BUILDINGS IN THE NDCS

Mapping Targets on Buildings in the Nationally Determined Contributions (NDCs)

PEEB Working Paper
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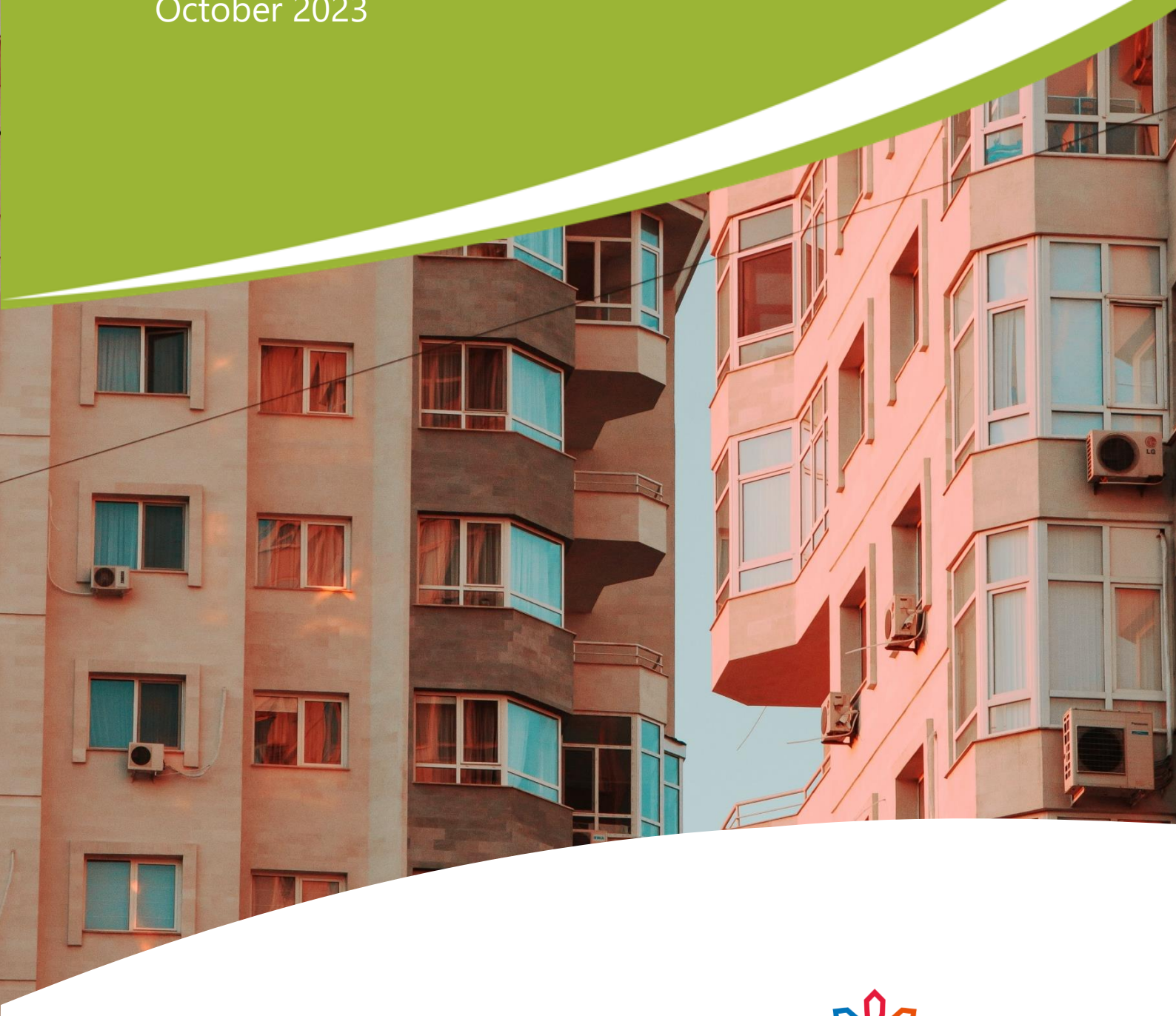

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PROGRAMME FOR ENERGY EFFICIENCY IN BUILDINGS

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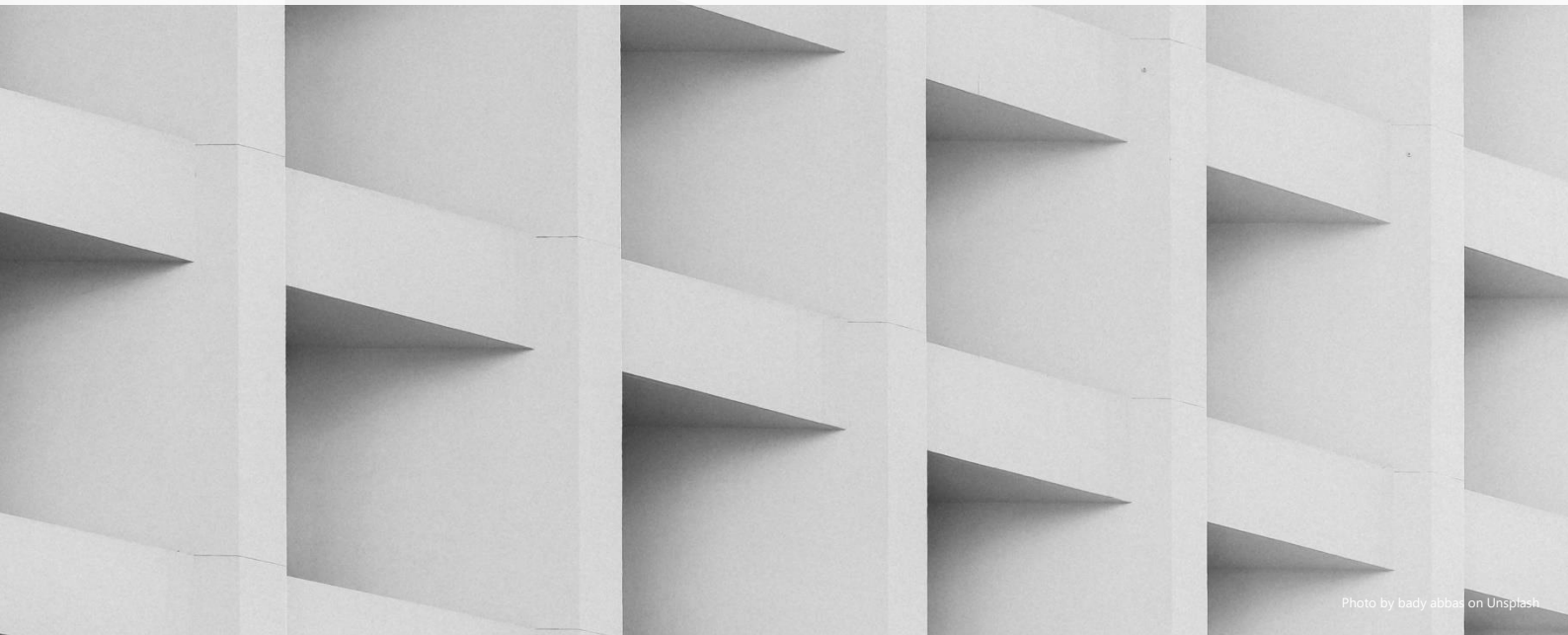

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Executive Summary

To date, 194 countries have submitted Nationally Determined Contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat. Our team analysed these submissions, looking for buildings-related measures. We classified each of these measures along three categories: (1) Mitigation; (2) Adaptation; and (3) Cross-cutting measures. For each of these, we created subcategories such as energy efficiency in design, building structure, or financing.

Climate action on buildings is a widely included measure in most NDCs. 168 out of 194 countries (87%) mention measures for the buildings and construction sector in their NDCs. Many countries provide extensive details of their plans to respond to climate change in the buildings sector. This puts an urgently needed spotlight on buildings, which, in 2021, accounted for 37% of global energy-related emissions.

Mitigation is the clear frontrunner in buildings-related measures. 80% of all NDCs analysed embrace mitigation action. Energy efficiency in design – including policy interventions such as building codes and certifications, as well as design innovations such as passive cooling and reflective surface finishes – is referenced in 113 out of 167 NDCs (68%). Beyond such integrated approaches, NDCs contain measures that tackle energy efficiency in appliances (62%), renewable energy (43%), building materials (38%), cooking (32%), and retrofitting existing buildings (20%).

Despite the clear focus on mitigation in NDCs that address buildings, adaptation measures are strongly represented too. Adaptation measures appear in 53% of all NDCs. Most adaptation efforts focus on building structures (40%), closely followed by site and planning (32%), and other measures such as community-based awareness campaigns on climate adaptation (11%).

Africa is leading the way. African countries have the highest ratio of NDCs with buildings sector measures (94%). Asia ranks a close second (89%), with the Americas (83%), Oceania (75%), and Europe (56%) – notably without counting the EU member states – following.

Countries with lower income per capita tend to include more buildings-related measures. While disparities between countries, as defined by income per capita according to the World Bank, are marginal, NDCs submitted by middle- or low-income countries (87% and 93%) have a higher share of buildings sector measures than NDCs submitted by high-income countries (73%).

And yet, only a fraction of all NDCs specify emission targets – financing schemes, too, are lacking. Our findings suggest that there is a rising awareness of the significance of buildings for climate action. But merely 18% of all NDCs provide quantifiable targets for their mitigation objectives. These measures must be backed up by financing. However, only 16% of NDCs outline funding for mitigation. Financing for adaptation is even less frequently addressed (3%).

Going forward, the next generation of NDCs must include more ambitious, specific, quantifiable, and readily financeable measures on buildings. This requires collaboration; the numeric tool used for this analysis is available upon request for further research and policy work.

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1 | Introduction

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WHAT DO WE KNOW ABOUT BUILDINGS AND THE NDCS?

