
[Matt Bridgestock, Director and Architect at John Gilbert Architects]

The Intergovernmental Panel on Climate Change's Working Group III (IPCCs WG III) contribution to the Sixth Assessment Report (AR6)

Overview and insights for buildings and cities

Érika Mata, Sara Johansson

Disclaimer: This document has not been subject to formal IPCC review processes and has not been endorsed by the IPCC.

The summary has been produced by IVL, based on the text and figures from the references listed at the end of this presentation, within the project *Knowledge-based roadmap for a carbon-neutral building sector* [In Swedish: Kunskapsbaserad färdplan för en klimatneutral byggnadssektor (KF4KB)]. More details on how the summary has been produced are given in reference [7].

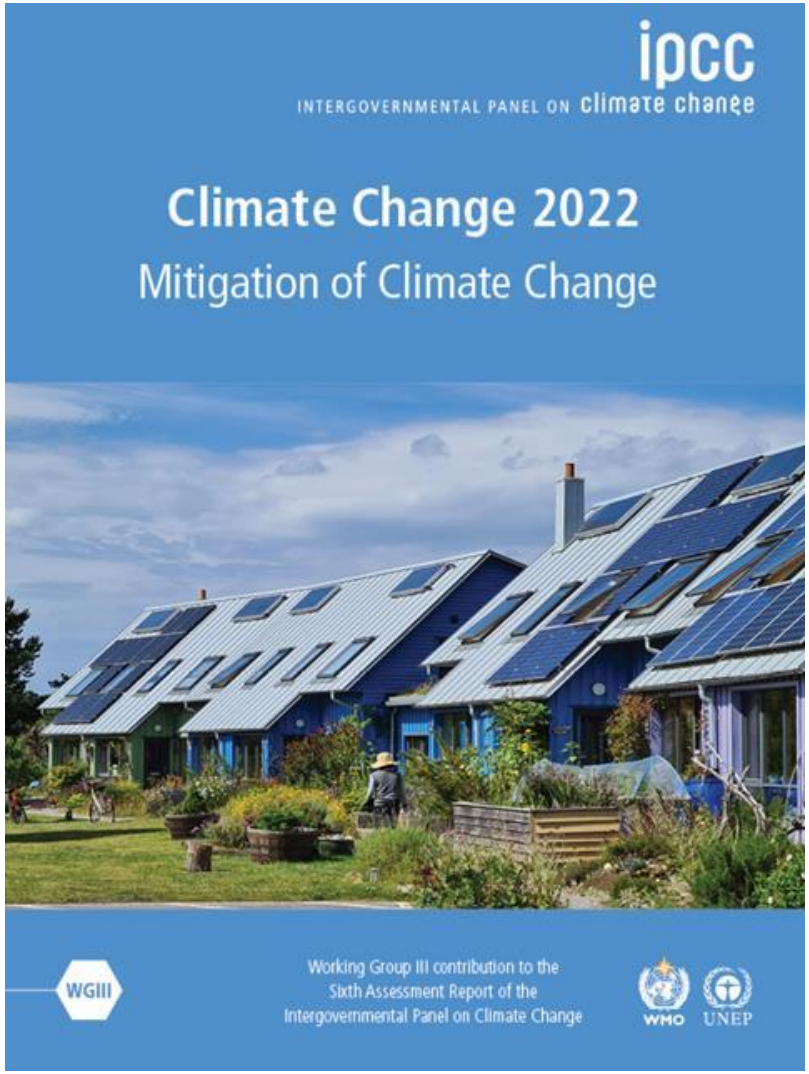
ivl SVENSKA MILJÖINSTITUTET

AR6 WGIII Report by numbers

- 278 Authors
- 65 Countries
- 41% Developing countries, 59% Developed countries
- 354 Contributing authors
- 29% Women, 71% Men
- More than 18,000 scientific papers
- 59,212 Review comments (governments and experts)

Source: AR6 WGIII Press conference [1]

ivl SVENSKA MILJÖINSTITUTET



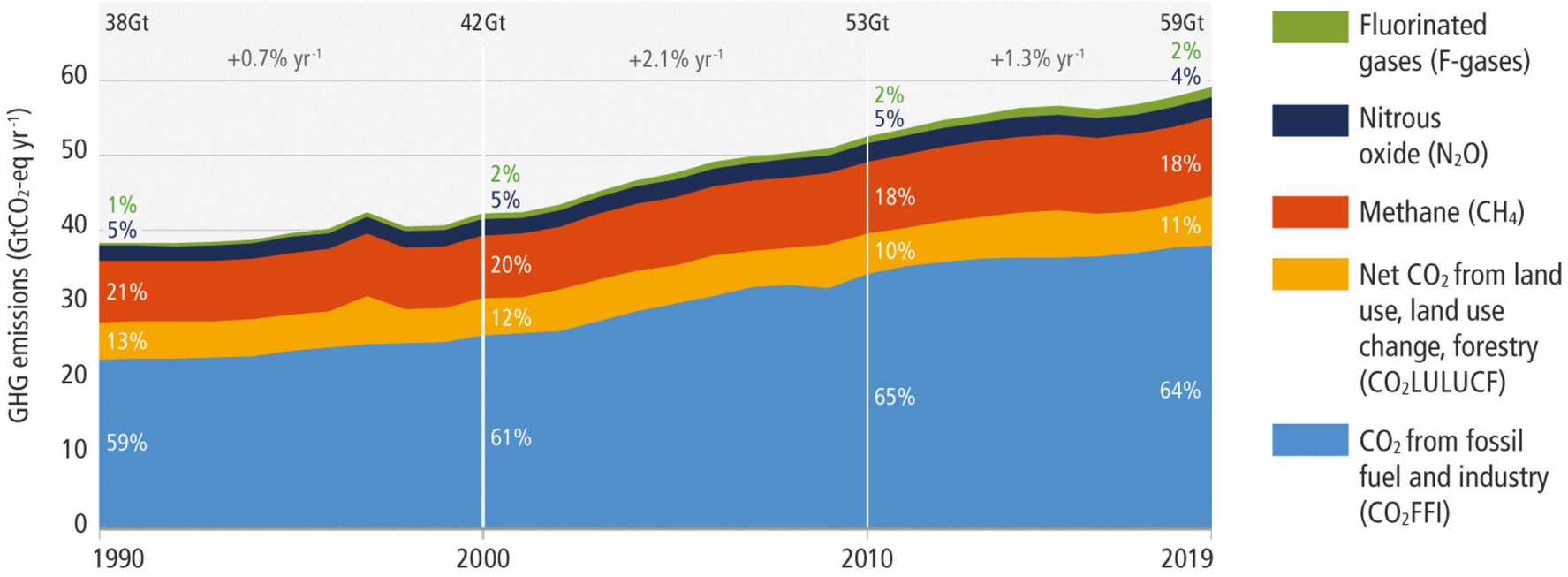
[Cover or IPCC AR6 WGIII]

2010-2019: Average annual greenhouse gas emissions at highest levels in human history

Source: AR6 WGIII Press conference [1]

ivl SVENSKA MILJÖINSTITUTET

We are not on track to limit warming to 1.5 °C



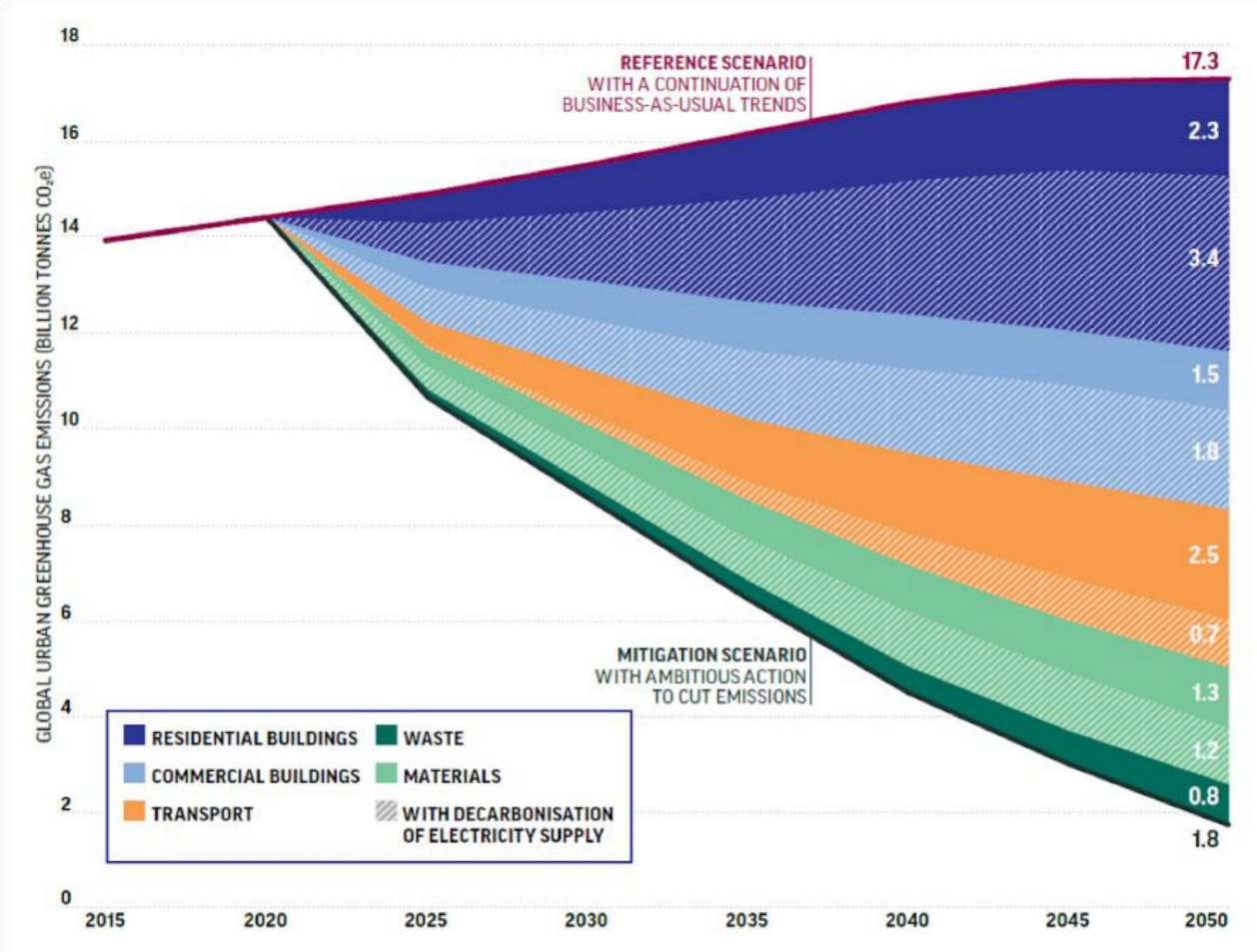
[Total anthropogenic GHG emissions 1990-2019, Panel a from Figure TS.2: Global anthropogenic emissions have continued to rise across all major groups of greenhouse gases (GtCO2-3 eq yr-1) 1990-2019 [6]]

