WORLD RESOURCES INSTITUTE

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WORKING PAPER

# STRENGTHENING NATIONALLY DETERMINED CONTRIBUTIONS TO CATALYZE ACTIONS THAT REDUCE SHORT-LIVED CLIMATE POLLUTANTS

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## EXECUTIVE SUMMARY

### Highlights

- Early and ambitious action to reduce short-lived climate pollutants (SLCPs) is essential to achieving the goals of the Paris Agreement and the Sustainable Development Goals. SLCPs include methane, hydrofluorocarbons, black carbon, and tropospheric ozone. Actions to reduce these highly potent pollutants help avoid crossing important thresholds, such as a 1.5°C temperature rise above pre-industrial levels, and potential climatic tipping points, which will affect poor and vulnerable communities first and worst.
- Reducing SLCPs also can deliver multiple benefits for development and human well-being, supporting efforts to improve health, enhance food security, and alleviate poverty.
- Despite the importance of reducing SLCPs, actions to mitigate these potent pollutants were often underrepresented in the first nationally determined contributions (NDCs) submitted by Parties to the Paris Agreement.
- As Parties look toward submitting new or updated NDCs by 2020 under the Paris Agreement's ambition process, countries now have an opportunity to take substantial steps to incorporate and strengthen actions to reduce SLCPs in their NDCs.
- This paper presents a set of options for how targets, policies, and actions on SLCPs can be incorporated in new or updated NDCs to support the achievement of global climate goals and national development objectives.

## CONTENTS



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**Suggested Citation:** Ross, K., T. Damassa, E. Northrop, A. Light, D. Waskow, T. Fransen, and A. Tankou. 2018. "Strengthening Nationally Determined Contributions to Catalyze Actions That Reduce Short-Lived Climate Pollutants. Working Paper. Washington, DC: World Resources Institute. Available online at www.wri.org/publications/reducing-SLCPs.

## About This Paper

This paper aims to help policymakers understand the importance of incorporating and strengthening actions to reduce short-lived climate pollutants (SLCPs) into new or updated nationally determined contributions (NDCs) by 2020, along with the multiple benefits of doing so. It describes how the ambition mechanism established under the Paris Agreement—and, specifically, the communication of new or updated NDCs by 2020—provides a key opportunity to strengthen actions that reduce SLCPs. The paper then explores the extent to which SLCPs are incorporated in Parties' first NDCs, identifying gaps and missed opportunities. Next, it presents a menu of options for including SLCPs in new or updated NDCs, offering policymakers some practical ideas for adding or strengthening targets, policies, and actions on methane, hydrofluorocarbons, and black carbon. Finally, the paper suggests next steps for Parties interested in pursuing ambitious and comprehensive coverage of SLCPs in their new or updated NDCs. The paper includes case studies that show how targeted SLCP interventions in specific sectors can support the achievement of development objectives.

## Protecting the Climate and Supporting Sustainable Development

Early and ambitious action to reduce SLCPs is essential to achieving both the goals of the Paris Agreement and the Sustainable Development Goals (SDGs). SLCPs include methane, hydrofluorocarbons (HFCs), black carbon, and tropospheric ozone. While each SLCP has distinct characteristics, it is important to consider them together as potent contributors to global climate change and threats to development and poverty eradication:

- **SLCPs have a powerful impact on global temperature and the climate system, particularly over short time horizons.** For example, methane and HFCs have significantly higher global warming potentials (GWPs) than carbon dioxide; black carbon can increase atmospheric warming and the melting rate when deposited on ice and snow. Moreover, the impact of these pollutants on global temperature rise can be mitigated in a comparatively short time span, since SLCPs exist for a relatively short period in the atmosphere (a few days to a decade or so). Therefore, removing SLCPs from the atmosphere has an almost immediate effect on limiting global temperature increases. In the near term, taking fast, ambitious action to reduce SLCPs is particularly vital to keeping temperature rise below 1.5°C. As with present-day impacts of climate change, the impacts associated with crossing such thresholds in the future will impact poor and vulnerable communities first and worst, counter to the Paris Agreement's principles of equity and goals for improving human well-being. Risks to women and other groups often marginalized from political and economic decision-making could be particularly acute. Over the long term, reducing SLCPs is an essential complement to rapidly reducing carbon dioxide emissions in order to achieve the Paris Agreement goals of keeping temperature rise well below 2°C, and limiting it to 1.5°C.

- **Reducing SLCPs can also deliver development, economic, health, food security, and other benefits across a range of sectors.** For example, cutting methane emissions reduces levels of tropospheric ozone, which is a health hazard and harms crop yields; reducing black carbon emissions, meanwhile, can prevent premature deaths from pulmonary and respiratory diseases. The health and agriculture gains from reducing SLCP emissions are among the many reasons that instituting mitigation measures for these pollutants can be closely aligned with achieving the 2030 SDGs (Haines et al. 2017) and efforts to reduce poverty (Hottle and Damassa 2018).

- **Importantly, SLCP mitigation actions should be implemented in a rights-based and gender-just way that respects and responds to community needs and capacity constraints.** This is because many SLCP sources (e.g., biomass-based cooking, rice production, and livestock rearing) are often linked to poor and vulnerable populations, including smallholder farmers, many of whom are women.

The mechanism to regularly strengthen climate ambition established under the Paris Agreement offers significant opportunities to address the critical role of SLCPs. Under the Paris Agreement, Parties are requested to communicate new or updated NDCs by 2020. Updating an NDC offers all Parties an opportunity to

- align their short-term mitigation targets, policies, and measures with the Paris Agreement's long-term temperature goals—specifically, the 1.5°C temperature

goal—as well as national socioeconomic goals and sustainable development objectives;

- reflect targets from new political commitments or international agreements that have been reached since initial NDCs were communicated;
- capture new information or areas of untapped mitigation potential that were not realized when first putting together the NDC; and
- factor in advances in innovation and declining costs of emissions mitigation technologies that have occurred since the initial NDCs were developed.

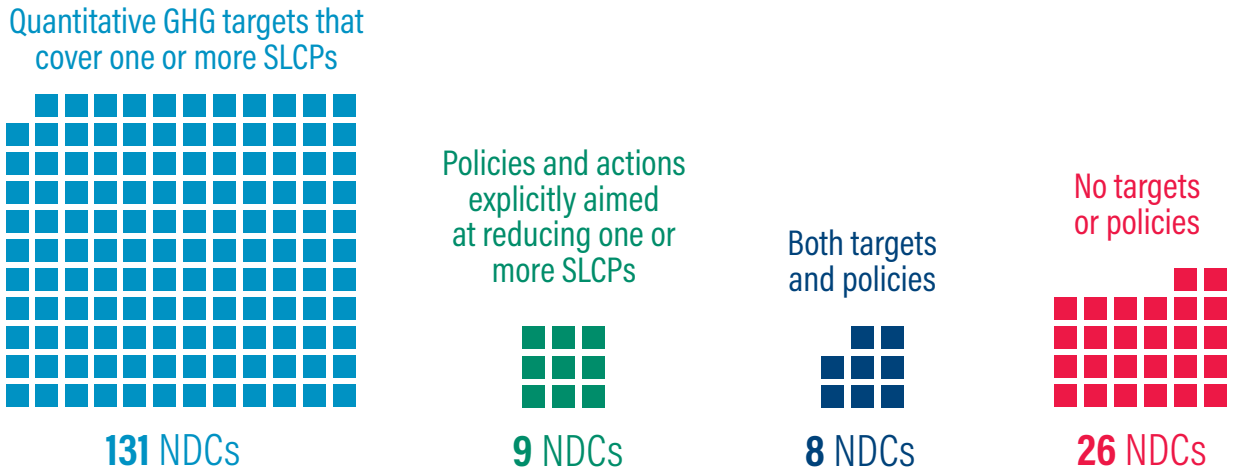
## Coverage of SLCPs in First NDCs

Actions to reduce SLCPs are often underrepresented in the first NDCs that Parties submitted. SLCPs can be covered in an NDC's quantitative greenhouse gas (GHG) emissions reduction target, and be addressed in other ways—for example, through policies and actions directed at specific SLCPs. Only a few NDCs include targets to address specific SLCPs, such as for methane, HFCs, or black carbon. For a range of key sectors (i.e., those that are highly relevant to SLCPs, such as agriculture, waste, transport, cooling, residential cooking, and lighting), the sectoral targets, policies, and actions in many NDCs do not explicitly address SLCPs. Figure ES-1 presents a summary of SLCP coverage in the first 174 NDCs that were communicated to the United Nations Framework Convention on Climate Change (UNFCCC) as of July 2018.

## Strengthening Actions to Reduce SLCPs in New or Updated NDCs

As Parties review their NDCs and identify how they can enhance their mitigation ambition more broadly by 2020, they have a crucial opportunity to add or strengthen SLCP-related targets, policies, and actions. One possibility is for Parties to expand their NDCs' scope and coverage to all GHGs, and thus have their economy-wide targets address all of those gases. Countries also can incorporate emission reduction targets on individual SLCPs. Additionally, SLCP-related policies and actions can be included in NDCs, which would help to limit global climate change and could provide opportunities to achieve development and economic benefits, such as improving air quality, health outcomes for citizens, and agricultural productivity and yields. Examples of these policies and actions are presented in Table ES-1.

Figure ES-1 | **Coverage of SLCPs in First NDCs**




*Sources:* CCAC Scientific Advisory Panel 2016; Climate Watch 2018; author analysis.

Table ES-1 | **Sample Policies and Actions to Strengthen a New or Updated NDC**

| GAS | SECTOR | SAMPLE POLICIES AND ACTIONS |
|---|---|---|
| METHANE | Energy | ■ Promote the capture and utilization of gas and unintended fugitive emissions during oil and gas production<br>■ Reduce leakage from long-distance natural gas transmission pipelines and distribution systems<br>■ Promote pre-mine degasification and recovery and oxidation of methane from ventilation air from coal mines |
| | Agriculture | ■ Promote the intermittent aeration of continuously flooded rice paddies and provide sufficient support for farmers—particularly, smallholder and women farmers—to adopt locally relevant best practices<br>■ Promote reduction of enteric fermentation in livestock through dietary supplements and shifts (e.g., from a cellulosic to a starch-based diet) with sufficient support for farmers, pastoralists, and herders, particularly those in poor and vulnerable communities<br>■ Support farmers to implement livestock anaerobic digestion projects<br>■ Review national dietary guidelines to promote the consumption of less meat and more plant protein |
| | Waste | ■ Recover and utilize methane emitted from waste<br>■ Improve waste and wastewater management/upgrade wastewater treatment with gas recovery and overflow control<br>■ Promote the treatment of biodegradable municipal waste and landfill gas collection<br>■ Reduce food loss and waste |
| HFCs | Economy-wide | ■ Increase the percentage of low-GWP alternatives in economy-wide uses of HFCs, consistent with the HFC phase-down level under the Kigali Amendment to the Montreal Protocol<br>■ Commit to exceeding the country's current Kigali phase-down schedule |
| | Sector-specific | ■ Provide incentives for companies and consumers to replace high GWP HFC commercial equipment or appliances with low-GWP alternatives<br>■ Adopt similar policies to countries/regions that have more stringent F-gas regulations, such as the EU, with or without delay<br>■ Replace high GWP HFCs with low-impact alternatives in specific classes of appliances and equipment, such as using R-290 instead of HFC-410a in room air conditioners<br>■ Introduce a policy requiring all new high-efficiency cooling equipment to use either a low-GWP HFC or an HFC alternative<br>■ Update public procurement processes to transition away from high GWP HFCs |
| BLACK CARBON | Transport | ■ Promote diesel particulate filters for road and off-road vehicles<br>■ Develop electromobility strategies and/or introduce a policy or legal framework (and associated incentives) to replace internal combustion engine vehicles with electric vehicles<br>■ Eliminate high-emitting vehicles from road and off-road transport and/or public transportation<br>■ Develop an integrated and sustainable strategy for transport modes in megacities and/or expand toward a greener and more sustainable public transport system |
| | Agriculture | ■ Ban open field burning of agricultural waste while ensuring sufficient support for farmers—particularly smallholder and women farmers—to transition to more sustainable growing practices |
| | Residential | ■ Replace coal with charcoal briquettes used in cooking and heating stoves in ways that do not cause financial hardship to poor and vulnerable communities and that support, in particular, women's rights<br>■ Introduce clean-burning biomass stoves for cooking and heating in developing countries in ways that respect local preferences, do not cause financial hardship to poor and vulnerable communities, and support, in particular, women's rights |
| | Industry | ■ Replace traditional brick kilns with vertical shaft kilns and Hoffman kilns<br>■ Replace traditional coke ovens with modern recovery ovens, including improving end-of-pipe abatement measures |

*Note:* The policies and actions listed in Table ES-1 may not necessarily enhance the mitigation ambition of a Party's NDC. To constitute enhanced mitigation ambition, the cumulative emissions under the new NDC would need to be lower than under the original NDC. In addition, SLCP mitigation actions should be implemented in a rights-based and gender-just way that respects and responds to community needs and capacity constraints. This is because many SLCP sources (e.g., biomass-based cooking, rice production, and livestock rearing) are often linked to poor and vulnerable populations, including smallholder farmers, many of whom are women.
*Source:* WRI.

Including SLCP-related targets, policies, and actions in new or updated NDCs can help bring countries' actions in line with the Paris Agreement's goals for addressing climate change in the context of sustainable development and efforts to eradicate poverty. It can also help mobilize funding toward SLCP-reduction initiatives and embed other issues, such as air pollution, health, food security, improved livelihoods, and poverty reduction, within the context of addressing climate change. Those Parties that have relatively greater capacity for policy action or are able to provide financial support are likely well-positioned to help elevate the profile of SLCPs in NDCs and drive mitigation actions.

Box ES-1 | **Abbreviations**

| | |
|---|---|
| **AC** | air conditioner |
| **AWD** | alternate wetting and drying |
| **CCAC** | Climate and Clean Air Coalition |
| **CFC** | chlorofluorocarbon |
| **$CO_2$** | carbon dioxide |
| **DALY** | disability-adjusted life year |
| **EEA** | European Environment Agency |
| **EPA** | Environmental Protection Agency |
| **FAO** | Food and Agriculture Organization |
| **GHG** | greenhouse gas |
| **GTP** | Global Temperature Change Potential |
| **GWP** | global warming potential |
| **HCFC** | hydrochlorofluorocarbon |
| **HFC** | hydrofluorocarbon |
| **IEA** | International Energy Agency |
| **LFG** | landfill gas |
| **LPG** | liquefied petroleum gas |
| **NDC** | nationally determined contribution |
| **ODS** | ozone depleting substance |
| **SDG** | Sustainable Development Goal |
| **SLCP** | short-lived climate pollutant |
| **SRI** | system of rice intensification |
| **UNEP** | United Nations Environment Programme |
| **UNFCCC** | United Nations Framework Convention on Climate Change |

# INTRODUCTION

This paper aims to help policymakers understand how targets and policies on highly potent SLCPs can be added to or strengthened in new or updated NDCs by 2020. It also provides examples of the multiple economic and social development benefits that can be reaped by taking action to reduce SLCPs.

The paper's introduction explains why early and ambitious action on SLCPs is essential to reducing near-term global temperature rise and how these actions can deliver a range of additional benefits for human well-being, including improved air quality and enhanced food security. We also describe how the process under the Paris Agreement to enhance ambition—and, specifically, the communication of new or updated NDCs by 2020—provides a key opportunity to strengthen actions to reduce SLCPs.

The first section of the paper provides an overview of SLCP coverage in the first round of NDCs, identifying gaps and missed opportunities. In the second section, we present a menu of options for including SLCPs in new or updated NDCs, offering policymakers some practical ideas for adding or strengthening targets, policies, and actions on methane, HFCs, and black carbon. Here we build on original analysis from the WRI paper "Enhancing NDCs by 2020: Achieving the Goals of the Paris Agreement" (Fransen et al. 2017). This section also includes case studies that show how targeted SLCP interventions in specific sectors can support the achievement of development objectives. Finally, we suggest next steps for countries that are interested in pursuing ambitious and comprehensive coverage of SLCPs in their new or updated NDCs.

## Reducing SLCPs to Protect the Climate and Support Development Objectives

The Paris Agreement establishes landmark goals for tackling climate change, including an aim to hold the global average temperature increase to well below 2°C above preindustrial levels, and pursue efforts to limit it to 1.5°C. To achieve this goal, countries agreed to peak global GHG emissions as soon as possible and undertake rapid reductions thereafter to achieve net-zero GHG emissions in the second half of this century, and to do so on the basis of equity and in the context of sustainable development and efforts to eradicate poverty (UNFCCC 2015, Article 4).

Stringent measures to reduce long-lived GHG emissions, such as carbon dioxide ($CO_2$), are essential for meeting the Paris Agreement's long-term temperature goal. Yet early and ambitious action on a set of powerful, short-lived climate pollutants—including methane, HFCs, black carbon, and tropospheric ozone (see Box 2)—is also essential, particularly to limit near-term temperature rise and avoid related climate change impacts, as well as support sustainable development and poverty alleviation imperatives.

SLCPs have a powerful impact on global temperature and the climate system. For example, methane and HFCs have significantly higher GWP than $CO_2$, particularly over shorter time horizons (see Box 1). Black carbon can increase atmospheric warming and the melting rate when deposited on ice and snow. Moreover, due to their relatively short lifetime in the atmosphere, SLCPs' impact on global temperature rise can be mitigated quickly through ambitious reduction efforts.

## Box 1 | The Global Warming Potential of SLCPs

The choice of time horizon markedly affects the global warming potential (GWP) weighting of short-lived climate pollutants (SLCPs). Although the United Nations Framework Convention on Climate Change (UNFCCC) adopts the 100-year GWP metric, it is only one of several possible emission metrics and time horizons. SLCPs are, by definition, short-lived in the atmosphere. As such, the net effect of the shorter lifetime and higher energy absorption can be reflected in GWPs of shorter time horizons (e.g., 20 years). It is also important to note that the GWP time horizon affects the timing and emphasis placed on abating short- and long-lived gases.

Another metric can be used to compare SLCP emissions' contributions to climate change—Global Temperature Change Potential (GTP). While GWP is based on the cumulative radiative forcing over a particular time horizon, GTP is based on the change in global mean surface temperature at a chosen point in time. Like GWP, GTP values can be used for weighting the emissions to obtain $CO_2$ equivalents.

Table B1 presents the GWP and GTP values for methane and HFCs over different time frames. Black carbon is not included, as there is yet to be scientific consensus on appropriate metrics to equate carbon dioxide and black carbon, since they impact climate in different ways and have very different lifetimes. Ozone is also not included, since the indirect effects of this gas are accounted for in the GWP and GTP of methane.

TABLE B1 | GWP AND GTP WITH AND WITHOUT INCLUSION OF CLIMATE-CARBON FEEDBACKS (CC FB)

| GAS | LIFETIME (YEARS) | CC FB | GWP, 20-YEAR TIME HORIZON | GWP, 100-YEAR TIME HORIZON | GTP, 20-YEAR TIME HORIZON | GTP, 100-YEAR TIME HORIZON |
|---|---|---|---|---|---|---|
| Carbon dioxide | N/A[a] | N/A | 1 | 1 | 1 | 1 |
| Methane | 12.4 | No cc fb | 84 | 28 | 67 | 4 |
| | | With cc fb | 86 | 34 | 70 | 11 |
| HFC-134a | 13.4 | No cc fb | 3710 | 1300 | 3050 | 201 |
| | | With cc fb | 3790 | 1550 | 3170 | 530 |

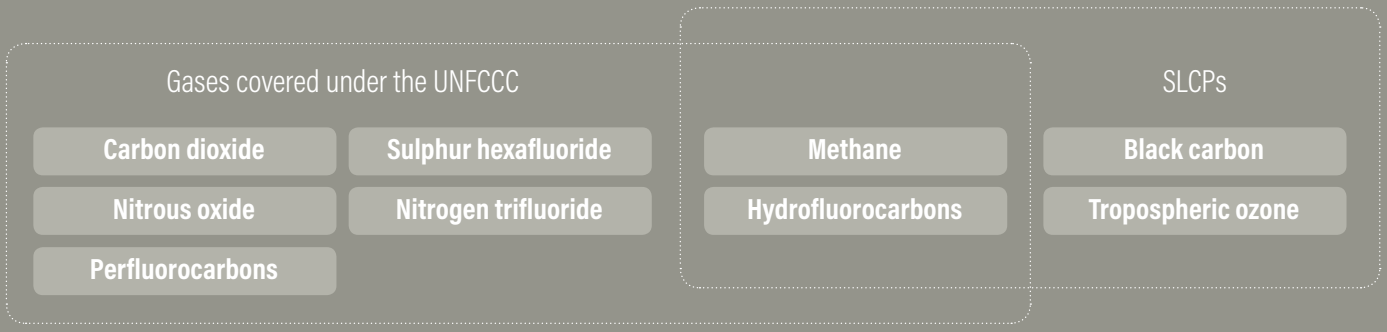
*Note:* a. No single lifetime can be provided for $CO_2$
*Source:* IPCC 2014.

