistleton Architects	Andrew Waugh and David Lomax
01/03/17	East London Housing Partnership	Scott Bryant (ELHP), Marcia Kirlew (LBBD), Roberto Bruni (LB Newham), Zoe Dunn (LBWF)
13/03/17	Build Offsite	Dennis Seal
27/03/17	G15	Paul Hackett (Amicus Horizon) and Jerome Geoghegan (L&Q)
29/03/17	Arcadis	Richard Jones
29/03/2017	GLA Housing and Land	Jamie Ratcliffe , Alex Hearn, Maja Jorgenson
31/03/17	LB Lewisham	Osama Shoush
31/03/17	LB Harrow	Alison Pegg

03/04/17	RICS	Abdul Choudhury and Mike Basquill
	BLP Insurance	Jeff Maxted
	Lloyd's Register	Terry Mundy
	Vision Modular	Kieran White
	Essential Living	Ray Theakston
	HCA	Mike D'Ath
	24/7 Living	David Alderson and Christine Hynes
	Swan Housing Association	Geoff Pearce
	TDR Capital	Giles Carter
	L&G Capital	James Lidgate

Appendix 2 – OSM typology

Volumetric

These units are 3D modules assembled in a factory. The term “modular” is used to describe load-bearing units. The main market for volumetric is for closed modules, either bathroom pods or single room units suitable for hotels and so on. Open-sided modules allow the construction of deeper plan buildings but offer fewer opportunities for standardisation. The greatest benefits from volumetric production are derived from making highly serviced areas in factory conditions. With bathroom pods, for example, more than 30 trade activities are transferred offsite, leading to fewer people on site, easier commissioning and less rework.

Panelised

These systems involve the onsite assembly of flat panel walls, and cassette floors and roofs. Systems range in complexity from simple timber or light steel frames (open), to more complex factory finished units incorporating insulation, lining, doors, windows and services distribution (closed panels).

The main market for panelised systems is residential construction, where in England and Wales, timber frame has a 5 per cent share, much lower than in Scotland and other European countries. The advantages of panelised construction are speed of construction, the reduced impact of weather on the programme, and flexibility in terms of layout and room size. CAD/CAM integration in the production of systems including Space 4, Pace and Fusion has enabled a degree of mass customisation to be achieved at relatively low volumes – giving housebuilders the flexibility they need to meet client demands.

Hybrid

Hybrid systems use a ‘best of both worlds’ approach by combining the benefits of modules for highly serviced areas and the flexibility associated with panelised construction for other spaces. Although volumetric bathroom pods are increasingly common in otherwise conventional construction, the full hybrid solution is relatively rare. In addition to housing, areas where the hybrid approach could be applied include the schools renewal programme and other urgent public investment programmes.

In the current marketplace, with healthy demand from established markets such as hotels, student accommodation and the MOD, the modular sector is working at close to capacity, and new investment will shortly add several thousand units/pa to capacity.

Source: <http://www.building.co.uk/cost-model-off-site-manufacture/3042466.article>

Appendix 3 – Case studies

Case study 1. PLACE/Ladywell, London Borough of Lewisham, London



PLACE/Ladywell is the London Borough of Lewisham's first endeavour using OSM. The council have used OSM as part of their solution to the growing need for temporary accommodation in the borough. The development was designed by Rogers Stirk Harbour + Partners and is constructed using volumetric timber from SIG. The six storey scheme has delivered 24 two bedroom homes and 880sqm of business and community space. These homes exceed the minimum space standards by 10 per cent.

The total cost of the scheme was £4.3million. The London Borough of Lewisham received grant funding of £430,000 from the Mayor's High Street Fund to fit-out the commercial units on the ground floor. Each unit cost £156,000, which included fitting all homes with kitchens, white goods and bathrooms. The London Borough of Lewisham expect to recoup the costs of this project in 7 to 10 years.

