Affordability in housing construction

RESEARCH BRIEFING

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HOUSING EUROPE OBSERVATORY

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This briefing is part of a series of research briefings on the ways public, cooperative and social housing providers address the key societal challenges of our times. Interested for more information or to contribute to the next editions? Feel free to contact Mariel Whelan at research@housingeurope.eu

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Affordability in housing construction

1.0 Introduction

Across Europe, we see that there is not enough construction of new homes to meet demand.[1] National governments wish to solve their respective housing crises, housing providers want to build, and the many thousands, if not millions, of households on waiting lists long for their own homes.

This briefing is dedicated to describing some of the more **innovative ways in which housing providers are trying to contain and decrease construction costs**. They bring up a range of different priorities: from achieving scale efficiency (for instance by using framework procurement contracts), deploying an industrial approach (with the use of serial and modular construction and off-site manufacturing), to using digital technology such as BIM, and the provision of catalogues reviewing products and services for social housing providers based on tested quality, performance and price.[2]

1.1 The gap in numbers

In Ireland: there were 85,799 households on the social housing waiting list In 2017, (Housing Agency 2017a).
A total of **81,118 homes are needed** between the period 2016 and 2020.
There were **14,932 housing completions** in 2016 (Housing Agency 2017b).

In the UK: there were 1,344,004 households on the social housing waiting list in 2018, specifically 1.15 million households in England (Shelter 2018), 157,806 households in Scotland (Scottish Government 2018) and 36,198 households in Northern Ireland (Northern Ireland Housing Executive 2018) in 2018.
A total of **4,420,000 homes are needed by 2031,** or 340,000 homes built every year, specifically: 90,000 units for social rent, 30,000 units for intermediate affordable rent, 25,000 units for shared ownership (NHF 2018).
There were **160,000 housing completions** in 2017 (State of Housing 2017).

In Germany: a total of **1.6 million apartments are needed** between 2016 and 2020 (or 400,000 per year).
There were **284,816 apartment completion**s in 2017 (Günther 2015).

In Sweden: a total **600,000 homes are needed** up to until 2025 with a large part of these expected to be needed by 2020, meaning an average annual rate of 93,000 (Boverket 2018a, 2018b).
There were approximately **127,700 housing completions** during the period between 2012 and 2015 and **51,600 housing completions** in 2018 (Eriksson 2018).

In the Netherlands: a total of **575,000 homes are needed** between the period of 2016 and 2016, with an **expected supply of 564,000 homes.**
In terms of social housing, there is an expected supply of 129,657 homes for the period between 2018 and 2022 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties 2018).

1.2 Background & context

In a 2013 study, Housing Europe analysed evidence from 6 "typical" new build construction projects within the social housing sector across 6 countries. The type of upfront costs incurred included mainly construction work and fees (from 65 to 85% of the total costs), the cost of buying land (this would range between 10 and 20%), as well as other costs

[1] Though reports from Austria, Germany and the Netherlands show the beginnings of a construction sector that is overheating.

[2] The attention of the European Commission towards this aspect is noticeably increasing, as shown by a number of initiatives such as **Construction 2020**, and the recent launch of the European Construction Observatory. The Observatory provides data and analyses regarding market conditions, policy developments, trends and experiences across EU member states and under five thematic objectives of Construction 2020 Strategy: Financing and digitalisation, Skills and qualifications, Resource efficiency, Regulatory framework, International competition.
https://ec.europa.eu/growth/sectors/construction/observatory_en

such as planning, architects and notary fees (Housing Europe 2013).