Buildings – huge potential for greenhouse gas mitigation and adaptation

Buildings are a sleeping giant for climate action. In 2021, buildings accounted for 37% of global energy- and process-related emissions (UNEP, 2022). With the global building floor area expected to double by 2060, emissions from buildings will keep rising in a business-as-usual scenario (UNEP, 2017).

At the same time, buildings are particularly vulnerable to extreme climate events such as floods, storms, heatwaves, droughts, soil erosion, or wildfires. Climate-resilient buildings – promoting flexible design, passive cooling, nature-based solutions, local materials, or water conservation – are vital in achieving mitigation and adaptation objectives (Bourgault, Zinecker, & Mitra, 2021).

Climate action in the buildings sector offers the most cost-effective mitigation potential of any industrial sector and a range of well-documented co-benefits, including job creation, improved indoor and outdoor air quality, and improved climate resilience and adaptive capacity (UNEP, 2018). Most scenarios examined by the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report show a significant mitigation potential in the buildings sector by 2050 (IPCC, 2022).

But climate action on buildings is lagging. Of the USD 5.8 trillion spent in the buildings and construction sector in 2019, only a fraction (2.6%) went towards building energy efficiency. Rising inflation rates have diverted the attention of many governments. In 2022, a modest 2% increase was estimated for investment in energy efficiency in buildings (UNEP, 2022).

NDCs for more efficient and resilient buildings

Nationally Determined Contributions (NDCs) are a key tool to address these challenges. Established as part of the Paris Agreement, they are a critical component of national planning and implementation frameworks for mid-term climate action. They articulate commitments to reduce emissions and adapt to climate change. All countries are required to update their NDCs in a five-year cycle. In parallel, the United Nations Framework Convention on Climate Change (UNFCCC) conducts a global stocktake of collective progress and issues recommendations to guide the update of NDCs (Figure 1).

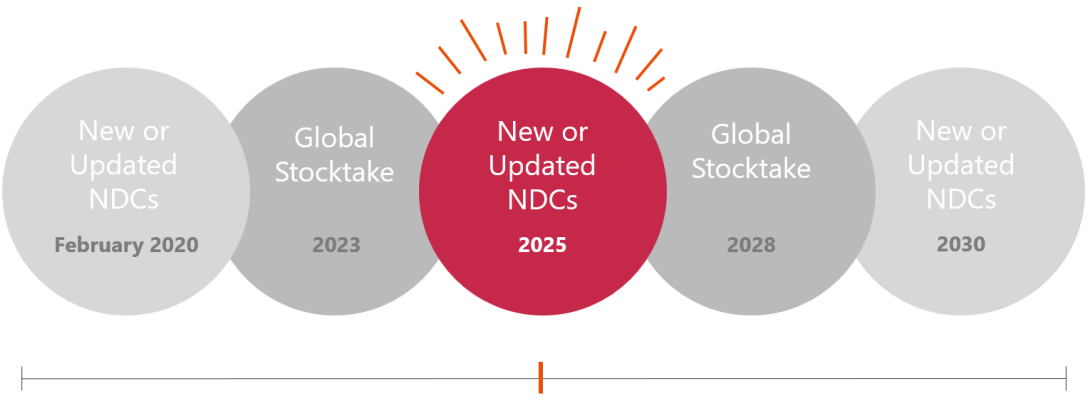

Figure 1: NDC cycle as set out in the Paris Agreement

Accounting for buildings in NDCs – a challenging feat

Locating action on buildings in the NDCs can be a challenge. Buildings are not a stand-alone category. The NDCs are often organised along IPCC sectors for national greenhouse gas (GHG) emissions inventories. The IPCC classifies GHG emissions across five sectors: Energy, Industry, Agriculture, Forestry and Other Land Use (AFOLU), Waste, and Other/Cross-sectoral (UNFCCC, 2021).

Measures in the buildings sector are in most cases a subset in one or more of these categories in NDCs. This mirrors the complexity and diversity in real life, where several ministries or agencies may have a stake in climate action in the buildings sector. This fragmentation complicates mapping existing climate measures in the buildings sector.

What we know about buildings in NDCs so far

According to the GlobalABC 2022 Global Status Report (GSR), 158 out of 196 countries – an increase by 70 NDCs as compared to 2015 – reference buildings as part of their NDCs (UNEP, 2022). Our analysis finds different results, due to divergences in methodology (pp. 5-6).

The 2022 UNFCCC NDC synthesis report found that energy efficiency of buildings is the second most frequently mentioned domestic mitigation action, with measures in 70% of all NDCs (UNFCCC, 2022).

A comprehensive review of buildings in the NDCs

Previous reports have focused on the extent to which NDCs reference buildings (UNEP, 2022) or tackle energy efficiency of buildings (UNFCCC, 2022). There is a lack, however, of information on the aspects of the buildings transition targeted by the NDCs.

This report aims to close this gap. In mapping and analysing buildings sector measures of NDCs submitted to the UNFCCC from March 2017 to July 2023, it systematically evaluates all NDCs for buildings-related measures and identifies to which sub-categories they belong[1]. It provides:

- A breakdown into the three categories of mitigation, adaptation, and cross-cutting measures
- A detailed quantitative analysis of key buildings issues such as building codes, certifications, design, appliances, building materials, renewable energy, building structure, or financing
- An overview of how buildings in NDCs compare by region and income

[1] The Excel file containing all buildings-related NDCs and their categorisation that was used for the analysis can be made available to researchers for further use upon request. We would be grateful to receive information about any potential errors included in this analysis. The researchers used utmost care to achieve correct results but, given the large amount of data treated, this cannot be guaranteed. Please feel free to reach out to the team via info@peeb.build.

2 | Methodology

Photo by Lucas Gallone on Unsplash

WHAT DID WE DO?

This study provides a detailed analysis of the measures on buildings included in the NDCs. For this study, our team searched in the texts of NDCs for buildings-related measures[2]. This means that only measures were counted, and not general mention of buildings, for example in the overarching introduction of an NDC.

Which NDCs were counted?

194 out of 198 countries that are Parties to the UNFCCC have submitted NDCs (UNFCCC, 2023).[1] All of these NDCs were considered for a general review of how many countries have NDCs that target buildings.

167 NDCs (excluding the European Union countries) were then analysed for a review of what specific measures on buildings each NDC contains. The joint EU NDC was excluded, as it has an overall quantitative target and only refers to a Directive that contains individual policy measures without stating them in the NDC (see below).

How was the EU NDC taken into account?

The European Union (EU) countries are a special case, as they have submitted the same joint NDC for all 27 member states. As the NDC of the EU mentions buildings, and specifically refers to the Energy Performance in Buildings Directive (EPBD) as a key and specific policy tool, all EU countries were considered to have mentioned buildings for the overall analysis. Through the Energy Performance of Buildings Directive (EPBD), which is referenced in its NDC, the EU acknowledges buildings as one of the largest sources of energy consumption in Europe. This regulatory framework is ambitious and, among others, aims for a fully decarbonised building stock by 2050.

For the detailed analysis of individual targets, by contrast, the EU NDC, and with it all EU countries, were excluded, as in the EU NDC itself, none of these measures are outlined. For the sake of comparability and consistency, we therefore decided to omit the EU NDC from the analysis.

For the classification of individual measures, we assigned these measures to one or several categories, including ten mitigation categories, three adaptation categories, and three cross-cutting categories. The latest version of each NDC submitted to the UNFCCC (UNFCCC, 2023) was reviewed. NDCs vary strongly in terms of detail, length, or concreteness of proposed actions. Assigning measures to categories can therefore be challenging. Categories have been defined to reduce the degree of interpretation and professional and academic bias (Table 1). If NDC measures address more than one buildings sector aspect, they have been assigned to several categories. For example, if an NDC mentions solar thermal and mechanical cooling systems in the same breath, we considered them as both *Renewable Energy* and *Energy Efficiency / Appliances* measures (Table 1).

[2] For the GlobalABC 2022 GSR, text mining techniques were applied to extract mentions of buildings-related measures from NDC updates. These were then classified according to six categories. Some of the countries that mentioned measures in buildings in their first NDC, such as Grenada and Marshall Islands, refrained from doing so in their latest versions. However, these countries were still included in the total count based on their earlier NDC submissions (UNEP, 2021). Furthermore, the 2022 GSR also classified countries according to the category of "Further detail in the 4th biennial report". Four more Annex 1 industrialised countries, which did not mention buildings measures in their NDCs but had committed to extensive buildings sector decarbonisation programmes, were included in the total count (UNEP, 2022).

The analysis considered mitigation and adaptation, as well as cross-cutting issues. Within mitigation, the study looks at energy efficiency, renewables, building materials, and retrofitting of existing buildings. In adaptation, it differentiates between action at the building level or at site level. Cross-cutting issues relate to the commitment to quantitative GHG reductions, financing, and jobs.

Cooking is included as a mitigation action in the study, even though it is not directly related to the operation of a building, as opposed to appliances such as cooling or lighting. In the UNFCCC Compendium on GHG baselines and emissions for the buildings and construction sector, cooking is considered in the operational phase of buildings when calculating buildings sector energy consumption by end-use as well as direct emissions from fuel combustion activities (UNFCCC, 2021). The GlobalABC Global Roadmap also recommends reducing energy demand from cooking as an opportunity for buildings sector decarbonisation (UNEP, 2018).