Source: AR6 WGIII Press conference [1]

ivl SVENSKA MILJÖINSTITUTET

Cities and other urban areas

- Are responsible for more than **two-thirds (67-72%, 2020) of global GHG emissions** through the production and consumption of goods and services.
- Are projected to **rise from 29 GtCO2-eq in 2020 to 34 GtCO2-eq in 2050** with moderate mitigation efforts (intermediate GHG emissions, SSP2-4.5),
- and up **to 40 GtCO2-eq in 2050 with low mitigation efforts** (high GHG emissions, SSP 3-7.0).



[Fig 8.11 in of AR6 WGIII Chapter 8 [5] Re-used from Coalition for Urban Transitions [6]]

Source: AR6 WGIII Chapter 8 [5]

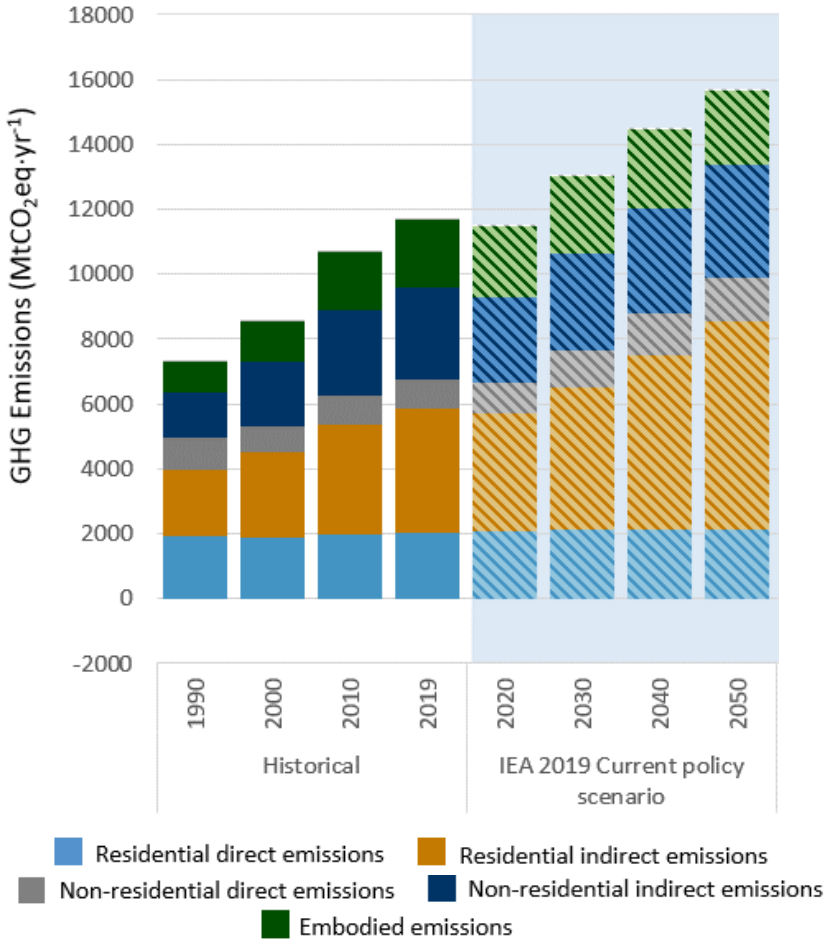
ivl SVENSKA MILJÖINSTITUTET

Buildings

- In 2019, **global direct and indirect GHG emissions from buildings** and emissions from cement and steel use for building construction and renovation were 12 GtCO2-eq.*
- For **non-residential buildings:+ 55%** compared to 1990, and for residential buildings: **+50%.**
- The increase is driven by the increase of the **floor area** per capita, **population** growth and use of **emission-intensive electricity and heat**; while efficiency improvements have partly decreased emissions.
- There are great **differences in the contribution** of each of these drivers to regional emissions.
- The **low renovation rates** and **low ambition** of retrofitted buildings have hindered the decrease of emissions.

(*) Incl indirect emissions from offsite generation of electricity and heat, direct emissions produced onsite and emissions from cement and steel used for building construction and renovation)

Source: AR6 WGIII Chapter 9 [4]



[Fig 9.3 in Chapter 9 of AR6 WGIII [4]]

ivl SVENSKA MILJÖINSTITUTET

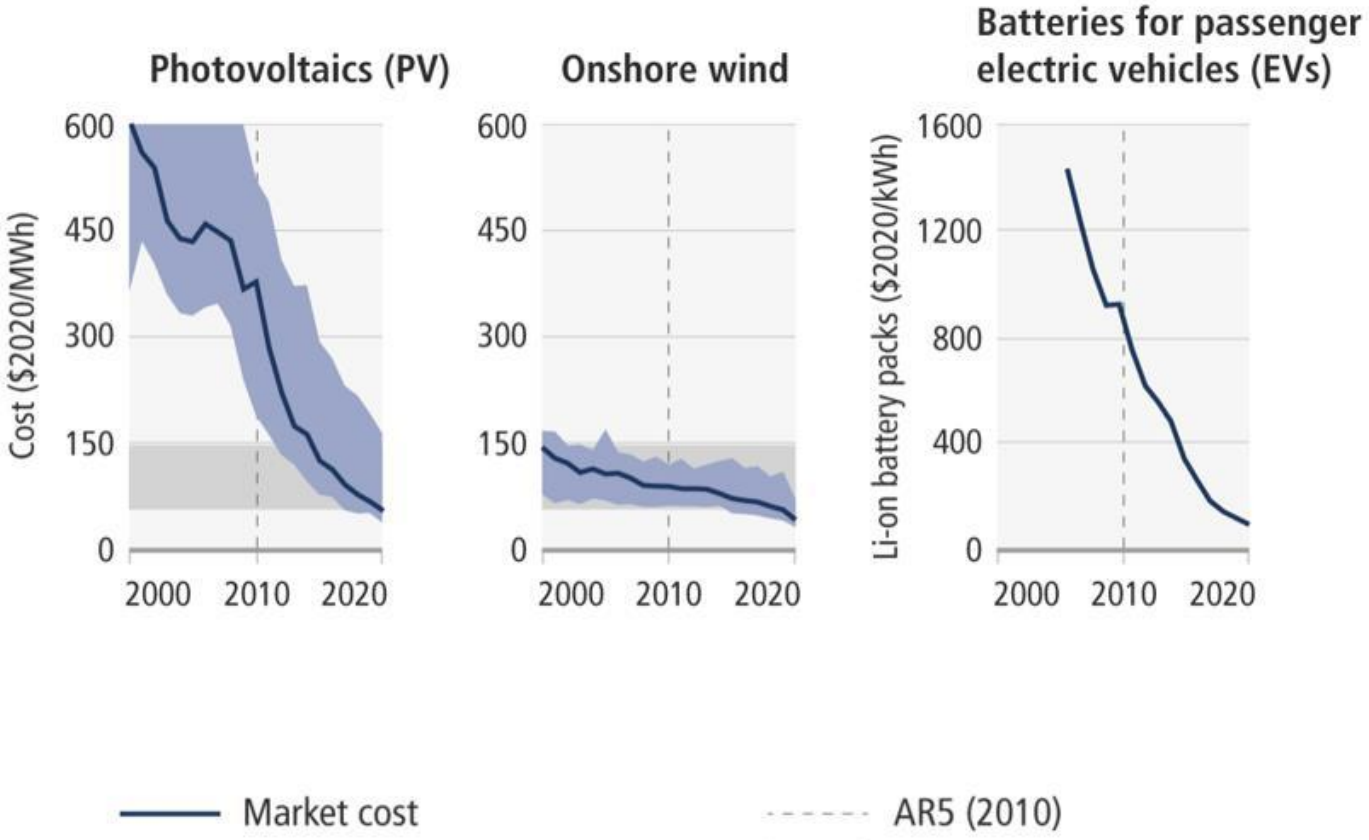
Increased evidence of climate action

- Some countries have achieved a steady decrease in emissions consistent with limiting warming to 2°C.
- Climate laws that result in reduced or avoided emissions are present in 56 countries, covering more than half of global emissions.
- Zero emissions targets have been adopted by at least 826 cities and 103 regions.
- …have enhanced energy efficiency, reduced rates of deforestation and accelerated the deployment of renewable energy.

