EFFICIENT AND BALANCED SPACE USE

SHAPING VIBRANT NEIGHBOURHOODS AND BOOSTING CLIMATE PROGRESS IN EUROPE

ANALYSIS DEEP DIVES

SYSTEMIQ

White Paper "Efficient and balanced space-use – shaping vibrant neighbourhoods and boosting climate progress in Europe"

Analysis Deep Dives

Overview

cover photo: Andrea Helbling, Allgemeine Baugenossenschaft Zürich (ABZ)

A. Analyses of the problem context

Explanation of the methodology and overview over the key literature used in the White Paper

This White Paper is based on an extensive literature review, expert interviews (see acknowledgements), analysis of different EU databases, case study analyses and analyses of EU policies.

While a wide range of literature on land use, sustainable urban development and densification was consulted, the following reports and studies have shaped the key concepts and conclusions in particular:

Based on extensive literature, but in particular on the following seminal studies, reports and books (in order of publication year):

- European Environment Agency et al., Land Take and Land Degradation in Functional Urban Areas., 2022
- UN Habitat, 'World Cities Report 2022 - Envisaging the Future of Cities', World Cities Report 2022
- Intergovernmental Panel on Climate Change, "IPCC Sixth Assessment Report - Mitigation of Climate Change." 2021
- Maarten A. Hajer et al., Neighbourhoods for the Future: A Plea for a Social and Ecological Urbanism 2020
- Coalition for Urban Transitions, 'Climate Emergency, Urban Opportunity', Global Report 2019
- International Resource Panel 'The Weight of Cities: Resource Requirements of Future Urbanization' 2018
- International Resource Panel 'Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future' 2018
- Urban Land Institute, "Supporting Smart Urban Development." 2018
- Nancy Holman et al., 'Coordinating Density; Working through Conviction, Suspicion and Pragmatism' 2015
- Working Papers by the European Commission's Directorate-General for Regional and Urban Policy

Analysis of how relevant European policies (dis-)regard space-use aspects

We analysed the most relevant European policies and initiatives for their consideration of space-use in the built environment, and their influence on related directives. While not exhaustive, the extensive analysis clearly shows a lack of space-use strategies in most directives, or the lacking implementation of space-use aspects from the more high-level initiatives.

Figure 1: Analysis of EU policies for their consideration of spatial efficiency aspects

EU'S FLAGSHIP CLIMATE AND RESOURCE POLICIES DO NOT YET PURSUE THE POTENTIAL OF BETTER SPACE UTILISATION

Colour legend: Not accounting for space utilization | Limited alignment and effort on better space utilisation | Aligned with better space utilization principles | Pending

	Policy	Focus of the policy	Space-utilization considered?
EU plans/ visions/ principles	Renovation wave	Decarbonization buildings through speedier renovation, greater energy efficiency, decarbonising heating and cooling, material recovery, and energy poverty	Mainly focused on insulation and heating switch
	European Bauhaus	Bring affordable sustainability, aesthetics and inclusiveness to cities. Programme 2023-2024 includes durability, regenerative buildings...	No explicit inclusion of balanced densification – but inclusiveness agenda overlaps
	Soil Strategy (2021) Biodiversity Strategy (2020) Roadmap to Resource Efficient Europe (2011)	Reach Zero Net Land Take by 2050. Member-states have until 2023 to set their national targets to reach this aim.	Yes, minimize soil sealing, mentions the impact of urban sprawl. [High-level vision only, no clear implementation plan]
	Mission for soil health and food	No net soil sealing and increase the reuse of urban soils for urban development. Land reuse rate to be increase to 50% (currently 13%).	Yes High-level vision only, no clear implementation plan]
	Circular Economy Action Plan	Current: Circular economy across products. Pending: Promised an EU Strategy for a Sustainable Built Environment by end of 2021- not yet delivered and discussions that it has been parked	Tbc focus of Built Env. Strategy; CEAP mentions "better utilisation" in one sentence.
EU directives	Energy Efficiency & Energy Performance of Buildings	Renovations and energy efficiency of buildings with a target of 32.5% overall improvement in energy efficiency of buildings by 2030	No, focusses on pure renovations and insulation.
	Strategic Env. Assessment & Env. Impact Assessment	Environmental impact assessment for large plans and projects (incl. urban and transport) focused on land-use, fauna, flora, human health, soil water, air...	Essential principle. Assessment remains focused on large project (covering around half of land take) and does not account for climate and wider systemiq impact.
	EU Taxonomy	Requires companies will have to disclose the amount of their investment that can be classified as sustainable under the taxonomy and justify how aligned they are with the principles.	Not explicitly. Include some requirements on construction and renovation of building

Sources: SYSTEMIQ analysis of
- European Commission, Directorate-General for Energy, 'A Renovation Wave for Europe - Greening Our Buildings, Creating Jobs, Improving Lives', 2020.
- European Commission, 'New European Bauhaus', 2022.
- European Commission, Directorate-General for Environment, 'EU Soil Strategy for 2030 Reaping the Benefits of Healthy Soils for People, Food, Nature and Climate', 2021.
- European Commission, Directorate-General for Environment, 'EU Biodiversity Strategy for 2030 Bringing Nature Back into Our Lives', 2020.
- European Commission, Directorate-General for Environment, 'Roadmap to a Resource Efficient Europe', 2011.
- European Commission, 'Soil Health and Food', 2021.
- European Commission, Directorate-General for Environment, 'A New Circular Economy Action Plan For a Cleaner and More Competitive Europe', 2020.
- European Commission, Directorate-General for Energy, 'Energy Efficiency Directive', 2012.
- European Commission, Directorate-General for Energy, 'Energy Performance of Buildings Directive', 2010.
- European Commission, 'Environmental Assessment - EIA and SEA', 2019.
- European Commission, 'EU Taxonomy for Sustainable Activities', 2020

DIRECTIONALLY PROMISING STRATEGIES AND PROGRAMMES REMAIN LIMITED IN INFLUENCE

Colour legend: Not accounting for space utilization | Limited alignment and effort on better space utilisation | Aligned with better space utilization principles | Pending

EU Funds	European Structural Investment funds	A minimum of 330mn EUR made available for "innovative action in the field of sustainable urban development" and a percentage of national programmes.	Enabling topics. Unclear current impact on underutilisation
	European Regional Development funds	An amount of at least 5% of the funding has to target "interlinked" (not in isolation) sustainable urban development by developing a project as part of a wider strategy responding to the problems of a specific urban area.	Enabling topics. Unclear current impact on underutilisation
	European Investment Bank	More than 10% (EUR 5-7B)of the annual lending is allocated to specific urban projects. New tools: framework loan, URBIS (advisory service to cities), and collaboration with other organisation on JASPERS, JEREMIE, JESSICA, JASIMINE,	Enabling urban action, large focus on transport – effect on compactness unclear/not explicit
	Mission Cities	Deliver 100 climate-neutral and smart cities by 2030 through experimentation and innovation to influence other cities in the future.	Consistent in principle, but no explicit strategic priority.
Intergov-ernmental cooperation in Urban policies	Leipzig Charter and Urban Agenda on the EU	Aim to support integrated urban development plans based on shared learning and strives to involve Urban Authorities in the design and implementation of EU policies, and want to make structural funds dependent on it. It sets the principles and guidelines for EIB urban lending. The Urban Agenda in particular has sustainable use of land and housing as a priority. These have support from all EU institutions and related associations.	Yes [Non-binding high-level vision, limited references found in other policies]
	European Spatial Development and Territorial Agenda for the EU	Outline the intentions of the Member States towards territorial development. It defines policy guidelines of the spatial planning agenda advocating for the development of a sustainable, polycentric and balanced urban system with compact cities, urban-rural partnership, parity of access to infrastructure and services, and sustainable development and protection of nature and cultural heritage.	Yes [Non-binding high-level vision, limited references found in other policies]

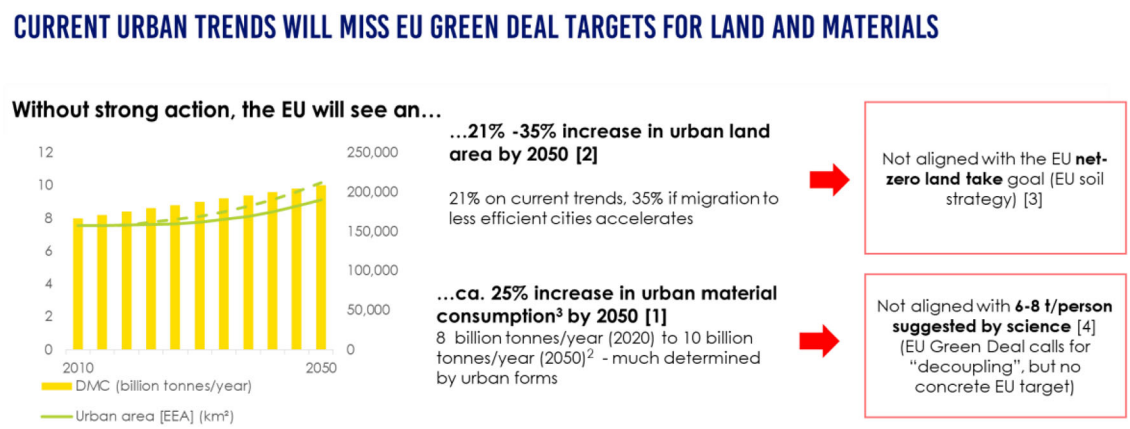
Sources: SYSTEMIQ analysis:
- European Commission, Directorate-General for Regional and Urban Policy, 'European Structural and Investment Funds', 2020.
- European Commission, 'EU Mission: Climate-Neutral and Smart Cities', 2022.
- 'LEIPZIG CHARTER on Sustainable European Cities', 2007.
- European Commission, 'New Leipzig Charter- The Transformative Power of Cities for the Common Good', 2020.
- European Commission, 'Futurium | Urban Agenda for the EU', 2022.
- European Investment Bank., *The EIB in the City : Investment on the Agenda*, 2019.
- European Committee of the Regions. *Spatial Planning and Governance within EU Policies and Legislation and Their Relevance to the New Urban Agenda, 2018.*
- EIB, 'How the EU Bank Helped Make Europe's Cities the Most Livable in the World', 2019.

In addition, we looked at samples of cities' climate plans, including London, Rotterdam and Barcelona, and found that these also neglect the spatial dimension; even though these cities' urban development and building plans regard the aspect.

Synthesis of how European built environment policies will not currently reach Green Deal targets – the urgency for additional levers

The following analyses show that relevant Green Deal policies are not yet sufficient to reach the Green Deal goals of net-zero land-take, resource decoupling (by 2050) or a 55% reduction in GHG emissions by 2030. Hence, the lever of better space utilisation must urgently be added to the tool box. This is true for building emissions, infrastructure emissions – including the industrial emissions to produce the respective material, and transport emissions.

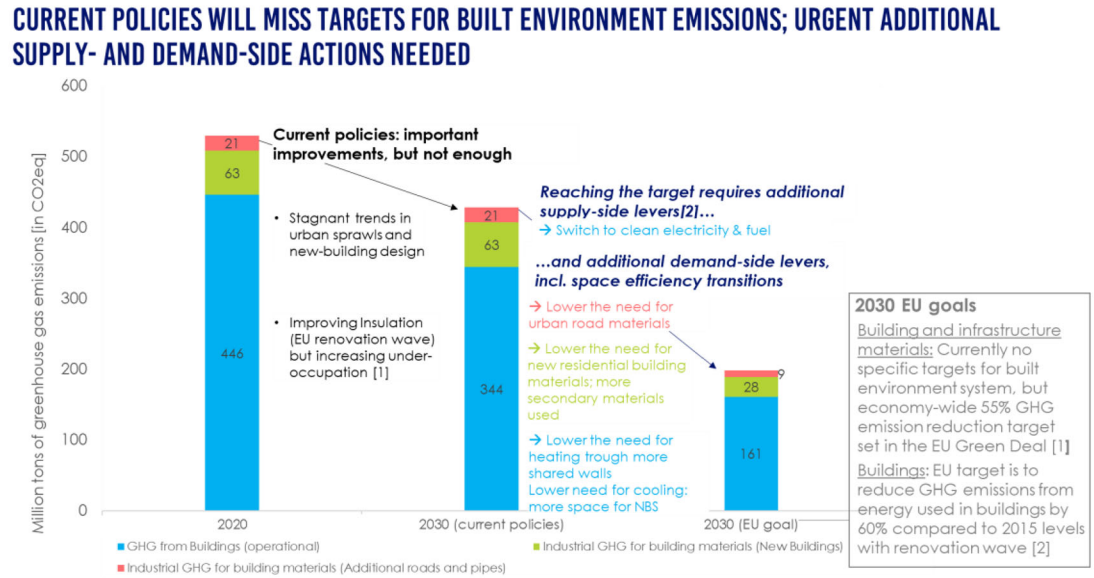
Figure 2: Estimation of the effect of continuing current trends for land and materials use



Footnotes: (1) when extrapolating EEA trend of 3% every 6 years [IRP models 90% increase[1] in urban land: 240,000 km² (2020) to 460,000 km² (2050) based on an annual de-densification rate of 2%]; (2) European population is expected to slightly decrease until 2050

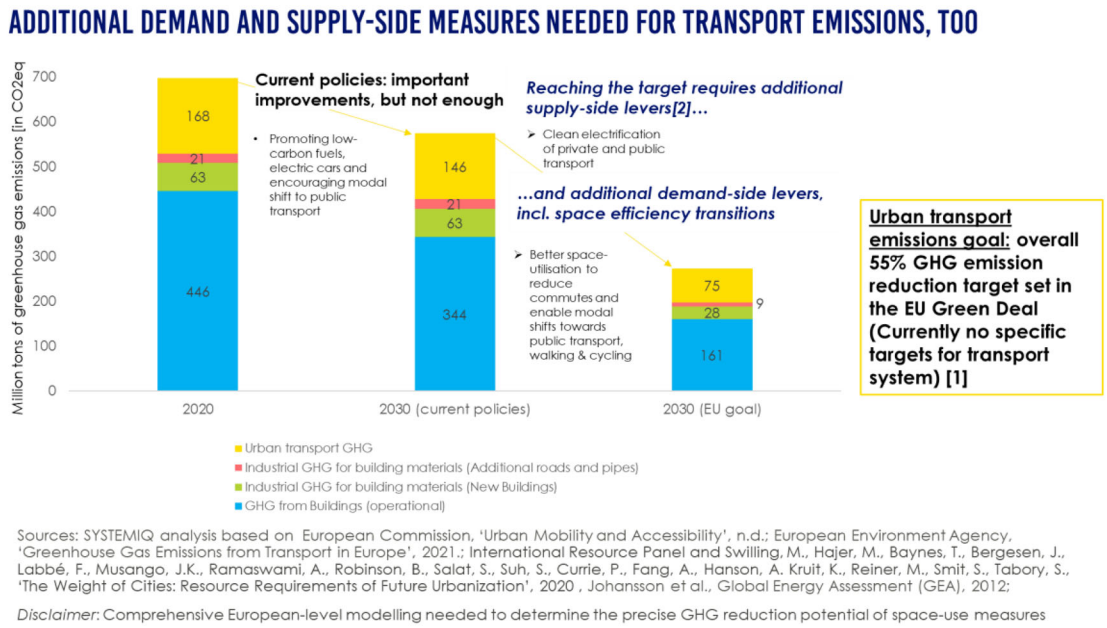
Source: SYSTEMIQ analysis based on [1] International Resource Panel and Swilling, M., Hajer, M., Baynes, T., Bergesen, J., Labbé, F., Musango, J.K., Ramaswami, A., Robinson, B., Salat, S., Suh, S., Currie, P., Fang, A., Hanson, A. Kruit, K., Reiner, M., Smit, S., Tabory, S., 'The Weight of Cities: Resource Requirements of Future Urbanization', 2020.; [2] Based on EEA data from European Environment Agency et al., Land Take and Land Degradation in Functional Urban Areas., 2022. [3] European Commission, Directorate-General for Environment, 'EU Soil Strategy for 2030 Reaping the Benefits of Healthy Soils for People, Food, Nature and Climate', 2021.; [4] International Resource Panel, 'Managing and Conserving the Natural Resource Base for Sustained Economic and Social Development'., 2014.

Figure 3: Estimation of effect of current policies for built environment and mobility emissions



Sources: SYSTEMIQ analysis based Marie Rousselot and Frederic Pinto Da Rocha, 'Energy Efficiency Trends in Buildings in Europe | Policy Brief | ODYSSEE-MURE', 2021; European Environment Agency, 'Greenhouse Gas Emissions from Energy Use in Buildings in Europe', Indicator Assessment, 2021; International Resource Panel and Swilling, M., Hajer, M., Baynes, T., Bergesen, J., Labbé, F., Musango, J.K., Ramaswami, A., Robinson, B., Salat, S., Suh, S., Currie, P., Fang, A., Hanson, A. Kruit, K., Reiner, M., Smit, S., Tabory, S., 'The Weight of Cities: Resource Requirements of Future Urbanization', 2020; Johansson et al., Global Energy Assessment (GEA), 2012; [1] European Commission, 'The European Green Deal', 2019; [2] European Commission, Directorate-General for Energy, 'A Renovation Wave for Europe - Greening Our Buildings, Creating Jobs, Improving Lives', 2020

Disclaimer: Indicative potential based on exemplary modelling (see BoE modelling). Yet, further modelling is required to estimate potential in European urban areas.



Sources: SYSTEMIQ analysis based on European Commission, 'Urban Mobility and Accessibility', n.d.; European Environment Agency, 'Greenhouse Gas Emissions from Transport in Europe', 2021.; International Resource Panel and Swilling, M., Hajer, M., Baynes, T., Bergesen, J., Labbé, F., Musango, J.K., Ramaswami, A., Robinson, B., Salat, S., Suh, S., Currie, P., Fang, A., Hanson, A. Kruit, K., Reiner, M., Smit, S., Tabory, S., 'The Weight of Cities: Resource Requirements of Future Urbanization', 2020 , Johansson et al., Global Energy Assessment (GEA), 2012;

Disclaimer: Comprehensive European-level modelling needed to determine the precise GHG reduction potential of space-use measures

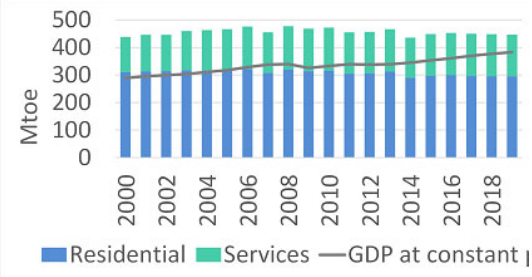
HOUSEHOLD ENERGY USE: GHG emission from household energy use (heating, cooling and electricity use in buildings) have been steadily declining in the last years . Still, when extrapolating the current trend under inclusion of the planned measure from the EU renovation wave the announced target of 60% reduction emissions from energy used buildings seems not to be achievable.
Considering that a person living in a multi-family dwelling consumes less energy than a person in a single-family house (~50% less) , focusing on efficient space-utilisation would have a significant impact on Europe's final household energy demand and therefore decrease dependence on oil and gas which make up 50% of energy use in buildings. (* 30% of energy use is from electricity which is currently only 17% renewable .) The large savings potential comes from reducing space heating (and cooling) demand by reducing floor space to adequate levels, having shared walls, and green space to counteract increasing summer temperatures. If only well-balanced multi-unit dwellings, with enough comfortable living space and a moderate amount of units, were built, Europe could save 32 TWh in household energy the next 8 years until 2030. If such measures were applied to existing stock, the impact would be much larger.
INDUSTRIAL EMISSION FROM CONSTUCTING NEW BUILDINGS AND ACCOMPANYING INFRASTRUCTURE: Further emission reductions can be achieved by building more efficiently and only when necessary. Reducing the need for constructing new buildings is possible through using existing un- and under-used buildings. And by constructing more resource-efficient multi-family units instead of single-family houses, construction materials can be saved. On top of that, the construction of additional roads and pipes can be reduced by focusing new development in well-connected areas and not in sprawled, suburban settings. Such measures reduce the need for fossil energy intensive materials, such as the oil-based compound bitumen and help mitigating hard-to abate energy embodied in these building materials (, which are attributed to the industrial (construction) sector). This shows that a focus on well-balanced efficiency can serve as lever towards EU's increased fossil-fuel independency as well as reducing absolute natural resource/material use, which is a step towards resilience.
TRANSPORT: Urban transport is responsible for 23% of Europe's total transport GHG emissions – shorter distances, walkable urban form and sufficient density for frequent public transport links can help in significantly reducing these emissions towards EU's

55% reduction target. The Global Energy Assessment modelled that transport energy in a sprawled city compared to a more compact city is more than double. Looking at the difference in transport emission of a land-efficient city such as Barcelona compared to a more sprawled city like Berlin, confirms this. Considering the many levers that balanced urban form has on changing urban transport, emission reductions of up to 42% would be achievable for example in Berlin by increasing the share of public transport, cycling and walking . Still, exact modelling is required to understand the full potential of space-efficient and balanced urban form in reducing transport emissions in the European context.