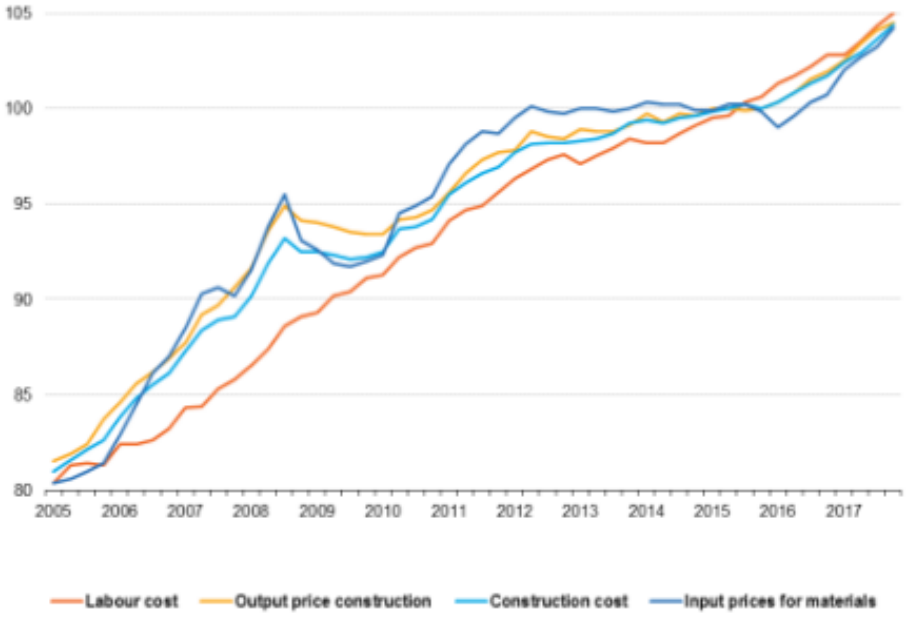
Alongside clear issues such as that of **public subsidies** (a key element in lowering the part of investment borne by the housing provider), just as pressing is the issue of **affordable access to land**. A report by McKinsey Global Institute has identified **"unlocking land supply" as the single most effective lever** for addressing the global affordable housing challenge (McKinsey 2014). This issue is very much linked to the interplay between local property markets, land policies carried out by municipalities and local authorities and planning regulation at both national and local level and thus is unlikely to be resolved at the EU level. However, the **Housing Partnership of the EU Urban Agenda,** of which Housing Europe is member, has discussed several tools that can help cities in delivering land at affordable prices for social housing. These include among others:

- Build up reserves of land in public ownership to be provided for free or at a discount for affordable housing construction
- Make use of unused public premises to be transformed into residential areas
- Use inclusionary zoning and planning obligations requesting a quota of affordable units in new residential development projects
- Identify and tax vacant land/properties to be put into use; "idle-land" policies.

Also significant is the **cost of financing**. Housing Europe is active in supporting its members accessing finance at low interest rates by:

- working with European Investment Bank (EIB) and Council of Europe Development Bank (CEB) and on the use of European Fund for Strategic Investments (EFSI)
- working on a label for investment in social housing housing to facilitate finance from long term ethical investors.

EU-28 Construction prices, construction cost and cost components 2005 - 2017, unadjusted data (20015 = 100)



Taken from: Eurostat 2018.

Furthermore, **taxation,** in particular VAT, has a significant impact on the costs incurred, and we are reviewing VAT rates applied to social housing across Europe – supporting our advocacy towards the EU in this area. All these mechanisms require further analysis.

Taken from: The Economist 2017.

However, it is clear that **the lion's share of the cost linked to provision of affordable housing is that of construction costs**, and this will be the focus of this briefing. These costs are far from being equal across Europe, and although measuring productivity growth in construction is widely regarded as a "classic challenge", numerous actors working in this area agree that productivity growth has generally

been low or non-existent. Construction is sometimes regarded as a nebulous and fragmented industry, one with contractual structures and incentives often misaligned, and where 20% of (large) projects go over-schedule and 80% over-budget (McKinsey 2016).

Reasons for this are related to macro-level political and economic forces, changing dynamics within the industries and organisational-level operational factors. More specifically, projects remain subject to extensive regulation, the cyclical nature of public investment and markets in general, as well as inadequate project management and design processes, low- or under-skilled labour forces and under-investment in digitisation and innovation.

2.0 Challenges & solutions

The affordable housing gap cannot be filled unless inefficiencies in construction are addressed. A wide range of solutions to the above challenges can take place at different levels within both policy-making and sectoral practices. These include but are not limited to:

2.1.1 Harmonisation & scale

Even before any construction has begun, a project can face numerous, different types of obstacles and delays.

Some of these include the process of applying for building permits or planning permission (famously opaque and difficult to navigate) the first step of entering the market as a newcomer or in a different country, the procurement process, and so on.

Throughout there is the practice of complying with standards, which are technical specifications that apply to various products, materials, services and processes.

2.1.1.1 Examples of projects & initiatives

At the national level, strategies to "streamline" the house production process include:

AEDES, the Association of Housing Corporations in the Netherlands, advocates for **cooperation *during* and the "professionalisation" *of* the procurement process**, and supports its members in doing so by e.g. having in place fixed-agreements with suppliers for goods and services that members can easily access. This type of cooperation can mean bringing down costs by buying products or materials in bulk. A concrete example of this was when six different housing providers from the same region formed a working group, identifying specific areas in which to collaborate. By, for example, sharing in the purchasing of elevators and central heating boilers, they were able to **bring down costs** and **make the process speedier and more efficient**, which in turn lead to **better, clearer agreements**, which can then **benefit tenants e.g. in terms of future maintenance arrangements** (van der Peijl 2016).

