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Updated compilation of information on the mitigation benefits of actions, initiatives and options to enhance mitigation ambition

Technical paper

Addendum

Technical examination process to unlock mitigation potential for raising pre-2020 ambition by addressing non-carbon dioxide greenhouse gas emissions

Summary

This updated technical paper compiles information on the mitigation and sustainable development benefits of actions, initiatives and options to enhance mitigation ambition, with a focus on the thematic areas of land use, urban environments, carbon dioxide capture, use and storage, and non-carbon dioxide greenhouse gas emissions. Information for the update was provided in literature, submissions from Parties and observer organizations, and at the technical expert meetings held during the sessions of the Ad Hoc Working Group on the Durban Platform for Enhanced Action held in June and October 2014 in Bonn, Germany. The technical paper builds upon the previous version of the technical paper, contained in document FCCC/TP/2014/3 and its addendum FCCC/TP/2014/3/Add.1.

This technical paper consists of the main document and four addenda. The addenda are focused on mitigation action in the thematic areas of land use, urban environments, carbon dioxide capture, use and storage, and non-carbon dioxide greenhouse gas emissions. The addenda elaborate on mitigation potential, progress, benefits, costs and barriers, as well as on good practice policies, key opportunities and options for catalysing action in these four thematic areas.

Contents

I. Introduction

1. This update of the technical paper on mitigation benefits of actions, initiatives and options to enhance mitigation ambition was requested by the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) at the third part of its second session.[1] The first and second versions of this technical paper were published on 28 May and 30 October 2013, respectively, and are contained in documents FCCC/TP/2013/4 and FCCC/TP/2013/8 and Add.1 and 2.

2. It comprises four parts: the main text, contained in document FCCC/TP/2014/13, and four addenda, contained in documents FCCC/TP/2014/13/Add.1–4. The main text contains a summary of the main findings, substantiated by the more detailed information provided in the addenda, which capture the content of the discussions that took place at the technical expert meetings (TEMs) on land use, urban environments, carbon dioxide capture, use and storage (CCUS) and non-carbon dioxide (non-CO_2) greenhouse gas (GHG) emissions, held in June and October 2014 in Bonn, Germany, during the fifth and sixth parts of the second session of the ADP.[2]

3. This addendum covers the discussions on non-CO_2 GHG emissions and consists of two parts, focusing on mitigation potential, progress, benefits, costs and barriers; and practices, policies and actions to unlock mitigation potential in relation to non-CO_2 GHG emissions.

II. Technical summary on non-carbon dioxide greenhouse gas emissions

A. Mitigation potential, progress, benefits, costs and barriers

4. In 2010, non-carbon dioxide (non-CO_2) greenhouse gas (GHG) emissions amounted to around 12 Gt CO_2 equivalent (CO_2 eq) and accounted for about 25 per cent of total anthropogenic GHG emissions, with methane (CH_4) (contributing 16 per cent) and nitrous oxide (N_2O) (contributing 6 per cent) as the main contributors, as demonstrated in figure 1 below (IPCC, 2014). Other non-CO_2 GHGs include fluorinated gases (F-gases), such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

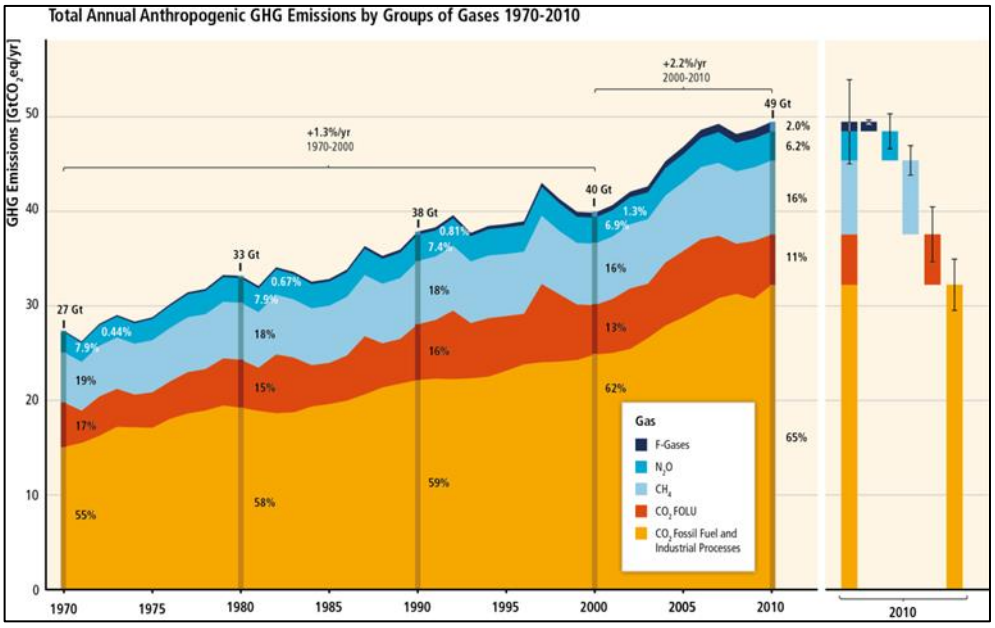
5. These gases are emitted from a broad range of sectors and sources, namely: CH_4 is mostly emitted from fossil-fuel extraction and combustion, industrial processes, enteric fermentation, rice cultivation, other agricultural sources, manure management and the waste sector; N_2O is mostly emitted from industrial processes, agricultural soils, manure management and wastewater; and F-gases are mostly emitted from industrial processes (see table 1 below) (EPA, 2014a).

[1] FCCC/ADP/2013/3, paragraph 30(c)(ii).

[2] Detailed information on the TEMs held in June and October 2014, including the initial summaries of the discussions at the meetings, is available at <http://unfccc.int/bodies/awg/items/8171.php>, <http://unfccc.int/bodies/awg/items/8170.php>, <http://unfccc.int/bodies/awg/items/8421.php> and <http://unfccc.int/bodies/awg/items/8420.php>.

Figure 1

Total annual anthropogenic greenhouse gas emissions by groups of gases for the period 1970–2010



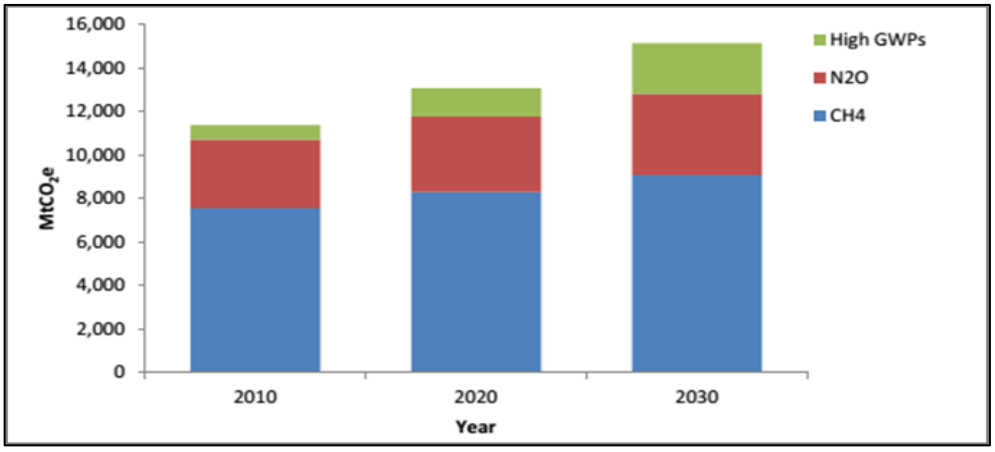
Source: Intergovernmental Panel on Climate Change. 2014. Summary for Policymakers. *In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

Abbreviations: F-gases = fluorinated gases, FOLU = forestry and other land use.

