Accelerating Climate Action: Refocusing Policies through a Well-being Lens

4 Building sustainable dwellings, neighbourhoods and communities

This chapter analyses the residential sector from a well-being perspective and proposes a number of policy priorities that are consistent with wider well-being and sustainability goals. It explores several indicators that can improve policy makers' ability to monitor progress in delivering these priorities in the sector, as well as guide decisions to capture the benefits of a two-way alignment between climate and wider well-being goals, while also managing trade-offs. The chapter examines the relationship between the proposed indicators and the indicators used by the Sustainable Development Goals and the OECD Framework for Measuring Well-being and Progress.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

In Brief

Building sustainable dwellings, neighbourhoods and communities

The residential sector is central to the low-emissions transition and also to public health, safety, security, comfort, affordability and equity outcomes. Buildings generated some 28% of global GHG emissions in 2017, and the residential sector accounted for 60% of these. The provision of services within buildings is a central driver of energy demand and emissions, mainly from space and water heating, cooling and cooking. These services are linked to other aspects of well-being, including clean energy access (SDG 7), which is necessary to prevent health risks. But many other characteristics of housing are also relevant. Its location, the availability and connections to services and opportunities (e.g. education, jobs), the surrounding environment (e.g. green spaces), and the form of a city (e.g. whether it is compact and fosters mixed land-use) all play a role in the sector's wider contribution to well-being and GHG emission reductions. These conditions help in particular to avoid sprawl, car dependence and transport emissions.

Decision-makers often have limited visibility across multiple scales or may pursue their goals in silos. Consequently, inappropriate policies create numerous unintended effects and miss important opportunities to improve quality of life and make ambitious contributions to climate change mitigation. Policies addressing housing affordability are often focused solely on dwellings, overlooking the availability of nearby opportunities and the affordability of other services (e.g. transport, energy, health care). This can perpetuate social segregation while increasing car dependency and transport emissions. At the city scale, densification strategies can overlook implications at the dwelling and neighbourhood level. Some examples are space reductions beyond minimum standards, limitations in water and transport infrastructure, or reductions in green space across the city. This could lead to detrimental impacts to well-being (e.g. health, equity) as well as off-setting any GHG emission reductions from densification.

By better capturing GHG mitigation, health, and equity benefits, a well-being approach can make a stronger case for solutions that align climate and other goals. For instance housing developments that are transit-friendly, and redevelopment projects that modernise and green deprived neighbourhoods, provide educational, leisure and employment facilities, and safer streets.

Developing new indicators to track progress and guide decisions is a key step towards redefining "good sustainable housing". Measuring accessibility from housing to different opportunities and mainstreaming it into decisions is crucial to developing a holistic view of equity and affordability that can unlock synergies between equity and climate goals. Moreover, there is a need to develop indicators that can help measure and monitor urban ecosystem services, as well as tools for eco-positive thinking and design, to support planning of nature-based solutions (NBS).

Policies, including stringent building standards and better schemes for building refurbishment, can encourage a move from marginal improvements to the use of best available practices, avoiding locking-in future emission levels that are incompatible with global climate goals. Equally important are actions at the level of neighbourhoods (e.g. eco-districts) and cities (e.g. land-use regulations and fiscal policies), which can have significant reinforcing effects, both positive and negative, with respect to one another and with respect to dwellings.

Infographic 4.1. Building sustainable dwellings, neighbourhoods and communities

4.1. Introduction

This report argues that a change in perspective – referred to as applying a **well-being lens** to policy making – is central to identifying, assessing and managing the synergies and trade-offs of policy actions, thus achieving a **two-way alignment** between climate and broader well-being objectives. Adopting a well-being lens implies first, that societal goals are defined in terms of well-being outcomes (including the risks and impacts of climate change) and are systematically reflected in decision-making across the economy. Second, it entails that decision-making considers multiple well-being objectives, rather than seeking to resolve a single issue (or a very narrow range of issues). Third, it requires a thorough understanding of the interrelations between the different elements of the system in which a policy intervenes (and thus between sectors in the economy), as well as of the flows and feedback loops within systems. This chapter explains how a well-being lens can be applied to the residential sector. It discusses policy goals that would be coherent with this approach and the type of measurement system (i.e. indicators for tracking progress and setting decision-making criteria) that would support it.

The built environment, i.e. "human-modified places such as homes, schools, workplaces, parks, industrial areas, farms, roads and highways" (Srinivasan, O'Fallon and Dearry, 2003[1]), affects well-being in several ways. On the one hand, it provides significant benefits, allowing human beings to be housed, to work and to carry out all kinds of daily activities. On the other hand, it can generate significant costs, including through pressures on ecosystems and the environment, which in turn jeopardise current and future human well-being. When it is degraded or has poor functional or aesthetic quality, the built environment can also significantly compromise well-being through its effects on physical and mental health, security and safety, etc. Buildings are an important part of the built environment and the residential or housing sector[1], the focus of this chapter, covers 70% of the total land use in cities (UN-Habitat, 2016[2]).

Access to housing has significant implications for well-being; thus, ensuring housing supply and access to housing has become an important policy focus. Nonetheless, housing can promote or hinder the attainment of wider sustainable goals in many other ways.

In 2017, the building sector was responsible for some 28% of global GHG emissions.[2] The residential sector accounted for some 60% of these emissions; the building sectors' main energy demand was related to space and water heating (34% and 19%) and cooking (20%) (IEA, 2018[3]) Energy demand for space cooling is rapidly growing and could triple if no further developments in energy efficiency are made (IEA, 2018[3]). In the residential sector, 35% of GHG emissions were direct, and 65% indirect; by contrast, 74% of emissions from commercial buildings were indirect, owing to electricity use (IEA, 2019[4]).

Housing affordability and stability are related to levels of stress and other mental health conditions (Robinson and Adams, 2008[5]). The quality of housing (i.e. a dwelling's internal and external physical structure), as well as its internal environment (e.g. adequate ventilation, moisture levels, internal air quality), are also key to human physical health and security. For instance, the use of fossil fuels for cooking and heating is linked to premature deaths stemming from poor indoor air quality, child poisoning and severe burns (WHO, 2018[6]). Overcrowding, for its part, is linked to risks of respiratory (and other) infections in children, as well as mental stress (Krieger and Higgins, 2002[7]). Moreover, the low energy efficiency levels of heating technologies could contribute to fuel poverty, i.e. the inability to maintain minimum standards of thermal comfort and safety (WHO, 2007[8]).

According to the Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment report (AR5), energy use and related emissions from buildings could double or even triple by the middle of the century, driven by several different factors (Lucon et al., 2014[9]). Yet significant potential exists to reduce both energy use and emissions, producing substantial benefits in other dimensions of well-being – constrained, however, by strong barriers. Addressing these barriers could improve energy security, affordability and health, in addition to providing workplace productivity and new employment opportunities (Lucon et al., 2014[9]).

The residential sector's impacts on well-being (including climate change mitigation) are even broader when looking beyond building and house's characteristics and the internal services provided. Urban form,[3] as well as access to nearby opportunities (e.g. employment, health and education), neighbourhood characteristics (e.g. the quality of services, public space and infrastructure), and the transport connections between a given dwelling and different areas of a city all have relevant impacts on GHG emissions, health, safety, comfort, equity and overall well-being. For instance, planned housing as part of more compact and mixed land-use development, integrated with high-quality public and non-motorised transport facilities, can avoid sprawl and car dependence, reducing GHG emissions and air pollution, and improving quality of life.

The rest of this chapter is structured as follows: Section 4.2 argues that applying a well-being lens to the residential sector implies shifting towards a comprehensive perspective when defining "good housing". On the one hand, policy priorities should duly consider the multiple impacts on current and future well-being. On the other hand, considering the spatial implications of housing – from the micro and local scale of individual dwellings and homes, to the meso scale of neighbourhoods, the macro scale of cities, the regional scale and the wider ecosystems in which the urban agglomerations are embedded – is also crucial.

Section 4.3 argues that an adequate measurement system to guide policies and track progress is central to a holistic perspective of "good housing". Such a system is key to revealing synergies and trade-offs across policy priorities at different spatial scales. The section discusses a number of limitations of commonly used indicators for policy making. It suggests some potential changes and alternatives, and provides examples of potential use where possible.

Chapter 9 in the second part of the report builds on the current chapter. It discusses a number of policies for decarbonising the sector that could support a two-way alignment between climate change mitigation and broader well-being goals. First, it considers how climate policy interventions can play out in terms of other relevant policy priorities, discussing how policy design and evaluation can increase synergies and minimise/mitigate trade-offs, and exploring the need for additional compensatory action. Second, it highlights how adopting a broader perspective on the sector increases the importance of some policies and actions that might not otherwise be considered relevant.

4.2. Adopting a vision of "good housing" based on multiple priorities and spatial scales

The residential sector has a direct and indirect impact on overall well-being and the Sustainable Development Goals (SDGs), notably those related to public health, safety, security and comfort. Just having access to housing is key to human well-being, yet ensuring universal access to housing is still challenging across countries. Improving access to housing is therefore a widely shared policy priority, even in the richest countries (Salvi Del Pero, Adema and Ferraro, 2014[10]). Population growth and the rapid pace of urbanisation have been driving the continuous expansion of urban areas in developing countries, particularly the construction of residential buildings in cities. This is reflected in the fact that the overall area dedicated to buildings worldwide expanded at an even faster pace than global population between 2010 and 2017[4] (UNEP, 2018[11]). Despite this, 1 out of every 8 people (i.e. around 1 billion) in the world still lives in a slum[5] (UN Habitat, 2015[12]). In the OECD area, the growth of urban land area has not exceeded urban population growth since the early 2000s, a reflection that these countries have already undergone rapid urbanisation. However, the lack of regular access to housing is also a persistent problem across the OECD area, where 1-8 people out of 1 000 lack regular access to housing (Salvi Del Pero, Adema and Ferraro, 2014[10]).

Nonetheless, the importance of housing for well-being goes well beyond simply ensuring access to shelter. Indeed, policy decisions solely based on providing access to a dwelling can miss important opportunities to produce wider benefits, and may even create significant unintended negative effects (often resulting in higher GHG emissions). For example, several OECD countries have established access to affordable housing as one of the main priorities for the sector (Salvi Del Pero, Adema and Ferraro, 2014[10]) However, the policy instruments used (e.g. rental assistance for low-income families) often tend to ignore to what degree different dwellings have access to quality services and opportunities nearby, or at locations within easy reach. They also ignore the cost burden households face if living in different neighbourhoods. Thus, beneficiaries are frequently priced out of areas that offer higher quality of services and opportunities, and are better connected to the rest of the city (Acevedo-Garcia et al., 2016[13]). Also, the cost of housing in certain "lower-opportunity" neighbourhoods can be lower than in "higher-opportunity neighbourhoods", but the spending per family on associated services, e.g. health care, energy and transport, can still be higher (Gan, 2017[14]). Hence, the support provided could ultimately not be helping to household's overall affordability issues. In addition, the higher costs related to transport services, for instance, are often associated with increased car use if the more affordable (in terms of housing costs only) neighbourhoods are in more remote locations and have lower accessibility to goods, services and jobs through sustainable modes (ITF, 2017[15]). As a result, these situations can create important trade-offs between improving access to affordable housing and increasing or perpetuating social segregation, while in many cases also generating higher GHG emissions.

