SUFFICIENCY AND THE BUILT ENVIRONMENT

Reducing Demand for Land, Floor Area, Materials and Energy as the First Step Towards Sustainable Buildings

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The Sufficiency Action Group formed under the Global Alliance for Buildings and Construction (GlobalABC) and led by the French Institute for Buildings' Performance (IFPEB) with ADEME and A4MT, brings together building professionals from all facets of the building industry.

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[1] Sufficiency Lab Website: https://www.thesufficiencylab.org/

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Sufficiency Action Group context

The Sufficiency Action Group aims to demonstrate the necessity, feasibility and desirability at social and personal levels of sufficiency solutions, fostering a shared understanding of sufficiency measures across all decision-making levels. The Action Group seeks to build a diverse and growing community of stakeholders from various countries, regions, governance levels, and segments of the building sector value chain. It aims to define general objectives to be adapted to each particular context, recognizing that priorities and solutions will differ between Global North and Global South economies. The Action Group also intends to highlight the need for increasing research efforts on the role of sufficiency in buildings.

The Sufficiency Action Hub is an initiative launched by the French Institute for Building Performance[2], in collaboration with Action for Market Transformation[3], supported by ADEME[4] and hosted by the Global Alliance for Buildings and Construction[5]. The decision to launch the hub was motivated by the absence of a space to discuss sufficiency within the international buildings' environmental transition community. This need arose at a time when the IPCC had included and defined sufficiency as a core concept in its 2022 Climate Mitigation report (AR6). Additionally, the concept has gained explicit recognition in some pieces of legislation and plans - e.g. in French politics in the context of the 2022-2023 Energy Crisis and in the energy and climate plan of the city Canton of Geneva. These developments underlined the critical importance of including sufficiency in policies and practices worldwide. The author, contributors and reviewers hope that the work of the Sufficiency Action Hub represents a critical step towards this goal, fostering collaboration and innovation to reshape the future of the building sector within planetary boundaries.

Methodology of the Action Group & how to read this paper

Sufficiency was introduced in The Breakthrough Agenda Report[6] which emphasized «Sufficiency measures must complement the role played by efficiency, behavior and renewables in the mitigation of emissions, as growth in floor area is outpacing the existing efforts to decarbonize the sector». Sufficiency was also introduced into the «Chaillot Declaration» signed by 70 countries on the occasion of the Buildings and Climate Global Forum (Paris, 2024) which included a session on sufficiency, this paper now seeks to elevate the importance of sufficiency further, so that it is considered FIRST in a policy framework that also includes energy efficiency and renewable.

This paper presents an analysis of current trends in the buildings sector from a resource and value chain perspective, extending the discussion beyond carbon emissions and energy consumption to include other planetary boundaries and resources. It emphasizes avoiding isolated analyses and solutions by understanding the interdependencies among different stages of the building value chain.

[2] French Institute for Buildings Performance Website: https://www.ifpeb.fr/
[3] Action for Market Transformation Website: https://a4mt.com/fr/
[4] French Ecological Transition Agency Website: https://www.ademe.fr/en/frontpage/
[5] Global Alliance for Buildings and Construction Website: https://globalabc.org/ 6 IEA (2023). The Breakthrough Agenda Report 2023: Chapter 6 - Buildings. p. 115-116, 129 URL: https://globalabc.org/resources/publications/breakthrough-agenda-report-2023

The analysis adopts a global perspective, offering principles and methodologies applicable universally, which can be adapted to specific contexts as needed. While it recognizes varying levels of building stock maturity, the distinction between the Global North and Global South is employed solely to illustrate the necessity of convergence between different regions under the framework of sufficiency.

The concept of "embodied carbon" is referred to as **"upfront carbon"**. As analyzed by *Lloyd Alter in 'The Story of Upfront Carbon: How a Life of Just Enough Offers a Way Out of the Climate Crisis',* embodied is often misunderstood as "captured into" when it actually represents upstream emissions at the moment of construction or manufacturing. The use of upfront carbon intends to emphasize the fact that the carbon emitted during the construction and manufacturing phase is not captured and stored in the building but rather released into the atmosphere.

While the paper focuses on buildings, the findings also have relevance to the wider built environment, including construction of infrastructures.

The findings of this paper are based on an extensive review of relevant literature, contributions from members of the Sufficiency Action Hub, and insights and analyses shared by the Action Group participants throughout the year.

EXECUTIVE SUMMARY

The building sector is off the Paris Agreement track

Accounting for 21%[7] of global greenhouse gas emissions and consuming up to 50% of all extracted materials[8], the building sector is a major contributor to climate change, resource depletion and overall environmental degradation.

- The biggest driver of resource consumption in buildings and infrastructure is floor area growth, projected to double by 2060[9] under the pressure of a growing global population[10], Global South countries construction activities development, as well as a global trend for increased floor-area per capita[11].

- Questioning the need to build, the possibility of building less or with less by rethinking buildings' surface and shapes and other land, material and energy demand lowering initiatives still remain the exception rather than the rule.

- The buildings and construction sector is also one of the biggest contributors to waste production worldwide, it is responsible for 30% of the waste flows generated[12]. This value is continuously increasing with no projected decrease so far.

- Operations have reached an all-time high environmental impact in 2021[13] - despite an decreased energy intensity - powered by the largest energy demand surge in 10 years by around 4% from 2020 to 135 EJ.

On top of its highly contributing to climate change and the overshooting of other planetary boundaries, urban and construction policies and activities have failed to provide all humans with a certain level of social livelihoods, shelter and infrastructure.

In short, we have an environmental problem: too many resources are going into buildings. It is urgent to understand what else can be done to get back on the climate and social justice track to mitigate emissions and fight precarity.

Yet, efforts have been made

Despite ongoing efforts to decarbonize this sector through energy efficiency measures, renewable energy adoption or low carbon material and constructing modes uptake, global progress remains flat[14], hitting what authors have qualified of "decarbonization ceiling".

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[7] Intergovernmental Panel on Climate Change (IPCC), Working Group III (2022). Climate Change 2022, Mitigation of Climate Change. Contribution to the Sixth Assessment Report of the IPCC. Page 100. URL: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

[8] European Circular Economy Stakeholder Platform (2022). EU Circular Talks Conference. URL available at the following link (Watched on April 20 2024).

[9] Architecture 2030. Why the Built Environment. URL: https://www.architecture2030.org/why-the-built-environment/

[10] United Nations. Global Issues: Population. URL: https://www.un.org/en/global-issues/population#:~:text=The%20world%20population%20is%20projected,and%2010.4%20billion%20by%202100

[11] Architecture 2030. Why the Built Environment. URL: https://www.architecture2030.org/why-the-built-environment/

[12] F. Pomponi, A.Stéphan (2021). «Water, energy, and carbon dioxide footprints of the construction sector: A case study on developed and developing economies». URL: https://www.sciencedirect.com/science/article/abs/pii/S0043135421001330

[13] UNEP (2023). 2022 Global Status Report for Buildings and Construction.» Page 16. URL : https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction.

[14] UNEP (2024). 2023 Global Status Report. Page 12. URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/45095/global_status_report_buildings_construction_2023.pdf?sequence=3&isAllowed=y

In the long run, technical improvements do not lead to decreasing energy consumption and related emissions but rather allow for the expansion of the economy and related environmental externalities. Therefore, the major loophole of the efficiency strategy is to keep focusing on energy and technical-only oriented approaches without setting clear resource boundaries attributed to each sector and related products' and services[15]. As Sachs analyzed "The 'efficiency revolution' remains direction-blind if not accompanied by a 'sufficiency revolution'. Nothing is as irrational as rushing with maximum efficiency in the wrong direction. "[16].

Renewable or low-carbon resources use is necessary, but cannot represent a satisfying response in and of itself: all resources are not infinitely renewable, and their uses widely add up to a 'business as usual' instead of replacing i[t17]. The Renewables 2021 Global Status Report notes that the share of global energy produced by renewable sources has not increased in the past 10 years but rather plateaued at around 20%[18], remaining at that level for around a decade despite massive investment and development.

Along with the global floor area and energy demand increase for the buildings sector, it is very important that we consider what renewables can and what they cannot achieve when it comes to building decarbonization.

Circularity is necessary but insufficient to decarbonize construction materials. Re-use and recycling are limited in their ability to provide enough resources for an expanding material economy, so we cannot totally rely on circularity as long as the need for new buildings is still growing. Most of global floor area growth will happen in developing countries where building stock development needs are often far from met, there is much less room for re-use and much more need for new materials.

If all decarbonization measures described are necessary approaches, one lever is never a stand-alone solution to reach overall decarbonization. floor area growth is bound to keep driving demand for land, materials, energy, water and other resources, offsetting decarbonization progress. This is why building sector decision makers urgently need to find alternatives to current decarbonization strategies. To ensure lasting sustainability, it is necessary to adopt a more systemic approach.

So what else can be done? Introducing the Sufficiency Principle

What is sufficiency?

According to the IPCC report on climate mitigation[19], decarbonizing buildings and the broader economy is unattainable without prioritizing sufficiency policies. Sufficiency is defined there as "a set of measures aimed at reducing the demand for resources—such as energy, materials,

[15] Fulfill Sufficiency Project. «Literature Review (Revised Version).». URL: https://fulfill-sufficiency.eu/wp-content/uploads/2023/10/D2.1-Literature-review-revised-version.pdf.
[16] Ibid p.13 in reference to Sachs, W. (1993). Die vier E's—Merkposten für einen maß-vollen Wirtschaftsstil. Politische Ökologie. https://epub.wupperinst.org/frontdoor/index/index/docId/66
[17] Ibid
[18] REN21 (2021). Renewables 2021 Global Status Report. 2021. URL : https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf.
[19] Intergovernmental Panel on Climate Change (IPCC), Working Group III (2022). Climate Change 2022, Mitigation of Climate Change. Contribution to the Sixth Assessment Report of the IPCC. Page 100. URL: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

Why sufficiency?

The implementation of sufficiency measures presents a triple benefit. Environmentally, it mitigates the building sector's contribution to resource depletion and greenhouse gas emissions, thereby safeguarding ecosystems and promoting sustainability.

On social aspects, sufficiency measures should not be confused with limiting growth for everything, everywhere, the same way. Rather, sufficiency should be tailored to specific regional and economic conditions and aim at liberating the resource budget needed for those for whom the social foundation is not yet met. On economical aspects, it offers significant potential for cost savings. For instance, investing in more resilient infrastructure could save trillions of dollars in climate change damages20, while avoiding the construction of unnecessary buildings and infrastructure further reduces expenditures.

How to implement sufficiency?

Sufficiency consists in questioning the true need, in order to move towards what is truly necessary. As needs can vary depending on the regional and economic situations,, there is no single "right" sufficiency process. Sufficiency is rather a set of measures allowing for an adjustment of resource demand according to the real needs at every step of a project. As such, it is very dependent on local conditions and is not a standardized solution.

As a systemic approach to climate mitigation, it requires collaboration between building specialists, urban policy-makers, social and political science specialists etc.

Key recommendations for policymakers

1. An alternative approach taking into consideration demand-side policies would start from the remaining carbon budget and decide what is the demand growth that we can afford. This is why measures aiming at tackling carbon emissions upstream have the greatest decarbonization potential. They also are the most efficient way to organize activities to allow for resources distribution equity.

    - **As a consequence, the single most important recommendation of this document is to integrate a "Sufficiency first principle» into all policies related to building sector climate preservation and energy transition policies, everywhere.**

    - As a consequence, each country must include sufficiency in its next NDC (Nationally Determined Contrubutions).

    - As a consequence, the most important "methodological" sufficiency character to highlight is the need to **incorporate sufficiency measures upfront,** ideally before even building.

[20] The World Bank. $4.2 Trillion Can Be Saved by Investing in More Resilient Infrastructure, New World Bank Report Finds. 2019. URL: https://www.worldbank.org/en/news/press-release/2019/06/19/42-trillion-can-be-saved-by-investing-in-more-resilient-infrastructure-new-world-bank-report-finds.

2 **Governments and public bodies must lead by example,** demonstrating the feasibility and benefits of sufficiency measures through their own buildings and operations. This sets a powerful precedent for the private sector , and encourages wider adoption.

3 **Avoid global land use by aiming for zero or decreasing floor area growth and land use to meet minimum needs:** review baseline scenarios for floor-area growth at global and national levels; build policies to control land use and artificialization; optimize existing spaces by fighting vacancy, convert buildings to new uses or invest in retrofitting; limit parking infrastructures, set protecting policies or schemes against land speculation.

4 **Avoid global upfront demand for new floor space, materials, water and energy associated with construction and demolition:** Allocate remaining top-down carbon budgets, and assess new proposals against these; Learn and understand the underlying carbon and resource challenges of buildings and the role that architects and property and construction industry professionals play in determining a building's future carbon footprint; Change building designs and architecture in order to minimize the new floor space and resources needed.

5 **Avoid or reduce as much as possible upfront demand for energy and water during building operations and use:** Reduce energy and water demand through putting strict turn off rules on designated uses that do not conflict with indoor comfort (heating, cooling, lighting) through new standards; Develop and implement enabling norms for changing lifestyles towards more sufficient practices; Set progressive tariffs on energy & water.

6 **To operationalize sufficiency, a data-driven approach is essential.** Policymakers need comprehensive and accurate data on land use, building occupancy rates, material demand, and energy/water consumption.

Finally, **international cooperation is crucial for scaling up sufficiency measures globally.** Countries can learn from each other's experiences, share best practices, and develop harmonized standards and regulations. This collaborative approach accelerates the transition towards a more sustainable and equitable building sector worldwide.

By embracing sufficiency as a guiding principle, the building sector can play a pivotal role in mitigating climate change, conserving resources, and ensuring a prosperous future for all. **It requires a fundamental shift in mindset,** moving away from the pursuit of endless growth towards **a more balanced and sustainable approach that prioritizes the well-being of both people and the planet.**

FOREWORD

Many practitioners and even policy makers in the Built Environment sector may be unfamiliar with the term 'sufficiency'. They are already confronted by a bewildering array of concepts such as sustainability, net zero, circular economy, and resource efficiency.

Sufficiency focuses upon policies that avoid demand for energy, land, materials and other natural resources while ensuring well-being for all within climate, biodiversity and other planetary boundaries. Although the IPCC emphasised that demand-side measures can reduce global emissions in buildings and other sectors by 40-70% by 2050, sufficiency is still overlooked in climate policies and modelling, with the exception of France that enacted an Energy 'Sobriété' Law in 2015.

I therefore commend Marine Girard and her team within the Buildings' Sufficiency Action Group, led by IFPEB with ADEME and A4MT under the auspices of the GlobalABC, in producing this ground-breaking and timely Position Paper on 'Sufficiency in the Built Environment'.

The concept has recently gained prominence in the sector, in response to concerns that emissions due to growth in floor area have surpassed gains in energy efficiency and renewables. In an apparent contradiction, the industry attests that the equivalent of another Paris should be built every week or another New York every month for the next 30-40 years, to meet population growth and urbanisation. It expects to continue a high-level of new construction, while hoping to meet the Paris Agreement by doubling energy efficiency and tripling the use of renewables.

strategies, though, are unlikely to be effective in tackling the scale of the industry transformation required over the pivotal next few years leading to 2030. It is important for policies to prioritise 'Sufficiency First' avoiding demand for resources over energy/resource efficiency and renewables.

This points to the need to constrain growth in new construction, floor area and land take, especially where a large building stock already exists, to enable underprivileged societies to increase access to shelter and infrastructure. In other words, to rebalance and redistribute building growth to serve those in most need an issue of climate and social justice.

Meanwhile, there is increasing recognition of the carbon 'embodied' in construction and production of materials, which is estimated to represent up to 85 per cent of all carbon by 2050. The industry expects to meet this challenge by the more efficient use of so-called low-carbon, circular, and bio-based materials. However, as Lloyd Alter has highlighted, the greatest gains can be made by tackling 'upfront carbon', which is emitted direct to the atmosphere by construction and production of materials such as steel and concrete. This may constitute around 70% of whole-life carbon.

I urge all readers to heed the Recommendations for Priority Action, including: review baseline scenarios for floor area growth at global and national levels; question the demand and need for a project at an early stage; aim to avoid and reduce upfront carbon; fight vacancies and seek to reuse, retrofit, and increase utilisation of existing stock; and investigate the equitable allocation of carbon budgets to countries, cities, sectors and buildings. As urged by Lisa Richmond, Senior Fellow at Architecture 2030, "we need to think differently about how we allocate our remaining carbon budget through the lens of sufficiency".

David Ness, Professor at the University of Adelaïde

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Introduction

Over the past three decades, numerous climate protection and energy transition oriented policies and market transformation efforts have been implemented by building professionals globally. Despite these substantial efforts, the demand for resources—including energy, materials, land, and water—has continued to escalate to unprecedented levels. This increasing demand is driving up carbon emissions, depleting our already limited carbon budget, creating significant climate justice challenges, over-exploiting natural resources and contributing to wider environmental degradation[21].

Efforts to improve efficiency have aimed to meet existing needs with fewer resources. However, these efficiency improvements alone have not succeeded in adequately reducing global energy and resource consumption. Gains in efficiency have been offset by increased consumption, as e.g. global and per person growth in floor area[22]. Similarly, while there has been a rapid expansion in the use of renewable energy and greener materials, this has not resulted in a significant transition away from fossil fuels or a decrease in resource extraction globally.

According to the IPCC report on climate mitigation[23], decarbonizing buildings and the broader economy is unattainable without prioritizing sufficiency policies. Sufficiency is defined there as "a set of measures aimed at reducing the demand for resources—such as energy, materials, land, metals, and water—while ensuring well-being for all and remaining within planetary boundaries". This approach involves questioning the necessity of resource use and reducing unnecessary demand to achieve a more equitable distribution of resources. Implementing sufficiency requires a systemic framework that addresses transitions within the building sector at various geographical scales and decision-making levels, with a strong emphasis on dialogue and social acceptability.

This paper analyzes the underlying reasons for the sector's decarbonization challenges and the critical role of sufficiency to diminish the sector's impact on climate change and other planetary boundaries. A section is dedicated to recommendations to help decision makers design and implement priority sufficiency measures for buildings.