	CATEGORIES	DEFINITION
MITIGATION	Energy Efficiency / Design / Building Codes	Building energy codes or statutory standards that provide minimum requirements for building components or for building performance to enable low-emission and energy-efficient buildings
	Energy Efficiency / Design / Certifications	Green buildings certifications (LEED, EDGE) or energy performance labels to assess and report building performance
	Energy Efficiency / Design / Others	Measures to promote energy efficiency in building design through envelope, passive design, external shading, reflective surface finishes, insulation, solar and thermal windows, daylighting, or bioclimatic design
	Energy Efficiency / Appliances	Measures to improve the energy efficiency of appliances, e.g., through minimum energy performance standards (MEPS), adopting efficient systems or labels for space heating and cooling, water heating, ventilation, lighting, and other appliances used in buildings
	Cooking	Measures related to improvements in cooking equipment, either through increased efficiency of cooking equipment or fuel switch
	Renewable Energy	Measures to promote onsite power/heat generation from renewable energy resources (e.g., solar photovoltaic (PV) systems and solar-thermal arrays)
	Building Materials / Bio-Based Local Materials	Measures to promote low-carbon, local bio-based alternatives for materials and techniques via research, incentives, standards, etc.
	Building Materials / Cement / Concrete	Measures related to reducing emissions in the cement industry via efficient production or alternative processing methods
	Building Materials / Others	Measures related to reducing emissions from other building materials (brick, glass, steel, etc.) via efficient production or alternative processing methods
	Existing Buildings	Measures that specifically target the existing building stock (e.g., energy-efficiency measures, energy audits)
ADAPTATION	Building Structure	Measures for adaptation of building structures to the effects of climate change and other natural disasters
	Site and Planning	Measures for adaptation that focus on building site, urban planning, or regional planning
	Others	Measures for adaptation that are not covered by the two other adaptation categories, e.g., increased capacity
CROSS-CUTTING	Quantitative GHG Reduction	Explicit statements regarding quantitative GHG reduction targets specific to mitigation measures in the buildings sector
	Financing	Explicit statements regarding the amount of financing required for the action
	Jobs	Measures targeting job creation arising from the action on buildings

Table 1: Types of building categories in NDCs

3 | A Closer Look

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WHAT IS IN THE NDCS ON BUILDINGS?

Our analysis found that **168 out of 194 countries (87%) mention measures for the buildings and construction sector**[3]. The NDCs were found to vary strongly in terms of activities covered, detail, length, or concreteness of proposed actions.

Which topics are covered in NDCs on buildings?

For an analysis of measures on buildings that were proposed in NDCs, 167 out of the 194 submitted NDCs were analysed (excluding the joint EU NDC, cf. explanation on the NDCs analysed on p. 5).

Mitigation is the clear frontrunner in NDCs. Out of the 141 NDCs that mention measures for buildings, most NDCs (133) mention mitigation action. In addition, mitigation is also referenced in the EU NDC, which was not counted. 88 NDCs mention adaptation (Figure 2, Table 2).

	Number	Percentage
NDCs with buildings sector measures (without joint EU NDC)	141	84%
NDCs with mitigation measures for buildings (without joint EU NDC)	133	80%
NDCs with adaptation measures for buildings (without joint EU NDC)	88	53%
NDCs with cross-cutting measures for buildings (without joint EU NDC)	45	27%
Total NDCs (without joint EU NDC)	**167**	**100%**

Table 2: NDCs by type of measure for buildings

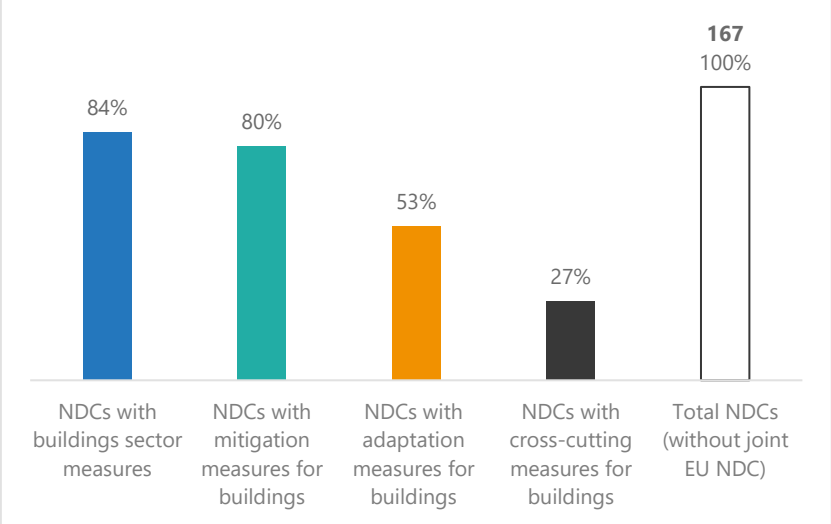


Figure 2: NDCs by type of measure for buildings

[3] This is a lower count in comparison with the 2022 Global Status Report for Buildings and Construction, in which 158 countries mention buildings sector measures in their NDCs. This is due to different methodologies applied in the PEEB NDC report and GlobalABC GSR.

Regional differences – Africa leads the way on NDCs for buildings

Analysis of the 141 NDCs with measures for buildings by region showed marked differences (Table 3, Figure 3). African countries had by far the highest ratio of NDCs with buildings sector measures (94%) – be it for mitigation (91%), adaptation (70%), or cross-cutting measures (45%). Asia ranks a close second, with 89% of NDCs outlining action on buildings. The Americas include the buildings sector in 83% of their NDCs. Compared to Asia, the Americas have a stronger focus on adaptation than mitigation measures. The buildings sector appears in 75% of NDCs submitted by Oceanian countries. Europe – notably without considering the EU member states – follows with 56%.

	NDCs with buildings sector measures		NDCs with mitigation measures for buildings		NDCs with adaptation measures for buildings		NDCs with cross-cutting measures for buildings		Total NDCs (out of 167)	
Africa	50	94%	48	91%	37	70%	24	45%	53	32%
Americas	29	83%	27	77%	19	54%	4	11%	35	21%
Asia	40	89%	37	84%	21	49%	10	22%	45	27%
Europe (without EU)	10	56%	9	50%	4	22%	5	28%	18	11%
Oceania	12	75%	11	69%	6	38%	2	13%	16	10%

Table 3: Regional breakdown of NDCs with buildings sector measures

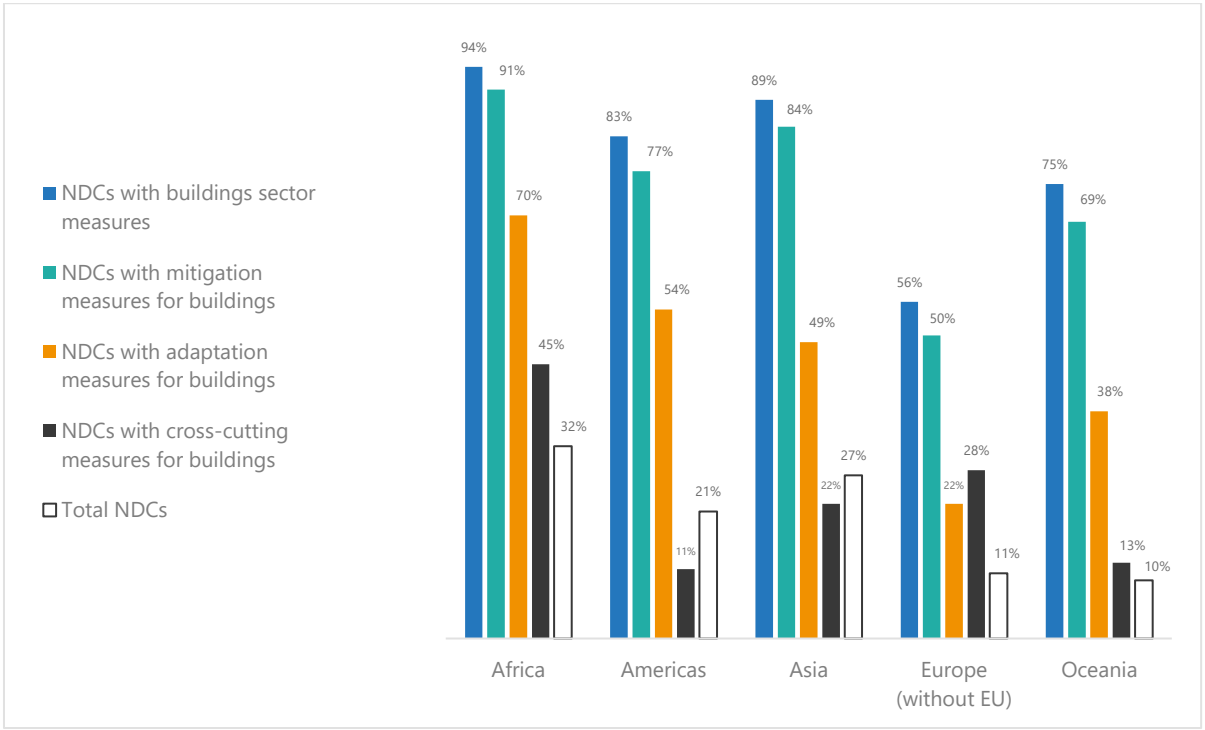


Figure 3: Regional breakdown of NDCs with buildings sector measures

Spotlight on buildings in the revised NDC of the United Arab Emirates (UAE)

The UAE is hosting the 28th session of the Conference of the Parties (COP). In July 2023, the country submitted the third update of its NDC. The buildings sector plays a crucial role in the newest update of the UAE.

The UAE's NDC has considerably more measures than most countries, with concrete quantitative and measurable targets. With 31 measures in mitigation, six in adaptation, and three in cross-cutting categories, the UAE – with 40 measures in total – has the second-highest number of measures on buildings. The country sets out to cut emissions in the buildings sector by 56% by 2030 compared to the 2019 base year. It aims for a 40% reduction in energy use and a 20% reduction in water consumption in the built environment by 2050 compared to business as usual (United Arab Emirates, 2023).

Displayed in the background: Wind towers or wind catchers, a traditional architectural technique used for passive cooling and natural ventilation.

Income levels – NDC targets for buildings are less common in high-income countries

Across all income categories, there is a high percentage of NDCs with buildings-related measures. NDCs submitted by high-income countries have a lower share of buildings sector measures (71%), compared to NDCs submitted by middle- or low-income countries (87% and 93%)[4] (Table 4, Figure 4).