Securing wider current and future benefits from the residential sector, therefore, requires policy makers to define "good housing" in terms of multiple well-being dimensions and priorities. These include contributing to limiting climate change; providing equitable access to opportunities, ensuring a healthy and safe living environment; and enhancing the efficient use and conservation of natural resources and ecosystems.

At the same time, considering the different spatial implications of housing when analysing and implementing policy and investment decisions is key to expanding the sector's role in mitigating climate change and delivering on other priorities listed above. Table 4.1 summarises different impacts of the residential sector on well-being at different spatial scales, including elements from the ecosystem in which urban areas are embedded and highlighting the need for consideration and planning for nature-based solutions (NBS). The concept of NBS captures measures that utilise natural systems to support the delivery of ecosystem services and wider societal benefits (Nesshöver et al., 2016[16]). Ecosystem services are defined as benefits provided by ecosystems to people (Nesshöver et al., 2016[16]). NBS are therefore "green" interventions that seek to use the properties of natural systems to address a set of challenges. As such, NBS can produce multiple ecological, economic, social and urban-planning benefits simultaneously (Cohen-Shacham et al., 2016[17]). NBS can be a complement or alternative to conventional methods of urban planning and development, which mainly deploy purely engineered or "grey infrastructure" (Nesshöver et al., 2016[16]). Ecosystem services and NBS are more present in discussions regarding non-urban territories. Nonetheless, their importance is increasingly acknowledged when addressing management and development of urban areas, as "the future of cities and the future of ecosystem services are inter-dependent" (Ravetz, 2015[18]).

Policy decisions solely based on providing access to a dwelling can miss important opportunities for bringing wider benefits, and even create significant negative effects. Securing wider current and future benefits requires policy makers to define "good housing" in terms of multiple well-being dimensions and priorities, and to consider different spatial implications.

Table 4.1. Well-being impacts from the residential sector across different spatial scales

Dwelling		Neighbourhood/community (including natural ecosystems)	
Characteristics	**Well-being Impacts**	**Characteristics**	**Well-being impacts**
Quality of the physical structure and internal environment, including basic services (electricity, water and sanitation)	• Poverty, equity: ensuring basic facilities (water, electricity, energy) is linked to ensuring minimum conditions for all population, and reducing poverty and inequality between groups. Access to electricity is also linked to education performance, itself key to reducing income and social inequalities. • Health: ensuring access to basic services is also linked to good health (e.g. basic sanitation facilities).	Green space and surfaces.	• Climate change mitigation: green space and surfaces have potential for carbon sequestration and storage, and for altering energy use in buildings (Box 4.1). • They can also encourage walking and cycling, with potential reductions in car trips and related emissions (see Chapters 5 on transport). • Health: green space promotes physical activity, reduces air pollution, noise and the incidence of respiratory diseases; it can also reduce urban heat island effects and thermal stress during periods of high temperatures (climate change adaptation measure). • Other environmental impacts: Reduction of flood risks (climate change adaptation purposes), improved biodiversity.
Sustainable construction materials	• Climate change mitigation: use of less carbon-intensive materials (e.g. cement, steel) or materials (e.g. wood) that store carbon. These could also support decarbonisation of the industry sector, as well as create less demand and hence less need for energy-intensive resource extraction. • Health: less disease caused by hazardous materials.	Brownfield/infill development.	• Natural ecosystem protection: limiting expansion of urban footprint. • Climate change mitigation: avoids sprawl and can lead to less car dependence and reduced GHG emissions from transport.
Type of fuels used inside the dwelling and energy efficiency levels	• Climate change mitigation: increasing use of cleaner fuels reduces GHG emissions. Also, the use of more-efficient technologies (e.g. for cooling) can help offset growing energy demand due to space cooling and other uses, and related emissions. • Health and comfort: clean and efficient provision of services (e.g. cooling, heating), coupled with high-performance building envelopes and enhanced ventilation, allow access to cooling/heating access while reducing heating and cooling demand, thereby improving comfort and indoor air quality. • Safety: cleaner fuels also reduce risk of accidents (e.g. from cooking with gas).	Compact and mixed-use development, especially around major transit hubs.	• Climate change mitigation: avoiding sprawl, long-distance and car-based trips (as opposed to the consequences of single-use development) can be key to reducing emissions, especially from transport. • - It can also put stress on infrastructure and cause dis-benefits (e.g. congestion, water shortages) if not well managed.

Dwelling		Neighbourhood/community (including natural ecosystems)	
Characteristics	**Well-being Impacts**	**Characteristics**	**Well-being impacts**
	• Affordability and equity: more-efficient dwellings and appliances reduce energy demand, and therefore fuel poverty (which, in turn, also reduces physical and mental health risks).		
Optimal space standards	• Health: lower risk of respiratory infections. Optimal living space is also relevant to mental health.	Improved access to key services and opportunities (e.g. education, health, transport, jobs) in the neighbourhood and wider community.	• Poverty, equity: improved access to key services and opportunities (e.g. education facilities, jobs) reduces inequalities. • Health: connection to health facilities is key to improvements in health and management of chronic conditions. • Better life satisfaction. • Climate change mitigation: if linked through quality infrastructure for sustainable transport.
Efficient water use for internal use	• Climate change mitigation: reducing energy use for water provision. • Health: better hygiene. • Climate adaptation: use of collected water for non-consumptive use reduces pressures on centralised water supply.	Water management system with use for energy recovery.	• Climate change mitigation potential: systems that use water for thermal storage (heat and cold) can further reduce GHG emissions.
Waste management in the home	• Material and resource efficiency supports circular approaches. • Health: less disease transmission. • Natural ecosystem protection: reducing food waste and improving management reduces disposal in surrounding areas.	Waste management system with use for energy production.	• Climate change mitigation potential: if the system uses waste for energy production. • Material and resource efficiency supporting circular approaches.
Affordability related to the dwelling	• Poverty, affordability and equity: affordable housing is a key pillar to bridge equity gaps. • Health: ensuring affordable and stable housing is linked to reducing stress and mental health problems.	Affordability beyond the dwelling (i.e. affordability of services, such as transport due to location or lack of affordability in high-quality neighbourhoods).	• Poverty, affordability and equity: costs of services (e.g. food, transport, education) that go beyond those direct costs of housing and internal services (e.g. water, energy, etc.) also have an impact on a household's disposable income. • Health: overall affordability of living, rather than only affordability of the dwelling, have an influence on stress and mental health.
		Neighbourhood quality.	• Equity: the number and quality of (environmental, economic and social) opportunities in a neighbourhood can make an important difference. • Reduced violence and crime: good-quality neighbourhood infrastructure (as opposed to degraded built environments) is associated with reduced violence and crime rates.

Source: Authors, based on (International Energy Agency, 2018[19]); (International Energy Agency, 2019[20]); (OECD, 2018[21]); (WHO, 2018[6]) .

The need to adopt this more holistic approach (i.e. one that systematically considers multiple well-being priorities and spatial scales) has been put forward in academic discussions, which highlight that "housing is a bundled good: it includes the housing unit but also the amenities associated with its location" (Acevedo-Garcia et al., 2016[13]). This is consistent with (Chapman, Preval and Howden-Chapman, 2017[22]), which highlights that "rather than seeing housing policy options as focused only on optimizing household welfare for a given time and place, it is more helpful to view housing policies as part of a set of government choices regarding outcomes from the urban built and social environment, with both short and longer term consequences for such outcomes". The World Resources Institute also emphasises that adopting a broader approach to housing policies can help address relevant challenges when aiming to provide adequate, secure and affordable urban housing; this is especially true in developing countries, where informal housing (such as slums) is a common feature in cities (King et al., 2017[23]). With this vision, governments could prioritise upgrading slums and promoting rental housing rather than pursue radical relocation measures that generally move people to areas outside the city without adequate infrastructure and services delivery, social networks and employment opportunities (King et al., 2017[23]).

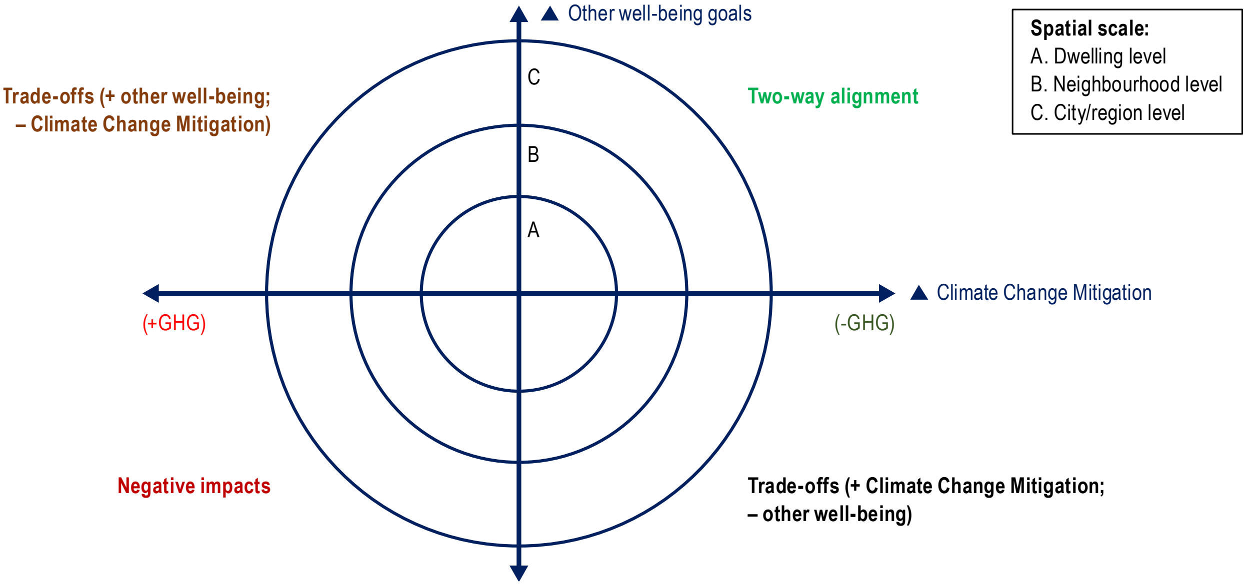
Along the same lines, the OECD is developing a housing strategy across different parts of the Organisation, which will be delivered by the end of 2020. A key objective of this project is to evaluate policies and objectives across policy dimensions, to support whole-of-government and holistic policy approaches.

Work carried out by the World Health Organization (WHO) also adopts this approach. It defines healthy housing as drawing on four interlinked levels: i) the feeling of *home*, and provision of a place that is a protective, safe and intimate refuge where people can develops a sense of identity and attachment; ii) the adequacy of the physical structure and the dwelling in ensuring physical health, security and comfort; iii) the presence of a community, and the quality of the neighbourhood and its relation to social interaction, sense of trust and collective efficacy; and iv) the nature of the immediate housing environment, such as the quality of urban design, including green spaces, services and public transport choices (WHO, 2018[6]).

In 2016, the United Nations adopted the New Urban Agenda (NUA), which outlines that cities and human settlements should be the places where all inhabitants enjoy equal rights and opportunities in just, healthy, affordable and sustainable areas (United Nations, 2017[24]). According to the NUA, adequate housing is embedded in broader considerations, which include: i) ensuring adequate social functions and standard of living that ensure access to basic services such as drinkable water, public goods, and quality services for food and security; ii) fostering inclusiveness and gender equality; iii) promoting civic engagement; iv) leveraging urbanisation to support the transition to a sustainable and formal economy; v) fostering territorial integration and development; vi) enhancing efficient and sustainable urban mobility, as well as improving accessibility; and (vii) protecting ecosystems and natural habitat, and promoting sustainable consumption and production*"* (United Nations, 2017[24]).