[21] Building and Climate Global Forum (2024). Declaration de Chaillot. See in particular sections: 2.3, 2.7 and 4.4. URL: https://www.ecologie.gouv.fr/sites/default/files/declaration-de-chaillot-forum-batiments-climat.pdf

[22] UNEP (2022). 2022 Global Status Report. Page 15. URL: https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction IEA (2023), World Energy Outlook. URL: https://iea.blob.core.windows.net/assets/86ede39e-4436-42d7-ba2a-edf61467e070/WorldEnergyOutlook2023.pdf

[23] Intergovernmental Panel on Climate Change (IPCC), Working Group III (2022). Climate Change 2022, Mitigation of Climate Change. Contribution to the Sixth Assessment Report of the IPCC. Page 100. URL: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

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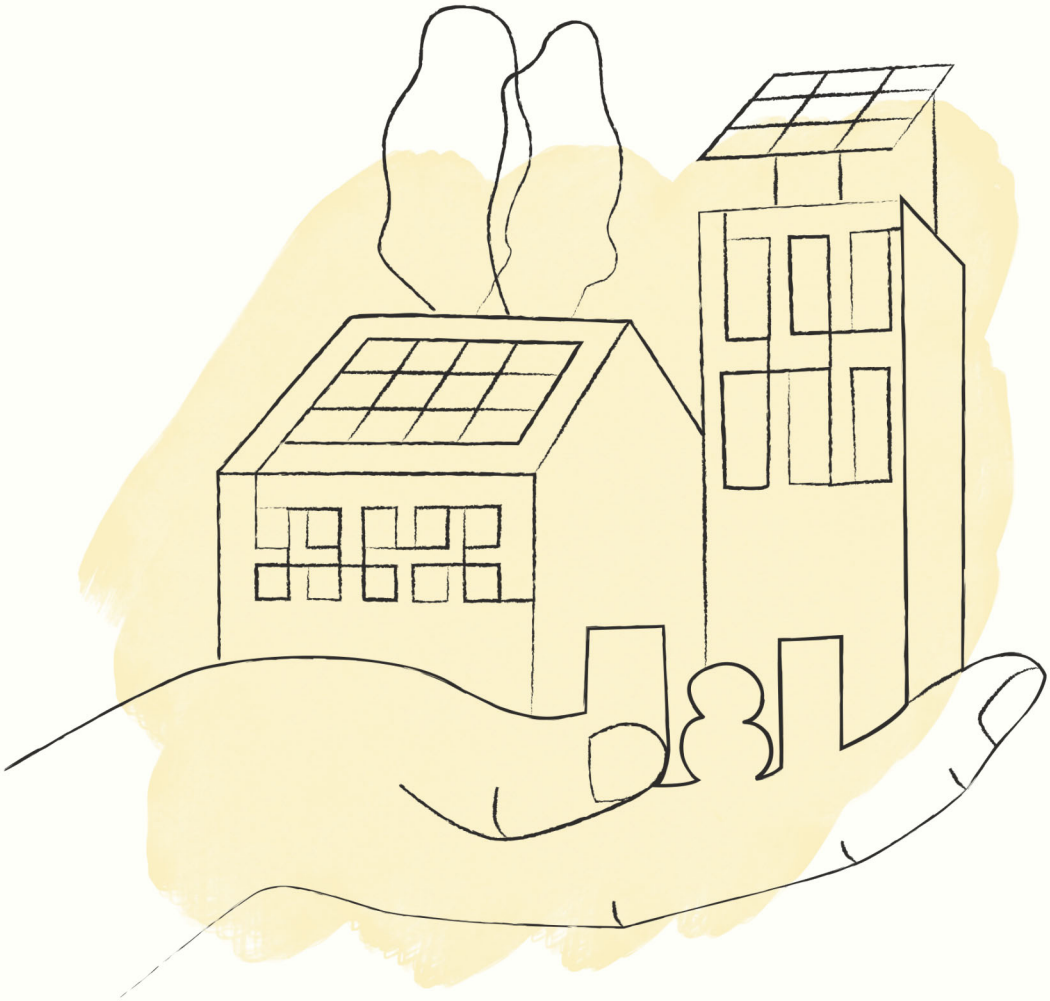
BUILDINGS AND THE PARIS AGREEMENT GAP

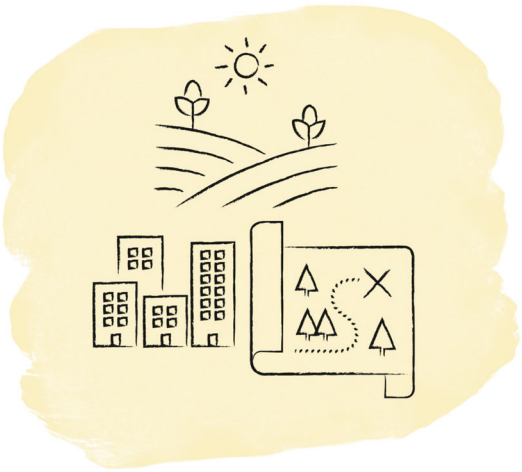


Buildings contribute to 21%[24] of global GHG emissions, 37% of energy and process-related CO2 emissions and consume up to 50%[25] of all extracted materials worldwide. The 2022 Global Status Report highlights a concerning stagnation in the building sector decarbonization results. In fact, the index set up for the Global Climate Tracker (BGCT) launched after the Paris Agreement is at similar level as it was in 2015, suggesting that all efforts have been offset by an continuous increase in activities intensity responsible for CO2 emissions[26].

Among the factors contributing to the lack of progress of the decarbonization trajectory is the rebound of construction activities to pre-pandemic levels in most major economies in 2021[27]. Despite continued efforts to enhance climate action and a slowdown of construction activities in 2022[28] due to regional crisis and global high interest rates[29], **the ongoing demand increase in floor area, energy and material for buildings, continues to escalate the sector's greenhouse gas emissions, depleting our limited carbon budget and posing a significant climate justice challenge.**

The next few years leading to 2030 are pivotal for implementing measures to achieve ambitious targets: constraining and questioning the need for new builds and floor area growth, decreasing the upfront carbon in new buildings, increasing retrofits and ensuring that all new buildings and 20% of the existing building stock are ready for zero-carbon operations by 2030[30]. To achieve Paris Agreement goals, rapid action is needed on all the levers at our disposal.

This section describes the different stages of the building value chain and how they each contribute to rising GHG emissions and environmental damage.



a. Floor Area Growth and Land Use

Pressure on land through new construction has a large environmental impact perse (e.g. loss of fertile soil, biodiversity,...) and is a big driver of the consumption of materials and energy. With a projected doubling of building floor-area by 2060[31] and a global trend of growing floor-area per capita[32], the built environment will be an increasing pressure on the planet in the coming decades. Scenarios also estimate that a 60% growth in infrastructure will be needed to cope with such increases[33]. This would mean building the equivalent of a new Paris every week for the next thirty years[34]. And not only the footprint of new constructions uses up new portions of land directly, but new constructions require materials and energy which in turn require use of further land for their extraction, transformation, delivery and disposal. These scenarios need to be revised in order to fit in humanity's limited remaining carbon budget.

Causes

Global demand for floor area will likely be driven by the global population increase, set

[24] Intergovernmental Panel on Climate Change (IPCC), Working Group III (2022). Climate Change 2022, Mitigation of Climate Change. Contribution to the Sixth Assessment Report of the IPCC. Page 100. URL: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf
[25] European Circular Economy Stakeholder Platform (2022). EU Circular Talks Conference.
URL available at the following link (Watched on April 20 2024).
[26] UNEP (2023). 2023 Global Status Report. Page 12.
URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/45095/global_status_report_buildings_construction_2023.pdf?sequence=3&isAllowed=y
[27] UNEP (2022). 2022 Global Status Report. Page 15. URL: https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction
[28] UNEP (2023). 2023 Global Status Report. Page 20.
URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/45095/global_status_report_buildings_construction_2023.pdf?sequence=3&isAllowed=y
[29] Ibid 30 IEA, Energy System, Buildings. Tracking Buildings. URL: https://www.iea.org/energy-system/buildings
[30] IEA, Energy System, Buildings. Tracking Buildings. URL: https://www.iea.org/energy-system/buildings
[31] Architecture 2030. Why the Built Environment. URL: https://www.architecture2030.org/why-the-built-environment/
[32] Intergovernmental Panel on Climate Change (IPCC), Working Group III (2022). Climate Change 2022, Mitigation of Climate Change. Contribution to the Sixth Assessment Report of the IPCC. Page 66. URL: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf
[33] European Circular Economy Stakeholder Platform (ECESP), Leadership Group On Buildings and Infrastructure, 2021.Circular Buildings and Infrastructure, State of Play Report. Page 9. URL: https://circulareconomy.europa.eu/platform/sites/default/files/circular_buildings_and_infrastructure_brochure.pdf
[34] Ibid

to grow by 20% to almost 10 billion by 2050[35], Global South countries' growing demand for floor area growth - 80% of total floor area growth by 2030[36] - as well as increases in per capita floor area.

The two first factors, combined with important rural areas to cities migration in some countries, often justify that we must[37] build more buildings and infrastructure to meet these populations' needs. It is clear that the total building stock will need to rise in Global South countries where supply does not yet meet needs.

However, substantial literature also draws particular attention to the offsets of carbon and energy efficiency gains through sustainable construction and material solutions due to increased demand for floor area per capita. Quoting Rees (2009), Ness he reports that while the average US household size fell from 3.7 to 2.6 people between 1950 and 2003, floor space per capita increased by over 230%.

Externalities

Floor area growth drives demand for land, material and energy as a result of growing demand for floor area and infrastructure to connect urban centers to ever growing suburban areas. As a result, land conversion for new development damages the soil's permeability, increasing water runoff, and threatening ecosystems and biodiversity38. It also contributes to rising energy use from buildings and transportation (particularly cars), increasing pollution and fragmenting communities[39].

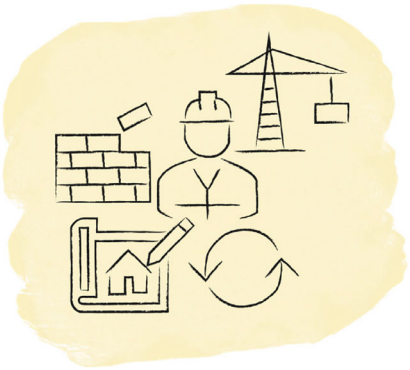
Where urban sprawl and construction are unregulated, new development may also pose major issues for local communities, including lack of access to basic amenities such as treated water supply, electricity, and sanitation[40].
Excessive development may also introduce conflicts, especially between buildings and agriculture needs[41].
Countries in the European Union are already trying to address this concern, where the Netherlands, France and Belgium are working on net-zero artificialization (soil sealing) objectives. In 2011, the EU roadmap for a resource-efficient Europe set the goal of "achieving no net land take by 2050"[42], a goal reinforced in 2021 by the adoption of the European Soil Strategy 2030[43] and in 2023 with a proposal by the Commission of a draft European directive on soil monitoring and health[44].

This issue is not confined to the EU. Sufficiency Action Group participants from different geographies have emphasized land use induced environmental and social issues. Medellín, Colombia, for instance, has high construction and housing densities, and limited developable land for new quality projects. This issue requires optimizing and repurposing existing spaces and construction. Currently, urban development has exceeded the territory's capacity and expose the city to floods and landslides in particular[45]. In Chile, real estate pressure has led to conflict over rural urbanization development[46] and damaging wetlands[47].

Conclusion

The biggest driver of resource consumption in buildings and infrastructure is floor area growth. This issue needs to be addressed by urba n development plans if societies do not wish to see decarbonization efforts offset by increased floor area.

[35] United Nations.Global Issues: Population. URL: https://www.un.org/en/global-issues/population#:~:text=The%20world%20population%20is%20projected,and%2010.4%20billion%20by%202100.
[36] UNEP (2023). 2023 Global Status Report. Page 32. URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/45095/global_status_report_buildings_construction_2023.pdf?sequence=3&isAllowed=y
[37] Ness, D. (2020). Growth in floor area: the blind spot in cutting carbon, Emerald Open Research. https://www.emerald.com/insight/content/doi/10.1108/EOR-05-2023-0002/full/html [38] INRAE (2017). Artificialised land and artificialisation processes: determinants impacts and potential responses. Page 5. URL: https://www.inrae.fr/sites/default/files/pdf/artificialisation-des-sols-resume-8-p-en-anglais-1.pdf
[39] Ministère de la transition écologie et de la cohésion des territoires. Artificialisation des sols. URL: https://www.ecologie.gouv.fr/artificialisation-des-sols
[40] Olden K. Urban Sprawl and Public Health: Designing, Planning, and Building for Healthy Communities. Environ Health Perspect. 2005 Mar;113(3):A202. PMCID: PMC1253792.
[41] Ibid
[42] European Commission (2011). Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Roadmap to a Resource Efficient Europe. Chapter 4.6. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0571
[43] European Commission (2021). Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, EU Soil Strategy for 2030 Reaping the benefits of healthy soils for people, food, nature and climate. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0699
[44] European Commission (2023). Proposal for a Directive of the European Parliament and of the Council on Soil Monitoring and Resilience (Soil Monitoring Law). URL: https://eur-lex.europa.eu/resource.html?uri=cellar:01978f53-1b4f-11ee-806b-01aa75ed71a1.0001.02/DOC_1&format=PDF
[45] Alcaldía de Medellín. Síntesis del Plan Municipal de Gestión del Riesgo de Desastres (PMGRD). 2017. URL: https://www.medellin.gov.co/irj/go/km/docs/pccdesign/medellin/Temas/GestionRiesgo/Publicaciones/Shared%20Content/Documentos/2017/sintesisPMGRD.pdf.
[46] Patagon Journal. «Corte Suprema: El Nuevo Campo de Batalla por los Megaloteos Rurales.» URL : https://www.patagonjournal.com/index.php?option=com_content&view=article&id=4459%3Acorte-suprema-el-nuevo-campo-de-batalla-por-los-megaloteos-rurales&catid=187%3Aguest-blog&Itemid=340&lang=en.
[47] «High Vulnerability of Coastal Wetlands in Chile at Multiple Scales Derived from Climate Change, Urbanization, and Exotic Forest Plantations.» URL: https://www.researchgate.net/publication/373096817_High_vulnerability_of_coastal_wetlands_in_Chile_at_multiple_scales_derived_from_climate_change_urbanization_and_exotic_forest_plantations.

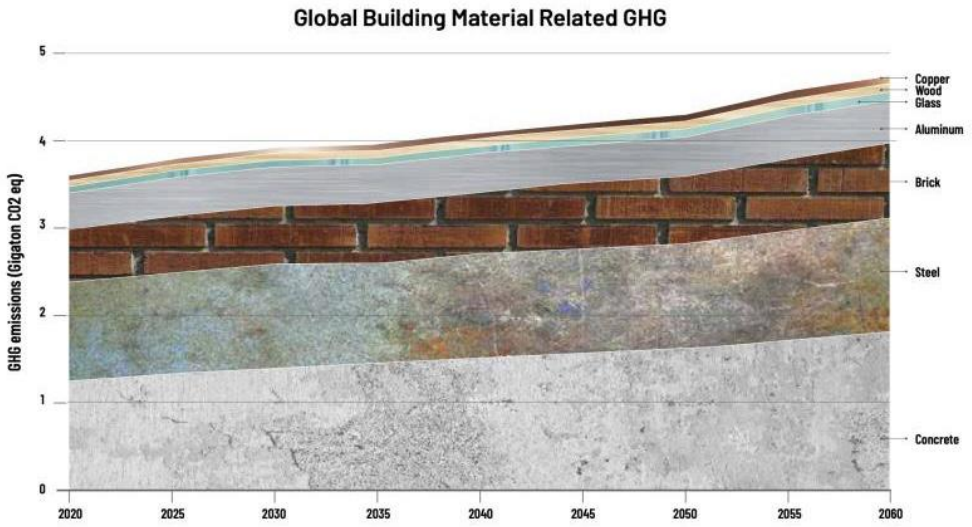


b. Design, construction, deconstruction

Causes

Concrete and steel are the predominant structural construction materials by a large margin, 66% and 29% respectively, and will realistically continue to be so for the next decade and beyond[49]. Buildings represent respectively 50 and 30% of these materials' total demand[50].

2.5 Projected greenhouse gas emissions from building materials in a business-as-usual scenario to 2060



Emissions from concrete, steel, brick, aluminium, glass, wood and copper are all set to increase substantially.

Source: Zhong *et al.* 2021.

Figure 151: Projected GHG emissions from building materials in a business-as-usual scenario to 2060. Source: United Nations Environment Programme (2023). Building Materials and the Climate: Constructing a New Future. Nairobi.

Concrete has become an increasingly popular global construction material due to its low labor qualification needs and cost-effectiveness in a low-price energy environment. Companies will often prefer materially heavy construction solutions such as reinforced concrete flat slabs despite their carbon inefficiency as they can be built quicker, with less labor and less complexity in terms of fitting out around them.

While China currently represents 51% of global concrete production, this figure is declining by over 10% per year as a result of the country's real estate crisis and coronavirus policies. Over the longer term, declining production in China is expected to be offset by production increases in Southeast Asia, Latin America and Africa to meet their development needs.

[48] UNEP (2024). «Global Status Report for Buildings and Construction 2023.». URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/45095/global_status_report_buildings_construction_2023.pdf?sequence=3&isAllowed=y

[49] WBCSD. «Navigating the Urban Transition: A Guide for Business Action.». https://www.wbcsd.org/contentwbc/download/15653/227132/1, Page 30.

[50] PEEB (2021). «Building Materials and Embodied Carbon". URL : https://www.peeb.build/imglib/downloads/PEEB_Building_Materials_Embodied_Carbon.pdf, page 9.

[51] GlobalABC. Sustainable Building Materials Hub Webpage. URL: https://globalabc.org/sustainable-materials-hub/home#:~:text=Construction%20material%20markets%20in%20fast,UNEP%2FGlobalABC%2C%202022)

Negative externalities

Concrete is made from sand, and over-consumption devastates entire coastlines, posing threats to ecosystems and local communities.

Steel is a very energy-intensive material and alone accounts for around a quarter of emissions in the construction process. Individual structural steel sections can vary significantly in terms of their carbon intensity depending on geography and whether their manufacturing process uses a fraction of clean energy versus more polluting processes.

In Global South economies, informal construction is not lasting, leading to increased and inefficient construction resource use over time.

Conclusion

Questioning building needs, buildings' total floor area and shape to reduce the need for material, questioning the need for specific materials, optimizing processes, and searching for alternate structural materials (avoiding steel and concrete) still remain the exception rather than the rule within the building industry.

Waste generation

The buildings and construction sector is also one of the biggest contributors to waste production worldwide, it is responsible for 30% of the waste flows generated[52]. The waste generation is very unevenly distributed, being much more significant in the Global North, in particular in countries such as France, Germany, South Korea, Italy and the USA[53]. In the EU, construction and demolition waste (C&DW) comprise the largest waste stream, amounting to 839 million tons, and annual construction waste is expected to reach 2.2 billion tons globally by 2025[54]. 15% of building materials are wasted in the construction phase itself[55].