6. The non-CO_2 GHGs have in common a higher global warming potential (GWP) than CO_2, while CH_4 and some HFCs have a shorter lifetime than CO_2 (IPCC, 2013; EPA, 2012). The mitigation of CH_4 and most HFCs can help to reduce the global short-term temperature rise, which might reduce the risk of dangerous climate feedbacks (IEA, 2013).

7. The report by the Unites States Environmental Protection Agency (EPA), *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions* (EPA, 2012) provides projections that indicate that non-CO_2 GHG emissions could rise to 15 Gt CO_2 eq (the projections range between 9 and 17 Gt CO_2 eq) by 2030 under a 'business-as-usual' scenario (EPA, 2012). This level is expected to correspond to a 50 per cent increase compared with 1990 levels. The projections are sensitive to changes in key assumptions regarding, for example, the growth of agricultural production as a result of increased meat consumption or changes in consumer preferences, and market penetration of cooling equipment with HFC emissions with a lower GWP (EPA, 2012).

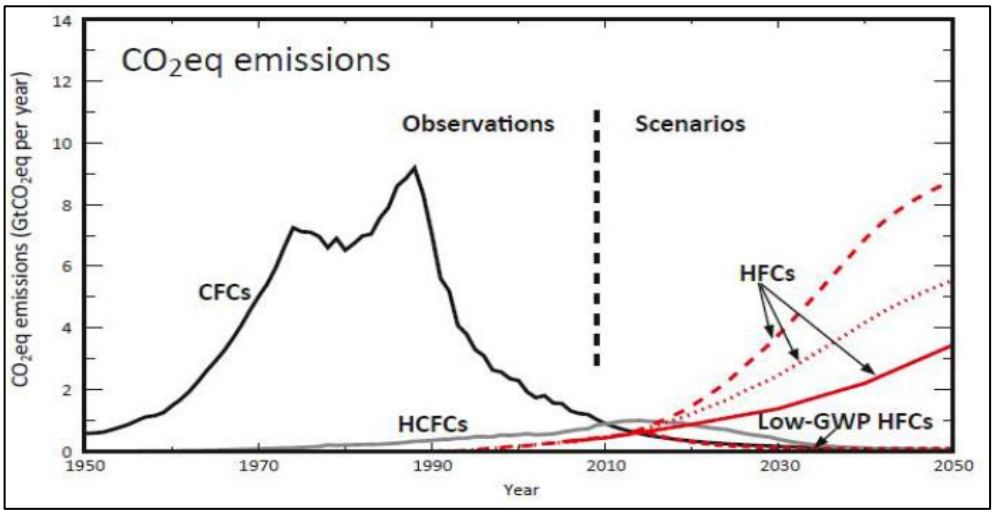
Figure 2
Projections of non-CO_2 emissions growth by 2030, by gas



Source: United States Environmental Protection Agency. 2013. *Global Mitigation of Non-CO_2 Greenhouse Gases 2010–2030*.
Abbreviation: GWPs = global warming potentials.

8. The EPA report also indicates that CH_4 and HFCs are expected to increase the most and to be the largest absolute contributors to the growth of non-CO_2 GHG emissions between 2010 and 2030, as shown in figure 2 above, while N_2O emissions are expected to experience a more modest increase. HFCs are currently growing at a rate of 8 per cent per year,[3] due to their use as replacements for ozone-depleting substances that are controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer (see figure 3 below), and due to the increased demand for cooling due to economic development, population growth and projected temperature rise (EPA, 2012).

Figure 3
Observed and projected emission trends for the period 1950–2050, by gas



[3] Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) technical expert meeting (TEM) on non-CO_2 GHG emissions; presentation by the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC), 2014.

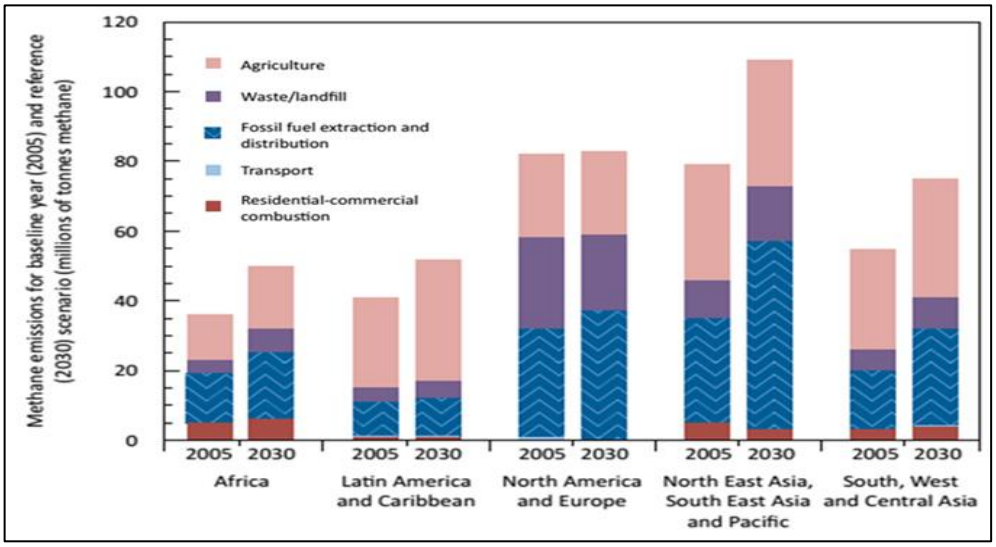
Source: Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on non-CO_2 greenhouse gas emissions; presentation by the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, October 2014.

Abbreviation: GWP = global warming potential.

9. Similarly to HFCs, economic development and population growth are the main drivers for the growth in CH_4 emissions, along with specific drivers such as large increases in livestock production (especially in developing countries), and increased waste generation rates (see figure 4 below). Countries with more advanced economies and stable or declining populations are likely to experience a minimal growth in CH_4 and N_2O emissions between 2005 and 2030 (EPA, 2012).

Figure 4

Observed and projected CH_4 emissions by 2005 and 2030, by subsector and by region



Source: United Nations Environment Programme. 2011. *Near-term Climate Protection and Clean Air Benefits: Actions for Controlling Short-Lived Climate Forcers.*

10. N_2O and CH_4 emissions from agriculture are projected to grow, driven by the need to meet the growing demand for food that stems from economic and population growth, and the need to meet sustainable development objectives, in particular in developing countries.[4]

1. Mitigation potential and practices

11. The mitigation potential of non-CO_2 GHG emissions is estimated by EPA at 1.8–3.0 Gt CO_2 eq by 2030 compared with the baseline emissions in 2005 (EPA, 2012). This mitigation potential means that efforts to reduce non-CO_2 GHGs must be viewed as a strategy that complements but does not replace CO_2 emission reductions.

12. As noted in paragraph 5 above, non-CO_2 GHGs are emitted from a broad range of sectors and sources. The available mitigation potential could be utilized through a combination of mitigation policies and options with the engagement of multiple stakeholders (EPA, 2014a).[5] The scale of this potential varies by sector (see table 1 above). With regard to the agriculture sector, the Food and Agriculture Organization of the United Nations (FAO) provides estimates of the mitigation potential of non-CO_2 GHG emissions,

[4] Submission from the Food and Agriculture Organization of the United Nations to the ADP, 2014.