Figure 4.1 offers a framework for understanding different potential policy outcomes in the context of this more holistic perspective and depending on the changes created in terms of climate change mitigation (x-axis) and other well-being objectives (y-axis). It also captures the interdependencies or reciprocal relations between the three scales of the residential sector (dwelling, neighbourhood, and the wider city and regional community[6]).It builds on previous work done by (Turcu, 2010[25]), (Turcu, 2012[26]) and (Brandon and Lombardi, 2005[27]), looking at the relationships between the various scales of the built environment and complex concepts such as sustainability and develops these ideas.

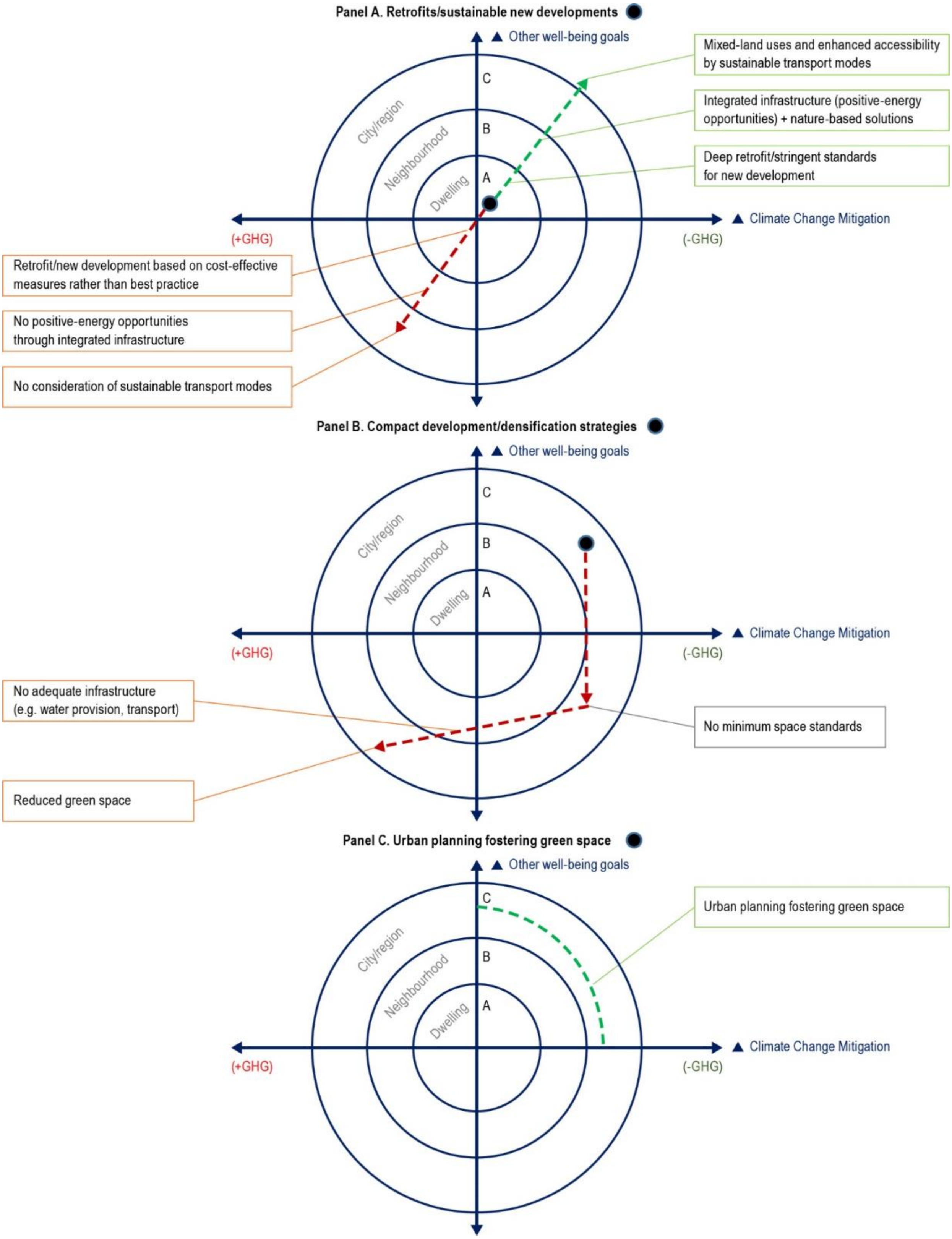
Figure 4.1. Comprehensive view of synergies and trade-offs in the residential sector



Policy outcomes in the upper-right quadrant of Figure 4.1 would fall into the so-called **two-way alignment** (i.e. the ideal situation where synergies between climate and well-being goal are achieved), while policy outcomes in the bottom-left quadrant would be detrimental to both climate change mitigation and other policy goals. Policies with outcomes falling in the upper left-hand and bottom right-hand quadrants would present trade-offs between climate goals and wider well-being. The upper left-hand quadrant shows benefits in terms of other policy priorities that are detrimental to climate, while the bottom right-hand quadrant creates the opposite effect. Changes in climate change mitigation are indicated in terms of increases (left-hand quadrants) or reductions (right-hand quadrants) in GHG emissions. Different points of reference could be set to divide left and right quadrants (e.g. current emissions, a baseline scenario, etc.). The different circles (A, B, C) represent different spatial scales in which policies can intervene.

Figure 4.2 illustrates, by using some policy examples, the complexity of combined climate and other well-being outcomes across spatial scales, and emphasises the need for this broader perspective to achieve better outcomes. These and other policies are discussed in more detail in Chapter 9, in the second part of this report.

Figure 4.2. Different policy outcomes for different set of actions



Panel A shows the example of retrofits and new housing developments that aim to be sustainable (e.g. using low-carbon materials and being built along design principles that foster energy efficiency). In principle, these retrofits and new developments would bring both climate and other benefits (e.g. health, reduction in fuel poverty) at the scale of the dwellings involved. Nevertheless, the wider impacts (depending on a number of considerations at different scales) could end up being incrementally positive (both in terms of climate change mitigation and other benefits), creating different trade-offs between them, or they could also even be detrimental, in terms of both climate and other priorities in the longer-run.

For example, whether these are deep retrofits and developments with ambitious targets (based on best practice, rather than only considering the most cost-effective set of measures) will make an important difference overtime in avoiding infrastructure lock-in to energy and emission levels that are far higher than those needed to meet global climate goals (Urge-Vosatz et al., 2013[28]). In addition, whether these projects are planned as part of integrated infrastructure systems and design that enables energy-positive development can also help determine the GHG emission reductions and wider benefits. The term energy-positive refers to buildings that produce more energy from renewable sources than what they consume, while maintaining adequate comfort levels. The definition can englobe however different cases. For instance, those where construction is also taken into account (zero-energy foot-print buildings), or those where all energy loads are included (all energy positive buildings) (Global Buildings Performance Network, 2013[29]). Finally, the location, the availability of different activities and services nearby (i.e. whether housing is developed under mixed land-use principles), and the connections to the wider city through sustainable modes can make an important difference in the transport-related costs borne by dwellers, the wider transport-related GHG and other pollutant emissions, and whether health and social exclusion issues are created. **Panel A** shows two opposite and extreme potential paths, but different combinations of the elements addressed could play a role in creating other scenarios that would fall in either of the two trade-off quadrants

Panel B shows the example of densification strategies, which are targeted at the city level and thus have potential impacts at this scale. As shown by the figure, these strategies can have an important potential to reduce GHG emissions as well as to bring other benefits. For instance, several urban services – e.g. public transport – are more feasible to provide if minimum densities are created (Aguilar Jaber and Glocker, 2015[30]). Less sprawl can also bring less pollution and more health benefits. Nonetheless, without taking into account minimum living-space standards, many dwellers could suffer from overcrowding as the city densifies, harming their well-being by reducing their physical and mental health. Overcrowding is associated with risks of respiratory (and other) infections in children and mental stress in adults (Krieger and Higgins, 2002[31]). All of this would bring potential outcomes towards the lower right-hand quadrant, by creating a trade-off between climate and health outcomes.

In addition, without considering criteria on the necessary infrastructure (e.g. water, transport) required to sustain such densities, or the need to integrate nature-based solutions (e.g. ensure green space), as discussed above, climate change mitigation and other benefits could also be reduced, taking policy outcomes towards the bottom left-hand quadrant. For instance, densifying areas with low water availability can increase the energy (and related GHG emissions) needed to ensure the water supply, increasing water stress. Densifying areas without sufficient levels of transport accessibility, particularly through sustainable transport modes, can increase congestion (especially in adjacent neighbourhoods), increasing GHG emissions and pollution, and reducing life quality. Likewise, densification policies that do not ensure minimum green space in urban areas can be a missed opportunity for contributing to climate change mitigation and resilience-by reducing urban heat islands- through nature-based negative-emission approaches (see Box 4.3). This could also reduce the physical and mental health of inhabitants, since the availability of accessible green spaces[7] in neighbourhoods is associated, for instance, with improved mental and physical health (e.g. reduced anxiety and depression, and increased physical activity) (Wentworth and Clarke, 2016[32]); (Power et al., 2009[33]).

Finally, **Panel C** shows the example of urban green space strategies, showing that these could expand the potential for achieving both climate and other policy related objectives. As shown and discussed in Box 4.1, studies estimating the potential carbon sequestration capacity of urban green space have found the potential reduction in carbon emissions to be relatively small when compared to fossil-fuel related emissions in cities. However, a number of studies have found net reductions in emissions from the development of urban green space (especially when adequately designed), and some have estimated positive related economic value. Several other studies show that these strategies can have a number of other potential benefits in terms of storm-water management and surface temperature moderation (Rogers, Jaluzot and Neilan, 2012[34]), as well as improved mental and physical health (Wentworth and Clarke, 2016[32]); (Power et al., 2009[33]). Thus, these strategies can support governments in delivering multiple well-being goals, in addition to contributing (even moderately) to climate change mitigation (as shown in **Panel C**).

Table 4.2 presents a number of two-way alignment opportunities, including but also going beyond those depicted in Figure 4.2, discussed above. An important consideration is that approaches focused on part of the diagram above (i.e. only at some spatial scales and a restricted number of well-being priorities) will not only ignore a number of synergies and trade-offs, but will also overlook the ways in which different stakeholders and authorities would need to co-ordinate in order to overcome governance challenges. This is particularly relevant as different infrastructure and policies are managed by different levels of government and/or ministries and departments, increasing the incidence of uncoordinated policies and policy outcomes. Level A (dwelling or building) in Figure 4.1 and Figure 4.2, for instance, is generally addressed by architects, designers, developers, building contractors and clients of individual structures, as well as housing ministries and authorities. Level B (neighbourhood) would involve actors in Level A, as well as decision-making authorities in charge of planning, ministries and authorities in charge of different policies and infrastructure at the local government level, and in some cases, some entities from the national government. Level C (city/region) involves all of Levels A and B actors, plus the wider civil society.