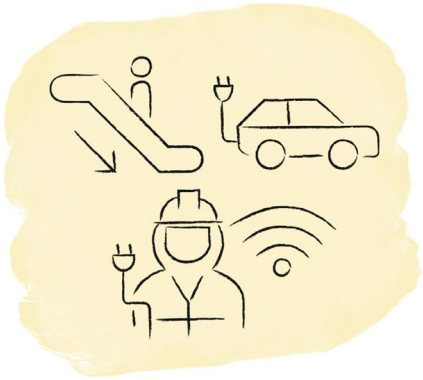
Water use

Construction and deconstruction are also very water-consuming. Water is used at the materials extraction stage, during product manufacturing - as lubricant, cleaning agent, or heat transfer agent for instance - and during demolition, mostly to prevent the spread of dust into the air[56].

A study shows over the year 2012 showed that concrete production alone was responsible for approximately 9% of global industrial water withdrawals and 1.7% of total global water withdrawals (including for civil uses) that year[57]. The UK Centre for Moisture in Buildings estimates that up to 8 000 liters of water may be needed in the mixtures and materials of an average-sized new-build home, although this varies depending on the design. Overall, the upfront water or water footprint (WF) of construction activities remains understudied[58].

If floor area growth projections discussed in section 1.a materialize, an important additional water demand will be added for construction activities. This will represent a true challenge as water availability is already in stress in many regions, increasing competition for water between different uses[59]: human hydration, agriculture, buildings and other manufacturing.

[52] F. Pomponi, A.Stéphan (2021). «Water, energy, and carbon dioxide footprints of the construction sector: A case study on developed and developing economies» URL: https://www.sciencedirect.com/science/article/abs/pii/S0043135421001330
[53] OECD. «Waste by Sector.» URL: https://stats.oecd.org/Index.aspx?DataSetCode=WSECTOR.
[54] Transparency Market Research (2024). «Construction Waste Market.» URL: https://www.transparencymarketresearch.com/construction-waste-market.html.
[55] European Commission (2021). «Circular Buildings and Infrastructure Brochure.» URL: https://circulareconomy.europa.eu/platform/sites/default/files/circular_buildings_and_infrastructure_brochure.pdf
[56] Bluebeam. «Why Water Management Is Among Construction's Most Pressing Issues.» URL: https://blog.bluebeam.com/why-water-management-is-among-constructions-most-pressing-issues/.
[57] Miller, S. Horvath, A. and Monteiro, P. (2018). Impacts of booming concrete production on water resources worldwide. URL: https://www.researchgate.net/publication/322315967_Impacts_of_booming_concrete_production_on_water_resources_worldwide
[58] F. Pomponi, A.Stéphan (2021). «Water, energy, and carbon dioxide footprints of the construction sector: A case study on developed and developing economies» URL: https://www.sciencedirect.com/science/article/abs/pii/S0043135421001330
[59] UNEP. «Global Status Report for Buildings and Construction 2023.». URL : https://wedocs.unep.org/bitstream/handle/20.500.11822/45095/global_status_report_buildings_construction_2023.pdf?sequence=3&isAllowed=y, page 63



c. Operations - Energy and Water

The amount of energy needed for buildings directly depends on how much we exploit land and materials. The more buildings, the more energy needed to operate them. The energy used for making materials and driving them on the construction site is accounted for in the previous section of this report.

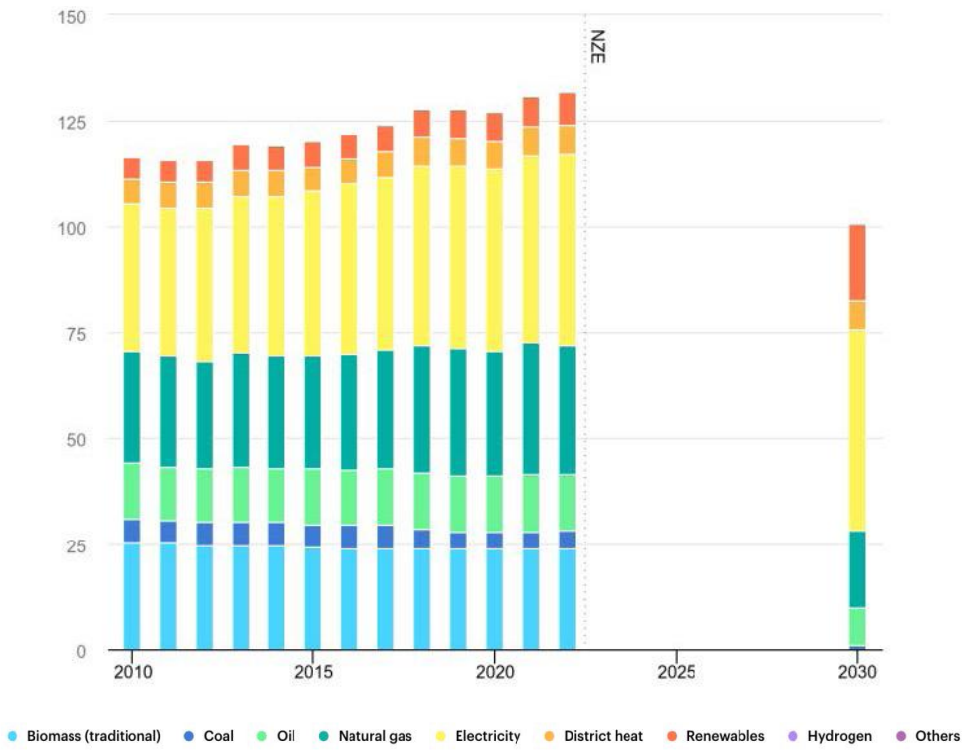


Figure 2: Energy consumption in buildings by fuel in the Net Zero Scenario, 2010-2030, IEA, Paris

The operations of buildings account for about 30% of global final energy consumption and 26% of global energy-related emissions[60]. Operations have reached an all-time high environmental impact in 2021[61] - despite an decreased energy intensity - powered by the largest energy demand surge in 10 years by around 4% from 2020 to 135 EJ.

This can be explained, in part, by an ever-growing global building stock, the reopening of workplaces after the COVID-19 crisis while hybrid work is still practiced and the loss of approximately 30% of the energy consumed in buildings during operation[62].

[60] IEA. «Energy System, Buildings.» URL: https://www.iea.org/energy-system/buildings.
[61] UNEP. «2022 Global Status Report for Buildings and Construction.» URL: https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction, page 16.
[62] U.S. Department of Energy. «About the Commercial Buildings Integration Program.» URL: https://www.energy.gov/eere/buildings/about-commercial-buildings-integration-program.
[63] IEA. «Energy System, Buildings.» URL: https://www.iea.org/energy-system/buildings.

In 2022 buildings' energy demand still increased by nearly 1% compared to 2021 with electricity accounting for 35% of buildings' energy use (30% in 2010). Despite a tentative shift from fossil fuels heat and electricity generation to renewables, the use of fossils in buildings has increased at an average annual growth rate of 0.5% since 2010[63]. This, combined with increased demand, has contributed to increasing buildings' operations global carbon footprint.

In Global North countries, rapidly decarbonizing operations implies decarbonizing the energy going into electricity and heat generation but also drastically increasing the renovation rate: 2.5% per year (or 10 million dwellings per year) by 2030 in developed economies[64]. Yet, across the European Union for instance, deep renovations that reduce energy consumption by at least 60% are carried out only in 0.2% of the building stock per year[65].

In Global South countries, where the building stock is still to extend importantly, decarbonizing operations require decarbonizing the electricity and heat generation solutions, while developing buildings whose design, size, materials and location will help maximize savings during operations.

Water

Buildings' operations would be responsible for 15% of freshwater use at global level[66]. However, research on this is pretty scarce and those numbers appear difficult to trace.

Overall there is very little information available on the contribution of buildings' use and operations to the water usage. It is key that this issue was further investigated since water is an essential good under a lot of stress in certain regions and is bound to be under more stress due to climate adaptation needs[67].

Conclusion

As described, every stage of the value chain contributes to the building sector not being on track to meet the 2030 milestones and the 2050 climate neutrality goal. And not only does the sector contribute to a fifth of global GHG emissions but it also contributes significantly to crossing other planetary boundaries such as land-system change or freshwater change.

In short, our societies have an environmental problem: too many resources are going into buildings. But also a social justice problem: despite using too much resources, we are not distributing them evenly enough for everyone to have their basic needs met. It is urgent to understand what else can be done to get back on the climate and social justice track to mitigate emissions and fight precariousness.

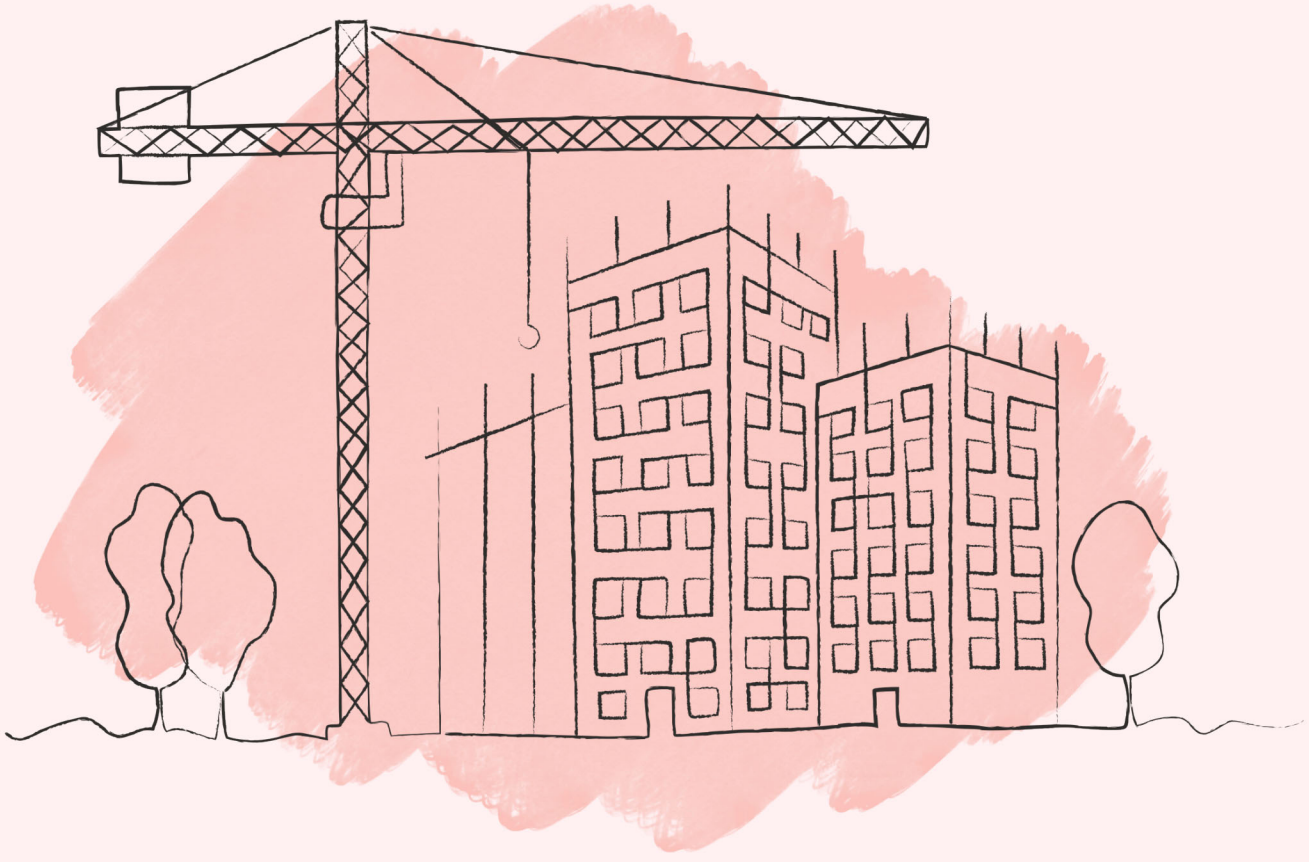
[64] International Energy Agency (IEA). Building Envelopes. URL: https://www.iea.org/energy-system/buildings/building-envelopes 65European Commission. «Q&A: Renovation Wave Strategy.» URL: https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_1836.

[66] F. Pomponi, A.Stéphan (2021). «Water, energy, and carbon dioxide footprints of the construction sector: A case study on developed and developing economies» URL: https://www.sciencedirect.com/science/article/abs/pii/S0043135421001330

[67] Miller, S. Horvath, A. and Monteiro, P. (2018). Impacts of booming concrete production on water resources worldwide. URL: https://www.researchgate.net/publication/322315967_Impacts_of_booming_concrete_production_on_water_resources_worldwide

2

THE DECARBONIZATION CEILING

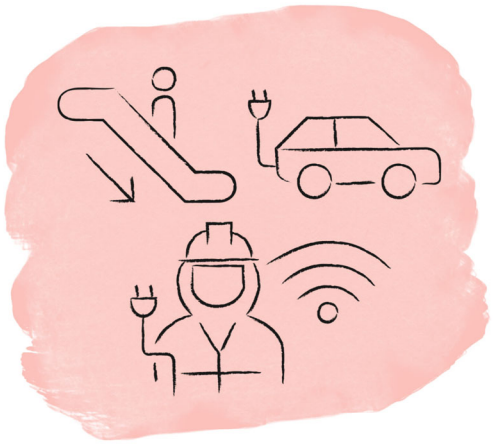


Nota bene: This part does not intend to describe all existing mitigation strategies undertaken by building actors but rather highlight results of the main decarbonizing strategies undertaken over the past few decades.

International cooperation, policy-making and business actors' mitigation strategies have focused for decades on the need to accelerate on efficiency efforts, especially **energy efficiency in operations** and shifting to greener or renewable resources to answer demand, mostly by developing **renewable energy for buildings' operations.** The launch of the Buildings Breakthrough at COP28 was accompanied by a commitment that «near-zero emission and resilient buildings are the new normal by 2030», including a doubling of energy efficiency and tripling the use of renewables[68].

In the last decade, the focus has grown from buildings' operations to integrate embodied carbon thanks to a methodology called "Whole-Life Cycle Assessment"[69] aiming at taking into account all of the emissions from a buildings' cradle to its grave: emissions linked to materials production and transportation, emissions linked to the construction process and emissions linked to operations until the "end-of-life" of a building. As emphasized throughout this paper, Upfront Carbon (phases A0-A5) is arguably the most important.

This part intends to describe and highlight long-term results of the main mitigation efforts undertaken by building actors. It aims at understanding the factors undermining climate mitigation results.



a. Decreasing Operating Emissions - Energy

On energy efficiency efforts

While energy efficiency policies and techniques first sparked interest during the 1970s in the face of successive oil crises, it was not until the 2010s that efficiency measures gained global momentum. Energy cost and widespread concerns about the climate crisis led to institutional efficiency commitments and finance, especially after COP21 in 2015. Still, a lot of work remains to be done to match those commitments with effective implementation.

At a regional level, the EU introduced an "Energy Efficiency First" principle in 2020[70]. The REPowerEU initiative has sought to improve the energy performance of buildings by boosting the take-up of efficiency retrofits, renewables and heat pumps, and the use of fiscal measures for energy efficiency products for buildings. Similarly, the US Inflation Reduction Act has also supported energy efficiency and renewable energy in buildings.

[68] Global Alliance for Buildings and Construction. (n.d.). Fostering Collaboration. URL: https://globalabc.org/our-work/fostering-collaboration
[69] RICS. (2023). Whole Life Carbon Assessment Professional Statement. URL: https://www.rics.org/content/dam/ricsglobal/documents/standards/Whole_life_carbon_assessment_PS_Sept23.pdf
[70] European Commission. «Q&A: Renovation Wave Strategy.» URL: https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_1836.

At a global level, the Glasgow Climate Pact agreed at COP26 (2021) emphasized the need to accelerate and rapidly scale up energy efficiency measures. The 2022 Buildings and Construction Global Status Report highlights the need to multiply such policy commitments. Increased investment will be critical to bending the emissions trajectory downward in the coming years.

The challenge is, reductions in energy consumption for specific product or service use do not necessarily lead to an overall energy consumption decrease.

In fact, most energy efficiency efforts are offset by a "rebound effect". Rebound effect is a multi-dimensional phenomenon that can be described as the increased demand for energy, goods or products, enabled by one or several increases in productivity[71].

This increase is in large part due to an increase in size or number of products or services offered, in response to freed purchasing power on the demand side. A textbook illustration comes from the transport sector where the increase in vehicle size and weight, in particular the increase in sales of Sport Utility Vehicles (SUVs) has completely offset the savings due to increased technical efficiency in motors[72]. In the building sector, most energy efficiency improvements have been offset by increased demand in energy mostly linked to the increase in floor area. As pointed in section 1.b of this report, operations have reached an all-time high environmental impact in 2021[73] - despite an decreased energy intensity - powered by the largest energy demand surge in 10 years by around 4% from 2020 to 135 EJ. In France for instance, the average surface area per person has risen from 22.7 to 40.4 m² between 1988 and 2006.

Higher productivity also causes or enables an increase in demand for energy, goods and services. For over ten years, the French CUBE competition has encouraged the decrease in buildings' energy consumption in relative terms over 12 months compared to the average consumption monitored over the three previous years. The models include corrections of climate and use discrepancies between years. Within this competition, a category is dedicated to "Labeled / Highly Efficient" buildings. Over the challenge, buildings in this category have reached an average performance of 20% energy consumption decrease when engaging in avoiding unnecessary demand. This indicates that, although a building can be highly performing on paper, its energy efficiency and overall environmental performance can be offset by excessive floor area and resource consumption.

An extensive literature review of the rebound effect was gathered by the EU Founded Fulfill Initiative, a project dedicated to studying lifestyle change towards sufficiency with a systemic approach across micro-, meso- and macro-level.

In the long run, technical improvements do not lead to decreasing energy consumption and related emissions but rather allow for the expansion of the economy and related environmental externalities. Therefore, the major loophole of the efficiency strategy is to keep focusing on energy and technical-only oriented approaches without setting clear resource boundaries attributed to each sector and related products' and services. This underlines the critical difference between consumption and demand and emphasizes the need for demand-reduction policies[74].

[71] Fulfill Sufficiency Project (2023). «Literature Review (Revised Version).» URL: https://fulfill-sufficiency.eu/wp-content/uploads/2023/10/D2.1-Literature-review-revised-version.pdf.
[72] Ibid. Page 23.
[73] UNEP. «2022 Global Status Report for Buildings and Construction.». Page 16. URL : https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction.
[74] Fulfill Sufficiency Project. «Literature Review (Revised Version).» URL: https://fulfill-sufficiency.eu/wp-content/uploads/2023/10/D2.1-Literature-review-revised-version.pdf.