## Box 2 | An Introduction to SLCPs

Short-lived climate pollutants (SLCPs) include methane, black carbon, hydrofluorocarbons (HFCs), and tropospheric ozone. These gases and pollutants have a short lifetime in the atmosphere (a few days to about a decade). SLCPs also compose a significant share of global greenhouse gas (GHG) emissions. In 2014, the latest date for which comprehensive data is available, methane and F-gases (including HFCs) represented around 20 percent of global GHG emissions.

Not all SLCPs are currently covered under the United Nations Framework Convention on Climate Change (UNFCCC) (see Figure B1). Specifically, black carbon and tropospheric ozone are not covered (although ozone is a GHG).

FIGURE B1 | COVERAGE OF GASES UNDER THE UNFCCC




While considered part of a group of pollutants that are atmospherically short-lived yet have a powerful impact on global temperature and the climate system, each SLCP has distinct characteristics and impacts:

- **Methane** is emitted during the production and transport of natural gas, oil, and coal; from livestock and other agricultural practices; and by the decay of organic waste in municipal solid waste landfills and wastewater handling and treatment facilities. Read more about methane in section 3.1.
- **HFCs** are used mainly in air conditioning and refrigeration systems. Read more about HFCs in section 4.1.
- **Black carbon** is a major component of soot and is emitted from incomplete combustion processes; for example, from burning biomass for cookstoves, black coal for electricity and household heating, and diesel in cars and trucks. Read more about black carbon in section 5.1.
- **Tropospheric ozone** is not directly emitted but formed by sunlight-driven oxidation of other agents—these are known as ozone precursors and include methane, carbon monoxide, nitrogen oxides, and non-methane volatile organic compounds.

*Source:* CCAC n.d.a, n.d.b, n.d.c.

FIGURE B2 | SLCP SOURCES, IMPACTS, AND LIFETIMES

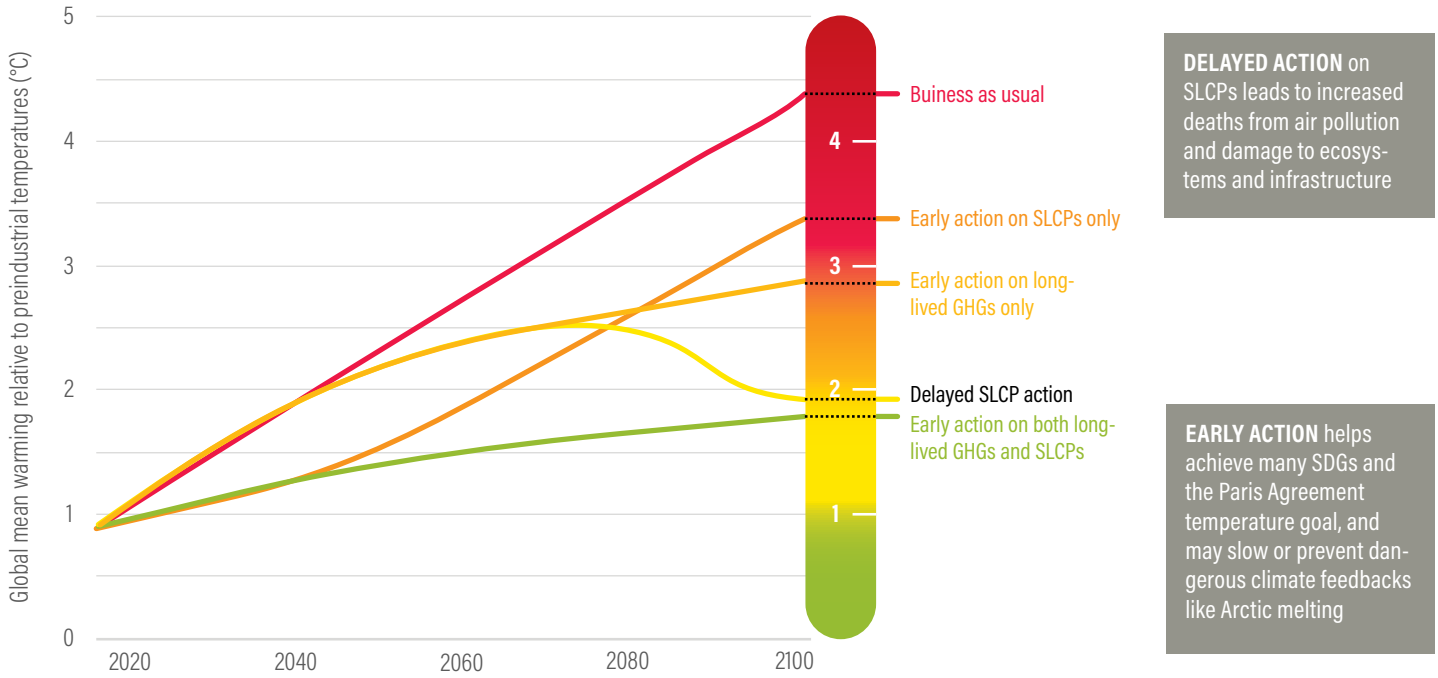

*Source:* CCAC n.d.d.

Without significant reductions in SLCPs, along with reductions in $CO_2$ emissions, global temperature increases are likely to exceed 1.5°C during the 2030s and exceed 2°C by mid-century (Shindell et al. 2017). As Figure 1 shows, strong action to reduce SLCPs is particularly vital to keeping temperature rise below 1.5°C, and over the long term is an essential complement to reducing $CO_2$ emissions. As a result, it is clear that, when taking both near- and long-term temperature trajectories into account, action on SLCPs will be critically important alongside reductions in $CO_2$ emissions.

While some climate models suggest it is possible to exceed the 1.5°C and 2°C temperature thresholds and then bring the global temperature back down again by 2100 (IPCC 2014), this is risky. This type of scenario is known as "overshoot," where atmospheric concentrations of GHGs and associated temperature increases temporarily exceed target levels before declining to stabilization (Huntingford and Lowe 2007). These overshoot scenarios come with the inherent risk that the climate may enter a state from which recovery becomes impossible (IPCC 2013). For example, melting of permafrost due to global warming may release significant quantities of methane, compounding the effect of the emissions already in the atmosphere. Moreover, continued increases in average temperatures and the potential passing of "tipping point" thresholds would likely impact poor and vulnerable communities first and worst, counter to the Paris Agreement's equity principles and goals for improving human well-being. Risks to women and other groups often marginalized in political and economic decision-making could be particularly acute. There is thus an imperative to ensure that those that have done the least to contribute to climate change do not face even greater challenges in escaping poverty, and that gender-based and other inequalities are comprehensively addressed as a component of climate change mitigation actions, including reductions of SLCPs.

Fortunately, measures to reduce SLCPs are often accessible and cost-effective (CCAC n.d.e). It is estimated that these measures, if implemented quickly, can slow the increase in global warming by as much as 0.6°C by 2050 (CCAC n.d.e). Moreover, sustained SLCP reduction strategies can help limit long-term warming when combined with the necessary steep reductions in $CO_2$ (UNEP 2017).

Figure 1 | **Mitigation Pathways for Early and Delayed Action on SLCPs and Long-Lived GHGs**




*Source:* Based on authors' personal communication with Drew Shindell, Nicholas School of the Environment, Duke University, Durham, North Carolina, 2018.

At the same time, robust mitigation action on SLCPs can also provide benefits for development. For example, cutting methane emissions reduces levels of tropospheric ozone, which is a health hazard and harms crop yields; meanwhile, reducing black carbon emissions can prevent premature deaths from pulmonary and respiratory diseases. At a global level, it is estimated that SLCP reduction measures can prevent as much as 52 million tonnes of crop losses per year and avoid an estimated 2.4 million premature deaths from outdoor air pollution annually by 2030 (CCAC n.d.e). The health and agriculture gains from reducing SLCP emissions are among the many reasons that instituting mitigation measures for these gases and pollutants can be closely aligned with achieving the 2030 SDGs (Haines et al. 2017) and with efforts to reduce poverty (Hottle and Damassa 2018). These SLCP mitigation actions should be implemented in a rights-based and gender-just way that respects and responds to community needs and capacity constraints, particularly as many SLCP sources (e.g., biomass-based cooking, rice production, and livestock rearing) are often linked to poor and vulnerable populations, including smallholder farmers, many of whom are women.

This paper—through several boxes in sections 3, 4, and 5—will explore opportunities to effectively and equitably reduce SLCPs to benefit air quality, agricultural productivity and livelihoods, gender justice, and waste management thereby helping to achieve the SDGs by 2030 (although this paper does not have an explicit focus on the SDGs).

## Communicating New or Updated NDCs by 2020: Supporting the Paris Agreement's "Arc of Ambition"

This section will look at the role NDCs play in national and international climate policy, providing an overview on why NDCs represent an important means of driving action to reduce SLCPs.

All Parties to the Paris Agreement first submitted an "intended" NDC ahead of the 2015 United Nations Climate Change Conference (COP21), setting out their country's contribution to climate action. The NDCs were "intended" because the goals and specific terms of the Paris Agreement were not yet agreed. Now that the Paris Agreement is in force, the NDCs are no longer "intended" but rather constitute the targets, policies, actions, and measures that Parties have agreed to implement domestically.

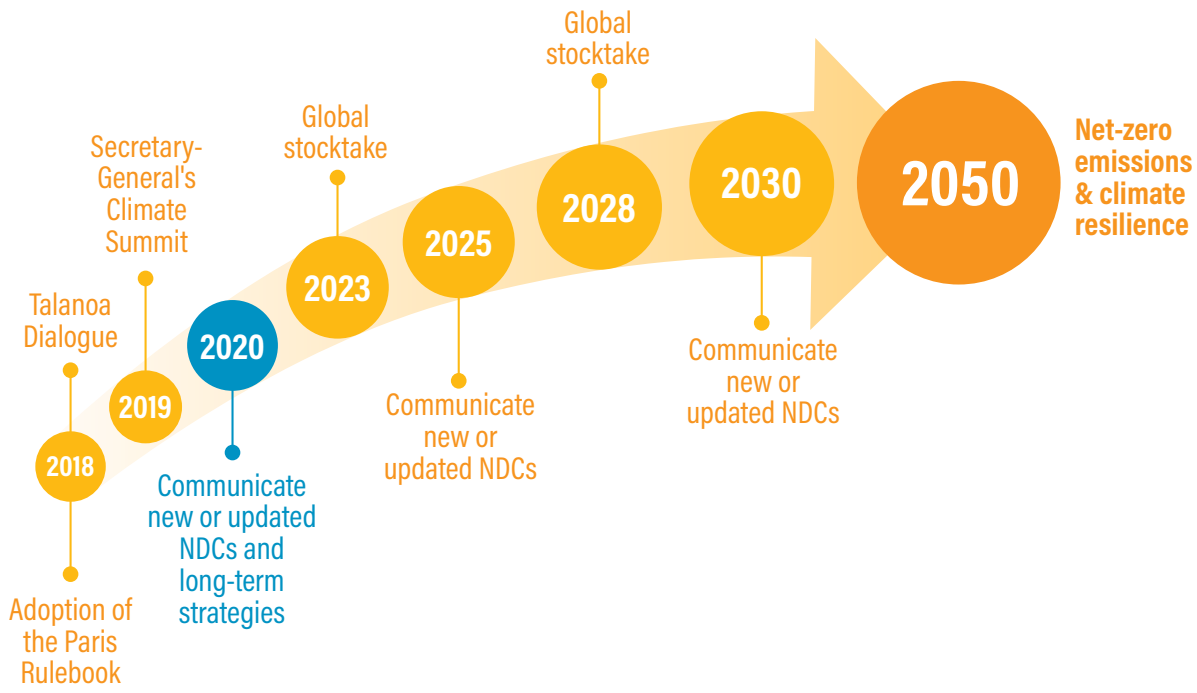
Critically, NDCs can be instrumental in driving domestic policy agendas and priorities. They can serve as roadmaps for finance and implementation, helping to attract the scale and type of funding needed to support climate action. These contributions can also ensure that short-term decision-making and budget allocation align with a country's long-term goals and strategies, including its broader development and economic objectives. NDCs can also support policy coherence across government and strengthen multistakeholder engagement to ensure ownership and buy-in for successful implementation.

To help mobilize action, the Paris Agreement built in regular periods of reflection and review at five-year intervals. This provides all Parties with the opportunity to consider whether their NDC continues to reflect not only their highest level of ambition in light of the Paris Agreement's goals but also whether it accurately reflects domestic priorities and long-term objectives in terms of decarbonization, sustainable development, and social and economic growth. While Parties can theoretically update their NDCs at any time (and several have already done so), the decision text that accompanies the Paris Agreement identifies 2020 as a key moment to communicate new[1] or updated[2] NDCs (decision 1/CP.21, paragraphs 23 and 24). This provides a critical opportunity for each country to reflect on what has changed since its NDC was first developed and ensure the NDC is fit for purpose and meets its own objectives.

The process of progression in action and ambition over time (see Figure 2) can enable countries to achieve the Paris Agreement's long-term goals and to meet the UNFCCC's ultimate objective—to stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (UNFCCC 2015).

In complement to the NDCs, the Paris Agreement and accompanying decision text invites Parties to develop mid-century, long-term, low-GHG-emission development strategies by 2020. These strategies underpin the transformative potential of the Paris Agreement, offering Parties a unique opportunity to develop a farsighted approach to development and climate—one that builds on the development gains of previous decades and aspirations for the next. Many Parties may develop and submit their long-term strategies prior to the communication of new NDCs, and those strategies can then very helpfully guide and inform the update of future NDCs.

Figure 2 | **The Arc of Ambition Established by the Paris Agreement**




*Source:* Adapted from Fransen et al. 2017.

Given that many Parties are in the midst of implementing their current NDCs, it is reasonable to ask why they would consider communicating a new or updated NDC by 2020. There are a number of answers to this question.

First, updating an NDC offers Parties an opportunity to align their short-term mitigation targets, policies, and measures with the Paris Agreement's long-term temperature goals—specifically, the 1.5°C goal—in a way that is consistent with their respective capacities and historic responsibility. The goal of "pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels" (UNFCCC 2015) was agreed to when the Paris Agreement was adopted in December 2015, after most Parties had already communicated their initial NDCs. Current efforts detailed in the first round of NDCs put us on path for a world that warms by 2.7–3.7°C (median chance) over preindustrial levels over the next century, depending on modeling assumptions (Levin and Fransen 2015). Parties can also ensure alignment with their national sustainable development strategies and objectives. Aligning the targets and actions under the NDC with socioeconomic goals and objectives ensures that a country is on a development pathway that is consistent with being low-emissions in the long-term, avoids emissions lock-in and stranded assets, and can maximize investment opportunities to pursue a low-cost transition toward a low-emissions economy.

Second, Parties can reflect targets from new political commitments or international agreements that have been reached since initial NDCs were communicated. For example, the Kigali Amendment to the Montreal Protocol was ratified in November 2017;[3] in December 2017, 16 countries committed to reaching carbon neutrality by 2050 (One Planet Summit 2017);[4] and in April 2018, the International Maritime Organization approved the organization's first-ever climate change strategy, which establishes quantitative GHG emission reduction targets for 2050 (IMO 2018).[5]

Third, Parties can capture new information or areas of untapped mitigation potential that were not realized when first putting together the NDC. Many countries have begun to implement the policies and actions that underpin their

NDCs. Through this process of implementation, some Parties are uncovering new information (better GHG inventory data, GHG emission projections, etc.) and areas of untapped mitigation potential.

Finally, Parties can factor in advances in innovation and declining costs of emissions mitigation technologies that have occurred since the initial NDCs were developed.

SLCP reduction can play a particularly valuable role in avoiding critical temperature thresholds, especially those that eclipse 1.5°C in the near term, while supporting national development agendas. Therefore, it is critical to advance action on SLCPs in new or updated NDCs to achieve the following:

- Help bring countries' policies and actions in line with the Paris Agreement's purpose and goals while delivering on sustainable development objectives. Those Parties that have relatively greater capacity for policy action or are able to provide financial support are likely well-positioned to help elevate the profile of SLCPs in NDCs and drive mitigation actions.
- Help to mobilize funding for SLCP reduction initiatives. As noted earlier in this section, NDCs are increasingly used as guides to prioritize public and private climate finance. Including SLCPs in new or updated NDCs offers developing countries in particular an opportunity to leverage finance at scale and facilitate access to financing for SLCP reduction projects as part of their broader sustainable development agendas.
- Embed other issues, such as air pollution, health, food security, improved livelihoods, and poverty reduction, in the context of attending to climate change. This serves to make addressing the climate challenge more local, resonant, and real for citizens and provides additional political support for those leaders who want to demonstrate more ambition on climate and development action. These linkages can reinforce the connection to many SDGs, which also makes action more immediate and practical.

Finally, while SLCPs themselves last only a short while in the atmosphere, the infrastructure that produces them can persist for decades. Net zero emissions levels are needed in the second half of the century to achieve the Paris goals, and the more SLCP emissions that persist, the greater the need will be for negative emissions. It is therefore important to view SLCPs in a long-term as well as a near-term context. Long-term strategies provide an opportunity to do just this.

While a full examination of how SLCPs can factor into long-term strategies is outside the scope of this paper, it is important to note that situating SLCPs in the context of long-term strategies can play an important role in supporting—and linking—countries' climate and development agendas.

## COVERAGE OF SLCPs IN FIRST NDCs

As noted earlier, NDCs represent a Party's contribution toward achieving the collective global goals of the Paris Agreement. NDCs are, by definition, "nationally determined" and take on various forms. The coverage of SLCPs in first NDCs is therefore unsurprisingly diverse.

This section summarizes the extent to which SLCPs are included in countries' first NDCs, based on information from Climate Watch (2018) and the Climate and Clean Air Coalition's (CCAC) Scientific Advisory Panel (2016). We do not assess the ambition of actions taken to reduce SLCPs in these first NDCs; rather, this is a simple mapping exercise that provides a high-level overview of the different ways that SLCPs have been covered. We also do not assess the barriers that countries may have faced when including SLCPs in first NDCs.

As of July 2018, 174 NDCs had been communicated to the UNFCCC. In an NDC, SLCPs can be covered in a quantitative GHG emissions reduction target, and be addressed in other ways—for example, through the policies and actions directed toward specific SLCPs. For example, Canada's NDC states that the country is developing regulations to reduce methane emissions from the oil and gas sector, including offshore activities, by 40–45 percent by 2025; China sets a quantitative emissions reduction target that covers $CO_2$ only, but supplies additional details about policies it plans to undertake to reduce HFCs and coal bed methane emissions.

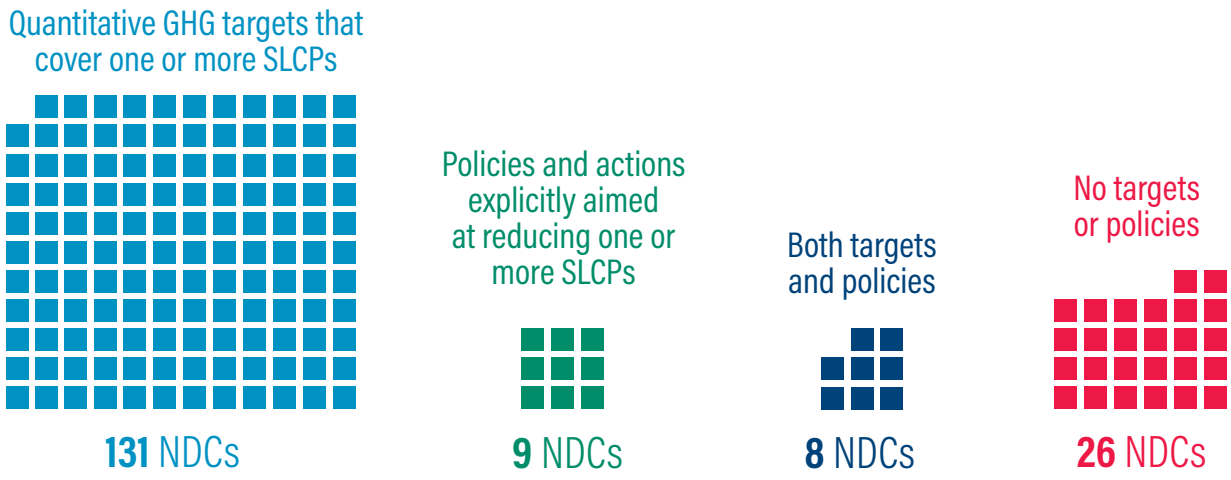
An overview of SLCP coverage in the first NDCs is presented in Table 1 and Figure 3, with full details provided in Appendix A.