A number of governance arrangements and instruments, e.g. national urban policies (OECD, 2017[35]) and metropolitan transport authorities (ITF, 2017[15]), have been recognised for their value in helping authorities overcome such challenges. While the governance of the residential sector is outside the scope of this chapter, the development of a shared vision across relevant actors on the need to define "good housing" in terms of the wider perspective proposed will help move the process forward. Moreover, the use of indicators like those discussed in the next section can help establish shared goals and criteria for decision-making across different ministries, authorities and government levels, and articulate actions towards ensuring "good housing" within this wider perspective.

The use of better indicators can help establish shared goals and criteria for decision-making across different ministries, authorities and levels of governments, and articulate actions towards ensuring "good housing" in terms of this wider perspective.

Box 4.1. Urban green space and climate change mitigation

Nature-based negative emissions from carbon sequestration and storage potential in trees

Green space areas, particularly trees, have the potential to sequester carbon. Nevertheless, trees in urban areas pose different challenges than those situated in non-urban areas. Urban green areas entail important costs and emissions, linked to their construction and maintenance. Like trees in non-urban areas, they also pose challenges in terms of mortality rates as dead trees decompose, releasing GHGs. For these reasons, conducting careful and comprehensive life-cycle assessment is key to assessing the climate change mitigation potential of urban green areas. The city of Leipzig in Germany has conducted such an analysis, illustrating the importance of considering the carbon footprint of construction and maintenance (Strohbach, Arnold and Haase, 2012[36]). In construction, the delivery of trees and excavation for planting these were found to have the largest carbon dioxide (CO_2) emission contribution (Strohbach, Arnold and Haase, 2012[36]). The analysis also highlights the relevance of developing reliable methodologies to estimate tree growth and mortality when predicting potential GHG emission reductions. Overall, with high tree mortality rates, emissions from construction and maintenance make a relevant share of total positive emissions that must be accounted for when looking at the net impact of urban green space on GHG emissions. These tend to weight more in the case of parks, which have a lower total sequestration potential than other green space populated more densely with trees (Strohbach, Arnold and Haase, 2012[36]).

Green space design (including diversity of tree population, and the share and distribution of open space relative to tree-covered space) has proven important for increasing the potential of carbon sequestration (Strohbach, Arnold and Haase, 2012[36]) (Hutchings, Lawrence and Brunt, 2012[37]) (Nero et al., 2017[38]). The next section discusses some of the most important indicators related to urban tree coverage. There is also potential for below-ground carbon storage, i.e. carbon storage in soil and root biomass, but not many studies have estimated this potential, due to lack of available data. A study in Ghana quantified the carbon pool from urban green space in the city of Kumasi (3 758 Gigagrams of carbon stored below and above ground). The study found that soil, roots and above-ground vegetation contributed respectively to 42%, 6% and 52% of carbon storage (Nero et al., 2017[38]).

Studies show that the potential reduction in carbon emissions from carbon sequestration and storage of green urban areas is relatively small when compared to fossil-fuel related emissions in cities. Nonetheless, several of these studies conclude that these strategies contribute to carbon neutrality, with several other positive benefits. One of the main conclusions of the study conducted in Leipzig (Strohbach, Arnold and Haase, 2012[36]) highlights the potential opportunity derived from greening brownfield sites although it also underlines the strong competition for redeveloping urban land for industrial, residential, and commercial uses. The study in Ghana also emphasises the need to account for the contribution of urban green spaces through carbon sequestration in national and regional estimates of carbon stocks (Nero et al., 2017[38]). Other studies have also estimated and monetised benefits from urban green space in terms of CO_2 sequestration and storage. Estimations in a report developed for a Business Improvement District project in London (United Kingdom) find that trees in Victoria remove 1.2 tonnes of pollutants, store 847.08 tonnes and sequester 18.35 tonnes of CO_2 per year (Victoria Business Improvement District, 2015[39]). The report estimates annual pollution-removal benefits at 85 149 GBP (pounds sterling), estimating the value of the carbon storage at almost 44 895 GBP and the value of carbon drawdown at 972.55 GBP yearly.

Source: based on (Strohbach, Arnold and Haase, 2012[36]); (Hutchings, Lawrence and Brunt, 2012[37]); (Nero et al., 2017[38]); (Victoria Business Improvement District, 2015[39]).

Table 4.2. Potential two-way alignment benefits from applying the well-being lens to the residential sector

Other policy priority	Contributing to limiting climate change	
	Generating synergies	Avoiding/reducing trade-offs
Offering affordable housing and contributing to more equitable access to opportunities and services.	Governments can reduce fuel poverty and the day-to-day cost of living for vulnerable groups by promoting efficient energy and water use in housing. This also has important benefits for climate (and health). Increasing infrastructure integration across buildings, energy and transport systems can reduce the cost of living, as well as the cost of maintaining the infrastructure – and in some cases, of developing housing. This can also lead to more-efficient and less carbon-intensive (sometimes zero or negative-carbon) housing, as well as less carbon-intensive behaviour (e.g. when housing is linked to quality public transport). Going for a broader view of equity (beyond socio-economic characteristics strongly focused on incomes) can highlight the relevance of unequal access to environmental and other opportunities (e.g. access of housing to green spaces). This can bring attention to the relevance of developing greenspace requirements for housing projects (especially those which have very limited access) while also resulting in GHG emission reductions.	Placing stricter climate-related regulations for the development of buildings and surrounding infrastructure can affect overall housing prices, making them less affordable for lower-income groups. Nonetheless, monitoring the changes in affordability of housing across income groups, and taking into account neighbourhood quality and services (e.g. sustainable transport connections or energy efficiency of buildings), can help identify the need for complementary policies/compensation. It can also help design policies, programmes and projects that can better reconcile climate change mitigation and equity benefits.
Promoting the efficient use and conservation of natural resources and ecosystems.	Protecting forest and biodiversity is an important incentive for brownfield development and implementing planning regulations to limit urban sprawl. It can also lead to relevant reductions in GHG emissions (through carbon sequestration from trees, avoided emissions from land-use change, etc.).	Monitoring green space availability can help prevent the reduction of green space ratios as a consequence of densification and infill strategies to mitigate climate change.
Ensuring a healthy and safe living environment.	Estimating the health benefits of energy-efficient programmes (e.g. retrofit, new buildings, eco-districts and eco-cities) can importantly reduce payback time and improve projects' cost-benefit ratio). In many cases tipping the balance towards more sustainable development. The increase of green and blue spaces in neighbourhoods and cities has an important health rationale; while also having potential to reduce CO_2 emissions (i.e. lower air temperatures and more less ground-level ozone, with more trees and plants to clean the air and provide oxygen). More stringent standards for cooling and heating, and the increasing deployment for renewables, foster the diffusion of more-efficient and clean appliances, bringing benefits in terms of air quality, comfort and health, while reducing energy demand and GHG emissions. Sustainable building design (improved natural ventilation, orientation, day light, etc.) can provide health benefits by bringing thermal comfort and reducing respiratory diseases that could arise from mould or particulate matter, while reducing energy needs and hence GHG emissions (World Health Organization, 2011[40]).	Enhanced insulation and thermal efficiency of dwelling envelopes and use of health-damaging insulation materials can lead to inadequate ventilation, reducing indoor air quality and causing respiratory diseases or cancer. Accounting for potential health risks, can lead to using construction materials and technologies that can prevent health damages while improving inhabitants' internal comfort and reducing emissions (World Health Organization, 2011[40]). Densification policies lead to more compact urban areas, with smaller units. Reduced habitable surface can lead to overcrowding and negatively affect mental health. Monitoring and regulating minimum adequate standards for given characteristics (number of inhabitants per square metre, living space) can avoid negative health impacts, while improving comfort and mental health. More stringent standards for cooling or heating can lead to affordability issues for low-income households in the short term if appliances become more expensive. Tackling affordability by allowing multiple actors and technologies in these appliance markets promotes innovation and competition, and therefore lower prices for appliances. Natural ventilation without air filtration (e.g. windows and doors with screens) can increase exposure to outdoor air pollution and vector-borne illnesses (World Health Organization, 2011[40]). Taking actions to reduce external air pollution, and promoting the use of household filters, can help avoid these negative impacts while improving public health.

Note: This table builds on work cited throughout the chapter as well as some additional sources. Where the latter is the case, these are indicated in the table.

4.3. Indicators for monitoring the residential sector's contribution to well-being

As stated in Chapter 1, a change in the measurement system is key to implementing a shift in perspective for policy making. Important efforts have been made to develop indicators sets that can support sustainable development. The SDGs and the OECD Framework for Measuring Well-being and Progress (henceforth the OECD well-being framework) incorporate a number of indicators, used throughout this report as references. Winston and Eastaway (2008[41]) explore a number of international indicator sets, analysing in particular to what extent they incorporate indicators for sustainable housing and pointing out that many challenges remain. First, housing, and its related indicators, are often still absent or barely addressed in overall sustainability measurement efforts. Second, housing-related indicators are often biased towards one of the pillars of sustainability (economic, social and environmental), while failing to capture the range of aspects that are key to other pillars, hence a general need for more comprehensive sets of indicators. Third, it is difficult to choose indicators sets reflecting the multiple aspects of housing, e.g. location, design and use. Moreover, as the highlighted indicators also need to gain political commitment to be influential (Winston and Eastaway, 2008[41]), developing these tools needs to strike a balance between multiple characteristics, including scientific validity, reliability, guiding vision, holistic perspective and relevance. They also should be easy to understand and have a practical focus.

This section discusses a number of indicators that can both improve policy makers' ability to monitor progress in applying a well-being lens to the residential sector and guide decisions to capture the benefits of two-way alignment between climate and wider well-being priorities, while managing potential trade-offs. The section is structured according to the different priorities identified in Section 4.2 as key to promoting wider well-being goals in the sector, as follows: limiting climate change; offering affordable and good-quality housing, and contributing to more equitable access to opportunities and services; ensuring healthy and safe environments; and fostering efficient use and conservation of natural resources and ecosystems. Systematically looking at indicators that reflect simultaneously outcomes related to different well-being objectives is necessary to identify and manage potential synergies and trade-offs. In other words, it is key to achieving a two-way alignment between climate change mitigation and other well-being policy priorities. Examples of how the type of indicators discussed can be – and have been – used to achieve greater two-way alignment are provided where these are known and available. Table 4.3 summarises the relation between the different policy priorities, the SDG goals and targets, and the domains and dimensions in the OECD well-being framework. Summary tables showing the indicators proposed for tracking progress and setting criteria towards each of the priorities are provided in each subsection. They also summarise the links between the indicators proposed and those already offered by the SDGs and the OECD well-being framework.

Table 4.3. Policy priorities for the residential sector and their link to the SDGs and the OECD well-being framework

Other policy priorities	SDG goal and target	OECD Well-being domain	OECD Well-being dimension
Limiting climate change	13. Climate action.	Future well-being: resources.	Natural capital.
	11.6. By 2030, reduce the adverse per capita environmental impact of cities.		
Offering affordable and good-quality housing, and contributing to more equitable access to opportunities	1.2. By 2030, reduce at least by half the proportion of men, women and children living in poverty.	Current well-being: material conditions.	Income and wealth.
	1.4. By 2030, ensure that all men and women have equal rights to economic resources.		
	3.8. Achieve universal health coverage.		Jobs and earnings.
	4.2. By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education.		