To ensure lasting sustainability, it is necessary to adopt a more systemic approach.

Another important component of operating carbon reduction has been greening the energy sources powering our buildings.

Renewable energy is often misunderstood as infinitely and readily available energy. Yet, renewable sources of energy are only available intermittently - when the wind blows, when the sun shines during the day, when there is enough water for power dams to function etc.

This creates challenges not only related to abundance, but also to distribution on the power grid. What this means is that only replacing fossil energy sources for renewables is not a stand-alone solution: societies do not have the capacity to sustain growing energy demand with renewable energy only.

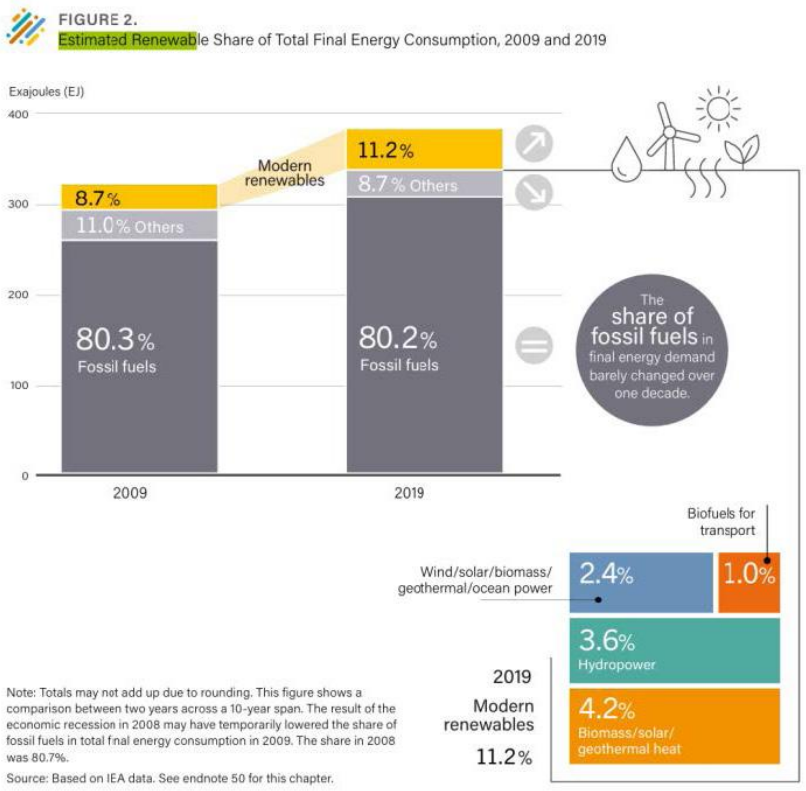


Figure 4: REN Global Status Report 2021, p.33.

Analyses by Fulfill[75] show that "we are currently not substituting fossil fuels with renewables, but rather adding both use of energy from renewable sources and large quantities from fossil sources on the global level". This reality may differ by region but is nonetheless alarming considering emissions affect the global climate. The Renewables 2021 Global Status Report notes that the share of global energy produced by renewable sources has not increased in the past 10 years but rather plateaued at around 20%, remaining at that level for around a decade despite massive investment and development[76].

[75] Fulfill (2023). Literature Review for Analysis of Lifestyle Changes. URL: https://fulfill-sufficiency.eu/wp-content/uploads/2023/10/D2.1-Literature-review-revised-version.pdf
[76] REN21 (2021). Renewables 2021 Global Status Report. 2021. URL : https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf.

Along with the global floor area and energy demand increase for the buildings sector, it is very important that we consider what renewables can and what they cannot achieve when it comes to building decarbonization.

Long-term energy consumption gains and replacement of fossil fuels by renewables are necessary but not sufficient. The capacity of renewables to fully replace fossil fuels is limited by intermittency, while producing renewable-energy equipment relies on finite resources and may cause sectorial use-conflict (room for solar panels or windmills implementation, biodiversity impacts etc.). Development of renewables must be accompanied by measures meant to limit demand. The Agency for Ecological Transition (ADEME) has developed four scenarios to achieve net-zero carbon by 2050: Sufficiency; Shared governance and cooperation; Innovation and decarbonized systems; and Investment in techniques and technology, including forecasts and land use objectives. The four scenarios include - to some extent - a degree of demand reduction. The president of ADEME then concludes : «avoiding energy demand is the key factor».

Energy efficiency and renewable energy are two necessary decarbonization - yet not sufficient - levers. Decarbonizing buildings' operations requires a reduction in energy demand in absolute terms, also to allow for a better allocation of this essential yet non-abundant good and avoid other environmental externalities and resource depletion issues.

b. Decreasing construction emissions

Efforts to decrease emissions linked to the construction phase have mainly focused on the upfront carbon emissions linked to material use. They include material demand reduction measures through more efficient use of materials at all stages of the material cycle. Given predicted growth in global floor area, material **efficiency strategies** alone will lead not to drastically less GHG emission reduction as predicted, unless accompanied by demand-side policy measures. For instance, cement efficiency - using less material for the same kind of slabs - may decrease emissions on one particular segment of a building's life, but may encourage a "business as usual" in other areas failing to take into account the complexity and consequences of this decision; using less cement to build the same building still implies using as much land, other materials and energy in operations compared to a traditional approach. Ultimately, to reduce upfront carbon and resources, it is necessary to question the need to build in the first place, consider options to meet needs by building less, or by adapting or sharing existing facilities.

Decreasing construction emissions is also increasingly tackled by **circular economy measures** aiming to close the loop by making construction materials reusable.

This strategy reduces the demand for floor area and new materials, reducing resource consumption, pollution from materials extraction, transformation and waste. Such measures are increasingly undertaken by market players and subject to growing attention from policymakers. A sample of non-residential buildings as part of the Reuse Booster[77], a French initiative aiming to mobilize players in the real estate sector to prescribe the use of reused materials in order to accelerate reuse in the building sector, has shown that materials reuse can help reduce total materials carbon impact by 10%. Of course this figure must be seen in the French context but it is a strong signal of the potential for reusing materials to lower demand for new material.

Such measures and obligations are increasingly reflected in national regulations. For instance, Japan has implemented the Building Material Reuse Promotion Law, which aims to promote the reuse of building materials and reduce construction waste. The law encourages the use of recycled materials in construction projects and provides support for research and development in the field of building material recycling[78]. France, introduced the French Circular Economy Roadmap[79], setting targets for reducing waste generation and increasing recycling rates in the construction sector. More recently, the Extended Producer Responsibility (EPR) scheme was introduced for the construction sector. The EPR are special arrangements for the prevention and management of waste related to certain types of products. These schemes are based on the principle of extended producer responsibility, under which producers, i.e, the entities responsible for placing certain products on the market, can be held responsible for financing or organizing the prevention and management of waste generated by these products at the end of their life cycle. Producers generally choose to organize collectively to fulfill these obligations within non-profit eco-organizations, approved by public authorities[80].

Circularity is necessary, it is insufficient to decarbonize construction materials. Re-use and **recycling are limited** in their ability to provide enough resources for an expanding material economy, so we cannot totally rely on circularity as long as the need for new buildings is still growing. Complete recycling is physically impossible due to the second law of thermodynamics (see “the entropy law and economic process” by Georgescu Roegen). Regional conditions are also important; most of global floor area growth will happen in developing countries where building stock development needs are often far from met, there is much less room for re-use and much more need for new materials.

In line with this analysis, ARUP’s Circular Building Toolkit (2022) and framework has ‘Build Nothing’ as the first strategy: «Decisions made in the early stages of a project have the greatest potential impact. A deep and thoughtful interrogation of the project brief against the client’s needs is needed to decide whether a new building is the best way to meet those needs. This strategy aims at avoiding the intensive material use linked to the construction of a new building by first reassessing if a physical building is necessary for the envisioned requirements, and if so, assessing if an existing building[81].

Architecture and design also play a crucial role in driving a building’s construction and operating emissions.

Some solutions may appear green but are not always optimal in terms of reducing the upfront carbon emissions or even later on the energy needed to operate the buildings. Vertical forests, for instance, demand a more massive concrete structure in order to bear the additional weight of trees. Although aesthetically green, the life-cycle assessment of some buildings calls for a shift in thinking towards building types, green certification systems and aesthetics.

[77] Reuse Booster (Booster du réemploi) Website: https://boosterdureemploi.immo/
[78] Ministry of the Environment, Japan. «Annual Report on the Environment in Japan 2023.» URL: https://www.env.go.jp/content/900452889.pdf.
[79] Ministère de la Transition Écologique. «Feuille de Route Économie Circulaire: 50 Mesures pour une Économie 100% Circulaire.» URL: https://www.ecologie.gouv.fr/sites/default/files/Feuille-de-route-Economie-circulaire-50-mesures-pour-economie-100-circulaire.pdf.
[80] Ministère de la Transition Écologique, France. «Cadre Général des Filières à Responsabilité Élargie des Producteurs.» URL: https://www.ecologie.gouv.fr/cadre-general-des-filieres-responsabilite-elargie-des-producteurs.
[81] Arup. Circular Economy Toolkit. URL: https://ce-toolkit.dhub.arup.com/framework

Part of this is to reduce materials' footprint by **changing materials.** However, with the very same building architecture, the only adequate material to meet the LCA threshold may be wood. Obviously, not all building demand on Earth can be met with wood-only, both for depletion and availability reasons. This analysis goes in line with previous comments that avoiding construction of new floor area should be first consideration, as this avoids both upfront embodied and ongoing operational emissions. Secondly, once a project is considered necessary, **the more we work on the architecture to reduce the need for materials, the more we can use bio-based and other types of materials.**

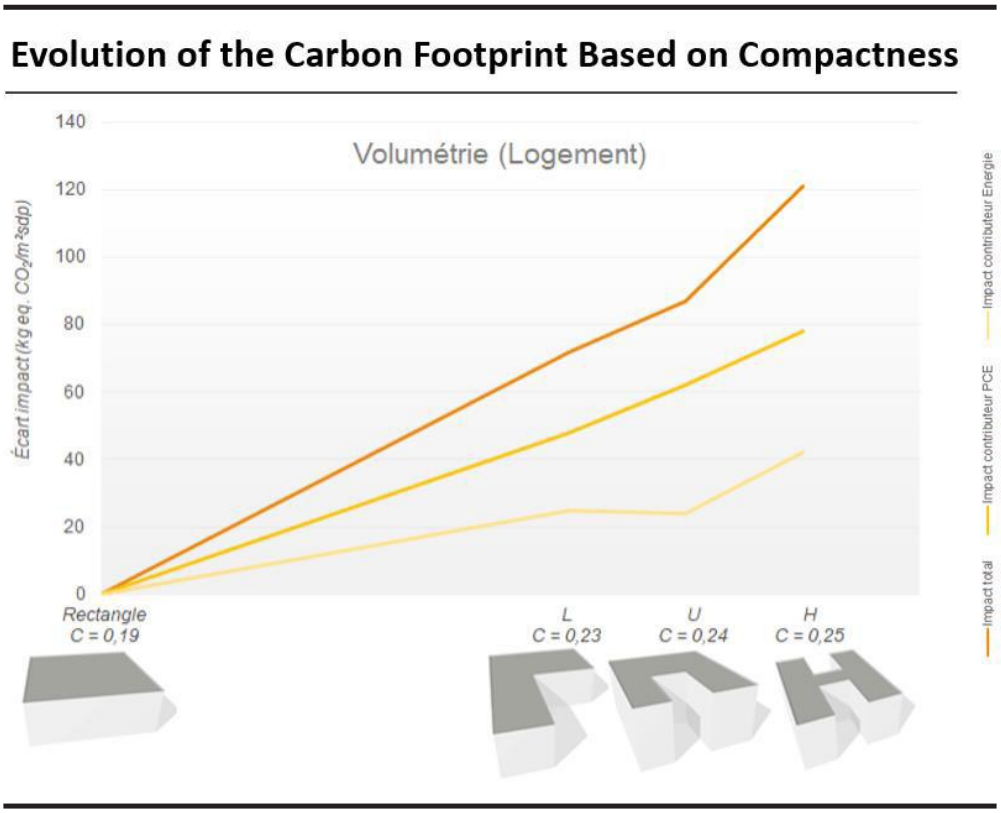


Figure 5: Low Carbon Experts' Hub Experimentation on the carbon footprint of buildings' based on the evolution of compactness.

An experiment led in France by the Low carbon experts hub[82] shows that compactness and glazing ratio appear to be affordable and low-cost levers for reducing a building's carbon footprint, each contributing 10% of the materials carbon impact. Of course, these figures need to be understood in the French context, but sustain the argument that working on different architecture and design paradigms is instrumental in decreasing a building carbon footprint. In this study, the more compact the building, the lower its carbon footprint: up to 120-130 kg CO2e/m² can be saved on a project. And, up to a certain threshold, the lower the glazing ratio, the lower the building's carbon footprint: up to 120 kg CO2e/m² can be saved on an LCA. However, it seems that these levers are rarely utilized by the buildings in the studied building sample to meet the regulatory thresholds. Focusing on these aspects during architectural design provides more flexibility for the rest of the project. If compactness and glazing ratios are two powerful levers, they touch upon buildings' desirability and demand a change in building types from architects.

[82] Le Hub des Prescripteurs Bas Carbone, an initiative led by IFPEB in partnership with Carbone 4: https://www.ifpeb.fr/travaux/le-hub-des-prescripteurs-bas-carbone/

These reflections on compatibility between architecture and decreasing buildings' environmental impact are not new. They are subject to different movements such as the Manifesto for a happy and creative frugality in the Architecture and Planning of Urban and Rural Areas83 or the European movement Unissons "Towards Low-Carbon and Living Architecture"[84]. These movements interrogate the practices and thoughts underlying the way we design buildings and aim to create a new architectural thinking more adequate to climate change and biodiversity loss induced by construction activities.

One last growing R&D trend is the manufacturing of low carbon materials. A parallel could be made with renewable energy. If research in this area and replacement of materials by lower-upfront carbon materials is absolutely necessary, development costs and other considerations such as land preservation and energy use limitation call for limiting demand before considering using low carbon materials. The building development steps would ideally go this way: build nothing, use as less materials as possible through questioning architecture types - and then - once all of these steps are optimized, use the best available materials, as much low in carbon as possible. However, at global level, we must take in consideration that not all regions have the same access to low-carbon materials. Therefore, regions with increasing construction activities and limited access or use of low-carbon materials risk locking in high upfront carbon and operational emissions for a long duration[85].

With projected urbanization rates bound to keep driving a materials demand - 4.2% per year in the next ten years, driven by growing demand for buildings and infrastructure[86] and a projection for more than a doubling of global materials demand from 79 Gt in 2011 to 167 Gt in 2060[87], it is urgent that the building sector controls demand to decrease its carbon and environmental footprint and its contribution to global materials demand.

[85] UNEP. «Global Status Report for Buildings and Construction 2023.» URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/45095/global_status_report_buildings_construction_2023.pdf?sequence=3&isAllowed=y, page 21

[86] Market Research Future.»Construction Materials Market.» URL: https://www.marketresearchfuture.com/reports/construction-materials-market-12121.

[87] OECD. «Highlights of the Global Material Resources Outlook to 2060.» URL: https://www.oecd.org/environment/waste/highlights-global-material-resources-outlook-to-2060.pdf

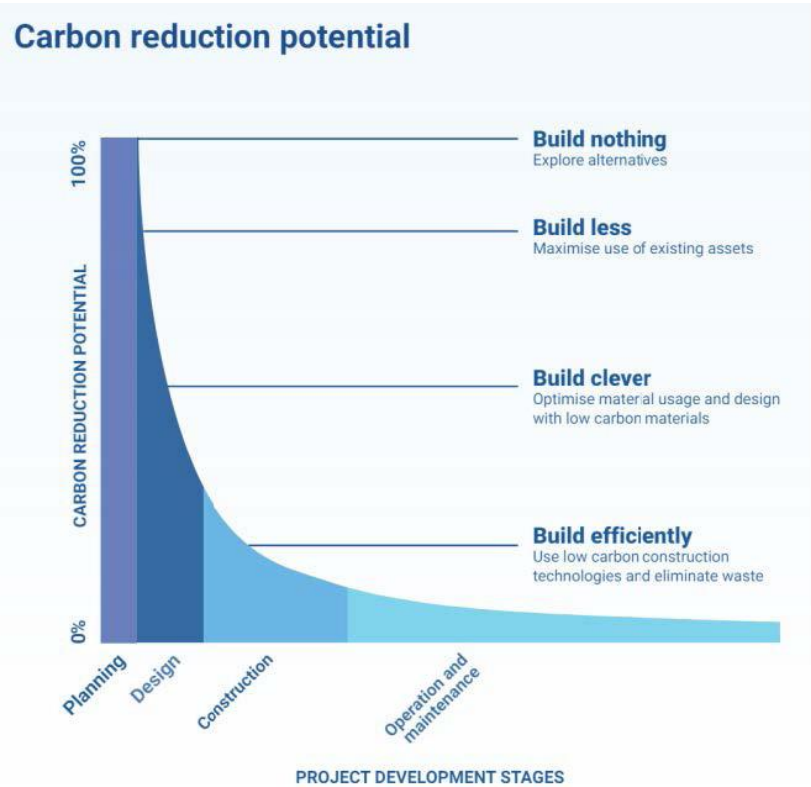


FIgure 6: Carbon reduction potential from stage of design process. Source: Bringing Embodied Carbon Upfront, WGBC (2019, p.20).

Several conclusions can be drawn from these results. First, on decarbonization levers. Resource efficiency appears necessary but not enough, due to rebound effects in the absence of clearly set boundaries. As Sachs analyzed "*The 'efficiency revolution' remains direction-blind if not accompanied by a 'sufficiency revolution'. Nothing is as irrational as rushing with maximum efficiency in the wrong direction.*[88]". Renewable or low-carbon resources use is necessary, but cannot represent a satisfying response in and of itself : all resources are not infinitely renewable, and their uses widely add up to a 'business as usual' instead of replacing it.

Second, on the process and strategies used to address the sectors' decarbonization. First, one lever is never a stand-alone solution to reach maximum decarbonization potential. So advocating for stand-alone solutions is a flawed vision. Second, all steps of a building's value-chain are intrinsically linked and decisions taken at each step further locks the resource use for the future of the building.

How to tackle this decarbonization ceiling at a building, urban, national and international level? By questioning the need at each and every step of a project, whatever the scale of action. Questioning the need for a project can help reduce the demand for land take. Questioning the need for a certain type of architecture over another can help reduce the demand in material at construction stage and energy use in operation.