	NDCs with buildings sector measures		NDCs with mitigation measures for buildings		NDCs with adaptation measures for buildings		NDCs with cross-cutting measures for buildings		Total NDCs (out of 167)	
High Income	24	71%	23	68%	12	35%	9	27%	34	20%
Middle Income	90	87%	83	81%	58	56%	24	23%	103	62%
Low Income	25	93%	25	93%	17	63%	12	44%	27	16%
Not Classified[5]	2	67%	2	67%	1	33%	0	0%	3	2%

Table 4: Income-wise breakdown of NDCs with buildings sector measures

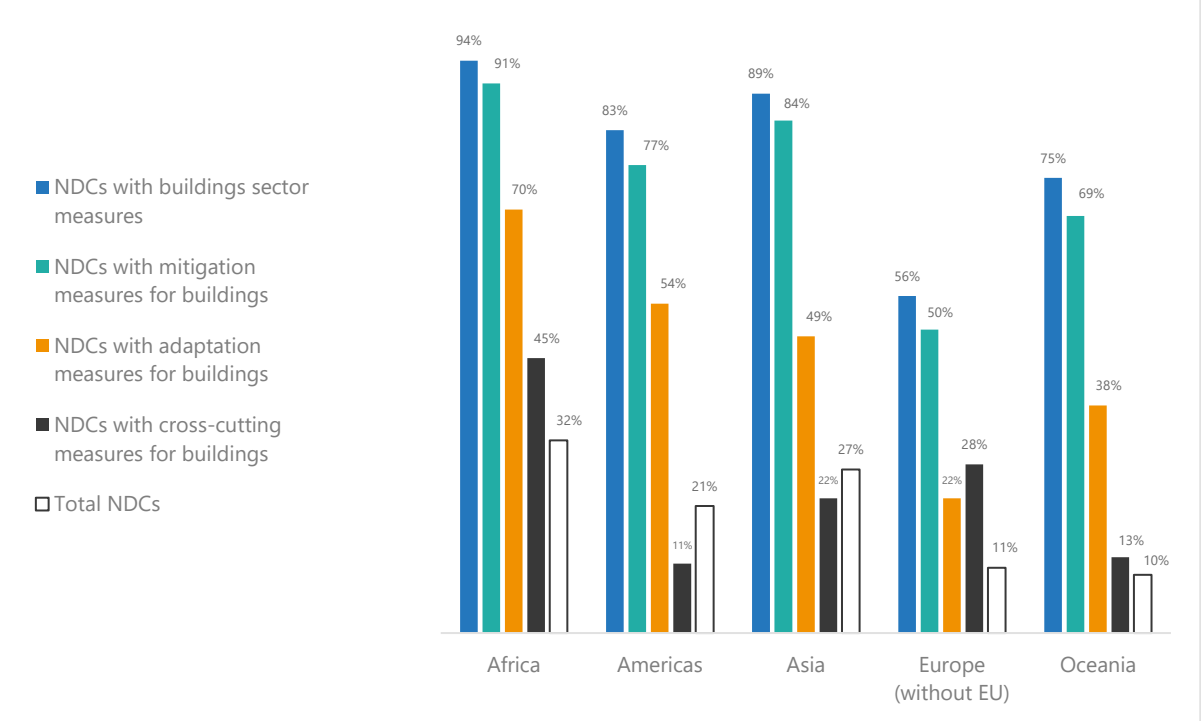


Figure 4: Income-wise breakdown of NDCs with buildings sector measures

[4] To analyse the differences between countries of different income levels, an income level classification was assigned to each country based on the World Bank data on country and lending groups (The World Bank Group, 2022).
[5] Cook Islands, Niue, and Venezuela are not classified in that database (The World Bank Group, 2022).

4 | Mitigation

Photo by Who's Denilo? on Unsplash

FROM APPLIANCES TO BUILDING MATERIALS

133 out of 167 NDCs mention mitigation measures on buildings (80%). Some NDCs only target parts of the building, such as the use of renewable energy, or the use of appliances such as cooking appliances or air-conditioners, while others target the quality of the building as a whole.

Mitigation measures were therefore classified in separate categories, to understand which ones cover the whole building *(Energy Efficiency / Design)*, or parts of it, such as appliances or renewable energy. Building materials were selected as an extra category.

Energy efficiency in design is mentioned in most NDCs, followed by appliances and renewable energy.

An analysis of the number of individual measures shows that energy efficiency in appliances is the most cited category with 224 measures, followed by energy efficiency in design (164 measures), renewable energy (161 measures), improvement in cooking appliances (104 measures), building materials (101 measures), and refurbishment of existing buildings (68 measures). 4 NDCs contain only activities on cooking in terms of mitigation in the buildings sector.

	Number of NDCs and percentage out of 167 (total)		Total number of measures
Energy Efficiency / Design	113	68%	164
Energy Efficiency / Appliances	103	62%	224
Renewable Energy	72	43%	161
Building Materials	63	38%	99
Cooking	53	32%	104
Existing Buildings	34	20%	68

Table 5: NDCs that contain measures in mitigation categories

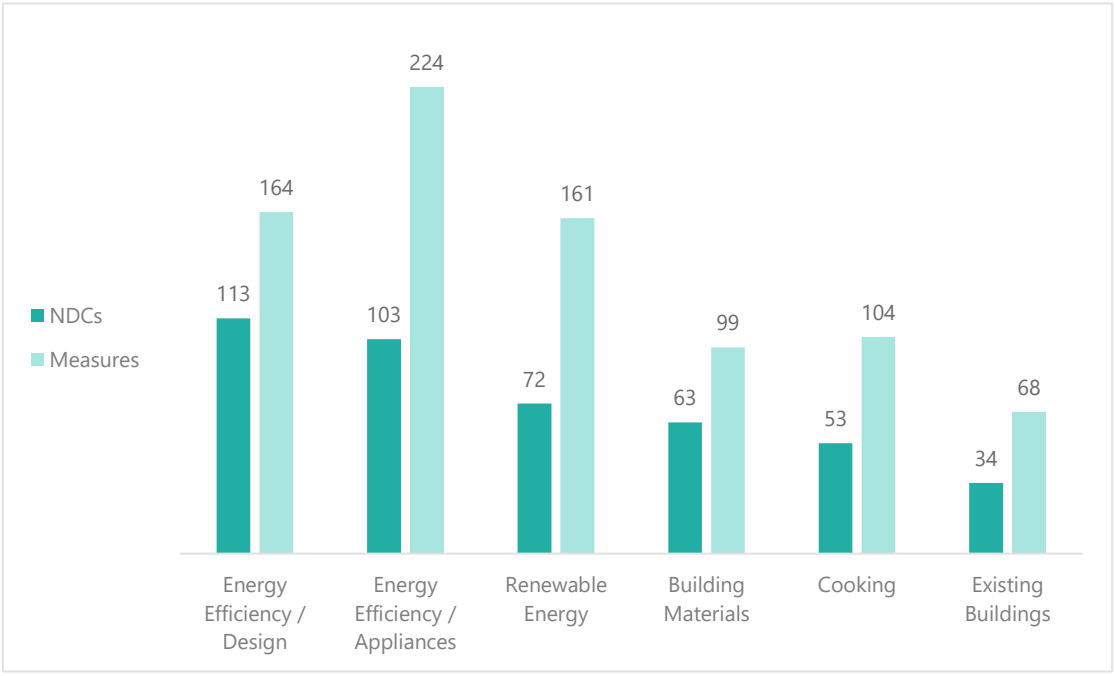


Figure 5: NDCs that contain measures in mitigation categories

Energy Efficiency by Design

113 NDCs include measures that address the entire building, with overall 164 measures. Many of these NDC measures on design include policy measures, including 45 NDCs with measures on building codes and 14 with measures on building certification. In addition, there are 54 NDCs with other measures for the promotion of energy efficiency through envelope design, passive design, external shading, insulation, daylighting, or bioclimatic design.

Many NDCs combine several measures. Türkiye's NDC, for example, mentions constructing new buildings and retrofitting existing ones in accordance with the Nearly Zero Energy Building (NZEB) concept *(Building Codes)*, applying an energy performance rating system to new and existing buildings to control energy consumption and GHG emissions *(Certifications)*, and promoting integrated building design, Building Information Modelling (BIM), and modular construction technologies *(Others)* (Republic of Türkiye, 2023).

	Number of NDCs and percentage out of 167 (total)		Total number of measures
Building Codes	45	27%	61
Certifications	14	8%	22
Others	54	32%	81
Total Energy Efficiency / Design	113	68%	164

Table 6: NDCs that contain mitigation measures in Energy Efficiency / Design

Country	Type of Document	Quote
Dominica	First NDC (Update)	Building energy performance - installation and appliance efficiency with the objective of net-zero in new and renovated buildings; net-zero buildings with energy efficiency certification like Leadership in Energy and Environmental Design (LEED), Platinum certification and Passive House certification need to be introduced.
Singapore	First NDC (Update)	For the buildings sector, Singapore has raised the minimum energy performance standards for new buildings and existing buildings undergoing retrofitting, and enhanced funding for the Green Buildings Innovation Cluster programme, which supports the research, development and demonstration of energy-efficient technologies.
Sri Lanka	First NDC (Update)	Implement Energy Efficiency Building Code on a mandatory basis.