Table 1 | **Coverage of SLCPs in First NDCs**

| SLCPS INCLUDED IN AN NDC'S COVERAGE OF GASES AND POLLUTANTS | | NDC |
|---|---|---|
| **139 NDCs** include SLCPs in the coverage of gases and pollutants | **1** NDC covers three SLCPs: methane, HFCs and black carbon | Mexico |
| | **69** NDCs cover two SLCPs: methane and HFCs | Antigua and Barbuda; Argentina; Armenia; Australia; Azerbaijan; Bangladesh; Barbados; Belarus; Belgium; Brazil; Bulgaria; Canada; Chile; Colombia; Costa Rica; Croatia; Cyprus; Czech Republic; Democratic Republic of Korea; Denmark; Dominica; Estonia; Eswatini (formerly Swaziland); European Union; Finland; France; Gambia; Georgia; Germany; Ghana; Greece; Hungary; Iceland; Ireland; Israel; Italy; Japan; Jordan; Kazakhstan; Latvia; Liechtenstein; Luxembourg; Lithuania; Malta; Mauritius; Monaco; Montenegro; Netherlands; New Zealand; Norway; Poland; Portugal; Republic of Korea; Republic of Moldova; Romania; Serbia; Singapore; Slovakia; Slovenia; South Africa; Spain; Saint Vincent and the Grenadines; Sweden; Switzerland; Thailand; Ukraine; United Kingdom; United States of America; Vietnam. |
| | **69** NDCs cover methane only | Afghanistan; Algeria; Andorra; Angola; Bahamas; Benin; Bhutan; Bosnia and Herzegovina; Botswana; Burkina Faso; Burundi; Cabo Verde; Cambodia; Cameroon; Central African Republic; Chad; Comoros; Congo; Cuba; Côte D'Ivoire; Democratic Republic of the Congo; Djibouti; Dominican Republic; Eritrea; Ethiopia; Gabon; Grenada; Guatemala; Haiti; Honduras; Indonesia; Jamaica; Kenya; Lesotho; Madagascar; Malawi; Malaysia; Maldives; Mali; Marshall Islands; Mauritania; Mongolia; Morocco; Mozambique; Namibia; Niger; Nigeria; Niue; Palau; Papua New Guinea; Paraguay; Peru; Rwanda; Saint Lucia; São Tome and Principe; Seychelles; Sierra Leone; Sri Lanka; Sudan; Tajikistan; Togo; Tonga; Trinidad and Tobago; Tunisia; Turkmenistan; Tuvalu; Uruguay; Zambia; Zimbabwe. |
| **35 NDCs** do not include SLCPs in the coverage of gases and pollutants or do not specify the gas coverage of their NDC | | Albania; Bahrain; Belize; Bolivia; China; Cook Islands; Egypt; El Salvador; Fiji; Guinea; Guyana; India; Kiribati; Kuwait; Federated States of Micronesia; Lao People's Democratic Republic; Myanmar; Nauru; Nepal; Pakistan; Panama; Qatar; Saint Kitts and Nevis; Samoa; Saudi Arabia; Somalia; Solomon Islands; State of Palestine; the Former Yugoslav Republic of Macedonia; Timor-Leste; United Republic of Tanzania; Uganda; United Arab Emirates; Vanuatu; Venezuela. |

*Sources:* Climate Watch 2018; CCAC Scientific Advisory Panel 2016; author analysis.

Figure 3 | **Coverage of SLCPs in First NDCs**




*Sources:* CCAC Scientific Advisory Panel 2016; Climate Watch 2018; author analysis.

As presented above, Parties' NDCs cover SLCPs in different ways—and, indeed, NDCs must be relevant to national circumstances and priorities. For economy-wide targets that are set in terms of a single metric like $CO_2e$ (which covers methane and HFCs), a country can pursue a flexible mitigation pathway toward climate goals. This means that countries can take advantage of emission reduction opportunities at the lowest cost, regardless of which gases are abated. In other words, an economy-wide target does not necessarily stipulate a given level of abatement from an individual gas; it only indicates that abatement of all GHGs can count toward the target. That said, countries should remain cognizant of the near-term benefits of reducing SLCPs. Therefore, targets and policies focused on individual SLCPs can provide an additional level of detail and accountability for specific actions to reduce methane, HFCs, and black carbon.

Ultimately, including SLCPs in NDCs—whether through quantitative targets, policies, and actions, or a combination of these—can offer all Parties an opportunity to be more ambitious with climate mitigation while capturing health and other development benefits by including these substances, particularly when poor and vulnerable communities are supported in adopting new SLCP-reduction technologies and practices. Moreover, even in cases where NDCs do cover SLCPs in some fashion, there might be opportunity to go further. Just because SLCPs are included in the first NDC does not necessarily mean that their mitigation potential and associated development benefits are being fully exploited.

The following sections (3–5) present practical ideas—a "menu of options"—for adding or strengthening targets, policies, and actions related to three SLCPs—methane, HFCs, and black carbon. The fourth SLCP, tropospheric ozone, is not addressed here, as this gas is not directly emitted and therefore not directly mitigated (see Box 2 for more information).

The individual options presented in the following sections are not mutually exclusive—it may be appropriate to pursue multiple options, depending on national circumstances, domestic priorities, respective capabilities, and international support, including financing.

# STRENGTHENING ACTION ON METHANE

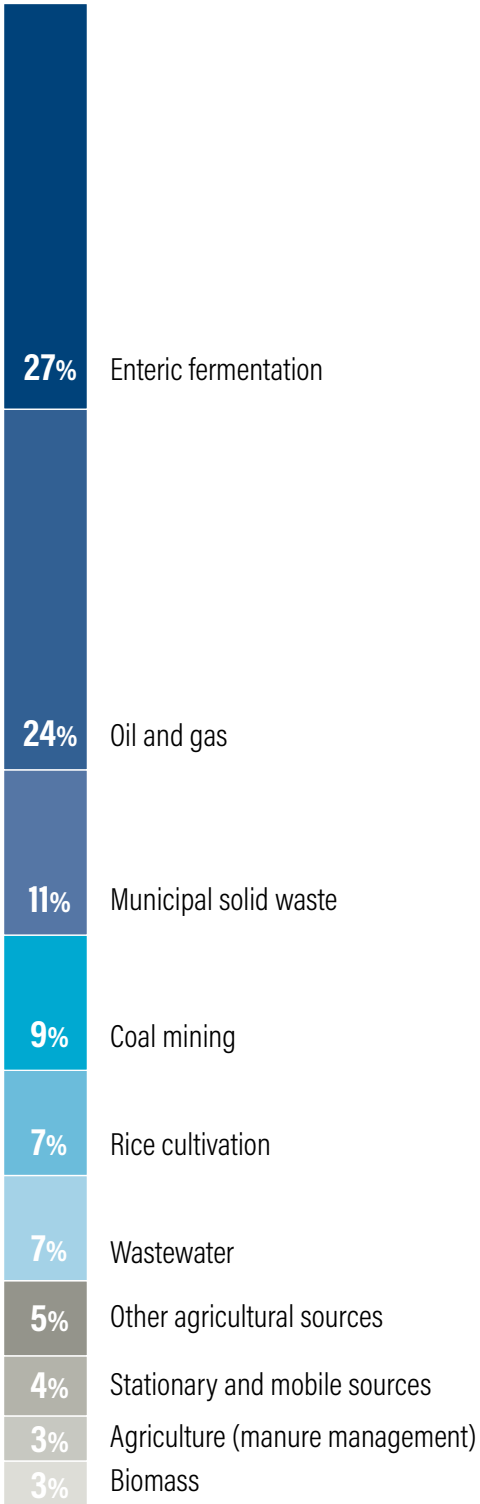
## Emission Sources, Mitigation Potential, and Abatement Opportunities

Methane is emitted from both anthropogenic (estimated around 60 percent) and biogenic (the remaining 40 percent) sources (IEA 2017; IPCC 2013). The largest source of anthropogenic methane emissions is agriculture (farming and livestock), responsible for around a quarter of the total, closely followed by the energy sector, which includes emissions from the production, transportation, and use of fossil fuels (natural gas, oil, and coal), and finally, the decay of organic waste in municipal solid waste landfills and wastewater handling and treatment facilities. The predominant biogenic source is wetlands (Zhang et al. 2017). Figure 4 presents projected global anthropogenic methane emissions by source in 2020.

As noted in Box 2, methane's lifetime in the atmosphere is much shorter than $CO_2$—approximately 12.4 years—but is more efficient at trapping radiation than $CO_2$. The comparative impact of methane is more than 28–34 times greater than $CO_2$ over a 100-year period, and 84–86 times higher when compared over a 20-year period (IPCC 2013).[6] By 2050, methane is anticipated to represent the largest mitigation potential of all the short-lived pollutants (IPCC 2013).

The amount of methane in the atmosphere has more than doubled since preindustrial times, causing about one-third of global warming (IPCC 2013). In 2014, global methane emissions totaled approximately 7.5 $GtCO_2e$[7] (the most recent year for which globally comparable data is available) (CAIT 2018), and are projected to keep rising due to the continued production, processing, and distribution of fossil fuels, including oil, gas, and coal; the expansion of agricultural practices; and increasing consumption of beef and dairy (Worden et al. 2017). Furthermore, recent analysis indicates that climate change is starting to accelerate the processes that release methane into the atmosphere (largely those linked to agriculture and wetlands), potentially triggering a troubling positive feedback loop in which further warming could produce more methane and yet more warming and melting permafrost (Pearce 2016; Zhang et al. 2017).

Figure 4 | **Estimated Global Anthropogenic Methane Emissions by Source in 2020**




*Source:* GMI n.d.

Methane is also the largest precursor to background tropospheric ozone, and its growth since preindustrial times has therefore also contributed to a global increase in ozone (UNEP and WMO 2011). This also means that methane has an indirect impact on air quality, with serious implications for human health as well as crop yields, which in turn can negatively affect food security and livelihoods, particularly those of subsistence farmers. On a global level, methane mitigation will significantly reduce tropospheric ozone formation.

Technical potential exists to reduce methane emissions from anthropogenic sources to approximately 5.5 $GtCO_2e$ in 2030 (UNEP 2017). This mitigation potential translates to 0.09 ± 0.03°C less warming relative to the International Energy Agency's (IEA) current policy scenario[8] for 2030, and to 0.30 ± 0.12°C less warming in 2050 (UNEP 2017). Expert assessments suggest that methane emissions from the distribution of gas and the production and transmission of oil and gas can be reduced by around 1.78 $GtCO_2e$/year in 2030 by implementing measures for recovering and utilizing vented gas and reducing leakages. Reductions of around 0.41 $GtCO_2e$/year in 2030 can be achieved in coal mining through pre-mining degasification measures and the installation of ventilation air oxidizers (UNEP 2017). In the waste sector, methane is the dominant greenhouse gas (90 percent of total emissions) (UNEP 2017). The Environmental Protection Agency (EPA 2016) estimates that landfill gas recovery can reduce emissions by 0.4 $GtCO_2e$/year in 2030.

In terms of agriculture, the United Nations Environmental Programme (UNEP) Gap Report (2017) does not estimate abatement potential for methane specifically, but does highlight that mitigation potential is more limited for emissions from enteric fermentation and manure management, which directly result in methane emissions and make up a significant part of total GHG emissions from agriculture. The most cost-effective potential mitigations have been identified as waste and manure digesters, antimethanogens (vaccines that suppress methane production in the rumen), intensive grazing, and improved feed conversion and propionate precursors (animal feed additions that convert more of the produced hydrogen into propionate instead of methane) (UNEP 2017). Implementing such solutions would likely require a thorough assessment of local contexts and needs, as livestock management practices vary considerably between and within countries. Certain strategies may also not be readily accessible to all livestock managers due to cost or technology access con-

straints. However, on the demand side, there is significant potential. Shifting diets from animal to plant protein is increasingly seen as a viable mitigation method, particularly in Western cultures where calorie intake from animal protein exceeds daily protein requirements (Ranganathan et al. 2016). As a result of less agricultural demand from less land- and resource-intensive diets, it is estimated that total GHG emissions could decrease by 0.37 to 1.37 $GtCO_2e$/year in 2030 (Stehfest et al. 2013).

North America and Europe combined represented nearly one-third of global methane emissions in 2010, predominantly based on emissions from oil and gas, landfills, and waste (UNEP 2017). The greatest regional abatement potential exists in regions that have a high share of emissions in the energy and waste sectors (compared to other sectors). For instance, in the United States, this is in oil and gas (EPA 2018); for China, capturing ventilation air methane from coal mines represents the key mitigation opportunity (UNEP 2017). In Europe and Brazil, reduction potentials are smaller, as agriculture is the dominant methane source (UNEP 2017).

A key reason to tackle methane emissions is that unlike other GHGs, if captured from its emission source, methane can be converted to usable energy, which provides a unique opportunity to increase the available energy supply. Particularly if the value of the methane and the energy it produces is greater than the cost of the technology to capture it, it would be possible to avoid the emissions of a potent GHG while simultaneously generating additional revenues, which in turn could be used to support other government priorities such as health, education, and rural development.

It is for this reason that the IEA has singled out methane as a central issue for oil and gas operations, concluding that global methane emissions could be reduced by 75 percent relative to 2015 levels using available technologies (based on technical feasibility)—and that around 40–50 percent of those reductions could be realized at zero net cost. Just implementing the zero net cost reductions could have the same climate impact in 2100 as immediately closing all the coal plants in China (IEA 2017). However, while methane capture is an effective and viable solution to reducing methane emissions from oil and gas operations in the short term, it does not address the longer-term viability of oil and gas in a global economy that must rapidly reduce GHG emissions in order the meet the goals of the Paris Agreement.

## Coverage of Methane in First Round NDCs

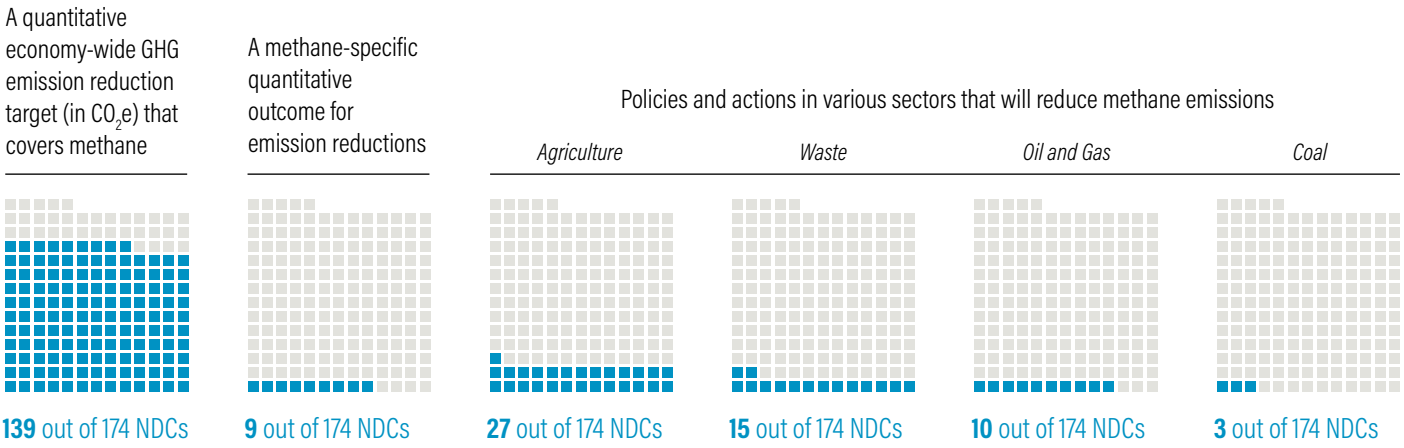
The first round NDCs include methane in three different ways. One is by including it in the scope of gases covered by the NDC and hence by a quantitative economy-wide emission reduction target that covers all GHGs. These economy-wide targets are typically set using a single metric in terms of carbon dioxide equivalent ($CO_2e$) and applying a GWP over a 100-year time frame. Here is an example from Canada's NDC: "Canada is committed to reduce greenhouse gas emissions by 30 percent below 2005 levels by 2030." This target is "economy-wide" and "covers 100 percent of the Canadian GHG inventory" and all seven gases covered under the UNFCCC (i.e., including methane).

The second way countries have included methane in their NDCs is by setting a methane-specific quantitative outcome for emission reductions. Here is an example from Rwanda's NDC: "With respect to the urban waste management, by 2030, Rwanda is committed to achieve the following: Development and implementation of landfill regulations in all urban areas, extraction and utilization of landfill gas (LFG) for power generation; approximately 586,000 tCO2e will be reduced from this action."

The third way countries have included methane in their NDCs is by listing policies and actions in various sectors that will reduce methane emissions. Here is an example from Pakistan's NDC, where the country lists mitigation options in the agriculture sector: "Introduce feedstock mixes, dietary oils, and additives for livestock, to reduce methane production from enteric fermentation."

The number of NDCs that have included methane in these three ways are presented in Figure 5, with full details and NDC excerpts presented in Appendix A.

Figure 5 | **Coverage of Methane in First Round NDCs**




*Sources:* CCAC Scientific Advisory Panel 2016; Climate Watch 2018; author analysis.

## Options for Strengthening Action on Methane in New or Updated NDCs

As countries look toward updating their NDCs, there are several options to include stronger actions on methane. These options are adapted from the menu presented in the WRI working paper, "Enhancing NDCs by 2020: Achieving the Goals of the Paris Agreement" (Fransen et al. 2017).

Table 2 identifies relevant options for including stronger action on methane in updated NDCs according to source or sector. This includes sector- or source-based targets, or commitments to introduce specific policies or incentive-specific measures through relevant policy instruments such as subsidies. See Boxes 3, 4, and 5 for examples of how to put these ideas into practice in the waste and agriculture (livestock and rice) sectors.

As with action on all gases, in addition to sector- or source-based action, there are economy-wide means to strengthen action on methane in NDCs:

- Include methane in the NDC's coverage of gases and hence its overall GHG target. For example, an existing NDC target that covers only $CO_2$ could be expanded to an economy-wide target inclusive of all UNFCCC gases (see section 3 for more information) or a specific economy-wide methane target could be added to the NDC.
- Specify that methane is included within an existing economy-wide target to enhance the clarity, transparency, and understanding of the NDC. For example, an existing GHG target may not specify which gases it covers. This could be updated to specify that methane is included with the target (in addition to specifying the other GHGs included).

Table 2 | **Sample Targets, Policies, and Measures to Strengthen Action on Methane, by Source/Sector**

| SECTOR | EXAMPLES OF TARGETS, POLICIES, AND MEASURES TO INCLUDE OR STRENGTHEN IN A NEW OR UPDATED NDC | POTENTIAL DEVELOPMENT BENEFITS |
|---|---|---|
| **Oil and gas** | ■ Target to reduce a set percentage or tonnage of methane emissions according to a set baseline from the oil and gas sector by 2030.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to promote capture and utilization of gas and unintended fugitive emissions during oil and gas production.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to reduce leakage from long-distance natural gas transmission pipelines and distribution systems.<br>■ Note: any targets, policies, or measures to reduce methane emissions from the oil and gas sector should be undertaken as part of a broader plan to ultimately phase out oil and gas production and consumption in line with pathways to meet the goals of the Paris Agreement, as well as other considerations, such as historic responsibility and opportunities for economic diversification. | ■ Contribute to reducing tropospheric (ground level) ozone. Ozone has been linked to premature mortality and asthma. In addition to its effects on human health, ozone can significantly impact vegetation and decrease the productivity of some crops.<br>■ Economic benefit from capture and sale or use of methane emissions for energy generation.<br>■ Contribute to the achievement of SDG 3.9 (by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination). |
| **Coal** | ■ Target to reduce a set percentage or tonnage of methane emissions according to a set baseline from the coal sector by 2030.<br>■ Commitment to introduce a policy or legal framework to promote pre-mine degasification and recovery, and oxidation of methane from ventilation air from coal mines.<br>■ Note: any targets, policies, or measures to reduce methane emissions from the coal sector should be undertaken as part of a broader plan to phase out coal production and consumption in line with pathways to meet the goals of the Paris Agreement. | |
| **Agriculture (including livestock)** | ■ Target to reduce a set percentage or tonnage of methane emissions according to a set baseline from the agriculture sector by 2030.<br>■ Commitment to introduce policies and/or associated incentives that promote the intermittent aeration of continuously flooded rice paddies and provide sufficient support for farmers—particularly, smallholder and women farmers—to adopt locally relevant best practices.<br>■ Commitment to introduce policies and/or associated incentives that promote reduction of enteric fermentation in livestock through dietary supplements and shifts (e.g., from a cellulosic to a starch-based diet) with sufficient support for farmers, pastoralists, and herders, particularly those in poor and vulnerable communities.<br>■ Commitment to introduce policies and/or associated incentives and provide sufficient support for farmers to implement livestock anaerobic digestion projects.<br>■ Commitment to review national dietary guidelines to promote the consumption of less meat and more plant protein. | ■ Intermittent aeration of rice paddies reduces water demand and can yield higher economic outputs for farmers.<br>■ Measures to mitigate enteric fermentation would not only reduce emissions but may also raise animal productivity by increasing digestive efficiency.<br>■ Anaerobic digestion projects can be a source of additional income and/or energy through biogas generation.<br>■ Health benefits associated with eating less meat and more plant-based proteins.<br>■ Contribute to the achievement of SDG 2.3 (by 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists, and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and nonfarm employment). |

Table 2 | **Sample Targets, Policies, and Measures to Strengthen Action on Methane, by Source/Sector (continued)**

| SECTOR | EXAMPLES OF TARGETS, POLICIES, AND MEASURES TO INCLUDE OR STRENGTHEN IN A NEW OR UPDATED NDC | POTENTIAL DEVELOPMENT BENEFITS |
|---|---|---|
| **Waste (solid waste and wastewater)** | ■ Target to reduce a set percentage or tonnage of methane emissions according to a set baseline from the waste sector by 2030.<br>■ Targets to achieve a set percentage of reduction in the level of organic waste disposed of according to a set baseline from the waste sector by 2030.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to recover and utilize methane emitted from waste.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to improve waste and wastewater management/upgrade wastewater treatment with gas recovery and overflow control.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to promote the treatment of biodegradable municipal waste and landfill gas collection.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to reduce food loss and waste. | ■ Economic benefit from capture and sale or use of methane emissions for energy generation.<br>■ Contribute to the achievement of SDG 12.3 (by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses).<br>■ Contribute to the achievement of SDG 12.4 (by 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed upon international frameworks, and significantly reduce their release to air, water, and soil in order to minimize their adverse impacts on human health and the environment).<br>■ Contribute to the achievement of SDG 12.5 (by 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse). |

*Note:* These options may not necessarily enhance the mitigation ambition of a Party's NDC. To constitute enhanced mitigation ambition, the cumulative emissions under the new NDC would need to be lower than under the original NDC. Importantly, many methane-related policies and actions also reduce carbon dioxide emissions, and vice versa. To constitute enhanced mitigation ambition in the new NDC, the emissions reductions associated with the newly added/strengthened methane-related targets, policies, and actions should not already be counted in the original NDC. In addition, methane mitigation actions should be implemented in a rights-based and gender-just way that respects and responds to community needs and capacity constraints and seeks to improve livelihoods and well-being, particularly for poor and vulnerable populations.
*Sources:* UNEP and WMO 2011; Adhya et al. 2014; TEEB 2015; Uphoff et al. 2011; Gerber et al. 2013; Ranganathan et al. 2016.