Similarly, French national federation for social housing **USH** (L'Union sociale pour l'habitat) have a national catalogue reviewing products and services for social housing providers based on tested quality, performance and price, amongst other things. These are agreed upon arrangements with suppliers and service providers, making it more efficient for housing providers to access.

Improved coordination between the municipal housing providers in the public procurement of housing construction and the development of ready-to-occupy housing can help stimulate industrialised house building and reduction of construction prices. For example, **SABO** (Swedish Association of Municipal Housing Companies) use framework agreements to speed up this process. They offer the Combo House, a multi-family apartment block "turnkey contract", that is available in three models varying in size, and with a fixed price per square metre. As the apartments are built in a large-scale all across the country, reports show that construction costs are **cut by up to 25%** and the time for completion is reduced.

2.1.2.1 Harmonisation & competition

The EU Construction Observatory states that a "more competitive" construction industry would produce buildings and infrastructure that could be "adapted to changing social and economic needs, could meet global challenges such as energy security and climate change, and would provide an attractive sector in which to work".

Many countries, e.g. the UK, are **dominated by a small number of large companies**, making it difficult for smaller companies to secure house-

building opportunities (Communities and Local Government Committee 2017). In Sweden, there is an insufficient number of construction companies capable of delivering on a large scale and at the same time, both indigenous SMEs and foreign companies face difficult entry barriers.

Barriers to entry include: high upfront costs, access to finance, intensity of competition, supply chains, bidding/tendering costs, financial and legal consultant fees, private information (De Valence 2012) differing technical rules and regulations, differing definitions and methods of measurement, lack of training in how to interpret the rules (SABO 2015).

Many actors and stakeholders working in this area highlight the fact that while there is a single market in the EU in which goods and services enjoy freedom of movement, this does not seem to extend to the construction industry. One example of this is how the same materials or construction products can have different values in different member states.

Another is how, even within the one region, for example in the Nordic countries, the fact that rules differ from country to country (different rules and regulations for e.g. energy, wet area standards and planning procedures), means that they are unable to collaborate with each other. Also in Germany, housing providers wish to bring in more contracts with construction companies from other member states, but again this proves difficult. Indeed, diverging sets of building codes can exist between regions in the same country, creating regional markets such as in Sweden and Germany. This remains an **obstacle in the way of sharing in knowledge, skills and resources, and bringing down the cost of building homes**.

Many actors in this area speak of harmonisation across the EU. Simply speaking, this could be done through coordination and usage of common and clear rules, reduction of administrative burdens, and the standardisation of regulations.

Bodies such as FIEC (European Construction Industry Federation) & CPE (Construction Products Europe) support an open and transparent CEN (European Committee for Standardisation) standardisation system involving all concerned parties in collaborating to develop, maintain and publish inter alia product standards, which support EU industry, not least by providing a common European technical language (FIEC & CPE 2016).[3]

In terms of Europe-wide harmonisation of building codes, the Eurocodes are reference design codes, or basic/minimum principles for construction (mostly related to safety), which countries can voluntary adopt as a basis and adapt or add their own regulations.[4] So far, Eurocodes have been implemented in 23 EU member states.

2.3.1 High quality modular & serial construction

Housing providers are increasingly turning towards (high quality) modular and serial construction.
Modular refers to a structure being made up of units (modules) that can assembled and disassembled ("plug-in system"; on-site and/or off-site).

Serial refers to the ability of production to be repeated multiple times and at different scales (industrial).
This can help save time, energy and costs, and has advanced from the "panel-building" and "pre-fabs" of the past.

2.3.2 Examples of projects & initiatives

In early 2018, German housing federation GdW (Federal Organisation of German Housing and Real Estate Companies) held a Europe wide call for proposals for **high-quality modular and serial** housing construction concepts with the following characteristics: single building for residential use, 4 floors, 24 apartments/units (varying in size), no lift/ elevator. The winning designs use unconventional processes and materials (e.g. timber and ferroconcrete). Within the proposed framework

[3] The Construction Products Regulation has endured implementation issues over the last few years (related to concepts such scope, mandatory nature and "exhaustiveness") (CPR Technical Platform, 2016). The CPR is meant to improve the free movement of construction products in the EU, by creating rules for marketing and by providing a common technical language for assessment (DG GROW 2011/2018). It is currently under review.