Source: AR6 WGIII Summary for Policymakers [2]

ivl SVENSKA MILJÖINSTITUTET

In some cases, costs for renewables have fallen below those of fossil fuels.

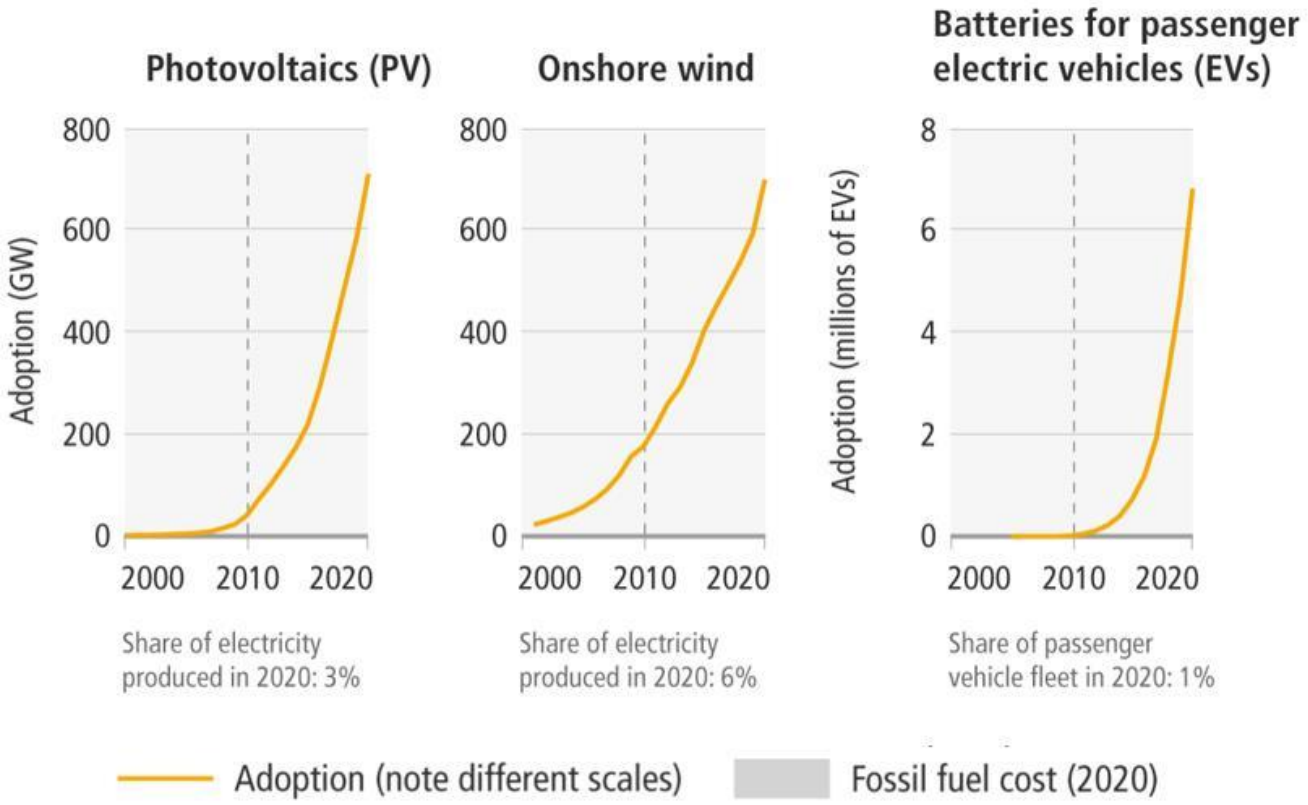


[Fig SPM.3 in [2]]

Source: AR6 WGIII Summary for Policymakers [2]

ivl SVENSKA MILJÖINSTITUTET

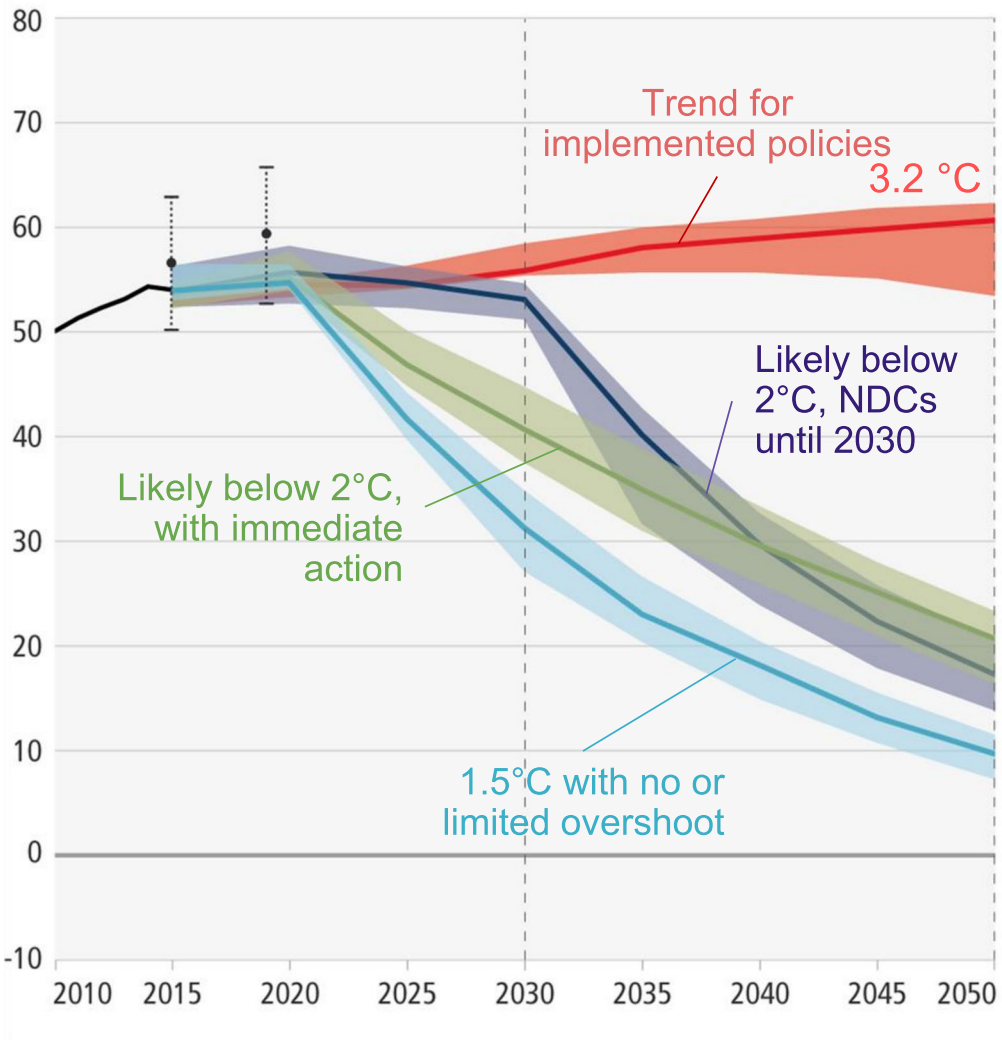
Electricity systems in some countries and regions are already predominantly powered by renewables.



[Fig SPM.3 in [2]]

Source: AR6 WGIII Summary for Policymakers [2]

ivl SVENSKA MILJÖINSTITUTET



Limiting warming to 1.5°C

- Global GHG emissions peak before 2025, reduced by 43% by 2030.
- Methane reduced by 34% by 2030

Limiting warming to around 2°C

- Global GHG emissions peak before 2025, reduced by 27% by 2030.

(based on IPCC-assessed scenarios)

Source: AR6 WGIII Press conference [1]

ivl SVENSKA MILJÖINSTITUTET

The temperature will stabilise when we reach net zero carbon dioxide emissions

Net Zero CO_2 emissions early 2050s → **1.5 °C**

Net Zero CO_2 emissions early 2070s → **2 °C**

(based on IPCC-assessed scenarios)

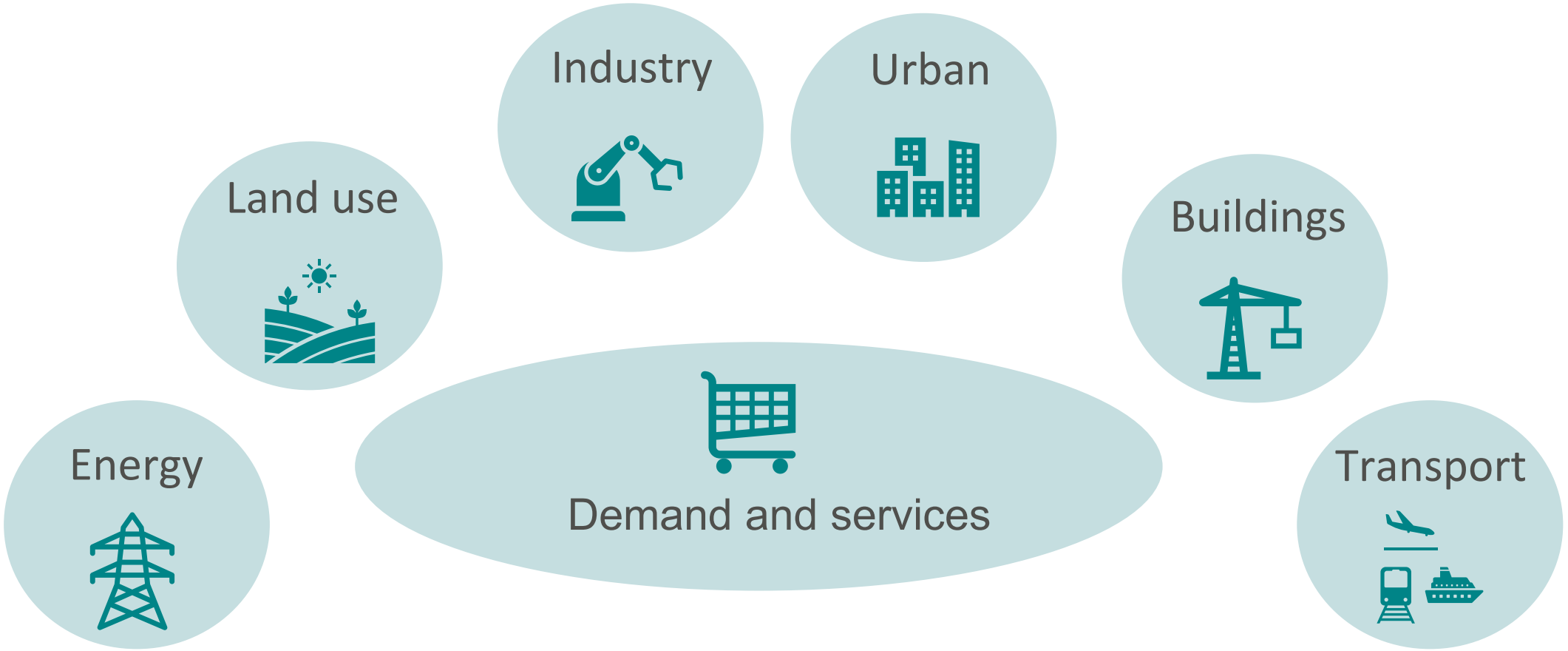
Source: AR6 WGIII Press conference [1]