[88] Fulfill Sufficiency Project. «Literature Review (Revised Version).» Page 13URL: https://fulfill-sufficiency.eu/wp-content/uploads/2023/10/D2.1-Literature-review-revised-version.pdf. In reference to Sachs, W. (1993). Die vier E's—Merkposten für einen maß-vollen Wirtschaftsstil. Politische Ökologie. URL : https://epub.wupperinst.org/frontdoor/index/index/docId/66

3

SO, WHAT HAVE WE MISSED? THE ROLE OF SUFFICIENCY

a. Why Sufficiency?

As evidenced in part two of this paper, efficiency and greener resources (renewable, low carbon solutions) have proven insufficient to reverse the trend of growing emissions and get the sector on track to meet Paris Agreement Goals and limit environmental damage linked to urbanization. Given the anticipated growth in resource demand by 2050, it is urgent that all countries introduce policies and measures that avoid demand or limit demand for resources to the real need, namely, sufficiency measures.

On the environmental need for sufficiency

According to IPCC, "Up to 17% of the mitigation potential of buildings could be captured by 2050 through sufficiency measures. Sufficiency interventions in buildings include the optimization of the use of buildings, repurposing unused existing buildings, prioritizing multi-family homes over single-family buildings, and adjusting the size of buildings to the evolving needs of households by downsizing dwellings. Sufficiency measures do not consume energy during the use phase of buildings."[89].

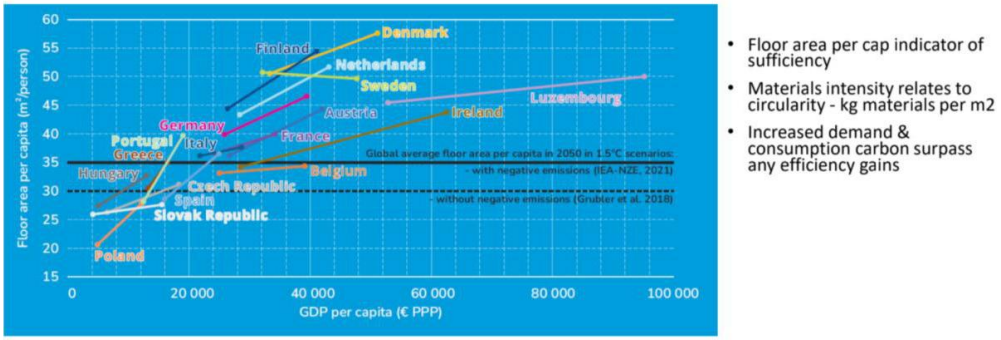
Therefore, harvesting the full potential of sufficiency also means adopting a more comprehensive and systemic approach when it comes to buildings and urban development, with measures taking into consideration land, floor area, material, water, **energy and any other necessary resource to preserve. It is acknowledged that energy use and building operations are not the cornerstone of the sector's climate track** but rather only part of the solution. Energy consumption is itself highly dependent on previous measures driving urban development, design and construction.

The most pressing issue identified by the Sufficiency Action Group is in fact the one that has historically been the least tackled by international cooperation and national policies: limiting new floor space and land take. Commonly accepted floor area growth models are a problem and push decarbonization policy-making to approach the problem from the wrong end: through measures centered on material and energy, policies try to make GHG emissions fit into a demand-growth set to double by 2050.

[89] Intergovernmental Panel on Climate Change (IPCC), Working Group III (2022). Climate Change 2022, Mitigation of Climate Change. Contribution to the Sixth Assessment Report of the IPCC. Page 955. URL: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

An alternative approach taking into consideration demand-side policies would start from the remaining carbon budget and decide what is the demand growth that we can afford.

The remaining carbon and resources budget should then be allocated to allow for geographical and social convergence[90].



Changes in floor area & GDP per capita 2000- 2018 in selected countries

Figure 7: Graph from Yamina SAHEB, 2021. Sufficiency & Circularity, EEB & OPENEXP. URL: https://youtu.be/ohH6CsCYhc0?si=TUKDXiJMOICgyr_U

Questioning the need for a resource at every stage of a building's life, everywhere, prior to any other decarbonization lever allows for :

A control over rebound effects, at the macro level. For instance, in the Swiss Geneva Canton 103, an energy law specifies that non-residential air-conditioning installations for comfort are only possible if the need for it has been duly demonstrated after applying solar protections, insulation, thermal mass, a part of the heat generated by the equipment is reused and the cooling water in the system is reused. The law also stipulates that alternatives to air-conditioning, such as solar protections, passive cooling, geo-cooling, etc. should be prioritized[91].

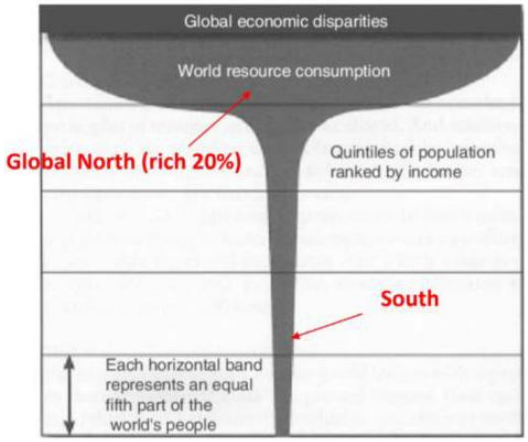
At project level, avoid oversizing of projects and equipment: by reducing the demand for a particular resource thanks to demand-side management measures prior to developing a new project or retrofitting for instance, the size of buildings or equipment can be decided according to the real space or energy use. While not impacting comfort, it can avoid unnecessary capacity building. For instance, Room AC is a growing source of energy consumption in the residential sector. Renovation could help reduce its needs. However, introducing sufficiency measures first can limit the need for room AC and lead to use less energy intensive solutions (comfort fans, efficient solar protections); promoting passive cooling during the conception of buildings; reduce size of installations and recommend moderate indoor temperatures in accordance to recent comfort standards (ASHRAE 55:2020, EN 16798:2017).

[90] M. Röck, A. Sørensen, B. Tozan, J. Steinmann, L.H. Horup, X. Le Den, H. Birgisdottir Towards embodied carbon benchmarks for buildings in Europe - #2 Setting the baseline: A bottom-up approach Zenodo (2022), 10.5281/zenodo.5895051

[91] République et canton de Genève. «Installations techniques de rafraîchissement et climatisation de confort.» URL: https://www.ge.ch/installations-techniques-rafraichissement/climatisation-confort.

On the social need for sufficiency

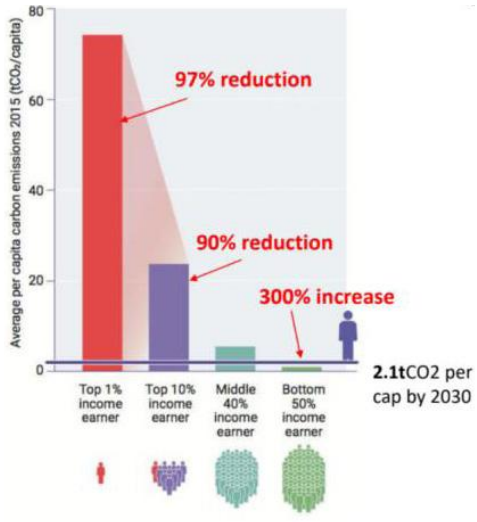
Growth projections take into account the need for Global South countries to reach a certain level of social livelihoods, shelter and infrastructure, just as countries of the Global North. If emissions have a global impact, emissions from developing countries resulting from massive growth will obviously have global consequences. **However, it is not acceptable to impede these countries from reaching a level of development that would allow them to meet what the economist Kate Raworth calls the social foundation**. For instance, the African continent only accounted for 6% of global energy demand and less than 3% of GHG emissions in 2021.



The **'champagne glass'** analogy of resource consumption in relation to world population by income groups (Agenda 21, Rio, 1992)

Figure 8: Graph from Agenda 21, Rio, 1992.

Growth projections take into account the need for Global South countries to reach a certain level of social livelihoods, shelter and infrastructure, just as countries of the Global North. If emissions have a global impact, emissions from developing countries resulting from massive growth will obviously have global consequences. **However, it is not acceptable to impede these countries from reaching a level of development that would allow them to meet what the economist Kate Raworth calls the social foundation**. For instance, the African continent only accounted for 6% of global energy demand and less than 3% of GHG emissions in 2021.



Consumption coarbon per cap - shift required by 2030
(UN Emissions Gap Report, 2020)

Figure 9: Graph from the UNEP Emissions Gap Report, 2020

It is even less acceptable when taking into account the **externalization of the environmental impact from high-consumption / Low Production countries to Low-consumption / High Production countries that allows for an apparent decoupling between consumption, total output and GDP in some regions and countries.**

Obviously this climate justice imperative is not confined to geographical considerations but also social class considerations.

Wealthier suburbs often have an emissions footprint 15 times that of nearby neighborhoods[92], making climate justice important in most societies.

It is equally important in the disadvantaged parts of the world in providing a means of addressing the inequity of insufficient resources. *Even in high income countries, some citizens* do not have access to the social foundation, while wealthier citizens from low income countries may contribute to planetary boundary overshoot. "*In the Global North, the trends towards sufficiency-levels are notoriously middle class and white, and are the exception rather than the norm. In the Global South, consumption of the upper-classes has leapt well beyond sufficiency levels, while hundreds of millions remain left in poverty."*[93]. For instance, in France, a recent study by Harris Interactive during the 2022-2023 winter energy crisis determined that, while French people had generally lowered their heating temperatures, low-income households reduced their temperatures by an average of 3°C, compared to only 0.6°C for higher-income households[94].

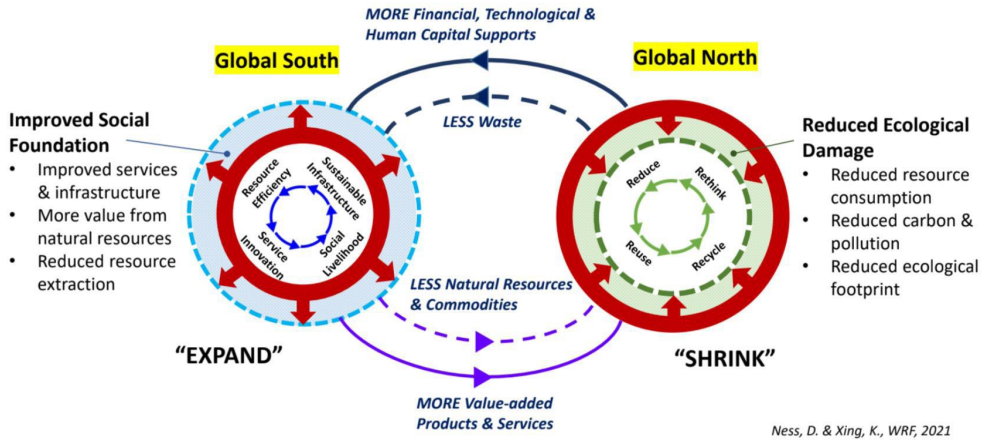


Figure 10: Ness, D. and Xing, K. (2021), Presentation to World Resources Forum 2021: 'Rebalancing resource disparities between partner countries'

Addressing climate justice through sufficiency measures is necessary if we are to meet climate goals with acceptable solutions that allow for social stability.

[92] Intergovernmental Panel on Climate Change (IPCC), Working Group III (2022). Climate Change 2022, Mitigation of Climate Change. Contribution to the Sixth Assessment Report of the IPCC. Page 989. URL: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

[93] Joel Millward-Hopkins, Julia K. Steinberger, Narasimha D. Rao, Yannick Oswald, Providing decent living with minimum energy: A global scenario, Global Environmental Change, Volume 65, 2020, 102168, ISSN 0959-3780,https://doi.org/10.1016/j.gloenvcha.2020.102168.

[94] Toluna Harris Interactive Report for the French Ministry of Ecological Transition and Territorial Cohesion (MTECT). Survey conducted online from August 11th to 14th, 2023, on a sample of 1,135 people representative of French citizens aged 18 and older. Quota sampling and weighting applied to the following variables: gender, age, socio-professional category, region, and size of the interviewee's urban area.

Sufficiency is also an economic opportunity

According to some World Bank estimates, investing in **more resilient infrastructure** could also save humanity as much as $4.2 trillion from climate change damages[95]. A recent study has just found that potential macroeconomic damage by climate change would in fact be six times higher than previously calculated[96]. Sufficiency measures could produce savings by avoiding the construction of excess buildings, spaces and energy capacity. Savings potential is important everywhere, and could be redirected to other budgets, including the quality of buildings and retrofits.

In Africa, around 56% of the population lives in informal housing (UN Habitat 2016). The total population of the continent is expected to reach 2.4 billion people by 2050 with 80% of this growth occurring in cities[97]. The need to provide housing now and in the future is a major driver of growth for buildings across the continent. There are enormous opportunities for these buildings and urban environments to be built to a high-quality and sustainable standard, to be zero carbon (or zero carbon ready) and to be capable of adapting to a changing climate. Sufficiency measures represent an enormous opportunity to leapfrog the suboptimal real estate developments found in developed countries to direct funding to a higher quality of urban development[98].

[95] The World Bank. $4.2 Trillion Can Be Saved by Investing in More Resilient Infrastructure, New World Bank Report Finds. 2019. Available at: https://www.worldbank.org/en/news/press-release/2019/06/19/42-trillion-can-be-saved-by-investing-in-more-resilient-infrastructure-new-world-bank-report-finds.

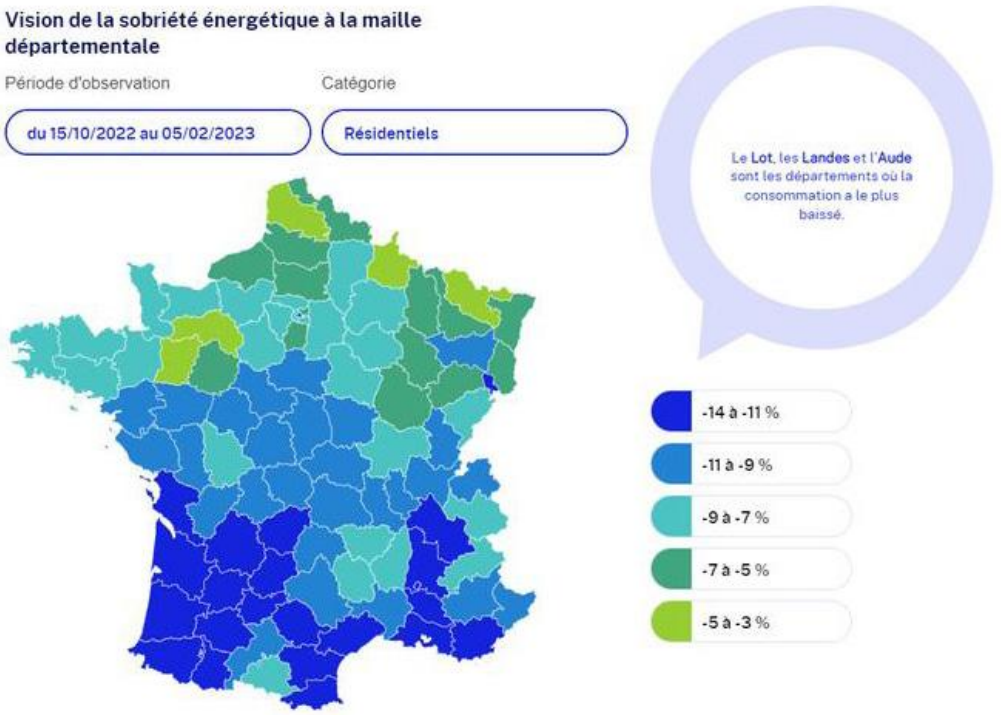


Figure 11: Geographical comparison of energy sufficiency results between French metropolitan departments from October 15 2022 to February 5 2023[99]

Despite all of the above, addressing demand through sufficiency measures has been mostly absent from building sector thinking and policy-making since the start of the industrial era. Its first appearance into regulation was in 2015 under the French Law for Ecological Transition and Green Growth but was only partial (confined to energy) and not defined. Sufficiency reappeared in the French decarbonization agenda during the winter of 2022 energy crisis during which the Government launched a "Sufficiency Plan". If the latter has contributed to an uptake of the sufficiency concept in the political agenda and immediate energy demand reduction through low cost measures, it consisted in a mix of immediate sustainability actions combining efficiency, sufficiency and other sustainable actions.

A much more global update of the sufficiency imperative is needed to drive emissions down rapidly. Indeed, as evidenced, sufficiency is:

- A crucial climate change mitigation lever: building decision-makers cannot afford to overlook such mitigation potential given GHG emissions trends.
- A crucial lever to address other planetary boundaries such as loss of biodiversity, air pollution, land conversion or freshwater withdrawals.
- A crucial lever to adapt our social infrastructure to economic and social issues.

[99] France Bleu (2024). «Carte électricité: Découvrez les Départements qui Ont été les Plus Sobres cet Hiver.» URL: https://www.francebleu.fr/infos/societe/carte-electricite-decouvrez-les-departements-qui-ont-ete-les-plus-sobres-cet-hiver-8192905.

b. What is sufficiency exactly?

After decades of research and practice, Sufficiency is a concept officially introduced and defined in 2022 IPCC **report as - *policies and daily practices that reduce or avoid the demand for energy, materials, land, water, and other natural resources at a global level while providing well-being for all within the planetary boundaries.*** Sufficiency is therefore a consented limit that the building sector, and the whole society, must give itself, in order to preserve resources and close the inequality gap to ensure a fair access to resources and space, at global and local levels.

The upper limit of sufficiency, in terms of CO2, is the remaining carbon budget with its normative target for distributional equity. The lower limit of sufficiency is the provision of decent living standards. A decent living standard is a set of essential material preconditions for human wellbeing which includes housing, nutrition, basic amenities, health care, transportation, information, education, and public space[100]. In contrast to efficiency, which is about doing more with less in relative terms without considering planetary boundaries, sufficiency is about consuming less in absolute terms and within the biophysical limits of the planet [101].

This has several implications:

- **Sufficiency is first about policy making[102]:** a very small portion of individuals can change their behavior to adopt sufficiency practices in all aspects of life. The scale and degree of changes is too high to let people bear the responsibility of adopting wide changes at individual level. In fact, people are locked into the solutions imposed by the social infrastructure. Addressing sufficiency at the systems level moves away from the idea that sufficiency would be the responsibility of consumers, and to clearly identify the need to build, in terms of regulation, infrastructure, or corporate action, a range of system-level sufficiency measures.

- **Sufficiency involves creating policies that address identified needs** related to common interest decisions, policies, and behaviors, distinguishing itself from technology-driven efficiency[103].