Some national estimations underline the insufficiency of current policies. For example, in England, under current policy, housing alone would consume 104% of England's cumulative carbon budget until 2050[1].

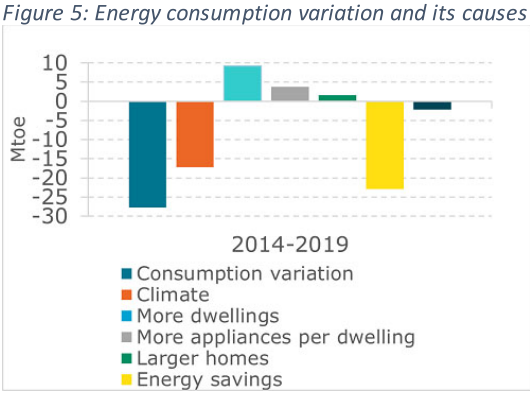
Background on trends in EU household energy consumption:
Why are current measures of insulation and retrofitting not enough to reach targets? The energy consumption of buildings in the EU is close to stagnation as efficiency improvements are cannibalized by more buildings and larger spaces:

Figure 4: Energy consumption in European buildings over time



Since 2000, energy consumption in commercial and residential buildings has not substantially been reduced [2].

Figure 5: Energy consumption variation and its causes



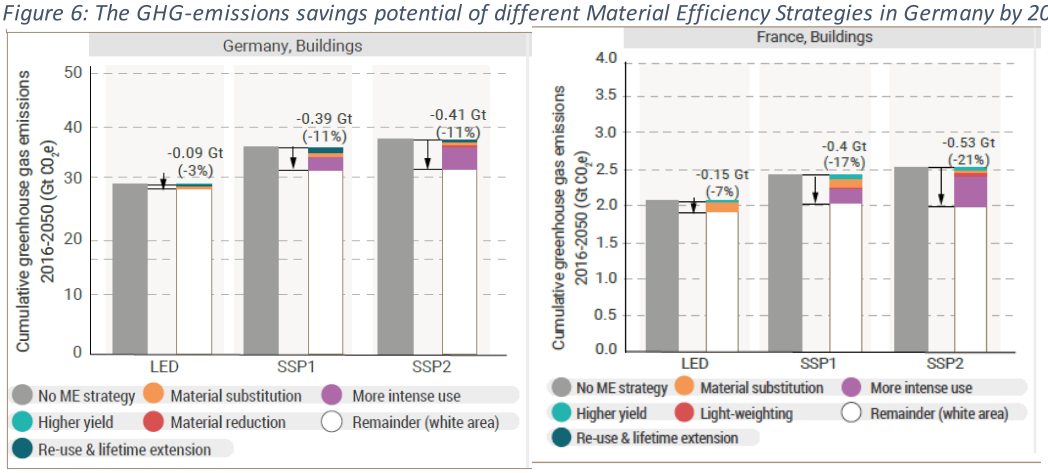
Efficiency improvements from retrofits and renovations, as well as more energy efficient appliances and milder winters, have been cannibalized by an increased

[1] Sophus O.S.E. zu Ermgassen, Michal P. Drewniok, Joseph W. Bull, Christine M. Corlet Walker, Mattia Mancini, Josh Ryan-Collins, André Cabrera Serrenho, "A Home for All within Planetary Boundaries: Pathways for Meeting England's Housing Needs without Transgressing National Climate and Biodiversity Goals."
[2] Rousselot and Pinto Da Rocha, "Energy Efficiency Trends in Buildings in Europe | Policy Brief | ODYSSEE-MURE."

building stock, more space use per person, and more electrical appliances in households[3].

Background on emission reduction potential of more efficient use of floor space[4]

Figure 6: The GHG-emissions savings potential of different Material Efficiency Strategies in Germany by 2050



By just preventing further underutilization of space, i.e. keeping current floor space per person stable only, Europe could already approx. save 8 – 11 % in life-cycle GHG emissions in 2050 from residential buildings – both from reduced need for construction and from reduced heating/cooling energy need.

B. Analyses of the opportunity of efficient, balanced space use Global climate context – synthesis of science on the role of space-efficient cities for reaching global climate targets

Global science is clear about the necessity of reducing global energy demand and materials demand in order to stay withing 1.5C of global heating, or even withing 2C. These need to go drastically, despite a growing population, given that energy supply can only be decarbonised at a certain speed, and given that even the cleanest energy uses natural resources, such as metals for solar and wind energy or land for bioenergy. The use of these resources has impacts such as biodiversity loss or loss of land space for carbon capture or food production. Hence the need for absolute reduction in addition to cleaner production. Cities have a major role to play in these absolute reductions, given they consumer ca. 70% of global energy and 60% of global materials. Making cities more compact and walkable could already reduce 25% of urban energy demand by 2050. The following figures synthesise the key numbers.

[3] Rousselot and Pinto Da Rocha.

[4] International Resource Panel, "Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future."

Figure 7: Overview over reduction requirements in energy-consumption and the role of cities - global

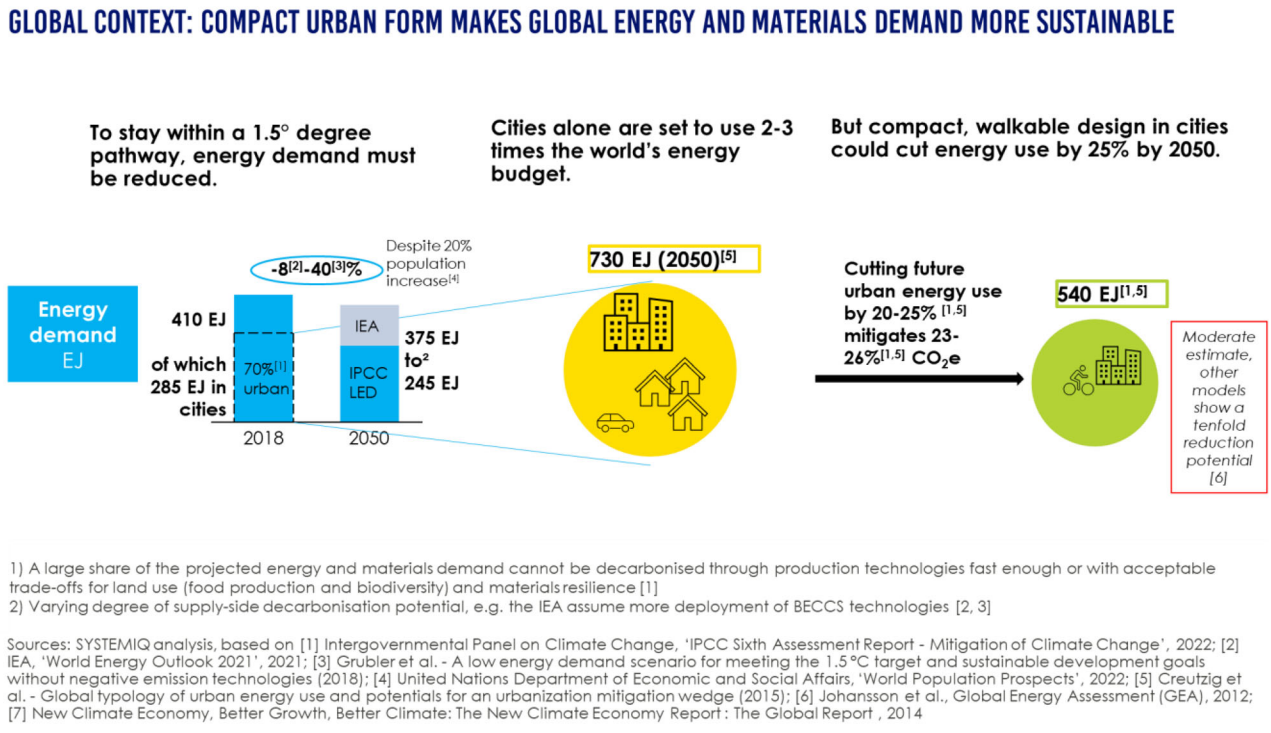
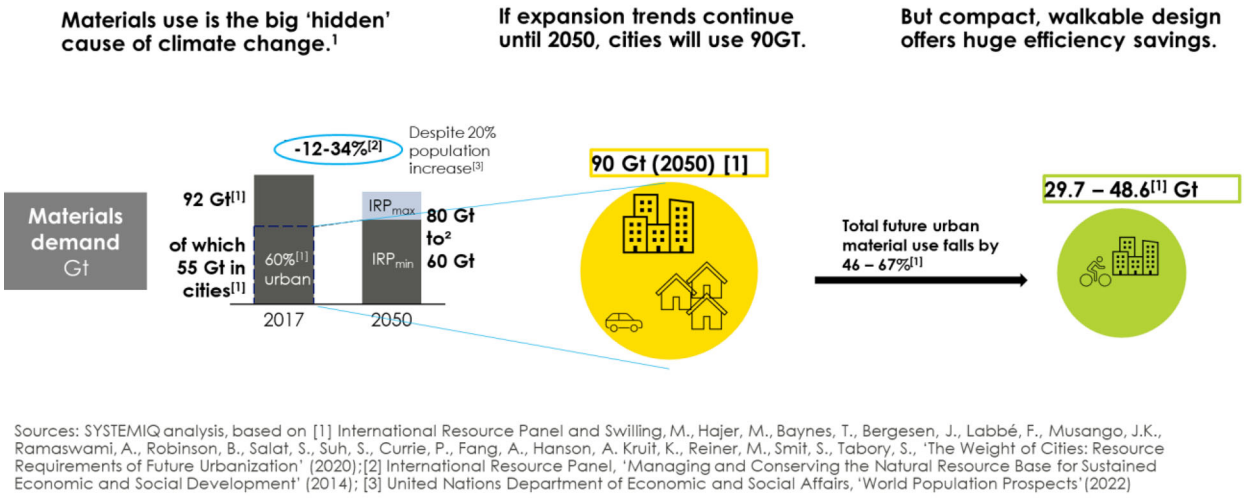


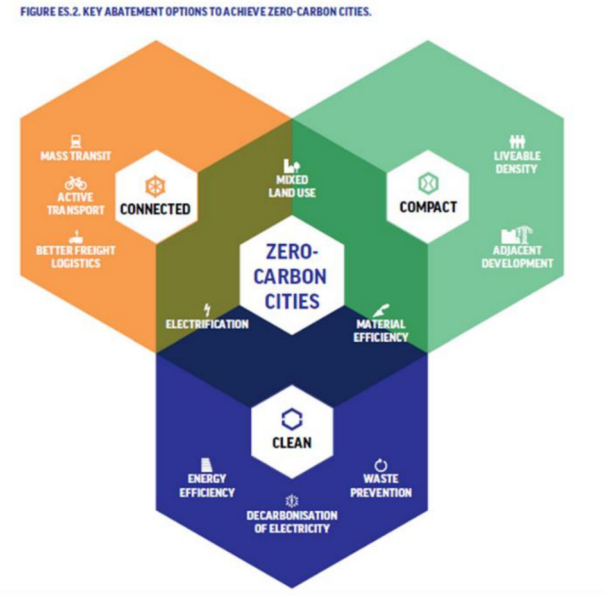
Figure 8: Overview over reduction requirements in materials-consumption and the role of cities - global



For context, this paper regards better space-utilisation – or liveable compactness, as coined by the Coalition for Urban Transitions – as one out of three key areas of required urban transitions in the climate context. See the overview of required urban transitions in Figure 9, with further detail to be found in the report Climate Emergency, Urban Opportunity from 2019[5].

[5] Coalition for Urban Transitions, "Climate Emergency, Urban Opportunity."

Figure 9: Overview over the different levers needed in urban climate mitigation

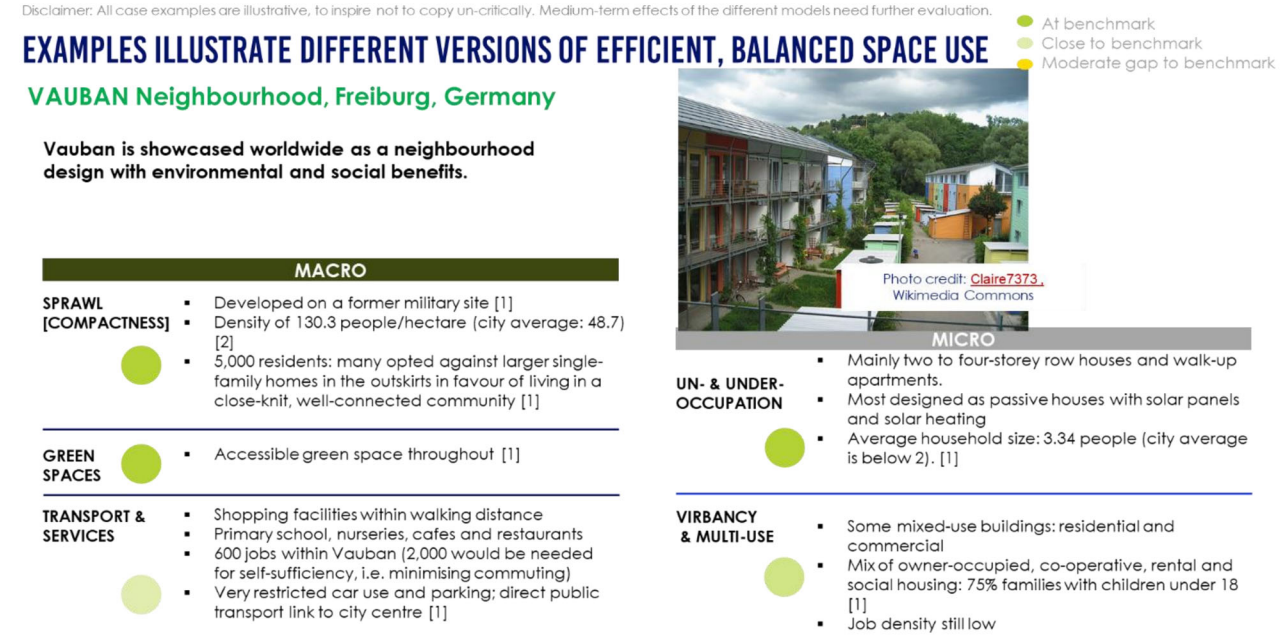


Source: Coalition for Urban Transitions, 'Climate Emergency, Urban Opportunity', Global Report (2019)

All analysis and suggestions made in this White Paper are for Europe only. Many are likely to be transferrable to other global context, but that analysis is out of scope for this White Paper.

Analysis of exemplary European neighbourhoods with efficient space use and high quality of life – and one contrasting example

Figure 10: Examples of space-efficient neighbourhoods



SYSTEMIQ analysis based on (1) Jan Scheurer and Peter Newman, 'Vauban: A European Model Bridging the Green and Brown Agendas', UN-Habitat, no. Revisiting Urban Planning: Global Report on Human Settlements 2009 (2008) (2) Quartiersarbeit Vauban, 'VAUBAN IN ZAHLEN |', 2012

Disclaimer: All case examples are illustrative, to inspire not to copy un-critically. Medium-term effects of the different models need further evaluation.

EFFICIENT UTILISATION AND HIGH LIVING QUALITY – EXEMPLARY ILLUSTRATION

At benchmark
Close to benchmark
Moderate gap to benchmark

BARCELONA, Spain

Barcelona is often cited as an example of good urban development. The high-density city with its 'superblocks' is making efforts to increase green space, limit car traffic and manage rental price and occupation.

Photo credit: Martin Abegglen, Wikimedia Commons

MACRO

SPRAWL [COMPACTNESS]
- High average density with 160 people/hectare [1]
- Mostly medium- to high-rises of 5+ stories in the city centre and central neighbourhoods

GREEN SPACES
- Current green space is limited: just 0.6% of the urban area in 2018. Plans to increase green spaces 44.41ha (2017-2019) and 165 ha (2020-2030) [2], but more efforts needed for climate adaptation

TRANSPORT & SERVICES
- Creation of 'superblocks' (400x400 meters): pedestrianised areas; car access, for residents only, at 10 km/h; former junctions adapted into public (green) spaces [3]

MICRO

UN- & UNDER-OCCUPATION
- Significant amount of vacant dwellings due to short-term rentals and speculation [4]

VIBRANCY & MULTI-USE
- Multi-functionality of buildings with a mix of residential, commercial and public space.
- Use of community consultations to ensure social balance within neighbourhoods – and find solutions to counteract gentrification

SYSTEMIQ analysis based on (1) Urban Resilience Hub, 'Urban Resilience Hub: Barcelona City Snapshot', 2022 (2) OPPLA, 'Urban Gardens in Barcelona: Multifunctional Green to Enhance Nature-Based Thinking in Cities', Oppla, 19 November 2021 (3) Ronika Postaria, 'Superblock (Superilla) Barcelona - a City Redefined', Citiesforum.Org (blog), 31 May 2021 (4) Paige McClanahan, 'Barcelona Takes on Airbnb', The New York Times, 22 September 2021 (5) La Pinya Barcelona, 'Here Come The Superblocks', La Pinya (blog), n.d.

EFFICIENT UTILISATION AND HIGH LIVING QUALITY – EXEMPLARY ILLUSTRATION

At benchmark
Close to benchmark
Moderate gap to benchmark

Photo credit: Andrea Helbling, *Allgemeine Baugenossenschaft Zürich (ABZ), published on shelterforce.org 2021*

ZURICH, Switzerland

Zurich has a long history of co-operative housing models: almost a fifth of the population live in a co-operative. Their housing developments have high environmental and social standards.

