

The Need for Speed

Reducing Short-Lived Climate Pollutants Can Cut the Rate of Global Warming By Half and Arctic Warming by Two-Thirds for the Next 30 to 40 Years

Summary. 17 July 2012. CO₂ is responsible for 55 to 60% of radiative forcing. *See Fig. 1.* Fast and aggressive CO₂ mitigation is essential to combat the resulting climate change. But this is not enough. CO₂ mitigation must be combined with fast and aggressive mitigation of the pollutants causing the other 40-45% of warming: black carbon aerosols, methane and the tropospheric ozone it catalyzes, and hydrofluorocarbons (HFCs). Because these pollutants have atmospheric lifetimes of days to decades, they are referred to as short-lived climate pollutants (SLCPs). While we have known about SLCPs for more than 35 years, the following scientific developments have catapulted them to the front lines of the war against climate change.

- First is the recognition that we have already added enough greenhouse gases to warm the planet by 2.4°C or more during this century. Reduction of SLCPs, in addition to CO₂ mitigation, is essential for keeping the cumulative warming under 2°C during this century. Thus it is nearly impossible to meet the Copenhagen protocols without reducing SLCPs.
- Second is the recognition that without fast-action, warming may cross the 1.5° to 2°C threshold by the middle of this century. Reducing SLCPs is the most effective strategy for preventing this in the short-term, since most of their warming effect disappears within weeks to a decade and a half after they are cut.
- Third is the recognition that in addition to being climate forcers two of the three SLCPs are also potent air pollutants and cutting them will prevent millions of premature deaths ever year and protect tens of millions of tonnes of crops.
- Fourth is the recognition that the health benefits and crop improvements will accrue primarily in the nations that mitigate these pollutants.
- Fifth is the recognition that there are practical and proven ways to reduce all three of these pollutants and readily available laws and institutions to support the reductions.

Reducing two of the non-CO₂ short-lived climate pollutants - black carbon and tropospheric ozone and its precursor, methane—can avoid 0.5°C in warming by 2050. *See Fig. 5.* This will cut the current rate of global warming by half and the rate of warming in the Arctic by two-thirds. It will also slow down the accelerated warming over the elevated regions of the Himalayas and Tibet and delay melting of the glaciers in this region. It also will produce significant collateral benefits for health, crops, and local air quality.

Avoiding growth in the other short-lived climate pollutant, HFCs, can avoid additional future warming of 0.1°C by 2050, adding another 20% to the 0.5°C in avoided warming from reductions in black carbon and methane. The combined reduction in rate of global warming from reducing the three short-lived climate pollutants will also slow down the rate of sea level rise, and reduce other impacts. Reductions can be achieved quickly, and in most cases by using existing technologies and existing laws and institutions.

This may offer the best near-term protection for the countries that are most vulnerable to climate change, including island nations, countries with low-lying coastal areas, and agriculture-dependent countries in Asia and Africa already suffering droughts, floods, and shifting rainfall.

The Climate and Clean Air Coalition ([CCAC](#)) to Reduce Short-lived Climate Pollutants, comprised of developing and developed countries, along with UNEP, the European Commission, and the World Bank, was recently launched to pursue these reductions. The G8 Leaders announced in their [Camp David Declaration](#) 19 May 2012 that they had joined the Coalition; they also requested the World Bank to conduct a study of how best to integrate SLCP reductions in the programs. See Appendix 1.

Phasing down production and use of HFCs is called for in the Rio + 20 declaration, [The Future We Want](#). It can be achieved under the Montreal Protocol, while simultaneously improving the energy efficiency of refrigerators, air conditioners, and other equipment and products that use these chemicals, which in turn will contribute to reductions in CO₂.

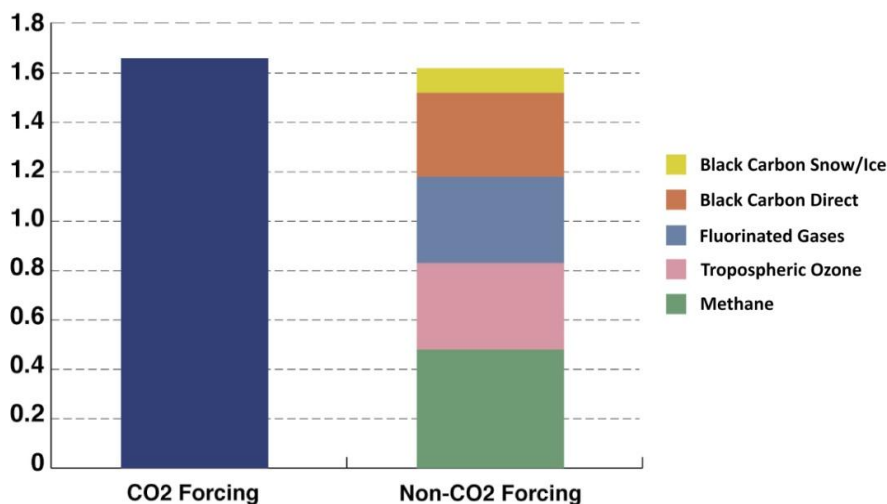
Reducing black carbon, methane, and tropospheric ozone can be achieved with 14 targeted control measures, providing global benefits for climate, crops, and health valued at \$5.9 trillion annually, starting in 2030.

If combined with substantial CO₂ reductions that begin quickly, these fast actions to reduce SLCPs have a high probability of keeping the increase in global temperature to less than 1.5°C above the pre-industrial temperature for the next 30 years and below the 2°C guardrail for the next 60 to 90 years, the aspirational goal many heads of State agreed upon to prevent dangerous interference with the climate system. See Fig. 4 & 5.

Given the profoundly persistent nature of CO₂ (see Fig. 2), it also is necessary to deliberately remove previously emitted CO₂ from the atmosphere on a timescale of decades rather than the millennia of the natural cycle, in order to return to a safe and stable climate by the end of the century. This can be done using CO₂ removal strategies such as bio-sequestration, biochar, and chemical air capture and re-utilization, although many of these tools need to be further developed at scale.

The following discussion elaborates these points, relying on direct quotes from the relevant science publications and from the relevant policy statements. Several appendices are included, starting at page 17.

Fig. 1. Changes in radiative forcing from anthropogenic emissions since the Industrial Revolution of 1750 (in W/m²)



Based on [IPCC](#), WG 1, Fig. 2.21, AR 4 (2007). (Note graph does not include all non-CO₂ forcings.)

Fast reduction of CO₂ is essential for a safe climate. CO₂ is responsible for 55-60% of warming, a substantial portion remains in the atmosphere for millennia, and most of the warming it causes remains for a thousand years after emissions stop.

While more than half of the CO₂ emitted is currently removed from the atmosphere within a century ... about 20% ... remains ... for many millennia. (IPCC, AR4 2007.)

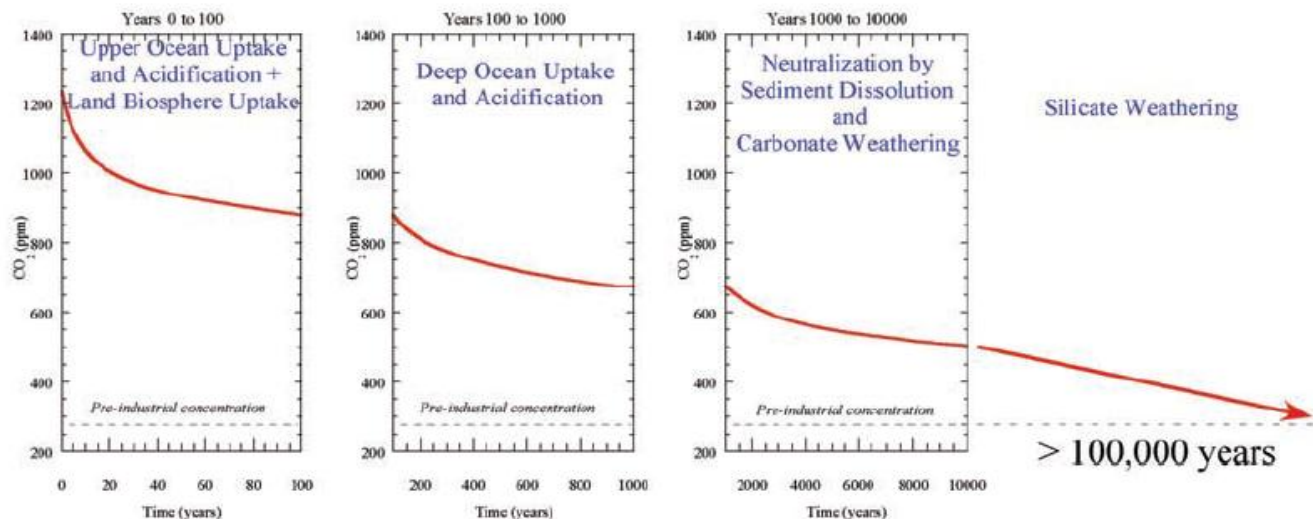
[W]hile approximately half of the carbon emitted is removed by the natural carbon cycle within a century, a substantial fraction of anthropogenic CO₂ will persist in the atmosphere for several millennia. (Matthews & Caldeira, GRL 2008, citing Archer, JGR 2005.)