Other policy priorities	SDG goal and target	OECD Well-being domain	OECD Well-being dimension
	7.1. By 2030, ensure universal access to affordable, reliable and modern energy services.		Housing.
	10.2. By 2030, empower and promote the social, economic and political inclusion of all.	Current well-being: quality of life.	Work balance.
			Health status.
			Education and skills.
			Social connections.
	11.1. By 2030 eradicate extreme poverty for all people.	Future well-being: resources.	Human capital.
	11.2. By 2030 provide access to safe, affordable, accessible and sustainable transport systems for all.		
	11.7. By 2030, provide universal access to safe, inclusive and accessible, green and public spaces.		Social capital.
			Economic capital.
Ensuring a healthy and safe living environment	1.4. By 2030, ensure that all men and women have equal rights to economic resources.	Current well-being: material conditions.	Housing.
	3.4. By 2030, reduce by one third premature mortality from non-communicable diseases and promote mental health and well-being.		
	3.9. By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.	Current well-being: quality of life.	Health status. Personal security.
	6.1. By 2030, achieve universal and equitable access to safe and affordable drinking water for all.		
	6.2. By 2030, achieve access to adequate and equitable sanitation and hygiene for all.		
	6.3. By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater.	Future well-being: resources.	Social capital.
Promoting the efficient use and conservation of natural resources and ecosystems	6.4. By 2030, substantially increase water-use efficiency across all sectors.	Current well-being: quality of life.	Environmental quality.
	11.3. By 2030, enhance inclusive and sustainable urbanisation.		
	11.6. By 2030, reduce the adverse per capita environmental impact of cities.		
	12.5. By 2030, substantially reduce waste generation		
	15.1. By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystem.	Future well-being: resources.	Natural capital.
	15.5. Take urgent and significant action to reduce the degradation of natural habitats.		

The indicators included in this section are not exhaustive. Rather, the analysis is suggestive and intended to stimulate further discussion while highlighting data limitations and potential data enhancements, as well as illustrating good practice where improved indicators are already proving valuable. The entire section mentions indicators focusing on the dwelling, but as these tend to already be widely used, the discussion focuses on indicators relating to the neighbourhood and wider city level, and those that provide information on different elements of ecosystems. The analysis in this section emphasises that taking a more comprehensive view expands the alignment between the sector and wider goals. For instance, only by taking a holistic view of equity and affordability (e.g. including physical access to health services) does the link with SDG Target 3.8 (coverage of essential health services) become evident. Transport and energy-related indicators can play a central role in determining what is "good housing" and monitoring progress in the sector. While these indicators are mentioned in this section, more detailed analysis on these tools can be found in Chapter 5 (transport-related indicators) and Chapter 2 (indicators for monitoring energy poverty).

4.3.1. Limiting climate change

Indicators for monitoring GHG emissions in the residential sector provide information of the sector's contribution to SDG 13, "take urgent action to combat climate change and its impacts" (the SDG framework does not have a specific indicator or target on GHG emissions). These indicators also help track and understand performance in relation to SDG 11 ("Make cities and human settlements inclusive, safe, resilient and sustainable"). Information is important to track specifically the sector's contribution to SDG Target 11.6, which calls for reducing the adverse per capita environmental impact of cities (again, without any indicator reflecting GHG emissions). In terms of the OECD well-being framework, indicators for understanding and tracking GHG emissions from the residential sector are also linked to the "resources for future well-being" domain and the "natural capital" dimension of well-being. GHG indicators for the residential sector would provide sector-specific data to complement the economy-wide indicators used by this framework[8]. The rest of this subsection describes data limitations and recommendations regarding the type of GHG emission indicators that would be important for the sector (summarised in Table 4.4).

GHG emissions coming directly from buildings and dwellings are relatively well understood. They comprise both direct (i.e. burning gas/oil for heating) and indirect emissions (i.e. from electricity consumption). However, one challenge is that GHG emissions related to the residential sector are amalgamated in many statistical sets with those from the commercial and service sector. Even when residential GHG emissions are shown separately from other emissions, the indicators used suffer from a number of limitations.

First, statistics on "carbon [dioxide] emissions in tonnes per household", a widely used measure for decision-making in the climate change arena, are typically only available at a national scale, and using simple averages. Hence, there is limited understanding of GHG emissions from the residential sector at the neighbourhood and city levels, or across territories. This may inhibit well-targeted, cost-effective action. Second, even where available, such data are not always disaggregated according to households' characteristics, such as household type, housing tenure and dwelling type. Many countries carry out income-expenditure surveys that track household expenditures over time, and could provide some insights on their behaviour and carbon footprint. However, few countries make disaggregated data easily available and public; and some countries have expenditure divisions that are not adequate for estimating carbon-related emissions. For instance, transport-related expenses from households do not always cover all modes of transport (ITF-OECD, 2017[42]).

Household energy consumption has shown a significant and positive link to income (Hargreaves et al., 2013[43])). Nonetheless, significant correlations between GHG emission levels and socio-economic characteristics beyond income – such as household size and location, housing tenure, the number of workers per household, employment status, socio-economic group and age – have also been found relevant (Hargreaves et al., 2013[43])). The study carried out by (Hargreaves et al., 2013[43]) not only focused on CO_2 emissions from energy consumption in homes, but also analysed differences in emissions from transport (private cars, public transport and international aviation). Overall, the study concluded that household characteristics such as the number of bedrooms, the number of occupants and the property type were more relevant for determining energy use in the home. By contrast, transport-related emissions are highly dependent on variables such as income, location, and the number of workers in the household. On average, emissions were the highest for households in villages, hamlets and isolated locations, and the lowest for households in urban environments (Hargreaves et al., 2013[43]).

This type of results confirms that having data on household characteristics and emissions could help policy makers better identify carbon-intensive population sectors, and target policies accordingly e.g. guiding retrofit programmes toward specific areas and targeting the most carbon-intensive type of dwellings, or improving the design of demand-management strategies by adjusting them to the specific behavioural trends identified. It also emphasises the relevance of land-use policy decisions, which play an important role in the type of development and dwelling choices, as well as the location of housing, and therefore the impact on transport-related emissions. In the same lines it also highlight the importance of incorporating criteria related to transport accessibility – particularly sustainable transport modes – to definitions of “good housing”, and systematically linking transport emissions to the residential sector and land-use policies rather than treating them in isolation (see Chapter 5 on transport).

Another important point would be to distinguish between the impact and relevance of different GHGs. For instance, pollutants affecting human health such as black carbon and methane are emitted when using solid fuels, such as wood or biomass for cooking, heating or lighting purposes. An estimated 25% of total black carbon emissions come from households burning solid fuels and 1-3 tonnes of CO_2eq per stove could be saved every year if replaced by clean and efficient stoves (Usaid, 2017[44]). Keeping track of the extent of the deployment of clean and efficient stoves is important for both climate change mitigation and health, and for actions to address both goals simultaneously.

Table 4.4. Summary table: Indicators for monitoring progress in limiting climate change and links to SDGs and OECD well-being framework

Policy priority	Proposed indicators	SDG goal and target	SDG indicators	OECD Well-being dimension/domain	OECD well-being indicators
Limiting climate change	GHG emissions : Total and disaggregated by household and individual characteristic (e.g. type, tenure, dwelling type, income), including emissions from energy production and use beyond the dwelling, differentiated between gases (e.g. CO_2, methane, black carbon).	13.	The framework does not provide a data-specific indicator on GHG emissions.	Future-well-being: resources. Natural capital.	GHG emissions from domestic production. CO2 emissions from domestic consumption.
		11.6.	No indicators that are related to GHG emissions are used, but the target calls for reducing the overall environmental impacts of cities.		

4.3.2. Offering affordable housing and contributing to more equitable access to opportunities and services

Ensuring access to good-quality and affordable housing links to well-being in multiple ways (e.g. poverty, physical and mental health). Housing costs tend to account for the largest share of household expenditures (Guerra and Kirschen, 2016[45]); (ITF-OECD, 2017[42]). Thus, housing affordability has an impact on a number of SDG targets (summarised in Table 4.6) related to poverty (SDG 1) and the reduction of inequality (SDG 10). Sustainable cities (SDG 11) uses the proportion of population living in slums, which is also related to the affordability of formal housing services. The OECD well-being framework specifically tracks housing affordability. In addition, housing affordability is also related to household income, another indicator used by the framework.

Box 4.2 provides some examples of different indicators that can be used to measure housing affordability.The examples provided highlight the need to consider costs beyond those directly linked to housing (i.e. rent and mortgage costs). For instance, the U.S. Department of Housing and Urban Development (HUD) includes in its analysis interest on mortgage payments, property taxes and utility costs (electricity, water, gas and sewer). Chapter 2 presents related measures to track energy poverty, which can also complement analysis on affordability. The OECD Affordable Housing Database includes the share of households experiencing difficulties in keeping the dwelling warm at different points of the income distribution (OECD, 2019[46]).

Taking into account other costs, for instance transport, is also relevant, as households often face important trade-offs between housing quality and improved transport conditions. Chapter 5 fully develops this discussion, also describing in detail the use of an indicator, the Housing plus Transport (H+T®) Affordability Index. Nonetheless, this indicator is also relevant for policy decisions regarding the residential sector, as transport expenses are importantly linked to housing location and often constitute the second-largest expenditure for households (ITF-OECD, 2017[42]). As shown in Chapter 5, there exists evidence that households living in more affordable neighbourhoods (in terms of both housing and transport) also tend to have lower car-related emissions as they generally have better public transport connections, offering a more sustainable and less expensive way for travel. Thus, capturing transport costs and other costs (such as utility charges) provides a more comprehensive picture of the affordability of different housing options and can support decision-makers in achieving two-way alignment between climate and equity goals.

Another important point is the need to account for wealth. The relative and absolute situation of different households can vary significantly when including housing wealth in income calculation (see (Forrest, 2013) and (Hamnett, 1991)).The housing tenure of different groups implies important divides between owners and renters, and outright and mortgage owners. These contribute to a growing polarisation of society (Forrest, 2013) and need to be taken into account when analysing affordability. Housing wealth is not easy to measure. Different methods and data (usually information on house prices and housing stock) can be used, and the size of housing wealth varies significantly across information sets and methods (Berge, 2006[47]). For example, methods can be based on: a) total housing stock (measured in square metres); or b) the value of housing capital in fixed prices, as calculated in the national accounts on the basis of cumulated gross investment in housing (Berge, 2006[47]).[9]

Box 4.2. Housing affordability indicators

Housing costs as proportion of income or expenditure

Affordable housing is measured as the "ratio between average house price and average household income": the higher the ratio, the less affordable the housing. A common threshold used is the 30/40 rule, i.e. a household is considered to lack affordable housing if it is in the bottom 40% of income distribution and spends more the 30% of its income on housing (Yates and Milligan, 2007[48]).

In many cases, a simple percentage of income spent on total housing costs is used for the income-cost indicator, regardless of the level of household income. In the OECD Affordable Housing Database, for example, the cost of housing includes mortgage (i.e. principal and interest repayments) and rent costs (i.e. private and market-subsidised rent) (OECD, 2019[49]). The OECD also uses the percentage of housing costs from total household expenditure. Other countries also use this indicator. For instance, HUD includes interest on mortgage payment, property taxes and utilities (electricity, water, gas, and sewer) when calculating housing costs, providing a more comprehensive picture of housing affordability. HUD applies two thresholds: 30% and 50% of income to identify households with a housing cost burden and with a severe housing cost burden respectively (Jewkes and Delgadillo, 2009[50]).