- **Sufficiency is about acting upstream,** before activating any other decarbonization solution, it questions the need for resources upfront, therefore acting on demand, rather than consumption once people are locked into wasteful behavior schemes.

- **Sufficiency is not about precariousness nor austerity.** Social and climate justice are inherent to the concept to allow for the political acceptability of changes. In buildings this would mean affordable and decent housing, affordable transportation for all, while respecting planetary boundaries.

[100] Rao, N.D., Min, J. Decent Living Standards: Material Prerequisites for Human Wellbeing. Soc Indic Res 138, 225–244 (2018). URL:https://doi.org/10.1007/s11205-017-1650-0
[101] Princen, Thomas PY - 2003/02/01. Principles for Sustainability: From Cooperation and Efficiency to Sufficiency (3). 10.1162/152638003763336374 Global Environmental Politics
[102] OpenExp. «Beyond Efficiency and Renewable Energy: Sufficiency Matters to Limit Global Warming by End of Century to 1.5ºC.» OpenExp, 5 Dec. 2017. URL: https://www.openexp.eu/posts/beyond-efficiency-and-renewable-sufficiency-matters-limit-global-warming-end-century-15degc.
[103] ADEME. «Rapport sur l'État des Lieux de la Notion de Sobriété 2019.» URL: https://librairie.ademe.fr/cadic/491/rapport-etat-lieux-notion-sobriete-2019.pdf?modal=false#:~:text=La%20sobri%C3%A9t%C3%A9%20puise%20ses%20racines,ou%20frugalit%C3%A9%2C.

c. How to create and implement sufficiency measures?

A sufficiency approach should be adopted at every stage of the buildings value chain. It consists in questioning about **the true need,** in order to move towards what is truly necessary. As needs can vary depending on the regional and economic situations,, there is no single "right" sufficiency process. Sufficiency is rather a set of measures allowing for an adjustment of resource demand according to the real needs at every step of a project. As such, it is very dependent on local conditions and is not a standardized solution. As a systemic approach to climate mitigation, it requires collaboration between building specialists, urban policy-makers, social and political science specialists etc.

On energy for instance, Négawatt,[104] a French non-profit organization, defines Energy Sufficiency as «prioritizing essential energy needs, in individual and collective energy uses.» **Here applied to energy, the focus is always on the need before the use of the resource itself.**

A crucial first step is for policymakers and decision-makers to have accurate information on the current building stock conditions, such as the number of vacant buildings, the amount of vacant square meters within buildings, and occupancy rates. This information allows them to adapt decisions based on expressed needs and to preserve resources as much as possible while guaranteeing access to wellbeing for all. According to Négawatt applied to cities, sufficiency measures can take 3 forms:

- **Service Sufficiency:** intensify the duration and intensity of building usage. Resource potential must be **optimized while being used**, responding to specific needs.

- **Dimensional Sufficiency:** optimize the size of equipment/facility, control of built surfaces, number and size of vehicles. The size of a room / building / neighborhood / car / city, is the result of studied / **identified needs.**

- **Organizational Sufficiency:** sharing of equipment or spaces, or territorial organization, to reduce distances to be covered. **Multiply the uses/actors of a facility,** during daytime/ nighttime, seasons, or its whole lifetime.

[104] Negawatt Work and Scenarios. URL: https://negawatt.org/Scenario-negaWatt-2022

Coordination with other mitigation levers

At every stage of a building's life, an optimal decarbonization strategy follows the following order:

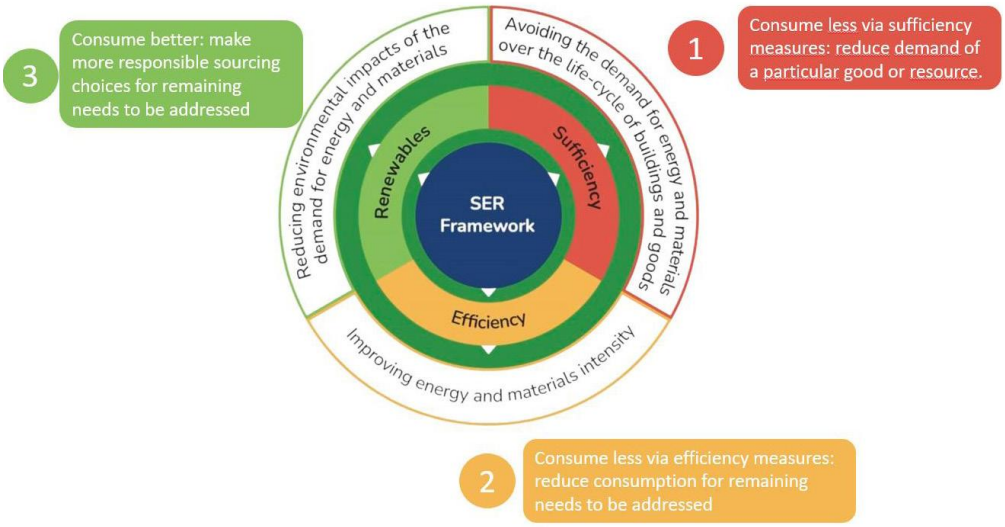
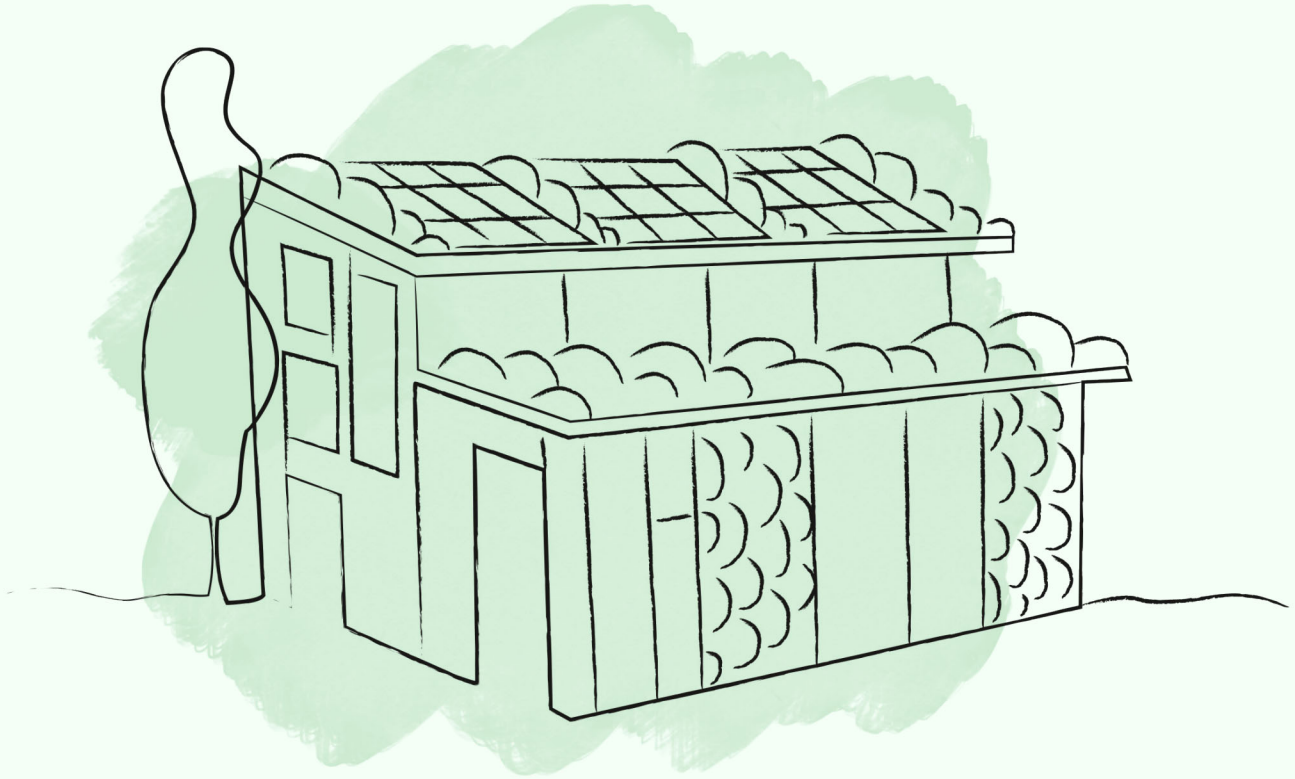


Figure 12 - Graphical presentation of the SER (sufficiency, efficiency and renewable) framework proposed by (Saheb, 2021) and partially adapted from IFPEB Work Program Priorities "Consume Less (first), then Consume better".

4

RECOMMENDATIONS FOR PRIORITY POLICY ACTION



This section proposes a set of priority recommendations to integrate sufficiency within public action and projects. As demonstrated along this paper, sufficiency is not an option but rather a necessity if the building sector is to meet the Paris Agreement Objectives.

This section has been built from workshop outputs reflecting stakeholders' experience and interviews, as well as the scientific literature.

This work does not intend to be exhaustive but should rather be seen as a preliminary work to be further developed by building stakeholders within the Sufficiency Action Group and beyond. The conclusion draws attention to the main takeaways for decision makers and points out priority research and development efforts to undertake.

a. Sufficiency must be first

Enabling a large scale uptake of sufficiency by business actors and citizens is **first and foremost the responsibility of public policy makers.** Indeed, if innovation and will can come from ground actions, the systemic character of decarbonization issues makes relying on national and local policy rules necessary to overcome obstacles: ever-growing economic output and unregulated private activity, economic incentives, organizational barriers etc. Policies should aim to bring harmony and structure to mitigation efforts.

The main and most important proposal from the Sufficiency Action Group is therefore to introduce a "Sufficiency First" principle in all public policies for building decarbonization on the model of the European Union "Energy Efficiency First Principle". At every stage of the value chain, and preferably at the earliest stage, public policy should start with a sufficiency objective aiming to minimize demand for resources to match real needs.

And since understanding is acting, governments need to rely on **data and measures - with very clearly defined indicators -** that reflect the actual performance of their territory regarding the preservation of a resource. This is the condition for building binding result-oriented policies. On land-take for example, the French Center for Studies and Expertise on Risks, the Environment, Mobility, and Urban Planning (Cerema) produces an annual measurement of land use within the frame of the Land Artificialization Observatory. All data are open source and aim for public actors at national, regional or municipal level, to inform land use planning decisions to align with the goal of zero net land artificialization.

Sufficiency is often confused with other types of decarbonization levers. This is why there is an important need for training.

b. Leading by example: the role of the State and Governmental action

The exemplarity of the state and public bodies is key to send a strong signal to the market and citizens. If this is true for sufficiency, it is in fact true for any measure and effort towards a sustainable building sector.

In this regard, thirty countries and the EU have signed the Net-Zero Government Initiative (NZGI, 2023). The NZGI aims for countries to lead by example to achieve net-zero emissions from national government operations by no later than 2050. Partner countries are taking action in recognition of the critical role of sustainability leadership from government to catalyze economy-wide shifts to reach country-level and global climate targets[105]. These initiatives should be complemented by sufficiency first measures.

[105] U.S. Federal Government. «Net Zero Initiative.» URL: https://www.sustainability.gov/federalsustainabilityplan/net-zero-initiative.html.

Among signatories, some "leading by example" initiatives can be found in France. The French Government has, for instance, engaged State Building into an energy demand reduction competition[106]. The French State Real Estate Directorate also aims at reducing its building stock by 25% by 2030.

c. Defining sufficiency policy objectives

More recently, the Buildings and Climate Global Forum, Paris, 7-8 March 2024, resulted in the Ministerial 'Declaration of Chaillot'. Objectives include «develop integrated urban planning policies aiming at greater resilience, efficiency, and sufficiency for all buildings....». As mentioned earlier, **this paper seeks to elevate the importance of sufficiency policy so that it is considered first.**

This section seeks to define general goals that can be implementable everywhere with the following rationale: reducing carbon emissions is a global challenge, resources need to be preserved everywhere, and development and management of buildings should allow for everyone to reach the social foundation.

The single most important "methodological" sufficiency character to highlight is the need to incorporate sufficiency measures upfront, ideally before even building.

Solutions and objectives will differ depending on where a country or specific territory lies in terms of attainment of social foundation and contribution to overshooting environmental limits.

As described in Figure 9, some territories will expand demand to meet needs while others will shrink demand to meet needs. In this regard, an important first step - as raised at the Buildings and Climate Global Forum 2024 - should be to «reconsider built environment growth scenarios to ensure compatibility with limited resources» (see Objective 1, Action 1). For example, will it really be necessary or, indeed, sustainable, to construct the equivalent of another Paris every 5 days until 2060? Can needs be met by making better use of and adapting what we have, via digital transactions, and the like? What needs to be built where, for whom, and for what purpose?

For each particular objective, a bundle of solutions is proposed. Implementation strategies are left to stakeholders according to their local reality.

[106] CUBE Etat website: https://www.cube-etat.fr/

Objective 1

Avoid global land use by aiming for zero or decreasing floor area growth and land use to meet minimum needs.

Bundle of actions to achieve this goal

Action 1
Review baseline scenarios for floor-area growth at global and national levels

Most of the global scenarios aiming at a 1.5°C target do not include sufficiency assumptions. On the contrary, these scenarios assume a linear increase of the per-capita floor area driven by affluence. Grubler et al. (2018), Millward-Hopkins et al. (2020) and Kuhnhenn et al. (2020) are among the few researchers working on global scenarios involving a cap in the per-capita floor area and a convergence between the Global North and South in the access to a decent living standard for all. As noted above, further research is required to reconsider these high-growth scenarios.

Action 2
Review baseline scenarios for floor-area growth at global and national levels

Before determining construction objectives, policy makers should launch a "battle plan" on existing buildings.

Measure 1 - Determine the rate of vacancy and analyze the underlying reasons

- Optimizing the use of vacant buildings can help reduce the need for new buildings and more artificialization.
- Understanding why part of the building stock is vacant can provide useful information to be included into construction codes for newbuilds to enhance the quality and the value of upcoming construction.

Measure 2 - Determine the rate of occupancy and analyze the underlying reasons

Working on the intensity of use of existing square meters can help reduce the need for newbuild and more artificialization.

Measure 3 - Set up a plan with intermediary milestones to overcome the weaknesses of the current state of the building stock to maximize existing square meters and avoid new land take.

Action 3 - Build policies to control land use and artificialization

Measure 1 - See zero artificialization goal at the national level.

Get there through:

- Limiting the expansion opportunities for zone-exempt buildings and conversions of agricultural land.
- Neutralizing and repurposing a portion of existing buildings.

To do this:

- Define intermediary milestones.
- Create a monitoring center to follow progress.

Example: Flanders and the Bowshift Policy to reach Zero Artificialization by 2040

This policy aims to reduce the intake of open space to zero hectares. Without this shift, Flanders risks losing over 40,000 hectares of nature and agricultural land. The historical analysis shows that the current cluttered state of Flanders emerged in the 1960s and 1970s, with excessive land designated for construction. The study also highlights the need for more protection of agricultural and natural spaces and the potential benefits of implementing the Bouwshift policy. A large portion of additional land use was allowed in less rural areas at the expense of nature and agriculture due to non-compliant zoning rules. The regional plans did not bring about any adjustment to keep developments more together in designated zones. As a result, more than 50% of land use ends up in less urbanized areas. The study also examines the future development of land use in Flanders. Without policy changes, a further loss of about 29,000 hectares of open space in rural areas and 13,000 hectares in urban areas are foreseen by 2050. The Bouwshift policy implementation aims at reducing this loss significantly .

Measure 2 - Protect land upfront as much as possible.

- Incorporate rules to limit ***artificialization to identified needs at national level,***
- Define **criteria to identify beyond which point the building stock is considered mature / sufficient.**
- Create a monitoring center to follow **progress.**

Action 5
Optimize existing spaces

Measure 1 - Fight vacancy in residential buildings

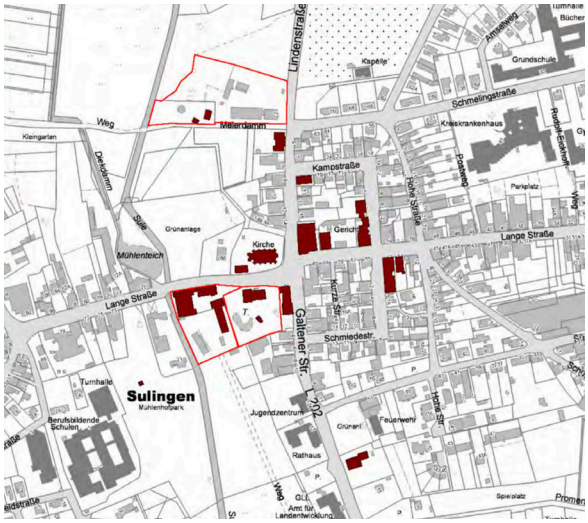
Through a national plan and by providing tools for local stakeholders to fight vacancy.

For instance, in France, the CEREMA (Centre for Studies and Expertise on Risks, the Environment, Mobility, and Urban Planning) has developed a database "LOVAC" for local and regional authorities as part of a national plan to combat vacant housing launched in 2020. LOVAC data is used in the «Zero Vacant Housing» solution developed within the framework of the Digital Factory. This solution enables the monitoring of a housing unit during the initial stages of its return to the market (from identifying the housing unit to engaging with its owner) and facilitates collaboration with all stakeholders involved in addressing housing vacancy in the area. A visualization tool, Cartoviz, is currently under development and is expected to be available in the near future[107].

In Germany, the «Baulücken- und Leerstandskataster» or «Cadastre on Gaps between Buildings and Vacancies (BLK)» was developed as part of two research projects of the Agency for Geoinformation and Land Surveying of Lower Saxony (LGLN) with two main objectives:

- Display of the age structure of the residents
- Recording and displaying vacancies and gaps between buildings.

The Agency expects concrete support to deal with demographic change, in finding and utilizing inward development potential and in the policy goal of reducing the consumption of land. The success of these examples has attracted interest of other German States for this service[108].



Through incentives such as a tax on vacant spaces that could be gradual depending if the building is in a highly demanded zone or not.

[107] Cerema. L'OVAC, un outil du Cerema pour identifier et remobiliser les logements vacants. URL: https://www.cerema.fr/fr/actualites/lovac-outil-du-cerema-identifier-remobiliser-logements
[108] Kleinwächter, D. Baulücken- und Leerstandskataster für niedersächsische Kommunen. j. Cartogr. Geogr. inf. 65, 67–71 (2015). https://doi.org/10.1007/BF03545090

In France, in certain municipalities, you must pay a tax on vacant housing if you own an unfurnished, unoccupied property that has been vacant for at least one year as of January 1 of the tax year. This applies if your property is located in a high-demand area[109].