About one-quarter of fossil fuel CO₂ emissions will stay in the air “forever”, i.e. more than 500 years.... Resulting climate changes would be ... irreversible. (Hansen et al., PTRS 2007.)

[C]limate change that takes place due to increases in carbon dioxide concentrations is largely irreversible for 1,000 years after emissions stop. (Solomon et al., PNAS 2009.)

[A] simplified way to view future warming persistence is that emissions of CO₂ and a handful of other extremely long-lived gases imply warming that is essentially irreversible on human timescales without geoengineering or active sequestration. (Solomon et al., PNAS 2010.)

Fig. 2. Time Scales for Removal of CO₂ from the Atmosphere



Model simulation of atmospheric CO₂ concentration for >100,000 years following a large CO₂ release from combustion of fossil fuels. Different fractions of the released gas recover on different timescales. (NAP 2011.)

The greenhouse gases emitted to the atmosphere have added 3 Wm⁻² heat energy (radiative forcing) to the planet (Fig.1) and this heating is sufficient to warm the planet by about 2.4°C (Ramanathan & Feng, 2008).

This article uses the greenhouse gases (GHGs) forcing of 3 (2.6 to 3.5) Wm⁻² estimated by the IPCC-AR4 for the preindustrial to present (year 2005) period.... Using these data, this study infers that we have already committed the planet to a global warming of 2.4°C (1.4–4.3°C).... (Ramanathan & Feng, 2008)

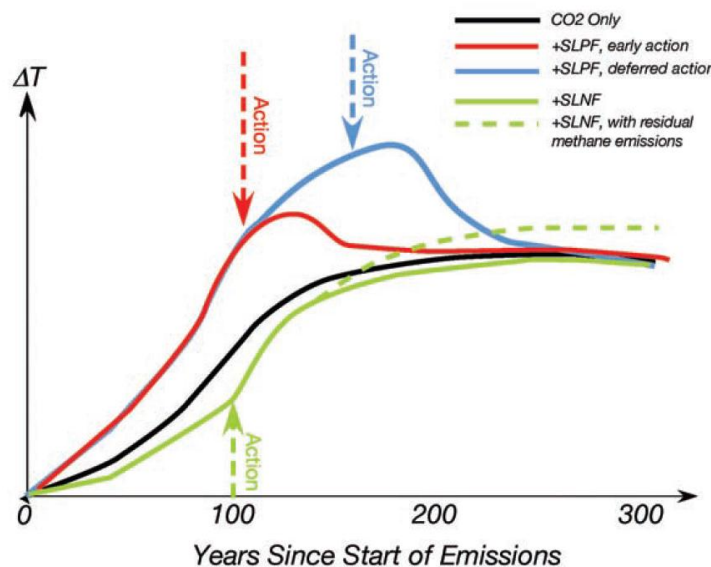
While reducing CO₂ is essential for limiting warming, reducing SLCPs also is essential for limiting warming in the next few decades; together, these two strategies provide the best chance to keep temperature below the 2C° guardrail through 2100 (Ramanathan & Xu, PNAS 2010). Due to its long lifetime in the atmosphere and the thermal inertia of the oceans, CO₂ reductions do

little to address warming in the critical next 30-40 years, but the mitigation benefit grows quickly 50 years after significant reductions begin. For cuts to SLCPs, however, up to 90% of the decrease in global mean temperatures would be realized in a few decades. *See Fig. 3.*

[M]itigation of 0.15°C due to CO₂ measures takes place only around 2050 ... under the CO₂ measures scenario; 30 years after emissions begin to decline rapidly. The influence of the CO₂ reductions grows rapidly, however, so that they mitigate roughly 0.5°C by 2070. (UNEP-WMO 2011.)

In the case of an SLCF this means that, when its concentration and hence its radiative forcing is reduced by emission controls, the global mean temperature will achieve most of its decrease towards a new equilibrium value in few decades. About 10 per cent of the full decrease will not be realized for hundreds of years, since the redistribution of heat stored in the deep ocean while the SLCF was active, and hence its upwards transport, will continue for hundreds of years.... In the case of CO₂, more than 80 per cent of the expected decrease in global mean temperature after emission reductions will not be realized for hundreds of years. (UNEP-WMO 2011.)

Fig. 3. Cooling from SLCP Mitigation in a Carbon Constrained Scenario



Qualitative sketch of the time-course of future temperature under various scenarios for control of emissions of short-lived radiative forcing agents. The time axis is given as time since the beginning of significant anthropogenic emissions of greenhouse gases. It is assumed that CO₂ emissions are brought to zero after 200 years. SLPF refers to short-lived positive forcing agents, like methane or black carbon on snow and ice. SLNF refers to short-lived negative forcing agents, primarily aerosols. “Early Action” refers to a scenario in which early, aggressive action is taken to mitigate emission of short-lived radiative forcing agents, while “Deferred Action” refers to a scenario in which such actions are delayed. The green line shows what happens in the aggregate of all short-lived forcings brought under control originally added up to a cooling effect (so that reducing them warms the climate). The dashed green line is similar, except that it assumes there is a residual methane emission that cannot be reduced to zero. The cumulative CO₂ emissions are assumed to be the same in all of these scenarios. (Solomon S. et al., NAS 2011.)

Reducing SLCPs will have fast effects; cutting black carbon and methane can cut the rate of Arctic warming by two-thirds and the rate of global warming by up to half or more within decades. The [UNEP-WMO](#) (2011 & [2011](#)) assessment selected 16 priority control measures for black carbon and methane from over 2,000 possible measures to cut black carbon and tropospheric ozone; [Shindell et al.](#) (2012) consolidated these into 14 measures (see below at page 13 for list).

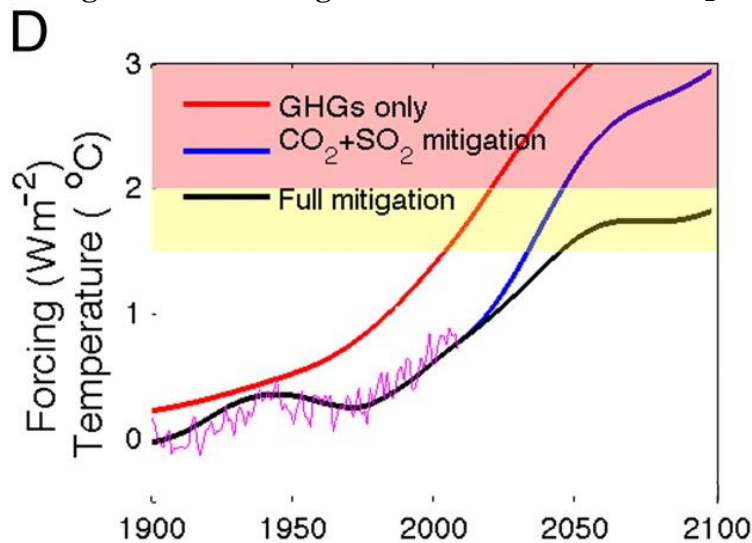
We identified 14 measures targeting methane and BC emissions that reduce projected global mean warming $\sim 0.5^{\circ}\text{C}$ by 2050 *** BC albedo and direct forcings are large in the Himalayas, where there is an especially pronounced response in the Karakoram, and in the Arctic, where the measures reduce projected warming over the next three decades by approximately two thirds.... ([Shindell et al.](#), SCI 2012.)

When all [control] measures are fully implemented, warming during the 2030s relative to the present day is only half as much as if no measures had been implemented. *** This could reduce warming in the Arctic in the next 30 years by about two-thirds compared to the projections of the Assessment's reference scenario. ([UNEP-WMO](#) 2011.)

The combination of CO₂ mitigation and SLCP mitigation—for all three SLCPs, HFCs, black carbon, and methane—provides the greatest chance of keeping global temperatures below 1.5°C until 2050 and below 2°C through 2100. ([Ramanathan & Xu](#) (PNAS 2010, Fig. 4, below).

These actions [to reduce emissions of SLCPs including HFCs, methane, black carbon, and tropospheric ozone], even if we are restricted to available technologies ... can reduce the probability of exceeding the 2°C barrier before 2050 to less than 10% and before 2100 to less than 50% [when CO₂ concentrations are stabilized below 441 ppm during this century]. ([Ramanathan & Xu](#), PNAS 2010.)