[4] https://eurocodes.jrc.ec.europa.eu/

One of the 9 winners of GdW competition.

agreement, housing companies can choose, among the 9 finalist model buildings, the **most suitable** for their needs and available property; and can **save time** as the framework agreement anticipates tendering and procurement processes as well as the planning of the building itself; realising the buildings in a straightforward fashion and at **affordable costs**.

Not-for-profit housing association Accords **owns and operates their own factories to build and deliver low carbon, environmentally-friendly homes** for itself, as well as working with contractors, developers, housing associations and local authorities across the UK. Using mostly timbre, they manufacture panels and parts off-site, taking one day, and assemble on-site, also taking one day. In addition, Accords employ local people and offer training and apprenticeships (Inside Housing 2018).

Clanmill Housing Group in Northern Ireland recently announced a **social housing project, using modular, off-site manufacturing and construction methods**. They report that delivery of the 40 houses and apartments will take 56 weeks faster than using traditional building methods (BBC 2018).

2.4 Social production of habitat

Demographic changes such as increasing number of mobile young people, an ageing population, increasing and new forms of migration, increase in one-person households as well as changes in the built environment like shrinking cities/regions and vacant properties mean that new housing approaches should be considered.

The **"social production of habitat"** describes the process and result of communities coming together to realise their own habitat, and includes models such as community land trusts (CLT), housing cooperatives, co-housing, self-build, eco-villages, community led housing, community self-build, to name a few, and involves different ownership, legal and, indeed, physical structures.

The Social Production of Habitat Platform and Habitat International Coalition describe the process as a "collective effort of individuals to build their own habitat: housing, towns, neighbourhoods, [and] major urban areas" (HIC 1995), and while it might not always involve 100% self-build, the initiative is most often a "bottom-up development" initiated and led by future residents, or with heavy involvement and participation.

While up-front costs can be the same or higher than "traditional builds", the **overall costs are lowered by** building smaller or denser personal dwellings/spaces, using reclaimed, natural and/or low-cost building materials, building on infill sites or cheaper "less-attractive" land, both urban and rural, omitting traditional intermediaries, reducing labour costs if done through self-build (Bortel et al 2018, Communities 2013 & 2018, Palmer 2016, Ruiu 2015, Stark 2009). Also, in the long-term, cost-saving schemes related to energy and maintenance costs and generally limiting resource consumption by the sharing of resources, amenities, facilities and communal areas both interior and exterior can further ameliorate cost, time and space concerns (Communities 2013 and 2018). This in turn can free up surrounding areas for other builds and developments.

These types of initiatives can be **scaled up or down** and involve partnerships of multiple actors: local authorities, housing associations, various types of funding bodies, civil society organisations, special

interest groups, at all different levels and forms of collaboration. They are especially suited for **independent living** designs for older people, people with disabilities, students and families including single parent households, who can then share on child-care, healthcare services, whilst also offsetting concerns of isolation and alienation and positively contributing towards **community building** and **social inclusion.** Actors in this area call on national governments to **diversify tenure** and create favourable policies and legislation in order to make the social production of habitat more feasible and achievable for more people (HIC 1995 & 2017, New Urban Agenda 2017).

2.4.1 Examples of projects & initiatives

In Zurich, the More than Housing project is a cooperative social housing endeavour involving City of Zurich, fifty different local cooperatives, national funding bodies, and is one of the largest most ambitious cooperative housing programmes in Europe (Housing Solutions Platform 2017). 13 buildings offer living and working paces for more than 1,300 people, as well as restaurants, shops, childcare services and mobility station (public transport/transport sharing station).

LILAC stands for Low Impact Living Affordable Community and is 20-unit autonomous community in Leeds, England. It combines environmentally low impact living the "Mutual Home Ownership Society" affordability model, meaning that people on low-income can also afford to live there. This, along with a "hands-on management" approach, meant that they managed to keep development costs 18% below that of traditional builds. One of the main features of the project is to act as an educational hub of knowledge and best practices for other groups who wish to replicate the model, as well as actively promoting it in wider society.

More than Housing community garden.

