Sector Analysis: Housing

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Executive Summary

There is a strong demand for capital to finance green real estate buildings today. Green buildings constitute attractive direct or indirect investment opportunities both for private and institutional investors such as pension funds looking to diversify their asset management and allocate a part of their assets to direct real estate investment.

Main developments and trends

Urban population growth is a major global trend with critical relevance for the housing sector. Not only is the urban population expected to double from 2010 to 2050, but it is also ageing, particularly in developed countries. The global urban material consumption will grow even faster than the population and resource requirements could grow from 40 billion tons of raw materials in 2010 to nearly 90 billion tons by 2050. The increasing material demand will make recycling and use of secondary materials more competitive compared to raw material extraction.

Impact of the housing sector

Construction materials make up around half of the world's overall material use. The use phase of buildings is the most energy and CO_2 intensive phase of a building's life cycle, mainly due to heating and cooling energy demand. In total, the construction industry and the buildings sector account for roughly 35% of global final energy consumption and 40% of global energy-related CO_2 emissions. Considering that more than 100 million people worldwide work in the construction industry, labor conditions, particularly in construction but also in resource deployment and demolition of buildings, can have large impacts on health and welfare.

Moving towards sustainability

Modular design is the key to a sustainable housing sector. Modular buildings are easy to disassemble: their elements are prefabricated offsite and can later be re-used in other projects. While modularization generates substantial financial savings (construction costs, time to completion, waste management), it also extends the life of materials.

In this study, Inrate aims to provide responsible investors with insights on current key sustainability trends and challenges that companies in the Housing Sector are facing. Furthermore, it presents solutions that several businesses, from the eleven different Housing sub-sectors, may offer to help solve global social and environmental problems. These issues are important both for ethical investors as well as investors who deliberately manage ESG-related investments risks and opportunities.

Content

1. Relevance for Responsible Investors

Investing in real estate, sustainable or traditional, covers different complex realities:. one can distinguish between direct investments in real estate property or indirect investments in real estate, either through a fund or equity relating to the housing industry.

It is therefore necessary to consider two key groups of investors: private and institutional investors who may have different sorts of motivations when it comes to investing directly in real estate or indirectly in the housing industry. The chart below gives an overview of these realities.

<table>
<tr><th rowspan="2"></th><th rowspan="2">Direct investments in real estate</th><th colspan="2">Indirect investments in real estate</th></tr>
<tr><th>Real estate funds</th><th>Real estate equities</th></tr>
<tr><td>Examples</td><td>Residential real estate (private apartment, holidays house); commercial real estate (hotels, shopping centers, etc.)</td><td>Raiffeisen Futura Immo Fonds, SF Sustainable Property Fund, etc.</td><td>Mobimo, PSP Swiss Property, etc.</td></tr>
<tr><td>Examples of private investors</td><td colspan="3">Owners, developers, family offices, small businesses, large real estate companies, private banks, etc.</td></tr>
<tr><td rowspan="2">Key motivations of private investors</td><td>Development of a business, construction of a house for own usage, creation of a real estate portfolio</td><td colspan="2" rowspan="2">Financial returns</td></tr>
<tr><td>Investment in assets and expectations of financials returns</td></tr>
<tr><td>Examples of institutional investors</td><td colspan="3">Insurances, pension funds, foundations, church, etc.</td></tr>
<tr><td>Key motivations of institutional investors</td><td>Asset allocation strategy, risk diversification</td><td>Alternative asset management strategy</td><td>Equities asset management strategy</td></tr>
</table>

Source: Inrate 2019

The financial case for investing in sustainable real estate

A strong demand for capital to finance green real estate buildings exists today. This can be observed in the US, where green buildings represented about 48% of the market in 2015 and the trend is increasing (USGBC 2015). The scale of the investment opportunity in energy efficiency building retrofits is significant, between USD 231 billion and up to USD 300 billion per year globally by 2020, and it is expected to continuously rise in the future (UNEP FI 2014). The compound annual growth rate of the green building market is estimated at 13% over the next five years (Credit Suisse 2015).

All these figures indicate that green buildings constitute attractive direct or indirect investment opportunities for both private and institutional investors, such as pension funds looking to diversify their asset management and allocate a part of their assets to direct real estate investment. In Switzerland, a market study published by Swiss Sustainable Finance in 2018 demonstrated that real estate funds or direct investments in properties have amounted to a total of 24.2% of the sustainability investments done by institutional investors, either pensions funds, insurances, foundations, etc. In terms of sustainability investments, green real estate is now the second largest asset class (Swiss Sustainable Finance 2019).

The growing interest for sustainable real estate among the investor community lies in the attainment of a combination of economic, social and environmental returns. Several reports show that green real restate achieves higher returns for both rents and sales prices: According to Credit Suisse, rents can be up to 10% higher and sales prices up to 30% higher (Credit Suisse 2015). A growing body of evidence suggests that there are strong links between the environmental performance of a building, notably in

terms of energy efficiency, and the financial benefits that it generates for its investors, owners or developers. Such benefits encompass (energy, natural resources, materials) cost savings, higher attraction for tenants or buyers, increased occupancy rates, increased liquidity, lower depreciation of the assets, etc. (WEF 2016b). In particular, buildings that are certified against sustainability standards, such as Minergie or LEED, generate a higher value on the market. Against the backdrop of a low-interest environment that has been characterizing the economy for some years now, the perspective of gaining higher premia through investments in sustainable real estate is of utmost interest for investors.

The above-mentioned figures mostly refer to direct investments in real estate carried out by individual or institutional investors. However, the arguments regarding higher value of green buildings also apply for indirect investment in sustainable real estate through investment vehicles, such as equities, bonds or funds. Several studies have shown strong evidence that sustainable companies are as profitable as non-sustainable companies, or even more profitable. In this regard, the housing industry is no exception. However, financial performance is only one aspect of a sustainable housing industry.

The ESG case for investing in a sustainable Housing industry

In addition to expected financial gains, responsible investors have other strong motivations to invest in a sustainable housing industry.

Firstly, mainstream investors, and especially institutional investors, are paying more attention to the **notion of fiduciary duty**[1]. They have become aware of the fact that the management and monitoring of environmental, social and governance (ESG) risks (and opportunities as well) associated with their portfolios, along with other financial risks, is now an integral part of their job. However, this perception has not translated into a complete integration of ESG considerations into asset management yet. When investing in the housing industry, investors are facing a considerable number of material ESG issues, which can turn into risks if they are not managed properly. Typically, such material risks include climate energy efficiency, product sustainability (green buildings), business ethics, employee and contractor health & safety, etc.

Secondly, a growing number of investors wish to align their investment with their ethical and moral values. They not only want to avoid risks that may arise with investment in non-sustainable companies (companies that pollute or have employee health and safety issues), but they also want to contribute to generate positive social and environmental impacts with tangible outcomes. In practice this means, for instance, that a public pension fund may wish to invest in real estate companies that develop affordable social housing designed for students, elderly people or other social categories of the population. This also means, of course, investing in housing companies that generally contribute to a low carbon economy, either through the supply of energy-efficient materials or through the development of innovative technologies. In this regard, impact investing and thematic investments are two strategies that suit these kind of investor expectations well.

Each of these topics, along with other ESG issues, may be considered in terms of **regulatory risks, reputation risks, commercial and financial risk**.