## Box 3 | Putting into Practice: Possible Commitments for Reducing Methane from the Waste Sector in New or Updated NDCs

Ninety percent of the greenhouse gas (GHG) emissions generated from the waste sector are methane, predominantly from decomposing garbage in landfills. Changing practices around the collection and processing of garbage represents not only a significant opportunity to reduce methane emissions but also offers a way to reduce the amount of garbage going to landfills, generate energy (either through landfill gas-to-energy or waste-to-energy generation), displace other forms of fuel (in the event of utilizing biogas over fossil fuels) and create new streams of revenue, lower energy costs, improve local air quality, and strengthen public-private partnerships that can increase recycling rates and provide new job opportunities. It would also support the achievement of Sustainable Development Goal 12, particularly targets 12.3, 12.4, and 12.5.

The EU, for example, has adopted solid-waste policies that helped decrease GHG emissions from Europe's waste sector by 41 percent between 1990 and 2016. The European Environment Agency (EEA) has forecast that emissions from waste disposal will further decrease in the future, despite the fact that the overall quantity of waste being generated is steadily increasing. This changing trend is caused by the decrease in waste being landfilled in the EU as a result of waste legislation there.[a] Following the EU's lead, other countries are rapidly increasing their capacity through incentives to promote either landfill gas capture or waste-to-energy generation.

In the United States, the state of California has also taken clear steps to reduce methane emissions from the waste sector through a comprehensive package of legislative targets and associated policies. These include a target to reduce statewide methane emissions by 40 percent below 2013 levels by 2030, targets to reduce organic matter that ends up in landfills (a 50 percent reduction in the statewide disposal of organic waste from 2014 levels by 2020, and a 75 percent reduction in the statewide disposal of organic waste from 2014 levels by 2025). and a commitment to adopt policies and incentives to significantly increase the sustainable production and use of renewable gas, including biomethane and biogas. A key part of the strategy is to reduce the amount of food waste (which accounts for approximately 17–18 percent of California's total landfill disposal) through encouraging edible food rescue, which, by diverting edible food to food banks and pantries, has the added benefit of assisting Californians who are unable to secure adequate, healthy food.

Through such incentives, countries are rapidly increasing their capacity to promote either landfill gas capture or waste-to-energy generation. China more than doubled its waste-to-energy capacity in the 2011–15 period (WEC 2016), and in Colombia, Mexico, Argentina, and Chile, regulations have been developed that stipulate incentives for electric power generation from nonconventional renewable energy sources, of which various types of energy from waste are categorized. Generating biomethane (or renewable natural gas) from landfill gas capture can be used as alternative energy sources, including as replacement fuels for vehicles. The pursuit of such strategies, and the degree to which such strategies can be effective in emissions reduction and energy generation, depends on the type of waste available. There is therefore no one-size-fits-all approach. Stringent regulations must follow any waste-to-energy policy, ensuring that garbage is properly sorted prior to incineration (separating biodegradable waste that cannot burned at set temperatures) and emissions and air quality data carefully monitored and reported.

To date, 53 NDCs include a target, policy, or measure focused on reducing emissions from the waste sector (see Appendix B for the full details and excerpts relating to waste in Parties' first round NDCs). To successfully reduce emissions, limit air pollution, promote greater recycling rates, and reduce organic matter reaching landfills, comprehensive waste programs need to be developed. Increasing food waste prevention, encouraging edible food rescue, and expanding the composting and in-vessel digestion of organic waste should be a key aspect of any program aimed at reducing methane emissions from the waste sector. In their NDCs, governments can commit to introducing comprehensive approaches to solid-waste management that address environmental concerns and result in substantial methane emission reduction, including targets to reduce the amount of organic matter that reaches landfills (and commitments to pursue associated policies and measures, including reducing food loss and waste), increasing recycling rates, and implementing effective waste-to-energy operations.

*Note:* [a] Refer to the EU's Landfill Directive, 1999/31/EC, available at https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31999L0031.
*Sources:* UNEP 2017; EU 2018; EEA 2017; California State Senate 2016; CalRecycle 2018; Alzate-Arias et al. 2018; Gasper and Searchinger 2018.

## Box 4 | Putting into Practice: Possible Commitments for Reducing Methane Emissions from the Livestock Sector in New or Updated NDCs

Livestock are essential to the livelihoods of millions of farmers and critical to human health, the global food supply, and nutritional security. Ruminants are responsible for 30 percent of global methane emissions, or 5.5 percent of total global greenhouse gas (GHG) emissions from human activities, 77 percent of which are from dairy and beef cattle. With the share of animal-based protein in people's diets expected to rise by nearly 80 percent between 2006 and 2050 (Ranganathan et al. 2016), finding viable mitigation options that can be brought to scale should be a priority.

Emissions are generated as a result of manure management, land-use change for cattle pasture, feed agriculture, processing and farm operations, but the largest share (39 percent of total emissions from the livestock sector) is from enteric fermentation—the methane that is produced from incomplete digestion. The amount of enteric methane expelled by the animal is directly related to the amount of food eaten, which itself is influenced by animal weight, level of productivity, reproductive status, and environmental factors such as temperature. It is also influenced by the type and quality of feed consumed.

Possible interventions to reduce emissions are predominantly based on technologies and practices that improve productivity and therefore offer significant cobenefits for farmers and the environment in terms of food security and economic development. They include improving the feed quality, improving breeding and animal health to help reduce unproductive members of the herd, and making genetic improvements such as live weight gain and milk yield. Breeding can help adapt animals to local conditions and also address issues associated with reproduction, vulnerability to stress, adaptability to climate change, and disease incidence. Importantly, these interventions can result in emission reductions within existing systems—e.g., as a result of improving practices rather than changing production systems. The Food and Agriculture Organization (FAO) estimates that a 30 percent reduction of GHG emissions would be possible if producers in a given system, region, and climate adopted the technologies and practice currently used by the 10 percent of producers with the lowest emission intensity.

In addition to interventions aimed at improving productivity, options to reduce enteric fermentation include the addition of food supplements or food switching. To date, these options have received less attention globally due to the dominance of synthetic supplements, making them a high cost option that is out of reach for many developing countries. However, there is increasing scientific research into low-cost options to reduce enteric fermentation, such as adding seaweed into a cow's diet, which could have broader economic and development benefits.

Investment and further research and development in this area can be greatly bolstered by sending strong signals through the NDCs. To date, 62 NDCs include a target, policy, or measure focused on reducing emissions from the livestock sector (see Appendix C for the full details and excerpts relating to livestock in Parties' first round NDCs). Governments could consider including targets on reducing methane emissions in the livestock sector; introducing new policies and/or associated incentives to support farmers to introduce dietary supplements to reduce enteric fermentation, to implement livestock anaerobic digestion projects; or making commitments regarding support for further research and development and investment in global cooperative initiatives to advance solutions in this sector. Governments could also simultaneously pursue measures to review national dietary guidelines to promote the consumption of less meat and more plant protein.

*Sources:* IPCC 2013; FAO n.d.; FAO 2016; Gerber et al. 2013; Nelson 2018.

## Box 5 | Putting into Practice: Possible Commitments Regarding the Rice Sector in New or Updated NDCs

Rice is a critical component of the global food system and essential to global food security. It is a staple crop throughout Asia,[a] and is increasingly important in both Africa and Latin America. As such, rice is an important calorie source for more than half of the world's people. Rice production is also the largest source of employment and income for people living in rural regions, supporting the livelihoods of more than 1 billion people, including 500 million women. Most rice producers, however, are smallholder farmers who currently lack the power and voice to capture a fair share of the rice value chain and escape food insecurity and poverty. Rice farmers are also dealing with the effects of climate change, including sea level rise and changing temperature and precipitation patterns.

At the same time, rice cultivation worldwide accounts for approximately 11 percent of annual anthropogenic emissions of methane. Methane from rice production derives primarily from the inundation of the planting fields (paddies), which creates an ideal environment for methanogenesis, in which bacteria produce methane that is then released into the atmosphere. Consequently, rice has one of the highest greenhouse gas "footprints" among commodity crops. One estimate of the potential emissions reductions in the rice sector suggests that approximately 8 percent of the emissions associated with rice in 2030 could be abated with technically feasible interventions at no cost, with additional reductions available at increasing costs. A primary strategy for achieving such methane abatement involves reducing water use and the time rice paddies are submerged during the growing process. Practices such as alternate wetting and drying (AWD), the system of rice intensification (SRI), dry seeding, and performing a single mid-season drawdown can reduce methane emissions from rice production while also reducing on-field water use, although the amount of reductions of both methane and water can vary significantly according to context. In addition, the implementation of these practices and associated estimates of methane abatement (and costs) in the rice sector should fully consider potential yield implications that may negatively affect the livelihoods of smallholder farmers, as well as all potential effects to the costs of production and processing for farmers in their local context.

To date, 27—mostly developing country—NDCs mention rice as a component of their climate mitigation or adaptation strategies (see Appendix D for the full details and excerpts relating to rice in Parties' first round NDCs). This speaks to the crop's importance in reducing methane emissions, as well as countries' concern that the sector transitions toward a more sustainable pathway. Measures and actions related to rice highlighted in country NDCs are typically qualitative in nature, although some countries—for example, Benin, Burkina Faso, Madagascar, and Uruguay—provide specific quantitative metrics and targets in terms of emissions reductions or the amount of land cultivated with water management practices. Interventions that reduce water from irrigated systems are the most commonly cited rice sector mitigation strategy among NDCs.

For example, five countries—Burkina Faso, The Gambia, Madagascar, Senegal, and Togo—acknowledge SRI as part of their strategy for reducing methane emissions from rice cultivation. SRI is a set of flexible, context-specific, farmer-led practices that include reduced water use through the periodic drying and rewetting of fields. SRI, which also uses fewer production inputs (e.g., seeds, fertilizer, and labor), has been shown to result in reduced emissions of methane while delivering comparable or enhanced yields and greater economic gains for farmers;[b] thus improving farmer livelihoods and food security while reducing water demand. Nevertheless, barriers remain to the uptake of SRI and other water management practices in rice production, including issues of water governance (policies and incentives), the need for additional water management and irrigation infrastructure, more systematic research to build the evidence base for various water management techniques,[c] better information dissemination services, and extensive farmer training and capacity building.

Given the development and climate challenges and opportunities facing the rice sector, greater attention from policymakers, businesses, and practitioners is warranted. Government engagement and the formulation of comprehensive and cross-disciplinary policies and support programs, in particular, are necessary to realize a low-emissions, resilient, and equitable rice sector. Market-based solutions may also offer new opportunities to reduce emissions while supporting farmers.[d] Countries' NDCs, and the processes that support them, are an opportunity to further examine national agricultural, economic, trade, climate, and other policies and incentives to outline specific ways in which methane emissions from rice production can be reduced, while supporting farmers' rights and livelihoods.

A new or updated NDC could mean further documenting the strategies countries are planning for or taking to reduce emissions in their national rice sector. For example, the fact that SRI has been demonstrated in more than 50 countries, suggests more information could be provided in a greater number of NDCs about what actions are already underway with respect to rice, the resulting emission reductions associated with these activities, and what further support is needed from the international community to scale sustainable rice practices. Countries should also be encouraged to highlight how low-methane rice production practices and enabling policies in their NDCs support the achievement of the Sustainable Development Goals, including enhanced food security, reduced hunger and poverty, improved farmer livelihoods, reduced inequality, and the support of responsible production practices in rice value chains. In turn, this can help ensure alignment of national development and climate agendas—an imperative of the Paris Agreement.

*Notes:* a. China and India alone account for approximately half of rice production and consumption (Muthayya et al. 2014); b. see, for example, a case study from Senegal in TEEB 2015; c. SRI, in particular, is context-specific and provides flexible adoption of associated practices, which helps farmers but does not always lend itself to assessments of causal attribution; d. see, for example, Potter 2017.

*Sources:* Muthayya et al. 2014; Africare, Oxfam America, and WWF-ICRISAT Project 2010; SRI-Rice 2014, 2017; IPCC 2013; Carlson et al. 2017; Pearl-Martinez and Gore 2016; EPA 2016; Adhya et al. 2014; TEEB 2015; Uphoff et al. 2011; Hottle and Damassa 2018.

## STRENGTHENING ACTION ON HFCS

### Emission Sources, Mitigation Potential, and Abatement Opportunities

HFCs are a large class of human-produced GHGs used primarily in refrigeration, air conditioning, foam insulation, and other specialized sectors. They are part of the broader category of "F-gases" that include chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs).

HFCs remain in the atmosphere for less than 15 years. Though they represent a small fraction (less than 1 percent) of the current total GHGs (CCAC n.d.b), their warming impact is particularly strong. Some of the most commonly used HFCs have high or very high GWPs, ranging from 12 to 14,800 (UNEP 2016). In many parts of the world they are the fastest growing GHG and are increasing at a rate of 10–15 percent per year (Zaelke et al. 2013).

Global HFC emissions totaled slightly over 1 $GtCO_2e$ in 2014,[9] the most recent year for which data is available (CAIT 2018). If left unchecked, HFC emissions could approximately double by 2030 (UNEP 2017) and could account for nearly 20 percent of global GHG emissions by 2050 (CCAC n.d.b). Technical potential exists to achieve a rapid reduction of HFCs to approximately 0.3 $GtCO_2e$ in 2030. This mitigation potential translates to 0.005 ± 0.002°C less warming relative to the IEA's current policy scenario in 2030, and 0.07 ± 0.02°C less warming in 2050 (UNEP 2017). Even higher rates of reduction in warming by the end of the century are also possible, a point that we review later.

A decade or so ago, significant discussion began over the possibility of using the Montreal Protocol to create an international agreement to phase down HFCs. The Montreal Protocol was created in 1987 to facilitate a global approach to combat depletion of the stratospheric ozone layer. Every country in the world is a party to the Protocol, and it has successfully phased out, or is in the process of phasing out, several key classes of chemicals, including CFCs, HCFCs, and halons. The transitions away from CFCs and HCFCs provide major ozone layer protection benefits. They also help to protect the climate as these ozone depleting substances (ODSs), like HFCs, are also GHGs. Even prior to the more recent attempt to use the Montreal Protocol to take on HFCs, the climate protection achieved by the Montreal Protocol in phasing out other ODSs was estimated to be greater than the reductions that would have been achieved by the first commitment period of the Kyoto Protocol (Velders et al. 2007). As CFCs and HCFCs were phased out under the Protocol, HFCs, which are not an ODS, rose as a substitute for them especially in refrigeration and air conditioning, the largest sectors in which these chemicals are used.

In 2016, Parties to the Montreal Protocol struck a landmark, legally binding deal to phase down HFC emissions after many years of intense negotiations over whether the agreement could be used to take on a pollutant primarily because of its role in global warming rather than as an ODS. While the Protocol had been designed to phase out ODSs, the Vienna Convention, under which Montreal was created, explicitly says that if the elimination of ODSs creates an unintentional hazard to humans or the environment, then it can be used to eliminate that substance as well. While some Parties were initially resistant to this move, claiming that the UNFCCC was the only proper forum to take on any agreement on HFCs, eventually all agreed to the new Kigali Amendment to the Montreal Protocol to phase out this potent class of GHGs. Along the way, this effort was accelerated through bilateral agreement—such as the 2013 "Sunnylands Summit," when Presidents Obama and Xi agreed to jointly push for an amendment to the Montreal Protocol to phase out HFCs—and in smaller multilateral fora such as the G20 and in the initial years of the creation of the CCAC itself.

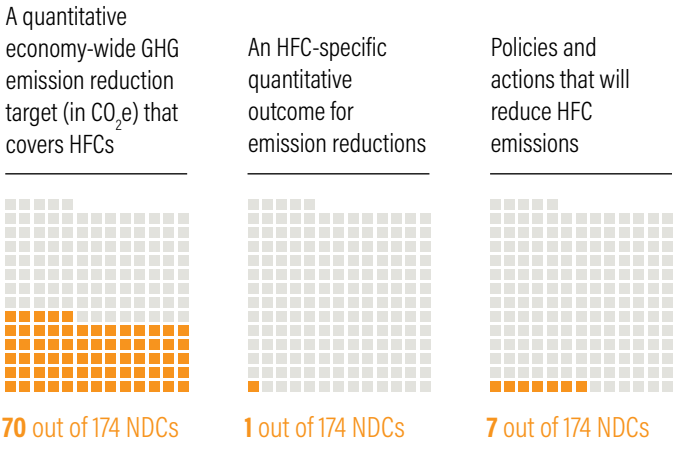
Kigali separates countries into three groups, each with an HFC target phase-down date. The richest countries, including the United States and those in the EU, will reduce the production and consumption of HFCs from 2019. Much of the rest of the world, including China, Brazil, and all of Africa, will freeze the use of HFCs by 2024. A small group of the countries, such as Bahrain, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, and the United Arab Emirates will freeze HFC use by 2028 on the basis of their status as "high-ambient" countries with climates that will be more vulnerable to increases in temperature, and hence increased demand for interior climate control (UNEP 2016).[10] The implementation of the Kigali Amendment would return HFC emissions to just under 1 $GtCO_2e$ by 2030 before achieving a near phase-out by 2050 (UNEP 2017), and could by itself avoid up to 0.5°C of global warming by the end of this century—due not only to the elimination of HFCs, but also the transition to more efficient appliances using non-ODS alternatives (Zaelke et al. 2013).

Since the Kigali Amendment was adopted after the first round of NDCs were communicated, a clear opportunity to strengthen action within the context of the Paris Agreement also presents itself. All Kigali parties could include their commitments under this agreement in a new or updated NDC. It is also possible to enhance exiting commitments under Kigali in a new or updated NDC, such as accelerating a timetable for a phase-down beyond what is currently iterated in their schedules. For example, earlier action than the Kigali schedule could provide more assurance that the full abatement potential of HFCs is reached in part by eliminating "HFC banks"—largely stockpiles of existing industrial and consumer appliances that slowly release HFCs over many decades. It is estimated that an additional amount equivalent to 50 $GtCO_2e$ trapped in HFC banks could potentially be avoided by 2050 if HFC production were to be phased out by 2020 (Velders et al. 2014). Even achieving part of this mitigation potential would be of significant value.

## Coverage of HFCs in First Round NDCs

First round NDCs include HFCs in three different ways. One is by setting a quantitative economy-wide GHG emission reduction target. Here is an example from the EU's NDC: "The EU and its Member States are committed to a binding target of an at least 40 percent domestic reduction in greenhouse gas emissions by 2030 compared to 1990." The scope of this target includes all seven GHGs covered by the UNFCCC, including HFCs.

Figure 6 | **Coverage of HFCs in First Round NDCs**




*Sources:* CCAC Scientific Advisory Panel 2016; Climate Watch 2018; author analysis.

The second way countries have included HFCs in their NDCs is by setting an HFC-specific quantitative outcome for emission reductions. Here is an example from China's NDC: "To phase down the production and consumption of HCFC-22 for controlled uses, with its production to be reduced by 35 percent from the 2010 level by 2020, and by 67.5 percent by 2025 and to achieve effective control on emissions of HFC-23 by 2020."[11]

The third way countries have included HFCs in their NDCs is by listing policies and actions that will reduce HFCs emissions. Here is an example from Nigeria's NDC under the section on SLCPs and air quality: "Here the adoption of standards for imported equipment will be considered, in particular in the field of refrigeration and air conditioning where there is a risk of dumping of HCFC and HFC installations that are being phased out in OECD countries."