Düzce Hope Homes is a cooperative housing programme in Northern Turkey. After a devastating earthquake in 1999, 140,000 people were left homeless. Co-operative members spent years mobilising and demonstrating, and the Turkish government eventually gave subsidised land with which to rebuild. The community-led approach involved future residents as well as experts and volunteers in the planning, design and construction phases. Costs have been kept down by "sweat equity" (future residents contribute towards cost by using their own labour), sourcing materials directly from producers and self-management. Further, the houses will be kept at affordable rents and the community will generate income through a Women's Production Cooperative, organic food market, repair shop and children's nursery.

2.5.1 Technological innovation & disruption

Namely, BIM (Building Information Modelling), or even much "further afield" technology such as AR (Augmented Reality) and VR (Virtual Reality) or robotics, and the incorporation of digital technology more generally, including new or unconventional materials and advanced (industrial) automation.

At first an opaque term, **BIM can be understood as a collection of processes which brings together data and information on digital platforms in multiple dimensions** (e.g. geometry, time, costs, sustainability, facility management).

BIM can assist with ensuring more efficient **Integrated Project Delivery** (IPD), an approach that emphasises **collaboration**, **transparency** and **problem-solving,** by using early collaboration from all parties (architect, designer, owner, contractors, sub-contractors, labourers, future users incl. maintenance crew) and systems involved in all phases of design, planning, manufacturing/fabrication, assembly/construction and management (McKinsey 2017).

For example, BIM apps on smartphones or tablets connected to cloud-based control towers can give stakeholders immediate, real-time access to all information, materials and documents related to every aspect of the project *("a single source of truth")* with which to collaborate.

Cost reducing benefits come from the ability of BIM to provide ever-more accurate cost estimation (Volk et. al. 2014, Ghaffarianhoseini et. al. 2017), which contributes towards clash detection, meaning less requests for information and change orders, saving time on delays. More specifically, BIM can eradicate unforeseen modifications by up to 40%, provides cost estimation with an error threshold of 3% and up to 80% reduced generation time (Ghaffarianhoseini et. al. 2017)

Many national governments are creating or have their own BIM standards and systems (UK: BSI, Norway: BuildingSmart, Netherlands: BimLoket, Estonia: X-Road) and as of 2018 there are two international BIM standards (ISO 2018). Interestingly, there are numerous free, open-source, open-standards BIM toolkits and platforms (BIMVision, BIMx, OpenBIM, BIMServer, 4BIM, etc).

7 dimensions of BIM. Taken from: BibLus.com.

While the building sector is increasingly adopting this technology, feedback from Housing Europe members show that housing providers are somewhat hesitant. And so though issues exist (e.g. up-front costs, necessity to keep updated with rapidly advancing technology, for all actors and stakeholders to be on board and for implementation to occur at all levels of planning process) and some actors remain reluctant - studies and reports show that BIM usage and adoption has gained momentum, that countries (mainly North American, UK and Scandinavian regions) are developing implementation strategies. Indeed, more and more countries are making BIM-usage mandatory for public procurement and works (Pedder 2015, NBS 2016).

63% of practitioners in the UK believe BIM will help bring about a 33% reduction in the initial cost of construction and whole life cost of built assets, and 57% believe BIM will help bring about a 50% reduction in the time from inception to completion for new-build and refurbished assets (NBS 2016). In France, 50% of architects and engineers and 100% of major construction companies are using BIM. Around 10% of social housing organisations and 10% of facility management companies (energy, facility management, services for older people) are experimenting with the technology (Lasserre 2018).

Further, it has been shown that:

- usage of drones and UAVs (unmanned aerial vehicles) or LIDAR (light imaging) can help with higher-definition geo-location and monitoring,
- development of new construction materials and methods can facilitate off-site manufacturing,
- advanced automated equipment or robotics can accelerate both off-site and on-site operations (McKinsey 2016 & 2017),
- GIS (Geographical Information Systems, map-based tool allowing for data storage, geocoding and manipulation of geospatial data) has the potential to increase functionality within spatial analysis and planning,
- blockchain technology (automated digital ledger system) has the potential to increase supply-chain transparency during contracting and building process, can be used as a tool for crowdfunding development and can aid in provision of real-time information on construction process (Pettitt, et. al. 2018).

It should be noted that concerns of privacy and security should be considered throughout the implementation and usage of the above technologies.

2.5.2 Examples of projects & initiatives

Riksbyggen, a national cooperative housing company in Sweden, has begun testing the use of ICT (Information, Communication and Technology), in both the construction and management of their projects with the help of a digital platform. The digital project Violroten is the first BIM test pilot in Riksbyggen. Another ongoing digital project is to offer energy efficiency solutions and smart maintenance, with the help of drones. By creating 3D visualizations of the property, Riksbyggen can show their clients a possible solar panel installation as a solution (Riksbyggen 2018).