- **Regulation risks:** the example of emerging regulations regarding climate change and CO2 emissions is particularly relevant. Companies adopting strategies to reduce their negative contribution to this problem either through management policies or green product strategies, seem to be better positioned to anticipate upcoming norms. Since the Paris Agreement was signed in 2015, governments, including in developing countries, are setting up national policies to favor a transition to a low-carbon economy. Efficiency norms alongside incentive schemes to invest in green buildings, at the local level, are being developed. The housing industry, whose impacts on climate change are significant, ranks among the key business actors affected by these regulations.
- **Reputation risks:** as other companies from other industries, the housing industry as a whole faces growing expectations from its stakeholders, including responsible investors, notably in

[1] http://www.sustainablefinance.ch/en/glossary-_content---1--3077.html#anchor_JFDHOG: In the institutional investment context, trustees of pension funds owe fiduciary duties to beneficiaries to exercise reasonable care, skill and caution in pursuing an overall investment strategy suitable to the purpose of the trust and to act prudently and for a proper purpose. The explicit legal nature of fiduciary duty varies depending on the country of origin. While most institutional investment funds strive to create financial benefits for their beneficiaries, it is also possible for trust deeds explicitly to require trustees to consider ESG factors in investments. Against the backdrop that there is increasing evidence supporting the materiality of ESG issues, some legal experts conclude that it is part of the fiduciary duty of a trustee to consider such opportunities and risks in investment processes.

terms of sustainability performance and transparency. Key institutional investors, for instance, are pressing real estate companies to be more transparent and provide ESG data through the GRESB initiative. Consequently, a company that fails to be up to the standard one expects it to reach, may lose part of its reputation and face difficulties with its customers, tenants, investors or even with its employees. Reputational issues may in turn trigger productivity problems (less motivated employees and disrupted supply chain), as well as commercial and financial problems to a company (disinterest/divestment from investors and loss of competitiveness on the market).

- **Commercial risks:** major sustainability trends like energy transition, are key drivers for some business innovations, including within the housing industry. The companies that fail to invest in sustainable products and solutions and do not anticipate major regulatory changes are most likely, to lose market shares in the mid- and long term. For example, in the building materials sub-sector clients' procurement criteria are getting more demanding, and companies may eventually encounter financial difficulties as a result. On the other hand, in a very competitive economic environment, the responsible and sustainable management of ESG issues may also bring up business opportunities.

In conclusion, the rationale for investors to take ESG factors into consideration is clear. Companies which demonstrate stronger ESG performance and generate positive impacts on the environment and the society are better equipped and prepared to properly respond to this diversity of present and upcoming risks and thus avoid mismanagement and other incidents. A selection of sustainable companies in their portfolios allows, in turn, investors to prevent serious damages. Therefore, knowing the sustainability impact of their investments is crucial not only for ethical investors, but also for risk-oriented investors.

With its ESG Impact Assessment, Inrate evaluates the overall impact of companies on the environment and society. This allows not only ESG risks to be identified but also opportunities associated with companies and their respective industries. The Inrate ESG Impact Assessment measures the ESG impacts of companies' products and services throughout entire product life cycles, i.e. during supply chains, production as well as product usage and disposal. In the Housing Sector, leaving these upstream and downstream processes of the real estate life cycles out of the rating would miss the most important ESG impacts as well as related risks and opportunities. This assessment is then complemented by an evaluation of the CSR (Corporate Social Responsibility) management of companies, i.e. their willingness and ability to deal with their ESG impacts.[2]

The Inrate ESG Impact Assessment brings an added value to responsible investors who wish to get a comprehensive understanding of the ESG characteristics of companies in the Housing sector. Another major benefit is the overall ESG Impact Rating. Its grades range from A+ to D-, with A and B grades signifying a positive, C and D grades a negative ESG impact and contribution to sustainable development. This absolute grade allows responsible investors not only to compare companies within an industry, but also alongside industries, for instance a real estate company with an airplane manufacturer. Furthermore, it allows the ESG impact of entire portfolios to be assessed and compared

The following chapters describe the basis of the ESG Impact Assessment methodology that Inrate applies for the Housing Sector: the definition and structure of the sector, current major developments, the main ESG-related impacts and challenges the sector is facing as well as the solutions it may bring up to solve global ESG problems.

[2] For more details see Inrate 2018.

2. The Housing Sector

Definition of the service sector housing

"International human rights law recognizes everyone's right to an adequate standard of living, including adequate housing."

Office of the United Nations High Commissioner for Human Rights (2009)

The housing service sector comprises many, mostly complementary, products and services (for instance: engineering, facility, or real estate services). These products and services aim to fulfill the basic social need for housing, which enables sheltered living and working. There is a wide variety of housing forms and structures worldwide and there are various culturally influenced demands and needs by industries and building occupants.

The service sector housing is closely linked to the construction industry and the production of building materials and building technologies. To meet housing needs, both building construction as well as the production and installation of building materials and building technology are required. The supply of comfortable and functional equipment is a relevant component. This includes kitchen equipment, sanitary facilities, etc., as well as furniture and decoration. Other important services include the development of projects and the sale and management of new and existing buildings. Real estate companies and facility management companies are therefore important players in the Housing Sector.

The Inrate service sector housing is structured into 11 sub-sectors (cf. following table):

Sub-sector	The subsector includes companies engaged in…	Product/service examples
(1) Concrete and cement	… manufacturing of ready-mix concrete and/or cement.	• Ready-mix concrete • Cement • Concrete products • Stone & mineral products
(2) Building materials	… the production of building materials used in construction such as bricks, clay, rocks and sand.	• Lime and gypsum product • Bricks, tiles & clay • Stone & mineral products • Concrete products
(3) Building products	… manufacturing of building products such as fixtures, glass products, insulating construction materials etc.	• Pottery, ceramics, plumbing fixture • Glass products • Insulating construction materials • Heating equipment • Metal products • Furniture & related products
(4) Residential construction	… residential construction.	• Building Construction (general contractors) • Real estate
(5) Special construction contractors	… the provision of specific services used in construction processes.	• Integrated systems engineering (e.g. HVAC, interior walls, building ICT)
(6) Property development	… primarily in the development of real estate.	• Building Construction (general contractors) • Real estate • Industrial construction • Hotels & accommodation
(7) Residential real estate	… renting, managing, selling and buying of residential properties.	• Real estate operations • Building Construction (general contractors) • Services to facilities and buildings
(8) Real estate for retail operations	… renting, managing, selling and buying of retail properties (e.g. Malls).	
(9) Real estate operating companies and real estate investment trusts	… investing in real estate real estate and either reinvest the	

Sub-sector	The subsector includes companies engaged in…	Product/service examples
	earnings into the business or distribute them to unit holders.	
(10) Diversified real estate	… developing, renting, managing, selling and buying a diversified real estate portfolio.	
(11) Industrial and office properties	… managing, selling and buying of industrial and office properties.	