Fig. 4. Warming Avoided Through Combined SLCP and CO₂ Mitigation



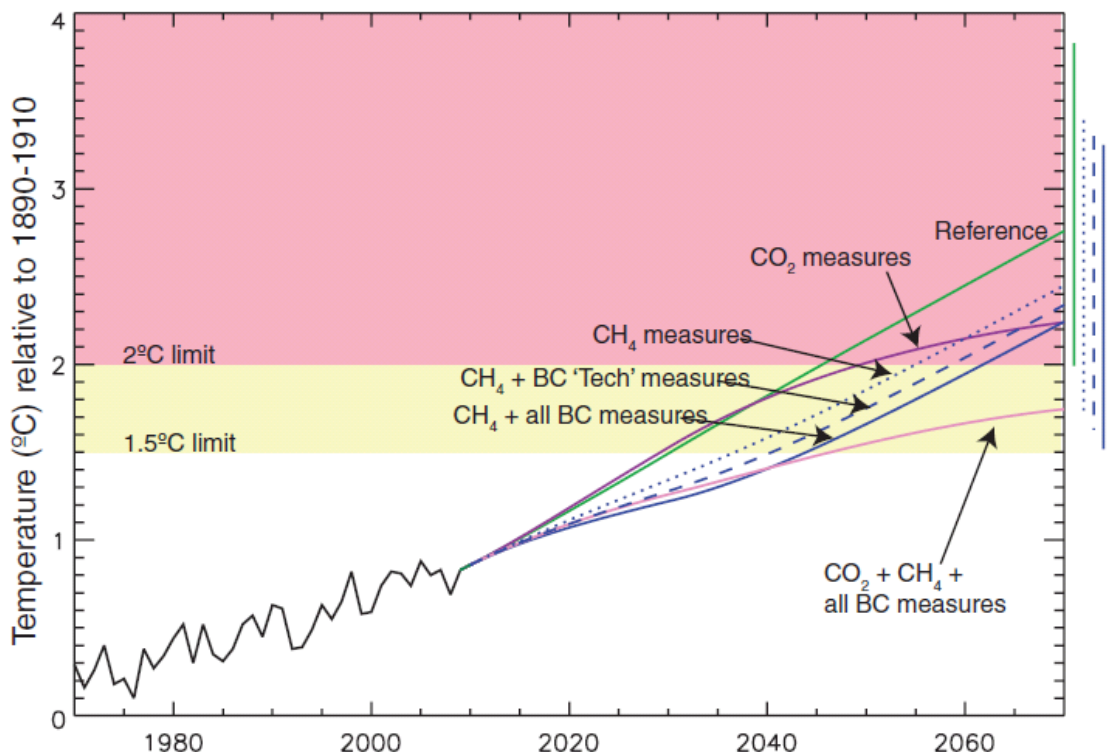
The red line depicts strong mitigation of CO₂ (peaking in 2015 and remaining at 2015 levels until 2100, reaching a concentration peak of 430 ppm by 2050), but no mitigation of non-CO₂ greenhouse gases, and does not account for forcing from aerosols or land use change; the blue line is the same as the red line except it includes warming and cooling aerosol forcing and the mitigation of cooling sulfate aerosols; the black line is the same as the blue line except it includes mitigation of all SLCPs including HFCs; the pink and yellow backgrounds show zones beyond 2°C and 1.5°C. ([Ramanathan & Xu](#), Fig 1D, PNAS 2010.)

Recent analysis by [Shindell et al.](#) (SCI 2012) and [UNEP-WMO](#) (2011 & [2011](#)) confirm how much the rate of warming can be slowed for the next 30 to 60 years by cutting just black carbon and methane, provided progress also is made cutting CO₂. These results are shown in Fig. 5, below.

The combination of CH₄ and BC measures along with substantial CO₂ emissions reductions [under a 450 parts per million (ppm) scenario] has a high probability of limiting global mean warming to <2°C during the next 60 years, something that neither set of emissions reductions achieves on its own.... ([Shindell et al.](#), SCI 2012.)

[T]he combination of CO₂, CH₄, and BC measures holds the temperature increase below 2°C until around 2070... [and] adoption of the Assessment's near-term measures (CH₄ + BC) along with the CO₂ reductions would provide a substantial chance of keeping the Earth's temperature increase below 1.5°C for the next 30 years. (UNEP-WMO 2011.)

Fig. 5. Temperature Rise Predictions Under Various Mitigation Scenarios



Observed temperatures (42) through 2009 and projected temperatures thereafter under various scenarios, all relative to the 1890–1910 mean. Results for future scenarios are the central values from analytic equations estimating the response to forcings calculated from composition-climate modeling and literature assessments (7). The rightmost bars give 2070 ranges, including uncertainty in radiative forcing and climate sensitivity. A portion of the uncertainty is systematic, so that overlapping ranges do not mean there is no significant difference (Shindell *et al.*, SCI 2012 and UNEP-WMO 2011, based on Ramanathan & Xu, Fig 1D, PNAS 2010.¹) (Note: HFC mitigation is not included in this graph, although it is included in Ramanathan & Xu, Fig. 1D, reproduced as Fig. 4, above.)

Mitigation of CO₂ and SLCPs is more effective if done sooner rather than later. This is because the heat stored in the deep oceans from any climate pollutant returns to the atmosphere on a century time scale after that pollutant is removed. In the case of CO₂, this is due to millennial time scale for removal of this climate pollutant, as well as the thermal inertia of the deep oceans (*see* Fig. 6). Reductions in CO₂ can do little to slow warming over the next thirty years, but mitigation benefits accrue quickly in the medium- to long-term.

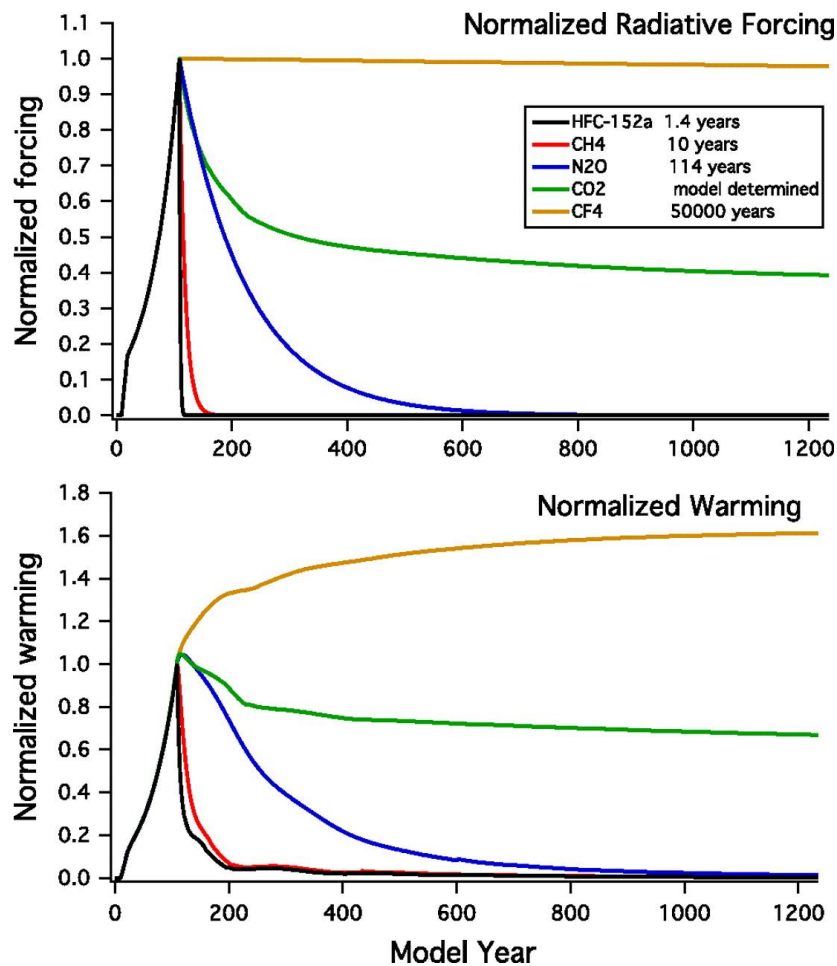
[M]itigation of 0.15°C due to CO₂ measures [in the IEA 450 Scenario] takes place only around 2050 ... under the CO₂ measures scenario; 30 years after emissions begin to decline rapidly. The influence

¹The science of SLCPs dates back to the 1970s (Ramanathan, 1975; Wang *et al.*, 1976). A major WMO-UNEP-NASA-NOAA report in 1985 concluded that non-CO₂ greenhouse gases in the atmosphere are adding to the greenhouse effect by an amount comparable to the effect of CO₂. (Ramanathan *et al.*, 1985.) This finding has been confirmed and strengthened in the following decades by hundreds of studies culminating in IPCC reports (IPCC 1990; IPCC 1995; IPCC 2001; IPCC 2007). In short, researchers have had at least 25 years to carefully develop the science of SLCPs and assess the findings.

of the CO_2 reductions grows rapidly, however, so that they mitigate roughly 0.5°C by 2070. (UNEP, 2011.)

*[M]ultiple centuries are required to warm or cool the deep ocean.... Maintaining a forcing for a longer period of time transfers more heat to the deep ... ocean, with a correspondingly longer timescale for release of energy if emissions were to be halted.... [T]he slow timescales of the ocean imply that actions to mitigate the climate impacts of these warming agents [SLCPs] would be most effective if undertaken sooner; conversely such actions would become less effective the longer the radiative forcing is maintained. (Solomon *et al.*, PNAS 2010.)*

Fig 6. Persistence of Warming From Greenhouse Gases



Relative changes in radiative forcing (Upper) and warming (Lower) in the Bern 2.5CC model, for the same assumed profile of increasing radiative forcing over 100 y, followed by a stop of emissions as in Fig. 3, for a range of greenhouse gases of varying lifetimes. The gases considered are HFC-152a (1.4-y lifetime), methane (≈ 10 -y lifetime), N_2O (114-y lifetime), carbon dioxide (see text), and CF_4 (50,000-y lifetime). All quantities are normalized to one when emissions stop, in order to examine relative changes. (Solomon *et al.*, PNAS 2010.)

Many vulnerable regions are warming faster than the global average warming. Global warming is expressed as an average increase in surface temperature but is experienced unevenly in different regions, with some of the world's most vulnerable regions warming much faster than the global average.