The development is temporarily situated on a former leisure centre site, utilising vacant brownfield land while larger scale regeneration plans for the area are formed. The intention is for the structure to remain on the site for no more than four years. This structure can then be moved around the borough.

Construction on the site began in November 2015 and the majority of residents moved in in August 2016. Site preparations were much faster than traditional builds as the units required low impact shallow foundations of

0.6 metres, compared to the deeper foundations needed for traditional construction.

Case study 2. Bacton Low Rise, London Borough of Camden, London

The redevelopment at Bacton Low Rise estate is part of the wider scale regeneration of Gospel Oak, the London Borough of Camden executed through a three way partnership between the London Borough of Camden, Rydon and Karakusevic Carson Architects (KCA). The site has been developed in two phases. KCA designed phase one of the redevelopment in Cross Laminated Timber (CLT). 44 out of the 67 homes in phase one of the redevelopment have been constructed in CLT.



KCA used this construction method on the first phase of the development as they were constricted by space and weight. The site of the first phase runs parallel to a working railway line, which is six metres below the ground level of the site.

Therefore the building needed to be lighter than a traditional build to prevent land movement and to ensure the railway line could continue to run normally.

The use of CLT meant that KCA were able to make the most out of the

space available. The development is one quarter of the weight of a concrete structure. The use of CLT has also enhanced liveability, enabled the building to be close to Passivhaus standards and helped to minimise noise from the train line. The homes were delivered in only 18 lorry loads and the CLT was constructed in ten weeks by ten people.

BOPAS accreditation was not available at the time of the development. KCA struggled to get insurance for the development from the UK and had to get insurance from a European based company. Cost consultants were also data poor in regards to CLT, so overestimated the costs by 15 per cent.

Case study 3. Swan Housing Association, London

Swan Housing Association operates in Essex and East London and manages over 11,000 homes. They are currently setting up their own factory facility in Basildon, Essex called NU Build to produce modular, Cross Laminated Timber (CLT) homes. The 80,000 sqf factory will produce 100 homes per year for their 570 home development at Beechwood Village in Basildon. The factory has the capacity to produce three times this number of homes. Swan's intention is to develop 50 per cent of all new homes once the factory is fully operational. Full production will start in late summer 2017.

Swan anticipates that initial costs will be 10 per cent lower than traditional construction. This is based on a production rate of 100 homes per year. When the factory is running at full capacity (300 homes per year) savings should reach 15 to 20 per cent. Time saving is estimated to be between 50 and 60 per cent.

Having their own factory means that Swan will have reduced costs as they will not be paying a profit margin, have full control over the onsite process, have significant improvements in quality of the homes and require reduced numbers of skilled labour.

Case study 4. hOUse, Urban Splash, New Islington, Manchester



Urban Splash is a British based regeneration company. They have worked with architects shedkm, to deliver their first offsite housing product – hOUse. Urban Splash has used offsite produced volumetric housing

to develop 43 terraced hoUSES in New Islington in Manchester. The starting price for these homes is £200,000.

The flexibility of this construction method allows owners to choose not only the internal layout and colour palette but also the size of their new home. The hoUSES range from 93 to 140 square metres. The external cladding can be adapted to suit local planning requirements. These homes can be completed in 20 weeks. This includes 16 weeks for the construction of the modules and a further three to four weeks to finish off the interiors.ⁱ

ⁱ <http://customandselfbuildtoolkit.org.uk/case-studies/house-manchester/#>

Case study 5. Pocket Living, London



Pocket Living is a private developer that delivers intermediate affordable housing for sale in London. Pocket homes are sold at a discount of at least 20 per cent. In 2013 Pocket received a £26.4million loan from the GLA to deliver thousands of homes over the next decade. Pocket Living has used OSM as a way to speed and scale up their delivery of affordable housing.

Pocket Living has used offsite volumetric construction as their preferred method of OSM. To date they have delivered 32 OSM homes in Streatham Hill (in just ten months). Pocket Living are in the construction phase for 70 homes in north Lambeth and Europe's largest modular residential tower at 26 stories (89 homes) in Wandsworth.