[5] ADP TEM on non-CO_2 GHG emissions; presentation by CCAC, October 2014.

which are even higher than those provided by EPA, and maintains that through a combination of supply-side and demand-side options, up to 80 per cent of emissions from agriculture could be reduced below the 2010 level by 2030.[6]

Table 1
Baseline and projected emissions of non-CO_2 greenhouse gas emission reductions and mitigation potential, by subsector

Subsector	*Greenhouse gas and main source (in brackets)*	*Baseline emissions in 2010, Gt CO_2 eq*[a]	*Baseline emissions in 2030 Gt CO_2 eq*[a]	*Share of total non-CO_2 GHGs in 2030 (%)*	*Mitigation potential at no cost in 2030 (%)*	*Mitigation potential feasible at increasing cost in 2030 (including at no cost) (%)*
Oil and natural gas systems	CH_4	1.7	2.1	16	40	58
Coal mining	CH_4	0.6	0.8	6	10	60
Industrial processes[d]	NF_3, F-gases, N_2O	0.4	0.9	7		
Refrigeration and air conditioning	HFCs	0.3	1.6	12	30	62
Livestock	CH_4 (enteric fermentation); CH_4, N_2O (manure management)	2	3	21	3	10
Rice cultivation	CH_4 (anaerobic digestion) N_2O (soils, fertilizers)	0.6	0.8	6	8	24
Cropland	N_2O (manure management, fertilizers)	0.5	0.5	4	5[b, c]	12[b, c]
Landfills	CH_4	0.8	1.0	7	12	61
Wastewater	CH_4	0.5	0.6	5	1	35
Other sources not included in the analysis by EPA	CH_4 (hydroelectric reservoirs, coal mines), N_2O (industrial wastewater), F-gases (manufacture of electrical equipment)			16[e]		

Sources:

[a] United States Environmental Protection Agency (EPA) report, *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2030*, for baseline emissions and projections. The *Global Emissions Report* was published in December 2012 and uses a combination of country-prepared, publicly available reports (UNFCCC national communications) and tier 1 methodologies provided by the Intergovernmental Panel on Climate Change to fill in missing or unavailable data.

[b] As the EPA report (2014a) includes soil carbon sequestration in its analysis of non-CO_2 GHGs, this analysis includes mitigation options that affect only CO_2 emissions (e.g. no tillage, 100 per cent residue incorporation). Therefore, these figures overestimate the mitigation potential for CH_4 and N_2O emissions in cropland.

[c] In the EPA study (2012), CH_4 emissions from non-rice cropland are considered to be a net sink and are included in all mitigation potential estimates.

[d] Industrial processes includes such activities as solvents, foams, aerosols, nitric and adipic acid production, fire protection, primary aluminium production, HCFC-22 production, semiconductor manufacturing, electrical power systems, magnesium production, photovoltaic cell manufacturing and flat-panel display manufacturing.

[e] This figure is based on 100 per cent minus the sum of all other mentioned sectors.

Abbreviations: EPA = United States Environmental Protection Agency, F-gases = fluorinated gases, GHGs = greenhouse gases.

[6] ADP TEM on non-CO_2 GHG emissions; presentation by the Intergovernmental Panel on Climate Change (IPCC), October 2014.

13. Cost considerations are essential when assessing mitigation potential. According to EPA, 12 per cent of the 2005 baseline non-CO_2 GHG emissions can be mitigated by 2030 at no cost or at financial gain (EPA, 2012). They can be reduced by 24 per cent at a cost below USD 20/t CO_2 eq, including mitigation potential at no cost (EPA, 2014a). The largest mitigation potential at no cost is estimated in oil and natural gas systems (40 per cent) and refrigeration and air conditioning (30 per cent), while at additional cost, the largest potential is estimated in addition to these two sectors, also in coal mining (60 per cent), as shown in table 1 above.

14. Mitigation actions addressing non-CO_2 GHG emissions are associated with co-benefits linked to the promotion of sustainable development, including its economic, social and environmental dimensions, poverty eradication and adaptation to climate change, as listed in table 2 below. An example of a mitigation option with significant co-benefits is the use of household methane cookers, as described in spotlight box 1 below. This mitigation option also improves air quality, creates energy security, provides sanitation and reduces the demand for fossil fuels.

Table 2
Co-benefits associated with the mitigation of non-CO_2 greenhouse gas emissions

Co-benefits	*Details drawn from the technical expert meeting and submissions from Parties*
Economic • Increased energy security • Enhanced economic growth through efficiency improvements in agriculture • Substantial energy efficiency gains • Cost savings • Increased productivity • Increased employment (waste)	Mitigation in the energy, industrial processes and waste sectors leads to improved access to local energy sources, energy security and reduced dependency on energy imports. Cost savings (and substantial energy efficiency gains) can be achieved through mitigation action in aluminium production, adipic and nitric acid production, and semiconductor manufacturing, if more energy-efficient air conditioners are used, as well as through reduced costs for food and fertilizers in the agriculture sector. Greater efficiency in the agriculture sector (e.g. livestock management) also leads to increased economic and productive resilience of farm systems, agricultural development and better livelihoods for farmers.
Social • Improved food security and resilience to climate change in agriculture • Improved health and safety • Improved sanitation • Improvements in building design	The mitigation of CH_4 and N_2O emissions contributes to protection of the ozone layer. Processing coal seam gas in coal mines improves health and safety conditions, while mitigation in the agriculture sector generates health benefits. A combination of the use of latrines and methane cookstoves in households improves sanitation. Lastly, enhanced building codes contribute to reduced demand for cooling and improved building design.
Environmental • Improved water quality • Erosion control • More efficient fertilizer use • Improved agriculture and environmental quality • Strengthening of ozone-layer protection	Greater efficiency in the agriculture sector contributes to improved water quality, erosion control and more efficient fertilizer use. Improved agriculture and environmental quality is accomplished via improvements in soil productivity and nutrient-use efficiency, reduced crop losses and less disrupted rainfall patterns caused by particle pollution from CH_4 emissions, recycling of water, nutrients and/or energy in biogas stoves, and waste collection. Lastly, N_2O mitigation in the agriculture sector leads to protection of the stratospheric ozone layer.

Sources: United States Environmental Protection Agency. 2013. *Global Mitigation of Non-CO_2 Greenhouse Gases 2010–2030*; Submissions to the Ad Hoc Working Group on the Durban Platform for Enhanced Action made by the World Bank, the United Nations Environment Programme, the Food and Agriculture Organization of the United Nations and the European Union in 2014.

Spotlight box 1
Use of household cookers

Household cooker biogas technologies can effectively address CH_4 emissions from manure, pit latrines, and/or crop residues by using biogas for cooking rather than biomass. The International Cryosphere Climate Initiative notes in its submission to the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) that "this combination makes household scale manure management with methane cookers one of the more promising mitigation methods for short-lived climate pollutants".

There are significant co-benefits associated with this action. The World Health Organization reports that "household methane cookers can reduce health-damaging air pollution by up to 90 per cent with a very low climate impact. If the digester is also linked to a latrine, the resulting improvement in sanitation could help prevent worm infestation, diarrhoeal disease and malnutrition". They are widely employed in China and South-East Asia for household cooking and lighting.

Sources: International Cryosphere Climate Initiative submission to the ADP; World Health Organization. 2014. *Health in the Green Economy Household Energy Sector in Developing Countries.*

2. Barriers to scaling up mitigation action and how to address them

15. Non-CO_2 GHG mitigation options span across a wide range of sectors, which each have their own unique barriers to implementation. These barriers are divided into three categories: socioeconomic; institutional, legislative and regulatory; and technological. They are also specific to certain regions, evolve over time and depend on national circumstances. The main barriers to non-CO_2 GHG mitigation are listed in table 3 below.