The NDCs that have included HFCs in these ways are presented in Figure 6, with full details and NDC excerpts presented in Appendix A.

## Options for Strengthening Action on HFCs in New or Updated NDCs

As countries look toward updating their NDCs in 2020, there are several options for strengthening actions on HFCs. These options are adapted from the menu presented in the WRI working paper "Enhancing NDCs by 2020: Achieving the Goals of the Paris Agreement" (Fransen et al. 2017).

Table 3 identifies relevant options for including stronger action on methane in updated NDCs according to source or sector. This includes sector- or source-based targets, or commitments to introduce specific policies or incentive-specific measures through relevant policy instruments. See Box 6 for an example of how to put these ideas into practice in the cooling sector.

As with action on all gases in NDCs, in addition to sector- or source-based action, there are economy-wide means to strengthen action on HFCs in NDCs:

- Include HFCs in the NDC's coverage of gases and hence its overall GHG target. For example, an existing NDC target that covers only $CO_2$ could be expanded to an economy-wide target inclusive of all UNFCCC gases.

- Specify that HFC is included within an existing economy-wide target to enhance the clarity, transparency, and understanding of the NDC. For example, an existing GHG target may not specify which gases it covers. This could be updated to specify that HFCs are included with the target (in addition to specifying the other GHGs included).

Table 3 | **Sample Targets, Policies, and Measures to Strengthen Action on HFCs, by Source/Sector**

| SECTOR | EXAMPLES OF TARGETS, POLICIES, AND MEASURES TO INCLUDE OR STRENGTHEN IN A NEW OR UPDATED NDC | POTENTIAL DEVELOPMENT BENEFITS |
|---|---|---|
| **Economy-wide** | ■ Target to reduce a set percentage or tonnage of HFC emissions according to a set base year by 2030.<br>■ Target to increase the percentage of low-GWP alternatives in economy-wide uses of HFCs according to a set base year by 2030, consistent with the HFC phase-down level under Kigali.<br>■ Commitment to exceed currently associated Kigali phase-down schedule. | Sector-specific; HFC reductions can support a range of development goals such as quality education, decent work, economic growth, responsible consumption and production, and sustainable cities and communities. |
| **Sector-specific** | ■ Commitment to provide incentives for companies and consumers to replace high-GWP HFC commercial equipment or appliances with low-GWP alternatives.<br>■ Commitment to harmonize policies with those of countries with more stringent F-gas regulations, such as the EU, with or without delay.<br>■ Commitment to simultaneously replace high-GWP HFCs with low-impact alternatives in specific classes of appliances and equipment, such as using R-290 instead of HFC-410a in room air conditioners.<br>■ Commitment to simultaneously replace high-GWP HFCs with low-impact alternatives in the mobile air conditioner sector, such as using HFO-1234yf instead of HFC-134a.<br>■ Commitment to introduce a policy that all new high-efficiency cooling equipment must use either a low-GWP HFC or an HFC alternative.<br>■ Commitment to introduce a policy or legal framework to update public procurement processes to transition away from high-GWP HFCs. | Improvements in refrigeration energy efficiency through HFC phase-down measures, for example, can contribute to the achievement of several SDGs by increasing the affordability of refrigeration, supporting human health (for example, refrigeration needs for vaccines), and reducing food waste, and SDG targets 1 and 3. |

*Note:* These options may not necessarily enhance the mitigation ambition of a Party's NDC. To constitute enhanced mitigation ambition, the cumulative emissions under the new NDC would need to be lower than under the original NDC. To constitute enhanced mitigation ambition in the new NDC, the emissions reductions associated with the newly added/strengthened HFC-related targets, policies, and actions should not already be counted in the original NDC. In addition, HFC mitigation actions should be implemented in a rights-based and gender-just way that respects and responds to community needs and capacity constraints and seeks to improve livelihoods and well-being, particularly for poor and vulnerable populations.
*Source:* Haines et al. 2017.

## Box 6 | Putting into Practice: Possible Commitments Regarding the Cooling Sector in New or Updated NDCs

Electricity demand from air conditioners is on the rise. The Clean Energy Ministerial estimates that the "additional electricity demand in 2020 from room air conditioners (ACs) bought between 2010 and 2020 is expected to be over 1,200 billion kilowatt hours (kWh) globally," equivalent to the output of five Three Gorges Dams by 2020 from India, China, and Brazil alone.

Demand for air conditioners will only increase as temperatures increase worldwide, especially given the threat of heat deaths. The World Health Organization estimates that between 2030 and 2050, climate change is expected to cause an additional 250,000 health-related deaths, with 38,000 due to heat exposure in elderly people. However, there is increasing evidence that temperature change will present even larger health risks in high-ambient temperature countries such as Algeria, India, Iran, Iraq, Kuwait, Pakistan, Qatar, Saudi Arabia, and the United Arab Emirates, based on studies that show that ambient temperature plays a larger role in temperature-associated mortality, including cardiovascular mortality.

There is also work indicating that for countries like India specifically, climate change will vastly increase the risk of heat-related deaths.

This rise in demand for air conditioners, however, need not necessarily continue to compound the changes in climate that make these environments increasingly risky. A 2013 estimate of the possible energy savings found that the total 2020 savings potential from cost-effective technology, which would pay for itself over the lifetime of the AC unit, was equivalent to 64 medium-sized power plants, or 192 TWh/year, while the total potential using available technology at that time was equivalent to approximately 123 medium-sized power plants, or 369 TWh/year.

The downside of this opportunity is that there are, of course, other ways to achieve some of these savings with technology that still uses HFCs. Currently, room ACs along with other refrigerant-using equipment use predominantly high-GWP HFCs. But in response in part to the push for the Kigali Amendment to the Montreal Protocol and other efforts, industry has responded with an abundance of non-HFC alternatives.[a] Historically, each transition from one F-gas to another phased out through the Montreal Protocol has been coupled with increases in efficiency.

In the first round of NDCs, only two countries explicitly addressed HFC abatement in the context of future demand for cooling—Ghana and Nigeria.

New NDCs could better make the connection between the need to take advantage of the efficiency gains from addressing global demand for air conditioning while avoiding compounding it by continuing to create HFC banks, which will continue to adversely impact temperatures over the lifetime of the installed units. The current phase-down schedule is a great start, but it could be improved by specific commitments to accelerate the phase down, especially in the countries with the largest demand profile for air conditioners over the next decade.

*Note:* [a] See Figure 3-2 of Shah et al. 2013 for an early comparative analysis.
*Sources:* CEM 2014; WHO 2018; Lee et al. 2017; Mazdiyasni et al. 2017; Shah et al. 2013.

## STRENGTHENING ACTION ON BLACK CARBON

### Emission Sources, Mitigation Potential, and Abatement Opportunities

Black carbon consists of dark-colored aerosols and is a major component of soot. It is created by incomplete combustion processes from wildfires, field burning of agriculture waste, burning biomass for cookstoves, black coal for electricity, and diesel in cars and trucks. One-third of black carbon emissions originate from fossil fuel sources (UNEP 2017). Residential combustion (cooking and heating in solid-fuel stoves) has also been a key source of black carbon emissions, with transport and industry gaining importance in recent years (UNEP 2017).

Black carbon can have a warming effect on the planet; however, it is not a GHG and warms the Earth in a different way. Instead of trapping the infrared energy emitted from the Earth's surface (like carbon dioxide, for example), black carbon absorbs sunlight directly as it comes from space. At the same time, the aerosols warm the surrounding air, which in turn impacts cloud formation. This leads to a compensatory cooling effect. Although the underlying processes around black carbon are now better understood, the total climate impact is still uncertain. What is known is that the strength of the climate impacts of black carbon is governed by the amount of emissions, the time that the aerosols remain suspended in the air after emissions, and where and when emissions occur (Aamaas et al. 2018). Current climate models estimate the atmospheric lifetime of black carbon as between five and ten days, but more recent research suggests that it may be at the lower end of this range, and possibly as low as three to four days (Aamaas et al. 2018).

Black carbon emissions have both global climate impacts and local health impacts. Black carbon emissions near eco-sensitive areas such as the Arctic and Himalayas have a particularly significant impact on these regions' climate and water security. Black carbon also negatively impacts human health and national health systems, since it forms part of PM2.5 air pollution, which is a major cause of pulmonary and cardiac disease and premature death globally (CCAC n.d.a). These impacts of black carbon can have a disproportionate impact on poor and marginalized communities, which have limited resources and capacities for coping and managing air quality. Gender disparities may also exist. For example, when considering residential combustion sources such as biomass for cooking and heating, women and children often suffer greater exposure rates due to spending more time in the home and bearing primary responsibilities for cooking (see Box 7).

Global black carbon emissions amount to approximately 9 million tonnes of black carbon per year (UNEP 2017). Under a reference case, they would be expected to decline slightly to just over 8 million tonnes of black carbon by 2030 (UNEP 2017). Recent policies, such as measures to introduce diesel particulate filters, would reduce 2030 emissions to just below 8 million tonnes (UNEP 2017). This estimate does not take into account the potential impact from a range of important ongoing processes, including Arctic Council goals to reduce black carbon emissions by 25–33 percent from 2013 levels by 2025; the Gothenburg Protocol to the United Nations Economic Commission for Europe's Convention on Long-Range Transboundary Air Pollution, which requires Parties to prioritize key black carbon sources; discussions under the International Maritime Organization to reduce black carbon emissions; and pledges under the CCAC.

There is technical potential to nearly halve 2030 emissions to just over 4 million tonnes of black carbon (UNEP 2017). Estimates of the regional distribution of black carbon abatement potential find that potential varies widely by region. In China, for example, the transformation in the coke sector, ever more stringent policies in transport, and reductions of coal use in the residential sector can lead to significant reductions relative to the reference scenario emission levels (UNEP 2017). There is also significant abatement potential in regions where solid fuel cooking and heating dominates black carbon emissions (UNEP 2017), which are more likely to be rural and poorer areas (see Box 7).

### Coverage of Black Carbon in First Round NDCs

Black carbon is not a pollutant covered under the UNFCCC.[12] However, due to black carbon's impact on the climate (see earlier in this section), some countries have included this pollutant in their first round NDCs in one of two ways. The first is by setting a black-carbon-specific quantitative outcome for emission reductions. Here is the only example from Mexico's NDC: "Mexico is committed to reduce unconditionally 25 percent of its Greenhouse Gases and Short-Lived Climate Pollutants emissions (below business as usual) for the year 2030. This commitment implies a reduction of 22 percent of GHG and a reduction of 51 percent of Black Carbon."

The second way countries have included black carbon in their NDCs is by listing policies and actions that will reduce black carbon emissions. Here is an example from Nigeria's NDC, included in the section on SLCPs and air quality: "Drastic measures to reduce soot (black carbon) pollution from cars and trucks, small generators and industry are needed. Failure to do so could make Nigeria's mega-cities unlivable. This includes enforcement of the importation ban of cars over 15 years' old, stricter inspections, and further consideration of setting efficiency standards for new cars similar to those in South Korea."

The number of NDCs that have included black carbon emissions in these two ways are presented in Figure 7, with full details and NDC excerpts presented in Appendix A.

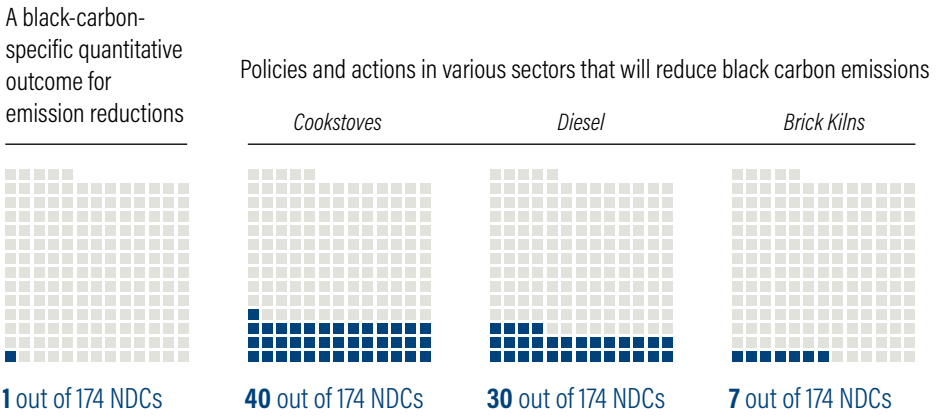
## Options for Strengthening Action on Black Carbon in New or Updated NDCs

As countries look to enhance their NDCs in 2020, there are several opportunities to include black carbon. Countries can set targets to reduce black carbon, but these should be reported and accounted for separately from GHG emissions since black carbon is not a pollutant covered under the UNFCCC. As noted earlier, black carbon accounting and warming uncertainties also remain high—carbon dioxide and black carbon impact the climate in different ways and have very different lifetimes; there is yet to be scientific consensus on appropriate metrics to equate the two. This should be noted explicitly in the NDC. Accordingly, black carbon targets should be in mass units, not in $CO_2e$ units.

Measures to reduce black carbon can be included in enhanced NDCs, but policymakers should take into account the net climate effect of these measures. In addition, while reductions in black carbon can produce significant air quality and health-related benefits for communities, poor and vulnerable communities in particular will likely require financial and technical support to reduce such emissions to ensure their livelihoods are not disproportionately affected and that any associated costs can be managed. Accordingly, countries should take an integrated approach when assessing the impacts and benefits of their air pollution and climate change actions to fully assess the impacts and benefits across diverse communities and stakeholders.

Table 4 presents relevant black carbon policies or measures to include in a new or updated NDC, classified by sector. These options are adapted from the menu presented in the WRI working paper "Enhancing NDCs by 2020: Achieving the Goals of the Paris Agreement" (Fransen et al. 2017). See Box 7 for an example of how to put these ideas into practice for cookstoves.

Figure 7 | **Coverage of Black Carbon in First NDCs**




*Sources:* CCAC Scientific Advisory Panel 2016; Climate Watch 2018; author analysis.

Table 4 | **Sample Targets, Policies, and Measures to Strengthen Action on Black Carbon in New or Updated NDCs, by Source/Sector**

| SECTOR | POLICIES OR MEASURES TO INCLUDE OR STRENGTHEN IN AN UPDATED NDC | POTENTIAL DEVELOPMENT BENEFITS |
|---|---|---|
| **Transport** | ■ Target to reduce a set tonnage of black carbon emissions relative to a set baseline/base year from the transport sector by 2030.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to promote diesel particulate filters for road and off-road vehicles.<br>■ Commitment to develop electromobility strategies and/or introduce a policy or legal framework (and associated incentives) to replace internal combustion engine vehicles with electric vehicles.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to eliminate high-emitting vehicles in road and off-road transport and/or public transportation.<br>■ Commitment to develop an integrated and sustainable strategy for transport modes in megacities and/or expand toward a greener and more sustainable public transport system. | Improved air quality and human health, as well as associated benefits such as reduced health care costs, enhanced economic productivity, greater ability to access education and skill development and to pursue leisure time. |
| **Residential** | ■ Target to reduce a set tonnage of black carbon emissions relative to a set baseline/base year from the residential sector by 2030.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to replace coal by charcoal briquettes in cooking and heating stoves in ways that do not cause financial hardship to poor and vulnerable communities and that support, in particular, women's rights.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to introduce clean-burning biomass stoves for cooking and heating in developing countries in ways that respect local preferences, do not cause financial hardship to poor and vulnerable communities, and that support, in particular, women's rights. | Improved air quality and human health, as well as associated benefits such as reduced health care costs, enhanced economic productivity, greater ability to access education and skill development and to pursue leisure time. |
| **Agriculture** | ■ Target to reduce a set tonnage of black carbon emissions relative to a set baseline/base year from the agriculture sector by 2030.<br>■ Commitment to ban open field burning of agricultural waste while ensuring sufficient support for farmers—particularly small-scale and women farmers—to transition to more sustainable growing practices. | Improved air quality and human health, as well as associated benefits such as reduced health care costs, enhanced economic productivity, greater ability to access education and skill development and to pursue leisure time. |
| **Industry** | ■ Target to reduce a set tonnage of black carbon emissions relative to a set baseline/base year from industry by 2030.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to replace traditional brick kilns with vertical shaft kilns and Hoffman kilns.<br>■ Commitment to introduce a policy or legal framework (and associated incentives) to replace traditional coke ovens with modern recovery ovens, including improving end-of-pipe abatement measures. | Improved air quality and human health, as well as associated benefits such as reduced health care costs, enhanced economic productivity, greater ability to access education and skill development and to pursue leisure time. |

*Note:* Black carbon mitigation actions should be implemented in a rights-based and gender-just way that respects and responds to community needs and capacity constraints and seeks to improve livelihoods and well-being, particularly for poor and vulnerable populations.

## Box 7 | Putting into Practice: Possible Commitments on Cookstoves in New or Updated NDCs

Sustainable Development Goal (SDG) 7 envisions a world in just over a decade where all people have access to safe, affordable modern energy. Despite some progress in recent years deploying sustainable residential energy solutions, some 3 billion people—most of whom live in poor, rural areas of Asia and sub-Saharan Africa—still use "traditional" biomass sources such as wood, charcoal, dung, kerosene, or coal as their primary fuel for household cooking and heating. The harvesting and production of these fuels can directly affect local ecosystems, while their combustion is a major source of black carbon and associated air pollutant emissions.

There are well-established risks to health from being regularly exposed to emissions associated with biomass-based cooking and heating, including black carbon. These include stroke, pneumonia, heart and lung disease, and cancer. Annually, nearly 4 million premature deaths are attributed to extended exposure to household or indoor air pollution, with over 100 million lost disability-adjusted life years (DALYs) in middle- and low-income countries. Critically, these health risks and livelihood impacts are disproportionately suffered by women and children who, due to cultural and gender-based norms, are tasked with cooking, household chores, and generally spending more time in the home, where exposure rates are highest. The indirect effects of biomass collection and burning and poor health can also mean reduced time for income-generating activities, education, and leisure. In some instances, women and young girls may also be exposed to an unsafe environment as they collect fuel wood, elevating the possibility for violence against women.

Consequently, helping communities transition to improved or clean-burning biomass cookstoves, or adopt clean-burning cooking and heating fuels such as liquefied petroleum gas (LPG)[a] or renewable electricity, can provide multiple benefits for human development and well-being. (Importantly, not all 'improved' or 'clean-burning' cookstoves reduce emissions of black carbon, so a stove's resulting climate and health impacts must be carefully assessed.) For example, in addition to addressing negative health and livelihood impacts, measures that mitigate black carbon emissions in the residential energy sector can reduce the relatively large share of household income spent on energy, giving families additional income to spend on other necessities, including education, health services, and food. In addition to poverty reduction, gender equality is also at the core of a just energy transition; improving access to clean cooking and heating options is therefore an area ripe for comprehensive policy support and financial investment to realize improved health and opportunities for education and income-generating livelihoods for women and girls.

In the first set of nationally determined contributions (NDCs), many countries recognized the importance of addressing emissions from the residential energy sector and the benefits of clean cookstove deployment and adoption (see Appendix E for further details). For example, about one-quarter of the NDCs (42) include commentary related to residential energy use and cookstoves. While some focus on measures to promote the use of efficient cookstoves, others specify a switch to cleaner cooking and heating fuels, such as LPG, biogas, or solar electricity. Countries also provide a mix of both qualitative and quantitative targets. The latter includes metrics of fuel wood consumption, the number of clean cookstoves deployed, reductions in the number of emissions-generating stoves, improved efficiency performance, and the amount of increase in clean fuel use.

Despite the sustainable development opportunities associated with and apparent enthusiasm within countries' NDCs for clean cooking and heating, there are several reasons why considerable barriers remain to widespread deployment and adoption, and slow progress has been made in deploying improved cooking technologies that reduce indoor air pollutants. First, transitioning to "cleaner" or "improved" stoves does not necessarily guarantee benefits for addressing climate change or for human health; stove design can vary the outcomes of realizing development and climate benefits considerably. Second, the costs of improved cookstoves or clean energy systems can be out of reach for many individuals living in poverty, even with a fuel cost savings. Third, successfully addressing the cultural sensitivities and nuances associated with cooking in a certain place and culture is challenging, particularly if a stove adds complexity to well-established routines.[b] Finally, while cooking and heating with clean renewable electricity arguably offers the most promise for achieving multiple climate and development benefits, electricity tends to have very small impacts on cooking with solid biomass, as poor households will often "stack" fuels rather than switching outright from biomass to electricity.[c,d] Innovative financing schemes, along with comprehensive cultural due diligence that informs stove design, and sustained capacity building, including bolstering local supply chains to ensure maintenance and replacement options, are necessary to overcome these challenges.