ivl SVENSKA MILJÖINSTITUTET

”Unless there are immediate and deep emissions reductions across all sectors, 1.5°C is beyond reach.”

Source: AR6 WGIII Press conference [1]

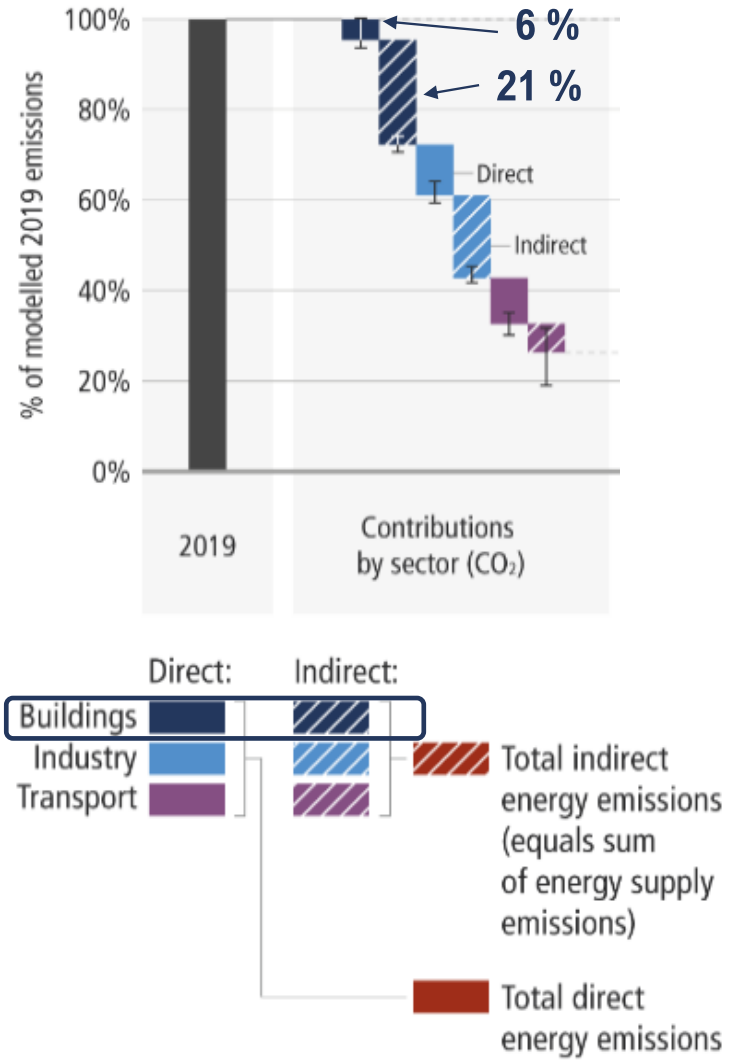
ivl SVENSKA MILJÖINSTITUTET



There are options available **now** in every sector that can at least **halve** emissions by 2030.

Text: AR6 WGIII Press conference [1]

ivl SVENSKA MILJÖINSTITUTET



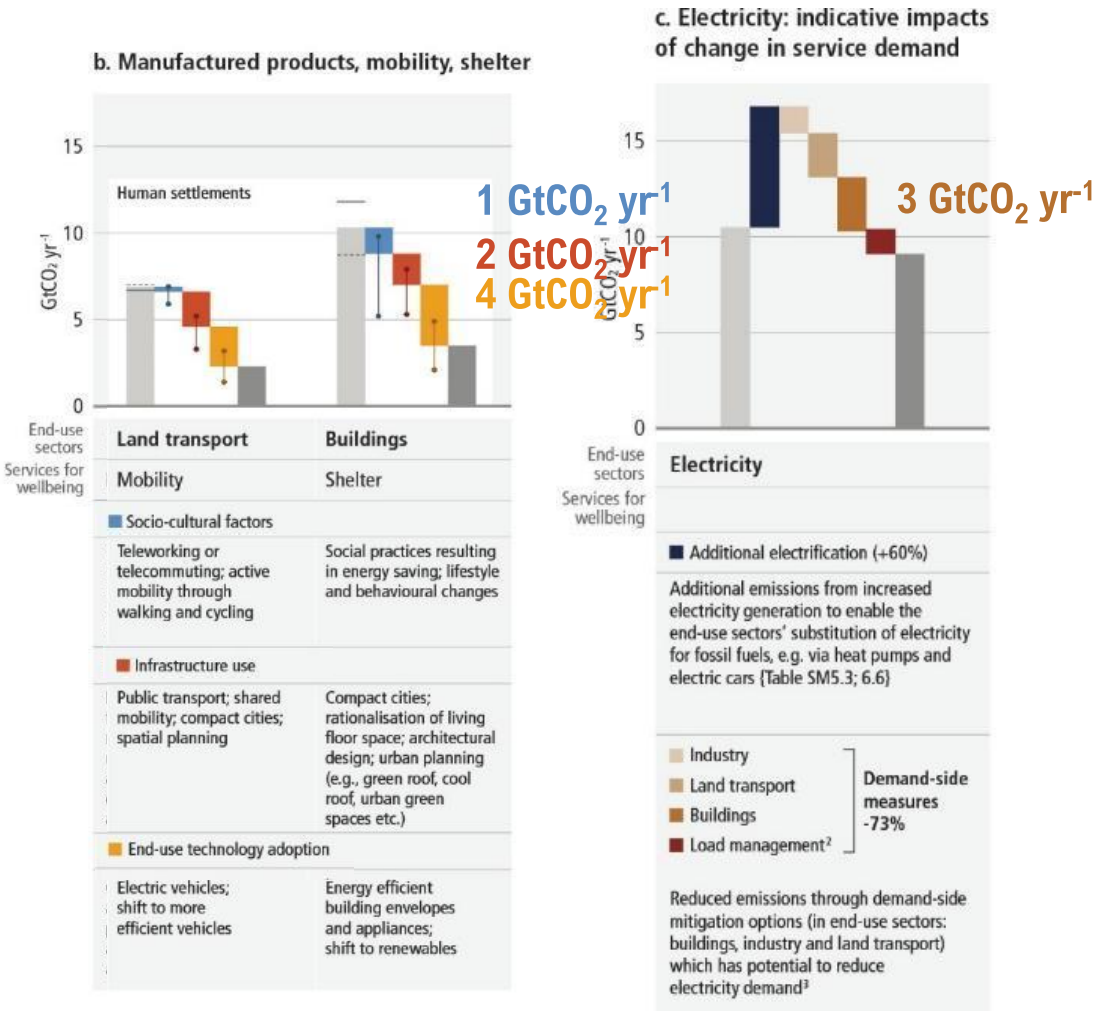
[Fig TS.10 in Technical Summary of AR6 WGIII [3]]

Contributions to reaching net zero GHG emissions, of modelled 2019 CO2 emissions reductions (for all scenarios reaching net-zero GHGs)

- Buildings direct emissions: 6%
- Buildings indirect emissions: 21%

Source: Technical Summary of AR6 WGIII [3]

ivl SVENSKA MILJÖINSTITUTET



[Fig SPM.6 from the AR6 WGIII Summary for Policymakers [2]]

Demand-side mitigation can be achieved through changes in socio-cultural factors, infrastructure design and use, and end-use technology adoption by 2050

Potential reductions:

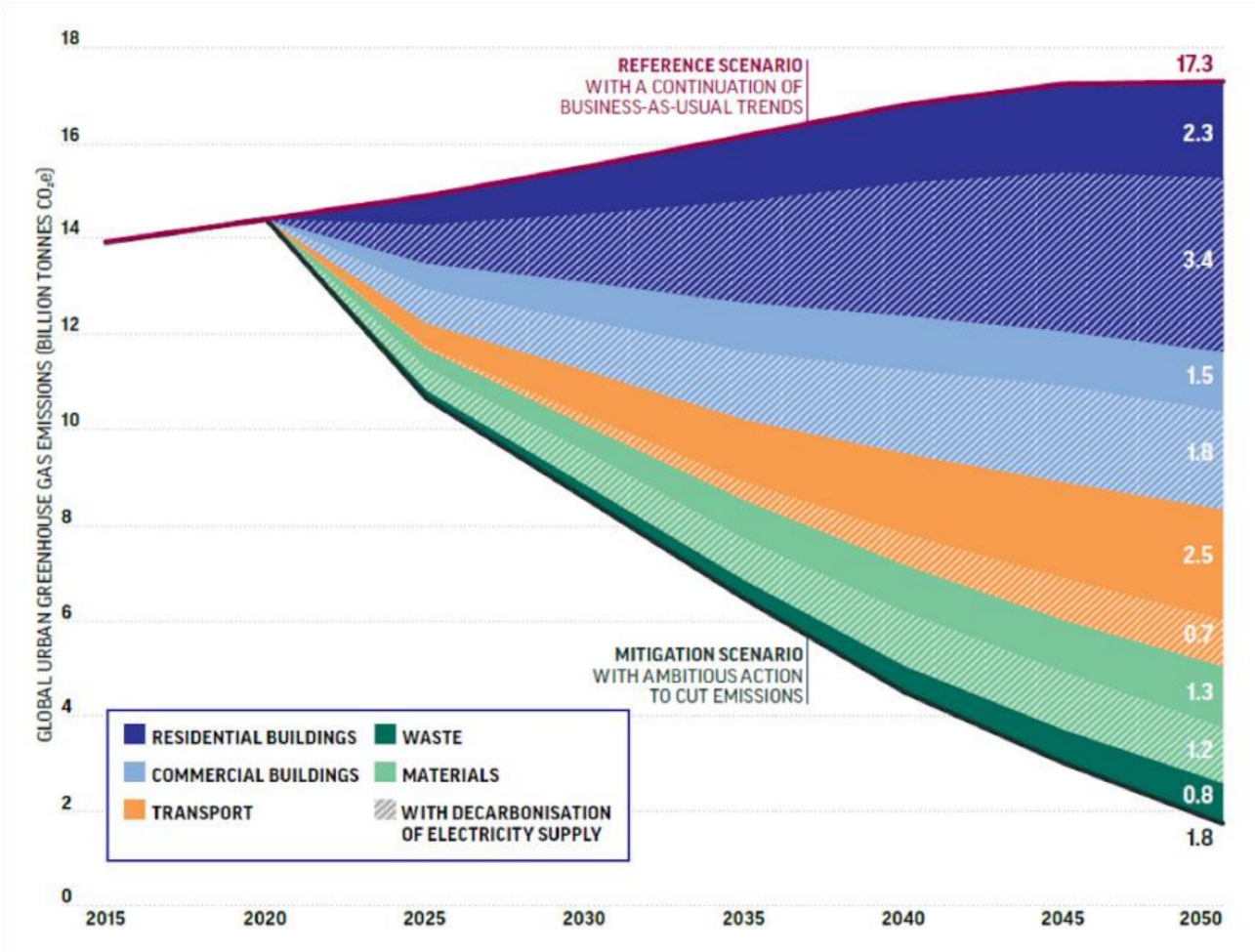
- Social practices resulting in energy saving, lifestyle and behavioral changes: 1 $GtCO_2$ yr^{-1}
- Compact cities, rationalisation of living floor space; architectural design, urban planning: 2 $GtCO_2$ yr^{-1}
- Energy efficient building envelopes and appliances; shift to renewables: 4 $GtCO_2$ yr^{-1}

Impact of demand-side measures reducing end-use electricity demand

- Buildings: 3 $GtCO_2$ yr^{-1}

Source: AR6 WGIII Summary for Policymakers [2]

ivl SVENSKA MILJÖINSTITUTET



[Fig 8.11 in Chapter 8 of AR6 WGIII [5] Re-used from Coalition for Urban Transitions [6]]

Global consumption-based urban CO2 and CH4 emissions could be reduced to 3 GtCO2-eq in 2050 (SSP1-1.9)

- With ambitious and immediate mitigation efforts: 1) reducing or changing energy and material consumption, 2) electrification, and 3) enhancing carbon uptake and storage in the urban environment.
- Cities can achieve net-zero emissions, but only if emissions are reduced within and outside of their administrative boundaries through supply chains, which will have beneficial cascading effects across other sectors.

Source: AR6 WGIII Chapter 8 [5]

ivl SVENSKA MILJÖINSTITUTET

The potential and sequencing of mitigation strategies to reduce GHG emissions will vary depending on a city's land use, spatial form, development level, and state of urbanisation.

- Rapidly growing cities can avoid future emissions by co-locating jobs and housing to achieve compact urban form, and by leapfrogging or transitioning to low-emissions technologies.
- New and emerging cities will have significant infrastructure development needs to achieve high quality of life, which can be met through energy efficient infrastructures and services, and people-centred urban design.

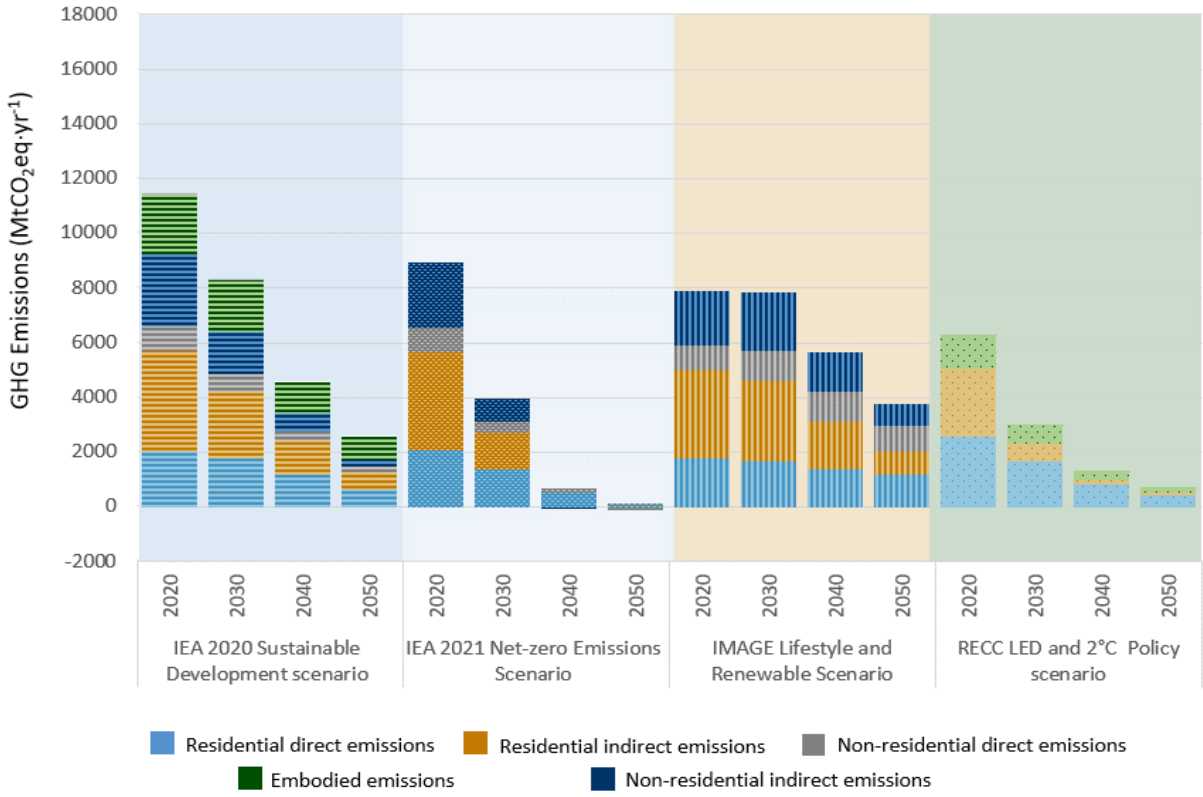
Source: AR6 WGIII Chapter 8 [5]

[Pelargoniums for Europe/Unsplash, City of St Pete CC BY-ND 2.0, Victor/Unsplash, EThekwini Municipality, Arne Müseler/arne-mueseler.com, CC BY-SA 3.0 de]

ivl SVENSKA MILJÖINSTITUTET

By 2050, up to 61% (8.2 GtCO2) of global building emissions could be mitigated.