Table 3
Barriers to mitigation actions to address non-CO_2 greenhouse gas emissions

Categories	*Details drawn from technical expert meeting presentations, submissions from Parties and relevant literature*
Socioeconomic barriers	• High costs related to upfront investment and capital (fossil-fuel industry, waste management, aluminium production, landfills, HFCs), transition to transition to low-GWP alternatives in smaller enterprises (HFCs), recycling of substances (HFCs), and monitoring, operation and maintenance (fossil-fuel industry, N_2O emission reductions in industry, HFCs) • Limited access to financing or financial mechanisms that reduces the incentive to invest in technology upgrading due to a limited number of financial mechanisms, low carbon prices, unstable carbon markets and absence of regulations for carbon markets • Lack of a market for recovered CH_4 and HFC alternatives with low GWP due to the location of CH_4 emission sources far from population centres and/or a lack of distribution networks (oil and gas production). If such a market is missing or has prices that are too low, it is not economically feasible to reduce CH_4 emissions from venting and flaring from oil and gas production at no cost • Limited community and stakeholder awareness about options to reduce non-CO_2 GHG emissions, especially in developing countries

Categories	*Details drawn from technical expert meeting presentations, submissions from Parties and relevant literature*
Institutional, legislative and regulatory barriers	• Lack of institutional capacity, especially in developing countries, limiting the development of climate-friendly technologies, the upscaling of good practices and the effective implementation of polices in sectors with a large number of stakeholders and many different subsectors (waste, nutrient management in agriculture, industry) • Lack of legislation, for example lack of legislation to direct investments in climate-friendly technologies, lack of adequate regulatory frameworks (waste, industry) and lack of institutional arrangements to ensure coherent action by multiple stakeholders (waste) • Weak law enforcement that can obstruct the effectiveness of cross-cutting complex policies (agriculture, leakage of HFCs from refrigeration, industry) • Complex legislation, for example permitting schemes (waste), liability issues (waste) and regulatory barriers to the use of alternatives to HFCs in aerosols • Lack of guidance and poor leadership capability regarding the scope of responsibilities, identification of key players, conflicting interests of stakeholders and local operational limitations (waste prevention) • Lack of training, leading to adherence to traditional practices (agriculture, industry, solvent replacement sector, HFCs), which restrains the upscaling, application, replication and improvement of mitigation actions and causes low capacity in the servicing sector for new technologies (HFCs)
Technological barriers	• Technical constraints of alternative technologies such as limited availability or applicability of alternatives (e.g. HFCs with low-GWP for high ambient temperature countries), limited market acceptability of alternatives due to mild flammability and insufficient supply of replacement components • Lack of innovation to overcome technical constraints of existing infrastructure affecting the deployment of new technologies (HFCs, fossil fuel sector). For example, the size and poor technical state of large natural gas transmission networks make it harder to address CH_4 leakage • Site- and case-specific considerations, which make replication more challenging (agriculture and HFCs) • Lack of technology transfer to developing countries • Ineffective recycling due to technical limitations and insufficient waste management. Recycling of HFCs is hampered by low recovery rates (approximately 30 per cent in Japan) and leakage in the use of equipment

Sources: Intergovernmental Panel on Climate Change. 2014. Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; International Energy Agency (IEA). 2013. Redrawing the Energy Climate Map. World Energy Outlook Special Report; IEA. 2014. Capturing the Multiple Benefits of Energy Efficiency: A Handbook for Policy Makers and Evaluators.

Abbreviations: GWP = global warming potential, TEM = technical expert meeting.

16. Developing countries face particular challenges in replicating policies and practices and in addressing the barriers listed above. International cooperative initiatives, summarized in table 4 below, provide assistance to developing countries to encourage them to implement more ambitious mitigation actions. For instance, CCAC assists countries in assessing the feasibility of HFC phase-down in high ambient temperature countries, while

FAO and the Global Methane Initiative (GMI) facilitate knowledge transfer on mitigation in the agriculture and energy sectors, respectively.

Table 4
Examples of initiatives with the aim of mitigating non-CO_2 greenhouse gas emissions

Cooperative initiatives	*Scope*
Food and Agriculture Organization of the United Nations (FAO)	FAO makes available information on non-CO_2 greenhouse gas (GHG) emissions from agriculture and land use, and supports member countries in identifying mitigation options that support adaptation, food security and rural development goals. See <www.fao.org>
Global Research Alliance on Agricultural Greenhouse Gases	The Global Research Alliance on Agricultural Greenhouse Gases is a research initiative founded in 2009 by 41 States. It aims to grow a greater quantity of food (and more climate-resilient food systems) without increasing GHG emissions by enhancing international cooperation and collaboration and by investing in agricultural research. See <http://www.globalresearchalliance.org/about-us/>
Refrigerants, Naturally!	This global initiative of several companies (Coca-Cola, PepsiCo, Red Bull and Unilever) was established in 2004 and is committed to substituting harmful fluorinated gases (such as CFCs, HCFCs and HFCs) with natural refrigerants. The initiative is supported by the United Nations Environment Programme and Greenpeace.[b] Its member companies have installed more than 2.5 million HFC-free refrigeration units which together avoid more than 1 Mt of CO_2 eq emissions. See <http://www.refrigerantsnaturally.com/natural-refrigerants/why-move-to-natural-refrigerants.htm>
Global Methane Initiative (GMI)	GMI was established in 2010 as a multilateral initiative for the recovery and use of CH_4 as a clean energy source. The initiative unites public- and private-sector interests in order to build capacity and overcome barriers to methane reduction projects around the world. GMI builds on the existing structure and success of the Methane to Markets Partnership. See <www.globalmethane.org>
Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC)	CCAC has launched large-scale initiatives such as Promoting HFC Alternative Technologies; Reducing Short-Lived Climate Pollutants; Agriculture Initiative; and Oil and Gas Methane Partnership. Within these initiatives, CCAC provides scientific information, supports national planning, helps enhance national capacity, raises awareness and develops case studies.[e] The Agriculture Initiative aims to reduce levels of methane and black carbon (soot) emitted during livestock and manure management, paddy rice production, and open agricultural burning. Companies and national governments announced new and concrete plans to reduce methane in oil and gas production. See <http://www.ccacoalition.org/>

Cooperative initiatives	*Scope*
Oil and Gas Climate Initiative	This initiative was presented by the Saudi Arabian oil company Saudi Aramco, with the objective for oil and gas companies to work together and share best practices and technical solutions to address climate change and sustainable energy. See <http://www.un.org/climatechange/summit/wp-content/uploads/sites/2/2014/09/INDUSTRY-oil-and-gas-climate-initiative.pdf >
Alliance for Responsible Atmospheric Policy	The Alliance for Responsible Atmospheric Policy is an industry coalition representing more than 95 per cent of HFC production in the United States of America and a significant majority of the user industries. Its goal is to reduce the contribution of global HFC GHG emissions by 80 per cent by 2050 relative to current emission levels. This will be accomplished by advancing technologies; improving servicing practices; increasing recovery, reclamation and reuse; and conducting technology assessments and workshops. See <http://www.alliancepolicy.org/>
Montreal Protocol on Substances that Deplete the Ozone Layer	The Montreal Protocol is an international treaty that became effective in 1989. It was designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion. See <http://ozone.unep.org/new_site/en/montreal_protocol.php>

17. Engagement of international organizations, partnerships and the private sector is facilitated by national or bilateral long-term comprehensive strategies, regulations and plans. Nationally appropriate mitigation actions (NAMAs) could be one of such instruments to define long-term priorities, provide incentives and mobilize funding. Lessons can be learned from recent developments in the implementation of international and bilateral agreements, such as a proposed amendment to the Montreal Protocol, the China–United States of America agreement to phase down HFCs, and a strategic dialogue between India and the United States of America on HFC control via the Montreal Protocol and finance, technology transfer and safety of HFC alternatives.[7] These agreements could create a worldwide market for HFC alternatives, which can accelerate their mitigation.