The increase in annual average temperature since 1980 has been twice as high over the Arctic as it has been over the rest of the world. (AMAP 2011.)

The proximate cause of the changes now being felt on the [Tibetan] plateau is a rise in temperature of up to 0.3 °C a decade that has been going on for fifty years — approximately three times the global warming rate. ([Qiu](#), NAT 2008.)

In all four regions [of Africa] and in all seasons, the median temperature increase [between 1980 and 2009] lies between 3°C and 4°C, roughly 1.5 times the global mean response. ([IPCC](#) 2007.)

Warming in the Arctic could lead to dangerous climate feedbacks that cause warming to accelerate past tipping points. The term ‘tipping element’ on a basic level is a chain of events that escalate to a point where it is impossible to return to former conditions. Some examples include Arctic sea-ice melt, permafrost melt, and Himalayan glacial melt.

*The word tipping element suggests the existence of a self-amplification process at the heart of the tipping dynamics. *** A prominent example of such self-amplification is the ice-albedo feedback ... in the Arctic sea-ice region and on mountain glaciers such as the Alps and the Himalayas: An initial warming of snow- or ice-covered area induces regional melting. This uncovers darker ground, either brownish land or blue ocean, beneath the white snow- or ice-cover. Darker surfaces reflect less sunlight inducing increased regional warming, the effect self-amplifies. ([Levermann et al.](#), CC 2012.)*

A variety of tipping elements could reach their critical point within this century under anthropogenic climate change. The greatest threats are tipping the Arctic sea-ice and the Greenland ice sheet, and at least five other elements could surprise us by exhibiting a nearby tipping point. ([Lenton et al.](#), PNAS 2008.)

Permafrost—permanently frozen ground—underlies most of the Arctic land area and extends under parts of the Arctic Ocean. Temperatures in the permafrost have risen by up to 2 °C over the past two to three decades.... The southern limit of the permafrost retreated northward by 30 to 80 km in Russia between 1970 and 2005, and by 130 km during the past 50 years in Quebec. ([AMAP](#) 2011.)

The thaw and release of carbon currently frozen in permafrost will increase atmospheric CO₂ concentrations and amplify surface warming to initiate a positive permafrost carbon feedback (PCF) on climate. ([Schaefer et al.](#), TELLUS B 2011.)

Reducing emissions of black carbon and tropospheric ozone and its precursor methane is critical for reducing warming and associated impacts in the Arctic and other vulnerable places in the short term. Black carbon is estimated to be responsible for 50% of the increase in Arctic warming, or almost 1°C of the total 1.9°C increase from 1890 to 2007. ([Jacobson](#), JGR 2010; [Shindell & Faluvegi](#), NG 2009.) Roughly 50% of the warming in the elevated Himalayan region has been attributed to the direct black carbon heating of the atmosphere and the surface. ([Ramanathan et al.](#), JGR 2007; [Flanner et al.](#), ACPD 2009; [Xu et al.](#), CB 2009; [Menon et al.](#), ACP 2010) Thus, reducing black carbon and other SLCPs is critical for slowing down the warming and glacier melting in the Arctic, the Himalayan-Tibetan region, and other vulnerable places ([Menon et al.](#), ACP 2010; [Ramanathan & Xu](#), PNAS 2010).

BC albedo and direct forcings are large in the Himalayas, where there is an especially pronounced response in the Karakoram, and in the Arctic, where the measures reduce projected warming over the next three decades by approximately two thirds. ([Shindell et al.](#), SCI 2012.)

Controlling FS [fossil-fuel soot] and BSG [solid-biofuel soot and gases] may be a faster method of reducing Arctic ice loss and global warming than other options, including controlling CH₄ or CO₂, although all controls are needed. ([Jacobson](#), JGR 2010.)

Reducing the current rate of warming and returning to a safer climate requires *fast-action mitigation for both CO₂ and SLCPs*, along with deliberate CO₂ removal from the atmosphere on a timescale of decades, starting with bio-sequestration, including biochar.

We define ‘fast-action’ to include regulatory measures that can begin within 2–3 years, be substantially implemented in 5–10 years, and produce a climate response within decades. We discuss strategies for short-lived non-CO₂ GHGs and particles, where existing agreements can be used to accomplish mitigation objectives. Policy makers can amend the Montreal Protocol to phase down the production and consumption of hydrofluorocarbons (HFCs) with high global warming potential. Other fast-action strategies can reduce emissions of black carbon particles and precursor gases that lead to ozone formation in the lower atmosphere, and increase biosequestration, including through biochar. These and other fast-action strategies may reduce the risk of abrupt climate change in the next few decades by complementing cuts in CO₂ emissions. ([Molina et al.](#), PNAS 2009.)

It should be recognized that mitigation of SLCPs should not be thought of substitute for CO₂ mitigation. In fact, both are required to keep the warming below during this century:

Therefore, efforts to reduce emissions of black carbon and ozone precursors should be presented not as substitutes for commitments to reducing carbon dioxide emissions but as ways to quickly achieve local environmental and economic benefits.

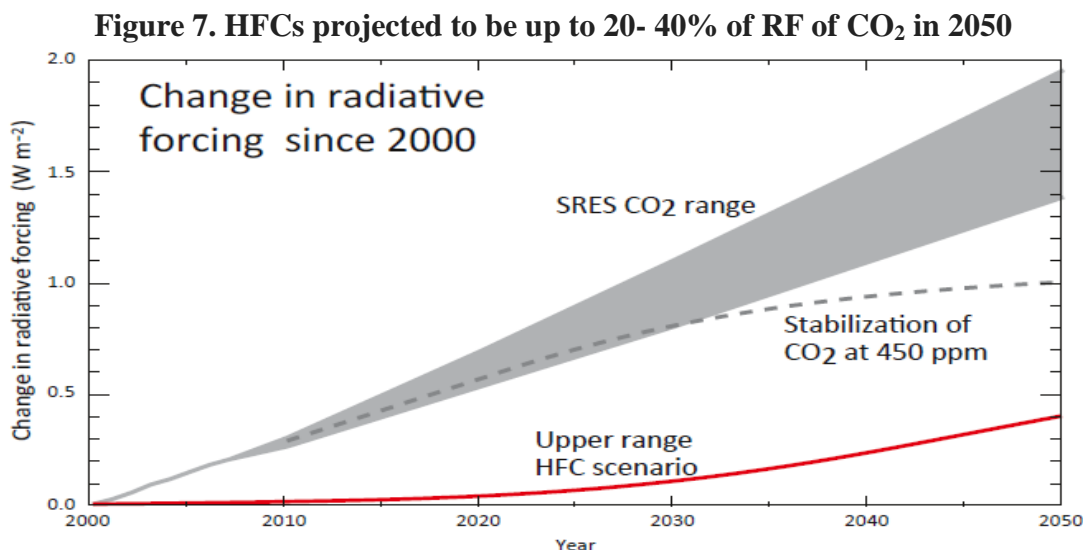
At the current rate of global warming the earth’s temperature stands to careen out of control. Now is the time to look carefully at all the possible brakes that can be applied to slow climate change, hedge against near-term climate disasters, and buy time for technological innovations. Of the available strategies, focusing on reducing emissions of black carbon and ozone precursors is the low-hanging fruit: the costs are relatively low, the implementation is feasible, and the benefits would be numerous and immediate. ([Wallack & Ramanathan](#), FA 2009.)

Fast-action strategy 1 is to strengthen climate protection under the Montreal Protocol stratospheric ozone treaty by phasing down high GWP HFCs. The Montreal Protocol has successfully phased out 97% of nearly 100 ozone-depleting and climate-warming chemicals. This has provided mitigation of up to 222 billion tonnes of CO₂-eq. and delayed warming by up to 12 years worth of CO₂ emissions ([Velders et al.](#), PNAS 2007.) The 197 Parties to the treaty are now phasing out ozone-depleting and climate-damaging HCFCs. Unfortunately, high-GWP HFCs are growing 10 to 15% per year as they are used as substitutes for HCFCs in an increasing number of applications. In 2005, the US emitted 34% of global HFC emissions, China 21%, and the EU 15%. ([CAIT](#) 2012.) Phasing down production and use of high GWP HFCs would substantially reduce one of the six Kyoto gases and achieve mitigation of over 100 billion tonnes of CO₂-eq. by 2050 through a treaty that has always succeeded, and at a cost that could be pennies of public funding per tonne of CO₂-eq. Historically, such transitions under the Montreal Protocol also have significantly improved the energy efficiency of the refrigerators, air conditioners, and other products and equipment using refrigerants, reducing CO₂ emissions ([TEAP](#) 2010.) Unless HFCs with high GWP are phased down, the high growth of HFCs will cancel the climate mitigation already achieved by the Montreal Protocol ([Velders et al.](#), SCI 2012; [UNEP](#) 2011.)

Total avoided net annual ODS emissions [under the Montreal Protocol] are estimated to be equivalent to about 10 Gt CO₂/year in 2010, which is about five times the annual reduction target of the Kyoto Protocol for 2008–2012. This climate benefit of the Montreal Protocol may be reduced or lost completely in the future if emissions of ODS substitutes with high GWPs, such as long-lived HFCs, continue to increase. ([Velders et al.](#), SCI 2012.)