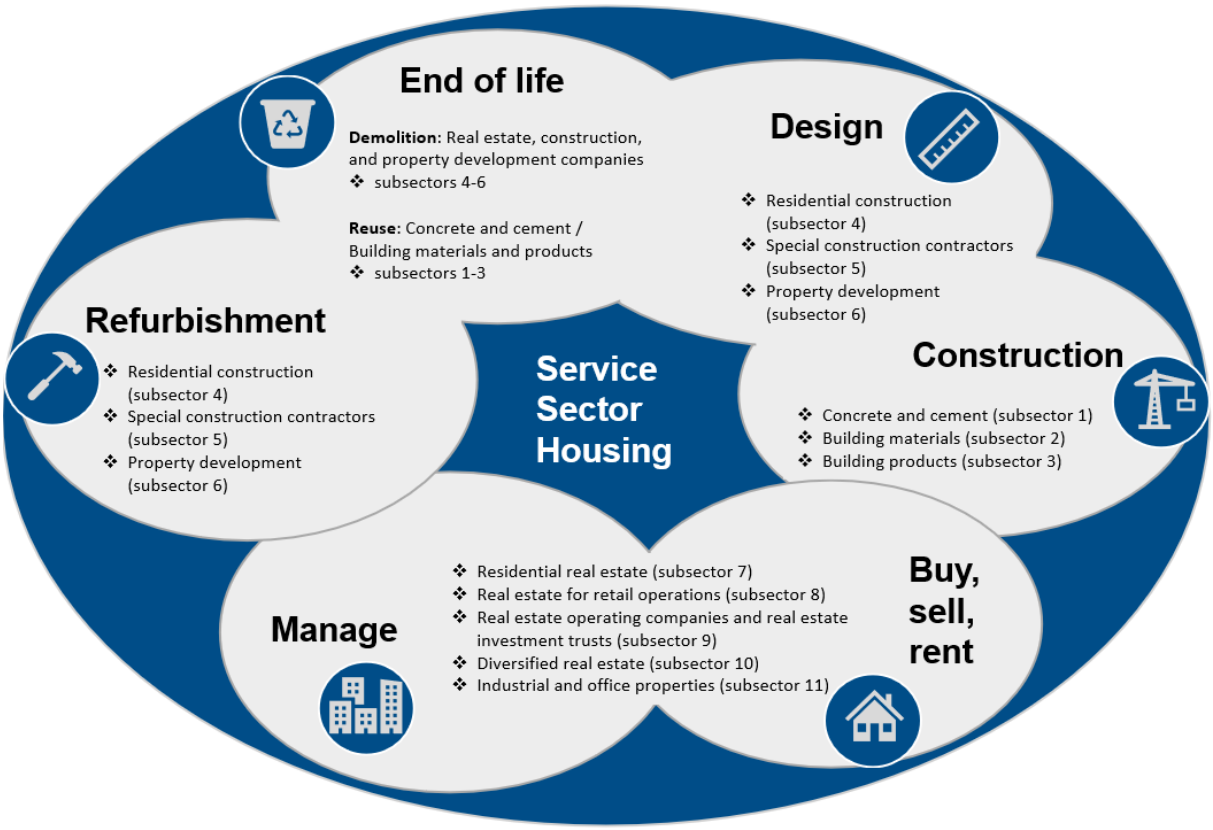
Table: Inrate 2019

Structure of the service sector

The service sector housing encompasses all suppliers of products and services in the building sector, including the suppliers of building materials and technology, furnishing and household appliances, as well as real estate operation and financing, and facility management.

The following figure shows the general allocation of the Inrate sub-sectors according to a building's value chain. Activities from various sub-sectors are involved in the different phases of a building's life cycle or its value chain.

Figure: Structure of sector activities according to a building's value chain



Source: Inrate 2019

The main elements of Inrate's sector delimitation

The housing service sector has many intersections with other sectors. Thus, a clear delimitation of sector activities is difficult in some cases, as many products or services of companies satisfy needs of other sectors as well, for instance, financing services or infrastructure construction. The most important sector intersections are shown in the following figure (the figure is non-exhaustive).

Figure: Service sector housing delimitation from other sectors

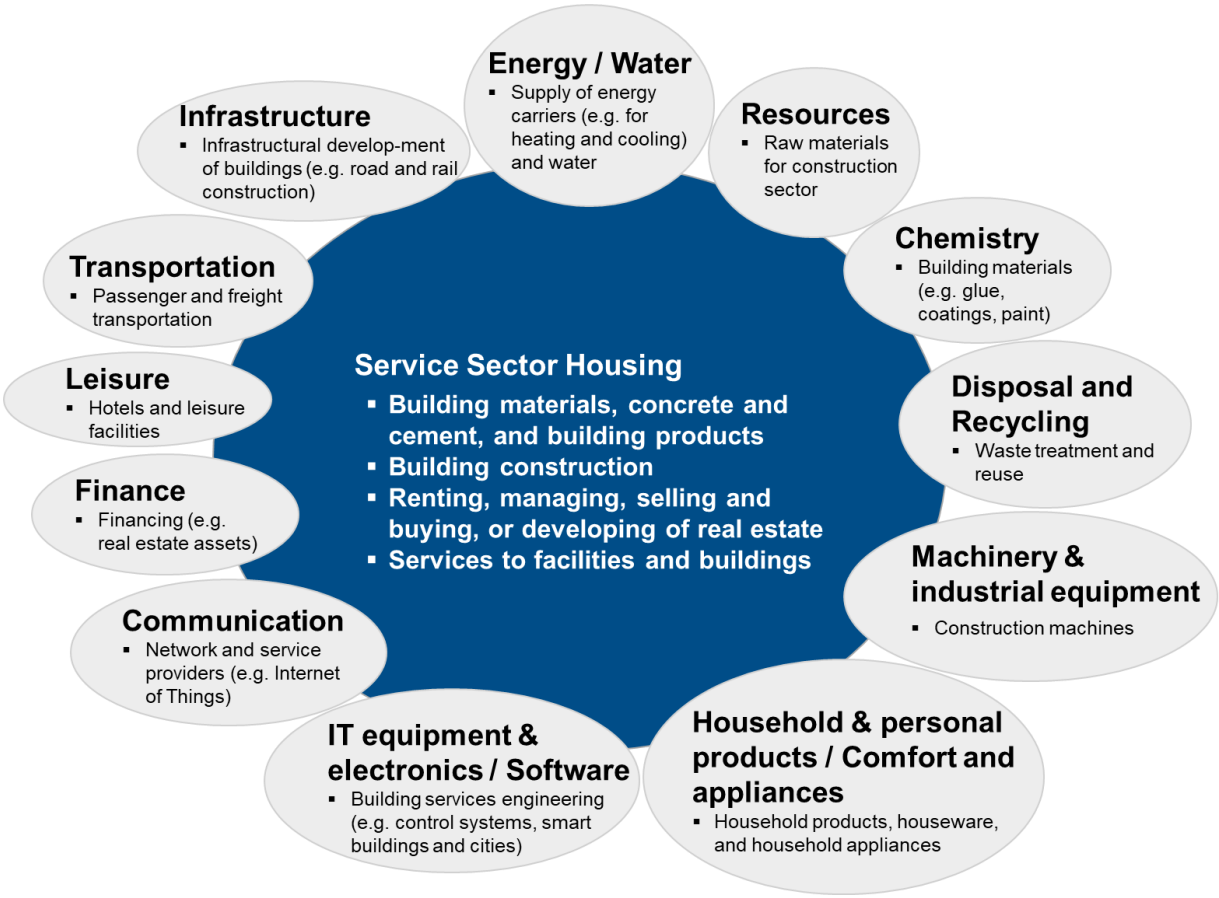


Figure: Inrate 2019

3. Main Developments and Trends

This chapter provides a brief overview of the major trends regarding the development of the housing service sector on a global scale. Subsequently, trends in Switzerland and Europe will be presented.

Global trends

Urbanization and population growth

Urban population growth is a major global trend with crucial relevance for the service sector housing. As Figure XY shows, the number of large cities and megacities in the world is expected to increase by almost 50% by 2030. By 2050, it is projected that the urban population will double and 66% of the global population will live in **urban areas** (IRP 2018). A large portion of this urbanization is taking place in Asia and Africa, where an increase of urban population shares by over 20% is taking place. Europe, Northern and South America are also seeing an increase of urban population, but only by roughly 10%. Considering the population growth of these five regions, the **increase of urban population in Asia and Africa** is of a much higher magnitude (IRP 2018).

The world's rural population is expected to remain at today's level and decrease by 2050. Africa is the only major area where the rural population – besides the urban population – is expected to continue growing (UN DESA 2014).

A major consequence of urbanization and population growth is an increase in global **lack of affordable housing**. which is further exacerbated if major investments are missing. This is particularly relevant given that one-third of today's urban population of the Global South lives in slums and informal settlements (IRP 2018).

Figure: World megacities in 1990, 2014 and projected for 2030

Source: UN DESA 2014

Graphic: Taken from IRP 2018

The population is not only growing, but also ageing, particularly in developed countries. This **demographic trend** is affecting the construction industry by different housing demands of elderly people and reduced availability of construction worker supply (WEF 2016a).

Urbanization and population growth also significantly affect **material consumption and energy use**. Energy consumption for cooling, which is at least partially driven by urbanization and population growth, is expected to increase by a factor of 1.5 globally and by a factor of 3 to 6 in developing countries by 2050 (IEA 2013). Further, increasing land use of growing urban areas and expansion of cities is putting more pressure on agricultural land and amplifying food supply risk (IRP 2018).