18. During the TEM on non-CO_2 GHG emissions, the Montreal Protocol process was referred to by some participants as the best platform to achieve a significant reduction of HFCs. Some developing countries raised concerns related to the timeliness of the discussion on HFC phase-down in the light of the limited availability of affordable low-GWP technologies in high ambient temperature countries and the need to initiate the dialogue with a technical discussion, which should be conducted taking into account the principles of the Convention.

19. To implement the provisions of the Montreal Protocol, many developing countries prepared, in collaboration with the Multilateral Fund and its implementing agencies such as the United Nations Industrial Development Organization (UNIDO), the HCFC phase-out management plans while retaining a degree of uncertainty regarding the possible conversions to low-GWP solutions in all sectors. The lesson learned from this process is that national comprehensive strategies, regulations and plans are instrumental to facilitate the work of international support institutions and the engagement of the private sector. UNIDO reminded participants that there are many ways of lowering HFC consumption and that the number of solutions and examples of available and cheap technologies to address

[7] ADP TEM on non-CO_2 GHG emissions; presentation by CCAC, October 2014.

HFCs is growing. However, it was also recognized at the TEMs that not all technological and financial solutions are able to address HFCs.

B. Practices, policies and actions to unlock mitigation potential by addressing non-carbon dioxide greenhouse gas emissions

20. Replication of good practices, policies and actions requires recognition and adjustments of policy design to the national circumstances of a country, sector or stakeholder. For successful implementation of non-CO_2 mitigation options, it is important to consider the following success factors, which are essential to overcome barriers and achieve significant co-benefits:

(a) For the agriculture sector, these factors include the identification of activities with synergies between food security, adaptation and mitigation.[8] For stakeholder involvement and education on new farming practices, it is necessary to design strategies for disseminating knowledge among farmers and local communities, and draw from the traditional knowledge base of local communities;[9]

(b) For the industry sector, these factors include maintaining or increasing the competitiveness of industrial products in the marketplace, which is essential to prevent companies from relocating to countries with less stringent emission reduction standards (IPCC, 2014). For developing countries, a healthy balance between resource endowments and technology developments is essential for successful industrial development (IPCC, 2014);

(c) For HFCs, these factors include synergy with safety considerations and standards, and with the development of markets for alternative refrigerants.[10] For the implementation of low-GWP (and low-cost) HFC alternatives, this includes adjustments in the manufacturing process and adaptations of use-patterns (i.e. changes in servicing), which are different for each application.[11, 12]

21. An overview of the practices, policies and actions which contribute to the mitigation of non-CO_2 GHG emissions is provided in this chapter and in tables 5–7 below. Mitigation options are described by gas and by sector, and are complemented by an overview of the cross-cutting measures to address each gas.

22. **Mitigation options to address CH_4 emissions** are implemented in the fossil-fuel extraction and combustion, agriculture and waste sectors (see table 5 below). Mitigation actions related to CH_4 emissions from fossil-fuel extraction and combustion aim at overcoming high initial investments and enabling market creation through the provision of financial incentives. An example of such action is the Coal Mining Abatement Technology Support Package established in Australia, with a capitalization of 80 million Australian dollars (AUD) from government and business, focusing on emissions from flaring, pre-drainage, ventilation and avoidance. There are many examples of development and demonstration of new technologies to capture and use fugitive CH_4 emissions from coal mining, including in India, Mexico and the United States of America.

[8] Submission from FAO to the ADP, 2014.
[9] Submission from the Institute for Global Environmental Strategies to the ADP, 2014.
[10] Submission from the European Union (EU) to the ADP, 2014.
[11] ADP TEM on non-CO_2 GHG emissions; presentation by the Technology and Economic Assessment Panel of the Montreal Protocol, October 2014.
[12] ADP TEM on non-CO_2 GHG emissions; presentation by the Alliance for Responsible Atmospheric Policy, October 2014.

23. CH_4 emissions from agriculture are abated through improved management of agricultural land (e.g. rice irrigation) and livestock (e.g. feeding, breeding and manure management). Examples of good practice policies are provided by China and the Philippines on irrigation practices in rice paddies (UNEP, 2011). For example, the practice of draining rice paddies in China led to a reduction in CH_4 emissions from rice fields of about 5 Mt CO_2 eq/year during the period 1980–2000. In addition, research, development and demonstration projects deliver new technologies to reduce CH_4 and N_2O emissions. For example, New Zealand has established the Agricultural Greenhouse Gas Research Centre, an internationally renowned centre for research and development, which works on mitigation solutions in the agriculture sector. Australia has developed the Carbon Farming Initiative where farmers can earn credits by reducing CH_4 (and N_2O) emissions from land and livestock.

24. The mitigation of CH_4 emissions from waste could be achieved through integrated waste management systems, including waste prevention, separation, reuse and recycling (IPCC, 2014; UNEP, 2011). The cross-sectoral policies could be complemented by specific policies aimed at reducing emissions from specific sources, for example CH_4 emission reductions from landfills. Examples of good practice policies aimed at landfill and waste management were shared by Australia, the European Union (EU), Mexico, South Africa and the United States of America at the TEM. In Mexico, a public–private initiative on the recovery of gas from landfills has led to a reduction in CH_4 emissions of 1.7 Mt CO_2 eq since 2010. Australia's Emission Reduction Fund (with a capitalization of AUD 2.55 billion) is set to provide economic incentives for economy-wide emission reductions. Effective landfill policies leading to proven [emission?] reductions, as implemented in Australia, the EU and the United States of America, are showcased in spotlight box 2 below.

Spotlight box 2

Greenhouse gas emission trends in the waste sector in Australia, the European Union and the United States of America

The **European Union** landfill directive (1999/31/EC) caused a doubling of energy production from municipal solid waste between 2000 and 2009. During the period 1990–2010, net greenhouse gas emissions from landfills in the **United States of America** decreased by approximately 27 per cent due to better waste composition, increased landfill gas collection and combustion, and increased rates of waste recovery and recycling.[a] During the same period, **Australia**'s landfills emitted about 18 per cent fewer emissions.[b]

Sources:

[a] Intergovernmental Panel on Climate Change. 2014. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*.

[b] Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on non-CO_2 greenhouse gas emissions; presentation by the International Solid Waste Association, October 2014.

25. In addition to sector-specific mitigation actions, several cross-cutting actions have been initiated by Parties and partnerships. For example, the Global Methane Initiative and the recently initiated World Bank Pilot Auction Facility for Methane and Climate Change Mitigation (PAF) represent innovative initiatives to address CH_4 emissions (see table 5 below). PAF is an innovative climate finance initiative by the World Bank Group with a USD 100 million target capitalization. This pilot facility could be replicated by other

financial institutions, such as the Green Climate Fund, and has the potential to be significantly scaled up.[13] Australia's Emission Reduction Fund and Carbon Farming Initiative are other examples of cross-cutting actions that enable market creation and deliver incentives to mitigate CH_4 emissions.