These indicators are easy to compute (since data are relatively available) and understand. The data can also be easily estimated at different territorial scales, contributing to spatial analysis and allowing comparisons over time (Jewkes and Delgadillo, 2009[50]) . Nonetheless, the indicator does not account for differences in living costs across different housing markets or in housing quality (size, location, etc.). Also, the ratio is often used as reflecting household's ability to pay, while many factors (including wealth) are not captured. It is also based on present income, while permanent income (i.e. income over time) is more relevant (Jewkes and Delgadillo, 2009[50]) . Finally, being based on average prices, it can misrepresent the situation for new entrants, as there is usually a gap between rents for new and long-term tenants.

The Housing Wage measure

This indicator was developed by the National Low Income Housing Coalition, an advocacy group focusing on affordability issues in the United Sates. It uses the fair market rent (FMR) as a base. The FMR is an estimate of what the net rent (base rent plus essential utilities, such as electricity and gas) of a dwelling with a specific size and in a specific neighbourhood costs.[10] The housing wage measure is then calculated, providing the hourly full-time wage a household would need to earn in order to afford a dwelling of a certain type without exceeding the 30% income threshold (Jewkes and Delgadillo, 2009[50]) .

The housing wage indicator discussed above can be used to analyse the situation of both renters and owners. Nonetheless, the Housing Wage measure provides specific insights on the situation of renters (Jewkes and Delgadillo, 2009[50]) , who generally include a higher proportions of low-income dwellers than owners. Another important advantage is that by using the FMR estimate, the indicator encompasses differences in wages and housing costs in different areas and for diverse housing types, instead of using simple averages (Jewkes and Delgadillo, 2009[50])

The ability-to-repay rule

This indicator was developed and is strongly used by the National Association of Realtors in the United States. It measures whether a typical family, i.e. a family earning the median gross family income reported by the U.S. Bureau of the Census, would be able to qualify for a mortgage loan on a typical home, i.e. a single-family home with the median-price calculated by the National Association of Realtors. The index is expressed as a percentage of the assets the family should have in order to qualify for the mortgage. Therefore, it provides information on the extent to which a household is under- or over-qualified, rather than using a binary measure (Jewkes and Delgadillo, 2009[50]) . This indicator is relatively easy to compute, providing median housing prices and incomes are available. It can therefore be easily calculated at both the national and local levels. It also considers mortgage interest rates, which are not usually included in the price-income ratio (Jewkes and Delgadillo, 2009[50]) .

Source: based on (Jewkes and Delgadillo, 2009[50]) .

Beyond housing affordability, the sector can also improve equity and wider well-being by promoting more equitable access to opportunities, ensuring that housing offers quality services and opportunities nearby, and is well connected to the wider community. Land-use and housing decisions are key to creating proximity to opportunities and transport services, and hence need to be at the centre of priorities. In line with this, the indicators proposed in this chapter also focus on the accessibility of housing to jobs and services. This, in turn, is linked to a number of other goals and indicators in the SDG and OECD well-being frameworks that track unemployment, access to health and education, educational attainment, and access to public and green spaces. Having accessible opportunities nearby can also reduce commuting times, which is linked to other goals monitored by the OECD-well-being framework (e.g. time off, under "work and life balance" in the well-being domain). Chapter 5 on transport provides detailed analysis on transport accessibility indicators and their use in linking housing and transport decisions, to reduce transport-related GHG emissions. However, as with the H+T® Affordability Index, these indicators should be used to define housing quality, particularly to evaluate and design social and/or affordable housing programmes (ITF-OECD, 2017[42]).

In addition, the Childhood Opportunity Index (COI), also proposed for this policy priority, aims to track neighbourhood quality and can therefore be used to discuss equity (and the role of housing) in terms that go beyond income inequality. The COI is a newly developed measure and a powerful policy tool created by Diversitydatakids.org and the Kirwan Institute for the Study of Race and Ethnicity at the Ohio State University. Its aim is to address residential inequalities in US metropolitan areas by measuring whether children have an equal chance to achieve healthy development groups (Acevedo-Garcia et al., 2016[51]) .

The COI incorporates 19 individual indicators grouped under 3 domains: educational, health and environmental, and social and economic opportunities. An important objective of the COI is to contribute to broadening equity conversations beyond socio-economic conditions. In addition, it seeks to provide data that can support authorities in developing and implementing policy initiatives to improve children's neighbourhood environments and reduce opportunity gaps between groups (Acevedo-Garcia et al., 2016[51]).

The COI methodology also offers particular indicators for each of the three domains covered, which can be useful for conducting particular analysis on different types of opportunities. Table 4.5 summarises the indicators used by the COI methodology to measure social, economic and educational opportunity.Table 4.8 features the indicators used for the health and environment category under the corresponding policy priority.

As suggested in (Acevedo-Garcia et al., 2016[13]), the COI can also be used in combination with the location affordability index (LAI).[11] The LAI reflects the predicted cost burden a household with a certain composition would incur when living in a specific location. It builds on eight representative household profiles (according to the number of family members, income and number of commuters). Specific household profiles were defined for different metropolitan areas or rural counties. The LAI is expressed as the percentage of cost (relative to income), just like the income-price ratio (featured in Box 4.2). Nonetheless, unlike the income-price ratio, this indicator uses both housing and transport costs (just as the H+T® Affordability Index discussed in Chapter 5 on transport) (Acevedo-Garcia et al., 2016[13]).

Table 4.5. Indicators for measuring the educational, and social and economic domains in the COI methodology

Domain	What is measured	Precise indicator
Educational opportunity	Adult educational attainment.	Percentage of adults age 25 and older with a college education.
	Student (school) poverty rate.	Percentage of students receiving free or reduced-price lunches, calculated as the average for the three nearest in-district schools.
	Reading proficiency rate.	Fourth-grade reading proficiency rate, calculated as the average for the three nearest in-district schools.
	Math proficiency rate.	Fourth-grade math proficiency rate, calculated as the average for the three nearest in-district schools.
	Early childhood education neighbourhood participation patterns.	Ratio of the number of children (three years and older) attending preschool/nursery school.
	High school graduation rate.	Percentage of students who graduated from high school on time.
	Proximity to high-quality (accredited by the National Association for the Education of Young Children early childhood education centres).	Number of early childhood education providers of any type located within the census tract or within a reasonable walking distance (1/2 mile).
Social and economic opportunity	Neighbourhood foreclosure rate.	Ratio of estimated number of foreclosures.
	Poverty rate.	Percentage of people below poverty.
	Unemployment rate.	Percentage of the civilian labour force who are unemployed.
	Public assistance rate.	Percentage of people receiving public assistance.
	Proximity to employment.	Average number of employees in zip codes within 5 miles.

Source: (Diversitydatakids and Kirwan Institute for the Study of Race and Ethnicity, 2016[52]).

When combined with indicators that can measure neighbourhood opportunities (such as the COI), the LAI can provide relevant insights on the potential facing trade-offs low-income families between neighbourhood opportunity and housing affordability. Combining the COI and LAI in the criteria used by programmes providing rental assistance to low-income families (e.g. housing vouchers) would allow authorities to ensure that the resources used improve the quality of the neighbourhood in which children develop (Acevedo-Garcia et al., 2016[13]). This can move analysis and policy beyond poverty rates and rent levels, towards a more comprehensive vision of housing affordability. On the one hand, this approach could cover both housing and transport costs (Acevedo-Garcia et al., 2016[13]); it could align sustainable transport and affordable housing strategies, and would even be more comprehensive if it incorporated the cost of utility services. On the other hand, a useful approach would include the quality of the wider environment in which different households can afford to live, as well as the connection between the housing they can afford and different types of opportunities (Acevedo-Garcia et al., 2016[13]). The opportunities addressed include environmental opportunities (such as green space), which can bring a number of ecosystem services (as discussed in Section **Error! Reference source not found.**). Therefore, incorporating this type of analysis in policy decisions can bring important opportunities for aligning equity and environmental priorities (including climate change mitigation).

Table 4.6. Summary table: Indicators for monitoring affordable housing and contribution to more equitable access to opportunities and links to the SDGs and OECD well-being framework

Policy priority	Proposed indicators	SDG goal and target	SDG Indicators	OECD well-being dimension/domain	OECD well-being Indicator
Offering affordable and good-quality housing, and contribute to more equitable access.	• Housing costs as a proportion of income or expenditure. • H+T® Affordability Index (see Chapter 5). • Energy poverty indicators (see Chapter 2). • Housing wage measure. • Ability-to-repay ratio. • Location affordability index. • COI. • Housing accessibility by different transport modes to key services and activities (see Chapter 5).	1.2.	Proportion of men, women and children of all ages living in poverty in all its dimensions, according to national definitions.	Current well-being: material conditions. Income and wealth.	• Household income. • Household net wealth.
		1.4.	Proportion of adults with secure tenure rights to land.	Current well-being: material conditions. Jobs and earnings.	• Employment • Earnings. • Long-term unemployment.
		3.8.	Coverage of essential health services.	Current well-being: material conditions. Housing.	• Housing affordability.
		4.2.	• Children participation rate in organised learning. • Adult participation rate in formal and non-formal education.	Current well-being: quality of life. Work balance.	• Working hours. • Time off.
				Current well-being: quality of life. Health status.	• Perceived health.
				Current well-being: quality of life. Education and skills	• Educational attainment.
		7.1.	• Proportion of population with access to electricity. • Proportion of population with primary reliance on clean fuels and technology.	Current well-being: quality of life. Social connections.	• Social support.
		10.1 - 10.2.	• Growth rates of household expenditure or income per capita among the bottom 40% of the population and the total population. • Proportion of people living below 50% of median income, by age, sex and persons with disabilities.	Future well-being: resources. Human capital.	• Young adult educational attainment. • Educational expectancy.
		11.1 - 11.3.	• Proportion of urban population living in slums, informal settlements or inadequate housing. • Proportion of population that has convenient access to public transport.	Resources for future well-being. Social capital.	• Trust in others.
		11.7.	• Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities.	Resources for future well-being. Economic capital.	• Household debt.

4.3.3. Ensuring a healthy and safe living environment

As discussed in Section **Error! Reference source not found.**, the characteristics of housing quality, such as lack of basic housing facilities, can result in diminished health, e.g. through the use of unsafe water and sanitation alternatives. These issues overlap with equity and poverty (addressed above), as a persistent problem is that the poorest population is generally subject to lower-quality housing. For example, in most OECD countries (except for Japan and Malta), the level of overcrowding is higher among residents in the lowest income quintiles. Similarly, the share of households that lack access to basic facilities (e.g. an indoor flushing toilet) or cannot afford to keep their home warm is higher among the poorest; these shares are particularly high in some OECD countries (Salvi Del Pero, Adema and Ferraro, 2014[10]).[12] The OECD well-being framework uses the "number of dwellings without basic facilities such as drinking water, sanitation, and heating" as a key indicator. Overcrowding, usually measured in terms of average rooms or floor space per person can also diminish health, safety and comfort. Different countries set their own minimum living-space standards; the WHO recommends at least 9 m^2 per capital. The OECD Housing Affordability database provides available data for OECD countries on overcrowding and the availability of other basic services (e.g. percentage of households living without an indoor flushing toilet). These types of indicators are relevant to track progress in the sector in promoting a healthy and safe living environment; both the SDG and the OECD well-being frameworks have a number of detailed indicators that go in this direction.