Market development

The **construction industry** accounts for about 6% of global GDP, and 8% in developing countries. The industry is **expected to grow** around 50% in annual revenues in the coming years to estimated revenues of $15 trillion by 2025. There will be a global construction demand shift towards **emerging countries** with 65% of the next decade's construction growth expected to take place in these countries (WEF 2018). The market is also expected to become more globally competitive. Asian construction companies in particular are actively securing construction contracts abroad (WEF 2016a).

The **real estate** sector is facing the challenge of **shifting demands** – from ownership of a building to property-as-a-service. Due to greater information transparency and changing occupier needs, building obsolescence is occurring faster. The vast existing building stock and changing use of real estate is challenging. In combination with **technological developments**, this leads to a "new supply", for instance in the office or hospitality segment, by offering co-working spaces or flat sharing. This is also crucial to the sector's evolution as **new players** enter the market, predominantly from the tech field (PwC and Urban Land Institute 2018).

The changing real estate landscape is one of several other major trends: population growth and increasing GDP per capita supports a **growing global investable real estate** universe, especially in emerging economies. The aforementioned urbanization and **growing cities** offer a wide range of investment opportunities – from low risk and low yield in developed countries, to high risk and high reward in emerging economies. Collaborating with governments will become more important, especially in emerging economies, as many governments will take the lead in urban real estate development. There are further important factors changing the real estate landscape, such as technology innovation and **sustainability requirements**, increasing competition for prime assets, and increasing and **new environmental, social, or political risks** (PwC 2014).

Construction industry trends

Global material consumption in urban areas will grow even faster than the urban population. Under a business as usual scenario, total resource requirements – not only construction related – could grow from 40 billion tons in 2010 to nearly 90 billion tons by 2050. (IRP 2018). The increasing material demand will make recycling and use of secondary materials more competitive compared to raw material extraction (OECD 2018). Given that the construction industry is the largest consumer of raw materials globally, its contribution could make a big difference. **Sustainability** is increasingly understood as a requirement for companies and the reduction of **waste and raw material use** is considered an important topic. **Resilience** becomes more important as well, as major cities and urban areas are vulnerable to growing natural hazards (WEF 2016a).

Innovation and innovation adoption are typically low in the **construction industry** compared to other industries. This is apparent in the US construction industry where over the past 50 years, the labor productivity has been decreasing. There are many and varying causes for this development: for instance, a lack of innovation and delayed adoption, informal processes or insufficient rigor in process execution, weak project monitoring, insufficient knowledge transfer from project to project, little cross-functional cooperation of stakeholders in an early design and planning phase and along the value chain, conservative company culture, little collaboration with suppliers, or shortage of young talent and people development. What is more is that the construction industry has inherent characteristics that make it difficult to transform. For instance, there are typically multiple stakeholders involved with diverse interests or needs; it is a project business with on-site construction, low profitability and capitalization, highly cyclical and volatile, and unstable workforce (WEF 2016a).

Globally, the construction industry faces increasing regulations (WEF 2016a). On the one hand, this results in increasing complexity. On the other hand, regulations can stimulate industry transformation and innovations with benefits for society and the environment.

More specific trends in Switzerland and Europe

Urbanization and population growth are major global trends affecting the housing service sector. This trend can also be observed in Switzerland and Europe where the urban population is expected to grow from 75% to more than 80% by 2050 (UN DESA 2014). Europe's population growth is expected to stagnate and even to decrease in Eastern Europe. However, Switzerland's and most EU-28 member states' population will probably continue growing (UN DESA 2014). Most of all, population growth will be due to immigration. Thus, **society** will age continuously as life expectancy increases. 10% of total population will **shift from working-age population to elderly persons** by 2080 (EUROSTAT 2015). The increasing share of elderly persons results in challenges for the service sector housing. The construction sector will face **challenging labor markets** (WEF 2018) and real estate **changing demands**.

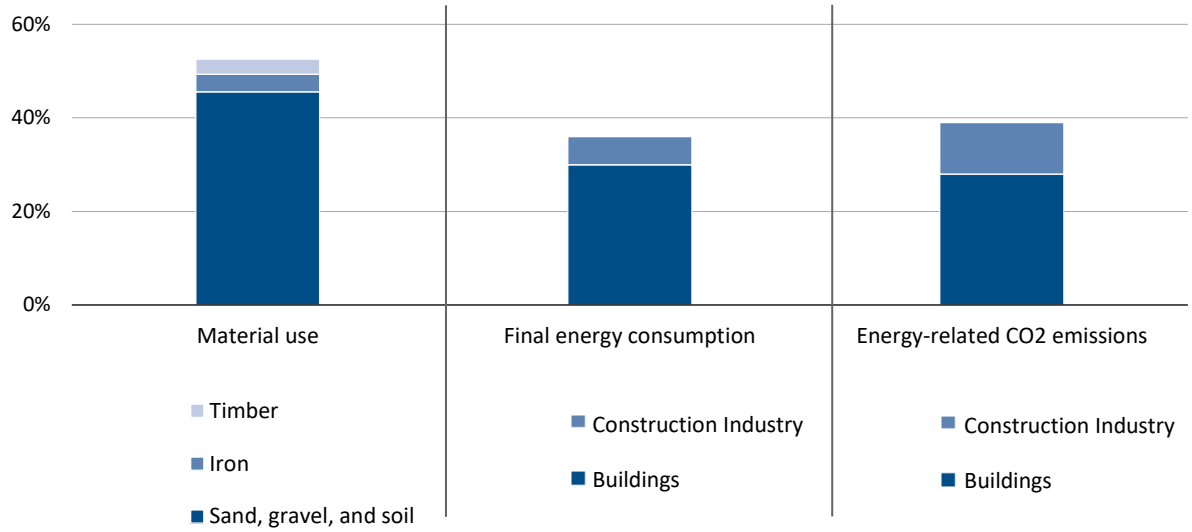
Most aspects of the above-mentioned **market development and trends in construction industry** hold true for Switzerland and Europe. More specific to Switzerland and European countries – but also other countries of the world –are stronger trends towards increased **interconnectivity** of buildings (e.g. with appliances and power systems), **green building** certifications and green building codes, as well as **demand and use shifts** in existing buildings due to new businesses, social, and technological developments. The biggest climate challenge is the high **energy consumption** of the existing **building stock**, as renovation and replacement rates are rather low.

The lack of affordable housing is not limited to emerging markets but is also an important topic for Europe and Switzerland. According to CIDOB (2017) “the increased cost of living above employment income is a key problem for more than a third of citizens in the European Union, …". Particularly, successful cities are attracting more and more people. This leads to continuously **rising cost of urban real estate** per square meter (PwC 2014). As a consequence, housing in cities is becoming increasingly unaffordable and gentrification of city centers is occurring (The Guardian 2016). Developers will have to be more innovative in the design of commercial and residential real estate to use space more efficiently and build in a cheap and eco-friendly way.

4. Environmental Impacts and Challenges

The construction of buildings is one of the most resource intensive economic activities. Construction materials make up around 50% of the world's overall material use (OECD 2018). Further, construction activities and manufacturing of construction materials such as steel and cement have a share of around 6% of global final energy consumption and cause around 11% of global energy-related CO_2 emissions (UN & IEA 2017). The use phase of buildings is the most energy and CO_2 intensive phase of a building's life cycle, mainly due to heating and cooling energy demand. In total, the construction industry and the buildings sector account for roughly 35% of global final energy consumption and 40% of global energy-related CO_2 emissions (UN & IEA 2017). Further, buildings have a share of around 25% of global water consumption (IRP 2017). A building's environmental impact over its life cycle (e.g. energy use, CO_2 emissions, acidification, or ozone depletion) result in high external environmental costs. Case studies in Germany, for instance, showed that the investment costs would increase by 20% to 40% if external environmental costs would be included (BMVBS 2010).