Case study 6. Dalston Lane, London



Dalston Lane is the world's largest CLT building. The project has been developed in a three way partnership between the London Borough of Hackney, timber-engineering specialists Ramboll and Waugh Thistelton Architects (WTA). Planning consent was granted in November 2014 and it is due to complete in spring 2017.

The development is ten storeys (33m) high and is mixed use. The development will include 121 homes, of which 20 will be affordable, 3,500m² of office space and around 1,500m² of retail and restaurant space. The residential element of the development is for private rent. The building is constructed entirely of CLT (external, party and core walls, floors and stairs) and uses 3,852 cubic metres of CLT. It weighs a fifth of a concrete building of the same size and the number of deliveries to the site during construction reduced by 80 per cent when compared to a building built using traditional methods. The building is clad in brick to fit within the character of the local area.

It has been estimated that the building will save 2,400 tonnes of carbon compared to a concrete building of the same size. The embodied carbon is 2.5 times less than a concrete building of the same size. The structure of the building is carbon negative.

High Speed 1 and Crossrail pass under the building site. This meant that the site was constrained due to the weight restrictions and traditional construction methods were not workable. The lightweight properties of CLT meant that smaller foundations were used and two more storeys of accommodation could be developed on the site.

Case study 7. Berkeley Group's Urban House



The development at Kidbrooke is one of Berkeley Group's first endeavours with offsite construction, with another development in Reading. The 'Urban House' concept Berkeley is using at Kidbrooke has been five years in the making.ⁱⁱ

The site has already delivered 22 homes using this concept in phase two and will deliver 15 more urban houses using OSM. The structural frame, walls and parts are made and assembled in a factory and are then transported in modular units called 'pods'. The homes are assembled and clad in brick onsite. Cladding improves the cosmetic value of the site and allows the homes to fit into the surrounding development with ease.

The starting prices for these OSM homes are £800,000 – £400,000 less than similar properties in the area.ⁱⁱⁱ These homes outperform energy use of traditional homes, reducing utility bills by up to 25 per cent, up to 80 per cent on gas bills and 30 per cent on water.^{iv} Each home has a private roof terrace and can be easily adapted as lifestyles change.

This design also means that there is less reliance on traditional building techniques and materials. The current capacity of the housebuilding industry has been raised as a major barrier to delivering more housing. Another reason for turning to offsite methods is speed; sites constructed using OSM can be delivered in ten weeks compared to over 40 weeks using traditional construction methods.

ⁱⁱ Tony Pidgley, 2016, London Assembly Planning Committee 29 June Meeting

ⁱⁱⁱ [Apex Housing Group, 2016, 'Pod' houses: the next generation of sustainable UK houses](#)

^{iv} [Berkeley, 2016, Berkeley breaks the mould with new housing model](#)

Our approach

The Planning Committee agreed the following terms of reference for this investigation:

- What is the potential for modular housing, using MMC, to help solve London's housing crisis, form part of the new London Living Rent product and to meet wider Mayoral objectives such as affordability and the low carbon agenda?
- What are the factors that have prevented, and are still preventing, the adoption of this type of housing more widely?
- What role can the Mayor play in removing barriers and accelerating the use of modular housing for London's new homes?

Appendix 1 sets out the evidence received this review.