In 2017, the Meadows project, a £5.5 million 54-home regeneration scheme in Nottingham, became the **first social housing to be built using BIM in the UK**. Nottingham City Homes (NCH) led the project and, at the same time, began another 48-home development, Cranwell Road, using traditional methods, meaning that the two could be compared. On a per-unit basis the BIM project cost almost 5% less than the traditional build, and is the cheapest scheme NCH has built up to date (Inside Housing 2017).

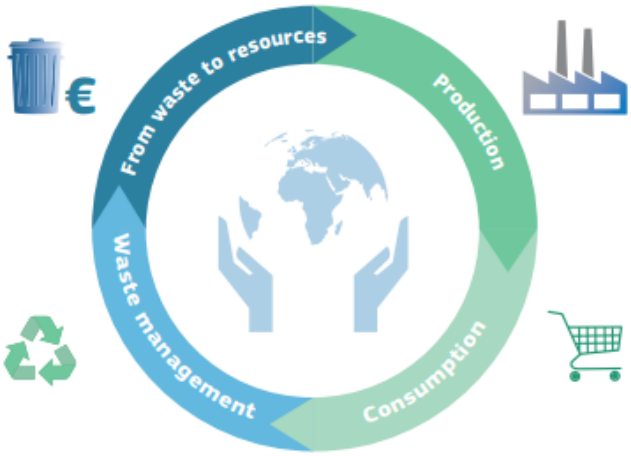
3D printing (aka additive manufacturing) also shows potential - in the spring of 2018, a family in Nantes, France became the first to move into a 3D printed house, the result of collaboration between the city council, local housing association and the local University. The 4-bedroom house took 54 hours and €196,000 to build, making it 20% cheaper than a traditional build (BBC 2018). We have seen other similar initiatives, and the disruption is only in its beginning phases.

2.6.1 The circular economy

Housing providers can work towards sustainability by engaging in the circular economy, recycling and valorisation of construction and demolition waste, and focusing on low emission construction.

The circular economy is a circular model in which **the value of products and materials is maintained for as long as possible**; waste and resource use are minimised, and resources are kept within the economy when a product has reached the end of its life, to be used multiple times to create further value (source). It currently accounts for 9% of the entire global economy, and many actors are working towards **a desired target of 100%,** a fully closed global loop (source).

Short-term, medium-term and long-term measures could include eradicating land-fill usage, extending uses of cycled CDW (Construction and Demolition Waste), avoiding the use of critical raw materials and developing "Design for Deconstruction/Disassembly/Future" or "cradle-to-cradle" approaches.



Taken from: European Commission 2015.

The European Commission has published "Public Procurement for a Circular Economy", outlining good practices and guidelines regarding for example circular procurement models at the system, supplier and product levels, organisational policies, evaluation and contract management (Local Governments for Sustainability 2017).

The **connection with housing** should be clear – construction and production of buildings and infrastructure make up for a large, if not, the largest portion of the global resource footprint. **Construction and Demolition Waste (CDW) accounts for approximately 25% - 30% of all waste generated in the EU** (DG Environment 2018). Also, buildings are responsible for approximately 40% of energy consumption and 36% of CO2 emissions (European Commission 2018) and **50% of the extracted materials in the EU** (ECORYS 2014).

Back to concrete - it is the **second most popular material in the world,** after water, and currently, most concrete from CDW (Construction and Demolition Waste) is cycled into RCA (Recycled Concrete Aggregates) which is then mostly down-

cycled into roads, or re- or up-cycled into ready-mix concrete (Circular Impacts 2018). Ideally, advocates of the circular economy encourage *upcycling* (value increases), not *downcycling* (value decreases). Currently, while recycled material might be downcycled quite often as secondary material, it accounts for a small percentage of the primary material used in construction (Gruis 2018, NIPHE 2015).

What would **circular buildings** look like? They could be designed by DfD/A and have digital passports – Building Passports and Material Passports. The Building Passport would contain detailed information on the composition of the building, and Material Passports would detail the condition and history of the thousands, if not tens of thousands, of materials and products within one building. These tools are meant to aid in future maintenance, replacement and repurposing, amongst others activities (BAMB 2016). Indeed, a functional circular economy could only exist through effective regulation of construction products generally.