Figure: Major environmental impacts of housing service sector activities

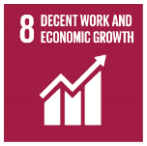


Source: OECD 2018 and UN Environment and International Energy Agency 2017

Graphic: Inrate 2019.

The housing service sector is an important field of action regarding sustainable development. The UN Sustainable Development Goal 11 (SDG 11), sustainable cities and communities, sets a key objective to the service sector housing. The environmental and social challenges associated with housing have global significance, which is reflected in the fact that 11 out of the 17 UN SDGs are related to the Housing Sector (cf. following table on relevant SDGs).

Table: SDGs relevant for service sector housing

Relevant SDG		Key topics
	**No poverty**	Access to resilient housing and infrastructure for all Access to affordable housing for all Fuel poverty
	**Good health and well-being**	Healthy indoor and outdoor environment Healthy building materials
	**Quality education**	Assure life-long learning opportunities for all Enable high quality education for a sustainable built environment
	**Clean water and sanitation**	Waste water treatment and recycling Water-use efficiency in building construction and building material manufacturing
	**Affordable and clean energy**	Buildings as renewable energy users and producers Energy efficiency in buildings
	**Decent work and economic growth**	Job creation through sustainable building sector Technological innovation for improved efficiency in construction work Safe working environment in construction industry
	**Industry, innovation and infrastructure**	Resource-use efficiency in construction Adoption of clean and sustainable technologies in buildings and infrastructure
	**Sustainable cities and communities**	Safe, affordable and accessible transport within cities and districts Inclusive and participatory planning and management of built environment Access to green, inclusive and accessible public spaces in cities
	**Responsible consumption and production**	Material life cycle and circularity & waste prevention, reduction and recycling in new building construction and renovation Sustainability reporting in construction value chain & sustainability-oriented procurement practices for new construction and renovation
	**Climate action**	Climate change mitigation and adaptation Resilience to natural disasters

Relevant SDG		Key topics
	**Partnerships for the goals**	Promoting creation and transfer of environmentally sound technologies (increase efficiency, use of natural resources, generate low waste, treat the generated pollution and mitigate climate change) More sustainable financial system by integrating the environment dimension

The list of relevant SDGs related to the built environment and key topics was taken from the website of the world sustainable built environment conference 2020. The list was adjusted regarding the housing service sector relevance and combined with the selection of relevant SDGs, related to sustainable building, by the UN Environment Programme 2018.

Source: United Nations 2015, World sustainable built environment conference 2020, and UN Environment Programme 2018

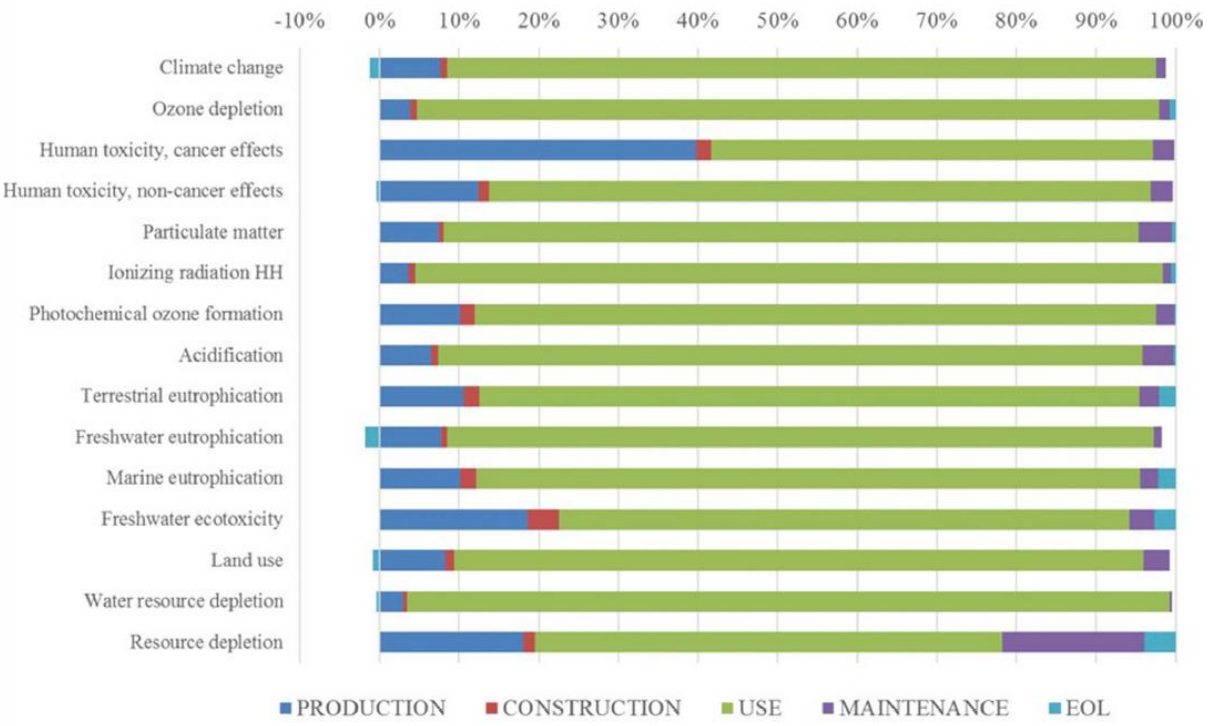
Table: Inrate 2019

The following subsections highlight the main issues of the service sector housing from an environmental sustainability perspective.

Environmental impacts and challenges

The following figure shows the different environmental impact categories of housing along a building's life cycle. The use phase and production phase (extraction of raw materials, transport, and manufacturing of building materials) constitute the largest environmental impacts of a building's life cycle.

Figure: Contribution of different life cycle phases of housing to different impact categories



Abbreviations: EOL; End of life / Ionizing radiation effects on human health (HH)

Source: Lavagna et al. 2018

Graphic: Taken from Lavagna et al. 2018

Climate change

The largest climate impacts occur during a building's use phase. Energy consumption and corresponding CO_2 emissions are increasing on a global scale. Global use of energy in buildings has grown by 1% per year, electricity use by 2.5%, and related CO_2 emissions by nearly 1% (IEA 2017). Heating and cooling account for over a third of the buildings sector's energy consumption (IEA 2013). The climate impact is directly dependent on the share of fossil energy carriers used. In 2015, the share of energy consumption in buildings supplied by fossil fuels was 82% (UN & IEA 2017).

A building's carbon and energy footprint are not only determined by its use phase. The selection of materials and the building's location, for instance, are equally important factors. Concrete production is responsible for 9% of global greenhouse gas emissions (OECD 2018). The amount of (traditionally produced) concrete used, therefore has a significant impact on the climate. The building's location affects the induced mobility by its occupants and can have a significant impact on the climate as well.

Resource depletion and environmental impacts

Service sector housing related activities have a large impact on resource consumption. 50% of the worlds overall material use can be allocated to the construction sector (OECD 2018).

Extraction of primary materials and processing them to construction materials, such as concrete or steel, are linked with a wide range of environmental consequences. They range from local to global scale. Most significantly, this includes human toxicity (particularly cement, concrete, bricks, and gravel), fossil fuel depletion, climate change, and metal depletion (particularly steel). Furthermore, building material production is associated with terrestrial acidification, photochemical oxidation, ecotoxicity, eutrophication, and particulate matter formation. The production of iron, steel, and other construction materials is linked to large emissions of energy-related greenhouse gases and air pollutants. (OECD 2018, Huang et al. 2018)

In addition to the extraction of raw materials, transportation of materials and production of construction materials (e.g. concrete and steel) as well as manufacturing of building products (e.g. glass and insulating materials), and supply of energy carriers (e.g. oil for space heating) have vast environmental and climate impacts.