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- ³ 2017 – Is Winter Coming? Arcadis Consulting p5
- ⁴ The Farmer Review of the UK Construction Labour Model 2016, p32
- ⁵ The Farmer Review of the UK Construction Labour Model 2016,
- ⁶ Office for National Statistics
<https://www.ons.gov.uk/peoplepopulationandcommunity/housing/bulletins/housingaffordabilityinenglandandwales/1997to2016>
- ⁷ Shelter, <http://blog.shelter.org.uk/2016/04/over-half-londons-private-renters-are-struggling-renting-needs-fixing-now/>
- ⁸ London Datastore, <https://data.london.gov.uk/dataset/registered-social-landlords-average-rents>
- ⁹ BBC, “Councils spent £3.5bn on temporary housing in last five years”, 17 November 2016 <http://www.bbc.co.uk/news/uk-38016728>
- ¹⁰ CLG Live tables on homelessness. Table 775: Type of temporary accommodation <https://www.gov.uk/government/statistical-data-sets/live-tables-on-homelessness>
- ¹¹ London Councils. Temporary accommodation in London report, February 2016 <http://www.londoncouncils.gov.uk/our-key-themes/housing-and-planning/homelessness/temporary-accommodation-london-report>
- ¹² Capital failure: Understanding the roots of London's housing crisis. London Housing Commission, December 2015
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- ¹⁵ Fixing our broken housing market, White Paper, February 2017
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/590464/Fixing_our_broken_housing_market_-_print_ready_version.pdf

¹⁶ Ibid and “Modular Construction in UK Housing”, Pinsent Masons briefing, February 2017 <http://constructingexcellence.org.uk/wp-content/uploads/2017/02/graham-robinson-pinsent-masons-14022017.pdf>

¹⁷ Affordable Homes Programme 2016-21 Funding Guidance, Mayor of London, November 2016

<https://www.london.gov.uk/sites/default/files/homesforlondoners-affordablehomesprogrammefundingguidance.pdf>

¹⁸ The challenge it is posing to the industry is to provide a delivery model to include at least three different methods of offsite construction and will build on the successes of the technologies to deliver an affordable and sustainable approach to developments that will set out a standard to meet the demands on housing in the UK. <http://homeworldexpo.net/>

¹⁹ Since 2008, it is estimated that some 30 per cent of new homes use some offsite component, National House Building Council, written submission, OS027

²⁰ Meeting with BLP Insurance and Lloyd’s Register, 3 April 2017

²¹ Using a variety of construction techniques such as steel frame, precast concrete, in situ concrete and timber frame

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²³ System Built Houses, Hansard, 12 March 1984.

²⁴ Homes through the decades, NHBC Foundation, March 2015 <http://www.nhbc.co.uk/NewsandComment/Documents/filedownload,59849,en.pdf>

²⁵ Tony Pidgely, Berkeley Homes, Kidbrooke site visit, 27 January 2017

²⁶ RSH+P written submission, OS011

²⁷ LB Harrow, meeting 31 March 2017

²⁸ Meeting with Dennis Seal, Build Offsite, 13 March 2017

²⁹ Meeting with Dennis Seal, Build Offsite, 13 March 2017

³⁰ Meeting with the East London Housing Partnership, 1 March 2017

³¹ Offsite Housing Review, Construction Industry Council, February 2013

³² SIG, written submission OS002

³³ RSH+P, written submission OS011

³⁴ Bacton Low Rise, site visit, 11 January 2017

- ³⁵ Berkeley Homes, Kidbrooke, site visit, 27 January 2017
- ³⁶ Waugh Thistleton Architects, written submission OS034
- ³⁷ LB Hackney, written submission OS032
- ³⁸ Site visit to Dalston Lane, 7 April 2017
- ³⁹ Ibid
- ⁴⁰ Evening Standard, 8 May 2017
- ⁴¹ Dalston Lane used 2000 tons of timber. If it was built of concrete, it would have been 12,000 tons of the material – more than 750 concrete deliveries into the city. 2000 tons of timber is less than 100 trucks.
- ⁴² 63,000 Homes, written submission OS012
- ⁴³ Site visit to Bacton Low Rise, Camden, 11 January 2017
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- ⁴⁶ BLP Insurance, written submission OS025
- ⁴⁷ Pocket Homes, written submission OS033
- ⁴⁸ ilke Homes Launch event, Gallions Reach, London, 10 May 2017
- ⁴⁹ The Housing Forum, written submission OS018.
- ⁵⁰ Premier Modular, written submission OS014
- ⁵¹ Swan Housing Association, written submission OS031
- ⁵² <http://www.hse.gov.uk/statistics/industry/construction/>
- ⁵³ Site visit to WTA sites in Dalston Lane and Pitfield Street, Hackney, 7 April 2017
- ⁵⁴ Offsite Housing Review, February 2013
- ⁵⁵ <http://www.laingorourke.com/media/eej-2016/dfma-in-housing.aspx>
- ⁵⁶ The Farmer Review, page 16
- ⁵⁷ RICS, meeting, 3 April 2017
- ⁵⁸ Tony Pidgely, Chairman of the Berkeley Group, “Could British builders be in for a ‘Prefab’ Future?” March 2017
- ⁵⁹ LHC, written submission OS006
- ⁶⁰ Vision Modular, written submission OS021
- ⁶¹ Bacton Low Rise, site visit, 11 January 2017