MACRO

SPRAWL [COMPACTNESS]
- In 2014, Swiss population voted for less wasteful and more effective use of land (1)
- Population density: 4,814/km² (2)
- Density could be further increased especially in some wealthy suburbs

GREEN SPACES
- 70% of people are a 10 min walk from a green space; 85% within 15 minutes (3)
- 30% of the population still lack good access

TRANSPORT & SERVICES
- Highly efficient public transport network, parking restrictions (1 per 1,200 m²), low vehicle ownership 281 cars per 1,000 inhabitants (4, 5)
- 80% of all journeys within city limits are on foot or by bike or public transport.

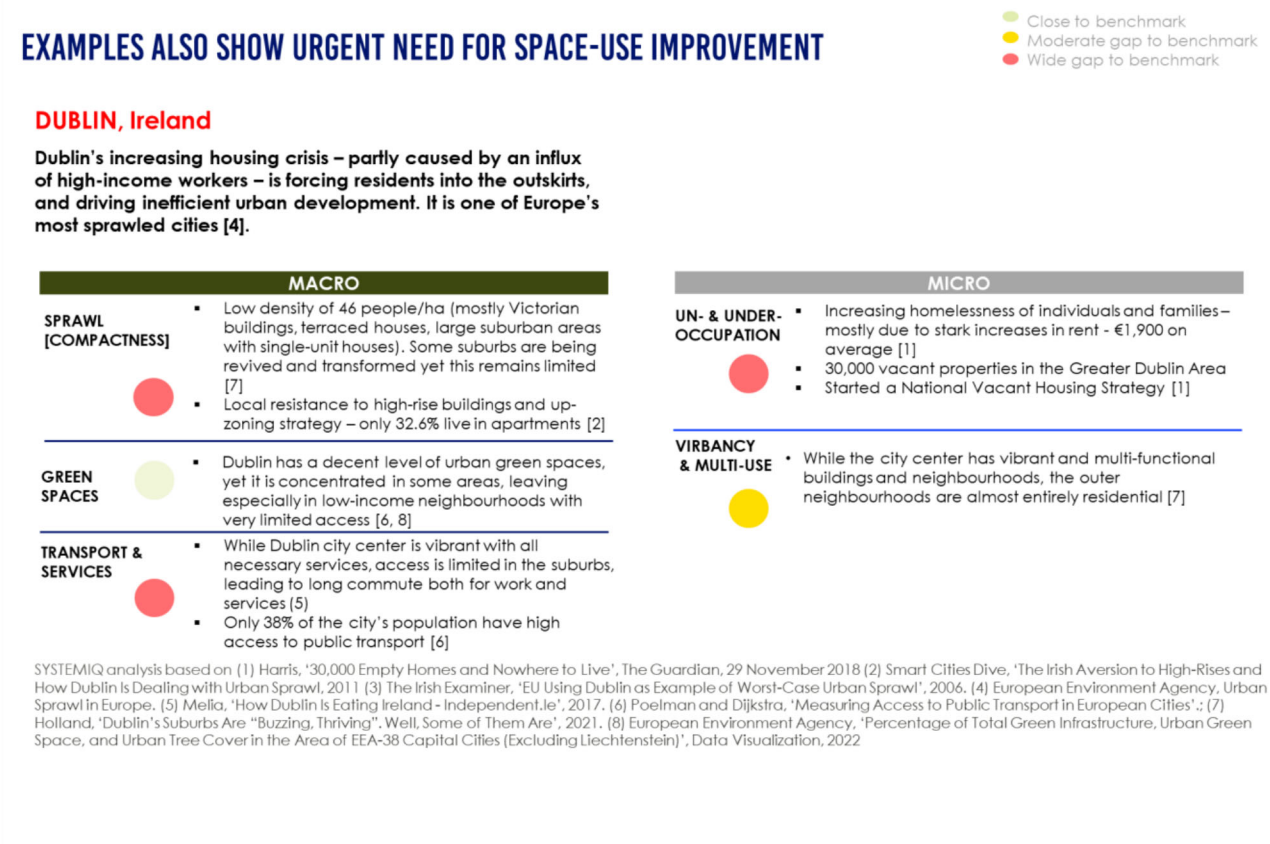
MICRO

UN- & UNDER-OCCUPATION
- 0.72 % of dwellings are vacant – trend decreasing
- 18 % of dwelling units operated as cooperative housing
- Co-ops have occupational restrictions – smaller apartments are offered to members whose residence is bigger than they need.

VIRBANCY & MULTI-USE
- Multi-functionality of buildings with a mix of residential, commercial and public space
- Co-operatives offer complementary services – childcare, health services, social services, local activities.
- Average co-operative rents are 20% lower than for private rental units

SYSTEMIQ analysis based on (1) Wälty, 'Greater Zurich Does Not Use Land Parsimoniously: Despite the Spatial Planning Act, Which Has Been in Force since 1980', Journal of Urbanism: International Research on Placemaking and Urban Sustainability 14, no. 1 (2 January 2021) (2) CityPopulation.de, 'City Population: Zurich', 2022 (3) Chênes, Giuliani, and Ray, 'Modelling Physical Accessibility to Public Green Spaces in Switzerland to Support the SDG11', 2021 (4) Menendez & Ambühl - 'Implementing Design and OperaCity Population – Zurich tional Measures for Sustainable Mobility, 2022 (5) WWF – Zürich sustainable transport, 2012

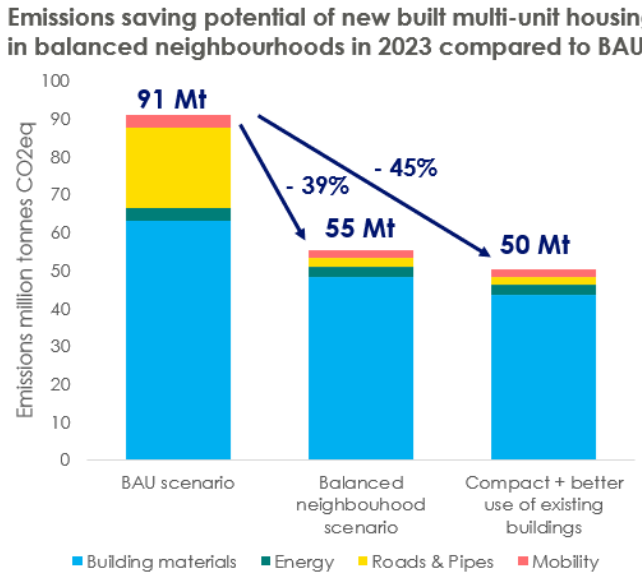
Figure 11: Example of urban area with few space-efficient neighbourhoods



Details on this paper's novel analysis of the European GHG reduction potential through better space use

An indicative model was developed, to get an impression of the potential of focusing new development on well-balanced neighbourhoods instead of following the status quo of often sprawled suburban single-family home development.
This considers savings in new-building only. Wider savings in existing stock might be possible with the dynamics of European urban growth and shrinkage and the need for deep retrofitting and selective substitution (e.g. energy reduction through enhancing occupation, reuse of materials from deconstruction, freeing land)

Figure 12: Estimation of Europe's potential to reduce emissions from additions to the built environment stock, per year



Every year approximately 1.5 million new dwelling units are built in Europe. At least 50% of these are in the form of single-family houses (SFHs) which are twice as material intensive per person and use 50% more energy per person as multi-family houses (MFHs)6. Also, SFHs are mostly built in suburban or rural settlements which entail at least 3 times the required infrastructure (in terms of roads and pipes) as dwellings in cities. Another knock-on effect of sprawled development of SFHs is the transport energy use and associated emissions – these are often twice as high in sprawled settings as in efficient cities.

A business-as-usual scenario was compared to two balanced neighbourhood scenarios:

Business-as-usual scenario: 50 percent of new development is single-unit housing in sprawling settlements, i.e. new roads and pipes needed. The remaining 50 percent is multi-unit development in denser urban settlements where less new road and pipe construction is required, and of which 50 percent is infill developed as infill with no requirement for new roads and pipes. This makes just 25 percent of alle new built units infill.

Balanced neighbourhood scenario 1 – better new built development: All new development is built as multi-unit dwellings with an average of four dwelling units per house. 75 percent of these multi-unit dwellings are constructed as infill, so that no new roads or pipes constructed.

Balanced neighbourhood scenario 1 – better new built development & better use of existing buildings: Again, all new development in multi-unit dwelling as described in scenario 1, yet now 10 percent of dwellings do not need to be newly constructed because existing, but vacant or underutilised, urban dwellings are used. This reduces the need for new built housing by 10 percent.

Details on the calculation:

Figure 13: Calculation of the emissions reduction potential in Europe's built environment by space efficiency

RESULTS	**New builds 2021** (avg. 2011-2020)	**BAU Scenario**	**Space-efficient Scenario**	**Space efficient + Use of existing vacant dwellings**

6 International Resource Panel, "Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future."

Total dwellings	1439082		1439082	1439082	1439082	
SFH	719541		719541	0	0	
MFH (new built, 4 apartments)	179885		179885	359771	323793	
Existing, vacant city dwellings					143908	
GHG from Buildings (embodied)			62.92	48.22	43.40	Mt CO2
GHG from Buildings (operational)			3.60	2.69	2.69	Mt CO2
GHG from Infrastructure			20.99	2.69	2.69	Mt CO2
GHG from Travel			3.56	1.86	1.86	Mt CO2
TOTAL			91.07	57.80	52.48	Mt CO2
		SAVINGS	Mt CO2	**33.26**	**38.59**	Mt CO2
				37%	**42%**	

General Assumptions & data

General Assumptions & data	Value	Unit	Sources
Number of new builds (annual)	1439082	#	Hypostat[7]
Share of SFH in BAU	50%		Eurostat[8]
Share of MFH in BAU	50%		Eurostat[9]
MFHs have 4 apartments	4		
Occupants SFH	3	#	Assumption based on average occupancy EU[10]
Occupants MFH	12	#	Assumption based on average occupancy EU[11]
Average size SFH	170	m2	Assumption
Average size MFH	500	m2	Assumption
Embodied Carbon urban infrastructure	1111.2	t CO2/km	Gabarrell et al (2015)[12]
Infrastructure length suburb per person	0.0077	km	Dijkstra et al (2019)[13]
Infrastructure length compact per person	0.0021	km	Dijkstra et al (2019) [14]
Share of MFH infill BAU (without new infrastructure requirement)	0.5		Eurostat[15]

[7] European Mortgage Foundation et al., "HYPOSTAT 2021."
[8] Eurostat, "People in the EU - Statistics on Housing Conditions."
[9] Eurostat.
[10] Eurostat.
[11] Eurostat.
[12] Gabarrell and et al., "Life Cycle Management Applied to Urban Fabric Planning | SpringerLink."
[13] Dijkstra, Poelman, and Ackermans, "ROAD TRANSPORT PERFORMANCE IN EUROPE."
[14] Dijkstra, Poelman, and Ackermans.
[15] Eurostat, "People in the EU - Statistics on Housing Conditions."

Share of MFH infill COMPACT (without new infrastructure requirement)	0.75		Assumption
Annual Transport emissions SFH	1.22	CO2eq	C40 Knowledge Hub[16]
Annual Transport emissions MFH	0.43	CO2eq	C40 Knowledge Hub[17]
Annual energy demand SFH per m2	290	MJ/m2	IRP - Resource efficiency and Climate Change[18]
Annual energy demand MFH per m2	235	MJ/m2	
CO2 intensity energy Europe	229	g CO2/kWh	EEA - emission intensity[19]

Calculation

INFRASTRUCTURE			
Emissions per km road	1111.2	t CO2/km	Gabarrell et al (2015)[20]
km per SFH (town/suburb)	0.0231	km	Under the assumption that all SFH are built in suburban areas, the avg. EU road length per suburban resident (7.7 m) is multiplied with the avg. occupation of an SFH (3 persons)
km per MFH (new city areas)	0.0252	km	Under the assumption that 50% of MFH are built in **new** city areas, the avg. EU road length per city resident (2.1 m) is multiplied with the avg. occupation of an MFH (12 persons).
km per MFH (infill)	0	km	The other 50% MFH are built as infill without new infrastructure needs.
Emissions per SFH	25.66872	t CO2	
Emissions per MFH (new city areas)	28.00224	t CO2	
Emissions per MFH (infill)	0	t CO2	

Explanation of road & pipe length assumptions:
BAU: All SFH is in suburban like new development (7.7 m road/person), 50% of MFH is in city like new development (2.1 m road/person) and 50% of MFH is is infill (no add. Infrastructure) .
Compact: 75% of MFH is infill (no add. Infrastructure) and 25% is city like new development (2.1 m road/person)

EMBODIED EMISSIONS HOUSES							
Housing Production (Materials)	Concrete	Steel	Wood	Cement	Other (glass)	Unit	Source
Material intensity SFH	950	50	50	50	50	kg/m2	IRP RECC
Material intensity MFH	650	50	100	30	30	kg/m2	IRP RECC

[16] "C40 Knowledge Hub."
[17] "C40 Knowledge Hub."
[18] International Resource Panel, "Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future."
[19] European Environment Agency, "Greenhouse Gas Emission Intensity of Electricity Generation."
[20] Gabarrell and et al., "Life Cycle Management Applied to Urban Fabric Planning | SpringerLink."

embodied C intensity	0.035	0.482	0.125	0.226	0.232	C/kg	Hammond and Jones (2008)[21]
embodied CO2 intensity	0.13	1.77	0.46	0.83	0.85	CO2/kg	
Embodied CO2/m2 **SFH**	121.94	88.39	22.92	41.44	42.54	CO2/m2	
Embodied CO2/m2 **MFH**	83.44	88.39	45.84	24.87	25.53	CO2/m2	
Embodied CO2/m2 **SFH**		317.24	kg CO2/m2				
Embodied CO2/m2 **MFH**		268.06	kg CO2/m2				
Embodied CO2 SFH		53.93	t CO2				
Embodied CO2 MFH		134.03	t CO2				
OPERATIONAL EMISSIONS HOUSES							
Annual energy demand SFH		49300	MJ				
Annual energy demand MFH		117500	MJ				
Operational CO2 SFH		**3.14**	t CO2				
Operational CO2 MFH		**7.47**	t CO2				
TRANSPORT EMISSIONS							
transport SFH total (3 people)		**3.66**	t CO2				
transport MFH total (12 people)		**5.16**	t CO2				

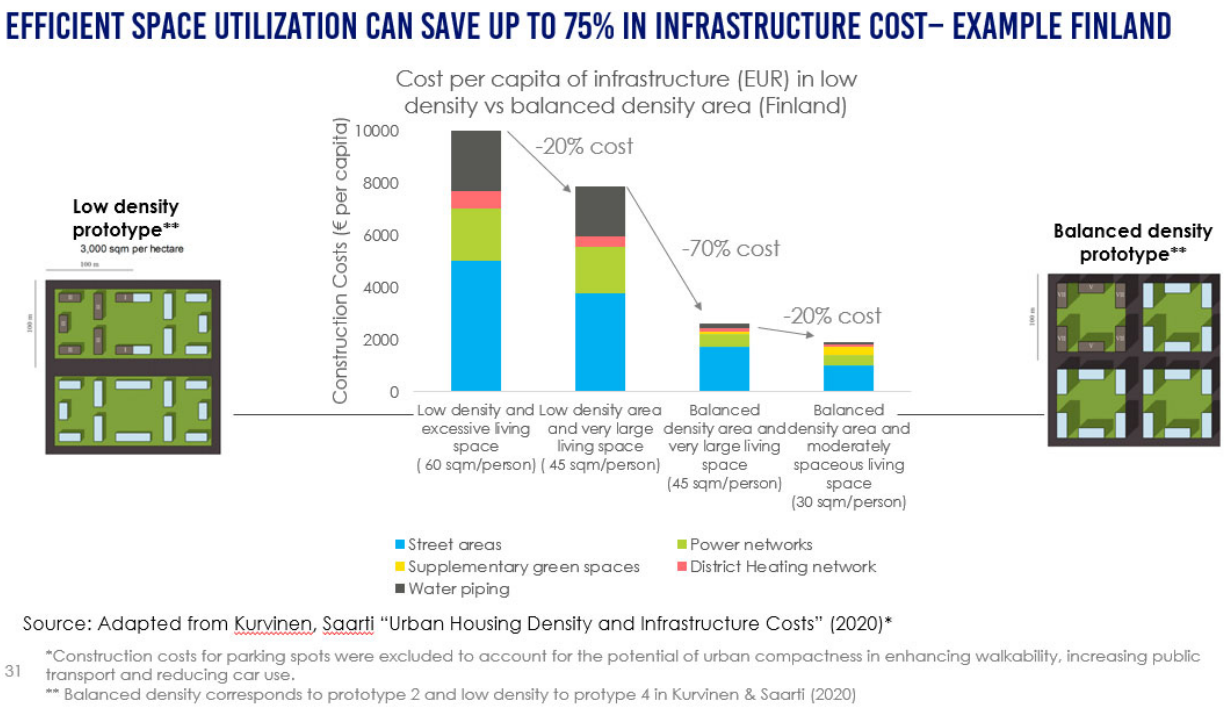
Synthesis of key literature on the economic benefits of efficient space use – cost, productivity, market potential

Infrastructure cost savings

Modelling for Finland by Kurvinen and Saari[22] in 2020 showed that up to 75% of public infrastructure costs could be saved by (re-)building and infilling towards "balanced density", rather than building low-density suburbs – see Figure 14 .

Figure 14: Summary of study on infrastructure cost savings in space-efficient neighbourhoods

[21] Hammond and Jones, "Embodied Energy and Carbon in Construction Materials."
[22] Kurvinen and Saari, "Urban Housing Density and Infrastructure Costs."



Source: Adapted from Kurvinen, Saarti "Urban Housing Density and Infrastructure Costs" (2020)*

*Construction costs for parking spots were excluded to account for the potential of urban compactness in enhancing walkability, increasing public transport and reducing car use.
** Balanced density corresponds to prototype 2 and low density to protype 4 in Kurvinen & Saarti (2020)

31

[Source in graphic: [23]]

Productivity and investment potential

An extensive literature analysis by the Coalition for Urban Transitions and the Urban Land Institute[24] in 2018 showed that, across 300 high-income cities globally, a 10% increase in density can raise productivity[25] -, by 71 USD per person per year. The value of increased innovation is equivalent to ca. two dollars per person per year. Where less space is used for buildings, more green space can be offered, improving mental and physical health (for example, through the natural cooling effect created by greener cities). This is already estimated to be worth USD 41, likely to increase in value fast with rising temperatures. The study also found significant detrimental effects of unmanaged density, such as extreme inequalities in green space access, pollution, congestion and unaffordable rent – a reminder to look at efficiency and balance in space as two sides of the same coin.

[23] Kurvinen and Saari.
[24] Urban Land Institute, "Supporting Smart Urban Development."
[25] meaning value-output of every hour worked and wages

Figure 15: Excerpt from study on economic benefits of urban density

Analysis by Coalition for Urban Transitions "Demystifying Compact Urban Growth"; study across 300 high-income cities

Benefits of good density	Increasing density in high-income cities by 10% is worth approximately (in USD) [1]
Productivity (increase in work productivity, wage => aligned with literature on agglomeration economies)	$71 per person per year
Innovation (increased number of patents)	$2.1 per person per year
Job accessibility (decrease in commuting time, distance and cost)	$62 per person per year
Service accessibility (decrease in distance to services and amenities)	$49 per person per year
Preservation of urban green space (preservation of open space and biodiversity)	$41 per person per year
Energy efficiency (lower energy consumption)	$25 per person per year
Pollution (reduced carbon emission, noise)	$14 per person per year
Safety in urban environments (lower crime rate)	$8 per person per year

Source for Table:[26]

Improving on efficient, balanced space utilisation offers direct benefits for real estate and infrastructure investors, both public and private. In large, well-functioning cities, these benefits are already well understood, at least since The Urban Land Institute's report *Supporting Smart Urban Development: successful investing in density* in year 2018[27]. Real estate investment returns are generally higher in denser, low-carbon cities. Models that improve micro-utilisation are among the top real estate trends (see Figure 16), such as affordable housing, Co-living, assisted living facilities, and serviced apartments.