Land use, pollution, and waste

The decision – by developers, investors, and planners – on what is going to be built, how, where and for whom, has far-reaching and long-lasting consequences and environmental impacts. Direct environmental impacts result, besides the before mentioned energy and material use, from land use, pollution from transportation and construction itself. Particulate matter, noise, soil compaction and sealing, water pollution, and waste generation are typical environmental impacts related to construction sites.

Particulate matter and noise directly affect workers and residents. Soil compaction leads to decreased soil fertility and other soil functions such as water permeability. Soil sealing causes such damages permanently. Chemicals or alkaline waste water from work with concrete can pollute natural water bodies (freshwater ecotoxicity). Construction work or, even more, demolition of buildings generates vast amounts of waste. Improper disposal creates more negative environmental impacts compared to professional disposal, waste separation, and recycling.

5. Social Impacts and Challenges

The built environment affects the entire population of the planet. Where and how buildings – and infrastructure – are built determines people's quality of life. In the United States, for instance, most people spend almost 90% of their time indoors. Therefore, buildings and particularly the used building materials can have major impacts on occupant's health and well-being (WEF 2016a).

Occupants well-being

People living and working in buildings are affected by the building and its location. Besides the negative health effects of toxic materials, the indoor environmental quality affects the occupant's health and well-being.

Furthermore, the location of a building and its connectivity with transportation means and proximity to social infrastructures (schools, hospitals, shops, etc.) influences the quality of life as well.

Workforce impacts

More than 100 million people worldwide work in the construction industry (WEF 2018). Labor conditions, particularly in construction but also in resource deployment and demolition of buildings, can therefore have large impacts on health and welfare. Social insurance, working hours, fair salaries, and safety regulations play an important role.

Negative impacts on workers' health, for instance, can ocure as result of particulate matter use containing toxic or cancerogene materials like asbestos.

Urbanization and affordability

Affordability of housing, social mix in urban areas, poverty ghettos, and informal settlements are major challenges regarding social impacts of the service sector housing (UNECE 2018). Today, the population living in slums is estimated to be around 900 million to 1.3 billion people. This population will reach over two billion by 2050 if current trends are continued (The Guardian 2015).

The housing service sector in cities faces significant challenges concerning affordability by developments like gentrification of city centers, with expensive flats and workspaces, and a resulting shift of middle- and lower-income classes to suburbs. The gentrification of city centers is therefore controversial.

Negative impacts of corruption

The construction industry accounts for about 6% of global GDP, and 8% in developing countries, and the industry continues to grow. The construction industry and real estate sector are more afflicted by bribery, corruption, and anti-competitive practices than other sectors are. This is a major barrier to economic and social development (WEF 2016a). Furthermore, it can also have severe consequences for the sustainability of building projects. For instance, by disregarding standards about materials, workers' health and safety, or building's energetic performance requirements can be jeopardized. Cash outflow due to corruption can further lead to reduced quality of a building. This can consequently lead to reduced energetic performance, bad indoor environmental quality, and, in the worst case, even to reduced structural strength of a building and thus to reduced resilience to external stresses such as earthquakes, floods, or storms.

Conclusions

Based on the major trends and major sustainability impacts of the service sector housing, the main conclusions for action towards a sustainable service sector housing are as follows:

1. Circular economy: use of healthy and sustainable building materials and designs that leads to a reduction of material consumption, embodied energy, and climate impact, while increases healthy and comfortable living and working spaces.
2. Decarbonization of the whole value chain (material deployment, manufacturing, transport, and construction) and particularly of the building's use phase (increased energy efficiency and use of renewable energy).
3. Compliance of contractors with labor standards is important. Fair and safe working conditions must be provided.
4. Avoiding anti-competitive practices, bribery, and corruption, for instance by increasing transparency.
5. Building resilient and climate change adapted cities and communities. This is particularly important regarding natural hazards and disaster risk reduction in growing urban areas and major cities.

These conclusions lead us to our vision of a sustainable housing sector (cf. chapter 6).

6. Inrate's Vision of a Sustainable Housing Sector

Sustainable solutions along the entire value chain

Solutions to mitigate impacts associated with the housing service sector and to bring about positive change are to be found along its entire value chain. A building's life can be considered through a process-lens, that highlights six separate steps that interconnect in several aspects:

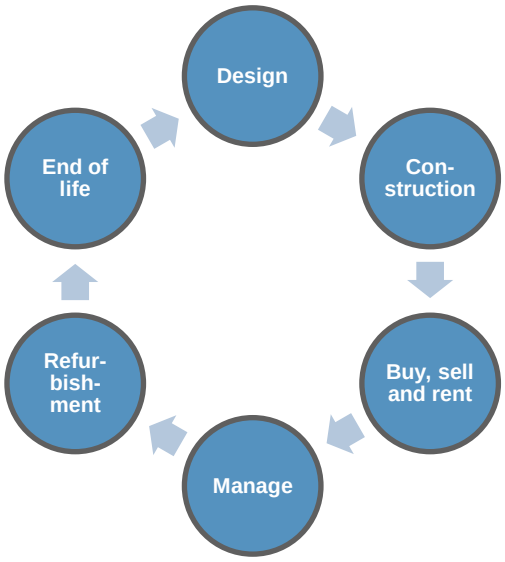


Figure: Inrate 2019

Considering each of these successive phases, one can identify good practices that are relevant in terms of sustainable solutions and eventually help preserve the environment while solving other social issues. With regards to this lifecycle approach, **the concept of circular economy** is here of utmost interest since it provides a global framework that helps integrate key sustainability considerations into the global economy, in a way that is more efficient and innovative than the linear economy model has been doing so far. Some large companies, like the French Klépierre Group, a company active in real estate for retail operations, have identified circular economy as a relevant topic within their sustainability strategy (Klépierre 2017). According to the Ellen MacArthur Foundation, an adapted circular development model would halve CO_2 emissions in Europe by 2030 compared to current levels. This model would also create jobs: in a circular scenario, European GDP could grow by up to 11% by 2030 and 27% by 2050, compared to 4% and 15% respectively in the current linear model (Ellen MacArthur Foundation, SUN, McKinsey & Co 2015).

In other terms, in relation with the housing service sector's particularities, circular economy means favoring seven core pillars: green procurement; eco-conception; industrial ecology; functionality; responsible consumption; durability of the product use phase; recycling and re-use of the product.

Design

From the earliest building project's stage, owners, real estate companies and other property developers should initiate a thorough reflection around the building they want to build, develop, refurbish or dismantle. This reflection, conducted by designers and architects, should strive to consider the entire building in its natural environment and its use in a long-term perspective, as it may have multiple lives and usages for different actors.

Ideally, the design of a green building requires a **life-cycle analysis** (LCA) of the materials and equipment that will be part of the building. The LCA allows to reduce negative environmental impacts by selecting materials and equipment that will lower their grey energy and enhance the building's sustainability.

Such a reflection should not only envisage the materials/equipment selection, but more generally it should examine the next life or use phase of the building and consider the disassembling of its structures and components and their re-use for other new projects. **Modular design is a key notion in this regard**. Modular buildings are easy to disassemble: their elements are prefabricated offsite and can later be re-used in other projects. While modularization generates substantial financial savings (construction costs, time to completion, waste management), it also extends the life or materials. **Flexibility also matters**. By designing flexible building cores, for example, developers can enable a building to switch purpose later during its use phase, without being demolished. Buildings should also be designed with the purpose of generating renewable energy instead of consuming it. Building integrated photovoltaics systems (BIPV) are a good example: they consist of "integrating photovoltaics modules into the building envelope, such as the roof or the facade. By simultaneously serving as building envelope material and power generator, BIPV systems can provide savings in materials and electricity costs, reduce use of fossil fuels and emission of ozone depleting gases, and add architectural interest to the building" (Whole Building Design Guide 2016). Further, the design of buildings should take into account climate change and its effects (storms, floods, draughts/fires, extreme heat and heat waves) to be more resilient and e.g. prevent overheating.