⁶² Budget 2016 Policy Paper *HM Treasury* available at:
<https://www.gov.uk/government/publications/budget-2016-documents/budget-2016>

⁶³ *Build Offsite* <http://www.buildoffsite.com/themes/bim-dfma/>

⁶⁴ Essential Living's Greenwich scheme was originally designed using traditional methods but then changed to OSM. This was 'quite a painful process'. 7 Essential Living, meeting 3 April 2017

⁶⁵ "Gap in the market: Building new homes in London on disused sites". GLA Conservatives, 2014 <http://glaconservatives.co.uk/wp-content/uploads/2014/07/gap-in-the-market.pdf>

⁶⁶ "Up or Out: Options for London's growth", London Assembly Planning Committee, January 2016

⁶⁷ <http://www.building.co.uk/homes-above-car-parks-plan-launched-at-ecobuild/5080534.article>

⁶⁸ <https://www.london.gov.uk/press-releases/mayoral/mayor-tackles-fuel-poverty-with-1m-boiler-fund>

⁶⁹ London Assembly debate on fuel increases, Wednesday 8 March 2017

⁷⁰ Meeting with LB Lewisham and LB Harrow, 31 March 2017

⁷¹ Network Homes, written submission OS007, meeting with TDR Capital and L&G Capital, 3 April 2017

⁷² LB Enfield, note OS013

⁷³ Farmer Review, 2016, page 47

⁷⁴ Offsite Housing Review, Construction Industry Council, February 2013

⁷⁵ There was almost unanimity amongst the experts who contributed to this review on this point.

⁷⁶ Meeting with the East London Housing Partnership, 1 March 2017

⁷⁷ Meeting with L&G Capital, 3 April 2017

⁷⁸ Site visit to Kidbrooke, Berkeley Homes, 27 January 2017

⁷⁹ <http://www.telegraph.co.uk/business/2016/12/19/chinese-state-owned-construction-firm-signs-25bn-deal-build/>

⁸⁰ Meeting with Swan Housing Association, 3 April 2017

⁸¹ Science, technology, engineering and mathematics

⁸² Willerby Homes, written submission OS005

⁸³ Meeting with Richard Jones (Arcadis) and Dennis Seal (Build Offsite), 5 October 2016