26. **Mitigation options to address N_2O emissions** are implemented mostly in the industrial processes (e.g. fertilizer production and adipic acid production) and agriculture sectors (e.g. fertilizer application) (see table 6 below). A large mitigation potential in nitric and adipic acid production can be effectively achieved through financial mechanisms, for example clean development mechanism (CDM) projects. Brazil has achieved a 50.5 per cent reduction in industrial N_2O emissions through CDM projects (see spotlight box 3 below). Other examples of economic instruments used in industry are the European Union Emissions Trading System; the application of this system resulted in an 85 per cent reduction in N_2O emissions from nitric acid plants between 1990 and 2013,[14] and the Climate Action Reserve, implemented in North America to stimulate voluntary carbon offset credits by companies; as a result of the operation of the Reserve, the Potash Corp invested in reduction catalysts in its United States fertilizer plant.

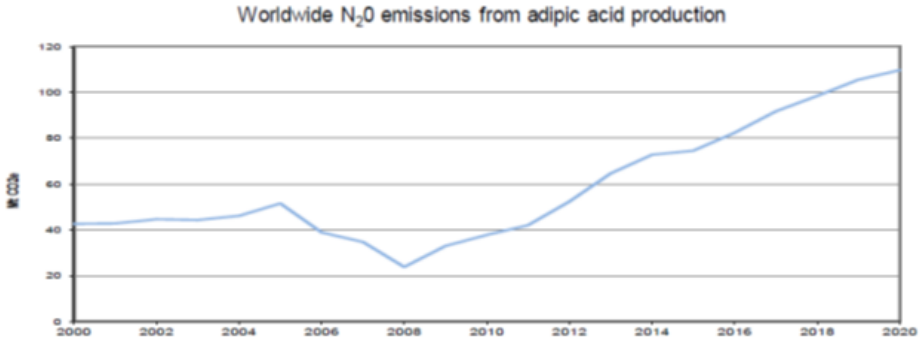
Spotlight box 3

Mitigation of N_2O emissions from adipic acid production

Until 2009, clean development mechanism/joint implementation (CDM/JI) projects were instrumental in reducing N_2O emissions from adipic plants worldwide. It was estimated that about 95 per cent of the mitigation potential could be achieved per plant. However, the incentives provided through the CDM/JI projects led to a more rapid production growth above the global average in countries hosting CDM projects. Therefore, the European Union adopted a regulation to ban emission reductions from new plants through CDM projects. As a result, N_2O emissions have increased again since 2009. The figure below provides projections of global N_2O emissions (expressed in Mt CO_2 eq) from adipic acid production up to 2020.

Existing plants face challenges in covering the operational costs associated with N_2O mitigation. It was recognized that a price signal is needed to relaunch the reduction of N_2O emissions and to reach record low levels. This could be achieved through the CDM, a new market mechanism or a cap-and-trade system.

Worldwide N_2O emissions from adipic acid production up to 2020



[13] ADP TEM on non-CO_2 GHG emissions; presentation by the World Bank Group on its Pilot Auction Facility for Methane and Climate Change Mitigation, October 2014.

[14] ADP TEM on non-CO_2 GHG emissions; presentation by the International Fertilizer Industry Association, October 2014.

Source: Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on non-CO_2 greenhouse gas emissions; presentation by Solvay, 2014.

27. In the agriculture sector, effective and replicable actions to reduce N_2O emissions focus on the efficient or reduced use of nitrogen-based fertilizers through financial incentives and regulatory control on the nitrogen content in fertilizers, as well as on fertilizer amounts and the timing of their application. An example of polices aimed at reducing N_2O emissions from rice paddies is provided by China, which was achieved at least in part by providing training to farmers on fertilizer application, for example on the appropriate dose, formulation, time and placement of fertilizers to demonstrate fertilizer use efficiency.[15]

28. Another example of an effective mitigation policy is the introduction of taxes on the nitrogen content in synthetic fertilizers introduced by Sweden. Also, the EU nitrates directive (91/676/EEC), which limits the use of nitrogen fertilizers and animal manure in nitrate-vulnerable zones, is a good example of a regulatory and control policy.

29. Nutrient management is one of the priority areas of the World Bank Group's investments in agriculture, which have increased from USD 4.1 billion in the period 2003–2005 to USD 10 billion in the period 2013–2015; half of these investments target improvements in nutrient management. An example of a policy at the subnational level is the provision of financial incentives to farmers through offset credit schemes, such as the Nitrous Oxide Emission Reduction Protocol for Carbon Offsets in Alberta, Canada. This system aims to reduce N_2O emissions from fertilizer use, manure management and crop residues. New Zealand demonstrated an efficient approach to nutrient management in the form of a farm-level nutrient management model that can estimate both GHGs and product lifecycle emissions on farms.[16]

30. **Mitigation options to address F-gas emissions** are implemented mainly in industries producing solvents (HFCs), HCFC-22 production (HFCs), magnesium production (SF_6), foams (HFCs) and primary aluminium production (PFCs). Good practice policies include the promotion of innovative technologies and the phasing-out of obsolete technologies, for example stricter regulations and technology upgrading (see table 7 below). One of the examples presented at the TEM demonstrates the lessons learned in Norway where, through the implementation of regulations, an 80 per cent reduction in PFC emissions in aluminium industry has been achieved since 2008 following the phasing-out of absolute technologies and their replacement with new technologies.

31. Voluntary initiatives by industries are another means of reducing emissions, as demonstrated by the first voluntary emission reduction goal of the World Semiconductor Council, aimed at reducing PFC emissions to 10 per cent below the 1995 baseline level by 2010 and to 30 per cent below the 2010 baseline level by 2020.

32. The Board Resolution on Sustainable Refrigeration by the Consumer Goods Forum mobilizes resources to begin phasing out HFCs used for refrigeration as of 2015 and replace them with natural refrigerant alternatives. Policies that provide a financial incentive are exemplified by Spain, where a progressive tax on F-gases, including SF_6 and PFCs, stimulates recycling and the prevention of leakage.

33. Policies and actions to reduce F-gas emissions in the cooling sector are mostly aimed at reducing leakage, increasing recycling and promoting alternative cooling agents

[15] ADP TEM on non-CO_2 GHG emissions; presentation by the World Bank Group, 2014.
[16] Submission from New Zealand to the ADP, October 2014.

with lower GWP.[17] The reduction of cooling demand can be achieved, for example, by the use of district heating or cooling; 'green' roofs; reducing the compactness of buildings in urban areas; modified design goals and engineering specifications for buildings; radiation management on roofs; water source heat pumps; spatial planning; and cooling networks. The last few years have shown a rapid development of low-GWP cooling agents, which are increasingly applied, for example, in mobile air conditioners and the foam blowing industry. This is the result of regional and subregional HFC policies, which have created favourable market conditions.[18]

34. For example, Denmark has introduced taxes on F-gases combined with a ban on certain applications and the promotion of alternatives. This has led to a reduction in F-gas emissions by two thirds in 2010 compared with 2000. The EU has issued a directive (2006/40/EC) that bans the use of vehicle refrigerants with a GWP above 150 in all new vehicles from 2017. An EU law to promote the eco design of air conditioners with a financial bonus for low-GWP refrigerants also provides an incentive to reduce F-gas emissions.

35. Japan has introduced an Act on the rational use and proper management of HFCs aimed at a 40 per cent reduction in emissions by 2020 and a 52 per cent reduction by 2025. The promotion of low-GWP alternatives is exemplified by policies in the EU, Norway and the United States of America. The latter promotes the use of safer alternatives to HFCs, providing funding opportunities for HFC alternatives, banning some of the most harmful HFCs for which lower-risk alternatives are available and implementing F-gas emission reduction targets for passenger cars.