Several tools, including the **Building Information Modelling (BIM),** help the different stakeholders involved in the development project to agree on a common concept before starting to build. BIM is a process used to design, construct and manage a construction project. When applied correctly, it can help identify materials to be used, where they are sourced from and ensure the reduction of embodied carbon. Moreover, such a digital tool gathers data from different sources and provides all stakeholders with a digital representation of a building's characteristics throughout its life cycle (Autodesk 2019).

The location of properties is also an important factor that must be considered at the very beginning of the design process. Real estate companies may give priority to buildings that are well served by public transport, well connected or located near basic infrastructures, such as hospitals or schools. For example, Swiss Finance & Property Investment AG has launched a real estate fund in Switzerland, SF Sustainable Property Fund, which invests in residential properties located less than one kilometer from a railway station.

From the very beginning of the construction process, a sustainable building project should strive to incorporate and follow **Green building standards' recommendations**. Among these standards, some are of particular interest in the Swiss context (Verein Green Building Schweiz 2019):

- **LEED (Leadership in Energy and Environmental Design)** is an internationally recognized green building certification system. LEED provides building owners and operators a concise framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions. A third-party verifies that a building was designed and built using strategies that improve energy savings, water efficiency, reduce CO_2 emissions, improve indoor environmental quality, etc.
- **BREEAM (Building Research Establishment Environmental Assessment Method)** is a sustainability assessment tool that helps manage projects, infrastructure and buildings. Launched in 1990, it sets standards for the environmental performance of buildings through the design, specification, construction and operation phases and can be applied to new developments or refurbishment schemes. An external verification body carries out the assessment.
- **Minergie** is the most famous construction label in Switzerland for new or renovated buildings. At the heart of the label is comfort – in terms of housing and workplace – for building users, as well as energy efficiency, quality and optimal maintenance of the value of the goods. Comfort is guaranteed, among other things, by means of a good quality building envelope and systematic air renewal. Minergie buildings are also characterized by very low energy requirements, a self-produced share of energy and the highest possible use of renewable energies.

Construction

Real estate and property developers need to adopt **green procurement policies** that will determine standards in terms of purchasing practices and eventually favor, during the construction phase, the use of eco-friendly and non-toxic materials. **Among other procurement factors such as price and quality, sustainability and environmental efficiency should be key criteria**. In other terms, contractors and

equipment suppliers will be selected upon the eco-efficiency of the products they provide to property developers, real estate owners, and managers. Suppliers, such as building materials companies, in turn, need to offer green products that respond to the demand, for example, in terms of water efficiency, energy efficiency or waste efficiency. The eco-efficiency of products has become a major competition factor for building materials companies like LafargeHolcim or Geberit. Eco-labelled products, that show evidence of their eco-efficiency, will be favored against other less eco-friendly materials (Ecolabel Index 2019). This assumption is particularly true in developed markets, like Switzerland (developing markets being less demanding).

For example, to maximize the performance of the building envelope, as a good practice and as an alternative to synthetic insulation, building contractors may be required to opt for natural materials that will serve as insulation layer (cellulose, wood fiber, sheep's wool, etc.). Different sorts of cement can be purchased on the market. Nowadays, e.g. a growing number of contractors are giving priority to Portland Pozzolana Cement (PPC) over Ordinary Portland Cement (OPC), as PPC is made of more sustainable raw materials and offers a better quality and durability to the building structure (World Business Council for Sustainable Development, Cement Sustainability Initiative).

To the extent possible, **recycled or re-used products should be selected and valorized** within the construction project. The same holds true for construction waste, which may be reused for other purposes in the building phase. In general, construction waste can be minimized by optimizing structural components with the use of innovative computer techniques. **Additive manufacturing (3D printing)** ensures that only required material is used, with no or very little wastage.

Often associated with the concept of smarter construction, **offsite construction** may also be an interesting solution that addresses materials efficiency challenge (KPMG 2016). This term refers to the prefabrication, modularization and standardization of building elements within controlled-environment factories. Fewer mistakes made thanks to offsite construction lead ultimately to less material wastage and health & safety incidents. China Resources Land, a Chinese real estate company, commits to using fabricated building solutions, that consist of prefabricated building elements that can be assembled on site, as it firmly believes this allows to improve quality and reduce costs and energy consumption in comparison to traditional building (China Resources Land Limited 2017).

In line with the principles of the circular economy, **the use of supplies and equipment, rather than their possession, is becoming an increasingly relevant option**. Some equipment suppliers, such as those providing floor coverings, offer their customers **a complete service rather than a product to buy**. In this example, the service includes advice on the product to be used, the supply and installation of coverings, the replacement of damaged slabs during the rental period, cleaning and maintenance, as well as the recycling of end-of-life products (Textifloor 2019).

All companies in the sector face **risks that can arise upstream in their supply chain**, whether related to corruption, health and safety, working conditions, child labor or human rights. That is why it is of the utmost importance that real estate companies, building materials companies and other businesses manage their relationships with their suppliers and partners in a responsible way. The concrete integration of sustainability into the supply chain strategy can consist of a wide range of measures, including the adoption of strict social standards, participation in multi-stakeholder initiatives, training programs for suppliers, a code of conduct for suppliers, external and independent audits, engagement with suppliers, etc. As an example, **Jones Lang LaSalle (JLL)**, a company specialized in real estate, has published a Vendor Code of Conduct that sets business ethics and provisions and other CSR standards especially designed for its business partners, contractors and suppliers. **The Vendor Code of Conduct** is very detailed, it explicitly gives directives on how to avoid practices that may violate data privacy of clients, intellectual property rights, or encourage bribery and other forms of corruption that seek to influence the clients. Moreover, referring to globally recognized human rights principles set by the United Nations, the document includes a comprehensive list of practices, relating to decent working conditions (salary, working hours, unions), that vendors need to completely ban (Jones Lang LaSalle 2019).

Buy, sell, and rent

Real estate companies, typically Real Estate Investment Trust (REITs), investing and managing properties, are aware of the importance of carefully monitoring their assets so that they keep their financial value. Tracking sustainability performance of their properties has become common practice

among some prominent asset owners and managers, as it is now widely assumed that green buildings bring higher premia and save financial costs in the long-term (WEF 2016b).

Portfolio optimization, with a focus on sustainability, can notably be achieved with the help of **data management platforms**, such as Measurabl (Measurabl 2019). Such tools typically apply to the portfolio and aim at tracking key performance indicators – for example energy use, water usage, waste disposal, CO_2 emissions together with asset data such as rent, lease detail, etc. While optimizing energy efficiency investment, managing these data help identify and avoid asset depreciation risks.

The integration of a portfolio into a digital platform would allow, for instance, a real estate asset manager to reduce its energy and water consumption as well as improve waste diversion. In parallel, thank to this technology, asset managers may **collect, report and deliver ESG data to socially responsible investors and other stakeholders, including tenants or clients**. They may also gain advantages in participating in sustainability initiatives such as Carbon Disclosure Project (CDP) or GRESB.

GRESB (Global Real Estate Sustainability Benchmark), for example, assesses the sustainability performance of real estate and infrastructure portfolios and assets worldwide, and delivers ESG research and ratings that help institutional investors measure the sustainability of their portfolios (GRESB 2019). For instance, the Swiss real estate company Mobimo in 2017 scored very well against GRESB criteria and consequently was awarded a Green Star. This means that the company, in comparison to its peers, shows an outstanding ESG management of its properties.

Another “smart” solution, that can be promoted by property managers in their renting practices, consists of **encouraging the share of working spaces in the building**. While these “smart asset optimization” solutions, enabled by digital technologies such as smart booking, smart parking and other collaborative platforms, allow to realize substantial financial gains for owners, they also help occupiers reduce their energy consumption and operating costs. Several companies have established platforms to satisfy the demand for greater flexibility in the work environment. In the commercial real estate market, for example, co-working schemes provide options for small business actors to have a small office in a central business district. In the same logic of flexibility, workspaces that are underused at certain times of the day or at certain times of the year can be quickly adapted for other commercial uses (KPMG 2018).