Indoor air pollution in a dwelling is also determinant to securing housing health and is measured in terms of the concentration of particulate matter (PM10 or PM2.5) in homes. It can be determined by heating, cooking, smoking, cleaning, and even furnishings or building materials, which can be important indoor sources of gaseous pollutants and particles – and hence, hazardous for human health (HE, 2004[53]); (Isaxon et al., 2015[54])). Long-term exposure to PM emissions is estimated to be responsible for 3 500 deaths annually in London (Walton et al., 2015[55]). PM2.5 and PM10 concentrations are not only dangerous for human health, but are also directly correlated to carbon emissions through residential combustion of wood, and the impact on air quality at the local and regional scales, especially during the winter (heating) period (Guerreiro et al., 2016). Monitoring indoor air pollution is key to tracking the sector's contribution to wider sustainable and well-being goals. It is directly linked to one of the indicators used to track SDG Target 3.9 (mortality rate attributed to household and ambient air pollution) and brings important information to understand the role of the sector on the OECD well-being framework indicator tracking life expectancy. Monitoring outdoor air pollution would also be important as a component of neighbourhood quality, supporting the case for quality building envelopes.

In addition, giving poor populations the possibility to inhabit more liveable and pleasant neighbourhoods is desirable in itself, and provides better life opportunities. Not only do poor people systematically face lower-quality housing in terms of basic services, low-income areas are also often associated with lower-quality education, less access to good-quality green space, and a lower quality of the dwelling itself (Wentworth and Clarke, 2016[32]). Safer environments will also elicit greater use of low-carbon and active modes of transport (walking, cycling, etc.). Thus, redevelopments aiming to modernise and green low-quality neighbourhoods while providing educational, leisure and employment facilities also need to make streets safer and homes more secure, and to redirect youth towards productive activities. Monitoring indicators that measure property crime can help track the progress of inclusive climate change policies and developments in a country or neighbourhood. These indicators are also linked to indicators in the OECD well-being framework, which track, for example, trust in others (as part of tracking the evolution of social capital). In Scotland, the Scottish Crime and Justice Survey measures, among other things, the property crime rate across Scotland, by conducting household surveys and public perception of fear or crime. In 2016-17, 6 000 adults living in private households took part on the survey (Scottish Government, 2019[56]). The results highlight, for example, that people were more likely to experience crime in deprived zones, highlighting the relevance of tracking such an indicator when establishing policies for upgrading or modernising neighbourhoods in order to monitor improvements (Scottish Government, 2019[56]). Thus, a number of opportunities exist to create synergies (and avoid trade-offs) between health, equity, safety and climate, but data and indicators that monitor these impacts at different spatial scales are key.

The COI uses several indicators to monitor neighbourhood health opportunities, summarised in Table 4.7. These indicators can help provide a broader view on the characteristics of neighbourhoods in which different forms of housing (and populations) are located, and how this promotes or hinders the delivery of a healthy environment. In some cases (e.g. proximity to toxic waste release sites and the volume of nearby toxic release), the indicators can provide relevant information to complement the analysis of SDG targets and indicators (e.g. the mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene – SDG Target 3.9). It can also help track the distribution of impacts across the population. For instance, one of the SDG indicators chosen for SDG Target 6.3 measures the proportion of bodies of water with good ambient water quality. However, this does not allow tracking the impacts on different population groups or the percentage of the population exposed to poor-quality bodies of water. The retail healthy food environment indicator (proposed by the COI) considers the link between access to food quality and housing location – which is relevant to health, but not always acknowledged when discussing "good housing" or quality neighbourhoods (see the agriculture policy discussions in the second part of the report). As highlighted in a number of indicators to track SDG 2 measure undernourishment and obesity. , the retail healthy food environment indicator can help monitor the role played by access or lack of access to healthy food, depending on housing location.

Table 4.7. Indicators for measuring health opportunity in the Child Opportunity Index methodology

Domain	What is measured	Precise indicator
Health opportunity	Retail healthy food environment indicator.	Percentage of healthy food retailers located in the census tract or within a reasonable walking distance (1/2 mile) of the census tract's perimeter.
	Proximity to toxic waste release sites.	Distance (in metres) to the nearest toxic waste and release site from the census tract centroid (geographic centre).
	Volume of nearby toxic release.	Aggregated toxic release volume (in pounds), based on the proportion of the census tract area that overlays a two-mile buffer around any toxic release sites nearby.
	Proximity to health care facilities.	Number of health care facilities in the census tract or within two miles of the tract's perimeter.

Source: (Acevedo-Garcia et al., 2016[51]) .

Table 4.8. Summary table: Indicators for monitoring healthy and safe living environments and links to the SDGs and OECD well-being framework

Policy priority	Proposed indicators	SDG goal and target	SDG indicators	OECD well-being domain/dimension	OECD well-being indicators
Ensure a healthy and safe living environment	Basic facilities: • Overcrowding. • Property crime. • Indoor air pollution. • Outdoor air pollution (as part of neighbourhood quality). • COI (health opportunities).	1.4.	Proportion of population living in households with access to basic services.	Current well-being: material conditions. Housing.	• Rooms per person. • Basic sanitation.
		2.	• A number of indicators measure undernourishment and obesity.	Current well-being: quality of life. Health status.	• Life expectancy.
		3.4.	• Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease.		
		3.9.	• Mortality rate attributed to household and ambient air pollution. • Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene. • Mortality rate attributed to unintentional poisoning.	Current well-being: quality of life. Personal security.	• Homicides. • Feeling safe at night.
		6.1. - 6.3.	• Proportion of population using safely managed drinking water services. • Proportion of population using safely managed sanitation services. • Proportion of wastewater safely treated. • Proportion of bodies of water with good ambient water quality.	Future well-being: resources- Social capital.	• Trust in others.
		16.1.	• Number of victims of intentional homicide per 100,000 population, by sex and age. • Conflict-related deaths per 100,000 population, by sex, age and cause. • Proportion of population that feel safe walking alone around the area they live.		

4.3.4. Promoting the efficient use and conservation of natural resources and ecosystems

Measuring resource efficiency in the dwelling is an important aspect of tracking progress towards this policy priority, based on relatively straightforward indicators, e.g. measuring the consumption of energy (energy use per square metre) and water (water use per usage type – e.g. flushing the toilet). SDG Target 6.4, for instance, includes an indicator on water-use efficiency. Indicators that measure the efficiency and emission performance of buildings are also widely used. Measuring the overall impact on water and air quality is also important. These indicators are used by the OECD well-being framework at the aggregate level, but also need more disaggregate monitoring. In the case of waste, SDG Target 11.3 uses the proportion of urban solid waste collected and adequately treated, and SDG Target 12.5 uses the national recycling rate. Again, disaggregated data and analysis for different sites and areas would be useful.

Moreover, as emphasised by (Birkeland, 2012[57]), sustainable development needs to be looked at as "development that makes everyone better off and expands future options", i.e. development that not only does not reduce the ecological base, but helps expand it. Thinking of urban development as "positive development" will promote design that supports ecosystems, eco-services and NBS. Shifting measurement tools to eco-positive thinking is key to implementing this change. Concretely, this means shifting from systems that measure impacts from "bad" to "no harm" or to "less bad", to using scales that allow measuring contribution to ecosystems and ecosystem services. The criteria according to which a project contributes to natural capital can be customised (Birkeland, 2012[57]).

Indicators and certification schemes based on energy efficiency and emission performance, for example, could shift scales to account for the possibility of energy-positive and negative-emission buildings and developments (see Table 4.9). Building design with passive solutions (e.g. orientation, ventilation) can significantly reduce energy needs (through natural daylight, heat loss reductions, etc.), while also improving thermal comfort and health (IEA, 2019[4]). Renger et al (2014[58]) argue that buildings could go beyond and become carbon sinks, even accounting for their entire life-cycle emissions, while bringing wider well-being and environmental benefits. However, they also argue that measurement tools and instruments are needed to incentivise net-positive carbon performance. Chapter 9 in the second part of the report further discusses eco-positive buildings and retrofits.

Indicators that are linked to the wider environmental characteristics and impacts of housing at the larger neighbourhood and community scales are also important, e.g. tracking residential development on brownfield land.[13] This is generally measured as the percentage change in brownfield land for residential development, providing a proxy measure for the extent to which former urban land is being re-used in the delivery of additional residential space. The indicator aims to ascertain efficient land use, as well as indicate the potential for avoiding additional carbon emissions associated with residential development as a consequence of land-use change (see residential policy chapter in the second part of the report for a discussion of incentives for brownfield development). This indicator can also add relevant information to current indicators tracking SDG Target 11.3, which uses the ratio of land consumption rate to population growth rate.

Brownfield development should proceed with green space development in mind, which requires tracking brownfield land development in tandem with the evolution of green and blue space. Most brownfield sites have some form of "greenish space" in the form of derelict, empty or vacant land, which is taken over by natural space. These green areas are often suppressed, because bringing nature back to contaminated sites is believed to be relatively expensive. Nonetheless, green space is a valuable asset that brings environmental and social benefits.

The Stockholm Royal Seaport site, for instance, was an extremely contaminated site (e.g. with coal tar and oil) that was decontaminated at the expense of the municipality (which owned the land and banked on future returns from property development). To promote the development of green areas as part of redevelopment, the Green Space Factor was used to set standards for developers (Box 4.3) for details on the Green Space Factor and Chapter 9 in the second part of the report for links to their use for setting standards in projects). In addition, where green spaces were to be located, the whole site was excavated to a depth of two metres and sealed to ensure that on-site water drainage from a previously contaminated site does not filter down into the aquifer and contaminate groundwater. Another urban infill redevelopment project, the Chatham Square in Alexandria, Virginia (United States), replaced old and deteriorated public housing units built during the 1940s that had very little natural space with higher-density buildings comprising 100 market-rate townhouses, as well as 52 affordable public-housing rental units (The Financing Sustainable Cities Initiative, 2019[59]). Chatham Square is built around green spaces and play areas; it offers pedestrian-friendly infrastructures, and short distances between transit stations, parks and commercial activities (The Financing Sustainable Cities Initiative, 2019[59]).

As previously mentioned, it is important to track changes in green and blue[14] space in cities over time. The SDG framework considers the land consumption rate relative to population growth (Target 11.3). SDG Target 15.1 also uses the proportion of forest area compared to total land area, while the OECD well-being framework includes total forest area. In terms of water sources, both frameworks use freshwater abstractions (which the OECD well-being framework measures as the proportion of total freshwater). The OECD well-being framework also includes an indicator for tracking renewable freshwater sources. Nonetheless, none of the indicators in these frameworks focus on monitoring changes in non-forest green space, nor do they explicitly track green and blue space in cities; hence, the indicators addressed in this section can make important contributions. In addition, both frameworks have indicators related to biodiversity and threatened species (including through the Red List Index, under SDG Target 11.3).

Change in the areas of parks and green space is often measured as the "change in the areas (hectares) of urban parks and open spaces per 1 000 population over the previous five years".[15] Beyond this more generic indicator, Green Space Factors are a way forward for acknowledging and rewarding the relative functionality of different types of green space areas. They are calculated by assigning different factors to diverse green-surface types, then calculating a weighted average. They can contribute, for instance, to monitoring and analysing the contribution of cities to global biodiversity targets. In many cases (e.g. Berlin, Malmo, Seattle, Stockholm, North West England and Southampton), cities have included the Green Space Factor in their planning system to establish both compulsory and voluntary standards for green space in different areas of the city or region, bringing a number of benefits.