36. Several examples touch on cross-cutting actions aimed at reducing F-gases. For example, at the TEM, China presented its plans for HFC phase-down in multiple sectors through its national Climate Change Action Plan.[19] Another example is the cross-sectoral EU regulation 842/2006 on F-gases dating from 2006 (which aims to reduce F-gases in refrigeration, air conditioning and insulation foams) to be superseded by new EU regulation 517/2014 from 1 January 2015 that introduces more stringent measures. The new EU legislation aims at reducing F-gas emissions by two thirds by 2030, compared to 2005, by strongly promoting low-GWP alternatives to high-GWP F-gases. According to the EU, its HFC policies could help to avoid 5 Gt CO_2 eq of emissions by 2050 and could lead to a global price reduction in HFC alternatives. In addition, the Green Public Procurement within the EU ensures that public authorities in Europe use their purchasing power to make an important voluntary contribution to emission reductions.[20] Finally, an example of cross-sectoral policies and actions is provided by Spain, which has a national tax on F-gases and voluntary agreements with industrial sectors producing aluminum for the reduction of PFC emissions, and suppliers of electrical equipment and electricity and distribution companies for the reduction of SF_6 emissions.

37. Cross-cutting measures complement sectoral policies and are aimed at removing systemic institutional barriers. The development of integrated management approaches covering a broad range of sectors and stakeholders can help to align stakeholders' priorities in, for example, the waste sector and educate farmers in smallholder agriculture.

[17] Submission from the United Nations Environment Programme (UNEP) to the ADP, 2014.

[18] ADP TEM on non-CO_2 GHG emissions; presentation by the Alliance for Responsible Atmospheric Policy, October 2014.

[19] ADP TEM on non-CO_2 GHG emissions; presentation by China, October 2014.

[20] The point system used to identify the most sustainable products or services assigns bonus points to medical freezers with refrigerants with a GWP<10.

38. In summary, several policies and actions are crucial to enabling the significant mitigation of non-CO_2 GHG emissions. They include:

(a) Policies to promote recovery, capture, reuse and leakage of CH_4 from several sources;

(b) Integrated waste management policies;

(c) Policies and practices aimed at a more efficient use of nitrogen fertilizers;

(d) Development of techniques and policies to improve sustainable land and livestock management;

(e) Creation of market conditions for technology development, transfer and deployment of climate-friendly alternatives to HFCs;

(f) Voluntary emission reductions from industry.

Table 5
Policy options menu for the mitigation of CH_4 emissions

Select policy options	*Select specific examples*
Sector: fossil-fuel extraction, production and transport	
Degasification and recovery of methane from venting in coal mines	• Australia – coal mining abatement technology support package[a] • India, Mexico and the United States of America – pilot projects on the mitigation of coal-mine emissions[b]
Recovery, capture and use of fugitive CH_4 emissions from the oil and gas sector	• Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) Oil and Gas Methane Partnership[c] • Global Methane Initiative – multiple countries and organizations • Oil and Gas Climate Initiative[d]
Reduction of gas leakage from transmission pipelines	• Russia – Gasprom energy conservation programmes • Global Methane Initiative – multiple countries and organizations
Sector: agriculture	
Livestock management, including feeding and breeding practices	• Australia – Carbon Farming Initiative[e] and Emission Reduction Fund • European Union (EU) – Common Agricultural Policy[f] • New Zealand – Agricultural Greenhouse Gas Research Centre and Primary Growth Partnership[g]
Sustainable manure management, including through on-farm manure management systems, better application methods and treatment technologies	• CCAC Agriculture Initiative; workstream on livestock and manure management - multiple Parties and non-State actors: • Global Methane Initiative, Agriculture Subcommittee[i] - multiple Parties and non-State actors • EU nitrates directive, 2010 • United States Environmental Protection Agency - AgSTAR programme[h]
Intermittent aeration of continuously flooded rice paddies	• China – practice of draining rice paddies[j] • Philippines – alternated wet–dry irrigation of rice paddies[k]
Sector: waste	
Integrated waste management	• EU – waste management legislation (waste framework directive (75/442/EEC) and landfill directive (1999/31/EC)), leading to a reduction of methane through better waste management[l] • South Africa – legislation on integration of air pollution and climate policies

Select policy options	*Select specific examples*
Waste reduction, recycling and reuse	• Germany – implementation of the EU policy on packaging through its Ordinance on the Avoidance and Recovery of Packaging Waste
Landfill management, including methane capture and energy recovery for heat and electricity generation	• Australia – Emission Reduction Fund with a capitalization of 2.55 billion Australian dollars covers costs on delivery of abatement[m] • Mexico – public–private partnership gas recovery from landfills[n] • United States of America – successful reduction of emissions from waste and landfills, including through landfill air regulations[o] • World Bank – Pilot Auction Facility for Methane and Climate Change Mitigation[p, q]

Note: Many of the policy options and examples provided in this table are taken from the presentations made during the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on non-carbon dioxide greenhouse gas emissions, held in October 2014. Detailed information on this meeting is available at <http://unfccc.int/bodies/awg/items/8420.php>. Many examples reference ongoing activities at the local and national levels. The list is not exhaustive and the examples are for informational purposes only.

Sources:

[a] Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) technical expert meeting (TEM) on non-CO_2 greenhouse gas (GHG) emissions; presentation by Australia, October 2014.

[b] United Nations Environment Programme (UNEP). 2011. *Near-term Climate Protection and Clean Air Benefits: Actions for Controlling Short-lived Climate Forcers.* Available at: <http://www.unep.org/pdf/Near_Term_Climate_Protection_&_Air_Benefits.pdf>.

[c] United Nations. 2014. Press release: "Industry leaders, including energy companies, forge partnerships to advance climate solutions and reduce short-lived climate pollutants". Available at: <http://www.un.org/climatechange/summit/wp-content/uploads/sites/2/2014/05/INDUSTRY-PR.pdf>.

[d] United Nations. 2014. Press release: "Industry leaders, including energy companies, forge partnerships to advance climate solutions and reduce short-lived climate pollutants". Available at: <http://www.un.org/climatechange/summit/wp-content/uploads/sites/2/2014/05/INDUSTRY-PR.pdf>.

[e] ADP TEM on non-CO_2 GHG emissions; presentation by Australia, October 2014.

[f] Submission from the European Union (EU) to the ADP, 20 May 2014.

[g] Submission from New Zealand to the ADP, June 2014.

[h] <http://www.epa.gov/agstar/>.

[i] <https://www.globalmethane.org/agriculture/index.aspx>.

[j] UNEP. 2011. *Near-term Climate Protection and Clean Air Benefits: Actions for Controlling Short-lived Climate Forcers.* Available at: <http://www.unep.org/pdf/Near_Term_Climate_Protection_&_Air_Benefits.pdf>.

[k] UNEP. 2011. *Near-term Climate Protection and Clean Air Benefits: Actions for Controlling Short-lived Climate Forcers.* Available at: <http://www.unep.org/pdf/Near_Term_Climate_Protection_&_Air_Benefits.pdf>.

[l] Submission from the EU to the ADP, 14 October 2014.

[m] ADP TEM on non-CO_2 GHG emissions; presentation by Australia, October 2014.

[n] UNEP. 2011. *Near-term Climate Protection and Clean Air Benefits: Actions for Controlling Short-lived Climate Forcers.* Available at: <http://www.unep.org/pdf/Near_Term_Climate_Protection_&_Air_Benefits.pdf>.