Figure 16: Investment benefits and trends in space-efficient cities and building designs

INVESTING IN SPACE-EFFICIENCY IS CLEARLY PROFITABLE AND BECOMING MAINSTREAM; BUT STILL MOSTLY IN LARGE AND ALREADY DENSE CENTRES

Macro-dimension: Real estate investment returns are generally higher in denser, low-carbon cities [2]

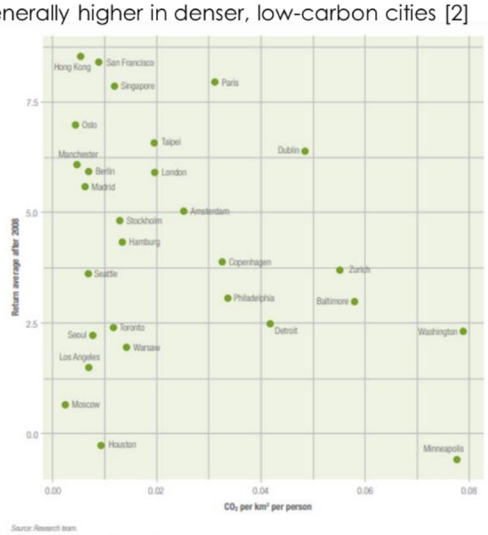


Figure: Urban Land Institute, 'Supporting Smart Urban Development: Successful Investing in Density', 201

Micro-dimension: Shared and diverse (affordable) living solutions are projected to be top real estate investment opportunities [2]

Table 2-1 **Sector prospects in 2022**

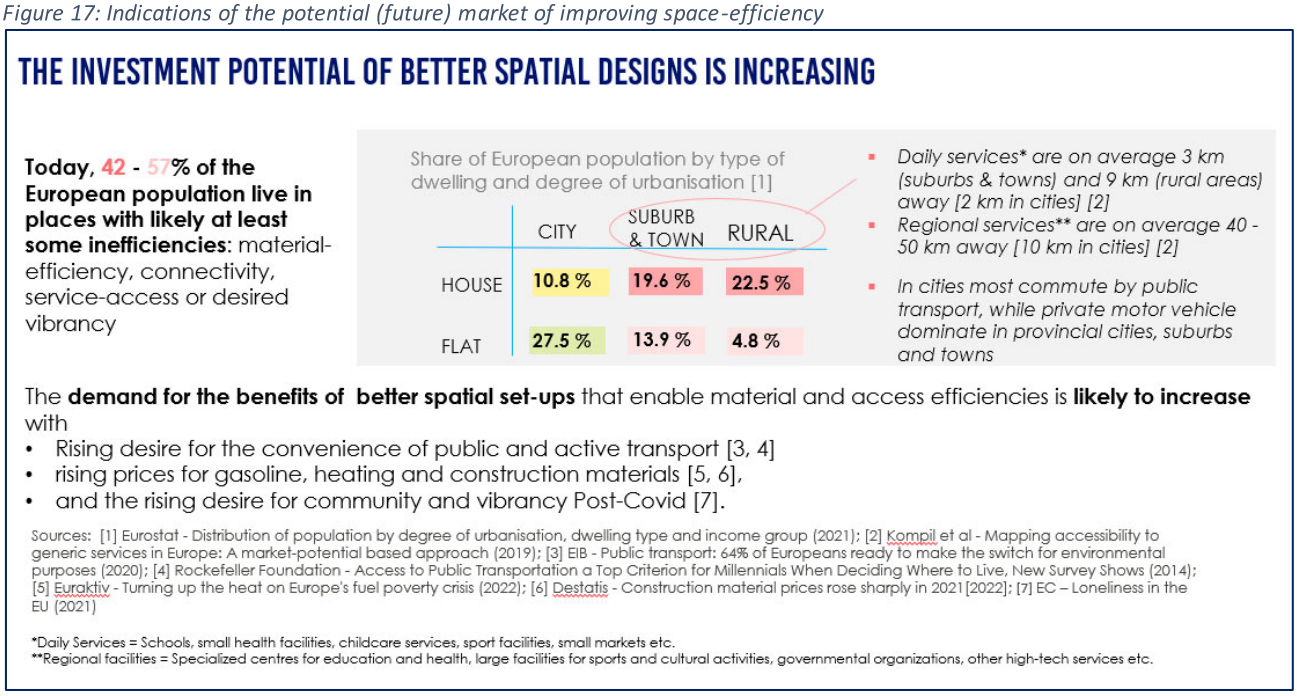
	Overall prospects	Rank	Investment	Rank	Development	Rank	Income
	1 New energy infrastructure	1	4.81	2	4.60	4	4.36
	2 Life sciences	2	4.65	4	4.49	2	4.48
	3 Logistics facilities	3	4.60	3	4.55	3	4.41
	4 Data centres	4	4.55	1	4.63	1	4.49
	5 Health care	5	4.46	6	4.31	5	4.19
→	6 Retirement/assisted living	6	4.44	5	4.33	8	4.13
	7 Industrial/warehouse	7	4.40	8	4.25	7	4.18
→	8 Affordable housing	8	4.33	9	4.22	13	3.88
	9 Self-storage facilities	9	4.32	12	4.13	9	4.10
→	10 Private rented residential	11	4.29	7	4.27	10	4.07
	11 Housebuilding for sale	10	4.29	10	4.21	6	4.18
→	12 Social housing	12	4.15	11	4.15	12	3.90
	13 Multi-let/flexible industrial parks	13	4.09	13	3.98	11	3.91
→	14 Co-living	14	3.96	15	3.88	15	3.76
→	15 Student housing	15	3.93	14	3.93	14	3.79
→	16 Serviced apartments	16	3.84	16	3.72	16	3.64
→	17 Flexible/serviced offices and co-working	17	3.74	17	3.54	18	3.45
	18 Leisure	18	3.74	18	3.41	19	3.37
	19 Central city offices	19	3.60	19	3.35	17	3.48
	20 Retail parks	20	3.56	22	2.98	20	3.29
	21 Business parks	21	3.40	20	3.10	21	3.13
	22 Hotels	22	3.36	21	3.05	23	3.00
	23 Parking	23	3.12	23	2.80	22	3.03
→	24 Suburban offices	24	3.01	24	2.79	24	2.90

Figure: Adapted from PWC & Land Urban Institute, "Emerging Trends in Real Estate 2022" (2021)

[26] Coalition for Urban Transitions, Ahlfedlt, and Pietrostefani, "Demystifying Compact Urban Growth: Evidence From 300 Studies From Across the World."
[27] Urban Land Institute, "Supporting Smart Urban Development."

Source for graphics:[28]
These trends, however, currently focus mainly on larger, already dense cities. The potential for investing in lower-density areas, where real estate markets are often dominated by small-scale developers or individual home-builders, is less straight forward but still interesting[29].

Figure 17: Indications of the potential (future) market of improving space-efficiency



[Sources in Graphic: [1][30] [2][31] [3][32] [4][33] [5][34] [6][35] [7][36]]

C. Analyses of the space-use patterns in Europe

Summary of existing analyses of different European space-use indicators

Land-inefficiencies (Macro-dimension) dominate in Northern and Eastern Europe, and are more prevalent in sub-urbs and smaller towns

Large cities generally use land more efficiently than smaller cities, with a positive efficiency trend. Some large cities are growing less efficient, mainly in Eastern Europe[37]. Across large and smaller cities, land use is generally high in suburbs with little improvement across city sizes. Many smaller cities also show high land consumption in some centres, in addition to suburbs. Overall, small towns have been becoming less efficient since 2012, whether they are growing or shrinking in population.

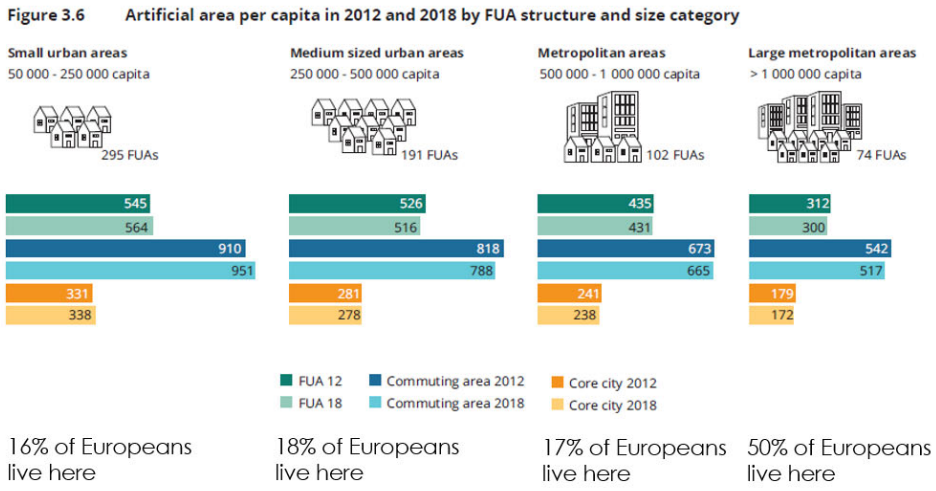
---

[28] PWC and Urban Land Institute, "Emerging Trends in Real Estate 2022."
[29] Booi and Boterman, "Changing Patterns in Residential Preferences for Urban or Suburban Living of City Dwellers."
[30] Eurostat, "Eurostat - European Statistics."
[31] Kompil et al., "Mapping Accessibility to Generic Services in Europe."
[32] European Investment Bank, "Public Transport."
[33] The Rockefeller Foundation, "Access to Public Transportation a Top Criterion for Millennials When Deciding Where to Live, New Survey Shows."
[34] Lloyd, "Turning up the Heat on Europe's Fuel Poverty Crisis."
[35] Destatis, "Construction Material Prices Rose Sharply in 2021."
[36] European Commission, Joint Research Centre, and Cassio, L., d'Hombres, B., Tintori, G., et al., "Loneliness in the EU: Insights from Surveys and Online Media Data."
[37] European Environment Agency et al., *Land Take and Land Degradation in Functional Urban Areas.*, 2022.

Figure 18[38] shows land consumption and trends since 2012 for different urban area sizes. Worsening trends and slow improvements from high-consumption levels are reasons for urgent action.

Figure 18: Land use per urban area size

LAND USE BY CITY SIZE: SMALL URBAN AREAS AND COMMUTER SUBURBS MUST BECOME MORE EFFICIENT



- Small urban areas use over 1/3 more land per person than big cities, and are becoming less efficient.
- Metropolitan areas have slightly improved in land use since 2012, but from a more efficient starting point.
- Efficiency improvements in commuting areas (suburbs) have been small despite high land consumption

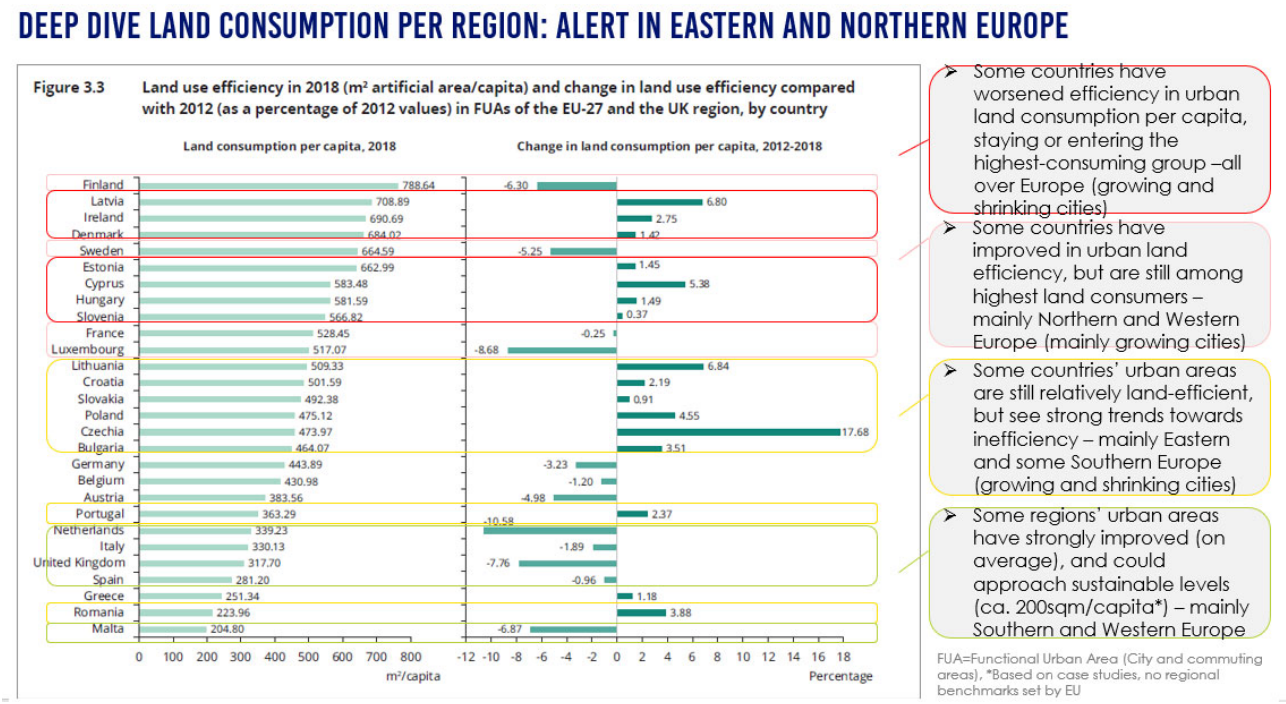
Figure: EEA "Land take and land degradation in functional urban areas" (2022). "FUA" = Functional Urban Area.

Figure 19[39] shows regional differences in urban land consumption. Worsening trends, slow improvements from high-consumption levels or fast worsening trends are reasons for urgent action.

[38] European Environment Agency et al., *Land Take and Land Degradation in Functional Urban Areas.*, 2022.

[39] European Environment Agency et al.

Figure 19: Urban land use and trends per country



Note that industrial and commercial sites contribute as much, or more, to land-take as residential developments – but as reasons and implications are different, land use by industrial sites will require a dedicated analysis outside of the scope of this White Paper.

Building-use inefficiencies (Micro-dimension) dominate in Southern Europe but apparent across European regions

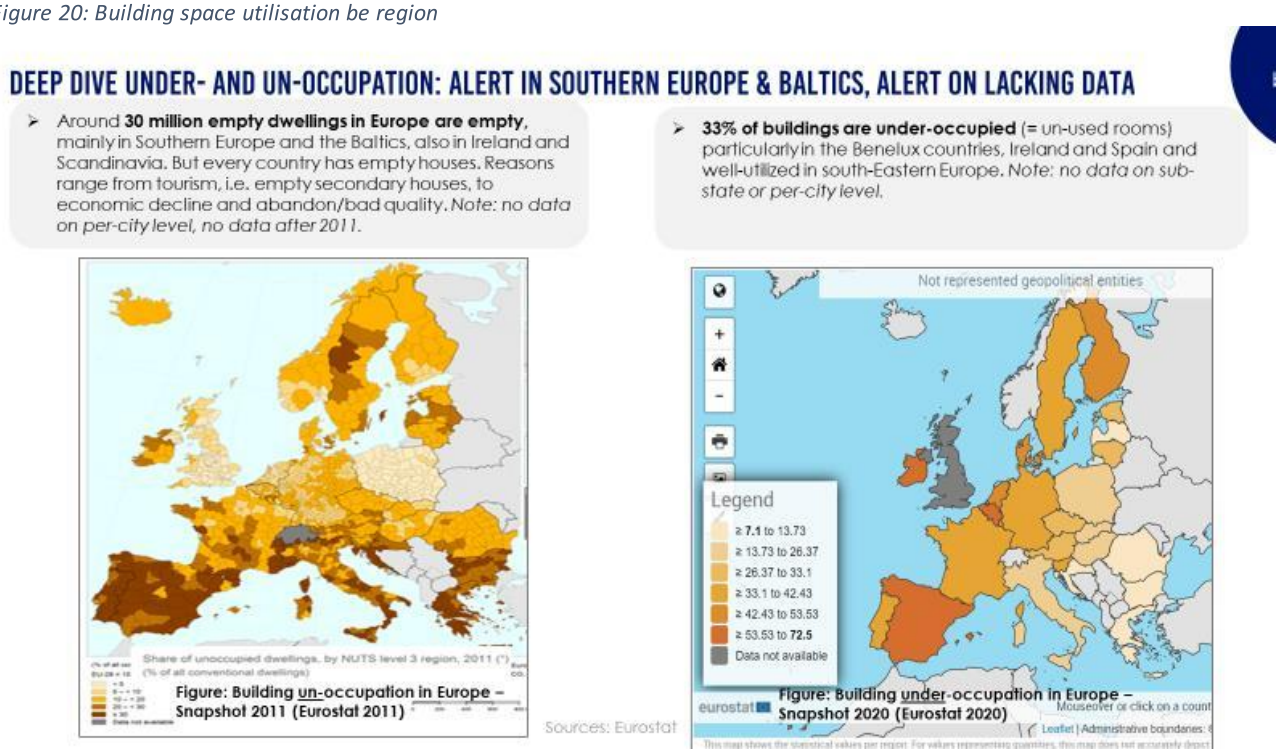
On the micro level, vacancies can be found in Southern Europe especially, across growing and shrinking cities. Unused rooms (or 'under-occupation'[40]) is common in different countries across Europe, including the Netherlands, Ireland and Spain. Figure 20[41][42] shows the geographical prevalence of un-occupation and under-occupation of buildings in Europe. Note that the data is not up-to-date and lacks granular detail – pointing to an important monitoring gap on European level.

[40] Eurostat defines an under-occupied dwelling as a dwelling where the household has more living space at its disposal than the minimum number of rooms considered adequate, which entails one room per household and one room per couple, per individual aged 18 or more, per pair of single people of the same gender 12-17 years of age, and per pair of children under the age of 12.

[41] Eurostat, "People in the EU - Statistics on Housing Conditions."

[42] Eurostat, "Share of People Living in Under-Occupied Dwellings."