Countries' NDCs, and the processes that support them, provide an opportunity to bring together relevant stakeholders to address these challenges in a systemic way and to articulate and quantify the strategies and support needed to expedite a just energy transition. An enhanced NDC could include additional qualitative information about existing challenges, as well as quantitative information and targets related to proposed solutions. This information would increase government transparency and accountability while providing critical guidance to prospective donors (many of which may be more interested in the potential development outcomes than the climatic ones). In addition to SDG 7, clean cooking and heating is also relevant to a number of other SDGs, including goals 1, 2, 3, 4, and 5. These links could be made explicit in NDCs to help ensure holistic approaches to addressing emissions from residential energy and engage both public and private sector communities. International development, health, and women's rights organizations may be particularly well placed to support national climate imperatives related to clean cooking and heating that enable those living in poverty—and women in particular—to access clean, sustainable energy, while promoting economic, education, and empowerment opportunities.

*Notes:* a. While reducing emissions of black carbon, burning LPG would result in increased emissions of carbon dioxide, reducing some of the climate benefit. However, even large-scale deployment of LPG for residential cooking and heating is not estimated to be a large emissions source (IEA 2017); b. for example, see Hottle and Damassa 2018, and references therein; c. notably, stacking does not only happen with electricity, but when any new fuel is introduced to an economy; d. for example, see Morrissey 2017; Rewald 2017; and references therein.
*Sources:* UN-DESA 2017; Bailis et al. 2015; Janssen et al. 2012; WHO 2018; Pillarisetti et al. 2016; Cordes 2011; Global Alliance for Clean Cookstoves n.d.; Morrissey 2017.

## LOOKING AHEAD

This paper argues for ambitious action to mitigate SLCPs and, as a means to facilitate that action, for NDCs to robustly cover SLCPs. Ambitious action is necessary because achieving the Paris temperature goals demands sharp reductions of SLCPs, as well as of carbon dioxide. Ambitious actions on SLCPs are also necessary to realize the SDGs, and, if implemented in a context- and rights-driven way, can deliver a wide range of development benefits that support poverty reduction, improve air quality, achieve greater food security, and improve livelihoods. Yet many NDCs do not explicitly address SLCPs at all, or address only a subset of them. The process of communicating new or updated NDCs by 2020 offers Parties an opportunity to improve the coverage of SLCPs in NDCs and codify intentions to realize available climate and development benefits.

How can countries go about taking advantage of this opportunity? Countries interested in pursuing ambitious and comprehensive coverage of SLCPs in their NDCs could take the following steps:

1. Compile and review available information. This information could include:

- SLCP emissions sources (sourced from GHG inventories and national communications)
- Mitigation potential analyses, which look across all sectors to maximize potential benefits (since SLCP emissions cut across all sectors of the economy)
- SLCP-related policies, planned or in place
- SLCP reduction projects
- Long-term climate strategies
- National development plans

2. Review the first NDC in light of information found. Consider whether existing policies capture all SLCP-reduction opportunities and are adequate to deliver on mitigation potential and key development benefits.

3. Consider whether the first NDC reflects these opportunities and captures all existing policies and any new policies that might be warranted to address SLCPs in light of their abatement potential and associated development benefits. Additionally, consider whether the coverage of SLCPs in the NDC is consistent with the country's long-term strategy to ensure that near-term actions are consistent with the long-term vision.

4. Determine whether enhanced coverage of SLCPs in the NDC is warranted, generally if SLCP coverage in the first NDC does not capture full potential and targeted benefits.

5. If enhanced coverage of SLCPs in the NDC is warranted, decide whether to reflect it in a new or strengthened economy-wide target, SLCP-specific target, policies and actions, or more than one of these options. Additionally, consider how targets, policies, and/or actions can promote equity and ensure that poor and vulnerable communities are supported in adopting new technologies and practices.

6. Communicate the updated NDC to UNFCCC by 2020, in line with the request to do so in the Paris Agreement's accompanying decision text.

Completing the process described above—not to mention implementing enhanced measures to address SLCPs—is likely to require additional funding and technical capacity for many countries. Countries that have existing capacities should be encouraged to be relatively more ambitious in reducing their own SLCPs while supporting other countries' efforts to take SLCP-mitigating actions, while countries without established resources should consider the role that coalitions and complementary initiatives can play in providing these.

For example, the CCAC, which is a partnership among countries and intergovernmental and nongovernmental organizations, and has a secretariat in the UNEP, has the goal of catalyzing action toward the reduction of SLCPs. Notably, the CCAC supports the SNAP initiative (Supporting National Action and Planning on SLCPs), which helps partners build capacity and strengthen institutions, with the goal of helping them embed nationally appropriate SLCP mitigation strategies and actions in their policies, including in new or updated NDCs. The CCAC also assists countries in implementing SLCP-reducing projects.

In addition, over 400 companies have set mitigation targets in line with the latest climate science.[13] Energy, waste, transportation, and food and beverage companies, among others, have a vested interest in finding ways to mitigate SLCP emissions throughout their operations and supply chains in order to achieve these commitments. Countries with limited capacities and resources may seek

to work with such companies. For example, countries may work with companies that have supply chain components domiciled in the country through public-private partnerships or other arrangements that support SLCP emission reductions. In addition to achieving SLCP mitigation outcomes, these partnerships can (and should) help ensure the rights of affected local communities and the realization of national development priorities.

Finally, countries with limited capacities and resources may benefit from engaging development-oriented organizations and institutions. Such organizations could be encouraged by countries to adopt SLCP mitigation strategies as part of their policy and programming work, particularly when considering interventions in sectors such as agriculture, transportation, residential energy, and urban development. These organizations could carry out integrated SLCP mitigation development activities as part of service delivery programs, incorporate SLCP mitigation into awareness raising and policy advocacy strategies, and help ensure coordination among various stakeholders' development and climate agendas (Hottle and Damassa 2018).

Looking ahead, given the imperative to reduce SLCPs to avoid critical temperature thresholds, it is critical that Parties advance enhanced action on SLCPs in new or updated NDCs. Doing so can bring countries' actions in line with the Paris Agreement's purpose and long-term goals over the coming years, while delivering on sustainable development objectives. This process also offers a key opportunity to mobilize funding toward SLCP-reduction initiatives and to embed other issues, such as air pollution, health, food security, improved livelihoods, and poverty reduction in the context of attending to climate change. This makes addressing climate challenge more local, resonant, and real for citizens, and provides additional political support for those leaders who want to demonstrate more ambition on climate and development action.

# APPENDIX A: COVERAGE OF SLCPS IN FIRST ROUND NDCS

## Coverage of Methane in First Round NDCs

In the first round of NDCs, countries included quantitative targets to reduce methane emissions (see Table A1), and listed policies and actions in various sectors that will reduce methane emissions (see Table A2).

Table A1 | **Quantitative Targets to Reduce Methane Emissions in First Round NDCs**

| COUNTRY | EXCERPT FROM NDC |
|---|---|
| **Rwanda** | Extraction and utilization of LPG for power generation; approximately 586,000 $tCO_2e$ will be reduced from this action. |
| **Benin** | Efforts to improve technical routes to limit methane fermentation and nitrous oxide emissions due to nitrification/denitrification in cropping systems would prevent the cumulative emissions of these gases to be approximately 20.9 $MtCO_2$ compared to the business as usual scenario, i.e., a 20.6 percent reduction by 2030 (conditional contribution). |
| **Ghana** | Improve effectiveness of urban solid waste collection from 70 percent to 90 percent by 2030 and dispose all to an engineered landfill for phase-out methane recovery from 40 percent in 2025 to 65 percent by 2030. |

Table A2 | **Policies and Actions to Reduce Methane Emissions in First Round NDCs**

| SECTOR | COUNTRY | EXCERPT FROM NDC |
|---|---|---|
| **Coal** | **Afghanistan** | Gas recovery in coal mines. |
| | **Zimbabwe** | Coal-bed methane (CBM) power. |
| | **Bosnia Herzegovina** | To install the equipment for power generation from methane from two underground mines (five coal pits). |
| **Oil and gas** | **Brunei** | Studies are being undertaken to identify measures to reduce flaring and venting during gas extraction, which in turn will reduce emissions of methane and carbon dioxide. Gas flaring and venting also wastes valuable energy resources that could be used to support economic growth. |
| | **Canada** | The federal government is currently developing additional regulatory measures that will reduce methane emissions from the oil and gas sector. |
| | **Saudi Arabia** | Actions will be taken to conserve, recover, and reuse hydrocarbon resources and minimize flaring and fugitive emissions. |
| | **Nigeria** | Work toward ending gas flaring by 2030. |
| | **Republic of Congo** | Non-flared gas is partially recovered in two new gas-fired power stations in Djéno (50MW) and Côte Maltève (300MW). This policy, which has already entered into force, is taken into account in the trend scenario. |
| **Waste** | **Burkina Faso** | Recovery of methane from the solid wastes of the city of Ouagadougou landfill. |
| | **Turkey** | Recovery of methane gas from landfill gas from managed and unmanaged landfill sites. |
| | **Nepal** | Waste management and air pollution control: Nepal promotes the generation of energy from waste, by converting and managing waste and minimizing the release of methane. |
| | **North Korea** | Prepare waste management plans. |
| | **Japan** | Reduction of municipal solid waste disposed of by direct landfill. |
| | **Cabo Verde** | The construction (or retrofitting/expansion) of at least four wastewater treatment plants and water reuse facilities. |
| | **Namibia** | Biogas collection from wastewater treatment plants for electricity generation. |
| | **Jordan** | Recycling wastewater. |

Table A2 | **Policies and Actions to Reduce Methane Emissions in First Round NDCs (continued)**

| SECTOR | COUNTRY | EXCERPT FROM NDC |
|---|---|---|
| Agriculture | **Pakistan** | Develop and adopt new breeds of cattle which are more productive in terms of milk and meat and have lower methane production from enteric fermentation. |
| | **Yemen** | Planned mitigation measures: Proper land management to reduce methane from soil. |
| | **Japan** | Measures to reduce $CH_4$ emissions from agricultural soils (reduction of $CH_4$ emissions from paddy rice fields). |
| | **Dominica** | Measures to reduce GHG emissions from the agriculture sector, including through the harnessing of biomass. |
| | **Madagascar** | Large-scale implementation of conservation agriculture and climate-smart agriculture. |
| | **Timor-Leste** | Promotion of biogas and composting for reduction of agricultural emissions. |

## Coverage of HFCs in First Round NDCs

In the first round of NDCs, countries included quantitative targets to reduce HFC emissions (see Table A3), and listed policies and actions that will reduce HFC emissions (see Table A4).

Table A3 | **Quantitative Targets to Reduce HFC Emissions in First Round NDCs**

| COUNTRY | EXCERPT FROM NDC |
|---|---|
| **China** | To phase down the production and consumption of HCFC-22 for controlled uses, with its production to be reduced by 35 percent from the 2010 level by 2020, and by 67.5 percent by 2025 and to achieve effective control on emissions of HFC-23 by 2020. |

Table A4 | **Policies and Actions to Reduce Methane Emissions in First Round NDCs**

| COUNTRY | EXCERPT FROM NDC |
|---|---|
| **Australia** | The enhanced management of synthetic greenhouse gas emissions under ozone protection laws and the Montreal Protocol. |
| **Barbados** | HFCs are on the rise nationally and globally but Barbados is committed to the transition to natural refrigerants with no-Ozone Depleting Potential (ODP), and little or no-ODP. |
| **Canada** | Canada has also committed to finalizing regulations to phase down the use of hydrofluorocarbons in line with the Kigali Amendment to the Montreal Protocol. |
| **Ghana** | Green Cooling Africa Initiative. Abatement of fluorinated gases (HFC-22 and HFC-410) from stationary air conditioners. |
| **Nigeria** | Here the adoption of standards for imported equipment will be considered, in particular in the field of refrigeration and air conditioning, where there is a risk of dumping of HCFC and HFC installations that are being phased out in OECD countries. |
| **Swaziland** | Swaziland's contribution is to phase out the use of HFCs, PFCs and $SF_6$ gases. This contribution will be achieved by developing the value chain for alternative zero-GWP gases, and enhancing the skill level for these conversions. |
| **United States** | Under the Clean Air Act, the United States EPA has approved the use of specific alternatives to high-GWP HFCs in certain applications through the Significant New Alternatives Policy program.[a] |

*Note:* a. The U.S. NDC was communicated under a previous administration. Also, the regulation to phase out HFCs was overturned in court.

## Coverage of Black Carbon in First Round NDCs

In the first round of NDCs, countries included quantitative targets to reduce black carbon emissions (see Table A5) and listed policies and actions that will reduce black carbon emissions in different sectors (see Table A6).

Table A5 | **Quantitative Targets to Reduce Black Carbon Emissions in First Round NDCs**

| COUNTRY | EXCERPT FROM NDC |
|---|---|
| **Mexico** | Mexico is committed to reduce unconditionally 25 percent of its GHG and SLCP emissions (below BAU) for the year 2030. This commitment implies a reduction of 22 percent of GHGs and a reduction of 51 percent of black carbon.[a] |

*Note:* a. It is important to note that black carbon accounting and warming uncertainties remain high—carbon dioxide and black carbon impact the climate in different ways and have very different lifetimes; there is not yet scientific consensus on appropriate metrics to equate the two in terms of carbon dioxide equivalent.

Table A6 | **Policies and Actions to Reduce Black Carbon Emissions in First Round NDCs**

| SECTOR | COUNTRY | EXCERPT FROM NDC |
|---|---|---|
| **Economy-wide** | **Canada** | In addition to addressing gases covered under the UNFCCC, Canada is taking action to reduce black carbon. |
| | **Chile** | The decontamination strategy of the Chilean government contemplates the implementation of atmospheric decontamination plans for fine particulate matter. Our country considers that the efforts made in reducing black carbon in the regions which have high levels of this substance will make a significant contribution to the sustainability of Chile's development. |
| **Transport** | **Nigeria** | Drastic measures to reduce soot (black carbon) pollution from cars and trucks, small generators and industry are needed [...] This includes enforcement of the importation ban of cars over 15 years' old, stricter inspections, and further consideration of setting efficiency standards for new cars similar to those in South Korea. |
| | **Jordan** | Reducing all emissions from transport sector (i.e., $CO_2$, CO, PMx,[a] $NO_x$ expressed in tons per day). |
| **Cookstoves** | **Bangladesh** | Put in place policy mechanisms to incentivize the uptake of improved (more efficient) gas cookstoves. |
| | **Liberia** | Replacing cooking stoves with low thermal efficiency (5–10 percent) with the higher efficiency (40 percent) stoves. |
| | **Democratic People's Republic of Korea** | To replace conventional coal stoves for cooking with efficient electric cookers at the households. |
| **Brick kilns** | **Bangladesh** | Improving kiln efficiency in the brick-making industry, composting of organic waste, and waste biomass-based thermal energy generation. |
| | **Burundi** | Training of charcoal producers on building and using improved kilns. |
| | **Cambodia** | Promoting use of renewable energy and adopting energy efficiency for garment factories, rice mills, and brick kilns. |

*Note:* a. PMx stands for "particulate matter" and includes a complex mixture of particles such as PM10, PM2.5, and black carbon.

# APPENDIX B: EXCERPTS FROM FIRST ROUND NDCS PERTINENT TO WASTE

Table B1 presents the excerpts from first round NDCs that include actions relating to waste.

Table B1 | **Excerpts from First Round NDCs that Relate to Waste**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON WASTE |
|---|---|
| **Afghanistan** | Waste management (solid waste management and wastewater recycling/composing of biodegradable waste instead of landfill, and methane recovery from landfill). |
| **Algeria** | Regarding methane emissions reduction, Algeria intends to give priority to the management of household solid waste, with the objective to achieve, by 2030, a full coverage of waste dumps in its territory. Main actions in the waste sector: waste valorization; composting organic waste and green waste; energy recovery and recycling of methane from landfill sites and waste water treatment plants. |
| **Antigua and Barbuda** | Domestic and industrial waste is a growing environmental concern in Antigua and Barbuda, whereas technological assistance could reverse this trend and create new opportunities. A preliminary review of annual waste streams to the sanitary landfill suggests that some 80,000 tons annually of feedstock could be available for conversion to energy if an appropriate facility were available, mitigating $CO_2$, $N_2O$, and $CH_4$ emissions. Antigua and Barbuda's goal is to, by 2020, finalize technical studies with the intention to construct and operationalize a waste-to-energy plant by 2025. |
| **Azerbaijan** | Develop modern solid waste management system at big cities of the country. |
| **Bangladesh** | Increase composting of organic waste; promote landfill gas capture and power generation. |
| **Barbados** | Projects to divert waste from landfill and to develop waste-to-energy plants are underway to deliver savings in this sector. |
| **Belize** | Implementation of the Solid Waste Management strategy and plan. Its overall goal is to assist the government of Belize in promoting sustainable development by ensuring that "the system for managing solid wastes in Belize is financially and environmentally sustainable and contributes to improved quality of life." It will focus on preventing, reusing, recycling, or recovering waste wherever feasible and beneficial and disposing of waste safely only as a last resort. The plan also aims to reduce methane emissions by capping and closing open dumps, capturing and utilizing landfill gas, and ensuring proper waste handling and organics management. |
| **Bhutan** | Minimize GHG emission through application of zero waste concept and sustainable<br>waste management practices: Enhancement of the three R principles, including the conversion of waste to resources; improving the current system and infrastructure for waste management. |
| **Cabo Verde** | Seek to provide proper waste management coverage (with waste segregation, recycling, and treatment in sanitary landfills) for at least 50 percent of the more vulnerable municipalities by 2030, including: implementing educational programs for the separation of basic waste types by households and waste producers; planning and building five waste collection and recycling facilities and/or general drop off points by 2025; planning and building at least one landfill equipped with gas-to-energy systems by 2025; and developing stand-alone bio-energy solutions. Seek to promote the use of the resulting sludge from the wastewater treatment process for the production of clean energy; seek to further develop and implement the Waste Roadmap for Cabo Verde, as well as regulate and implement the new General Solid Waste Law; seek to further develop and implement the water and sanitation master plans ("Planos Diretores de Água e Saneamento – PDAS"), as well as regulate and implement the new Water and Sanitation Code; and seek to improve governance, institutional and technical capacities by: collecting and organizing relevant data on waste generation; designing an intermunicipal integrated waste management system; and capacitating the public sector to engage with private sector operators and technology providers. |
| **Cambodia** | Reducing emissions from waste through use of biodigesters and water filters. |
| **Chad** | Elimination of solid waste and treatment of used water. |
| **Eritrea** | Planned adaptation goal for 2030: wastewater treatment plant established to treat 3 million $m^3$ of water/year. |

Table B1 | **Excerpts from First Round NDCs that Relate to Waste (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON WASTE |
|---|---|
| **Ghana** | Adopt alternative urban solid waste management: improve effectiveness of urban solid collection from 70 percent to 90 percent by 2030 and dispose all to an engineered landfill for phase out methane recovery from 40 percent in 2025 to 65 percent by 2030; scale up 200 institutional biogas systems in senior high schools and prisons nationwide; double the current waste to compost installed capacity of 180,000 tonne/annum by 2030. |
| **Guyana** | The government of Guyana will continue to work closely with farmers in agricultural areas across Guyana to encourage the use of biodigesters to reduce waste, produce biogas, and provide affordable, healthy, and efficient cooking means at the household level. |
| **India** | India recognizes the dual benefits that can arise from efficient waste disposal leading to enhanced environmental benefits along with conversion to energy. Incentives are being granted to cities to take up waste-to-energy conversion projects. |
| **Indonesia** | For the waste management sector, the government of Indonesia (GOI) is committed to develop a comprehensive strategy to improve policy and institutional capacity at the local level, enhance management capacity of urban waste water, reduce landfill waste by promoting the "reduce, reuse, recycle" approach, and the utilization of waste and garbage into energy production. The GOI is committed to further reduce emissions from the waste management sector by 2020 and beyond, through comprehensive and coherent policy development, institutional strengthening, improved financial and funding mechanisms, technology innovation, and social-cultural approaches. |
| **Jordan** | Developing a system for sorting, reusing, and recycling (KPI-style "target" to reduce percentage of solid waste that is disposed of in landfills from 80 percent to 60 percent in 2025 and increasing percentage of treated and reused solid waste from 20 percent to 40 percent in 2025). |
| **Kuwait** | Projects related to energy production from municipal solid waste where the first project will start operating by 2020. |
| **Lesotho** | Sustainable waste management systems: solid waste management, wastewater recycling, composting of biodegradable waste and possible methane recovery from landfills. |
| **Madagascar** | Biogas production from waste water; sustainable management (compost) of organic household waste (50 percent of waste treated in urban agglomerations). |
| **Malawi** | Mitigation interventions recommended are reduction of waste generation, recovery and use of landfill biogas, controlled waste incineration, and composting for organic manure as technological approaches to mitigate GHG emissions in the waste sector. |
| **Mauritius** | Sustainable and integrated waste management, including waste-to-energy. |
| **Monaco** | With regard to waste-to-energy, the Principality of Monaco has had a tri-generation plant since 1982, and this is due to be replaced soon. Reducing emissions from this source and from waste management more broadly is a priority for the government. |
| **Morocco** | National Household and Similar Waste Program: mainstream household waste management master plans and standardize them for all regions and provinces of the kingdom; improve the collection of household waste to achieve an urban collection rate of 90 percent by 2020 and of 100 percent by 2030; establish landfill and recycling centers for household waste for the benefit of all urban areas by 2020; rehabilitate or close all illegal landfills by 2020; make the management of the sector more professional; develop chains of "sorting-recycling-recovering" with sorting pilot projects to achieve a 20 percent rate for recycled materials by 2020; train and raise awareness of stakeholders on waste issues. |
| **Namibia** | Waste can be valorized through various systems to curb down emissions usually associated with the management practices being used presently. These will be reviewed to reduce emissions from both municipal solid waste and wastewater. It is planned to convert municipal solid waste and sludge from wastewater management systems from the main cities to energy. This measure will lead to a reduction of some 200 Gg $CO_2$-eq. Additional benefits such as a cleaner environment, better sanitation, with fewer risks for health problems will be reaped while the treated water can be used for irrigation to alleviate problems linked with water scarcity. |