Table 7: Examples from NDCs for measures in Energy Efficiency / Design

Appliances

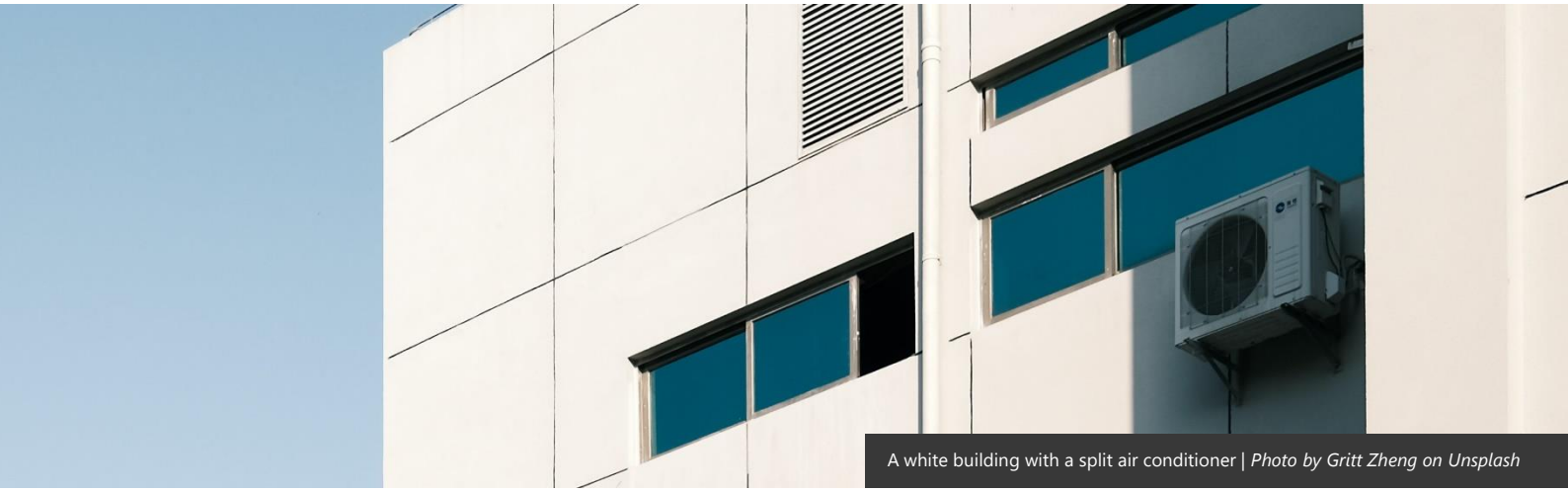
Energy efficiency in appliances is the most frequently mentioned measure on buildings. 103 out of 167 NDCs mention measures related to energy efficiency in appliances, with 224 measures. Measures in this category include adopting labels and minimum energy performance standards (MEPS) for appliances used in buildings, such as heating/cooling systems, ventilation, or lighting *(Appliances)*. For example, Rwanda mentions promoting the use of energy-efficient lamps in residential, commercial, and public building through government subsidies and Value-Added Tax exemptions (Republic of Rwanda, 2020).

	Number of NDCs and percentage out of 167 (total)		Total number of measures
Energy Efficiency / Appliances	103	62%	224

Table 8: NDCs that contain mitigation measures in Energy Efficiency / Appliances

Country	Type of Document	Quote
Papua New Guinea	Second NDC	Increased efficiency of energy use will play a key role in mitigating the growth in PNG's demand for energy linked to a growing economy and population. Central to this approach will be the adoption and implementation of Minimum Energy Performance Standards and Labelling (MEPSL) Regulations as well as enhancing public awareness of energy use and means of reducing energy use. In-depth work in the areas of building energy efficiencies such as evaluating the performance of installed air conditioning and refrigeration systems and developing recommendations to improve such systems as retrofits or in industrial energy efficiency audits and retrofits will require financial and technical support. The draft MEPSL is intended to be fully implemented by 2030. Limited data on existing energy use and potential trends currently prohibits placing a quantified target on the impact of these actions.

Table 9: Examples from NDCs for measures in Energy Efficiency / Appliances



A white building with a split air conditioner | *Photo by Gritt Zheng on Unsplash*

Cooking

The category *Cooking* includes any measures on energy efficiency and fuel switch in cooking equipment. Furthermore, 53 out of 167 NDCs include measures on cooking, with 104 mentions in total. 4 NDCs have measures on cooking as the only mitigation measures for buildings.

	Number of NDCs and percentage out of 167 (total)		Total number of measures
Cooking	53	32%	104

Table 10: NDCs that contain mitigation measures in Cooking

Country	Type of Document	Quote
Malawi	First NDC (Update)	Improved charcoal cookstoves - rural households (a) Deployment of efficient charcoal cookstoves to urban households; increasing from 20% to 30% efficiency thereby reducing demand for charcoal and CH4 and N2O emissions.

Table 11: Examples from NDCs for measures in Cooking

A woman cooking on a traditional *chulha* using firewood in Fatehpur, UP, India | *Photo by Shruti Singh on Unsplash*

Renewable Energy

With 161 measures in 72 NDCs, renewable energy is the second highest referenced category according to our analysis. This category includes any measures that promote onsite power and/or heat generation from renewable energy resources such as solar PV systems or solar-thermal arrays. The Bhutan NDC, for instance, provides details of measures to install more than 50 Solar Water Heating Systems in public institutions to curtail pressure on firewood demand. The NDC also mentions installing roof-mounted solar PV systems in 300 rural households to reduce fuelwood consumption and provide access to clean energy (Royal Government of Bhutan, 2021).

	Number of NDCs and percentage out of 167 (total)		Total number of measures
Renewable Energy	72	43%	161

Table 12: NDCs that contain mitigation measures in Renewable Energy

Country	Type of Document	Quote
Rwanda	First NDC (Update)	Off-grid and rooftop solar electrification: Penetration of off-grid solar and rooftop solar PV panels consistent with the ESSP targets of around 1,500,000 households to be electrified through, equivalent to 250,000 connections per year. Displacement of grid power and diesel consumption and associated GHG emissions.

Table 13: Examples from NDCs for measures in Renewable Energy

A heat pump outside of a residential building | *Photo by HarmvdB on Pixabay*

Building Materials

Building materials are less frequently addressed in NDCs. Nevertheless, 63 out of all NDCs (38%) mention them, with 99 measures in total. Cement and concrete are the most frequently cited sub-categories, with 37 NDCs referring to 65 measures in cement usage, its production, and available alternatives. The use of bio-based construction materials is not yet prevalent, as only 5 NDCs refer to the promotion of low-carbon, local bio-based alternatives for materials and techniques, with just 6 measures. The reduction of energy use and greenhouse gas emissions in other building materials, such as brick, glass, and steel, is addressed by 21 NDCs with 28 measures.

The NDC of Iraq mentions measures for promotion of development and use of environmentally friendly materials and local products *(Bio-Based Local Materials)*, the development of industrial processes and low carbon technologies in cement manufacture *(Cement/Concrete)*, and the use of modern construction techniques, such as glass reinforced concrete, to reduce the amount of reinforcing steel used in construction *(Others)* (Republic of Iraq, 2020).

	Number of NDCs and percentage out of 167 (total)		Total number of measures
Building Materials / Bio-Based Local Materials	5	3%	6
Building Materials / Cement / Concrete	37	22%	65
Building Materials / Others	21	13%	28
Total Building Materials	63	38%	99

Table 14: NDCs that contain mitigation measures in Building Materials

Country	Type of Document	Quote
Bangladesh	First NDC (Update)	Brick Kilns: Enforcement and Improved technology use | 14% emission reduction through Banning Fixed Chimney kiln (FCK), encourage advanced technology and non-fired brick use.
Egypt	First NDC (Update)	Implement measures in the low carbon roadmap for the Egyptian cement industry including alternative fuels partial substitution, lowering the clinker content in cement up to 80% conditional on meeting relevant national standards, and energy efficiency improvements. Ministerial Decree 49/2021 for mandatory partial replacement of alternative fuels in cement sector was issued in March 2021 by the Ministry of Environment as supporting policy measure. The cement sector has already started using alternative fuel at a share of 6.4% in 2015 to replace a percentage of the coal used as the main fuel for the thermal energy.
Malawi	First NDC (Update)	Mitigation potential from IPPU (industrial processes and product use) sources is by comparison relatively limited, with the majority of emissions reductions arising from increased use of rice husk ash (RHA) blending and earth stabilised blocks (ESB) to reduce clinker and cement demand; over the longer term, the use of emerging low carbon clinker processes may also be feasible.

Table 15: Examples from NDCs for measures in Building Materials

Existing Buildings

This category includes any measures that specifically target energy efficiency in the existing building stock, envelope renovations and energy performance audits. 34 out of 167 NDCs mention existing buildings, with 68 mentions in total. Canada, for example, lists upgrading of building envelopes, hot water tanks, and furnaces/boilers, as part of a comprehensive public housing units renovation programme in the territory of Nunavut (Government of Canada, 2021).

	Number of NDCs and percentage out of 167 (total)		Total number of measures
Existing Buildings	34	20%	68

Table 16: NDCs that contain mitigation measures in Existing Buildings

Country	Type of Document	Quote
The Bahamas	First NDC (Update)	Energy audits for all existing hotels and industrial facilities. Energy audits are instrumental in the identification of energy efficiency options for buildings. The tourism sector is a key economic factor in The Bahamas and the hotels plays a critical role in energy consumption. This is an enabling measure for the introduction of energy efficiency building measures.

Table 17: Examples from NDCs for measures in Existing Buildings

Construction workers in Bangkok, Thailand | *Photo by Etienne Girardet on Unsplash*

5 | Adaptation

Photo by Luigi Estuye on Unsplash

FROM BUILDING SCALE TO URBAN SCALE

Adaptation is mentioned in 88 out of all 167 examined NDCs (53%). Adaptation refers to any measures to improve resilience to the impacts of climate change. This study disaggregates adaptation measures in NDCs into planning for future climatic conditions on different levels *(Site and Planning)*, retrofitting of buildings to withstand the effects of climate change and natural disasters *(Building Structure)*, and any measures to improve the buildings sector's capacity to cope with climatic changes *(Others)*.

The analysis shows that site and planning, building structure, and other measures are mentioned by 67, 54, and 19 NDCs respectively, with 223 measures in total.