As a way to further achieve specific goals (e.g. increasing biodiversity), the city of Malmö in Sweden designed a point system requiring developers to choose at least ten points from a list of elements involving more specific design guidelines and linked to desired outcomes (Box 4.3). This type of tool can be used to monitor and analyse the contribution of cities to global biodiversity targets.

While Malmö developed the Green Space Factor to focus on climate change adaptation and biodiversity, some of the elements in the Green Points System could be key to estimating potential carbon sequestration from trees (e.g. tree diversity – Point 10) (Hutchings, Lawrence and Brunt, 2012[37]); (Rogers, Jaluzot and Neilan, 2012[34]) or reducing energy use in buildings (e.g. wall coverage with climbing plants – Point 7). In the case of tree diversity, some studies of carbon sequestration and storage in urban green spaces suggest more specific parameters, e.g.: "no species should represent more than 10%, no genus more than 20%, and no family more than 30%" (Hutchings, Lawrence and Brunt, 2012[37]). Other parameters on the structure and composition of urban forests, which have been found to increase the potential for carbon capture, could also be included in the Green Space Factor and Green Points System, which could in turn also be used to design larger green areas. Other important parameters for estimating carbon storage potential are: size class distribution (to ensure there are enough young trees to replace old ones); tree cover area (surface made up by leaves, branches and stems of trees, viewed from above); and the leaf area index (which calculates the leaf area at all levels of the forest). Carbon capture capacity is linked closely to this index (Hutchings, Lawrence and Brunt, 2012[37]).

Finally, the previously described COI methodology also uses proximity to parks and open spaces as a component of the indicators included in the health and environmental opportunities dimension. This is measured as the distance in metres to the nearest park or open space. The relation of the COI to healthy development is based on evidence that children with better access to parks and open spaces have a greater tendency to perform safe physical activity and is therefore also linked to health priorities (Acevedo-Garcia et al., 2016[51]) .

Table 4.9. Summary table: Indicators monitoring the efficient use and conservation of natural resources and ecosystems and links to the SDGs and OECD well-being framework

Policy priority	Proposed indicators	SDG goal and target	SDG indicators	OECD well-being domain/dimension	OECD well-being indicators
Promoting the efficient use and conservation of natural resources and the ecosystem	• Resource efficiency (e.g. energy, water). • Percentage change in brownfield land for residential development. • Green Space Factor. • Plot and tree information. • * A shift to eco-positive type of tools (i.e. with scales that measure positive impacts to the environment) is important.	6.4.	• Change in water-use efficiency over time. • Level of water stress: freshwater withdrawal as a proportion of available freshwater resources.	Current well-being: quality of life. Environmental quality.	• Water quality. • Air quality.
		11.3. and 11.6.	• Ratio of land consumption rate to population growth rate. • Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities.		
		12.5.	• National recycling rate, tonnes of material recycled.	Resources for future well-being: natural capital. Resources.	• Forest area. • Renewable freshwater resources. • Freshwater abstractions. • Threatened species.
		15.1. 15.3. 15.5.	• Forest area as a proportion of total land area. • Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type. • Red List Index.		

Box 4.3. The Green Space Factor and the Green Point System developed by Malmö

The Green Space Factor uses a weighted average, which is calculated using the area dedicated to each green and blue surface types, multiplied by the factor assigned to each of these (see

Table 4.10). The sum of all area factor products is then divided by the total court area in a given zone. The highest factors are assigned to trees. Other factors range between 0 and 1, with higher factors assigned to vegetation that is in contact with ground water and open water surface, followed by green roofs and facade areas covered with vegetation. In 2009, factors where revised downwards to increase ambition, and the minimum overall score required was raised from 0.5 (used in the B001 eco-district) to 0.6 (

Table 4.10).The point system requires developers to choose at least ten of the points (

Table 4.11).

Table 4.10. Green Space Factor

Surface type	Factor
Vegetation on ground.	1
Vegetation trellis or façade.	0.7
Green roofs.	0.6
Vegetation on beams, soil depth between 200 millimetres and 800 millimetres.	0.9
Water surfaces.	1
Collection and retention of storm water.	0.2
Draining of sealed surfaces to surrounding vegetation.	0.2
Sealed areas.	0
Paved areas with joints.	0.2
Areas covered with gravel or sand.	0.4
Tree, stem girth 16-20 centimetres (20 square metres for each tree).	20
Tree, stem girth 20-30 centimetres (15 square metres for each tree).	15
Tree, stem girth more than 30 centimetres (10 square metres for each tree).	10
Solitary bush higher than 3 metres (2 square metres for each bus).	2

Table 4.11. Green Points

	Elements included
1	A bird box for every apartment.
2	A biotope for specified insects in the courtyard (water striders and other aquatic insects in the pond).
4	Bat boxes in the courtyard.
5	No surfaces in the courtyard are sealed, and all surfaces are permeable to water.
6	All non-paved surfaces within the courtyard have sufficient soil depth and quality of growing vegetables.
7	The courtyard includes a rustic garden with different sections.
8	All walls, where possible, are covered with climbing plants.
9	There is 1 square metre of pond area for every 5 square metres of hard surface in the courtyard.
10	The vegetation in the courtyard is selected to be nectar rich and provide a variety of food for butterflies.
11	No more than 5 trees or shrubs of the species.
12	The biotopes within the courtyard are all designed to be moist.
13	The biotopes within the courtyard are all designed to be dry.
14	The biotopes within the courtyard are all designed to be semi-natural.
15	All storm water flows for at least 10 metres on the surface of the ground before it is diverted into pipes.
16	The courtyard is green but there are no mowed lawns.
17	All rainwater from buildings and hard surfaces in the courtyard is collected and used for irrigation..
18	All plants have some household use.
19	There are frog habitats within the courtyard, as well as space for frogs to hibernate.
20	In the courtyard, there is at least five square metres of conservatory or greenhouse for each apartment.
21	There is food for birds throughout the year within the courtyard.
22	There are least two different old-crop varieties of fruits and barriers for every 100 square metres of courtyard.
23	The facades of the buildings have swallow nesting facilities.
24	The whole courtyard is used for cultivation of vegetables, fruit and berries.
25	The developers liaise with ecological experts.
26	Greywater is treated in the courtyard and re-used.
27	All biodegradable household waste is composted.
28	Only recycled construction materials are used in the courtyard.
29	Each apartment has at least 2 square metres of build-in growing plots or flower boxes on the balcony.
30	At least have the courtyard area consists of water.
31	The courtyard has a certain colour (and texture) as the theme.

32	All the trees and bushes in the courtyard bear fruit and berries.
33	A selection of the courtyard is left for natural succession (i.e. to grow and regenerate naturally).
34	There should be at least 50 flowering Swedish wild herbs within the courtyard.
35	All the buildings have green roofs.

Source: Authors, based on (Kruuse, 2011[60]).

4.4. Conclusion and looking ahead to Chapter 9 (Part 2)

This chapter argued for a broader view of "good housing" that can systematically guide policies in the residential sector towards considering multiple well-being priorities (including climate change mitigation) and the implications for different spatial scales. It showed how this approach could help policy makers create a two-way alignment between climate and wider well-being goals, proposing indicators to support its adoption.

The residential policy chapter (Chapter 9) in part 2 of the report will build on this discussion to address climate change mitigation policies in the residential sector. It will look at policies targeting enhanced energy and emission-related performance (like building regulations and retrofit programmes), as well as neighbourhood and city-level measures (such as eco-neighbourhood implementation and land-use policies). It will also explore the role of planning and incentives for nature-based solutions as part of decarbonising strategies. In line with discussions in this chapter, it will focus on identifying ways in which policy design and complementary policies can enhance synergies and reduce or mitigate potential trade-offs with other policy priorities. It will also identify ways in which actions taken at different spatial levels can generate positive reinforcing effects.

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Notes

[1] The terms “residential sector” and “housing sector” are used interchangeably in the literature, with a preference for “residential” in policy-making circles and “housing” in academic debates. It is mainly understood as comprising material objects, i.e. goods that can be manufactured, demolished, produced, consumed and bought. However, it can also reflect a wider understanding, where it can be defined as a “commodity” in the economic literature, but also as “one of the pillars” of the welfare state in policy studies.

[2] Of which 9% were direct emissions and 19.5% indirect emissions from electricity use (IEA, 2019[4]).

[3] Urban form is defined as “the physical characteristics that make up built-up areas, including the shape, size, density and configuration of settlements” (Williams, 2014[62]).

[4] Total floor area in buildings increased by more than 15% between 2010 and 2017, while global population increased in less than 10%.

[5] Defined as “a contiguous settlement that lacks one or more of the following five conditions: access to clean water, access to improved sanitation, sufficient living area that is not overcrowded, durable housing and secure tenure” (UN Habitat, 2015[12]).

[6] Although neighbourhoods are already communities, the term “community” here refers to the wider community making up the city in which a neighbourhood and dwelling are embedded.

[7] “[N]atural or semi-natural areas partially or completely covered by vegetation that occur in or near urban areas” (Wentworth and Clarke, 2016[32]).

[8] GHG emissions from domestic production and CO2 emissions from domestic consumption.

[9] For instance, the Norwegian Bank (Norges Bank) uses two different methods to calculate housing wealth, discussed in: (Berge, 2006[47]).

[10] HUD publishes the FMR for more than 2 500 metropolitan and non-metropolitan counties every year (The balance small business, 2018[64]). It derives the FMR for each area based on census data and through renter surveys (The balance small business, 2018[64]).

[11] The index was developed by the Partnership for Sustainable Communities in the United States, comprising HUD, the U.S. Department of Transportation and the U.S. Environmental Protection Agency.

[12] In 2014, the incidence of overcrowding in the bottom quintile reached shares as high as 47% in Poland, 45% in Mexico, 44% in Hungary and 43% in Romania. Also in 2014, the share of poor households (i.e. below 50% of equalised disposable income) that did not have an indoor flushing toilet was as high as 73% in Romania, 60% in Mexico, 42% in Bulgaria and 32% in Lithuania (Salvi Del Pero, Adema and Ferraro, 2014[10]). In addition, among OECD countries for which data are available, Bulgaria, Greece, Portugal and Cyprus present the highest percentage of population in the lowest quintile that cannot afford to keep the dwelling warm (Ameli and Brandt, 2014[65]).

[13] "Brownfield" is not easy to define, and is also known as "previously developed", contaminated, derelict, vacant, underused land, etc. It generally comprises land subject to legal sanction and the opposite of greenfield. Definitions vary across countries. For example, brownfield can be synonymous with contaminated land (e.g. in Italy and Spain); previously developed land (e.g. in the United Kingdom and Germany); derelict, underused or vacant land (e.g. in Scotland, Ireland and the Netherlands); and land where intervention is needed (e.g. in France) (NICOLE Brownfield Working Group, 2011[61])

[14] Defined as "[h]ealth-enabling places and spaces, where water is at the centre of a range of environments with identifiable potential for the promotion of human wellbeing" (Foley and Kistemann, 2015[63]).

[15] Open space can refer to freely accessible public parks, formal gardens, nature reserves, local nature reserves, cemetery and crematoria, water parks, open spaces, sites of special scientific interest, woodlands, playgrounds, and so on.