Table B1 | **Excerpts from First Round NDCs that Relate to Waste (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON WASTE |
|---|---|
| **Qatar** | Qatar aims to use upgraded wastewater treatment plants to improve the treated water quality and further support using it for agricultural purposes to reduce the demand on fresh water and accordingly decrease the fuel consumption in water desalination and associated gaseous emissions. |
| **Sri Lanka** | The generation of methane from landfill sites is likely to be an acute problem. In almost all the municipal councils, landfill sites are located within the respective city limits, amidst the highly populated residential areas. One ton of biodegradable waste gives 300 liters of methane (0.4 tons of methane more than 8 tons of $CO_2$, equivalent GHG). Providing solutions to the issue of solid waste management solves the issues of health hazards, environment pollution, and addresses GHG emission reduction. The proposed NDCs for the waste sector directly or indirectly influence the reduction of GHG emissions in the waste sector by modifying, adopting, and applying appropriate technology during the period of 2020–30. |
| **United Republic of Tanzania** | Waste management systems in the country are being enhanced by encouraging private sector and community involvement in waste-to-energy management approaches; enhancing management of waste disposal sites; encouraging waste recycling and reuse; mapping and identifying informal dump sites; and implementing landfill gas recovery as well as electricity generation programs. |
| **Tunisia** | The mitigation plan provides for the implementation, from 2016, of a plan to install facilities to transform solid waste into refuse derived fuel intended for cement facilities, as well as a program for introducing degasification systems in controlled landfills. It is planned to recover electricity from captured gases, at least at the main landfills. This energy option is covered in the low-carbon scenario for the energy sector. |
| **United Arab Emirates** | The UAE will increase the amount of treated waste, and waste diverted from landfill, through a number of key initiatives, including: developing a federal law to regulate and oversee waste management; defining a federal roadmap for integrated waste; and, developing a federal database to gather and collect information regarding waste. |
| **Vietnam** | Develop waste management planning and enhance waste management capacity; promote reducing, reusing, and recycling waste; research and apply advanced waste treatment technologies; deploy modern waste treatment technology in urban and rural areas; strengthen the management and treatment of industrial and household wastewater; utilize landfill gas and solid waste combustion for power generation. |

# APPENDIX C: EXCERPTS FROM FIRST ROUND NDCS PERTINENT TO LIVESTOCK

Table C1 presents the excerpts from first round NDCs that include actions relating to livestock.

Table C1 | **Excerpts from First Round NDCs That Relate to Livestock**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON LIVESTOCK |
|---|---|
| **Afghanistan** | Agriculture and livestock (manure management, land use/change for agriculture). |
| **Angola** | The objective is to strengthen food security and DRR/M and increase the resilience of agro-pastoral livelihoods by increasing capacity to manage risks related to natural disasters at the level of communities and local institutions. The expected results are: improved agricultural and livestock production, health and animal nutrition, soil and water management and management of early warning systems. As a conditional adaptation option, Angola proposes to "study the implication of climate change on disease patterns for humans and livestock." |
| **Azerbaijan** | Azerbaijan listed "collect methane gas from manure of livestock and poultry" as part of its mitigation effort in the agricultural sector. |
| **Bangladesh** | Bangladesh listed "stress tolerant (salinity, drought and flood) variety improvement and cultivation (including livestock and fisheries)" as an adaptation priority. |
| **Belize** | Belize listed "increase access to drought tolerant crops and livestock breeds" as a main action to be implemented to build climate resilience. Belize listed "improve both crop and livestock husbandry practices" as a main action to be implemented to build resilience. |
| **Bhutan** | Bhutan listed "organic livestock farming and eco-friendly farm designs" and "improvement of livestock breeds, including conservation of native genetic gene pool/diversity" as climate-smart livestock farming practices for low-carbon emissions. Bhutan listed "livestock insurance against climate induced extremes" as a resilient livestock farming practice to reduce poverty. |
| **Botswana** | Botswana listed "improve livestock diet through supplementary feeding" as an adaptation priority. Botswana listed "improve genetic characteristics of the livestock breed such as Musi breed" as an adaptation priority. |
| **Brazil** | "In the agriculture sector, strengthen the Low Carbon Emission Agriculture Program (ABC) as the main strategy for sustainable agriculture development, including by restoring an additional 15 million hectares of 10 degraded pasturelands by 2030 and enhancing 5 million hectares of integrated cropland-livestock-forestry systems (ICLFS) by 2030." |
| **Burkina Faso** | Burkina Faso listed "five livestock breeding intensification zones are established within the country" as part of its adaptation effort. |
| **Burundi** | Burundi listed "enable the diversification of activities (breeding of multiple species of animals, combination of agriculture and livestock, sale of harvest transport services, fodder crops, etc.)" as a key measure to support the security of animal and fishing production. Burundi listed "improve agricultural and livestock production activities (drainage, conservation, drying, and cold chain) including the use of renewable energy sources (hydraulic, solar and wind)" as a key measure to support facilities that use renewable energy. Burundi listed "water control with a view to increasing agricultural and livestock production" as a priority action for its climate change adaptation effort. |
| **Cameroon** | Cameroon listed "promote agriculture-livestock integration, agroforestry, and conservation agriculture especially at the level of community and private plantations" as part of its mitigation effort in the agriculture/livestock/fisheries sector. Cameroon listed "Program 17: Reducing livestock vulnerability to the effects of climate change (REVEECC): Management of pastures, water points; Space management, mapping of terroirs; improvement of shifting cultivation; forage production" as part of its 2016–25 intervention strategy. |
| **Chad** | To secure migration of livestock and support the combining agriculture and livestock raising, Chad intends to "enable the diversification of activities (livestock of multiple animal species, combining of agriculture and livestock, sale of harvest transportation services, fodder crops, etc.)." To improve population well-being, Chad intends to "support social agreements between the various groups of livestock rearers and farmers in areas of transhumance." To improve population well-being, Chad intends to "improve agricultural production and livestock rearing activities (drainage, dry storage, cold chain) using renewable energy sources (hydroelectricity, solar, wind)." For control and management of water resources, Chad intends to "adapt arrangements for rain fed and flood-recession crops and livestock watering." Chad listed "reinforce the capacities of the stakeholders (farmers, fishermen, and livestock rearers) and their revenue-generating activities" as a priority in terms of climate change. |

Table C1 | **Excerpts from First Round NDCs That Relate to Livestock (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON LIVESTOCK |
|---|---|
| **China** | To increase carbon sinks, China plans to "to promote mechanism of maintaining the balance between grass stock and livestock." |
| **Colombia** | Colombia listed "10 subsectors of the agricultural sector such as rice, coffee, livestock and silvopastoral, with improved capabilities to adapt appropriately to climate change and variability" as a prioritized climate action of its 2030 adaptation effort. Given the significant share of agriculture, forestry, and other land use (AFOLU) emissions (emissions associated with livestock subsectors, agriculture, forestry, and other land use) in the national emissions profile (about 58 percent of the total), Colombia reaffirms its commitment to reduce deforestation in the country and to preserve important nine ecosystems, such as the Amazon region, given its huge potential to contribute to the stabilization of GHGs in the atmosphere. |
| **Comoros** | Comoros listed "the country benefits from an early warning system and effective intervention capable of intervening throughout the territory in case of emergence of new bovine or goat disease" as a 2030 main objective in terms of adaptation. |
| **Costa Rica** | Costa Rica is promoting its nationally appropriate mitigation action (NAMA) in the coffee sector, and developing NAMA proposals for livestock and biomass, and for a very important sector of its economy, small and medium enterprises. |
| **Côte d'Ivoire** | Côte d'Ivoire listed "development of basic infrastructure that will improve the logistics of transport of agricultural products, livestock and fish farming" as a measure to develop agriculture without its extension on the remaining forest areas. Côte d'Ivoire listed "promotion of the agriculture-livestock association, agroforestry, and conservation agriculture particularly at the level of community and private plantations" as being part of its agricultural development without extension on the remaining forest areas strategy. Côte d'Ivoire listed "promotion of the agriculture-livestock association, agroforestry, and conservation agriculture particularly at the level of community and private plantations" as part of its strategy for the intensification of environmentally sound agricultural, livestock, and fisheries production. Côte d'Ivoire listed "develop agro-pastoral dams to facilitate livestock watering" as a measure to reduce climate vulnerability in the water sector. Côte d'Ivoire listed "develop the agro-ecological approach (soil fertility management practices, development of the use of organic fertilizers and compost from household waste, the agriculture-livestock association)" as a measure to reduce climate vulnerability in the agriculture sector. |
| **Democratic People's Republic of Korea** | Korea listed "conduct scientific research for and develop methodologies of GHG emission reduction in agriculture and livestock breeding" as a mitigation measure to achieve the 2030 target of its NDC. Korea listed "use biogas from livestock manure and domestic sewage instead of coal or firewood for cooking" as a prioritized mitigation measure. |
| **Djibouti** | "Rural Community Development and Water Mobilization Project (PRODERMO): The main component of this project concerns surface water mobilization and sustainable land management. This encompasses, among other activities, the repair and construction of tanks for drinking water and livestock." |
| **Ecuador** | "In the agriculture and other land uses sector, the main contributions until 2025 include the following: the application of actions to reduce the vulnerability of the impacts of droughts, floods, frosts, and other climate change impacts in local planning with regards to the livestock sector in areas with a higher recurrence of these phenomena." As an adaptation effort in the agriculture and other land uses sector, Ecuador "will include the diffusion of technology and knowledge in the agriculture and livestock sector at the local level, as a tool for improving lifestyle and diversification of production." "Technologies that allow for further agricultural diversification and livestock production, as well as response capacity to the impacts of climate change will be identified, disaggregated, adapted, and assimilated." |
| **Egypt** | Egypt listed "achieve biological diversity of all livestock, fishery, and poultry elements to protect them and ensure food security" as part of its adaptation effort in the agricultural sector. |
| **Eritrea** | Eritrea listed "livestock production increased by 75 percent" as one of its 2030 adaptation goals. |
| **Federal Democratic Republic of Ethiopia** | Ethiopia listed "improving crop and livestock production practices for greater food security and higher farmer incomes while reducing emissions" as one of the four pillars to mitigate GHG emissions. Ethiopia listed "enhancing ecosystem health through ecological farming, sustainable land management practices and improved livestock production practices to reverse soil erosion, restore water balance, and increase vegetation cover, including drought tolerant vegetation" as medium- and long-term actions for its adaptation contribution. |

Table C1 | **Excerpts from First Round NDCs That Relate to Livestock (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON LIVESTOCK |
|---|---|
| **Gambia** | As part of the large-scale ecosystem restoration of the river Gambia Watershed, Gambia will work on "improving long-term planning and management through development of national and subnational land use policies and plans for crop and livestock production." "In addition to institutional strengthening, climate change adaptation priorities will be mainstreamed into national agriculture and livestock policies, plans, and programs." |
| **Ghana** | To build resilience in agriculture and vulnerable landscape, Ghana plans to "scale up penetration of climate-smart technologies to increase livestock and fisheries productivity by 10 percent." |
| **Honduras** | As part of the prioritized measures identified in its national strategy for climate change, Honduras plans the "implementation and diffusion of intensive livestock under housing." |
| **India** | The government of India adopted a mega project called the National Initiative on Climate Resilient Agriculture (NICRA). Its four main modules include natural resource management, improving crop production, livestock and fisheries, and institutional interventions. The National Agroforestry Policy (NAP) of India aims at encouraging and expanding tree plantation in complementarity and integrated manner with crops and livestock. It will help protect and stabilize ecosystems and promote resilient cropping and farming systems to minimize the risk during extreme climatic events. It will also complement achieving the target of increasing forest/tree cover. |
| **Kenya** | Kenya listed "enhance the resilience of the agriculture, livestock and fisheries value chains by promoting climate smart agriculture and livestock development" as a priority adaptation action. |
| **Lesotho** | Lesotho listed "improve resilience of livestock production systems under extreme climatic conditions in various livelihood zones in Lesotho" as prioritized climate change adaptation action. |
| **Liberia** | Liberia listed "develop climate resilient crop/agroforestry diversification and livestock production systems" as a measure supporting its adaptation effort in the agriculture sector. |
| **Madagascar** | Madagascar listed "widespread application of Resilient Agriculture Integrated Models in major agricultural centers, cash crop zones, extensive livestock farming areas, priority areas for fisheries, mangroves, as well as drought hotspots" as being part of its adaptation effort and to be undertaken between 2020 and 2030. |
| **Malawi** | The mitigation options for agriculture are: the promotion of sustainable intensification pathways for the livestock sector, including improved feeding, breeding, and veterinary services, as well as improved manure management. |
| **Mali** | "For the livestock and chemical fertilizer subsectors, the mitigation measure will focus on the substitution of nitrogen-rich urea with organic manure, the production of which will reduce decomposition-related manure emissions." Mali listed "research and development on adaptation of agriculture and livestock to climate change" as one its 2020 adaptation projects. |
| **Mexico** | Mexico listed "strengthen the diversification of sustainable agriculture by conserving germplasm and native maize species, thermal comfort for livestock, development of agro-ecosystems, through the incorporation of climate criteria in agriculture programs" as an adaptation action to be implemented during the period 2020–30. |
| **Moldova** | Moldova listed "develop technical solutions to cope with extreme weather events, to protect the crops and livestock" as an important agricultural adaptation measure at the local/farm level. Moldova listed "landscape management by maintaining landscape elements that provide shelter to livestock" as an important agricultural adaptation measure at the local/farm level. Moldova listed "introduce livestock species resilient to extreme temperatures and adapt the nutritional regime of livestock to demands caused by climate change" as an important agricultural adaptation measure at the local/farm level. |
| **Mongolia** | Mongolia listed "maintain livestock population at appropriate levels according to the pasture carrying capacity" as a mitigation measure in the agriculture sector. Mongolia listed "agriculture (development of a comprehensive plan for emission reductions in the livestock subsector for implementation between 2020 and 2030)" as an additional mitigation measure (additional to those already proposed for 2030). |
| **Morocco** | "National development of rangelands program and regulation of transhumant flows: first phase by 2020: develop rangelands in a way that will combat desertification, enhance livestock farmers' income and protect biodiversity." |

Table C1 | **Excerpts from First Round NDCs That Relate to Livestock (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON LIVESTOCK |
|---|---|
| **Mozambique** | Mozambique listed "increase the resilience of agriculture, livestock, and fisheries, guaranteeing the adequate levels of food security and nutrition" as one of the strategic actions to be included in the NAP. |
| **Myanmar** | In the livestock sector, actions have been taken in the recovery stages of areas affected by climate change through livestock management, loans for farmers, animal feed management research, and provision of training to minimize risk of disease. |
| **Namibia** | Namibia listed "increasing the number of livestock heads in feedlots to reduce enteric fermentation by some 4 percent" as a mitigation measure in the AFOLU sector. Namibia listed "shifting livestock to alternative grazing areas" as a long-term adaptation goal. Namibia listed "promotion of better adapted crop varieties and livestock species" as a priority adaptation action that is currently underway. |
| **Nigeria** | Nigeria listed "adopt improved agricultural systems for both crops and livestock (for example, diversify livestock and improve range management" as an adaptation strategy for agriculture. Nigeria listed "intensify crop and livestock production in place of slash and burn" as an adaptation strategy for agriculture. |
| **Pakistan** | Pakistan added "introduce feedstock mixes, dietary oils, and additives for livestock to reduce methane production from enteric fermentation" as a mitigation option with high emission reduction potential in the agricultural sector. |
| **Saint Kitts and Nevis** | Saint Kitts and Nevis listed "semi-intensive livestock farming" as a measure to increase climate resilience in the agricultural sector. |
| **Sierra Leone** | Sierra Leone listed "integrated management of crops and Livestock management" as a priority climate change response strategy. |
| **Somalia** | Priority adaptation measures that emerged from the consultation included the need for protection of critical water resources through the construction of medium- to large-scale water storage infrastructure (e.g., reservoirs) including diversions for irrigation, livestock watering points, and boreholes. |
| **South Sudan** | Climate change is negatively impacting the livelihood of the populations. "South Sudan will thus embark on promoting sustainable, climate-smart agriculture and livestock production and management." "The country will prioritize the enhancement of climate resilience in the agricultural sector (crop production, livestock, fisheries) through the promotion of climate-smart agriculture, livestock improvement, enhancement of fisheries productivity and soil erosion control." |
| **Sri Lanka** | Sri Lanka listed "identification of vulnerability in the livestock sector" and "identification of vulnerabilities in livestock species" as a measure to build resilience in the livestock sector. Sri Lanka listed "identification of potential clean and renewable energy sources for livestock-related activities" as an adaptation measure. Sri Lanka listed "promotion of green livestock procedures and processing techniques" and "promotion of consumption of green livestock products" as options for sustainable responsible consumption and sustainable production. Sri Lanka listed "conduct awareness and educational programs on smart green livestock activities" as a measure for enhancing education, awareness, and capacity building. |
| **Sudan** | Sudan listed "forest plantations and more balanced livestock production" as part of its REDD+ strategy. |
| **Swaziland** | Swaziland listed "livestock selective breeding" as an adaptation measure in the agriculture sector. |
| **Timor-Leste (East Timor)** | Timor-Leste listed "improve planning and legal framework for promoting sustainable and balanced food for livestock production under increased climate variability and climate change conditions" as an adaptation measure. Timor-Leste listed "promotion of biogas and composting for reduction of agricultural emissions" as a livestock management strategy. |
| **Togo** | "Concerning livestock, the actions will involve the introduction of fodder to improve animal digestion, support in the promotion of local breeds, and extensive livestock farming." Togo listed "construction and/or improvement of reservoirs for micro-irrigation and livestock watering in rural areas throughout all regions" as a priority adaptation measure in the agricultural sector. "For farmland, a study will be conducted to characterize it into agro-ecological zones, as well as a research and support programme on organic and synthetic enriching agents that release less GHG, the study and promotion of optimal waste management for livestock and harvest remnants, and the promotion of land use planning practices that boost carbon's binding to farmland and agroforestry." |
| **Tunisia** | Tunisia listed "adapting mixed farming-livestock production to climate change in vulnerable regions" as an adaptation measure in agriculture. |

Table C1 | **Excerpts from First Round NDCs That Relate to Livestock (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON LIVESTOCK |
|---|---|
| **Uganda** | Uganda listed "expanding diversification of crops and livestock" as a priority adaptation measure. |
| **United Republic of Tanzania** | Tanzania listed "enhancing development of livestock infrastructures and services," "promoting development of livestock insurance strategies," and "promoting livelihood diversification of livestock keepers" as intended adaptation contributions in the livestock sector. |
| **Uruguay** | Uruguay listed "adoption of good practices of natural grasslands management in livestock production in 3,000,000 ha (30 percent of grasslands), thus avoiding the loss of soil organic carbon, and favoring carbon sequestration towards 2025" as a main mitigation measure of its NDC contribution. |
| **Venezuela** | "Promote research, innovation, and the production of technological inputs under environmental impact, as well as the rescue of ancestral technologies for agricultural and livestock production and processing, among others, increasing the efficiency and productivity indexes." "Promote the technological adaptation for a transformation of the productive sector, in a sustainable manner, with special emphasis on the energy, agricultural and livestock sector, incorporating the principle of prevention and management of solid and hazardous waste." |
| **Vietnam** | Vietnam listed "ensure food security through protecting, sustainably maintaining and managing agricultural land; restructuring of crops and livestock; create new climate change resilient varieties; complete the disease control and prevention system" as an adaptation measure to ensure social security. "Research and develop solutions to reduce GHG emissions in farming, livestock, fisheries, and animal feed and food processing." |
| **Yemen** | Yemen listed "Rain-fed Agriculture and Livestock Project" as a main program under adaptation. Yemen listed "promoting agriculture drought management as well as sustainable crop and livestock management" as a measure to address climate vulnerability of the agricultural sector. |
| **Zambia** | Zambia listed "guaranteed food security through diversification and promotion of climate-smart agricultural (CSA) practices for crop, livestock, and fisheries production, including conservation of germplasm for land races and their wild relatives" as a priority adaptation action in the agriculture sector. Zambia listed "promote livestock CSA practices through: improved feed management, improved animal health, improved rangeland management and use of drought-tolerant breeds" as a key adaptation activity in agriculture. |
| **Zimbabwe** | Zimbabwe listed "promoting the use of indigenous and scientific knowledge on drought tolerant crop types and varieties and indigenous livestock that are resilient to changes in temperatures and rainfall" as an adaptation intervention to promote climate-smart agricultural practices. |
| **Republic of Moldova** | Moldova listed "develop technical solutions to cope with extreme weather events, to protect the crops and livestock," "improve ventilation and air conditioning systems of livestock farms," "landscape management by maintaining landscape elements that provide shelter to livestock," and "introduce livestock species resilient to extreme temperatures and adapt the nutritional regime of livestock to demands caused by climate change" as important adaptation measures at the local/farm level. |
| **State of Palestine** | Palestine listed "improve livestock-production pens" as an adaptation action to address the high climate vulnerability of livestock production. "Adoption of climate-smart production practices and more resource-efficient post-harvest processing practices in agricultural value chains (including fruit trees, vegetables, field crops and livestock) that reduce greenhouse gas emissions and increase carbon sequestration in plant biomass and soil organic matter. The objective is for at least 50 percent of farms in the State of Palestine to apply climate-smart agriculture by 2040." Palestine listed "enhancing agricultural value chain and improving infrastructure for livestock-production" as an adaptation measure to address domestic food price vulnerability to climate change. |

# APPENDIX D: EXCERPTS FROM FIRST ROUND NDCS PERTINENT TO RICE

Table D1 presents the excerpts from first round NDCs that include actions in the rice sector.