Manage

As mentioned above, “smart” solutions are available to reorganize space with the aim of saving natural resources and energy consumption. **A growing number of smart building solutions**, **enabled by the Internet of Things (IoT)**, are also emerging and being developed by real estate companies to better track and manage the sustainability performance of their residential or commercial properties (while “Smart Home” solutions are designed for individual tenants/occupants). “Smart Building” is mainly about collecting data across multiple systems, applying “intelligence” to the data through software, and leveraging this higher control and connectivity to optimize operations (Deloitte 2016). The scope of Smart Building is very broad covering various objects within a building from windows or elevators to door and sanitary systems. Energy efficiency can be increased notably through:

- **smart lighting systems**: the light is automatically adjusted according to various parameters (natural light, occupancy, etc.) measured by sensors.
- **smart HVAC systems**: heating, ventilation and air conditioning, linked with different sensors, can be adapted according to weather forecasts, occupancy, ineffective systems, etc.

Facility managers are then able to monitor remotely the energy used by activating/deactivating lights, HVAC systems thanks to the communication with other equipment like smart windows or presence detectors. The major motivation for building managers to implement these solutions remains the substantial reduction of the electricity costs. According to Gartner, a consultancy company, “in large sites, such as industrial zones, office parks, shopping malls, airports, or seaports, IoT can help reduce the cost of energy, spatial management, and building maintenance by 30%” (Gartner 2015). Smart solutions may also improve the working/living conditions of employees and occupants (better air quality, thermal comfort, etc.), and contribute to a higher productivity.

The Commercial Real Estate (CRE) sector has a particular interest in making a good use of IoT technology and related smart building solutions (Deloitte 2016). As mentioned above, companies in this sector can save significant costs in terms of eco-efficiency. Kimco Realty, a US listed owner of shopping centers, was awarded for its efforts to make its lighting systems more efficient. The Property Gateways

System, a remote controlling system, has allowed, since 2011, to save on average 18% electricity consumption (Kimco Realty 2017). Additionally, on a very competitive market affected by the growing threat of e-commerce, CRE companies that have implemented smart building into their building management system can differentiate from their competitors by offering more leverage to retailers, in order to enhance the shopping experience of their clients.

Finally, green lease also appears to be an interesting solution for tenants and building owners. A green lease is a contractual arrangement made between tenants and the landlord, which contains "green" clauses that parties should abide by. They generally refer to concrete measures that all parties should take at different stages (supply, maintenance, operations, etc.) (Better Buildings Partnership 2019).

Refurbishment

The decision, refurbishment or new building, has to be made for each case. In some cases, a refurbishment is the more sustainable option, while in other cases new buildings show better results. **The method of Life Cycle Carbon Footprint (LCCF)** can help answer this question. LCCF calculations, from different case studies, show that the assessed building's use phase makes up 75% of its life cycle CO_2 emissions. Embodied carbon, on average, accounts for 24% and demolition for 1% (Schwartz et al. 2018a). The decision-making, eventually, might be based on the optimal combination of minimal LCCF and Life Cycle Cost (LCC) (Schwartz et al. 2018b). Further parameters like market demand and social aspects might be considered as well (Baublatt 2017).

Ideally, refurbishment with sustainability purposes should be conceptualized at the early stage of the project design (see stage 1), when designers discuss and select eco-efficient materials. Concretely, this means selecting materials with a higher recycled content, with lower embodied carbon and water, locally sourced materials and with minimal maintenance requirements.

To initiate a building refurbishment that meets sustainability criteria, real estate companies can use a **series of tools that first help assess the sustainability performance of an existing building and then help make renovations**. Some of the major schemes, as evidenced under the design phase, are BREEAM, LEED, Green Star, etc. While the majority of these schemes primarily address new construction, BREEAM, an assessment and certification method for whole buildings, explicitly refers to the notion of refurbishment and has developed a specific standard in this field (BREEAM 2016). In Switzerland, for a simplified but high-quality energy renovation of residential buildings, Minergie offers five models leading to a Minergie certificate. Renovation models combine measures related to the building envelope, heat production and controlled ventilation. Furthermore, it can be combined with the Minergie ECO standard. This combination adds the topics health (daylight, sound insulation and indoor climate) and building ecology (sustainable building concept, materialization and processes, and embodied energy) to the Minergie standard (focus on energy efficiency and comfort).

In Germany, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety has published in 2016 the Guideline for Sustainable Building, a very comprehensive catalogue of 47 sustainability criteria that correspond to the refurbishment phase (BMUB 2016). These criteria, designed for developers, cover several dimensions to be considered, such as ecological quality, economic quality, socio-cultural and functional quality, and technical quality. In Switzerland, a sustainable building standard was launched in 2016: the NNBS (Netzwerk Nachhaltiges Bauen Schweiz): it also integrates considerations on renovation.

Swiss Finance & Property Investment AG indicates, in its annual report 2017, that it applies the SFIA energy efficiency guidelines to monitor the energy consumption of its building portfolio and, when needed, readapt and renovate a building to save energy.

End of life

All projects should develop a **site waste management plan** which seeks to:

- **Eliminate:** Some waste generated in the process of construction **can be eliminated** and thus benefit human health and the environment. For example, one may opt from the earliest stage for demountable and reusable construction elements (modularity).
- **Reduce:** At the design phase of the project, actors involved in the property development should identify areas where the design may generate unnecessary waste or where to apply a construction process that may **minimize waste**.
- **Reuse:** In the previous refurbishment phase, whenever possible, when removing and replacing materials, one should reuse these materials. For example, doors and windows in good condition may be donated or sold to be used within a new project.
- **Recycle:** All projects should set up recycling facilities for the major waste streams to maximize recycling opportunities and minimize the amount of waste going to landfill.

More concretely, real estate companies, along with their construction contractors, can adopt a group-wide zero-waste strategy and implement a series of measures that follow the above-mentioned principles. They may start by elaborating a Site Waste Management Plan prior to starting the project. This plan includes a strategy for reducing waste to landfill from the construction process. Companies may then set targets for construction and demolition waste to be diverted from landfill. Where feasible, they should strive to recycle or reuse existing building structures, fabric and materials. To this end, they need to develop training programs and sensitize their employees and contractors on good waste management practices. In collaboration with tenants, for instance retails in a shopping center, they may exchange on best practices to minimize waste generation. They may also monitor and report, within their sustainability reports, on their waste management systems and their performance against predefined metrics.

For a shopping center owner like Klépierre, managing the waste produced by customers and tenants is a key issue (mainly cardboard, paper, food, etc.). The Group has set the target to divert 100% of its waste from landfill by 2022. To this end, the Group reports in its sustainability that it strives to increase the number of sorting solutions in order to grow the proportion of waste sorted on site. The measures taken at the centers are designed to emphasize the environmental and financial benefits of on-site separation. They involve raising awareness among employees and working closely with retailers. In 2017, the company managed to divert 94% of waste from landfill (Klépierre 2017).

Cement Roadstone Holding (CRH), an Irish multinational construction materials company that notably produces cement and concrete, as indicated in its sustainability report 2017, is striving to reduce its own waste by recycling by-products in its production process. Internal wastes, like dust particles or excess quarry rock, are recycled back into production processes, like for example baghouse fines in asphalt mixes. This allows to minimize raw materials usage and enhance process efficiency (CRH 2017).

Mirvac, an Australian property group, is targeting a minimum 95% diversion of its construction and demolition waste from landfill and has committed to the Green Star Construction and Demolition Waste Reporting Criteria. This standard has been developed to ensure that contractors and waste processing facilities are operating with environmentally responsible due diligence (Mirvac 2018).

7.

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