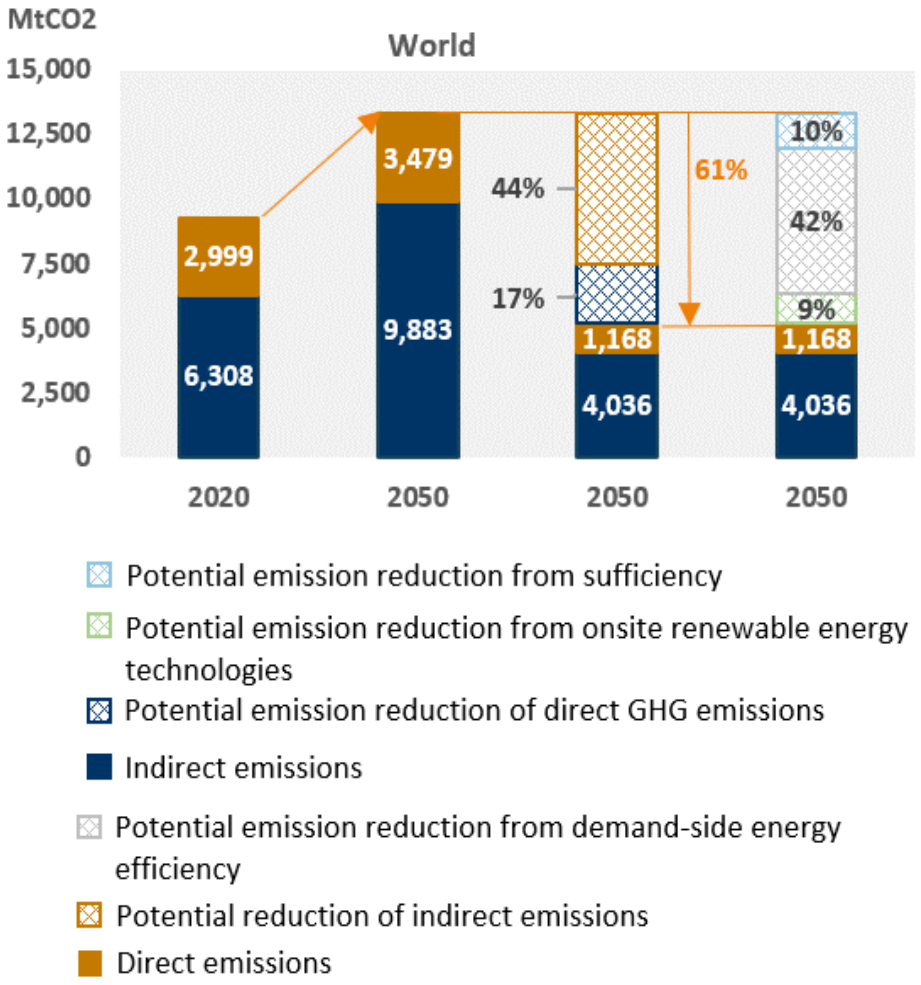
- The largest share of the mitigation potential of **new buildings** is available **in developing countries** while in **developed countries** the highest mitigation potential is within the retrofit of **existing buildings**.
- **2020-2030 is critical** for accelerating the learning of know-how, building technical and institutional capacity, setting appropriate governance structures, ensuring flow of finance, and developing the skills needed to fully capture the mitigation potential of buildings.



[Fig 9.3 in Chapter 9 of AR6 WGIII [4]]

Source: AR6 WGIII Chapter 9 [4]

ivl SVENSKA MILJÖINSTITUTET



[Fig 9.16 in Chapter 9 of AR6 WGIII [4]]

In modelled global scenarios, existing buildings, if retrofitted, and buildings yet to be built, are projected to approach net zero GHG emissions in 2050 if policy packages, which combine ambitious sufficiency, efficiency, and renewable energy measures, are effectively implemented

- Sufficiency: avoid the demand for energy and materials 10%
- Energy efficiency 42%
- Renewable energy 9%

Source: AR6 WGIII Chapter 9 [4]

ivl SVENSKA MILJÖINSTITUTET

Buildings Mitigation Interventions

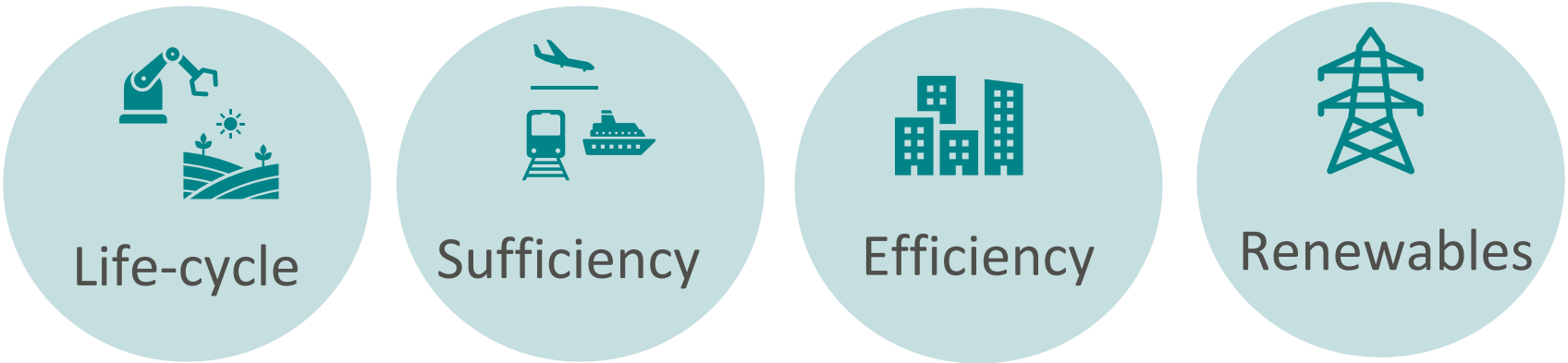
- Design stage: buildings typology, form, and multi-functionality to allow for adjusting the size of buildings to the evolving needs of their users and repurposing unused existing buildings to avoid using GHG-intensive materials and additional land.
- Construction phase: low-emission construction materials, highly efficient building envelope and the integration of renewable energy solutions.
- Use phase: highly efficient appliances/ equipment, the optimisation of the use of buildings and the supply with low-emission energy sources.
- Disposal phase: recycling and re-using construction materials.

Source: AR6 WGIII Chapter 9 [4]

[Pelargoniums for Europe/Unsplash, City of St Pete CC BY-ND 2.0, Victor/Unsplash, EThekwini Municipality, Arne Müseler/arne-mueseler.com, CC BY-SA 3.0 de]

ivl SVENSKA MILJÖINSTITUTET

The 2020-2030 decade is critical to build the technical and institutional capacity, set the appropriate governance structures, ensure the flow of finance, and develop the skills needed.



Text: AR6 WGIII Chapter 9 [4]

ivl SVENSKA MILJÖINSTITUTET

Closing investment gaps

- Financial flows: **3-6x lower** than levels needed **by 2030** to limit warming to below 1.5°C or 2°C
- There is **sufficient global capital** and liquidity to close investment gaps
- Challenge of closing gaps is widest for developing countries

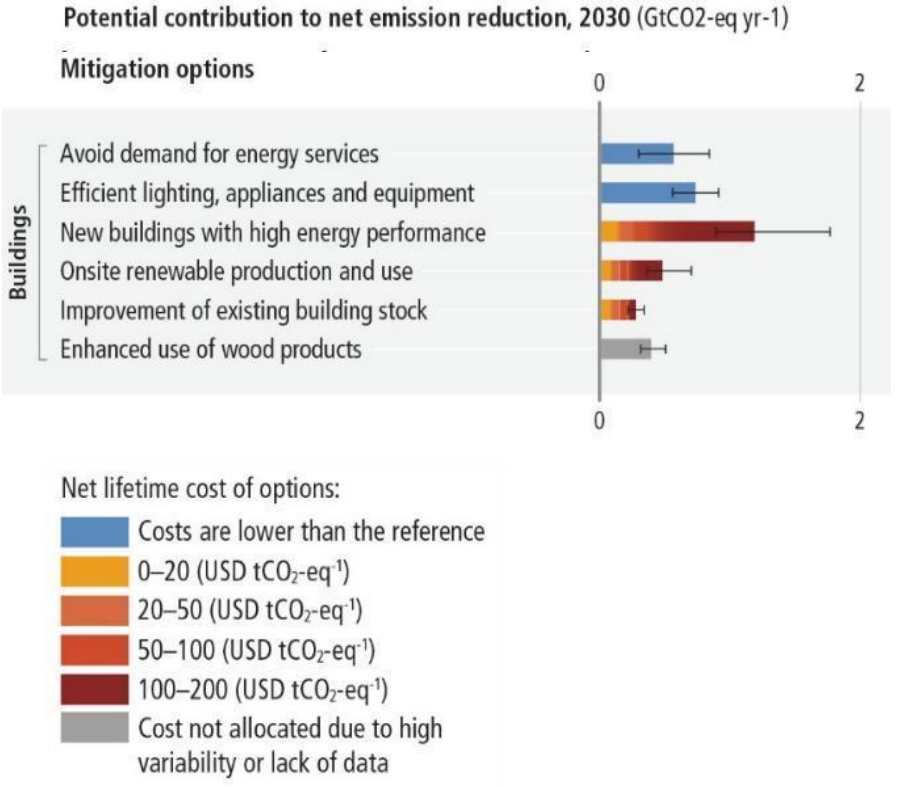
Without taking into account the economic benefits of reduced adaptation costs or avoided climate impacts, global GDP would be just a few percentage points lower in 2050 if we take the actions necessary to limit warming to 2°C or below, compared to maintaining current policies.

ivl SVENSKA MILJÖINSTITUTET

Costs of mitigation options

- **High-performance buildings** are expected to become a business-as-usual technology by 2050 with costs below USD20 tCO2-1 in developed countries and below USD100 tCO2-1 in developing countries.
- For **existing buildings**, in many examples of deep retrofits costs per CO2 abated are not significantly higher than those of shallow retrofits.
- However, for the whole building stock they could be in cost intervals of USD-200 and >USD200 tCO2.