The atmospheric abundances of major HFCs used as ODS substitutes are increasing 10 to 15% per year in recent years.... In an upper-range scenario, global radiative forcing from HFCs increases

from about 0.012 W/m^2 in 2010 to 0.25 to 0.40 W/m^2 in 2050. This corresponds to 14 to 27% of the increase in CO_2 forcing under the range of Intergovernmental Panel on Climate Change (IPCC) business-as-usual scenarios from 2010 to 2050.... If the current mix of HFCs with an average lifetime of 15 years (average GWP of 1600) were replaced by HFCs with life- times less than 1 month (GWP less than ~ 20), the total HFC radiative-forcing contribution in 2050, even under the high-emission scenario, would be less than the current forcing from HFCs (see the graph). Such choices are currently available. ([Velders et al.](#), SCI 2012.)



Projected radiative forcing of climate by HFCs and CO_2 since 2000, when the influence of HFCs was essentially zero. The HFC climate forcing for an upper range scenario is compared with the CO_2 forcing for the range of scenarios from IPCC-SRES and the 450 ppm CO_2 stabilization scenario. Clearly, the contribution of HFCs to radiative forcing could be very significant in the future; by 2050, it could be as much as a quarter of that due to CO_2 increases since 2000, if the upper range HFC scenario is compared to the median of the SRES scenario. Alternatively, the contribution of HFCs to radiative forcing could be one-fifth the radiative forcing due to CO_2 increases since 2000, if the upper range HFC scenario is compared to the upper range of the SRES scenario. The contribution of HFCs to radiative forcing could also be as much as 40% of the radiative forcing by CO_2 under the 450 ppm scenario. ([UNEP](#) 2011)

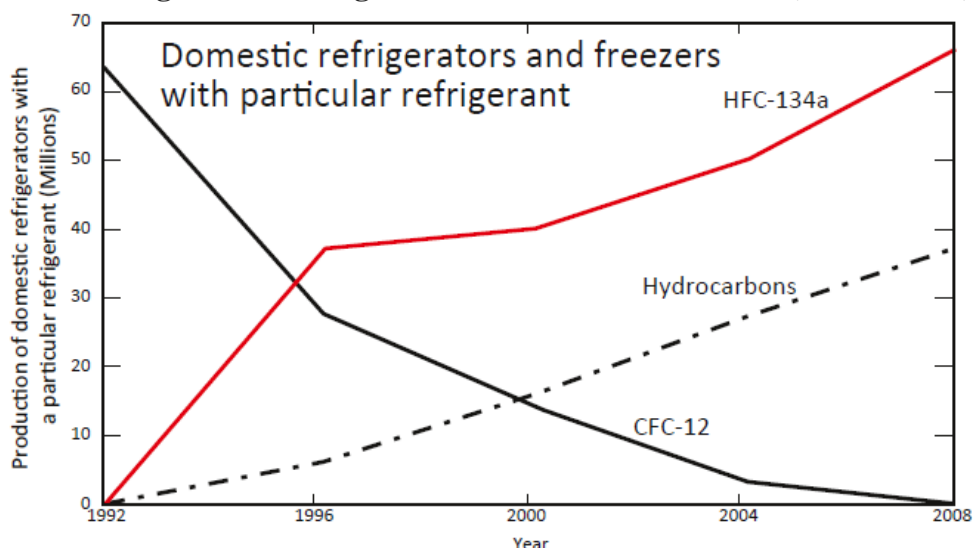
Substitutes for HFCs already exist for many uses and others are expected soon, according to TEAP and other authorities. In addition, a coalition of 650 companies in the Consumer Goods Forum has already pledged to avoid HFCs beginning in 2015.

Approaches to reduce climate forcing from future HFC use and to preserve climate benefits provided by the Montreal Protocol include....: (i) replacing high-GWP HFCs with substances that have low impact on climate (e.g., hydrocarbons, CO_2 or certain HFCs) and alternative technologies (e.g., fiber insulation materials) and (ii) reducing HFC emissions (e.g., by changing the design of equipment and capturing and destroying HFCs when equipment reaches the end of its useful life).... Low-climate-impact substitutes are already in commercial use in several sectors. ([Velders et al.](#), SCI 2012.)

Technology is available to leapfrog high-GWP HFCs in some applications, which would avoid a second transition out of HFCs and complications of an increasingly large inventory of HFC equipment requiring servicing with HFCs that may be expensive or not easily available. ([TEAP](#) 2010.)

[T]he Consumer Goods Forum's Board has agreed on a resolution and action plan in November 2010: The companies recognize the major and increasing contribution to total greenhouse gas emissions from hydro fluorocarbons (HFCs) and derivative chemical refrigerants. The companies are taking action to mobilize resources within their respective businesses to begin phasing out HFC refrigerants by 2015.... ([CGF](#) 2012.)

Figure 8. Annual global production of domestic refrigerators and freezers, showing changes in the refrigerants used from 1992 to 2008 (RTOC 2011).



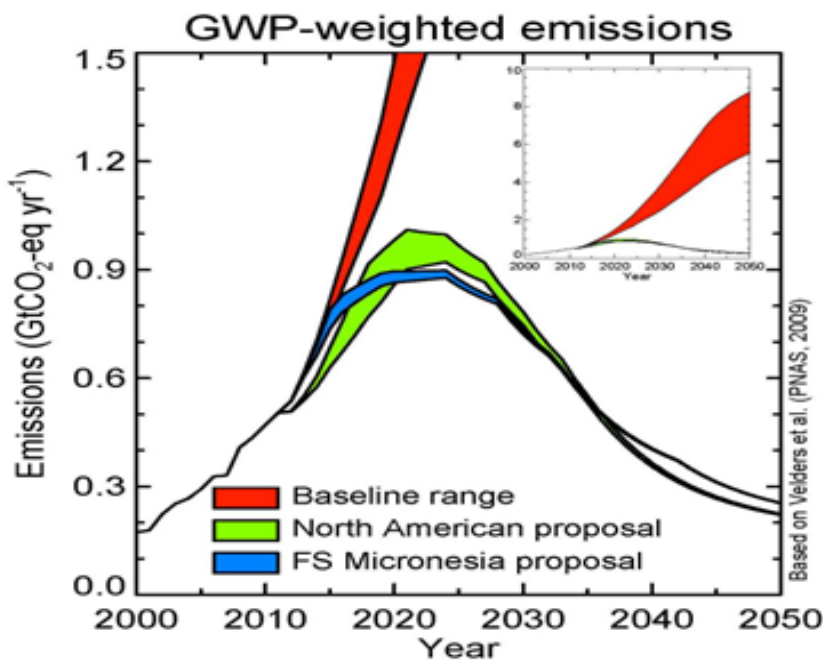
About 104 million domestic refrigerators and freezers are produced annually. Each unit can contain 50 - 250 grams of HFC refrigerant, and up to 1kg of HFC blowing agent in the insulating foam. When CFCs were being phased out in the 1990s, hydrocarbon technology was developed for domestic refrigerators to provide a low-GWP alternative to ODSs and HFCs. The use of hydrocarbons has grown to about 36% of the global market for new domestic refrigerators and freezers (Figure 4.1), and is expected to reach about 75% of global production by 2020 (TEAP 2010a). Energy efficient hydrocarbon systems are now used by refrigerator manufacturing companies in many countries, including: Argentina, China, Denmark, France, Germany, Hungary, India, Indonesia, Italy, Japan, South Korea, Mexico, Russia, Swaziland, Turkey, Brazil and recently in USA (Maté 2010; TEAP 2010a). ([UNEP 2011](#).)

Vulnerable island States have proposed phasing down production and use of high-GWP HFCs under the Montreal Protocol, leaving control of emissions of HFCs in the Kyoto Protocol. ([Montreal Protocol 2012](#).) The US, Mexico, and Canada made a similar proposal ([Montreal Protocol 2012](#)), and 107 Parties have expressed support ([Montreal Protocol 2010](#) & [2011](#)).

The FSM's 2012 Proposed Amendment will strengthen climate protection under the Montreal Protocol by phasing down the production and consumption of HFCs, a group of super-greenhouse gases. Phasing down HFCs is essential to fulfilling obligations under the Vienna Convention to limit the adverse environmental effects, including effects on the climate system, of actions taken to protect the ozone layer. The resulting benefit will be up to 100 billion tonnes of CO₂-eq. mitigation by 2050 under a treaty that has successfully phased out nearly 100 other chemicals. ([Montreal Protocol 2012](#).)

Cumulative benefits of the HFC phasedown estimated by the U.S. Government amount to reductions of 2,200 million metric tons of carbon dioxide equivalent (MMT CO₂eq) through 2020, and about 85,000 MMTCO₂eq through 2050.... Cumulative benefits from HFC-23 byproduct emissions controls as estimated by the U.S. Government amount to an additional 11,300 MMTCO₂eq through 2050.... The proposal leaves unchanged the provisions of the UNFCCC/Kyoto Protocol that govern HFC emissions. Parties could follow Montreal Protocol obligations to meet certain UNFCCC obligations ([Montreal Protocol 2012](#).)