Measure 2 - reorganize and / or convert non-residential spaces into housing to decrease vacancy and under-occupancy

Some cities with falling office occupancy have programs to incentivize conversion of older office buildings to residential. Architects have developed evaluation tools to help assess the suitability of a building for such a conversion. For instance, in Victoria[110], Canada, office buildings are being converted into residential buildings.

Measure 3 - Invest in retrofitting over newbuilds

Many old buildings and dwellings need to be renovated, within a variety of periods of construction. Renewing existing buildings by investing in retrofits limits the demand for new land use.

Policies encouraging retrofits must accompany stakeholders in financial and technical support.

Action 6
Parking infrastructures limitation for sufficiency

Introducing low or no parking minimum requirements for new buildings and / or replacing these obligations by minimum requirements for bike parking contributes to lowering construction costs, saving space and incentivizing city development models based on public transport.

In Japan, for instance, some cities have developed much lower parking minimum requirements than in most cities of the world, including some minimum exemptions for small buildings. This policy allows for massive space and money savings, making housing more accessible. This is true for cities - known in Japan for their good transportation network - but also in smaller towns with higher car owning rates, thanks to policies pushing for public parking availability at the same time[111].

In the EU, the revised EPBD (Energy Performance of Buildings Directive) mandates requirements for bicycle parking spaces in new and renovated buildings and in existing large non-residential buildings[112].

Action 7
Protection against land speculation

Land speculation consists in buying vacant land and holding it until development interest and the overall market value of real estate increases in the area, driving prices up and pushing some populations to leave certain areas to go further, contributing to urban sprawl.

[109] Service Public - French Government.Taxes on vacant housing (Tascom). URL: https://www.service-public.fr/particuliers/vosdroits/F17293?lang=en.
[110] Calgary Herald. (2023, November 28). Converting office space into homes is reducing downtown vacancy rate, says analyst. URL: https://calgaryherald.com/news/local-news/converting-office-space-into-homes-is-reducing-downtown-vacancy-rate-says-analyst#:~:text=A%2520%2524100%252Dmillion%2520effort%2520to,per%2520cent%252C%2520said%2520Avison%2520Young. City of Calgary. Downtown Development Incentive Program. URL: https://www.calgary.ca/development/downtown-incentive.html. Johnson, L. (2023, October 3). Extreme makeovers: Interest grows in converting empty Edmonton office towers into housing. CBC News. URL: https://www.cbc.ca/news/canada/edmonton/extreme-makeovers-interest-grows-in-converting-empty-edmonton-office-towers-into-housing-1.6979033.
[111] Parking Reform Atlas. Japan's Low-Harm Parking Minimums. URL: https://www.parkingreformatlas.org/parking-reform-cases-1/japan%E2%80%99s-low-harm-parking-minimums.
[112] European Commission. (2024, June 12). Questions and Answers on the 2024 Climate and Energy Package. URL: https://ec.europa.eu/commission/presscorner/detail/en/qanda_24_1966.

Conclusion

Paying attention to space and quality of living should not only be defined by an absolute number of square meters. The comfort and attractiveness of a space should also be defined by the surrounding amenities, quality of outdoor public spaces and available transportation and other services.

It is necessary to develop metrics more adapted to land preservation objectives. One important consideration should go to the uniformization of these metrics, in order to ease the global evolution of progress and fix global objectives. In line with this, evaluating the number of square meters per person or the **"surface footprint" per capita** is an interesting methodology, in an analogy with the carbon footprint.

Objective 2

Avoid global upfront demand for new floor space, materials, water and energy associated with construction and demolition.

The best resource is the one we do not use. Optimizing upfront carbon and future energy use is highly dependent on architecture and design. This is why this section focuses on the role of architects as key agents of a building's overall carbon, energy and resource performance, in close collaboration with their clients where possible. Regrettably, many architects have limited influence, so other stakeholders such as politicians, private corporations, investors, and property industry professionals also need to be sensitized and trained to support decisions and measures towards sufficiency. **Raising awareness of all stakeholders is key to identify barriers to sufficiency policies and overcome regulatory or economic obstacles.**

Action 1
Allocate remaining top-down carbon budgets, and assess new proposals against these

Measure 1: Countries, cities and jurisdictions to ascertain remaining carbon budgets for sectors.

Measure 2: All proposals for new projects to be assessed at development approval stage against the budget, according to priority and need, using estimates of upfront embodied carbon[113].

Action 2
Learn and understand the underlying carbon and resource challenges of buildings and the role that architects and property and construction industry professionals play in determining a building's future carbon footprint.

Measure 1: Make learning life-carbon assessment methodology (LCA) mandatory for all architecture curriculum, in addition to education of other key stakeholders such as facility managers, engineers, and property professionals.

Measure 2: Create incentives for architecture agencies and other property and construction activity businesses, to train their employees in LCA methodologies and raise awareness of sufficiency strategies.

[109] Service Public - French Government.Taxes on vacant housing (Tascom). URL: https://www.service-public.fr/particuliers/vosdroits/F17293?lang=en.
[110] Calgary Herald. (2023, November 28). Converting office space into homes is reducing downtown vacancy rate, says analyst. URL: https://calgaryherald.com/news/local-news/converting-office-space-into-homes-is-reducing-downtown-vacancy-rate-says-analyst#:~:text=A%2520%2524100%252Dmillion%2520effort%2520to,per%2520cent%252C%2520said%2520Avison%2520Young. City of Calgary. Downtown Development Incentive Program. URL: https://www.calgary.ca/development/downtown-incentive.html. Johnson, L. (2023, October 3). Extreme makeovers: Interest grows in converting empty Edmonton office towers into housing. CBC News. URL: https://www.cbc.ca/news/canada/edmonton/extreme-makeovers-interest-grows-in-converting-empty-edmonton-office-towers-into-housing-1.6979033.
[111] Parking Reform Atlas. Japan's Low-Harm Parking Minimums. URL: https://www.parkingreformatlas.org/parking-reform-cases-1/japan%E2%80%99s-low-harm-parking-minimums.
[112] European Commission. (2024, June 12). Questions and Answers on the 2024 Climate and Energy Package. URL: https://ec.europa.eu/commission/presscorner/detail/en/qanda_24_1966.
[113] M. Röck, A. Sørensen, B. Tozan, J. Steinmann, L.H. Horup, X. Le Den, H. Birgisdottir Towards embodied carbon benchmarks for buildings in Europe - #2 Setting the baseline: A bottom-up approach Zenodo (2022), 10.5281/zenodo.5895051

Measure 3: Create widespread access to advice on architectural types compatible with lower-carbon footprint buildings for property and construction industry professionals, architects and the general public.

Action 3
Change building designs and architecture in order to minimize the new floor space and resources needed.

Measure 1: Question the demand for new projects, consider alternative options (e.g. adapt existing, sharing) and construction practices in relation to the real needs of the final user to adapt the services as closely as possible to those needs.

Example: an Assistant to User Management, a relatively recent practice aiming to integrate the user into the team of stakeholders in building projects, can, for example, be considered to better address the future user's needs (if they are known, of course).

Measure 2: Identify the most suitable building configuration and construction method as early as possible.

Work on compactness, reduce the span of ceilings, consider arches rather than straight long beams, to promote the optimization of the amount of material needed.

Adopt a geometry favoring material sufficiency (aligning grids, straightening ...).

Refer to Figure 5 on page 20 for the Low Carbon Experts' Hub Experimentation on building carbon footprints. The compactness ratio, which measures the facade area relative to the habitable area or the surface to volume ratio, is an important indicator. In the buildings studied, keeping these ratios low helped reduce material use and minimize unwanted energy gains or losses. However, in warm, humid climates, buildings may need larger surface areas with big openings for better ventilation.

Measure 3: Include low tech solutions to help maximize comfort with minimum water and energy use in operation.

Enhance summer comfort with air velocity thanks to air velocities of 0.5 to 1.5 m/s using ceiling fans or natural ventilation, reducing the need for cooling energy and ensuring safety during energy shortages. Perceived temperature could be reduced by 3-4°C.

Use adaptive comfort models to assess and guide the design of naturally ventilated spaces, and to adjust active cooling setpoints based on outdoor conditions. This approach enhances comfort and reduces energy consumption.

Design flexible outdoor spaces such as balconies, that can be used in warm climates when indoor cooling is ineffective. These spaces should be designed to reduce discomfort from extreme temperatures without excessive energy use.

Design for energy sufficient laundry drying solutions. Designing stylish and practical line-drying solutions for outdoor spaces, offering privacy and convenience will encourage people to air-dry clothes instead of using energy-consuming tumble dryers, significantly saving energy.

Use movable or optimally fixed external solar protection tailored to the building's latitude and facade orientation. This will help minimize solar heat gain in summer and maximize it in winter, reducing energy consumption for heating and cooling.

Measure 4
Adapt the size of equipment to the real needs

Implementing sufficiency measures in building design and designing a building as close to the user's needs as possible should help avoid oversizing of equipment in new construction or retrofitting.

On top of aiming at minimizing the need for resources, the choice of design and architecture typology should pay particular attention to adaptation needs. Indeed, some decisions aiming at lowering the carbon emissions of a building can be counterproductive in terms of adaptation challenges and vice-versa. Therefore the role of architects and their understanding of mitigation and adaptation issues is fundamental to make buildings that positively contribute to climate mitigation while making them adapted to the forecasted climate evolution. This is essential to limit comfort issues and overconsumption of heating or cooling in operations to counterbalance ill-adapted designs or worse, expose the building to alteration or destruction risks which, on top of human catastrophes would represent a not loss in terms of invested natural and financial resources.

On specific adaptation solutions, see the work of GlobalABC's Adaptation Hub.

Action 4
design for deconstruction or re-purposing of buildings and component

In Bordeaux, the TEBiO project obtained the first unallocated building permit in France, marking a major step forward in reversible real estate. This type of permit enables the construction of buildings capable of changing use over time, thus promoting sustainability and flexibility. Reversible real estate aims to adapt buildings to the changing needs of society, thereby reducing the costs and environmental impact of demolition and reconstruction (BordeauxImmo9).

San Antonio Reuse is an initiative by the City of San Antonio focused on promoting deconstruction and circular economy practices. It provides resources, training, and information on reusing building materials to minimize waste and support local economic and social prosperity. The site features details about deconstruction policies, the Material Innovation Center, a list of contractors and reuse stores, and examples of community projects. The aim is to transition San Antonio into a sustainable city by encouraging the reuse and repurposing of materials.

Conclusion:

While circularity approaches like the reuse of materials and components are vital measures, they represent a downstream approach to decarbonization. The focus here is on upstream policies and measures, such as «build nothing» and «build less» strategies. For more comprehensive information on circularity, refer to the flagship publications available on the Materials Hub. These resources offer detailed insights into sustainable practices and their implementation.

Objective 3

Avoid / reduce as much as possible upfront demand for energy and water during building operations and use

The best kWh is the one we do not use. This section intends to give recommendations on priority measures to decrease demand in energy. The same recommendations can apply for water.

Action 1
Energy and water demand knowledge

Measure 1: Get data on how much energy and water your building stock consumes.

In Chile, the National Energy Law passed in 2021 sets that big energy consumers must report all their energy consumption.

In France, the Tertiary Decree sets binding targets for non-residential buildings over 1000 square meters to reach a certain level of energy performance by a certain date. Building owners or operators need to report consumptions through a platform administered by ADEME for the State.

OPERAT
Observatoire de la Performance Energétique de la Rénovation et des Actions du Tertiaire

In France, the Tertiary Decree sets binding targets for non-residential buildings over 1000 square meters to reach a certain level of energy performance by a certain date. Building owners or operators need to report consumptions through a platform administered by ADEME for the State.

Measure 2: Training and Sensitizing building managers (or alike) and building users.

Professionals in charge of managing buildings or whose decisions have a direct impact on the building energy performance must be trained to understand the challenge linked to buildings energy performance, including regulation and financial factors.

To effectively reduce energy demand without compromising comfort and to enhance social dialogue, it has proven successful to avoid a top-down management approach. Instead, initiatives involving users in discussions about their needs and comfort levels while explaining the reasons behind decisions have proved effective.

CHAMPIONNAT de FRANCE des ÉCONOMIES D'ÉNERGIE

Energy demand reduction competitions such as Battle of the Buildings in the US, the Real Estate Energy Challenge in Québec[114] or CUBE[115] France and Europe intend to do so. The CUBE challenge is particularly interesting in the sense that it follows and recognizes real demand reductions only - through sufficiency and efficiency measures.

Action 2 - Reduce energy and water demand through putting strict turn off rules on designated uses that do not conflict with indoor comfort (heating, cooling, lighting) through new standards.

Regulations must be updated and redefined to match sufficient standards: what is comfortable lighting? What is a comfortable temperature? In general, these questions are really complex and not well researched. More research is needed on building management and how that impacts comfort. When enough research is available, these can help build new standards to allow for energy use reduction.

For instance, the use of energy-consuming heating or air-conditioning systems operating outdoors on public property is prohibited in France since 2021.

Action 3 - Develop and implement enabling norms for changing lifestyles towards more sufficient practices.

Working and living norms have an impact on building management standards. This is especially true when it comes to heating, cooling or lighting, whose levels do not always reflect external conditions.

The "Cool Biz Campaign" is a Japanese campaign initiated by the Japanese Ministry of the Environment from summer 2005 as a means to help reduce electricity consumption by limiting the use of air conditioning and changing the standard office air conditioner temperature to 28 °C and by introducing a liberal summer dress code[116].

[114] Le défi énergie en immobilier
[115] CUBE Competition is part of a wider initiative called The French Championship for Energy Demand Reduction: https://championnatdefrancedeseconomiesdenergie.org/
[116] «Janetschek, H. (2021, November 22). COP26: Why sufficiency is needed for future climate policy. Buildings & Cities. URL: https://www.buildingsandcities.org/insights/commentaries/cop26-sufficiency.html.

Action 4
Set progressive tariffs on energy & water

A (relatively low) flat price of energy can allow the poor families not to die of cold (or of heat wave) only for a certain short term (prices of energy can suddenly go up as e.g. in case of war,..etc) and will continue to subsidize waste of energy, uncomfortable, unsafe buildings, and the collapse of the planet.

Progressive tariffs (also called rising block tariffs or increasing block tariffs), on the other hand, apply by increasing the price of electricity with increasing consumption. Usually, the first block or consumption bracket is a low tariff (e.g. US$/kWh), which corresponds to the minimum electricity consumption of a household. The second block or consumption bracket has a slightly higher unit price of electricity and is set to meet the average electricity consumption of a household. Subsequent consumption brackets are charged at an even higher price.

Proposals for deployment of progressive tariffs were made both in the Global North and the Global South over the past decades[117]. They would consist in collecting a levy on gas, electricity, water, via progressive tariffs, and with the funds collected, finance an incentive programme for the people suffering from "energy poverty" so that they can retrofit the envelope of their house.

Conclusion: No one size fits all solutions

The sufficiency recommendations given in section 4 of this paper intend to define general objectives that can be applied universally by building policy makers and decision making stakeholders. The measures and examples proposed intend to reflect how these objectives can be implemented. This list is neither exhaustive, nor universally applicable. It should rather be seen as an inspirational bundle of solutions to be adapted to each local context.

Indeed, as stated in section 3 of this document, Sufficiency is rather an approach than a one universally stand alone solution. Section 4 recommendations is a way to illustrate this sufficiency approach that could be summarized as approaching building, infrastructure and urbanization as a whole with the following priorities or methodology[118]:

1. Prioritize upstream decarbonization actions (Sufficiency):

    a. First, prioritize building nothing - challenge the need for developing new floor area
    b. Then prioritize building less - make the most of existing floor area, adapt architecture and design to real needs while minimizing the upstream need for resources, build long term value oriented buildings.
    c. Then prioritize building for minimum energy and water waster in operation

2. Then Prioritize downstream decarbonization solutions:

    a. Prioritize building clever - reuse material and components, use low-carbon material and equipment
    b. Prioritize building efficiently - low carbon construction and technologies.

[117] Goldemberg, José (Brasil), Thomas B Johansson (Norway), Amulya K. N. Reddy (India), and Robert H. Williams (USA). 1985. "Basic Needs and Much More with One Kilowatt per Capita." Ambio, Energy in Developing Countries, 14 (4/5): 190–200.
[118] Partially adapted from Figure 6: Carbon reduction potential from stage of design process. Source: Bringing Embodied Carbon Upfront, WGBC (2019, p.20).

CONCLUSION

The lack of decarbonization progress of the global building sector compels building decision making stakeholders to a critical analysis of current decarbonization strategies. Despite efficiency and low carbon emissions solutions uptake, results have been offset by a continuous increase in demand for new floor area.

Not only is the constant overshooting of our planets' capability to provide the resources the sectors' growing demand but it must also be acknowledged that this model of development has not been able to provide access for all to a minimum level of social livelihoods, shelter and infrastructure.

Given the anticipated growth in resource demand by 2050, it is urgent that all countries introduce policies and measures that avoid demand or limit demand for resources to the real need through sufficiency measures.

As demonstrated, sufficiency measures are about acting upstream in order to reduce demand for resources while closing the social gap and allow societies to stay within planetary boundaries. As such, they must come first.

This is why the single most important recommendation of this paper is the introduction of a "Sufficiency First Principle" within all new and revised climate preservation and energy transition oriented policies.

Introducing sufficiency measures should not be confused with limiting growth for everything, everywhere, the same way. Rather, **sufficiency should be tailored to specific regional and economic conditions and aim at** liberating the resource budget needed for those for whom the social foundation is not yet met.

Enabling the large-scale development of sufficiency policies and measures requires collaboration and support to define common indicators and tools that can be used and adapted to each local context.

Sufficiency Action Group participants have expressed the need for specific work on building and real estate metrics that are more in line with sufficiency objectives, including the potential for employment. They also pointed out necessary regional or country level cooperation on this topic in order to align as closely as possible with the reality of each region.

To address all of these challenges, enhanced international cooperation will be crucial.