	Number of NDCs and percentage out of 167 (total)		Total number of measures
Site and Planning	67	40%	104
Building Structure	54	32%	95
Others	19	11%	24

Table 18: NDCs that contain measures in adaptation categories

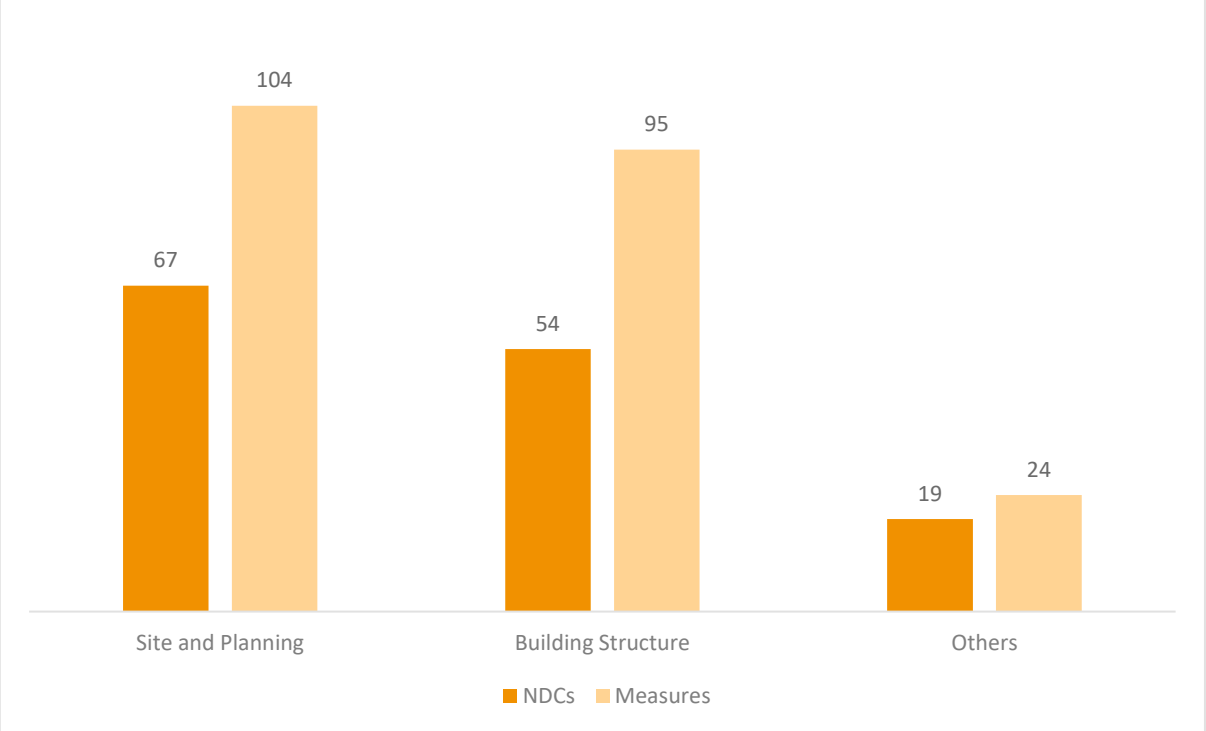


Figure 6: NDC mentions and measures per adaptation category

Building site and (urban and regional) planning

This category is defined broadly and includes any measure for adaptation that addresses building sites, urban planning, or regional planning. Such measures appear in 40% of all analysed NDCs. With 104 measures in total, the category is mentioned just as much as cooking (Table 10).

Some NDCs aim for specific physical interventions. Kenya, for instance, mentions in its NDC the introduction of nature-based solutions for flood protection, particularly around informal settlements, where high population densities coupled with a lack of adequate drainage systems increase the likelihood of flooding (Republic of Kenya, 2020). Other NDCs focus on institutional change. Mainstreaming climate resilience in construction activities, as outlined in Sudan's NDC, is one way to contribute towards such change (Republic of the Sudan, 2021).

Country	Type of Document	Quote
Albania	First NDC (Update)	Mainstreaming climate change adaptation into spatial/territorial development planning legislation, regulations, procedures and tools, including building codes (orientation of constructions in areas protected by floods and marine erosion)
Jordan	First NDC (Update)	Adoption of more greenery/green/nature-based infrastructure/solutions that not only helps with issues such as flooding, but can also mitigate heat islands and energy load etc. at an urban design scale.
Viet Nam	First NDC (Update)	Planning, relocating residential areas in places frequently affected by extreme climate; monitoring, supervising and warning to promptly evacuate and reduce risks for places where relocation is not possible.

Table 19: Examples from NDCs for measures in Site and Planning

Aerial view of buildings by the waterfront | *Photo by Tim Gouw on Unsplash*

Strengthening building structures for better preparedness

54 NDCs contain adaptation measures on the structure of buildings. Around every third NDC thus mentions the category, with 95 measures in total.

These measures are primarily aimed at adapting the building structure to an already changed and further changing climate. Sometimes, however, they also have mitigation effects. Kazakhstan, for example, predicts in its NDC that the country's planned thermal modernisation of buildings would not only protect residents from heat but also save energy in the process (Republic of Kazakhstan, 2023).

Other NDCs in the category of *Building Structure* tend to focus on preparing for the worst effects of natural disasters. The archipelago of Fiji, for instance, aims to further strengthen the housing stock, both existing and future (Republic of Fiji, 2022). Vanuatu declares in its NDC it would further develop climate-proofed buildings to minimise loss and damage (Republic of Vanuatu, 2022).

Country	Type of Document	Quote
Dominica	First NDC (Update)	Resilient housing: Transformation of the structural reliability of national housing to extreme weather.
Ethiopia	First NDC (Update)	Improve provision and condition of housing for enhanced human safety against climatic stressors | Indicator: Percentage of urban dwellers residing in safe and adequate housing (gender-disaggregated).
Morocco	First NDC (Update)	Promotion of green walls and roofs: Green roofs and facades improve the thermal comfort of buildings, particularly in hot, dry climates. *[translated from the French]*

Table 20: Examples from NDCs for measures in Building Structure

Aerial view of houses and trees in Fiji | *Photo by Alec Douglas on Unsplash*

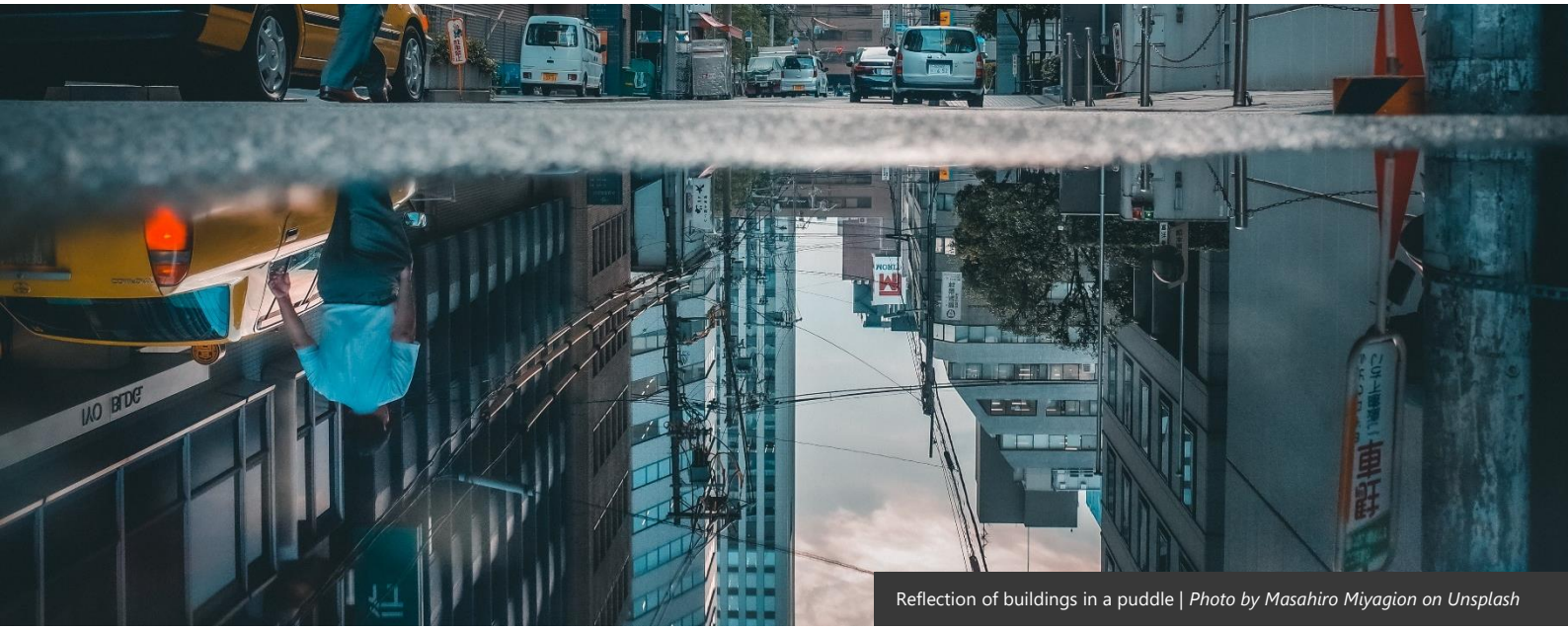
Other adaptation measures

All other measures that did not fit in the previous two adaptation categories were counted as *Others*. 19 NDCs, or 11% of all NDCs, included such measures, of which there were 24 in total.

Some of these measures target the support of research on physical, biological, and social aspects of adaptation, as presented in the NDC of Albania (Republic of Albania, 2022), or the development of future-proof construction materials, as in the NDC of the UAE (United Arab Emirates, 2023). Other NDCs, including Indonesia's and Turkmenistan's, press for climate adaptation awareness campaigns for the built environment (Republic of Indonesia, 2022) (Government of Turkmenistan, 2022).

Country	Type of Document	Quote
Antigua and Barbuda	First NDC (Update)	Supporting the mainstreaming of climate-proofing measures into funding mechanisms, policies, and standards for the building sector
Tanzania	First NDC (Update)	Mainstreaming of climate change in the engineering and architecture curricula.
Uruguay	Second NDC	By 2030, support materials have been updated and disseminated to incorporate climate change and variability in the planning of Uruguayan cities. *[translated from the Spanish]*

Table 21: Examples from NDCs for measures in Others



Reflection of buildings in a puddle | *Photo by Masahiro Miyagion on Unsplash*

6 | Cross-Cutting

Photo by Augustine Wong on Unsplash

FROM GENERATING JOBS TO FINANCING

An important criterion for the implementation of NDCs is whether they are tagged to financing. While for many NDCs this may not be included in the same document, it indicates how concrete plans are. Quantitative targets may be informed by underlying analyses of buildings sector action. Therefore, this criterion was also recorded separately. In addition, job creation was analysed as an important additional co-benefit of sustainable buildings.