Figure 20: Building space utilisation be region



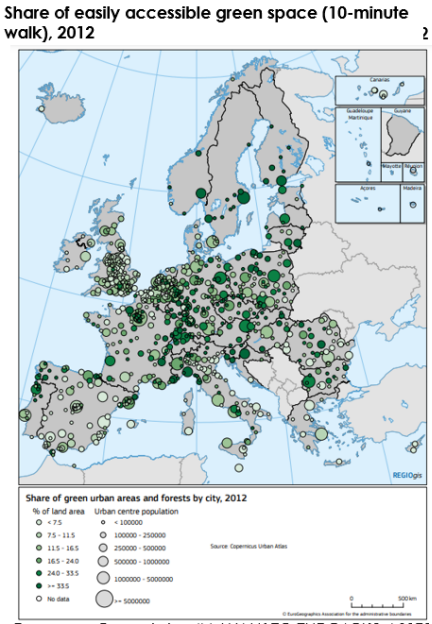
Imbalances: Green space often missing in Southern Europe, public transport scarce in lower-density areas

In terms of public transport access, which is a key indicator both of efficiency and balance, European cities generally fare well. However, very good connections are often missing in lower-density areas and more generally in Southern Europe. Southern Europe also performs less well on access to green spaces, a key element of balanced space use. This is particularly alarming as global temperatures increase. Figure 21[43] show the distribution of easy access to green space across Europe. While 'some access' to 'medium access' is common across Europe, 'very good' access is found in only a few places, mainly in central and North-Eastern Europe. Green space access does not correlate clearly with city size or density. Some larger (e.g. Stockholm, Vilnius), denser cities (e.g. Vienna) are among the best for green space access , suggesting it is possible to create a good balance while also attaining efficient utilisation of space.

[43] Poelman, "A WALK TO THE PARK? ASSESSING ACCESS TO GREEN AREAS IN EUROPE'S CITIES."

Figure 21: Green space access across Europe

DEEP DIVE GREEN SPACE ACCESS (KEY 'BALANCE' INDICATOR): HIGH ALERT IN SOUTHERN EUROPE, BUT GAPS IN ALL COUNTRIES



Map: European Commission "A WALK TO THE PARK? ASSESSING ACCESS TO GREEN AREAS IN EUROPE'S CITIES" (2018)

- Northern and North-Eastern Europe (DE, PO, CZ, SW, FI, LT) have more cities with good access to green urban areas (as well as forests)
- Southern and some Western Europe (UK, FR, SP, IT, RO, BU, GR) have few cities with adequate access to green areas

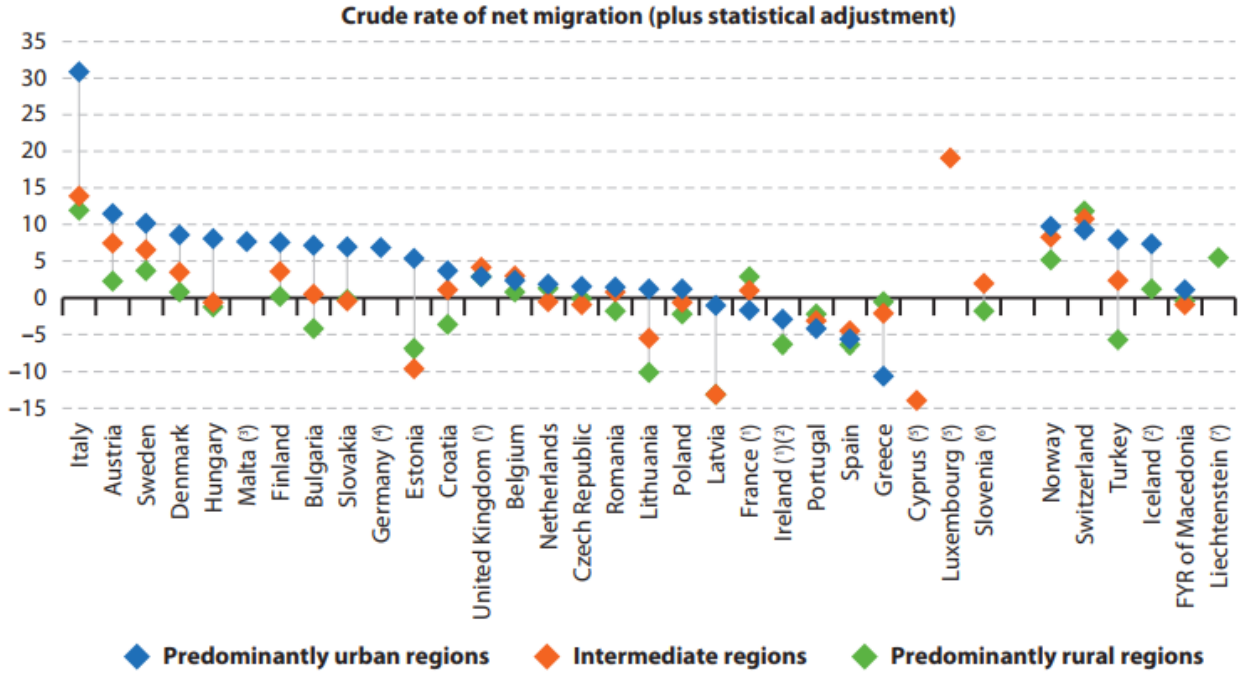
Source: (1) European Commission "A WALK TO THE PARK? ASSESSING ACCESS TO GREEN AREAS IN EUROPE'S CITIES" (2018)

Migration will change housing demand with increased pressures for efficient downsizing mainly in the South and smaller towns and efficient growth in the North and medium-large cities

European Commission research finds that the total population of Europe's urban areas is likely to increase on average by 6.8% by 2050. Within that, however, only half of Europe's cities will grow, half of urban areas will lose population, with 12% of cities losing more than a quarter of their population between 2015 and 2050[44]. Cities in Southern and North-Eastern Europe are particularly affected by population losses. In terms of land-efficiency trends in population-shrinking cities, some medium and small cities are mainly just emptying, but many cause sprawl and absolute land-consumption while emptying out from the centre, also causing un-occupation[45][46] Large cities are not (yet) shrinking in Europe. However, climate migration will change this. It is predicted that extreme heat - and inadequate adaptation to it – will cause many people to leave Southern Europe's space-efficient and currently popular cities. This will cause inefficiencies in the form of vacancies in housing but also in terms of opportunity cost, as many of those climate migrants will move north where standard plots are less efficient.

[44] European Commission and Joint Research Centre, "The Future of Cities."
[45] Eurostat defines un-occupation as a dwelling reserved for seasonal or secondary use (such as holiday homes) or if they are vacant (dwellings which may be for sale, for rent, for demolition, or simply lying empty and unused).
[46] European Environment Agency et al., *Land Take and Land Degradation in Functional Urban Areas.*, 2022.

Figure 22: Population development in different settlement forms per country, 2013



(1) Provisional.
(2) Intermediate regions: not applicable.
(3) Intermediate regions and predominantly rural regions: not applicable.
(4) 2012. Intermediate regions and predominantly rural regions: not available.
(5) Predominantly urban regions and predominantly rural regions: not applicable.
(6) Predominantly urban regions: not applicable.
(7) Predominantly urban regions and intermediate regions: not applicable.

Source: Eurostat (online data code: urt_gind3)

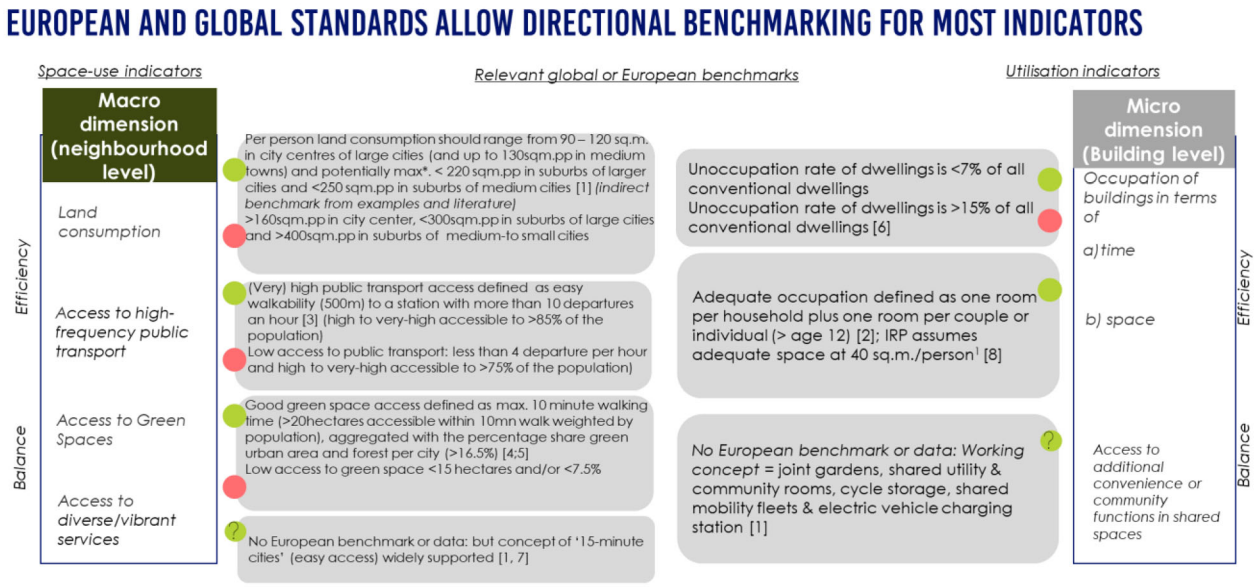
Figure source: [47]

Details on this paper's definition of the directional working benchmarks of good space use

In absence of clear European quantitative benchmarks for good urban space use, this Paper has developed directional working benchmarks, based on previous evaluations by the European Commission, Eurostat, the European Environment Agency, literature on 'articulated density' and the example of highly efficient yet fairly balanced cities in Europe.

[47] European Commission. Statistical Office of the European Union., *Urban Europe*.

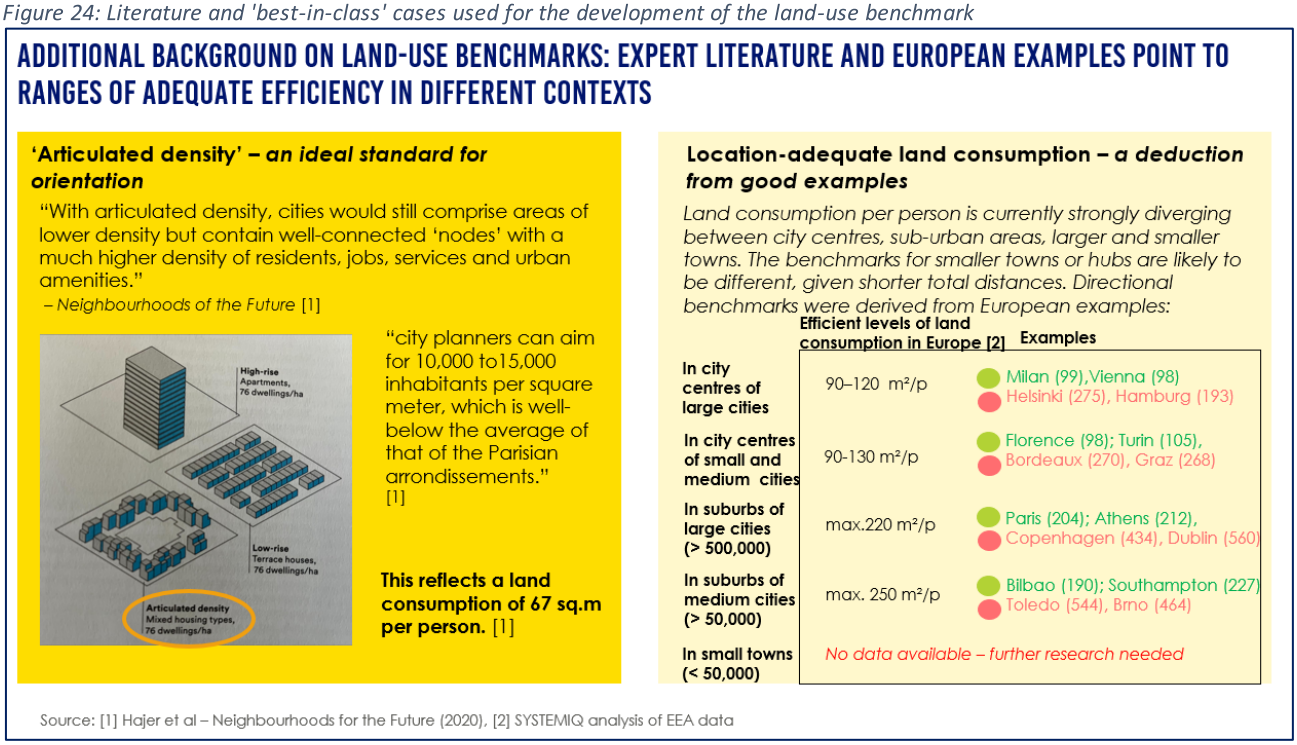
Figure 23: Directional benchmarks for space-use indicators



Source: SYSTEMIQ synthesis, based on [1] SYSTEMIQ analysis of high-performing European cases – see details in following [2] Eurostat, 'Glossary: Under-Occupied Dwellings', 2021, [3] Hugo Poelman and Lewis Dijkstra, 'Measuring Access to Public Transport in European Cities', European Commission WP 01/2015, no. Regional Working Paper 2015 (2015) [4] Hugo Poelman, 'A Walk to the Park? Assessing Access to Green Areas in Europe's Cities', European Commission, no. WP 01/2018 (2018) [5] European Environment Agency, 'Who Benefits from Nature in Cities? Social Inequalities in Access to Urban Green and Blue Spaces across Europe — European Environment Agency', Briefing, 2022, ; [6] Eurostat, 'Share of People Living in Under-Occupied Dwellings' [7] European Commission and Joint Research Centre, 'The Future of Cities', European Commission, 2019 [8] International Resource Panel, 'Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future, 2018

Deriving quantitative benchmarks for an 'ideal' land use, in particular, is contentious, because cities across Europe are so different, and start from very different levels of land use per capita today – especially in terms of smaller versus larger cities. Figure 24 shows how the directional benchmarks for efficient land-use was derived from literature on sustainable urban settlements and best-in class city performances across Europe.

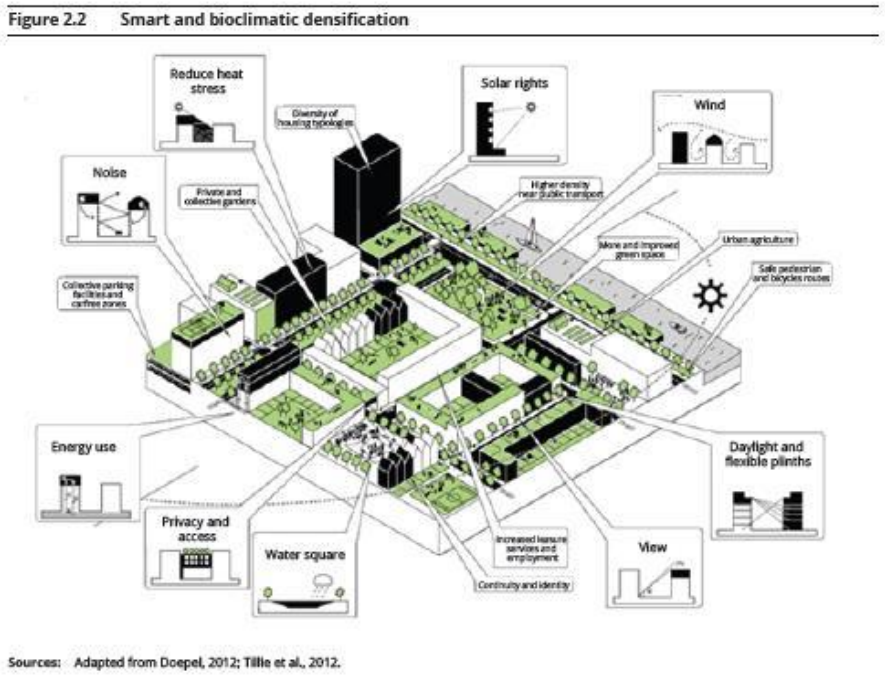
Figure 24: Literature and 'best-in-class' cases used for the development of the land-use benchmark



Source: [1] Hajer et al – Neighbourhoods for the Future (2020), [2] SYSTEMIQ analysis of EEA data

[Source in graphic: [1][48] [2] SYSTEMIQ Analysis based on:[49]]
Figure 25, adapted from the European Environment Agency's leading research on resource efficient cities[50], shows another example of a dense, yet highly liveable and green settlement structure that can illustrates the directional benchmark, and also serves as inspiration for this paper's main illustration of an efficient, balanced city.

Figure 25: European model illustration of a sustainable neighbourhood



[51]

These directional benchmarks form the basis for the following analyses, being regarded as good general indicators for high-functioning space utilisation. EU-level modelling is needed to refine these benchmarks, determining with more nuance what level of utilisation would perform best for European land-use, energy and material targets, as well as economic performance and social cohesion – especially in different regional contexts and city sizes.

Details on this paper's quantitative evaluation behind the 15 urban profiles

The following table displays the numeric factor for each indicator for the example cities in each profile.
Cities not yet listed can use the same source databases to start evaluating their space use and directional profile.

Figure 26: Quantitative analysis of European Urban Areas

[48] Hajer et al., *Neighbourhoods for the Future*.
[49] European Environment Agency et al., *Land Take and Land Degradation in Functional Urban Areas.*, 2022.
[50] "Urban Sustainability Issues - Resource-Efficient Cities: Good Practice."
[51] "Urban Sustainability Issues - Resource-Efficient Cities: Good Practice."