BIBLIOGRAPHY

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

Global Alliance for Buildings and Construction

a4mt ACTION FOR MARKET TRANSFORMATION

ifpeb

BIBLIOGRAPHY

Reports and legal documents

- ADEME (Florian Cézard, Marie Mourad). 2019. Panorama sur la notion de sobriété – définitions, mises en oeuvre, enjeux (rapport final). URL: https://librairie.ademe.fr/cadic/491/rapport-etat-lieux-notion-sobriete-2019.pdf

- Building and Climate Global Forum (2024). Déclaration de Chaillot. Sections: 2.3, 2.7, 4.4. URL: https://www.ecologie.gouv.fr/sites/default/files/declaration-de-chaillot-forum-batiments-climat.pdf

- European Circular Economy Stakeholder Platform (ECESP). (2021). Circular Buildings and Infrastructure, State of Play Report. Page 9. URL: https://circulareconomy.europa.eu/platform/sites/default/files/circular_buildings_and_infrastructure_brochure.pdf

- European Commission. (2011). Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Roadmap to a Resource Efficient Europe. Brussels. Chapter 4.6. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0571

- European Commission. (2021). Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, EU Soil Strategy for 2030, Reaping the benefits of healthy soils for people, food, nature and climate. Brussels. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0699

- European Commission. (2023). Proposal for a Directive of the European Parliament and of the Council on Soil Monitoring and Resilience (Soil Monitoring Law). Brussels. URL: https://eur-lex.europa.eu/resource.html?uri=cellar:01978f53-1b4f-11ee-806b-01aa75ed71a1.0001.02/DOC_1&format=PDF

- INRAE. (2017). Artificialised land and artificialisation processes: determinants impacts and potential responses. Page 5. URL: https://www.inrae.fr/sites/default/files/pdf/artificialisation-des-sols-resume-8-p-en-anglais-1.pdf

- International Energy Agency. (2023). World Energy Outlook. URL: https://iea.blob.core.windows.net/assets/86ede39e-4436-42d7-ba2a-edf61467e070/WorldEnergyOutlook2023.pdf

- IPCC. (2022). Climate change 2022, Mitigation of climate change (Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change). ISBN 978-92-9169-160-9. Cambridge (UK) and New York (NY, USA): Cambridge University Press. Pages 66, 100, 955, 989. URL: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

- Ministère de la Transition Écologique. (2018). Feuille de route Économie Circulaire: 50 Mesures pour une Économie 100% Circulaire. DICOM-DGPR/PLA/18061. URL: https://www.ecologie.gouv.fr/sites/default/files/Feuille-de-route-Economie-circulaire-50-mesures-pour-economie-100-circulaire.pdf.

- Organization for Economic Cooperation and Development (OECD). (2018). Highlights of the Global Material Resources Outlook to 2060. URL: https://www.oecd.org/environment/waste/highlights-global-material-resources-outlook-to-2060.pdf

- PEEB. (2021). Embodied Carbon – A hidden heavyweight for the climate. Paris. Page 9. URL: https://www.peeb.build/imglib/downloads/PEEB_Building_Materials_Embodied_Carbon.pdf

- RICS. (2023). Whole life carbon assessment for the built environment. 2nd edition, September 2023, Version 2, issued November 2023, Effective from 1 July 2024. Published by the Royal Institution of Chartered Surveyors (RICS). London. ISBN: 978 1 78321 503 4. URL: https://www.rics.org/content/dam/ricsglobal/documents/standards/Whole_life_carbon_assessment_PS_Sept23.pdf

- Martin Röck, Andreas Sørensen, et al. (2022). Towards embodied carbon benchmarks for buildings in Europe - #2 Setting the baseline: A bottom-up approach. Aalborg University. URL: https://zenodo.org/records/5895051

- United Nations Environment Programme (2021). Catalysing Science-based Policy action on Sustainable Consumption and Production – The value-chain approach & its application to food, construction and textiles. Nairobi. URL: https://www.oneplanetnetwork.org/sites/default/files/from-crm/report_unea5_catalysing_science-based_policy_action_on_scp_-_task_group_irp-one_planet_0.pdf

- United Nations Environment Programme (2022). 2022 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector. ISBN: 978-92-807-3984-8. Nairobi. Pages 15, 16. URL: https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction

- United Nations Environment Programme (2023). 2023 Global Status Report for Buildings and Construction: Beyond foundations: Mainstreaming sustainable solutions to cut emissions from the buildings sector. ISBN: 978-92-807-4131-5. Nairobi. Pages 12, 20, 21, 63. URL: https://doi.org/10.59117/20.500.11822/45095.

- WBCSD. (2023). Navigating the Urban Transition: A Guide for Business Action. Geneva, Amsterdam, Beijing, New Delhi, London, New York City, Singapore. Page 30. URL: https://www.wbcsd.org/contentwbc/download/15653/227132/1

Toluna Harris Interactive Report for the French Ministry of Ecological Transition and Territorial Cohesion (MTECT). Survey conducted online from August 11th to 14th, 2023, on a sample of 1,135 people representative of French citizens aged 18 and older. Quota sampling and weighting applied to the following variables: gender, age, socio-professional category, region, and size of the interviewee's urban area.

Ministry of the Environment, Japan. Annual Report on the Environment in Japan 2023.» URL: https://www.env.go.jp/content/900452889.pdf.

Research Papers

- Adrien Bilal, Diego R. Känzig. (2024). The macroeconomic impact of climate change: global VS. local temperature. Cambridge. URL: https://www.nber.org/system/files/working_papers/w32450/w32450.pdf?utm_campaign=PANTHEON_STRIPPED&amp%3Butm_medium=PANTHEON_STRIPPED&amp%3Butm_source=PANTHEON_STRIPPED

- Comités Économie circulaire du foncier et Stratégie foncière des territoires du LIFTI. (2022). Guide pratique de la reconversion des friches. Edition Octobre 2022. URL: https://lifti.org/wp-content/uploads/ressources/LIFTI_Guide_pratique_reconversion_des_friches_2022.pdf.

- Claudia Hidalgo Corrotea, Alberto J. Alaniz, Pablo M Vergara, Dario Moreira-Arce. (2023). High vulnerability of coastal wetlands in Chile at multiple scales derived from climate change, urbanization, and exotic forest plantations. URL: https://doi.org/10.1016/j.scitotenv.2023.166130. Santiago: University of Santiago.

- Lise Horup, Jacob Steinman, et al. (2022). Towards embodied carbon benchmarks for buildings in Europe - #3 Defining budget-based targets: A top-down approach. URL: https://zenodo.org/records/6411884

- Lorenzo Pagliano, Gianluca Brunetti, Matteo Clementi, Silvia Erba, Alessandro Rogora. (2023). Literature review for analysis of lifestyle change: fundamental decarbonisation through sufficiency by lifestyle changes. Milan. URL: https://fulfill-sufficiency.eu/wp-content/uploads/2023/10/D2.1-Literature-review-revised-version.pdf Page 13. In reference to Sachs, W. (1993). Die vier E's—Merkposten für einen maß-vollen Wirtschaftsstil. Politische Ökologie. URL: https://epub.wupperinst.org/frontdoor/index/index/docId/66

- Thomas Princen. (2003). Principles for Sustainability: From Cooperation and Efficiency to Sufficiency. Online ISSN: 1536-0091. Massachusetts Institute of Technology.

- Yamina Saheb. (2022). Beyond Efficiency and Renewable Energy: Sufficiency Matters to Limit Global Warming by End of Century to 1.5°C. URL: https://www.openexp.eu/posts/beyond-efficiency-and-renewable-sufficiency-matters-limit-global-warming-end-century-15degc

Transparency Market Research. «Construction Waste Market.» URL: https://www.transparencymarketresearch.com/construction-waste-market.html.

Institutional websites

- African Development Bank (AfDB). Tracking Africa's Progress in Figures: Human Development. URL: https://www.afdb.org/en/knowledge/publications/tracking-africa%E2%80%99s-progress-in-figures/human-development

- Architecture 2030. Why the Built Environment. URL: https://www.architecture2030.org/why-the-built-environment/

- California Department of General Services. California Green Building Standards Code (CalGreen). URL: https://www.dgs.ca.gov/BSC/CALGreen

- City of Calgary. Downtown office conversion programs. URL: https://www.calgary.ca/development/downtown-incentive.html

- European Commission. Q&A: Renovation Wave Strategy. URL: https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_1836.

- European Commission. Q&A: Revised Energy Performance of Buildings Directive (EPBD). URL: https://ec.europa.eu/commission/presscorner/detail/en/qanda_24_1966

- International Energy Agency (IEA). Energy system: buildings, tracking buildings. URL: https://www.iea.org/energy-system/buildings

- Ministère de la Transition Écologique et de la Cohésion des territoires. (2024) Artificialisation des sols. URL: https://www.ecologie.gouv.fr/artificialisation-des-sols

- Ministère de la Transition Écologique et de la Cohésion des territoires. (2024). Cadre Général des Filières à Responsabilité Élargie des Producteurs. URL: https://www.ecologie.gouv.fr/cadre-general-des-filieres-responsabilite-elargie-des-producteurs.

- OECD. Waste by Sector. URL: https://stats.oecd.org/Index.aspx?DataSetCode=WSECTOR

- République et canton de Genève. Installations techniques de rafraîchissement : La climatisation de confort. URL: https://www.ge.ch/installations-techniques-rafraichissement/climatisation-confort.

- United Nations. Global Issues: Population. URL: https://www.un.org/en/global-issues/population.

- U.S. Department of Energy. About the Commercial Buildings Integration Program. URL: https://www.energy.gov/eere/buildings/about-commercial-buildings-integration-program

- U.S. Federal Government. Net Zero Government Initiative. URL: https://www.sustainability.gov/federalsustainabilityplan/net-zero-initiative.html.

- Service public. Taxe annuelle sur les logements vacants (TLV) et taxe d'habitation sur les logements vacants (THLV). URL: https://www.service-public.fr/particuliers/vosdroits/F17293?lang=en

Videos

- ECESP CIRCULAR ECONOMY. EUCircularTalks What role do secondary materials play in new constructions and in building renovations [YouTube].2022.(WatchedonApril102024).URL:https://circulareconomy.europa.eu/platform/en/news-and-events/all-events/what-role-do-secondary-materials-play-new-constructions-and-buildings-renovation#:~:text=Construction%20materials%20and%20products%20represent,50%25%20of%20all%20waste%20generated.

Articles

- Astier J., Salem A., Fack G., et al. (2024). Performance énergétique du logement et consommation d'énergie: les enseignements des données bancaires. Focus (n°103). URL: https://www.cae-eco.fr/staticfiles/pdf/focus-103-dpe-230110.pdf

- CEREMA. (2022). LOVAC: un outil du Cerema pour identifier et remobiliser les logements vacants. Actualités CEREMA. URL: https://www.cerema.fr/fr/actualites/lovac-outil-du-cerema-identifier-remobiliser-logements

- Bonnyman Clare. (2023). Extreme makeovers: Interest grows in converting empty Edmonton office towers into housing, City administration looking at possibility of incentivizing high-rise conversion projects. CBC. URL: https://www.cbc.ca/news/canada/edmonton/extreme-makeovers-interest-grows-in-converting-empty-edmonton-office-towers-into-housing-1.6979033

- Bornarel Alain, Gauzin-Müller Dominique, Madec Philippe. (2018). Manifesto for a Happy and Creative Frugality, in the Architecture and Planning of Urban and Rural Areas. Frugalité Heureuse et Créative dans l'architecture et le ménagement des territoires. URL: https://frugalite.org/en/manifesto-for-a-happy-frugality/

- Camp Hamish. (2023). Why Water Management Is Among Construction's Most Pressing Issues. Bluebeam. URL: https://blog.bluebeam.com/why-water-management-is-among-constructions-most-pressing-issues/.

- Cerema. (2023). Recyclage des friches : quels enseignements tirer de centaines de projets ? Cerema. URL: https://www.cerema.fr/fr/actualites/recyclage-friches-quels-enseignements-centaines-projets

- International Energy Agency (2022). Evolution of global floor area and buildings energy intensity in the Net Zero Scenario, 2010-2030 – Charts – Data & Statistics – IEA. Paris. URL: https://www.iea.org/data-and-statistics/charts/evolution-of-global-floor-area-and-buildings-energy-intensity-in-the-net-zero-scenario-2010-2030

- Kaufmann Bill. (2023). Converting office space into homes is reducing Calgary's downtown vacancy rate, says analyst. Calgary Herald. URL: https://calgaryherald.com/news/local-news/converting-office-space-into-homes-is-reducing-downtown-vacancy-rate-says-analyst

- Kleinwächter Doris. (2015). Baulücken- und Leerstandskataster für niedersächsische Kommunen. Journal of Cartography and Geographic Information. Volume 65. Pages 67-71. URL: https://doi.org/10.1007/BF03545090

- Millward-Hopkins Joel, Steinberger Julia K., Rao Narasimha D. , et al. (2020)., Providing decent living with minimum energy: A global scenario. Global Environmental Change. (Volume 65). URL: https://doi.org/10.1016/j.gloenvcha.2020.102168

- David A. Ness. (2020). Growth in floor area: the blind spot in cutting carbon. Emerald Open Research. URL: https://www.emerald.com/insight/content/doi/10.1108/EOR-05-2023-0002/full/html

- Olden Kenneth. (2005). Urban Sprawl and Public Health: Designing, Planning, and Building for Healthy Communities. Environmental Health Perspectives ISBN: 1-55963-912-1

- Parking Reform Atlas. (2021). Japan's low-harm parking minimums. Parking Reform Atlas. URL: https://www.parkingreformatlas.org/parking-reform-cases-1/japan%E2%80%99s-low-harm-parking-minimums

- Peñasco Cristina, Díaz Anadón Laura. (2023). Assessing the effectiveness of energy efficiency measures in the residential sector gas consumption through dynamic treatment effects: Evidence from England and Wales. Energy Economics. (Volume 117). URL: https://www.sciencedirect.com/science/article/pii/S0140988322005643?via%3Dihub.

- Peychieras Jade. (2024). Carte électricité: Découvrez les départements qui ont été les plus sobres cet hiver. France Bleu. URL: https://www.francebleu.fr/infos/societe/carte-electricite-decouvrez-les-departements-qui-ont-ete-les-plus-sobres-cet-hiver-8192905.

- Rao Narasimha D., Min Jihoon. (2018). Decent Living Standards: Material Prerequisites for Human Wellbeing. Soc Indic Res. (Volume 138). Pages 225–244. URL: https://link.springer.com/article/10.1007/s11205-017-1650-0

- Pomponi F., Stéphan A.. (2021). Water, energy, and carbon dioxide footprints of the construction sector: A case study on developed and developing economies. Science Direct. URL: https://www.sciencedirect.com/science/article/abs/pii/S0043135421001330

- Saheb Yamina. (2021). COP26: Sufficiency Should be First. Buildings & Cities. URL: https://www.buildingsandcities.org/insights/commentaries/cop26-sufficiency.html

- Segura Patricio. (2023). Chile's Supreme Court: The new battleground for rural real estate development projects. Patagon Journal. URL: https://www.patagonjournal.com/index.php?option=com_content&view=article&id=4459%3Acorte-suprema-el-nuevo-campo-de-batalla-por-los-megaloteos-rurales&catid=187%3Aguest-blog&Itemid=340&lang=en

Books

- David A. Ness. (2021). The impact of overbuilding on people and the planet. Cambridge Scholars Publishing. URL: https://www.cambridgescholars.com/product/978-1-5275-2402-6

- David A. Ness. (2022). Towards sufficiency and solidarity: COP27 implications for construction and property. Volume 3. URL: https://journal-buildingscities.org/articles/10.5334/bc.268

- David A. Ness. (2023). Technological efficiency limitations to climate mitigation: why sufficiency is necessary. Volume 4 URL: https://journal-buildingscities.org/articles/10.5334/bc.297

Other

- Le Hub des Prescripteurs Bas Carbone, an initiative led by IFPEB in partnership with Carbone 4. URL: https://www.ifpeb.fr/travaux/le-hub-des-prescripteurs-bas-carbone/

- Observatoire du Hub des Prescripteurs Bas Carbone / based on a 50-year life cycle assessment (LCA) URL: https://championnatdefrancedeseconomiesdenergie.org/

- GlobalABC. «Sustainable Building Materials Hub.» URL: https://globalabc.org/sustainable-materials-hub/home

- Unissons. «Le Manifeste.» URL: https://unissons.eu/le-manifeste/.

- Negawatt work and scenarios. URL: https://negawatt.org/Scenario-negaWatt-2022

- GlobalABC. URL: https://globalabc.org/our-work/fostering-collaboration

- ARUP, Circular Buildings Toolkit. URL: https://ce-toolkit.dhub.arup.com/framework

APPENDIX I - List of figures

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Figure 2: IEA, Energy consumption in buildings by fuel in the Net Zero Scenario, 2010-2030, IEA, Paris.

Figure 3: Translated from J.Astier et A.Salem, G.Fack, J.Fournel, F. Maisonneuve - CAE Éco (2024). «Performance énergétique du logement et consommation d'énergie: les enseignements des données bancaires» URL : https://www.cae-eco.fr/staticfiles/pdf/focus-103-dpe-230110.pdf

Figure 4: REN Global Status Report 2021, p.33.

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Figure 7: Graph from Yamina SAHEB, 2021. Sufficiency & Circularity, EEB & OPENEXP. URL: https://youtu.be/ohH6CsCYhc0?si=TUKDXiJMOICgyr_U

Figure 8: Graph from Agenda 21, Rio, 1992.

Figure 9: Graph from the UN Emissions Gap Report, 2020.

Figure 10: Ness, D. and Xing, K. (2021), Presentation to World Resources Forum 2021: 'Rebalancing resource disparities between partner countries'.

Geographical comparison of energy sufficiency results between French metropolitan departments from October 15 2022 to February 5 2023.

Figure 12: Graphical presentation of the SER (sufficiency, efficiency and renewable) framework proposed by (Saheb, 2021) and partially adapted from IFPEB Work Program Priorities "Consume Less (first), then Consume better".

[117] Goldemberg, José (Brasil), Thomas B Johansson (Norway), Amulya K. N. Reddy (India), and Robert H. Williams (USA). 1985. "Basic Needs and Much More with One Kilowatt per Capita." Ambio, Energy in Developing Countries, 14 (4/5): 190–200.

[118] Partially adapted from Figure 6: Carbon reduction potential from stage of design process. Source: Bringing Embodied Carbon Upfront, WGBC (2019, p.20).

SUFFICIENCY AND THE BUILT ENVIRONMENT

Over the past three decades, numerous climate protection and energy transition oriented policies and market transformation efforts have been implemented by building professionals globally. Despite these substantial efforts, the demand for resources—including energy, materials, land, and water—has continued to escalate to unprecedented levels.

According to the IPCC report on climate mitigation, decarbonizing buildings and the broader economy is unattainable without prioritizing sufficiency policies. Sufficiency is defined there as "a set of measures aimed at reducing the demand for resources—such as energy, materials,

This paper analyzes the underlying reasons for the sector's decarbonization challenges and the critical role of sufficiency to diminish the sector's impact on climate change and other planetary boundaries. A section is dedicated to recommendations to help decision makers design and implement priority sufficiency measures for buildings.

With the contribution of David Ness, Professor at the University of Adelaïde

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