Cross-cutting categories are addressed in just 45 out of 167 NDCs (Table 2, p. 8). Mostly these cross-cutting categories were found in connection with mitigation measures (211 mentions), with merely 12 mentions of adaptation measures (Table 22). Of all NDCs, 30 included quantitative GHG reduction objectives, 27 provided concrete plans of financing, and 4 linked action on buildings to job creation.

	Number of NDCs and percentage out of 167 (total)				Total number of measures	
	Mitigation		Adaptation		Mitigation	Adaptation
Quantitative GHG Reduction	30	18%	1	<1%	103	1
Financing	27	16%	5	3%	101	9
Jobs	4	2%	2	1%	7	2

Table 22: NDCs that contain measures in cross-cutting categories

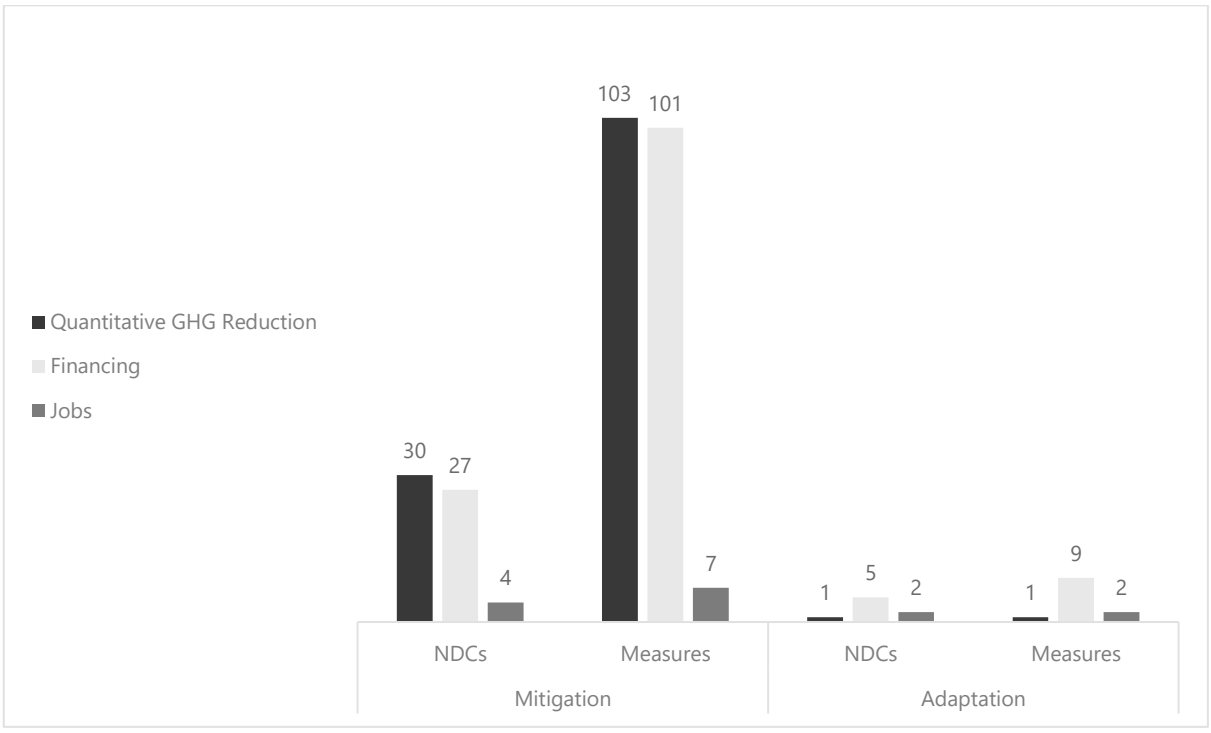


Figure 7: NDC mentions and measures per cross-cutting category

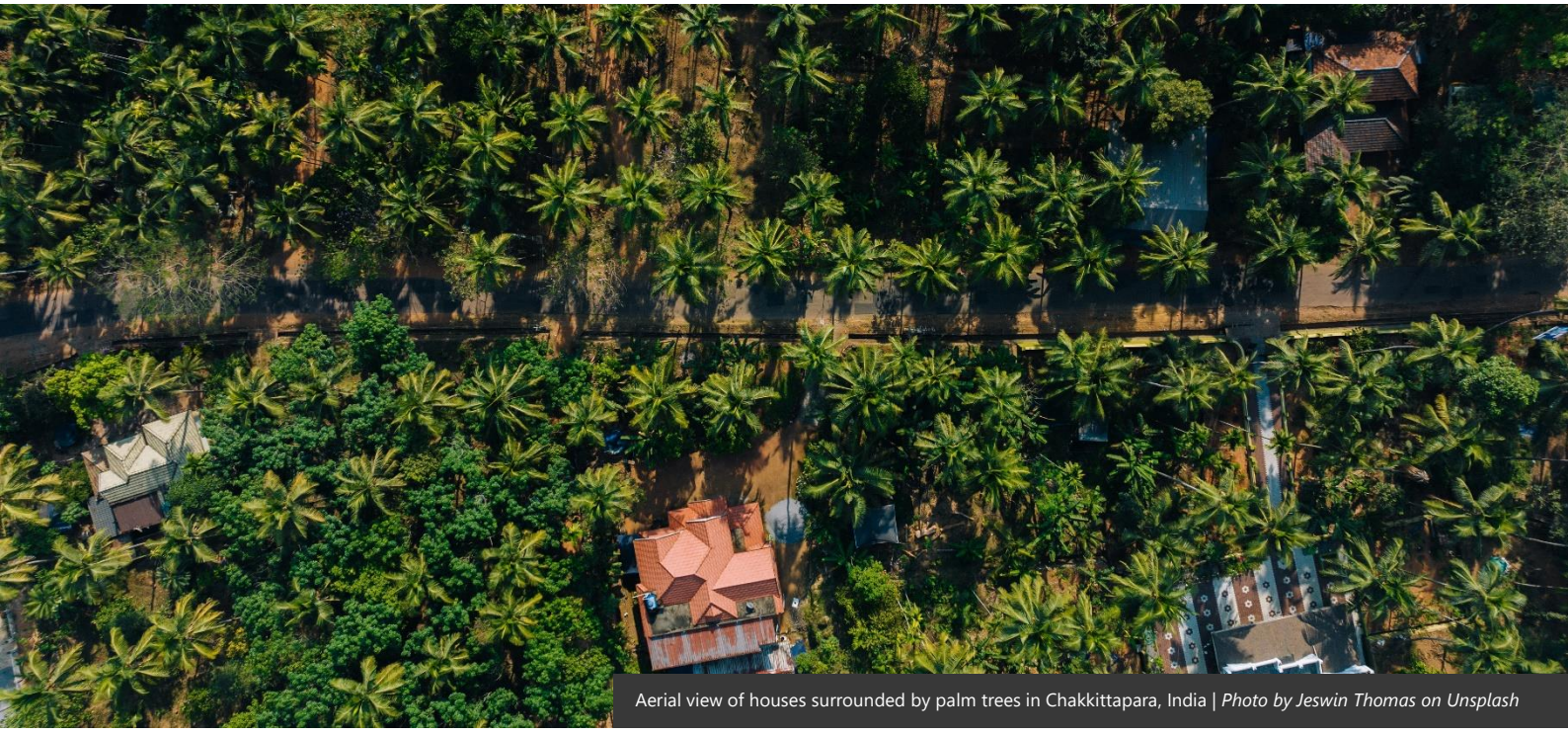
Quantitative greenhouse gas reduction targets

Few emissions reductions for measures on buildings in NDCs are quantified. Only 30 out of 167 NDCs specify estimated GHG reduction targets for at least one of the mitigation measures, with 103 measures in total. The Bahamas, for example, mentions in its NDC a measure to avoid 135.9 GgCO2eq of GHG emissions through energy audits for all existing hotels and industrial facilities *(Mitigation)* (Government of The Commonwealth of The Bahamas, 2022).

Adaptation measures in the sector have mitigation co-benefits. However, only one out of 167 NDCs specify estimated GHG reduction targets for at least one of the adaptation measures, with only one measure. This can be found in Cambodia's updated NDC: In implementing passive cooling solutions in its public buildings, the Southeast Asian country predicts a GHG reduction potential of 0.07 Mt CO2e until 2030, arguably a rather small effect (Kingdom of Cambodia, 2020).

Country	Type of Document	Quote
China	First NDC (Update)	The LieChe New Town Project in Gaobeidian has a planned floor area of 1.2 million m2, including an ultra-low energy area of 820,000 m2. […] This contributes to annual CO2 and sulfur dioxide (SO2) emission reductions of 11,031 tons and 36 tons respectively.