Projected population evolution (2015-2050)	Typologies / Profiles	City	Land-consumption per person city center	Land-consumption per person suburbs	Land use trend 2012-2018 (center/suburbs evolution)	Access to transport (Share of the population with access to public transport at high or very high frequencies)	Access to green spaces (Share of green urban areas and forests as % of land area in 2012)	Unoccuppied conventional dwellings (Share of unoccupied dwellings as part of total conventional dwellings 2011)
Sources: European Commission (2019) "Future of Cities"	*SYSTEMIQ analysis*		*EEA (2022) "Land take and land degradation in functional urban areas"*			*EUROSTAT; European Commission (2020) "How many people can you reach by public transport, bicycle or on foot in European cities? Measuring urban accessibility for low-carbon modes"*	*EUROSTAT; European Commission (2018) "A walk to the park? Assessing access to green areas in Europe's cities"*	*EUROSTAT (Warning: regional data - variable size of region. We have chosen to remove the data for its lack of*
Benchmarks			cities <120sqm.pp; Inefficient large cities >160sqm.pp Efficient medium cities <130sqm.pp: Inefficient medium	Efficient large cities <220sqm.pp; Inefficient large cities >300sqm.pp Efficient medium cities <250sqm.pp: Inefficient medium cities >400sqm.pp		Efficient >85%; Inefficient <75%	Balanced >20% ; Imbalanced <15%	*Efficient: <7%; Inefficient: >15%*
GROWING Large cities	Persistent Urban dispersion	Prague	187	407	Stable (-2;1)	89.9	19.1	7.7
		Warsaw	172	419	Worsening (1;2)	90.1	24.2	3.7
		Budapest	187	374	Improving (-1;-1)	85.9	15.6	13
		Krakow	207	478	Worsening (3;4)	78.9	11.9	3.2
		Dublin	189	560	Worsening (1;3)	57.1	8.3	11.6
	Extensive Urban-Rural expansion	Munich	144	317	Improving (-5;-4)	X	14.4	7.4
		Berlin	154	418	Improving (-7; -6)	89	26.8	5.3
		Hamburg	193	345	Improving (-5;-3)	89.9	14.4	4.2
		Lyon	146	396	Improving (-3.6; -3.2)	86.6	14.5	9.3
		Helsinki	275	482	Improving (-5;-6)	77.7	44.5	6.8
		Stockholm	108	415	Improving (-9;-7)	79	56.2	14.9
		Copenhagen	126	434	Slightly Improving (-2;0.5)	78.9	13	6.4
	Regional scattering	Amsterdam	165	215	Improving (-18;-11)	75.7	9.6	7.6
		Rotterdam	138	176	Improving (-36; -19)	70	9	X
		London	140	206	Improving (-6;-1)	84.6	12.6	4
	Pressured hyper-compact	Paris	67	204	Slight improving (-2;-1)	85	15.2	14
		Athens	51	212	Stable (0; 0)	75.2	9.9	28.7
		Milan	99	221	Improving (-7;-3)	X	4.8	6.1
	Fairly compact urban expansion	Vienna	98	285	Slight improving (-1;-5)	92.9	28.2	14.8
GROWING Medium & Small cities	Persistent town sprawl	Toledo	396	544	Stable (1;0)	X	2.1	37.6
		Brno	253	464	Worsening (1;10)	X	31.8	11.9
		Brugge	510	631	Worsening (4;2)	45.6	10.6	27
		Aalborg	828	1,176	Worsening (1.5; 2)	64.7	10.4	X
		Metz	264	569	Worsening (2;1)	65.9	20.6	9.6
		Gyor	415	728	Worsening (3.3; -0.3)	X	19.8	9.7
		Arhus	450	726	Worsening (2;2)	79.2	9.4	X
		Helsingborg	509	703	Worsening (1.5; 1.2)	70.3	8.4	X
		Cherbourg	399	858	Worsening (3.8; 3.9)	X	11.7	X
		Galway	343	1,109	Worsening (1;2)	X	6.3	X
		Le Havre	312	545	Worsening (2;3)	75.7	7.2	9.9
	Pressured town expansion	Bordeaux	270	672	Improving (-5;-3)	72.4	25.8	14.7
		Gothenburg	239	522	Improving (-4.9; -4.8)	68.4	42.2	X
		Cambridge	234	556	Improving (2.3; -18.4)	63	10.6	3.1
		Montpellier	174	415	Improving (-5;-2)	79	13.6	26.4
		Exeter	116	614	Improving (-2.3; -29.4)	83.4	10	X
		Trento	283	436	Improving (-2.8; -2.6)	62.8	53	37
		Leipzig	252	574	Improving (-11;-5)	77.4	12.5	12.3
	Worsening moderate town	Nice	173	330	Slightly worseing (1;2)	64.8	42.2	32.1
		Cluj-Napoca	165	225	Worsening(7;3)	67.9	19.7	17.1
	Improving moderate town expansion	Linz	254	587	Slightly improving (-0.8;-4)	80.9	24	13.8
		Grenoble	163	468	Stable (-0.3; 0.2)	85.4	45.5	15%
		Ljubljana	269	476	Slightly improving (-2.9; -0.	83.1	43.6	X
		Graz	268	619	Slightly improving (-0.6;-5)	81.4	28.3	14.8
		Treviso	342	475	Improving (-4.3; -2.5)	X	3.6	14
		Colmar	308	615	Slightly improving (-1.9; -1.1	X	25.9	X
		Middelburg	267	365	Improving (0.1; -16)	X	4.6	X
	Low pressure compact town expansion	Maastricht	132	175	Improving (-8;-3)	50.6	7.7	X
		Turin	105	251	Slightly Improving (-2, -1)	87.6	18	15.8
		Florence	98	199	Improving (-5;-4)	91.1	10.7	10.2
		Bilbao	53	190	Slight improving (-1.5;-0.5)	91.3	21.1	X
		Southampton	117	227	Highly Improving (-2.3;-25)	61.8	13.2	2.8
		Aachen	130	207	Highly Improving (-25.8; -17	70.1	23.9	X
Not-yet-SHRINKING Large Cities	Compact (future) emptying	Barcelona	81	153	Stable (0;-1)	99.4	21.1	16.7
		Madrid	109	187	Slightly improving (-1;-4)	96.9	11.2	14.6
		Naples	117	191	Stable (-0.5;0)	X	12.1	11.2
SHRINKING Cities	Moderately compact emptying city	Porto	257	282	Worsening (3;3)	X	33.1	22.2
		Bacau	131	200	Stable (-1;1.3)	X	4.7	17.1
		Braga	186	282	Worsening (3.8;3.7)	59.4	27.9	28.5
		Calarasi	244	272	Worsening (6.2; 6.7)	X	X	X
		Valladolid	169	352	Slightly worsening (2;-0.6)	X	12.9	25
		Blackpool	112	205	Worsening (1;21)	64.4	3.7	5.9
	Emptying center expansion	Lens	254	333	Worsening (4.8;3.4)	X	10	X
		Vilnius	267	548	Worsening (2.9; 3.9)	75.5	41.4	X
		Lublin	229	549	Worsening (7;8)	70.9	17.5	X
		Bourges	538	1,064	Worsening (7.6; 4.4)	X	9	18.3
		Banská Bystric	279	461	Worsening (3.3; 1.8)	X	56.3	X
		Pila	335	500	Worsening (3.3;5.8)	X	57.2	1.5
		Szeged	354	691	Worsening (1.5;2.6)	73.4	11.2	X
		Olsztyn	194	537	Worsening (6;13)	82.4	37.3	X
		Riga	227	598	Worsening (2; 4)	73.3	28.9	16.7
		Ostrava	261	365	Heavily worsening (6;50)	X	20.9	9.8
		Kaunas	307	567	Worsening (13;12)	76.1	25.2	X
		Debrecen	427	644	Worsening (5;5)	X	33.3	9.5

A more detailed literature summary of the socioeconomic drivers of inefficient and imbalanced space use

While not exhaustive, the following list summarises what we found to be the most recurring factors across literature.

Drivers of inefficient space utilisation (sprawl, un-used rooms, vacancies) range from cultural and norm factors shaping personal preferences, to economic conditions driving inefficient building patterns and straight-out adverse policies that hinder efficient building, such as land-zoning for low-density settlements:

- Culture, norms and dominant designs
    - Individual housing with garden is still often perceived as higher quality of life and safety[52] (often overlooking the hidden costs of maintenance and commuting, and the forgone benefits of service-access, connectivity or potential for higher convenience through shared multi-functional spaces and appliances)
    - Rising income therefore still often lead to desire for more space and secondary homes[53]
    - In some cases, too small and/or bad quality and hard-to adapt housing disincentivise living in space-efficient areas[54]. Especially in Eastern Europe, too small city centre apartments seem to drive people into inefficient sub-urban alternatives.
    - There is a lack of attractive housing alternatives beyond too small apartments vs detached houses. The analysis has not found wide-spread availability of high-quality, mixed-rise, 4-8 unit buildings with garden access that are an attractive alternative to detached homes.

[55] [56]

- Economic conditions
    - Economic growth (high GDP) and access to car can be both the trigger and the result of urban sprawl[57]
    - High demand for housing results in higher prices on the housing market, often forcing families and lower income households in particular to move into cheaper outskirts, causing sprawl and partial vacancies[58][59]
    - Cheap infrastructure in sprawled areas relative to its actual cost to the municipality is an indirect public subsidy incentivising suburban building. It is sometimes combined with direct tax incentives
    - Fast value-increasing and unregulated real estate markets foster speculation investment and limit incentives to let out to long-term tenants, increasing the number of housing vacancies in high-pressure cities.
    - On the micro-level, repurposing of buildings and renovation is often more costly due to higher labour implications, or missing opportunities to renovate at scale.

Adverse policies

- Public narratives have been promoting living in suburban single-family houses in the 60-70s[60]

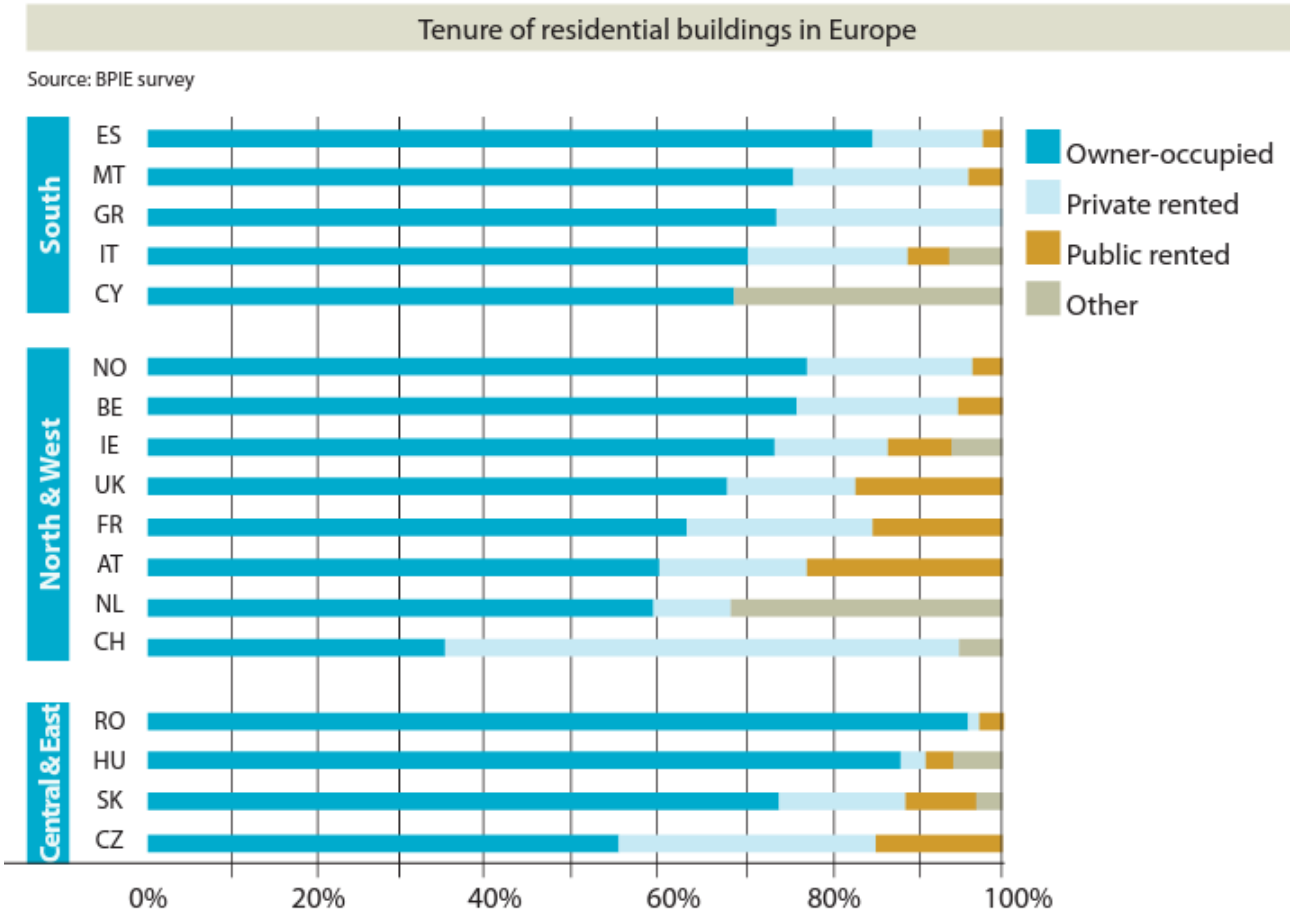
[52] European Environment Agency, *Urban Sprawl in Europe*.
[53] I et al., "The Future of Cities - Opportunities, Challenges and the Way Forward."
[54] Wolff, Haase, and Haase, "Compact or Spread?"
[55] Rosni and Mohd Noor, "A REVIEW OF LITERATURE ON URBAN SPRAWL: ASSESSMENT OF FACTORSAND CAUSES."
[56] Litman, "Analysis of Public Policies That Unintentionally Encourage and Subsidize Urban Sprawl."
[57] European Environment Agency, *Urban Sprawl in Europe*.
[58] European Environment Agency.
[59] Wolff, Haase, and Haase, "Compact or Spread?"
[60] Wolff, Haase, and Haase.

- In many instances, adverse zoning policies are fostering monofunctional low-density housing, parking requirements etc[61]
- Cumbersome bureaucratic procedures, sales tax, and higher relative price for smaller housing often hinder people from moving housing and downsizing when family size changes
- On the micro-level, old safety regulations or overspecifications for construction can hinder a modular design, deep renovation and repurposing.

A driver related to both norms and often public financial incentives, is the structure of land – and home ownership. Literature has shown that fragmented ownership can be a considerable barrier to coordinated, integrated neighbourhood shaping and building renovation at scale. Case studies suggest that improvements in integrated planning often go hand-in-hand with larger public or cooperative ownership[62]. 70% of the EU population live in owner-occupied dwellings, The remainder represents renters (regular and social housing), from private, public or cooperative owners.[63] There are large disparities in ownership rates between Eastern Europe with more than 80% owner-occupiers (originating from the 1990s privatisation movement) and Austria and Germany with less than 60% (see Figure 27 from BPIE). For context, Eastern Europe is facing particularly pronounced sprawl trends, the Austrian capital is known for its balanced efficiency. Supply of social housing in Europe also varies widely with Austria and the Netherlands providing respectively 24% and 29% social housing while Germany and Portugal provide less than 3% social housing.[64]

[61] European Environment Agency, *Urban Sprawl in Europe*.
[62] Rogers, "Gentle Densification of Suburbs Could Help Meet London's Housing Needs."
[63] Eurostat, "7 in 10 people in the EU live in a dwelling they own."
[64] Housing Europe, "State of Housing in Europe 2021."

Figure 27: Overview over ownership structure of residential buildings in Europe



Graphics from BPIE 2011 [65]

In terms of imbalances (lack in green & community space and service-access), the driver can be summarised as fragmented and short-term value perspectives:

- Developers of hyper-dense areas often cannot see how to benefit from the value that balanced space creates on the neighbourhood level (e.g. increasing real estate value and reducing health costs)
- Building developers are often distant from infrastructure planners and investors.
- Effective coordination of investors through masterplans or public orchestration is often missing, related also to the before-mentioned fragmented ownership structures.

D. Analyses behind the solutions and action suggestions (underpinning Chapter 5)

Detailed analysis of 9 cases of applied multi-stakeholder approaches in different city profiles

Approaches in large growing cities (profiles 1-3)

To recap the priority physical transitions, large, growing cities need to pay extra attention to:

[65] Buildings Performance Institute Europe, "Europe's Buildings under the Microscope - A Country-by-Country Review of the Energy Performance of Buildings."

- Transition 1: Cooperation with smaller towns to balance population pressures and ensure complementary regional development
- Transition 3 & 5: Minimizing un-occupation/under-occupation and ensuring affordability
- Transition 4: Infilling/upfilling of selected low-pressure hubs with good transport connections

The 15 profiles analysis showed that, while large cities are naturally pushed to be decently efficient in the city centre due to scarce land and housing pressure, efficiency can still often be improved through regional collaboration (see: Hamburg), or by tackling vacancy and unused/decaying spaces in the centre (see: Rotterdam, Hamburg) and crucially by making suburbs more efficient and balanced. Another big challenge in city centres of large cities is their lack of access to green space and the risk of heat islands, needing to be tackled through climate change adaptation measures such as nature-based solutions (see: Lisbon).

In terms of multi-stakeholder approaches, the cases of growing large city improvement show that vision building and public orchestration of investments, in combination with master planning are approaches of particular importance for this group.

Figure 28: Case study Profile 2

[Sources Case study Hafencity Hamburg: 66676869]

[66] HafenCity Hamburg GmbH, "HafenCity Hamburg GmbH: Integrated Development Management."
[67] Jacuniak-Suda, "Interim Pilot Implementation Report - URMA."
[68] LSE Cities, "Port Redevelopments Hamburg, HafenCity - Data | Urban Age."
[69] Urban Land Institute, "Public-Private Partnerships in Sustainable Urban Development."

Figure 29: Case study profile 3

ROTTERDAM (NL) – EFFICIENT LOCAL MAPPING AND TARGETED INVESTMENTS REVIVE DECLINING AREAS AND REDUCE VACANCY

City profile 3: Growing large city – Regional scattering

Background and challenge: The City of Rotterdam has found an innovative, low-key solution to influence the revitalisation of deprived areas and areas with empty, unmanaged spaces.

Multi-stakeholder approaches taken:

VISION and MISSION BUILDING

- The City developed the **Klushuis "do-it-yourself house" concept** (2004): low cost supply of obsolete houses (privatization) in deprived neighborhoods.
- And the ***Klein & Fijn "Small & Beautiful" concept***: for infilling smaller plots and overlooked gaps in the urban fabric.

PUBLIC CAPACITY BUILDING

- Identified and mapped gaps in the city center which could accommodate new infill, and identified neglected houses.
- Plots/apartments were purchased from landlords who had failed to maintain them to a legal standard, and resold at a low price, 'as is', on condition that: buyers 1) had resources to renovate or build, and would occupy the property for at least three years; 2) had developed a valid plan with an architect; and 3) could meet insulation and other sustainability standards.

COOPERATIVE INVESTMENT MODELS

- National fund for urban renewal funded the original 200 pilots, taken up by the City since 2009.
- The cost to the City of the Klushuizen scheme was around €30,000 per apartment.
- Private individuals invest in upgrading / construction.

CULTURE and COMMUNITY (RE-) BUILDING

- Opportunities for people who otherwise could not afford to own a home.
- Revitalisation of deprived areas.

Photo credit: Guiding Architects, Edwin Prins https://www.guiding-architects.net/inding-gaps-recent-infill-projects-rotterdam

Main physical transitions employed:

- 2) Quality-upgrade of building
- 4) Infill of suburbs
- 5) Enable higher occupation

Results for efficient, balanced space use and quality of life:

- Improving land consumption per person
- Success of concept: Almost all houses and plots placed on the market were sold (500 appartments over 10 years).
- Eurocities renovation award (for Klushuizen)
- Small plots led to innovative housing solutions, some industry standards

Sources:
- architectuur MAKEN, 'Architectuur MAKEN', 2022,
- Eurocities, 'Do-It-Yourself Houses', 2012.
- ANNEKE, 'Minding the Gaps: Recent Infill Projects in Rotterdam', *Guiding Architects* (blog), 5 April 2018.
- Turkington and Watson, *Renewing Europe's Housing*, Policy Press, 2016.

[Sources Case study Rotterdam:[70][71][72][73]]

[70] architectuur MAKEN, "Architectuur MAKEN."
[71] Eurocities, "Do-It-Yourself Houses."
[72] ANNEKE, "Minding the Gaps."
[73] Turkington and Watson, *Renewing Europe's Housing*.