When it comes to ownership of buildings, circular business and financial models would advocate a shift from "owner" to "integrator" and supplier of products to provider of services. This means that the "integrator" would lease elements of the building, products, materials, facades, from the supplier, who would then provide maintenance services.

Much of what is discussed above aims to maximise adaptability and durability. In terms of lowering costs, stakeholders in this area argue that circular buildings can lower **the total cost of usage** – including the costs of maintenance, replacement and repurposing, which goes further than the total cost of ownership.

2.6.2 Examples of projects & initiatives

A concrete example of housing and the circular economy the Co-Green project by **Eigen Haard** in the Netherlands: during the construction of climate-neutral affordable housing, amongst other ecologically conscious and energy efficient strategies, a requirement to re-use or re-cycle 90% of the recyclable building materials coming from demolition was pursued (Eigen Haard 2018).

In France, **Paris Habitat** is working on creating an entire new district: conversion of the Reuilly military Barracks (formerly the "royal mirror factory") to a 600-unit development. Alongside opening up the development to connect it to the rest of the neighbourhood and creating public gardens, there is a major focus on recovering and repurposing materials from the old building e.g. finishings such as doors (Paris Habitat 2018).

In Sweden, **HSB's** (Federation of Cooperative Housing) **Living Lab** is a four-storey residential building and fully equipped laboratory at the Chalmers University campus in Gothenburg. The building was assembled in modules on-site and can be dismantled if necessary. The façade is replaceable up to an extent. Short and long-term research projects are taking place inside HSB Living Lab throughout the project's ten-year life span.

Living Lab, "Journey towards the future of sustainable living". Photo: Felix Gerlach.

One of the research projects is The Circular Kitchen (CIK). It aims to increase all forms of circularity in and around a kitchen, from resource and energy efficiency, including appliances during production via the kitchen's use in daily life and expanding the

kitchen's lifespan to design for circularity and end-of life.

The circular kitchen aims to support a more sustainable life-style to prevent food waste, provide waste separation, enable re-use and recycling and develop energy efficient and smart appliances. It will be adaptable to changing user needs over time and can accommodate improved accessibility and mobility. The use of circular business models hopes to lead to a higher end value of building materials and components. The concept also aims at facilitating negotiations with tenants or building owners in deep renovation projects (HSB Living Lab 2018).

HOUSEFUL is a multi-stakeholder, multi-sectoral research project looking **at 11 circular and innovative solutions** including: Material Passports (MP) based on BIM to share data across building's value chain, Sourcing of circular building materials from secondary material platforms or local producers; joint treatment of blackwater, solid fraction and ground blackwater for reuse in toilet, irrigation and renewable energy from biogas, to name a few, which will be tested in four dwellings across Europe over four years (HOUSEFUL 2018).

2.7.1 Energy & standards

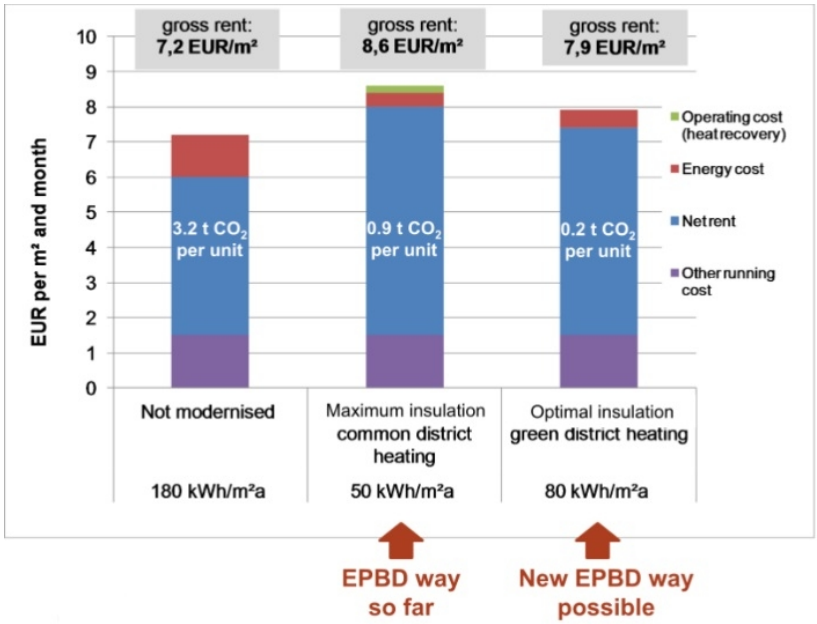
While not necessarily related to new builds, it is worth briefly discussing costs related to energy renovation of existing buildings. When it comes to energy standards – sometimes an increase in regulated standards can mean an increase in costs. While it is our collective responsibility to produce and maintain energy-efficient housing within "nearly zero energy neighbourhoods" - in some countries with already very high standards, it is neither cost-effective nor energy-efficient to upgrade them even further.