[o] Intergovernmental Panel on Climate Change. 2014. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Available at: <http://www.ipcc.ch/report/ar5/wg3/>.

[p] Submission from the World Bank Group to the ADP, 20 March 2014.

[q] ADP TEM on non-CO_2 GHG emissions; presentation by the World Bank Group Annex on its Pilot Auction Facility for Methane and Climate Change Mitigation, October 2014.

Table 6
Policy options menu for the mitigation of N_2O emissions

Select policy options	*Select specific examples*
Sector: industrial processes	
Reducing N_2O emissions from industry through financial incentives, mechanisms and voluntary agreements	• Brazil – clean development mechanism projects[a] • European Union (EU) – European Union Emissions Trading System[b] • Netherlands – Reduction Programme for Non-CO_2 Gases (target of 8–10 Mt CO_2 eq emission reductions by 2020, or a reduction of 50 per cent below the 1990 level)[c] • North America – voluntary carbon offset credits[d]
Sector: agriculture	
Integrated sustainable land management	• Indonesia – five-year plan of the Ministry of Forestry[e]
Efficient use of nitrogen fertilizers through regulations and training of farmers	• China – training and capacity-building[f] • EU – nitrates directive[g] • New Zealand – Agricultural Greenhouse Gas Research Centre, Primary Growth Partnership and farm-level nutrient management[h] • World Bank Group – investments in agricultural improvements in nutrient management[i]
Reducing N_2O emissions from soils through financial incentives	• Canada – Alberta Nitrous Oxide Emission Reduction Protocol For Carbon Offsets[j] • Sweden – tax on the nitrogen content of synthetic fertilizers[k, l]

Note: Many of the policy options and examples provided in this table are taken from the presentations made during the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on non-carbon dioxide greenhouse gas emissions, held in October 2014. Detailed information on this meeting is available at <http://unfccc.int/bodies/awg/items/8420.php>. Many examples reference ongoing activities at the local and national levels. The list is not exhaustive and the examples are for informational purposes only.

Sources:

[a] Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) technical expert meeting (TEM) on non-CO_2 GHG emissions; presentation by Brazil, October 2014.

[b] ADP TEM on non-CO_2 GHG emissions; presentation by the International Fertilizer Industry Association (IFIA), October 2014.

[c] <http://www.unep.org/ccac/Partners/CountryPartners/Netherlands/tabid/131837/Default.aspx>.

[d] ADP TEM on non-CO_2 GHG emissions; presentation by the IFIA, October 2014.

[e] Submission from the Institute for Global Environmental Strategies to the ADP, 30 May 2014.

[f] ADP TEM on non-CO_2 GHG emissions; presentation by the World Bank Group, October 2014.

[g] Intergovernmental Panel on Climate Change (IPCC). 2014. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available at: <http://www.ipcc.ch/report/ar5/wg3/>.

[h] Submission from New Zealand to the ADP, June 2014.

[i] ADP TEM on non-CO_2 GHG emissions; presentation by the World Bank Group, October 2014.

[j] IPCC. 2014. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available at: <http://www.ipcc.ch/report/ar5/wg3/>.

[k] IPCC. 2014. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available at: <http://www.ipcc.ch/report/ar5/wg3/>.

[l] ADP TEM on non-CO_2 GHG emissions; presentation by the World Bank Group, October 2014.

Table 7
Policy options menu for the mitigation of fluorinated gas emissions

Select policy options	*Select specific examples*
Sector: industrial processes	
Creation of market conditions for technology development, transfer and deployment of climate-friendly alternatives to high global warming potential (GWP) hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs)	• Denmark – taxes on fluorinated gases (F-gases) combined with a ban[a] • European Union (EU) – law to promote eco design of air conditioners used in small motor vehicles and the F-gas regulation that covers all other applications in which F-gases are used[a] • Norway – PFC regulations (phase-out and replacement)[b] • Spain – tax on F-gases including SF_6 and PFCs,[a] national tax on F-gases and voluntary agreements with industrial sectors,[a] taxes on F-gases combined with a refund for recovered or eliminated gas[a] • PFC Reduction/Climate Partnership for the Semiconductor Industry (United States Environmental Protection Agency, World Semiconductor Council)[c, d]
Responsible management of existing equipment and better design of future equipment in order to minimize leaks	• EU – EU directive on mobile air-conditioning, which bans the use of vehicle refrigerants; EU directive on recycling of waste from electronic equipment containing F-gases; European Management and Audit Scheme for organizations; the Green Public Procurement voluntary instrument;[a, e] a project (with funding of EUR 5 million) to address the waste treatment of HFCs in the Asia-Pacific region[a] • Japan – Act on the rational use and proper management of HFCs[f] • United States of America – Voluntary Aluminum Industrial Partnership[g] • Voluntary initiatives: Consumer Goods Forum Board Resolution on Sustainable Refrigeration[h]
Encouraging uptake of climate-friendly alternatives to reduce reliance on high-GWP HFCs[i]	• China – HFC phase-down programmes, including capacity-building to collect and report HFC emissions data; mobilization of financial resources for further actions to phase-down HFCs; research, development and deployment of environmentally sound, effective and safe alternatives and technologies; and multilateral agreements to phase down HFCs[j] • EU – legislation on F-gases from 2006, to be superseded by new legislation from 1 January 2015 that introduces more stringent measures (promotion of low-GWP alternatives to high-GWP HFCs)[k] • United States of America – promoting safer lower-GWP alternatives to HFCs; providing funding opportunities for HFC alternatives; banning some HFCs; including F-gases in emission reduction targets[l] • Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants – projects to support the preparation of HFC inventories, the establishment of standards, and the implementation of demonstration projects, as well as capacity-building activities

Note: Many of the policy options and examples provided in this table are taken from the presentations made during the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on non-carbon dioxide greenhouse gas emissions, held in October 2014. Detailed information on this meeting is available at

<http://unfccc.int/bodies/awg/items/8420.php>. Many examples reference ongoing activities at the local and national levels. The list is not exhaustive and the examples are for informational purposes only.

Sources:

[a] Submission from the European Union (EU) to the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP), 14 October 2014.

[b] ADP technical expert meeting (TEM) on non-CO_2 GHG emissions; presentation by Hydro Norsk, October 2014.

[c] World Semiconductor Council. 2012. *World Semiconductor Council Best Practice Guidance of PFC Emission Reduction.* Available online since 7 October 2014 at <http://www.semiconductorcouncil.org/wsc/uploads/Final_WSC_Best_Practice_Guidance_26_Sept_2012.pdf>.

[d] United States Environmental Protection Agency (2014b). 6 October 2014. Available at <http://www.epa.gov/semiconductor-pfc/basic.html>.

[e] ADP TEM on non-CO_2 GHG emissions; presentation by the EU on regulating fluorinated gases (F-gases), October 2014.

[f] ADP TEM on non-CO_2 GHG emissions; presentation by the Japan Refrigeration and Air Conditioning Industry Association, October 2014.

[g] <http://epa.gov/climatechange/ghgemissions/gases/fgases.html>.

[h] ADP TEM on non-CO_2 GHG emissions; presentation by CCAC, October 2014.

[i] Submission from the United Nations Environment Programme to the ADP, 2014.

[j] ADP TEM on non-CO_2 GHG emissions; presentation by China, October 2014.

[k] ADP TEM on non-CO_2 GHG emissions; presentation by the EU on regulating F-gases, October 2014.

[l] *Fact Sheet: Obama Administration Partners with Private Sector on New Commitments to Slash Emissions of Potent Greenhouse Gases and Catalyze Global HFC Phase Down*. 16 September 2014.