Table D1 | **Excerpts from First Round NDCs That Relate to Action in the Rice Sector**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON RICE |
|---|---|
| **Afghanistan** | Afghanistan listed "rice paddies: modified rice strains" among the list of climate actions contributing to its 2030 mitigation effort. |
| **Bangladesh** | Bangladesh listed "scale up rice cultivation using alternate wetting and drying irrigation" as a possible mitigation measure. |
| **Burkina Faso** | Burkina Faso listed "1,000 ha per year of bottom lands are developed and enhanced, associated with the system of rice intensification (SRI)" as part of the series of adaptation measures planned in the AFOLU sectors. |
| **Benin** | To promote hydro-agricultural developments, Benin proposed the "development and irrigation of 52,000 ha of rice plots with water control" as a planned mitigation measure. |
| **Burundi** | Upon availability of financial support, Burundi plans to develop a program for "intermittent drainage in rice cultivation." |
| **Cambodia** | In Cambodia's NDC, "promoting use of renewable energy and adopting energy efficiency for garment factory, rice mills, and brick kilns" is listed as potential mitigation measure in manufacturing and industries. |
| **Cameroon** | To promote practices that will improve agricultural production capacity and reduce GHG emissions, Cameroon proposed to "limit methane emissions from rice growing by minimizing flooding." To valorize resources in rural areas (including waste resources), Cameroon proposed to "develop energy production based on agricultural wastes, notably through the upgrading of cocoa pods, cashew apples, sugarcane bagasses, molasses, cassava effluents, rice straw for the production of briquettes; etc." |
| **China** | To build on energy efficiency and low-carbon industrial system, China plans to "control methane emissions from rice fields and nitrous oxide emissions from farmland." |
| **Colombia** | Priority measure for adaptation by 2030: "10 subsectors of the agricultural sector such as rice, coffee, livestock, and silvopastoral, with improved capabilities to adapt appropriately to climate change and variability." |
| **Côte d'Ivoire** | To intensify environmentally sound agricultural production, Côte d'Ivoire aims for a "maximum reduction in rice submersion to limit methane emissions." |
| **Democratic People's Republic of Korea** | As a prioritized mitigation measure, North Korea wants to "build the rice husk cogeneration plants." |
| **Egypt** | Egypt listed "rice cultivation" as a GHG emissions reduction action in non-energy sectors. |
| **Gambia** | Upon financial and technological support, Gambia plans to "reduce methane emissions from flooded rice fields by replacing them with efficient dry upland rice." |
| **Guinea** | To build community resilience and revive economic activities, Guinea plans to "develop rice production by improving yields through use of varieties better able to cope with the impact of climate change (particularly ingress of salt water)." As part of its forest management strategy, Guinea plans to "stabilize the area of mangroves between now and 2030 (peak deforestation in 2020; more systematic replanting measures will have been introduced by then, together with measures in respect of technological alternatives to limit wood-energy consumption and measures to intensify rice production)." |
| **Lao People's Democratic Republic** | To advance appropriate technologies for climate change adaptation, Lao is planning to "promote two seasons rice cultivation in flood area by adaptive and short rotation rice varieties." |
| **Japan** | As a non-energy GHG reduction action, Japan is planning "measures to reduce $CH_4$ emissions from agricultural soils (reduction of $CH_4$ emissions from paddy rice fields)." |
| **Madagascar** | Madagascar listed "large-scale dissemination of intensive/improved rice farming techniques (SRI/SRA)" as a major mitigation action to achieve an emission reduction of at least 14 percent by 2030. Madagascar also listed the "promotion of intensive/improved rice farming system and rain-fed rice farming technique" as a priority action to be achieved before 2020. |

Table D1 | **Excerpts from First Round NDCs That Relate to Action in the Rice Sector (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON RICE |
|---|---|
| **Mali** | "For the irrigated rice subsector, mitigation will focus on water management through intermittent irrigation to avoid permanent flooding of rice-growing land as a source of fermentation emissions." One of the main actions that is foreseen in Mali's GHG reduction effort in agriculture is the use of "intensive rice cultivation system (IRS)" techniques. |
| **Mauritania** | Mauritania's ambition agenda for adaptation in 2030 includes "a food requirement ratio of 117 percent for rice, 80 percent for wheat, 75 percent for traditional cereals; 160 percent for milk, 126 percent for white meat." |
| **Malawi** | Malawi listed "increase use of soil-cement stabilized block and rice husk ash blended cement to around 10 percent of current cement production" to reduce GHG emissions from industrial processes. |
| **Malaysia** | To strengthen food security, Malaysia's NDC mentioned that "new granary areas and adequate and efficient irrigation and drainage infrastructure will be developed to increase the production of rice." |
| **Myanmar** | "The Ministry of Agriculture and Irrigation is researching alternative wet and dry paddy production techniques" to reduce GHG emissions from rice paddies. "Research is being carried out on the resilience of rice varieties' resilience to drought, flood tolerance, salt tolerance and into alternative varieties that are resistant to pests and disease." |
| **Pakistan** | As a priority mitigation measure, Pakistan plans to "manage water in rice cultivation to control release of methane from agricultural soils and introduce low water dependent rice varieties." |
| **Senegal** | As a conditional adaptation measure in its agriculture sector, Senegal plans to use Intensive Rice System (SRI). This is estimated to result in an "economy of almost 40 percent in water compared to traditional flooded rice cultivation." |
| **Somalia** | The rehabilitation of the Fanoole Dam will help to "facilitate the irrigation of rice and sesame farms and to regain their productive capacity." "Crop production machinery and equipment, transport vehicles, and processing of rice shall be acquired to facilitate production of processing rice and other products." |
| **Togo** | Togo identified agriculture as one of its priority sectors to reduce GHG emissions. The country listed "the identification and promotion of varieties of rain-fed rice, and support and guidance in the better use of organic matter (for faster decomposition) in the paddy field" as a mitigation measure in this specific sector. |
| **Uruguay** | Uruguay listed the "introduction of intermittent irrigation technology with alternate wetting and drying (AWD) of soils in at least 10 percent of the rice crop area (16,000 ha) by 2025" as a main mitigation measure to achieve the unconditional mitigation objectives of its NDCs. |

# APPENDIX E: EXCERPTS FROM FIRST ROUND NDCS PERTINENT TO COOKSTOVES

Table E1 presents the excerpts from first round NDCs that include actions relating to clean cookstoves.

Table E1 | **Excerpts from First Round NDCs That Relate to Cookstoves**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON COOKSTOVES |
|---|---|
| **Afghanistan** | Afghanistan listed "clean cookstoves" as part of its 2030 mitigation contribution. |
| **Bangladesh** | As part of the objective to reach 70 percent market share of improved biomass, Bangladesh proposed the action to "support the replacement of biomass with LPG for cooking purposes."<br>Counting as part of its unconditional mitigation effort "more than 1.5 million improved cookstoves and 4 million solar home systems have already been distributed across the country" in Bangladesh. Bangladesh listed "put in place policy mechanisms to incentivize the uptake of improved (more efficient) gas cookstoves" as a possible conditional mitigation action for its contribution. |
| **Belize** | To reduce fuel wood consumption, Belize is looking into the use of more efficient cookstoves. "Emissions savings potential of efficient cookstoves comes from a reduction of wood used for the same result." |
| **Benin** | As a program for strengthening energy efficiency actions (2021–30), Benin intends to "support for the organization and development of internal markets for the production and marketing of efficient cooking equipment (improved stoves using wood energy, butane gas cooking equipment)." "Saving wood energy by promoting access to (i) 140,000 new households improved fireplaces and (ii) 275,000 households with cooking equipment." |
| **Burkina Faso** | Burkina Faso listed "540,000 improved cookstoves are produced and distributed, at least 50 percent in urban and semi-urban areas" as a mitigation measure in its biomass energy sector. Burkina Faso listed "promotion of dolo cookstoves with the aim of reaching 97 percent of dolo brewers at the 2030 horizon" as a priority adaptation action. Burkina Faso listed "production and distribution of improved cookstoves in urban and semi-urban areas" as a priority adaptation action. |
| **Cabo Verde** | As a measure in its forestry sector "Cabo Verde also aims at eliminating three stone cooking stoves (35 percent of households still use three stone stoves) through improved low-emissions cookstoves by 2025 at the latest, and thereby substantially removing demand for firewood." |
| **Cambodia** | Cambodia listed "promoting energy efficiency for buildings and more efficient cookstoves" as a key sectoral mitigation action for its 2030 contribution. As part of the implementation of the Climate Change Action Plan for Manufacturing Industry and Energy Sectors (2014–18), Cambodia listed the climate action "efficient cookstoves." |
| **Central African Republic (CAR)** | As its fifth adaptation option—improvement and development of basic infrastructure—CAR listed "promote the use of improved cookstoves" as an adaptation measure. |
| **Cuba** | Cuba's new energy policy provides, among other programs, "the replacement of 2 million electric resistance cookers by induction cookers." |
| **Democratic People's Republic of Korea** | As a prioritized conditional mitigation measure, North Korea plans "to use biogas from livestock manure and domestic sewage instead of coal or firewood for cooking." As a prioritized conditional mitigation measure, North Korea plans "to replace conventional wood stoves for cooking with efficient wood stoves at rural households." |
| **Djibouti** | As a priority mitigation measure under study or pending funding, Djibouti plans to "decrease in the consumption of wood for cooking, estimated at 56,100 tons each year, through the replacement of 1,000 units by systems that use LPG." |
| **Gambia** | Gambia plans to reduce firewood consumption via "efficient cookstoves." |
| **Ghana** | To achieve its mitigation goal by 2030, Ghana plans to "expand the adoption of market-based cleaner cooking solutions." To achieve its mitigation goal by 2030, Ghana plans "to scale up access and adoption of 2 million efficient cookstoves up to 2030." |
| **Guyana** | "The government of Guyana will continue to work closely with farmers in agricultural areas across Guyana to encourage the use of biodigesters to reduce waste, produce biogas, and provide affordable, healthy, and efficient cooking means at the household level." |

Table E1 | **Excerpts from First Round NDCs That Relate to Cookstoves (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON COOKSTOVES |
|---|---|
| **Lesotho** | Lesotho built a project for the "dissemination of efficient biomass cookstoves and efficient biomass space heating stoves" as part of its mitigation contribution effort by 2030. |
| **Liberia** | Capture methane gas emitted from landfills and use for fueling vehicles, cooking at home or generation of power. |
| **Liberia** | The energy sector is the highest GHG contributor in Liberia. "Replacing cooking stoves with low thermal efficiency (5–10 percent) with the higher efficiency (40 percent) stoves" is a proposed measure to decarbonize the energy sector. Upon support from the international community, Liberia plans to "produce and distribute 280,543 energy-saving cookstoves that use fuel wood and 308,004 energy-saving cookstoves that use charcoal by 2030" to facilitate the implementation of its NDC. |
| **Malawi** | Malawi proposed to unconditionally "distribute energy saving cookstoves to 400,000 households" as part of its mitigation contribution. To reduce pressure on its national forest, Malawi wants to "promote use of biofuels for lighting and cooking, replacing fossil-based fuel." |
| **Marshall Islands** | To advance its NDC, the Marshall Islands plan to "transition to electric and solar cookstoves from LPG cookstoves." |
| **Morocco** | As part of its "Energy Efficiency Cook-Stove Program 2010–2030" Morocco planned the "distribution of 1,600 cookstoves per year between 2010 and 2015, and of 6,000 cookstoves per year between 2016 and 2030 to reduce forest fuel wood consumption when compared to traditional cookstoves, to provide for coastal side inhabitants' cooking and heating needs." |
| **Myanmar** | As part of a comprehensive plan for Dry Force Zone Greening (2001–31), Myanmar plans "to increase the number of energy efficient cookstoves disseminated in order to reduce the amount of fuel wood used for cooking." |
| **Nepal** | As part of its strategy to recover from the fuel crisis that started in September 2015, Nepal plans to "increase the share of biogas up to 10 percent as energy for cooking in rural areas" and "equip every household in rural areas with smokeless (improved) cooking stoves (ICS) by 2030." |
| **Somalia** | As part of the UN Joint Programme on Sustainable Charcoal Production and Alternative Livelihoods (PROSCAL) to Mitigate Against Deforestation, Somalia is planning an "accelerated diffusion of energy efficient cookstoves for reduction in charcoal consumption." |
| **Timor-Leste (East Timor)** | Timor-Leste listed "reduce the average amount of fuel wood used for cooking in private households, and thereby deforestation) by introducing fuel substitution and supporting the use of energy efficient cookstoves" as a potential mitigation option for its contribution. |
| **Zambia** | As part of its sustainable forest management strategy, Zambia is planning for "improved cooking devices to include improved biomass stoves, use of ethanol and LPG stoves, and switch to electric stoves." |
| **Ecuador** | To reduce its emissions in the energy sector to 20.4–25 percent below BAU (scenario 1) or 37.5 and 45.8 percent below BAU (scenario 2), Ecuador plans the "incorporation of 1,500,000 induction stoves in the first scenario and 4,300,000 in the second scenario." |
| **Comoros** | Comoros listed "Improved cookstove" as a mitigation action to achieve its NDC. |
| **Eritrea** | Eritrea listed "efficient wood stoves" as a conditional GHG reduction option for its overall NDC mitigation effort. |
| **Ethiopia** | "Ethiopia's greatest emission reduction potential is in the agriculture and forestry sectors, constituting 85 percent of emissions in 2010. Therefore, one of the priority initiatives under the Climate Resilient Green Economy Strategy is the use of more efficient stoves, amounting to an emissions reduction rate of 50 $MtCO_2e$ per year by 2030." |
| **Guinea** | To reduce wood energy consumption "several programs to disseminate improved stoves have therefore been put together and implemented since 1985 [...] The Integrated Programme of Access to Modern Energy Services (PRONIASE) plans to disseminate 10,000 improved wood- and charcoal-fired stoves and 2,000 improved charcoal production kilns in 2015. Another program aims to develop efficient wood-fired stoves for rural areas." |
| **Honduras** | "Through the NAMA of efficient stoves, the consumption of firewood in families is expected to be reduced by 39 percent, helping to combat deforestation." |

Table E1 | **Excerpts from First Round NDCs That Relate to Cookstoves (continued)**

| COUNTRY | EXCERPT FROM NDC RELATING TO ACTION ON COOKSTOVES |
|---|---|
| **Haiti** | Upon support from the international community, Haiti will "promote the use of energy-efficient stoves to replace traditional fireplaces (energy savings of 25–30 percent per stove)" to support its NDC mitigation effort. |
| **Madagascar** | Madagascar listed "disseminate improved stoves (by 2030: 50 percent of households adopting improved stoves)" as a major action of its contribution effort. |
| **Malawi** | To better manage energy utilization, Malawi plans to "distribute energy-saving cookstoves to 400,000 households" and to "increase the number of households adopting energy-saving stoves to 2,000,000 by 2030." |
| **Mongolia** | "Reduce fuel use in individual households through improving stove efficiency (with the cobenefit of air pollution reduction)" is marked as an additional action planned by Mongolia to contribute to the global mitigation effort. |
| **Niger** | Niger listed "reduction in the demand for wood energy per inhabitant by the mass spread of improved cookstoves, with a rate of penetration of 100 percent in urban areas and 30 percent in rural areas; promotion as domestic gas of biogas and biofuels at both the industrial and family level" as an energy measure contributing to its 2030 GHG emission reduction strategy. |
| **Nigeria** | "Efficient cookstoves are one way to reduce fuel demand, and alternative heating sources such as LPG could be provided." |
| **Pakistan** | Pakistan listed "efficient stoves" as among the top high priority mitigation options in the energy demand sector. |
| **Republic of Congo** | In a low-carbon conditional perspective, the Republic of Congo proposed to "generalize the use of improved stoves (20 percent in 2025 and 50 percent in 2035)." |
| **Rwanda** | As part of its strategy to promote environmentally sustainable use of biomass fuels, "Rwanda intends to increase the diffusion of improved cookstoves and reach 100 percent of all households in need by 2030." |
| **Sierra Leone** | As part of its pre-2020 GHG emissions reduction plans, Sierra Leone proposed "expanding clean energy utilization (e.g., solar, mini-hydroelectric power, LPG, biomass stoves etc.)." |
| **Togo** | Among its technology transfer needs, Togo listed "produce and popularize energy-efficient stoves using wood, charcoal, and gas among all of the country's social strata (a process that will need to begin with subsidies or appropriate tax benefits)." To reduce GHG emissions from its energy sector, biomass utilization needs to be better managed. "This will entail the implementation of a proactive policy (with incentives, support and training for craftsmen, appropriate distribution channels, etc.) that can promote the rollout of energy-efficient stoves, which can yield 50–60 percent savings in wood and charcoal." |
| **Uganda** | As part of its mitigation contribution "Uganda aims to build on existing Clean Development Mechanism (CDM) projects and Programmes of Activities pipeline, such as the Bujagali Hydropower Project and Improved Cookstoves for East Africa." Contingent upon support from the international scene, Uganda is envisioning the "promotion and wider uptake of energy-efficient cooking stoves or induction cookers." |

## ENDNOTES

1. Applicable to Parties whose NDC contains a time frame up to 2025 (UNFCCC 2015, para 23).
2. Applicable to Parties whose NDC contains a time frame up to 2030 (UNFCCC 2015, para 24).
3. Read more about the Kigali Amendment to the Montreal Protocol in section 4.1.
4. The "Towards Carbon Neutrality" coalition, led by New Zealand and the Marshall Islands, includes 16 countries that have committed to publish by 2018, and no later than 2020, a "carbon neutrality" path by 2050.
5. The initial strategy envisages for the first time a reduction in total GHG emissions from international shipping as follows: to peak as soon as possible and to reduce the total annual GHG emissions by at least 50 percent by 2050 compared to 2008 levels, while, at the same time, pursuing efforts toward phasing them out entirely.
6. The GWP for methane includes indirect effects of tropospheric ozone production and stratospheric water vapor production.
7. This is over a 100-year time horizon, which is the same time horizon adopted by the UNFCCC. However, as noted in Box 2, no single GWP value is optimal for all policy goals.
8. IEA's current policy scenario considers the impacts of those policies and measures that are firmly enshrined in legislation.
9. This is over a 100-year time horizon, which is the same time horizon adopted by the UNFCCC. However, as noted in Box 2, no single GWP value is optimal for all policy goals.
10. For more about the groups, see UNEP 2016.
11. While HCFC-22 is not a GHG itself, the production of HCFC-22 releases HFC-23, which is a potent GHG. HFC-23 has the highest GWP among all HFC gases (IPCC 2013).
12. UNFCCC gases include $CO_2$, $CH_4$, $N_2O$, HFCs, PFCs, $SF_6$, and $NF_3$.
13. See the Science-Based Targets website, https://sciencebasedtargets.org/.

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## ACKNOWLEDGMENTS

We are pleased to acknowledge our institutional strategic partners, who provide core funding to WRI: Netherlands Ministry of Foreign Affairs, Royal Danish Ministry of Foreign Affairs, and Swedish International Development Cooperation Agency.

The authors would like to thank the following people for their review, feedback, and inputs: Daniel Benefor, Nathan Borgford-Parnell, Carmen Gloria Contreras, Andrés Flores, Karen Florini, Dan Lashof, Kelly Levin, Dan McDougall, Le Nguyet Minh, James Morrisey, Ed Pomfret, and Jessica Seddon. While our colleagues were very generous with their time and input, this working paper reflects the views of the authors alone.

Thank you also to Kelsey Lopez, Romain Warnault, Carni Klirs, and Lauri Scherer for providing administrative, editing, and design support.

Funding from the Pisces Foundation made this analysis possible. We appreciate their support.


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