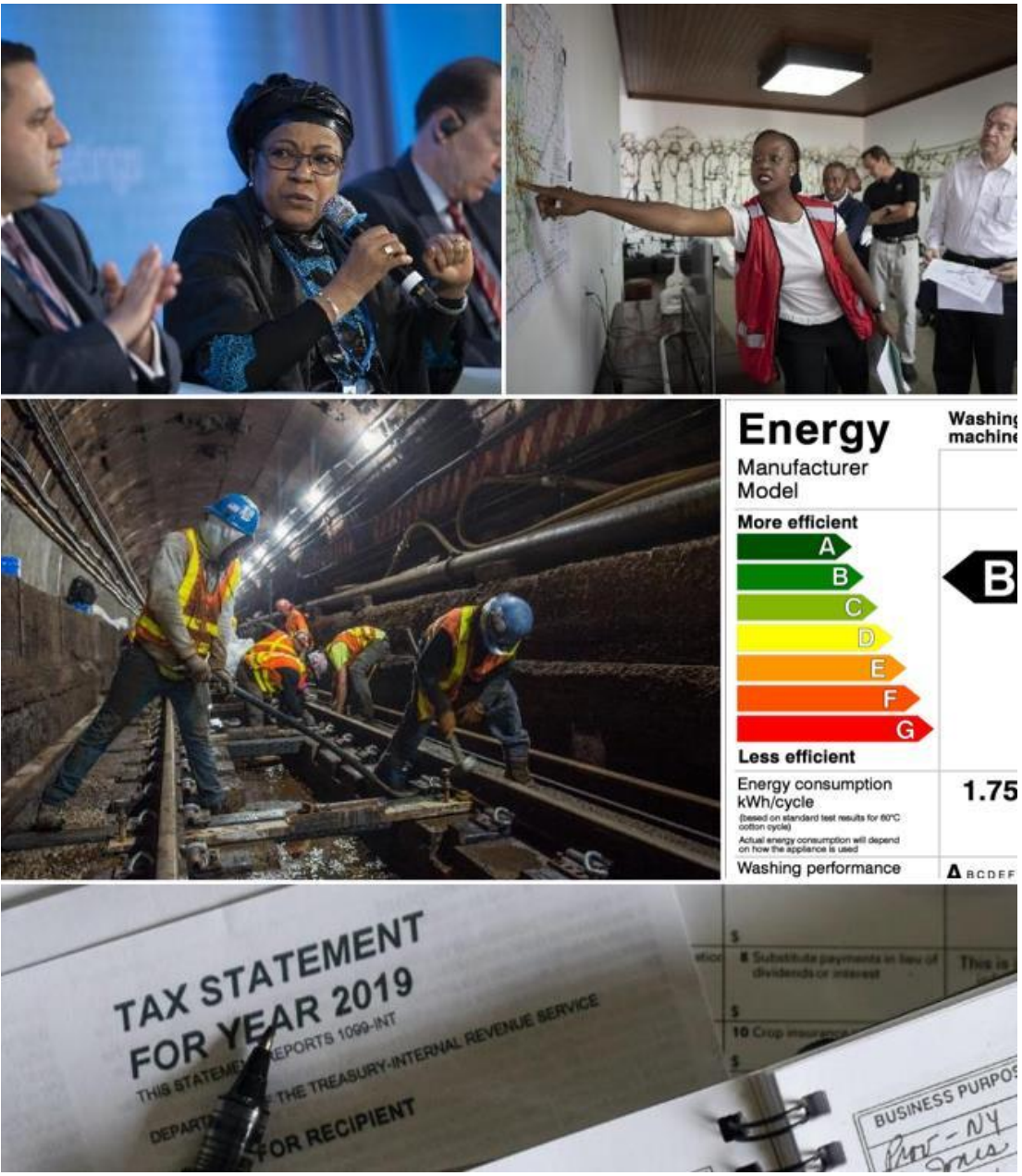
Global investment in the decarbonisation of buildings was estimated at USD164 billion in 2020. However, this is not enough by far to close the investment gap.



[Fig SPM.7 AR6 WGIII Summary for Policymakers [2]]

Source: AR6 WGIII Chapter 9 [4]

ivl SVENSKA MILJÖINSTITUTET



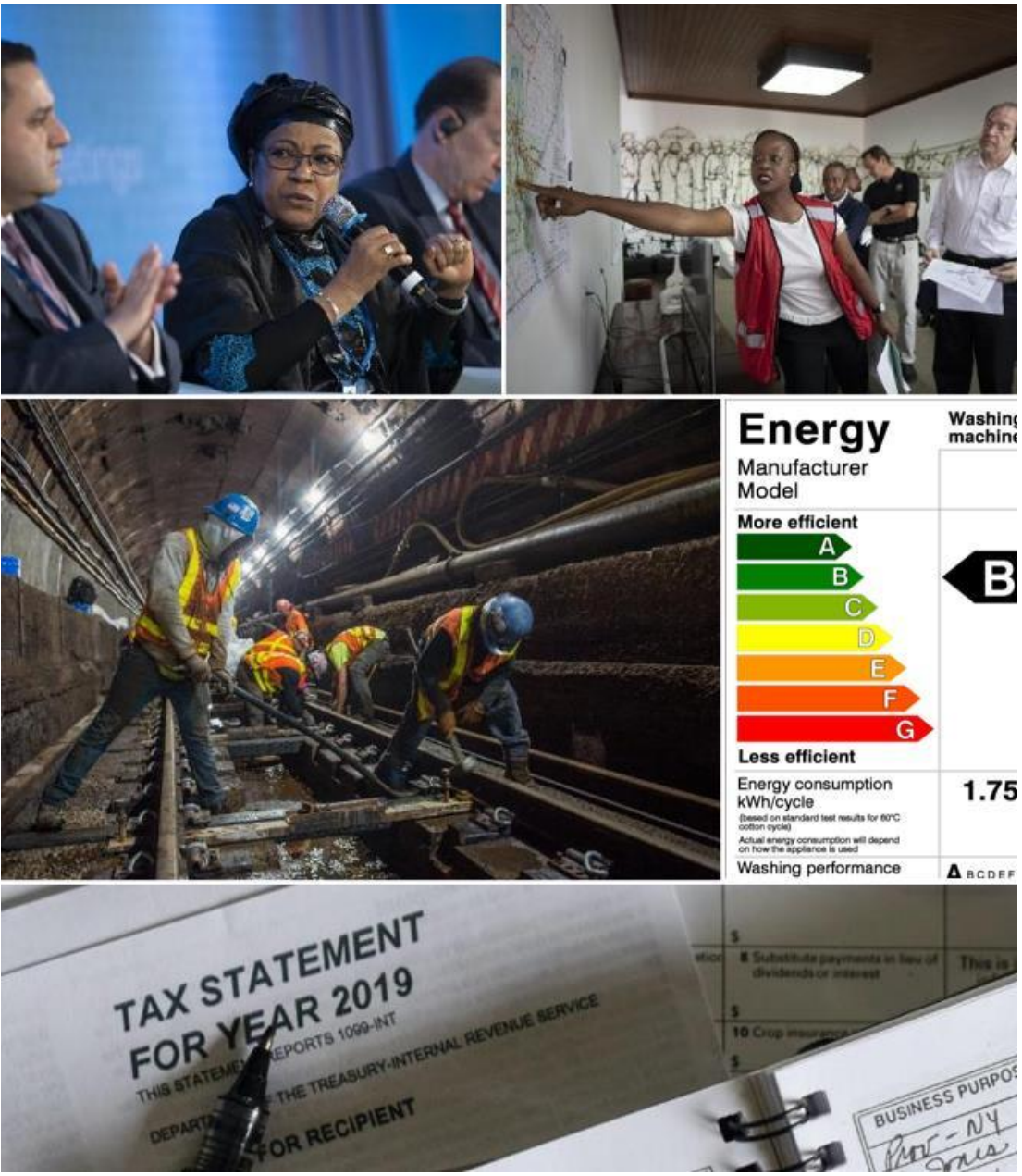
Policies, regulatory and economic instruments

- Regulatory and economic instruments have **already proven effective** in reducing emissions
- **Policy packages** and **economy-wide packages** are able to achieve **systemic change**
- Ambitious and effective mitigation requires **coordination across government** and society

Source: AR6 WGIII Press conference [1]

[World Bank/Simone D. McCourtie, Dominic Chavez CC BY-NC-ND 2.0, Trent Reeves/MTA Construction & Development CC BY 2.0, IMF Photo/Tamara Merino CC BY-NC-ND 2.0, Olga Delawrence/Unsplash.]

ivl SVENSKA MILJÖINSTITUTET



Policy packages could grasp the full mitigation potential of the global building stock

- Building energy codes: new and existing buildings, three pillars of the SER framework, LCA
- Energy performance standards for appliances and equipment
- Market-based instruments such as carbon taxes with recycling of the revenues and personal or building carbon allowances
- Low ambitious policies increase the risk of lock-in buildings in carbon for decades

The building sector is highly heterogenous.

Source: AR6 WGIII Chapter 9 [4]

[World Bank/Simone D. McCourtie, Dominic Chavez CC BY-NC-ND 2.0, Trent Reeves/MTA Construction & Development CC BY 2.0, IMF Photo/Tamara Merino CC BY-NC-ND 2.0, Olga Delawrence/Unsplash.]

ivl SVENSKA MILJÖINSTITUTET

Technology and Innovation

- Investment and policies **push forward low emissions** technological **innovation**
- **Effective decision making** requires assessing potential benefits, barriers and risks
- **Some options** are technically **viable**, rapidly becoming **cost-effective**, and have relatively **high public support**. Other options face barriers

Adoption of low-emission technologies is slower in most developing countries, particularly the least developed ones.