Figure 9. Cumulative Decrease of Direct GWP-Weighted Emissions of HFCs under the Proposed Micronesian and North American Amendments to the Montreal Protocol



The North American proposal and the Micronesian proposal are similar; both decrease the cumulative (2013-2050) direct GWP-weighted emissions of HFCs to 22-24 GtCO₂-eq from 110-170 GtCO₂-eq, for a total of ~87 to 146 GtCO₂-eq in mitigation. This is equivalent to a reduction from projected annual emissions of 5.5 to 8.8 GtCO₂-eq/yr in 2050 to less than ~0.3 GtCO₂-eq/yr. Prepared Dr. Guus Velders, based on Velders G. et al., [The large contribution of projects HFC emissions to future climate forcing](#), PNAS (2009).

[Bali] Declaration on the global transition away from hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs).... [The 107 Party signatories] Encourage all Parties to promote policies and measures aimed at selecting low-GWP alternatives to HCFCs and other ozone-depleting substances;... Declare our intent to pursue further action under the Montreal Protocol aimed at transitioning the world to environmentally sound alternatives to HCFCs and CFCs. ([Montreal Protocol](#) 2010 & [2011](#).)

The Rio+20 declaration, *The Future We Want*, provides universal support for phasing down consumption and production of HFCs.

222. We recognize that the phase-out of ozone-depleting substances is resulting in a rapid increase in the use and release of high global-warming potential hydrofluorocarbons to the environment. We support a gradual phase-down in the consumption and production of hydrofluorocarbons. ([The Future We Want](#) 2012)

Fast-action strategy 2 is to cut black carbon, tropospheric ozone and its precursor, methane—local air pollutants that harm public health, crops, ecosystems, and carbon sinks, and that also cause climate change. Unlike CO₂, black carbon, tropospheric ozone and its precursor, methane, disappear quickly from the atmosphere once emissions are cut. Reducing these local air pollutants can cut the rate of global warming by up to half and the rate of Arctic warming by up to two-thirds over the next thirty years. In addition to producing fast climate results, cutting these local air pollutants also delivers strong collateral benefits for public health, food security, and ecosystems, including carbon sinks, providing independent justification for fast action. These benefits, including much of the climate mitigation benefits, are enjoyed by the regions making the cuts. For example, eliminating

emissions of black carbon from traditional solid biomass stoves with improved cook stoves would have a major impact in reducing black carbon direct climate effects over South Asia (by about 60%) ([Ramanathan & Carmichael](#), NG 2008).

Reducing black carbon, methane and tropospheric ozone now will slow the rate of climate change within the first half of this century.... A small number of emission reduction measures targeting black carbon and ozone precursors could immediately begin to protect climate, public health, water and food security, and ecosystems. (UNEP-WMO 2011.)

The selection criterion [for a mitigation measure] was that the measure had to be likely to reduce global climate change and also provide air quality benefits, so-called win-win measures. Those measures that provided a benefit for air quality but increased warming were not included in the selected measures. (UNEP-WMO, 2011)

These measures can accomplish about 38 per cent reduction of global methane emissions and around 77 per cent of black carbon emissions, if implemented between now and 2030, relative to a 2030 'reference' emission scenario. (UNEP 2011.)

This small number of mitigation measures is capable of realizing “nearly 90% of the maximum reduction in net GWP.” ([Shindell et al.](#), SCI 2012.) They include the following 14 measures:

Methane Control Measures

- Control fugitive emissions from oil and gas production
- Control emissions from coal mining
- Control fugitive emissions from long distance gas transmission
- Capture gas from municipal waste and landfills
- Capture gas from wastewater treatment facilities
- Capture gas from livestock manure
- Intermittent aeration of constantly flooded rice paddies

Black Carbon Control Measures

- Install particulate filters on diesel vehicles
- Replace traditional cooking stoves with clean burning biomass stoves
- Modernize brick kilns
- Modernize coke ovens
- Ban open burning of biomass
- Eliminate high emitting on and off-road diesel vehicles
- Provide global access to modern cooking and heating

([Shindell et al.](#), SCI 2012.)

Full implementation of the identified measures [by 2030] would reduce future global warming by 0.5°C (within a range of 0.2–0.7°C)... by 2050.... Full implementation of the identified measures... could reduce warming in the Arctic in the next 30 years by about two-thirds compared to the projections of the Assessment's reference scenario, [in addition to providing substantial benefits in] the Himalayas and other glaciated and snow-covered regions. (UNEP-WMO 2011.)

In addition to climate benefits, reducing SLCPs provides strong collateral benefits for public health and food security.

We estimate that, for PM_{2.5} [black carbon] and ozone respectively, fully implementing these [14] measures could reduce global population-weighted average surface concentrations by 23-34% and 7-17% and avoid 0.6-4.4 and 0.04-0.52 million annual premature deaths globally in 2030. Over 80% of the health benefits are estimated to occur in Asia.... Based on our estimates, avoided deaths would represent 1-8% of cardiopulmonary and lung cancer deaths among those age 30 years and older, and

1-7% of all deaths for all ages, assuming constant baseline mortality rates. ([Anenberg et al.](#), EHP 2012.)

This strategy avoids 0.7 to 4.7 million annual premature deaths from outdoor air pollution and increases annual crop yields by 30 to 135 million metric tons due to ozone reductions in 2030 and beyond. ([Shindell et al.](#), SCI 2012.)

Full implementation of the identified measures could avoid ... the loss of 52 million tonnes (within a range of 30–140 million tonnes), 1–4 per cent, of the global production of maize, rice, soybean and wheat each year. ([UNEP-WMO](#) 2011.)

Air pollution is set to become the world's top environmental cause of premature mortality, overtaking dirty water and lack of sanitation. Air pollution concentrations in some cities, particularly in Asia, already far exceed World Health Organization safe levels, and they are projected to deteriorate further to 2050.... The number of premature deaths from exposure to particulate matter ... is projected to more than double worldwide, from just over 1 million today to nearly 3.6 million per year in 2050, with most deaths occurring in China and India.... The absolute number of premature deaths from exposure to ground-level ozone is to more than double worldwide (from 385 000 to nearly 800 000) between 2010 and 2050. Most of these deaths are expected to occur in Asia, where the ground-level ozone concentrations as well as the size of the exposed population are likely to be highest. ([OECD](#) 2012.)

Reductions of black carbon and tropospheric ozone provide benefits that accrue disproportionately to the region making the cuts.

The health benefits from implementing black carbon mitigation measures would be realized immediately and almost entirely in the regions that reduce their emissions. Regions taking action on black carbon would also benefit significantly from reduced regional warming, reduced disruption of regional weather patterns, as well as a substantial reduction in crop-yield losses.... Nearly all of the health benefit, 87-99 per cent, would be realized within the same regions that implement the measures, which is worth considering when deciding on national actions to reduce SLCFs. ([UNEP](#) 2011.)

Most of the control measures for reducing black carbon and tropospheric ozone and its precursor, methane, can be implemented today with existing technologies and often with existing laws and institutions.

BC can be reduced by approximately 50% with full application of existing technologies by 2030.... Strategies to reduce BC could borrow existing management and institutions at the international and regional levels, including existing treaty systems regulating shipping and regional air quality. ([Molina et al.](#), PNAS 2009.)

*National efforts to reduce SLCFs can build upon existing institutions, policy and regulatory frameworks related to air quality management, and, where applicable, climate change. *** Regional air pollution agreements, organizations and initiatives may be effective mechanisms to build awareness, promote the implementation of SLCF mitigation measures, share good practices and enhance capacity. *** Global actions can help enable and encourage national and regional initiatives and support the widespread implementation of SLCF measures. A coordinated approach to combating SLCFs can build on existing institutional arrangements, ensure adequate financial support, enhance capacity and provide technical assistance at the national level. ([UNEP](#) 2011.)*

Many other policy alternatives exist to implement the CH₄ [methane] and BC measures, including enhancement of current air quality regulations. ([Shindell et al.](#), SCI 2012.)

Regulatory policies and forums exist to reduce non-CO₂ warming agents. The Montreal Protocol with modifications for HFC regulations can be an effective tool for reducing watts attributable to HFCs. National policies exist to limit CO and other ozone-producing gases. (Ramanathan & Xu, PNAS 2010.)

These measurements ... provide a direct link between regulatory control policies and the long-term impact of anthropogenic emissions. Our model calculation indicates that the decrease in BC in California has lead to a cooling of 1.4Wm⁻² (±60%). The regulation of diesel fuel emissions in California therefore has proven to be a viable control strategy for climate change in addition to mitigating adverse human health effects. (Bahadur et al., AE 2011.)

Half of the identified measures can be implemented with a net cost savings for those making the investment, and all are ultimately cost-effective when the \$5.9 trillion annual benefits that start in 2030 are taken into account.

About 50 per cent of both methane and black carbon emission reductions can be achieved through measures that result in net cost savings (as a global average) over their technical lifetime. The savings occur when initial investments are offset by subsequent cost savings from, for example, reduced fuel use or utilization of recovered methane. A further third of the total methane emission reduction could be addressed at relatively moderate costs. (UNEP 2011.)

*Benefits of methane emissions reductions are valued at \$700 to \$5000 per metric ton, which is well above typical marginal abatement costs (less than \$250). *** ... [T]he bulk of the BC measures could probably be implemented with costs substantially less than the benefits given the large valuation of the health impacts. (Shindell et al., SCI 2012.)*

While many measures can provide a net cost savings, new policies and financing measures are likely required to overcome implementation barriers.