Table 23: Example from NDCs for measures in Quantitative GHG Reduction



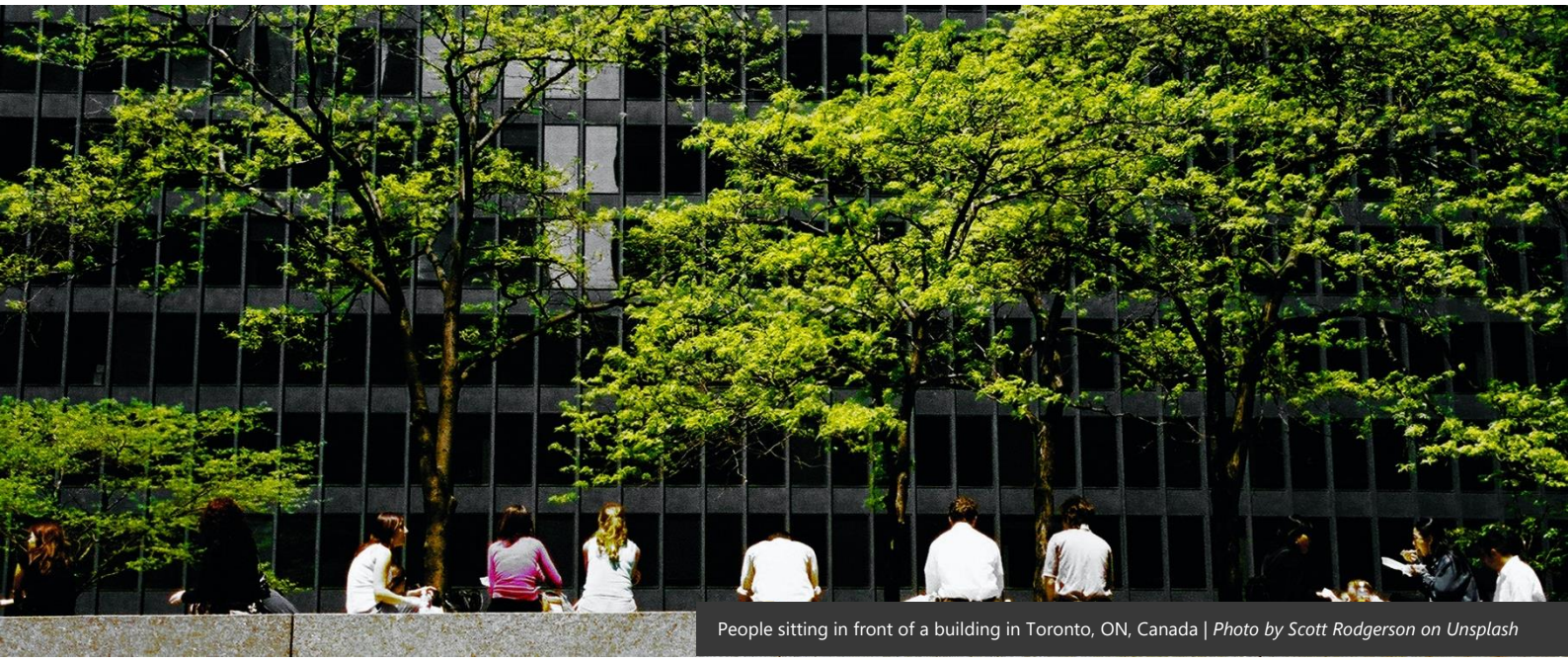
Aerial view of houses surrounded by palm trees in Chakkittapara, India | *Photo by Jeswin Thomas on Unsplash*

Financing for NDCs

Implementing the mitigation measures in NDCs requires financing. However, only a few of the NDCs on buildings indicate financing requirements. 27 out of 167 NDCs specify financing requirements for at least one of the mitigation measures, with 101 measures in total. Despite 88 NDCs mentioning adaptation measures, only five of them specify financing requirements for adaptation with just nine measures. For example, Cambodia mentions in its NDC a USD 49 million financial commitment for integrating climate change response measures onto the construction design for buildings and for rural housing *(Adaptation)* (Kingdom of Cambodia, 2020).

Country	Type of Document	Quote
Canada	First NDC (Update)	Invest $1.5 billion to support green and accessible retrofits, repairs or upgrades of existing public community buildings, and the construction of new, publicly accessible community buildings that serve high-needs, underserved communities across Canada.
Canada	First NDC (Update)	The Government of Nova Scotia will invest $9.5 million from its Green Fund into the HomeWarming and the Affordable Multi-Family Housing energy efficiency programs. This will help 1,200 more low-income Nova Scotians make their homes more comfortable and protect their family budgets. More than 300 local businesses work on Efficiency Nova Scotia projects and are part of the Efficiency Trade Network. Together, those businesses employ about 2,500 Nova Scotians.

Table 24: Examples from NDCs for measures in Financing



People sitting in front of a building in Toronto, ON, Canada | *Photo by Scott Rodgerson on Unsplash*

Jobs from buildings sector transition

Investments in energy efficiency measures in the buildings sector may generate additional jobs. However, only 4 out of 167 NDCs specify potential job creation linked to a mitigation measure, and only two out of 167 NDCs mention job creation resulting from an adaptation measure, accounting for seven and two measures in total respectively. Ghana mentions generating 1,000 jobs through shifting to clean rural household lighting *(Mitigation)*, and 1,025 jobs through a city-wide climate resilient infrastructure planning *(Adaptation)* (MESTI, 2021).

Country	Type of Document	Quote
Eswatini	First NDC (Update)	Build capacity of youth in climate policy development, accessing climate finance, to engage in income generating climate action including manufacturing of energy efficient technologies, retail and repair services, climate smart livestock practices, urban gardening, rainwater harvesting, sustainable apiculture, greenhouse farming and innovative agriculture technologies, agri-business, agroecological practices, agri-processing, water resource management technologies, water conveyance, waste management, green industrial processes, bottling and water purification and retrofitting buildings.

Table 25: Example from NDCs for measures in Jobs

Buildings in the city of Mbabane, Eswatini | *Photo by S'mile Vilakation on Unsplash*

7 | Summary

Photo by Yana Marudova on Unsplash

KEY FINDINGS

NDCs are the key mechanism of the Paris Agreement. Our analysis found that the vast majority of countries now provide extensive details of their plans to respond to climate change in the buildings sector. This confirms the critical role the built environment plays in cutting emissions and adapting to climate consequences already happening. A wide variety of building components is covered – well beyond building design. They range from building materials to certifications to energy efficiency.

Going forward, an analysis and benchmarking of the NDCs on specific topics may help introduce an even more effective next generation of NDCs on buildings. At the same time, there is a need to quantify targets, and back them up with financing. The sheet of NDCs used for this analysis is available for further research and policy work.

Five takeaways – why do buildings matter for NDCs?

1	168 out of 194 countries (87%), including all EU member states, mention measures for the buildings and construction sector in their NDCs[6].
2	Mitigation is the clear frontrunner in NDCs that address buildings. Of all 167 NDCs analysed, 133 contain mitigation action (80%).
3	The NDCs take an integrated approach when it comes to buildings. 113 NDCs mention building design, flanked by appliances (103), renewable energy (72), building materials (64), improvement in cooking tools (53), and refurbishment of existing buildings (34).
4	Adaptation measures on buildings appear in 88 of all 167 analysed NDCs (53%). While the majority of these NDCs (67) addresses urban planning and building sites, many NDCs (54) also aim to adapt existing and future building structures to climatic changes.
5	And yet, buildings continue to be a sleeping giant. Though the sector is crucial for climate action, only a fraction of NDCs – 30 out of 167, or 18% – specify estimated GHG reduction targets for mitigation, and only 27 NDCs (16%) specify financing requirements for at least one of the mitigation measures.

Differences by region and income

- African countries had by far the highest ratio of NDCs with buildings sector measures (94%). Asia ranks a close second (89%), with the Americas (83%), Oceania (75%), and Europe (56%) – notably without considering the EU member states – following.
- Across all income categories as defined by the World Bank, there is a high percentage of NDCs with buildings-related measures. However, NDCs submitted by high-income countries have a lower share of buildings sector measures (71%), compared to NDCs submitted by middle- or low-income countries (87% and 93%).

[6] Note that the joint EU NDC, and with it all 27 EU member states, have been excluded from the breakdown analysis for the sake of comparability and consistency.

Mitigation – from appliances to building materials

- For mitigation, many NDCs include action on building design and its various components.
- Breakdown according to mitigation categories:
    - **Energy efficiency in design** includes policy interventions such as building codes and certifications. It is the category referenced in most NDCs: 113 out of 167 NDCs (68%). There are 45 NDCs with measures on building codes and 14 with measures on building certification. In addition, there are 54 NDCs with other measures for the promotion of energy efficiency through envelope design, passive design, external shading, insulation, daylighting, or bioclimatic design through other measures.
    - **Energy efficiency in appliances:** 103 out of 167 NDCs mention measures related to energy efficiency in appliances, with 224 measures.
    - **Cooking:** 53 out of 167 NDCs include measures on cooking, with 104 mentions. 4 NDCs have measures on cooking as the only mitigation measures for buildings.
    - **Renewable energy:** With 161 measures in 72 NDCs, renewable energy is the second highest referenced category. This includes onsite power and/or heat generation from renewable energy resources such as solar PV systems and solar-thermal arrays.
    - **Building materials** are less frequently addressed in NDCs. Still, 63 out of all NDCs (38%) mention them, with 99 measures in total. Cement and concrete are the most frequently cited sub-categories, with 37 NDCs referring to 65 measures in cement usage, its production, and available alternatives. The use of bio-based construction materials is not yet well established, as only 5 NDCs refer to the promotion of bio-based alternatives for materials and techniques, with just 6 measures.
    - **Existing buildings:** 34 out of 167 NDCs mention the retrofitting of existing buildings in mitigation measures, with 68 mentions in total.

Adaptation – from building scale to urban scale

- Though mitigation in buildings is the clear frontrunner, adaptation is by no means lagging.
- Concrete adaptation measures for buildings appear in 88 out of 167 NDCs – more than half of all NDCs analysed.
- 67 NDCs (40%) include measures considering future climatic conditions on regional, urban, and building site levels, with overall 104 measures.
- Adaptation of building structures to the impacts of climate change is outlined in 54 NDCs (32%), with 95 measures.

Cross-cutting measures – from generating jobs to finance

- 30 NDCs (18%) provide quantifiable targets for their mitigation objectives, with 103 measures. For adaptation, it is just 1 NDC.
- Funding in the buildings sector is much more common for mitigation than adaptation.
  27 NDCs (16%) specify financing requirements for mitigation, with 101 measures.
  5 NDCs (3%) outline funding schemes for adaptation, with 9 measures.
- Jobs in the buildings sector resulting from mitigation and adaptation measures are referenced in 4 and 2 NDCs respectively.

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