Figure 30: Case study profile 3 (2)

[Sources Case study Lisbon:[74][75][76][77]]

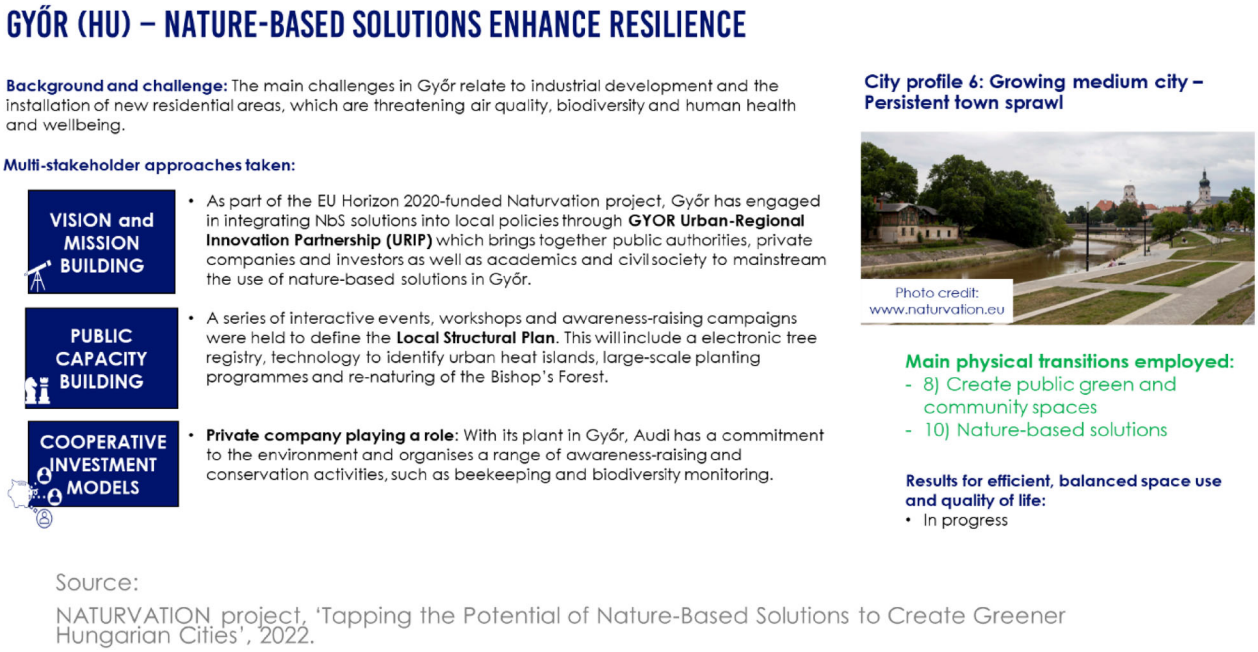
Approaches in medium-smaller growing urban areas (profiles 6-9)
To recap the priority physical transitions, this group of urban areas **(profiles 6-9)** need to pay extra attention to:
- Transition 3 & 5: Minimizing un-occupation/under-occupation and ensuring affordability
- Transition 4: Infilling/upfilling of selected low-pressure hubs
- Transition 7: Upgrading or developing active and public transport links within the centre and to various hubs
- Transition 8: Creating green and community spaces
- Transition 9: Creating space for local business and culture

This is because the key physical challenge in almost all medium-size urban areas is how to make sprawled suburbs (and in some cases city centres) more efficient, prevent further sprawl, and reattract people towards a space-efficient and balanced city centre. To tackle this challenge, each urban areas will need to develop a clear joint purpose for local productivity and vibrancy, building on the local identity, to motivate citizens in their demand for connected neighbourhoods as well as develop a regional funding plans.
In terms of multi-stakeholder approaches, cases of growing medium urban area improvement show that vision building, public capacity building and orchestration has been essential and that specific projects have focused on design for innovation when setting ambitious environmental goals and standards at the vision-building

[74] Lisbon Municipality, "Application Form for the European Green Capital Award 2020 - 2. Climate Change: Adaptation."
[75] European Investment Bank, "Lisbon Climate Adaptation Drainage System."
[76] OPPLA, "Lisbon."
[77] LifeLUNGS, "Project LifeLUNGS."

stage and on community and culture building especially in neighbourhood's revitalization projects. Blended/cooperative investment models have been employed in all cases, more often than not involving EU funds, with a focus on on neighbourhood revitalization, transport infrastructure investment, support for social housing, and nature-based solutions.
The case studies illustrate some effectively employed approaches: from compact and balanced new developments in the suburbs (see: Cambridge, Gothenburg), to making already compact suburbs more sustainable, diverse, and vibrant – for all income groups (eg: Overvecht), to improving the city centre efficiency through repurposing unused sites (see: De Bonne, Grenoble) or repurposing vacant housing (see: Treviso), or finally improving city balance through revitalization (see: Cluj-Napoca or Ljubljana (in previous short examples) or through nature-based solutions (see: Gyor).

Figure 31: Case study profile 6



Source:
NATURVATION project, 'Tapping the Potential of Nature-Based Solutions to Create Greener Hungarian Cities', 2022.

Sources case study Gyor[78]

[78] NATURVATION project, "Tapping the Potential of Nature-Based Solutions to Create Greener Hungarian Cities."

Figure 32: Case study Profile 7

CAMBRIDGE (UK) – BALANCED SUBURBAN INFILL FOR A HIGH-PRESSURE CITY

Background and challenge: Housing pressure leads to natural infilling of the suburbs. The city has an interest in ensuring efficient developments to maintain proximity, vibrancy and prevent urban expansion.

Multi-stakeholder approaches taken:

VISION and MISSION BUILDING

Cambridge City Council sought to foster compact, balanced settlement on publicly owned plots in suburbs through greenfield development in areas already surrounded by constructed sites (e.g., university buildings, residential areas and roads).

Great Kneighton: multi-functional infill of 2,250 new homes (40% affordable housing), a 120-acre country park, library, fitness studio, shops and cafés, market square, active transport routes.

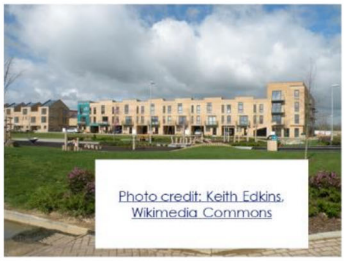
Marmalade Lane: City working jointly with K1 Cohousing on Cambridge's first co-housing scheme, a multi-generational area with shared spaces and facilities to foster community and sustainable living.

King's College had the vision to reduce carbon emissions of student accommodation on **Cranmer Road**.

DESIGN INNOVATION PROGRAMMES

- **Cranmer road:** All-electric, passive house project with extra insulation, thermally efficient windows, PHPP modelling, and CLT airtightness sealing.
- **Marmalade Lane:** High environmental standards, using passive design principles. Houses use Trivselhus Climate Shield system of pre-fabricated timber frame panels for thermal efficiency and airtightness.

City profile 7: Growing medium city – Pressured town expansion (suburb)



Great Kneighton, Source: Keith Edkins, Wikimedia Commons

Main physical transitions employed:

- 4) Infill of suburbs
- 8) Create public green and community spaces

Results for efficient, balanced space use and quality of life:

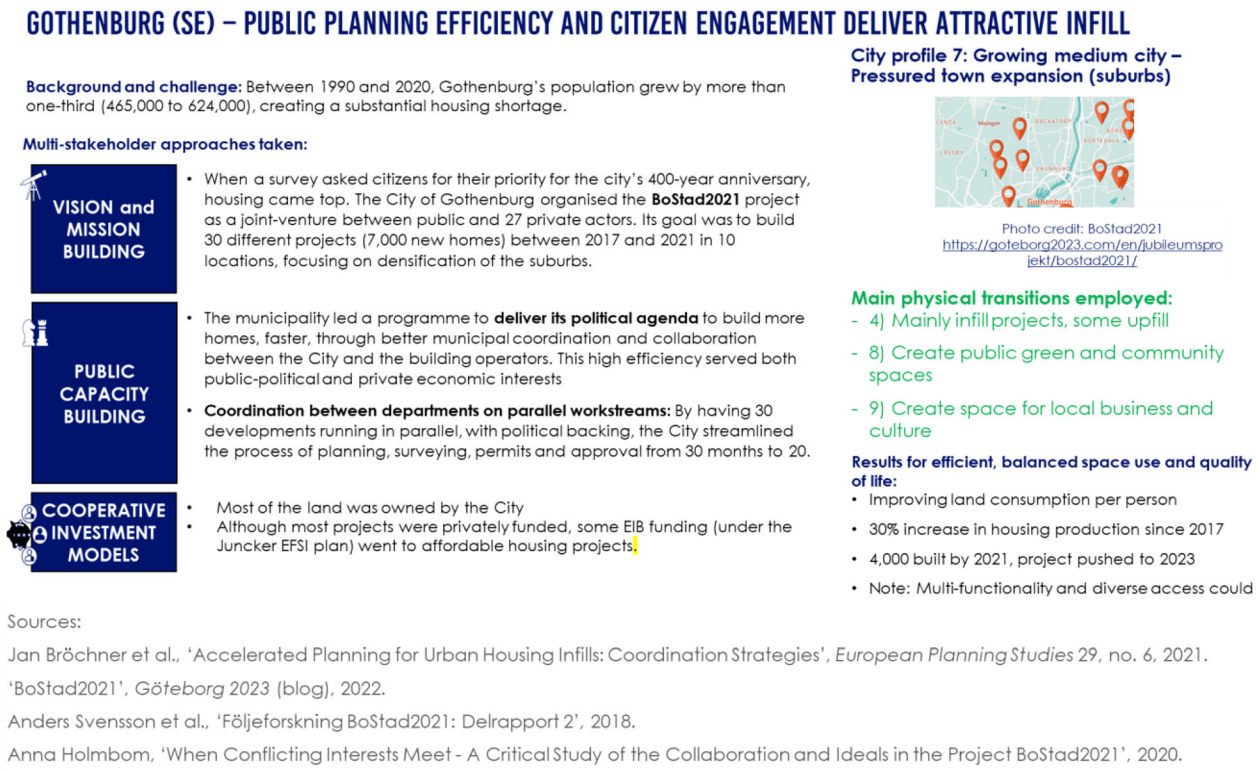
- Improving land-consumption per person in the suburbs
- Awards for design and sustainability of sites

Sources:
- Lacchia, 'Cambridge Choses Passive House Comfort for Kings' College Students', PassiveHouse+, 2021.
- Countryside, 'Countryside Partnerships - Case Studies - Great Kneighton, Cambridge', Countryside, 2020.
- ArchDaily, 'Marmalade Lane Cohousing Development / Mole Architects', ArchDaily, 2019.
- Marmalade Lane, 'Marmalade Lane - Cambridge's First Cohousing Community', Marmalade Lane, 2022.
- Mole Architects, 'MARMALADE LANE COHOUSING, CAMBRIDGE, 2018', Mole Architects, 2019.
- Allies and Morrison, 'Projects: King's College, Cambridge', Allies and Morrison, 2020.

Sources case study Cambridge[79][80][81][82][83][84]

[79] Lacchia, "Cambridge Choses Passive House Comfort for Kings' College Students."
[80] Countryside, "Countryside Partnerships - Case Studies - Great Kneighton, Cambridge."
[81] ArchDaily, "Marmalade Lane Cohousing Development / Mole Architects."
[82] Marmalade Lane, "Marmalade Lane - Cambridge's First Cohousing Community."
[83] Mole Architects, "MARMALADE LANE COHOUSING, CAMBRIDGE, 2018."
[84] Allies and Morrison, "Projects: King's College, Cambridge."

Figure 33: Case study profile 7 (2)



Sources case study Gothenburg:[85][86][87][88]

[85] Bröchner et al., "Accelerated Planning for Urban Housing Infills."
[86] "BoStad2021."
[87] Svensson et al., "Följeforskning BoStad2021."
[88] Holmbom, "When Conflicting Interests Meet - A Critical Study of the Collaboration and Ideals in the Project BoStad2021."

Figure 34: Case study profile 7 (3)

Sources case study Overvecht [89][90][91][92][93][94]

[89] Bradley, "ACA-flats | Utrecht."
[90] "Faster towards Europe's First Positive Energy Apartment Building Thanks to Corona - News - Utrecht University."
[91] "Housing Europe Will Partner in a New Project for Climate Positive Circular Communities, Funded by EU's Green Deal Grant | Housing Europe."
[92] Hajer, *Neighbourhoods for the Future*.
[93] Visited, "Officiële Start Bouw DeBuurt in Utrecht Overvecht."
[94] "Utrecht Science Park."

Figure 35: Case study profile 8

CLUJ NAPOCA (RO) – CLEAR VISION AND STRONG INVESTOR- AND CITIZEN ENGAGEMENT FOR ROUNDED REVITALISATION

Background and challenge: While Romania depopulates, its second city has a slightly increasing population and a decent density. It hosts 11 universities and 80,000 students, and its economy is focused on IT start-ups and research [3].

Multi-stakeholder approaches taken:

VISION and MISSION BUILDING

- **Smart and climate-neutral city by 2030**: Strategy implemented to increase the city's attractiveness and prevent further emigration from Romania. Plan to invest €100 million in 100% electric public transport, €100 million in walkability, €100 million in 110 hectares of green spaces & 100,000 new trees, and €120 million in energy-efficient public buildings [3].
- **A public-private-people partnership model**: The city embraces a "quintuple helix" local governance model, which means it is committed to bringing together public administration, universities, private sector, organized civil society (NGOs) and citizens when creating its vision and strategy [2].

COOPERATIVE INVESTMENT MODELS

- **EU funds...** The city received €420 million in European funds:
  - ERDF co-financed a €30 million investment in modern and sustainable transport infrastructure with €25 million, for modernising 25km of tram network and creating 60km of bike lanes and a self-service cycle network [5].
  - EIB is investing €35 million in university campus development [6].
  - €60 million for the planned regeneration of the river Somes [3].
- **...Attracting private investment**: The €500 million development by IULIUS Group indicates that EU funds have increased the city's investability. The private group is planning a mixed-use urban regeneration project in the industrial area (retail, art and culture centre, parks and urban gardens, eco-neighbourhood, bicycle and pedestrian infrastructure) – construction begins early 2023 [5].

City profile 8: Growing medium town – Worsening moderate town expansion

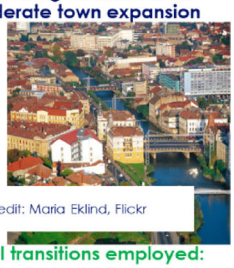


Photo credit: Maria Eklind, Flickr

Main physical transitions employed:

- 1b) Strategic Revitalization
- 8) Create public green and community spaces
- 9) Creating space for local business and culture

Results for efficient, balanced space use and quality of life:

- Slightly increasing population
- More efficient and accessible transport
- Attracting private investment in new area
- However: Slightly worsening land-consumption per person in the city center → need to strategically focus on sprawl prevention and renovation in the center.

Source case study Cluj-Napoca[95][96][97][98][99][100]

Figure 36: Case study profile 9

DE BONNE, GRENOBLE (FR) – VISION OF ENERGY EFFICIENCY, FAIRNESS AND VIBRANCY LEADS TO HIGHLY ATTRACTIVE INNER-CITY LIVING

Background and challenge: Surrounded by mountains, Grenoble suffers from being a pollution sink, with cold winters and hot summers. Its urban sprawl particularly affects families. When the old military barracks in the city center became vacant, the city acquired it.

Multi-stakeholder approaches taken:

VISION and MISSION BUILDING

- The city adopted CO2 emissions reduction targets and supported the development of renewable energy.
- Authorities set up a project to bring families back to the city centre, focusing on social diversity with a required share of 40% of social housing.

PUBLIC CAPACITY BUILDING

- Successful management and completion relied on the clear political vision and collaboration of many experts and citizens' associations.
- Energy performance monitoring was sponsored by the EU 6th European Research Framework Programme, aimed at piloting and promoting energy efficiency, innovation and monitoring.

DESIGN INNOVATION PROGRAMMES

- **The area has high environmental quality and energy performance** thanks to new technology: gas cogeneration, solar panels, high-end insulation.
- The barracks were partly refurbished and partly demolished. **Circularity principles** were applied, requiring material from the demolition to be reused in construction.
- De Bonne was the first eco-district to plan for the **monitoring of energy performance.**

CULTURE and COMMUNITY (RE-) BUILDING

- **Multi-functional neighbourhood** creates a **diverse community**: shops, restaurants, student housing, retirement home, pool, offices, social housing...
- **Access to nature**: neighbourhood centred around a 3.5-hectare park.

Sources:

Fondazione Eni Enrico Mattei, 'De Bonne – Energy Efficiency Assessment in an Eco-District', 2016.

BeSustainable Brussels, 'Ecoquartier ZAC de Bonne, Grenoble', 2020.

City profile 9: Growing medium town – Worsening moderate town expansion

Photo credit: City of Grenoble, adapted from https://pocacito.eu/sites/default/files/DeBonneEE_Grenoble.pdf

Main physical transitions employed:

- 1b) Strategic revitalization
- 2) Quality-upgrades of building
- 3) Repurpose vacant buildings
- 4) Infill of city center
- 8) Create public green and community spaces
- 9) Creating space for local business and culture
- 10) Nature-based solutions

Results for efficient, balanced space use and quality of life:

- Stable land-consumption per person (slightly improved in center; slightly worse in suburbs) -> important to extend efficiency strategy to suburbs
- Good social and economic results
- EcoQuartier Award (2009); EcoQuartier Label (2019)
- However, energy consumption has been higher than expected – official study established that the main factor is residents' over-use.

[95] "Cluj-Napoca | URBACT."
[96] "IULIUS is launching a new investment in Cluj-Napoca - the largest urban regeneration project in Romania."
[97] proGIreg, "Cluj-Napoca, Romania."
[98] Cimpean, "Cluj-Napoca - Strategic Priorities."
[99] European Commission, "Cohesion Policy and Romania."
[100] "Romania."

Sources case study Grenoble[101][102]

Figure 37: Case study profile 9 (2)

TREVISO (IT) – RE-ATTRACTING INNER-CITY LIVING REDUCES VACANCY IN A HIGH-SPRAWL TOWN

Background and challenge: From the 1980s, urban growth developed along the road from Treviso to Vicenza. The municipalities of the first and second belt of Treviso became part of the main city and this new conurbation gradually consolidated, but sprawled.

City profile 9: Growing medium town – Improving moderate town expansion

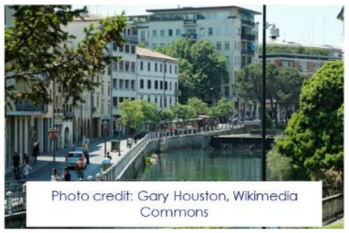


Photo credit: Gary Houston, Wikimedia Commons

Multi-stakeholder approaches taken:

VISION and MISSION BUILDING

- The city government launched a **"House Plan"** to boost the renovation and redevelopment of existing degraded houses to bring people back in the city center, reduce land consumption per person, and enhance city-center vibrancy and business activity. Their plan fostered densification and efficiency.

PUBLIC CAPACITY BUILDING

- Property owners who present the municipality with a viable renovation project for a previously vacant house in the city center will be eligible for tax reliefs (for both buyers and construction companies contributing to the project) upon development of the project.
- The municipality will lead and manage this process and facilitate the renovation process.

Main physical transitions employed:

- 3) Repurpose vacant buildings
- 4) Infill of city center

Results for efficient, balanced space use and quality of life:

- Improving land-consumption per person in the suburb
- Reduce vacancy

Sources:

Vettoretto and Laura Fregolent, 'Contemporary Process of Urban Regionalization: The Case of the Veneto Region', 2016.

'House Plan of the Municipality of Treviso: Discounts and Greater Volumes for Those Who Renovate. Breaking Latest News', 2022.