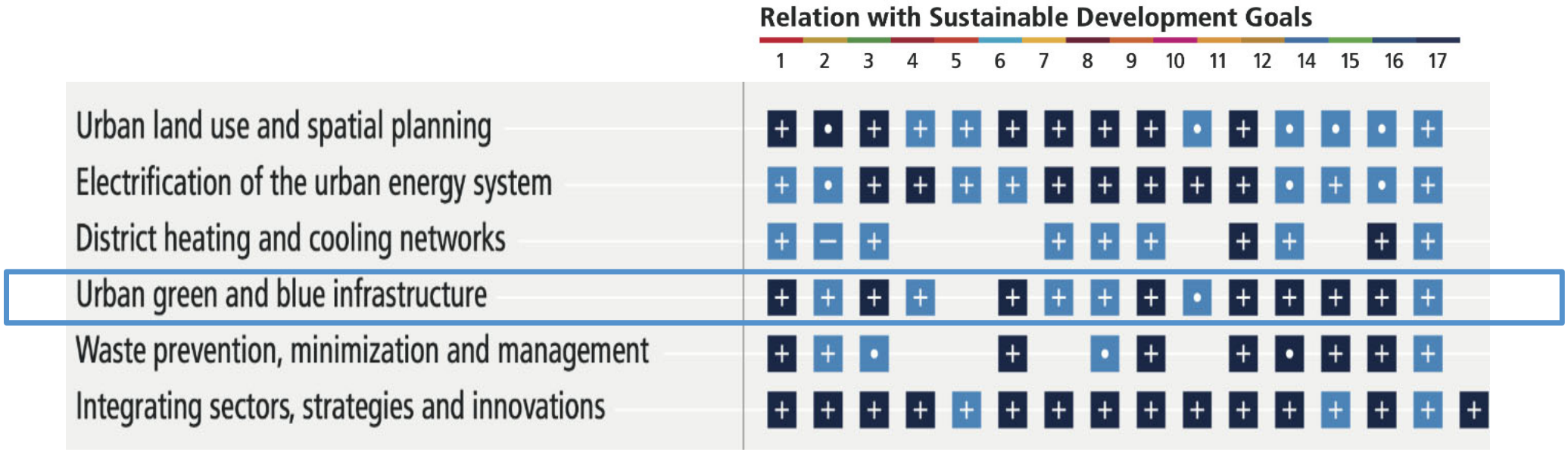
Text: AR6 WGIII Press conference [1]

ivl SVENSKA MILJÖINSTITUTET

Accelerated climate action is critical to sustainable development

Text: AR6 WGIII Press conference [1]

Mitigation options in urban areas



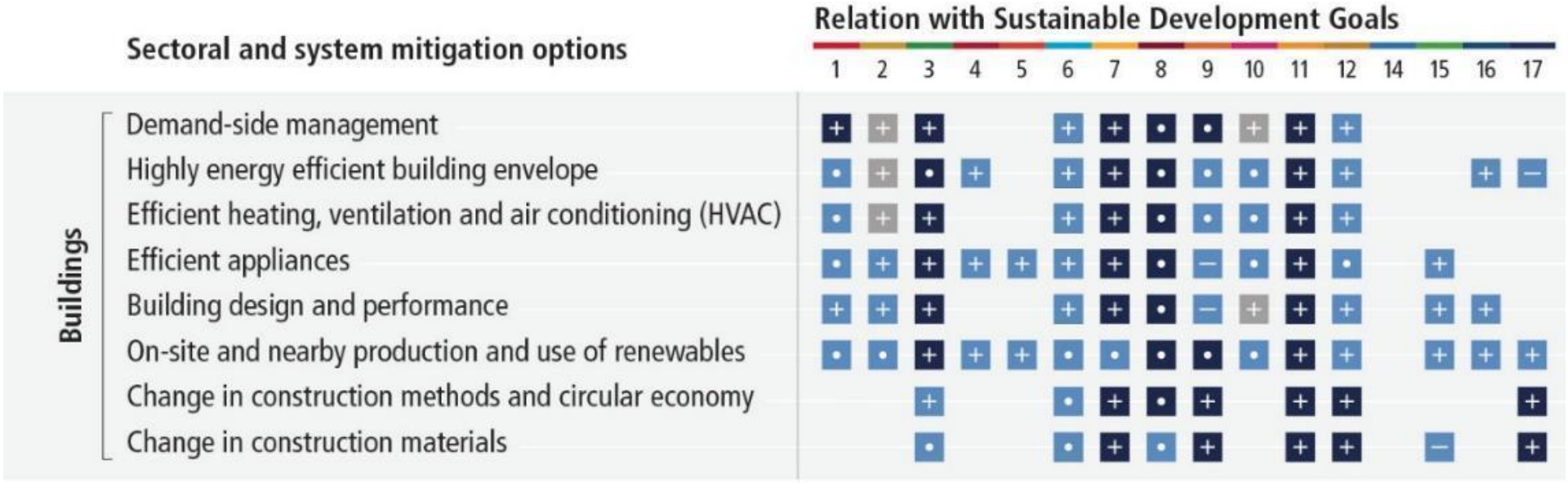
[Fig SPM.8 from the AR6 WGIII Summary for Policymakers [2]]

Green roofs and facades, networks of parks and open spaces, wetlands and urban agriculture not only absorb and store carbon but, at the same time, they can reduce pressure on urban sewer systems, reduce flood risk and heat-island effects, and deliver health benefits from reduced air pollution.

Source: AR6 WGIII Press conference [1]

ivl SVENSKA MILJÖINSTITUTET

Mitigation options in buildings



[Fig SPM.8 from the AR6 WGIII Summary for Policymakers [2]]

Well-designed and effectively implemented mitigation actions in the buildings sector have significant potential to help achieve the SDGs and positive synergies with climate adaptation measures.

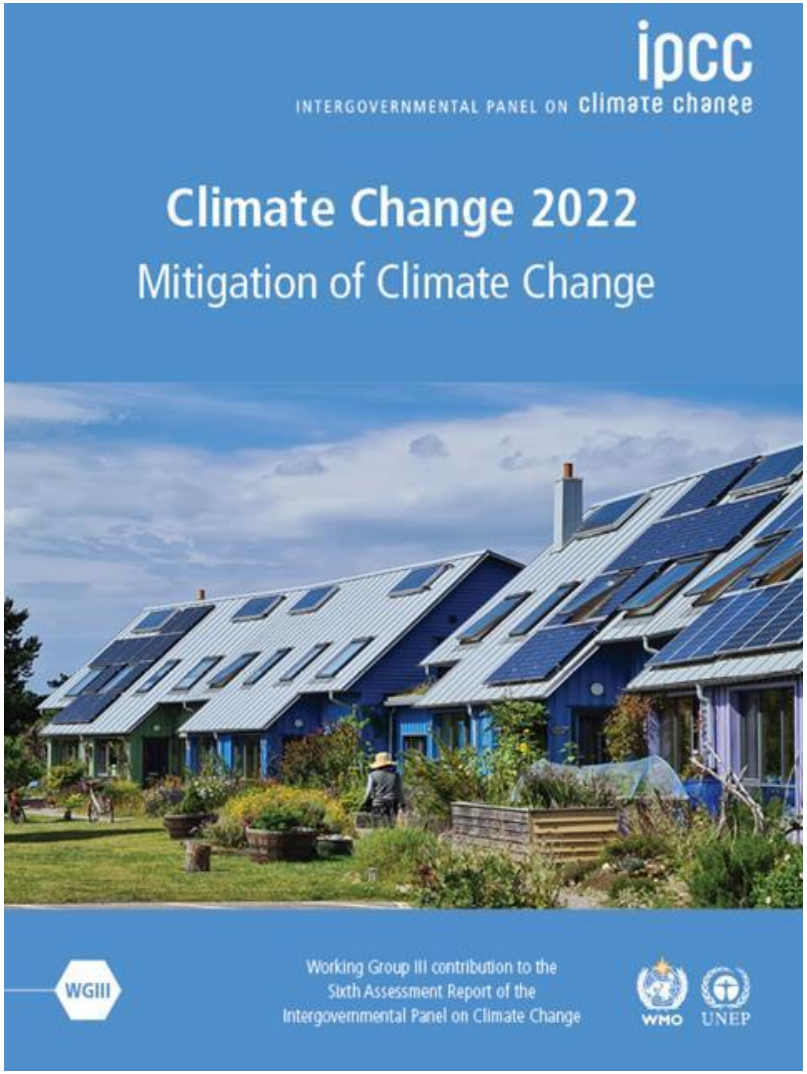
(+) Health gains through improved indoor air quality and thermal comfort; and positive significant macro and micro-economic effects, such as increased productivity of labour, job creation, reduced poverty, especially energy poverty, and improved energy security.

Source: AR6 WGIII Chapter 9 [4]

ivl SVENSKA MILJÖINSTITUTET

This decade is critical to fully capture the mitigation potential of buildings.

Source: AR6 WGIII Summary for policymakers [2]



[Cover or IPCC AR6 WGIII]

ivl SVENSKA MILJÖINSTITUTET

References

[1] IPCC, 2022. *Climate Change 2022: Mitigation of Climate Change* [PowerPoint presentation]. Date of presentation: 2022-04-04.

[2] IPCC, 2022: *Summary for Policymakers*. In: *Climate Change 2022: Mitigation of Climate Change*. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001

[3] M. Pathak, R. Slade, P.R. Shukla, J. Skea, R. Pichs-Madruga, D. Ürge-Vorsatz,2022: *Technical Summary*. In: *Climate Change 2022: Mitigation of Climate Change*. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.002

[4] Cabeza, L. F., Q. Bai, P. Bertoldi, J.M. Kihila, A.F.P. Lucena, É. Mata, S. Mirasgedis, A. Novikova, Y. Saheb, 2022: *Buildings*. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.011

[5] Lwasa, S., K.C. Seto, X. Bai, H. Blanco, K.R. Gurney, Ş. Kılkış, O. Lucon, J. Murakami, J. Pan, A. Sharifi, Y. Yamagata, 2022: *Urban systems and other settlements*. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA.doi: 10.1017/9781009157926.010

[6] Coalition for Urban Transitions, 2019. *Climate Emergency, Urban Opportunity*. C40 Cities Climate Leadership Group and World Resources Institute (WRI) Ross Center for Sustainable Cities, London, UK and Washington, DC, USA, 160 pp. https://urbantransitions.global/wp-content/uploads/2019/09/ Climate-Emergency-Urban-Opportunity-report.pdf

[7]] Mata É, Meolinna N, Larsson H, 2023. *Summary of IPCC AR6 WGIII Buildings*, IVL report.

ivl
SVENSKA
MILJÖINSTITUTET

Thank you!