- ⁸⁴ Network Homes, written submission, OS007
- ⁸⁵ Meeting with Dennis Seal, Build Offsite, 13 March 2017
- ⁸⁶ Meeting with 24:7 Living and Swan Housing, 3 April 2017
- ⁸⁷ Tier 1 constructors are the largest companies with the financial strength to access the largest amount of finance at the most competitive rates
- ⁸⁸ Council of Mortgage Lenders, written submission OS023
- ⁸⁹ BOPAS was launched in March 2013 and was developed by Buildoffsite, Lloyds Register and BLP Insurance with RICS, the Council of Mortgage Lenders and the Building Societies Association. BOPAS provides an independent assessment of quality and reassurance from inception through to construction for investors, developers and owners of OSM products. BOPAS provides assurances on the durability of an accredited OSM product for a minimum of 60 years.
- ⁹⁰ Meeting with BLP Insurance and Lloyd's Register, 3 April 2017
- ⁹¹ The London Housing Strategy 2014, page 31
https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Housing%20Strategy%202014%20report_lowresFA.pdf
- ⁹²
https://www.london.gov.uk/sites/default/files/housing_spg_revised_040516.pdf
- ⁹³
https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Sustainable%20Design%20%26%20Construction%20SPG.pdf
- ⁹⁴ Pocket Living, written submission OS033
- ⁹⁵ RSH+P, written submission OS011, Bacton Low Rise site visit, 11 January 2017
- ⁹⁶ <https://sourceable.net/behind-australias-first-modular-construction-code/>
- ⁹⁷ The G15 represents London's 15 largest housing associations, providing homes for one in ten Londoners and one quarter of all new building
- ⁹⁸ London Councils Modular housing workshop, Thursday 16 March 2017
- ⁹⁹ Just a few of many such projects are explored in Appendix 3
- ¹⁰⁰ Homes for Londoners Affordable Homes Programme 2016-2021 (2016) p29

Other formats and languages

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Chinese

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Vietnamese

Nếu ông (bà) muốn nội dung văn bản này được dịch sang tiếng Việt, xin vui lòng liên hệ với chúng tôi bằng điện thoại, thư hoặc thư điện tử theo địa chỉ ở trên.

Greek

Εάν επιθυμείτε περίληψη αυτού του κειμένου στην γλώσσα σας, παρακαλώ καλέστε τον αριθμό ή επικοινωνήστε μαζί μας στην ανωτέρω ταχυδρομική ή την ηλεκτρονική διεύθυνση.

Turkish

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Punjabi

ਜੇ ਤੁਸੀਂ ਇਸ ਦਸਤਾਵੇਜ਼ ਦਾ ਸੰਖੇਪ ਅਪਣੀ ਭਾਸ਼ਾ ਵਿਚ ਲੈਣਾ ਚਾਹੋ, ਤਾਂ ਕਿਰਪਾ ਕਰਕੇ ਇਸ ਨੰਬਰ 'ਤੇ ਫ਼ੋਨ ਕਰੋ ਜਾਂ ਉਪਰ ਦਿੱਤੇ ਡਾਕ ਜਾਂ ਈਮੇਲ ਪਤੇ 'ਤੇ ਸਾਨੂੰ ਸੰਪਰਕ ਕਰੋ।

Hindi

यदि आपको इस दस्तावेज का सारांश अपनी भाषा में चाहिए तो उपर दिये हुए नंबर पर फोन करें या उपर दिये गये डाक पते या ई मेल पते पर हम से संपर्क करें।

Bengali

আপনি যদি এই দলিলের একটি সারাংশ নিজের ভাষায় পেতে চান, তাহলে দয়া করে ফো করবেন অথবা উল্লেখিত ডাক ঠিকানায় বা ই-মেইল ঠিকানায় আমাদের সাথে যোগাযোগ করবেন।

Urdu

اگر آپ کو اس دستاویز کا خلاصہ اپنی زبان میں درکار ہو تو، براہ کرم نمبر پر فون کریں یا مذکورہ بالا ڈاک کے پتے یا ای میل پتے پر ہم سے رابطہ کریں۔

Arabic

الوصول على ملخص لهذا المستند بلغةك،
فارجاء الاتصال برقم الهاتف أو الاتصال على
العنوان البريدي أو عادي أو عنوان البريدي
الإلكتروني أعلاه.

Gujarati

જો તમારે આ દસ્તાવેજનો સાર તમારી ભાષામાં જોઈતો હોય તો ઉપર આપેલ નંબર પર ફોન કરો અથવા ઉપર આપેલ ટપાલ અથવા ઇ-મેઇલ સરનામા પર અમારો સંપર્ક કરો.



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