Sources case study Treviso[103][104]

Approaches in shrinking urban areas (profiles 13-14)

To recap the priority transitions, this group of urban areas **(profiles 13-14)** need to pay extra attention to:

-Transition 1b: Revitalizing city centre and hubs
-Transition 2: Quality upgrade and up-size of dwellings/buildings
-Transition 3 & 5: Minimizing un-occupation/under-occupation and ensuring affordability
-Transition6: Right-size declining areas
- Transition 7: Upgrading or developing active and public transport links within the centre and to various hubs
- Transition 8: Creating green and community spaces
- Transition 9: Creating space for local business and culture

The challenge for shrinking urban areas is how to stop or slow down population decline, while adapting to smaller population numbers. In addition, capital is more difficult to raise in medium-size urban areas which requires a strong focus on multi-stakeholders' funding, including multi-level public funding (EU, national, city). Few urban areas are known for their success in this area, but some cities have managed to slow down decline and some even re-branded themselves as the new sustainability hubs (see: Leipzig) or have managed through civil society to create a new vision, renewed activities, and solidarity through their local community (see: Altena).

Cases of shrinking medium urban area improvement show that all approaches are needed to shift the trend, with a somewhat lesser focus on design innovation, potentially seen as secondary when the focus is on revitalisation and renovation.

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[101] Fondazione Eni Enrico Mattei, "De Bonne – Energy Efficiency Assessment in an Eco-District."
[102] BeSustainable Brussels, "Ecoquartier ZAC de Bonne, Grenoble."
[103] Vettoretto and Fregolent, "Contemporary Process of Urban Regionalization."
[104] "House Plan of the Municipality of Treviso: Discounts and Greater Volumes for Those Who Renovate-Breakinglatest.News-Breaking Latest News."

Figure 38: Case study profile 14

LEIPZIG (DE) – CLEAR VISION AND COLLABORATION WITH GOVERNMENT AND INDUSTRY LEADS TO REVITALISATION

Background and challenge: Once Germany's fourth largest city with 700,000 inhabitants, Leipzig was an industrial hub [1]. The Second World War and Germany's reunification saw its population drop to 470,000. In 2000, the city took measures to boost its population. Today it stands at 600,000, and continues to grow [2].

City profile 7: Growing medium city – Pressured town expansion ***(previously profile 14 – Emptying center)***

Photo credit: Abenteuer Albanien
https://unsplash.com/photos/hgziNh-d5qY

Multi-stakeholder approaches taken:

VISION and MISSION BUILDING

- **Leipzig 2030** (2001) focused on policies to reverse deindustrialization by making the city more attractive to investors and developing high-quality housing - breaking the 'downward spiral'[3]. Today's guiding principle is "Leipzig is growing sustainably!" and its focus has been extended to urban planning in line with the Sustainable Development Goals [4].

COOPERATIVE INVESTMENT MODELS

- Leipzig used German federal and regional **subsidies** for large-scale investment in infrastructure and to attract investment from industry [7].
- In 2001, **BMW** chose Leipzig for its new plant – mostly for its good infrastructure and available workforce.
- **Leipziger Baumwollspinnerei:** In early 2000, private investors bought what had been Europe's largest cotton mill and redeveloped it into a cultural centre. The site received European Regional Development funding (ERDF) and national funding to support the renovation [5]. Today, the well-known venue has shaped the entire west of Leipzig into a cultural and liveable neighbourhood [1].

CULTURE and COMMUNITY (RE-) BUILDING

- **Bürgerbahnhof Plagwitz (2009):** A former freight terminal became a community area with green spaces and play areas for children. The development of the brownfield site was funded by ERDF and fell under the priority "social inclusion" [6]
- Re-greening of an old railway station into the multifunctional **Lene-Voigt Park**.

Main physical transitions employed:

- 1b) Revitalization
- 2) Quality upgrade of buildings
- 3) Repurpose vacant buildings
- 6) Right-size declining areas
- 8) Create public green and community spaces (from brownfield sites)
- 9) Create space for local business and culture

Results for efficient, balanced space use and quality of life:

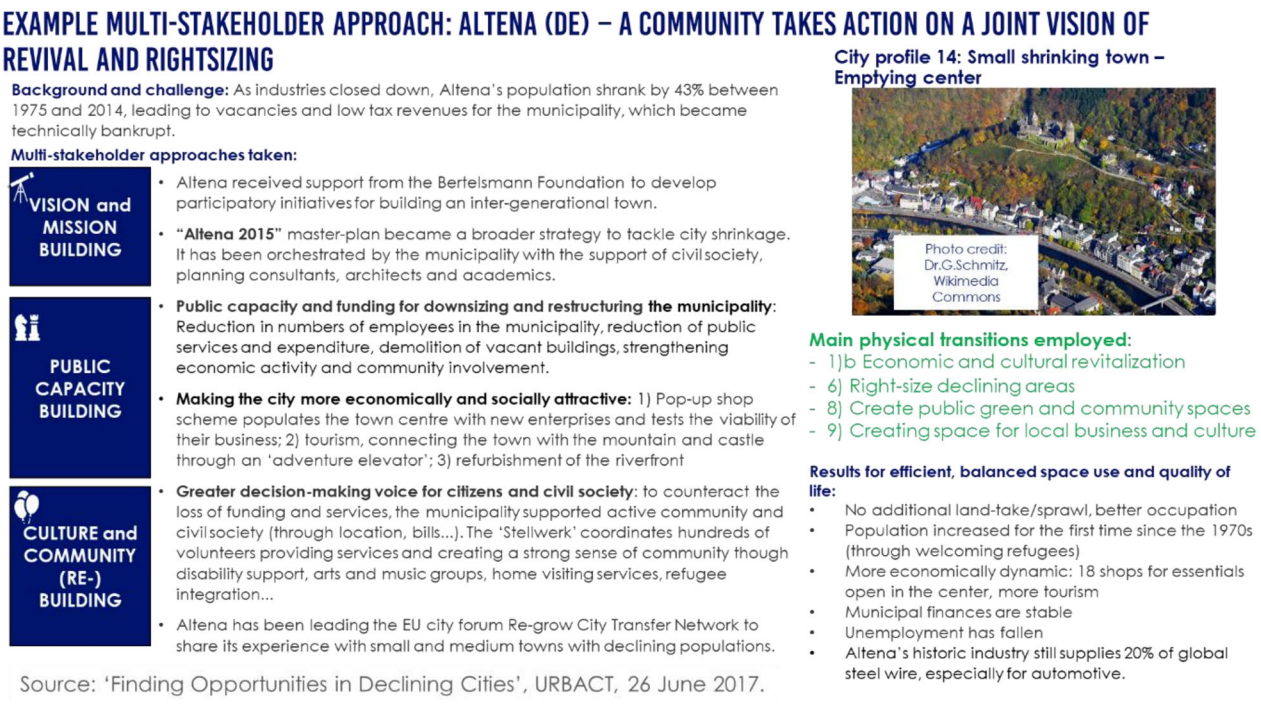
- Improving land consumption per person
- Leipzig, sometimes refered to as "Hypezig" or the "new Berlin", became highly attractive for young professionals and the art/culture scene
- Steady population growth and a doubling of the economy since 2000
- The city offers a lot of green space

Sources:
European Commission, 'Crazy Ideas in the Spinning Mill', 2013.
Joseph Rowntree Foundation, 'International_cities_leipzig.Pdf', 2017.
'Leipzig.de', City of Leipzig, 2022.
'The Heady Early Days - Leipziger Baumwollspinnerei - FROM COTTON TO CULTURE', 2022.
Čamprag, 'The Trap Within Anticipated Regrowth : Two Sides of Strategic Response to Urban Decline in Leipzig', 2018.
European Commission, 'Turning Wasteland into a Vibrant Public Space in Leipzig, Germany-Projects', 2020.

Sources case study Leipzig[105][106][107][108][109][110]

[105] "Crazy Ideas in the Spinning Mill."
[106] "International_cities_leipzig.Pdf."
[107] "Leipzig.de."
[108] "The Heady Early Days - Leipziger Baumwollspinnerei - FROM COTTON TO CULTURE."
[109] Čamprag, "The Trap Within Anticipated Regrowth."
[110] "Turning Wasteland into a Vibrant Public Space in Leipzig, Germany-Projects."

Figure 39: Case study profile 14 (2)



Sources case study Altena[111]

While the case studies are inspiring, in no case has an urban area reached perfect efficiency and balance through a single initiative. Those urban profiles, or neighbourhoods, reaching almost sufficient performance like Barcelona or Vauban have been shaped over decades or centuries.

Urban areas with improving macro-efficiency – raw analysis for further research

The analysis also revealed those urban areas with most improving trends (albeit from very different levels). We are sharing these lists as a basis for further research into the causes and dynamics of the improvements, which could offer important learnings.

[111] "Finding Opportunities in Declining Cities."

Figure 40: List of small urban areas improving in land efficiency

SMALL TOWNS (POP < 100,000) WITH GROWING IN POPULATION IMPROVING IN LAND EFFICIENCY*

Top improvers (between 2012 – 2018) in macro-efficiency among profiles 2-5

Alessandria
Arrecife
Aschaffenburg
Asti
Bamberg
Béziers
Burnley
Carpi
Cerignola
Colmar
Como
Cremona
Deventer
Flensburg
Friedrichshafen
Fulda
Grosseto
Hastings
Iasi
Irun
Kempten
Konstanz
L'Acquila
La Spezia
Landshut
Lecco
Lincoln
Lüneburg
Massa
Mons
Neumünster
Pardubice
Pavia
Pisa
Ragusa
Rosenheim
Santiago de Compostela
Treviso
Tübingen
Varese
Villingen-Schwenningen
Wetzlar

Context and research suggestion: Small Urban Areas are the highest land-consumers per person in Europe. Some few towns have reduced their land-use per person.
The reasons and implications are still unknown for most of these cities.
Further research would be highly interesting to understand key approaches that might be learned from or replicated.

* Land consumption per person is decreasing while the population is growing

Source: Analysis by SYSTEMIQ, based on data from [1] EUROSTAT, 'Database - Cities (Urban Audit) - Eurostat', 2022', Population in Cities and greater cities (2011/2012 – 2018/2019) and [2]] European Environment Agency et al., Land Take and Land Degradation in Functional Urban Areas., 2022.

Figure 41: Medium and large urban areas with improving land efficiency in suburbs

MEDIUM AND LARGE CITIES WITH GROWING POPULATION IMPROVING LAND EFFICIENCY IN SUB-URBS*

Top improvers (between 2012 – 2018) in macro-efficiency among profiles 9-10

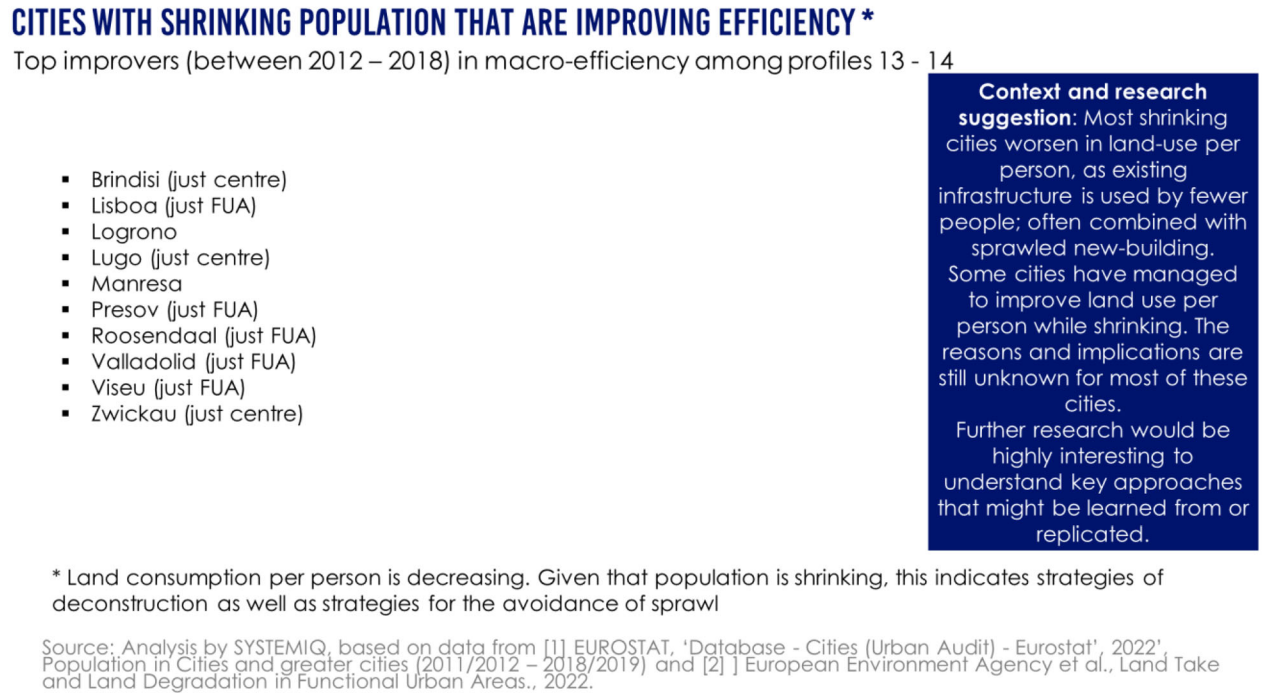
- Aachen -17 m2/capita
- Alphen an den Rijn -25 m2/capita
- Breda -19 m2/capita
- Burnley -47 m2/capita
- Cambridge -18 m2/capita
- Derby -27 m2/capita
- Deventer -26 m2/capita
- Exeter -29 m2/capita
- Heerlen -16 m2/capita
- Leeds -30 m2/capita
- Leiden -14 m2/capita
- Lincoln -32 m2/capita
- Middlesborough -17 m2/capita
- Portsmouth -27 m2/capita
- Rotterdam -19 m2/capita
- Sheffield -45 m2/capita
- Southampton -25 m2/capita
- Zwolle -25 m2/capita

Context and research suggestion: Sub-urbs of medium-size cities are among the highest land-consumers per person in Europe. Some few cities have reduced their sub-urban land-use per person.
The reasons and implications are still unknown for most of these cities.
Further research would be highly interesting to understand key approaches that might be learned from or replicated.

* Land consumption per person is decreasing in suburbs

Source: Analysis by SYSTEMIQ, based on data from [1] EUROSTAT, 'Database - Cities (Urban Audit) - Eurostat', 2022', Population in Cities and greater cities (2011/2012 – 2018/2019) and [2]] European Environment Agency et al., Land Take and Land Degradation in Functional Urban Areas., 2022.

Figure 42: Urban area with shrinking population improving in land efficiency



Illustrative examples of inspiring actions taken by local authorities, private actors and EU regional development funds

Illustrative examples of public master planning and orchestration of private investors and planners:

Combining zoning and integrated master planning, the city of Munich is regenerating the former Bayernkaserne, a former military area in Munich (see Box x); and the borough of Southwark, London, is regenerating the formerly decaying residential area Elephant & Castle in south-east London (see Box x).

Box 1

Local planning and investment orchestration for the inclusive regeneration of the former military area Bayernkaserne in Munich[112]

With a strong focus on vibrancy, diversity and community, the former military area 'Bayernkaserne' is currently being regenerated and developed into a new neighbourhood for 15,000 people called 'Neufreimann'. As main investor and orchestrator of the development, the local government puts strong emphasis on environmental a social sustainability: there are many green areas, short distances are guaranteed by including daily amenities, and during the construction, concrete of the existing building is recycled and reused on the site. Eighty percent of the apartment units are going to be rented out by local housing associations and cooperatives to ensure fair rents, while only the remaining twenty percent are developed and rented out by private property developers.

[112] Landeshauptstadt München (City of Munich), "Neufreimann (ehemalige Bayernkaserne)."

Photo credit: Stadt Muenchen

Box 2

Elephant and Castle – public planners working with visionary architects, master planners and developers to create a climate-friendly neighbourhood while maintaining local identity and cultural balance[113] [114] [115]

The car-centric neighbourhood dominated by modernist high-rises suffered from increasing neglect since the 1960s until the local London College of Communication and the local shopping centre joint forces to initiate an architecturally visionary redevelopment into a housing-led, mixed-use neighbourhood with an educational campus.

To realise this, a new masterplan was developed with focus on mixed-use. To maintain local identity and cultural balance, affordable space for over 50 local shops, cafes and restaurants was created. The local Southwark Council co-invested to ensure that affordable and council homes are included in the GBP 4 billion development, in close cooperation with developer Lendlease and master planners including Allies & Morrison.

While being on the edge of hyper-density, the area features substantial and curated green infrastructure. By completion in 2025, the Elephant & Castle area aims to be the UK's first climate positive development.

Photo credit: https://www.alliesandmorrison.com/

[113] Allies and Morrison, "Elephant and Castle Town Centre."
[114] Lendlease, "Elephant Park."
[115] Southwark Council, "Elephant and Castle."

Examples of private actors – from developers to individuals – taking action:

Box 3Example private bank action

The Alternative Bank of Switzerland evaluates construction projects according to social and environmental criteria (including urban sprawl), in addition to economic criteria. These criteria include "community ownership, participation and community promotion. [...] Dense construction, eco-efficient and biologically healthy building materials and buildings with high energy efficiency and the lowest possible primary energy consumption."[116][117]

Box 4

Example developer action

In the sprawled city of Copenhagen, **NREP** strived to develop space-efficient, vibrant and healthy neighbourhoods for long-term value such as **UN17 Village** and **Tingbjerg**, closely cooperating with public authorities, to align the projects with the UN 17 Sustainable Development Goals and ensure the integration of the project in the wider city plan and network. With the aim to develop a thriving and diverse community, they worked jointly to develop the necessary services, infrastructure and community/green spaces (with high-level of biodiversity) while ensuring good-quality and affordability of housing. NREP is also focused on minimising operational emissions material consumption.

Illustrative examples of EU funds and programmes with transformative urban impact

Box 5

Examples of EU Programmes successfully supporting urban transformations in line with a better space-use purpose[118][119] **(illustrative examples)**

- **Leipzig** transformed its 'Baumwollspinnere' (cotton mill) in a cultural and artistic center, supported by the European Regional Development Fund –ERDF.

[116] European Environment Agency, *Urban Sprawl in Europe*.
[117] "Fördern | Alternative Bank Schweiz."
[118] "OP 2014-2020 Finances Planned by TO | Data | European Structural and Investment Funds."
[119] Urban Innovative Actions, "A Roadmap for Cities."

- **Cluj-Napoca** received €420 million in European funds for its revitalisation. ERDF co-financed a €30 million investment in public and modal transport and €60 million for the planned regeneration of the river Somes ; EIB invested €35 million in university campus development.
- **De Bonne District** (Grenoble) recieved the 6th European Research Framework Programme to fund the Energy performance monitoring system and analyse overtime the district's innovative and efficient system in a compact (mixed renovated and new) neighbourhood.
- **Lisbon** developed green corridors and LIFE LUNGS, co-financed by EU funds and EIB loans.
- **Home Silk Road** (Lyon) renovated central old iconic factory for the integration of vulnerable people through housing and employment opportunity.
- **E-co-living** (Budapest) developed a regenerative and collaborative social housing community with modular design that is aiming to scale, supported by ERDF (EUR 4.5M)
- **Brussels CALICO** renovated high-quality community-based social housing for marginalised groups, supported by ERDF (EUR 5M)
- **Mataro** (Barcelona region) developed cooperative affordable housing scheme, supported by ERDF (EUR 2.5M)
- **ICCARus** (Ghent) supported the renovation of houses of vulnerable home-owners: ERDF (EUR 4.8M)

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