For example, the issue of maximal vs. optimal insulation – it is sometimes more efficient to go with "optimal" insulation, together with greening of district heating and use of renewables. More specifically, in Germany, optimal insulation with green district heating can bring down the rent to €7.9/m^2, can bring down the CO^2 to 0.2t CO^2 per unit, and up the energy to 80 kWh/m^2a (Gedashko 2017).

Relatedly, a study by GBV in Austria has identified the increase in cost of construction deriving from stricter regulations including on energy efficiency: additional costs to constructions can range from €111 to €340 extra per m^2 (GBV 2015).

2.7.2 Energy & resident participation / acceptance

As per EU regulations and guidance, and national policies, much social housing stock across Europe is undergoing energy efficiency retrofitting/upgrades/refurbishment. In terms of the success of these initiatives, it is essential to secure residents' participation and acceptance from the outset, through-out and during the use-phase (Blomsterberg and Pedersen 2015, Brown, et al 2014, Sunikka-Blank 2012). Participation can occur at different degrees, from information sessions to comprehensive consultation processes and direct involvement in decision-making.



Maximum vs. optimal insulation.

A well planned and communicated renovation or refurbishment schedule, that includes descriptions of intention, reasoning and necessary daily tasks can keep residents informed and on board. This can help to avoid potential complaints or issues that would prolong time of the project and therefore costs.
During the use-phase, it is necessary to make sure that residents have been demonstrated and shown how to use any new technologies that have been added or fitted into their home. Potential energy savings can be lost if residents are not made aware of how to correctly or efficiently operate their new habitat. Similarly,

the "rebound effect" describes the behavioural phenomenon of an increase in (energy) usage as a response to installation of new technology, consequently offsetting potential energy savings (Gillingham, Rapson and Wagner 2015).

2.8 Skills

Continuous re-and up-skilling is necessary to train workforce in the latest equipment, digital tools, methods and practices, also in response to migration and demographic change. **Indeed, much of the discussion above is predicated on the presumption that this type of training and re- and up-skilling within the industr(ies) will occur.**

Generally speaking, investment in **education, training and apprenticeship programmes**, both class-room (off-site) and field-based learning (on-site), will benefit both the existing and future workforce, especially in the face of high numbers of un-or low-skilled workers and major labour shortages. The UK Government and Construction Industry Training Board have announced funding for 20 on-site construction skills training hubs across the UK, ideally within large housing developments or infrastructure projects (NHF 2018).

For example, with regards to re- and up-skilling in energy efficiency - PROF/TRAC is an Open Training and Qualifications platform for professionals dealing with nearly Zero Energy Buildings (nZEB). It makes available European recommendations for minimum nZEB skill levels per work field; lists of certified and available PROF/TRAC trainers and training organisations across Europe; an online "Train the Trainers" program; and an online training material repository.

Similarly, Build Up Skills is an EU initiative aimed at boosting continuing/further education and training of craftspeople and construction workers, with the final goal of increasing the number of qualified workers able to deliver nZEB new builds and renovations.[5]

3.0 Conclusion

One possible approach in the struggle towards closing the affordable housing gap is to close the affordable housing *construction* gap. Certain obstacles do exist, such as the existence of an unfavourable policy environment and lack of supports and structures that might be helpful when pursuing some of the strategies mentioned above. These included everything from collaborations in the procurement process to the manufacturing off-site and assembly on-site of modular housing units and the social production of habitat.

The Housing Europe network of social, cooperative and affordable housing providers can act as a platform for the sharing of experiences and good practices. Of course, every locality is different and is rooted own unique geographical, cultural, political and economic context. Therefore, what might be suitable in one, is not in another.

Again, the cost of housing construction is one issue alongside others, including that of access to land and finance. At the same time, the project examples highlighted above can be learned from, scaled up and replicated. Policy- and decision-makers at the national and EU levels can be proactive in supporting this. Containing and decreasing construction costs can be one obstacle overcome in the journey towards providing decent, affordable homes for all people in all communities.

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