[A]bout half of the temperature reduction would emerge from Group 1 measures [low cost methane and black carbon measures], which result in net cost savings to society over their full technical lifetime. However, the required up-front investments over an assumed 20 years implementation period do constitute a considerable barrier to implementation. Prevailing short-term profit expectations of private investors make these measures less attractive to the market.... For all Group 1 measures, targeted interventions or appropriate financing mechanisms could help to overcome implementation barriers. In comparison, measures of Group 2, which could potentially be competitive on a carbon market, require much lower up-front investments, especially for methane recovery in coal mines. Some of the more costly measures for controlling SLCFs are often/usually implemented for other development related objectives. (UNEP 2011.)

Fast-action strategy 3 is to deliberately remove excess CO₂ from the atmosphere on a timescale of decades rather than millennia in order to return to a safe and stable climate. Reducing CO₂ concentrations to a level consistent with a safe and stable climate requires that sinks ultimately exceed sources. Strategies for enhancing sinks include protecting and expanding forests, wetlands, grasslands, and other sources of biomass that are removing CO₂ from the atmosphere, as well as pyrolysis of waste biomass (cooking with limited oxygen) to produce a permanent form of carbon called biochar that can safely return carbon to permanent storage for hundreds to thousands of years. Bio-sequestration of CO₂, including biochar, can match and ultimately exceed CO₂ emissions to achieve a net drawdown of CO₂ on a timescale of decades rather than the millennia timescale of the natural cycle, assuming aggressive CO₂ mitigation as well.

A combined approach of deliberate CO₂ removal (CDR) from the atmosphere alongside reducing CO₂ emissions is the best way to minimize the future rise in atmospheric CO₂ concentration, and the only

timely way to bring the atmospheric CO₂ concentration back down if it overshoots safe levels.... By mid-century, the CDR flux together with natural sinks could match current total CO₂ emissions, thus stabilizing atmospheric CO₂ concentrations. By the end of the century, CDR could exceed CO₂ emissions, thus lowering atmospheric CO₂ concentration and global temperature. ([Lenton](#), CM 2010.)

In the most optimistic scenarios, air capture and storage by BECS [bioenergy and carbon sequestration], combined with afforestation and bio-char production appears to have the potential to remove ≈100 ppm of CO₂ from the atmosphere...on the 2050 timescale. ([Lenton & Vaughan](#), ACP 2009.)

Strong mitigation, i.e. large reductions in CO₂ emissions, combined with global-scale air capture and storage, afforestation, and bio-char production, i.e. enhanced CO₂ sinks, might be able to bring CO₂ back to its pre-industrial level by 2100, thus removing the need for other geoengineering. ([Lenton & Vaughan](#), ACP 2009.)

Other CO₂ removal strategies include direct air capture and capture at smokestacks. The CO₂ captured from smokestacks then requires permanent storage, or re-utilization, for example as calcium carbonate, which can be used as a substitute for a portion of ordinary Portland cement or of aggregate.

While about half of the anthropogenic CO₂ emissions are the result of large industrial sources such as power plants and cement factories, the other half originate from small distributed sources such as cars, home heating, and cooking. For those, CO₂ capture at the emission source is not practical and/or economical. A possible pathway to deal with these emissions is to capture CO₂ directly from the air. One of the advantages of CO₂ capture from the atmosphere is that the needed infrastructure can be placed anywhere, preferably where it has the least impact on the environment and human activities or close to CO₂ recycling centers. ([Goeppert et al.](#), JACS 2011.)

DAC [Direct Air Capture] is one of a small number of strategies that might allow the world someday to lower the atmospheric concentration of CO₂. ([APS](#) 2011.)

Calera ... can capture up to 90% of CO₂ from power plants...and can convert the CO₂ into stable calcareous material and bicarbonate solution with an energy penalty ranging from about 10% to 40%.... The ... calcareous material ... [can] replace a portion of either the product called “Ordinary Portland Cement” (OPC) or to replace or reduce OPC ingredients in blended cement, and thus potentially avoiding CO₂ emissions from cement manufacture... In some cases, the combined reductions in greenhouse gas emissions from power plant CCS and avoided cement production are potentially greater than the total emissions of either process alone.... ([Zaelke et al.](#), 2011.)

Conclusion. All of these strategies are necessary to reduce current climate impacts, to slow dangerous feedbacks, and to reduce the risk of passing tipping points that could lead to irreversible climate impacts. Reducing CO₂ remains the top priority, but we also need to simultaneously reduce SLCPs for near-term benefits that will keep us from losing the climate battle while serious CO₂ mitigation is being achieved. We also need to perfect and implement strategies to deliberately reduce excess CO₂ from the atmosphere on a time scale of decades. The take-away message from the science and the growing impacts is *the need for speed* and the importance of fast-action mitigation to address all causes of climate change.

Appendices

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Appendix 1: The Climate & Clean Air Coalition to Reduce Short-Lived Climate Pollutants

The Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants ([CCAC](#)), launched on 17 February 2012, held its inaugural Ministerial Meeting in Stockholm on 24 April and agreed on five new initiatives aimed at accelerating and scaling-up action against SLCPs.

The Coalition now has 19 members from both developing and developed countries including: the US, Canada, Mexico, Ghana, Japan, Bangladesh, Sweden, Norway, Nigeria, Colombia, the World Bank, the European Commission, and UNEP. The G8 Leaders announced in their [Camp David Declaration](#) 19 May 2012 that they were joining the Coalition, adding Russia, Italy, France, the UK, and Germany. On 19 June 2012, the CCAC and World Bank and the Global Methane Initiative joined with the Clinton Climate Initiative and C40 Cities to launch a new partnership to reduce methane and black carbon pollutants from municipal solid waste. ([CCAC](#).) [Finland](#) joined 27 June.

The CCAC Secretariat will be hosted by UNEP's Paris office, and will manage a dedicated Trust Fund with an initial contribution of \$16.7 million from the U.S., Canada, Sweden, and Norway. The World Bank has also announced that it has \$12 billion in its portfolio contributing to the CCAC's goals.

The CCAC is the first-ever global effort specifically dedicated to reducing emissions of SLCPs as a collective challenge. The targeted climate pollutants include black carbon (soot), tropospheric ozone and its precursor methane, and hydrofluorocarbons (HFCs), used as refrigerants and to make insulating foams. The CCAC goals are:

- Raising awareness of short lived climate pollutant impacts and mitigation strategies;
- Enhancing and developing new national and regional actions, including by identifying and overcoming barriers, enhancing capacity, and mobilizing support;
- Promoting best practices and showcasing successful efforts; and
- Improving scientific understanding of short-lived climate pollutants impacts and mitigation strategies.

[Five initiatives](#) were approved during the April 24 Ministerial meeting in Stockholm:

- Fast action on diesel emissions including from heavy-duty vehicles and engines, through the freight supply chain, city action plans, and lower sulfur fuels.
- Upgrading old inefficient brick kilns, including the 20,000 small and medium sized one in Mexico, and the 6,000 in Bangladesh.
- Accelerating the reduction of methane emissions from landfills, by improving municipal solid waste planning.
- Speeding up cuts in methane and other emissions from the oil and gas industry, by stopping venting and flaring.
- Accelerating alternatives to HFCs, by fast-tracking environmentally safe alternatives.

The CCAC Coalition will be developing additional proposals, starting with one by Ghana on open burning and by one by Bangladesh on cookstoves. The next meeting is 23-25 July in Paris.

Three leading SLCP scientists will advise on the formation of a Science Advisory Panel: Drew Shindell of NASA's Goddard Institute for Space Studies, Mario Molina, the distinguished Mexican chemist and 1995 Nobel Prize co-winner, and Veerabhadran Ramanathan, chair of the UNEP Atmospheric Brown Cloud project and Distinguished Professor of Atmospheric and Climate Sciences at the Scripps Institution of Oceanography, University of California San Diego.

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Remarks by Secretary of State Hillary Rodham Clinton at the Climate Clean Air Coalition and Green Embassy Event (Helsinki, Finland, 27 June 2012):

And last week, at the sustainability conference, Rio+20, the coalition launched a new initiative to reduce methane and other pollutants from landfills. We have encouraged and enlisted mayors from several major world cities. We also have the World Bank on board, and other countries are joining. In fact, all of the G-8 countries recently signed up to the coalition at the last meeting.

But we're not stopping there, because we formed this coalition for the purpose of taking action, and demonstrating globally that we can actually do things, that we can translate our concerns and our words into actions and results. In partnership with the UN Environment and Development Programmes, the European Commission, and key private sector companies, we are co-hosting a conference in Bangkok this July to showcase new technologies that can drastically reduce the need for HFCs in refrigeration and air conditioning.

Here is a perfect example of the problem: As you have a growing middle class in countries like India and China, where the climate can often get very, very hot, you have an increasing demand for air conditioning. The increasing demand for air conditioning in turn puts more HFCs into the air, thereby creating more of a problem from the short-lived pollutants. So what we want to do is try to get ahead of this, not to tell people – certainly, we in the United States are in no position to tell people, “Look, you’ve lived without air conditioning for thousands of years; you can keep doing it for the sake of the climate.”

No, instead we want to say, “Look, as you have developed, as your incomes have risen, we know that you want to take advantage of air conditioning, but let’s see if we can find a way to do that that is more climate-friendly.” And that is part of the mission that we have in this new coalition.

Plenary Remarks by Secretary of State Hillary Rodham Clinton at Rio+20 Conference on Sustainable Development (Rio de Janeiro, 22 June 2012):

[E]arlier this year, I was privileged to host six countries in the United Nations Environment Program as we launched the Climate and Clean Air Coalition. The goal is to reduce short-lived climate pollutants that cause more than 30 percent of current global warming, as well as millions of premature deaths and extensive crop losses. We know we have to keep working together on CO₂, but we think that our Climate and Clean Air Coalition, to which many more countries are joining, and we welcome you, can take targeted action and produce results with respect to methane and black soot and HFCs.

CCAC Rio Announcement of Solid Waste Partnership with C40 cities network (19 June 2012):

Former President Bill Clinton: *As we all know methane, black carbon, and hydrofluorocarbons clear the atmosphere much quicker than carbon dioxide. We need both these strategies, those that cut CO₂ and those that produce the fastest results by cutting other pollutions. If we focused on the methane, the black carbon, the hydrofluorocarbons we can reduce the rate of climate change for the next thirty years by half and reduce the change in the Arctic by up to two-thirds. That's why the Secretary of State has worked so hard on this issue and why she's coming to Rio to push it. (SLCPs at 28:45; full speech starts 22:55.)*

U.S. Special Envoy for Climate Change Todd Stern: *This initiative encapsulates perfectly what we're trying to do with the newly launched Climate and Clean Air Coalition. Countries, cities, the World Bank, and civil society partnering together to make real-world, scaled-up reductions of 'short-lived climate pollutants,' which cause some 30% of current warming. With this solid waste initiative, we're*

making a big dent in the third-largest source of methane worldwide, and, at the same time, improving the health and environment of local communities.

C-40 Chair and New York City Mayor Michael Bloomberg: *Improving the management of city solid waste, including reducing the release of methane and other greenhouse gases is a top priority of many C-40 cities. The success of this partnership and of our new C40 network will move us a long way toward the greenhouse gas reduction goals we are setting.*

U.S. Special Representative for Global Intergovernmental Affairs Reta Jo Lewis: *Urban areas contribute nearly 80 percent of global greenhouse gas emissions. At the same time, city-driven solutions can quickly reach billions. Quite literally, cities are where the rubber hits the road.*

Today we are announcing a groundbreaking partnership.....cities, countries, our Coalition, the World Bank, the Global Methane Initiative, and CCI/C-40 are all joining together to reduce climate pollutants from solid waste, the third largest source of man-made methane worldwide.

And remember that methane is a substance 20 times more potent a greenhouse gas than carbon dioxide. Moreover, left unaddressed, municipal solid waste is predicted to double by 2025.

We'll be working with cities to provide an array of common-sense, results-driven technical expertise and capacity building. And our Climate and Clean Air Coalition partner countries like Mexico, Canada, Bangladesh, the United States, Nigeria, and others will cooperate closely. We'll also be building a knowledge platform of best practices to share with cities around the world.

Letter to Secretary Clinton by US Congressmen Waxman, Markey, and Berman Supporting International Efforts to Address Short-Lived Climate Pollutants (19 June 2012):

We strongly support the initiatives of the recently-launched Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants. By partnering with a number of developed and developing countries, as well as international organizations, the United States has taken a leadership role in addressing these pollutants. The Coalition promises to produce concrete environmental and health benefits by focusing on the rapid implementation of five initiatives, including reducing diesel emissions from heavy-duty vehicles, upgrading old inefficient brick kilns, and accelerating the reduction of methane emissions from landfills. We believe that your personal commitment to this effort has been crucial to its early success.

In 2009, the United States joined Mexico and Canada in proposing an amendment to the Montreal Protocol to phase-down the production and consumption of HFCs, which are extremely potent greenhouse gases. The amendment has not yet been adopted, but each year the North American proposal has gained support – from 41 countries in 2009 to 91 countries in 2010 and 108 countries in 2011.

This year, the United States, Mexico, and Canada have once again placed the HFC proposal on the agenda of the Meeting of the Parties in November. This year is the twenty-fifth anniversary of the Montreal Protocol. It is a time when parties will naturally reflect on past successes and look to harness the potential of the Protocol to confront new challenges. In 2007, with the leadership of the United States, the parties agreed to accelerate the phase-out of hydrochlorofluorocarbons (HCFCs), which both deplete the ozone layer and contribute to climate change. Five years later, the pressing task is to adopt the North American HFC proposal. We encourage you to personally engage with the governments of key developing countries, such as India, China, and Brazil, to make substantive negotiations a reality. The foundation for progress has already been laid. It is time for the Montreal Protocol to take its next big stride forward.

Remarks by Secretary of State Hillary Rodham Clinton and Swedish Minister for Environment Lena Ek at Climate and Clean Air Coalition Event (Stockholm, Sweden, 3 June 2012):

MINISTER EK: *** *Much as happened in the short time since we met in Washington in February to launch the Climate and Clean Air Coalition to reduce SLCPs. We were proud to host the first formal meeting of the coalition here in Stockholm in April, where we were joined by new members, and the coalition has now grown from six to 16 countries, plus the European Commission, UNEP, and the World Bank. And we especially, of course, welcome the decision of all G-8 members to join at the recent summit in Camp David.*

Short-lived climate pollutants is a strange and maybe unfamiliar set of words to most, but SLCPs such as black carbon, soot, tropospheric ozone, methane, and short-lived HFCs all have some characteristics in common. They significantly contribute to global and regional warming. They also impact crop yields, deteriorate air quality, and affect human health across the globe. And they are short-lived. And just because of this, they represent a golden opportunity to slow down climate warming in the near term, even more so because they represent as much as a third of increases in average global temperature.

I believe this coalition owes to rapid success to two things. Firstly, it delivers a simple but powerful message based on science. By preventing SLCPs emissions, we can significantly reduce near-term climate change and at the same time save 2.5 million lives per year, increase crop yields and food security, and promote gender equality and women's rights across the globe.

Secondly, this is a coalition of action. All partners bring something to the table, and in joining have agreed to take action also at home. The coalition is structured around the basic idea that we need to act now, and countries are demonstrating their will and ability to reduce domestic emissions by agreeing to implement national reduction actions on SLCPs.

*It's only through effective action on greenhouse gases that we can stop climate change. Researchers are telling us that without drastic CO2 emission reductions we are facing temperature increases that will be substantially higher than the two-degree target. Therefore, we are wholly committed to the UNFCCC negotiations and to making the necessary mitigation efforts at home. Measures to reduce CO2, such as the Sweden carbon tax of 150 U.S. dollars per ton CO2, are not only necessary but contribute to green growth and enable lower taxes in other areas and job creation in the economy as a whole. ****

SECRETARY CLINTON: *** *The Climate and Clean Air Coalition is designed to get results for what are called – as the minister just said – short-lived climate pollutants, including methane, black carbon, and the hydrofluorocarbons. These pollutants are responsible for more than 30 percent of current global warming. And because they are also very harmful to human health and to agriculture, we can save millions of lives and tons of crops as well by acting now. This is what we call a win-win for sure.*

*In February, Sweden, the United States, four other nations, and the UN Environmental Program launched the Climate and Clean Air Coalition, and since then, as the minister said, we've been growing, bringing on all G-8 countries, as well as Norway, Nigeria, Denmark, and Colombia. And we were pleased when the World Bank and the European Commission signed up as well. We've also increased our funding thanks in part to contributions from Sweden and Norway. We are setting up a science advisory panel. And just in April, Sweden hosted the coalition's first ministerial meeting, when we decided on a set of global action-oriented initiatives to implement immediately. So we have built some strong initial momentum, but we need your help. Today, Sweden and the United States are beginning a global campaign to close the information gap about short-lived climate pollutants. Few people actually know about the impact we could have on global warming if we aggressively target them. And fewer still know that many cost-effective solutions already exist and are just waiting to be broadly implemented. ****

Now, included in the group that Minister Ek and I met with were leading Swedish companies also supporting this effort, because we know we cannot solve this crisis without the active cooperation and, indeed, the leadership of the private sector, particularly oil and gas companies, makers of diesel trucks, green tech companies that can help turn methane from landfills into clean energy. Today, for example, representatives from Volvo, Mack Trucks talked about how to cut down black carbon worldwide, 20 percent of which is emitted by the transportation sector.

Major reductions of short-lived pollutants can be done inexpensively and with existing technologies. Experts tell us, for example, that one third of all methane leaked and vented by oil and gas companies can be avoided at a net cost of zero dollars or zero kroner. So we need to convince decision makers everywhere, political leaders, CEOs, civil society leaders, investors, and students that this is one of those areas where we can show tangible progress almost immediately and that we can do it in a cost-effective way.

Here are just a few concrete examples. We're launching an initiative focused on hydrofluorocarbons. By 2050 – 2050 – at the current rate, these greenhouse gases could grow to nearly 20 percent of carbon dioxide emissions. So we will start by holding a technology conference in Bangkok in July to showcase new technologies that can eliminate the need for these potent greenhouse gases in refrigeration and air conditioning. At the upcoming sustainability conference in Rio, we'll launch an initiative working with cities to reduce methane and other pollutants from their waste systems, and we will be working with oil and gas companies to take advantage of all the currently available zero-cost options.

*Now, we're aware that reducing these short-lived pollutants by themselves will not solve the collective crisis facing the world. We must also aggressively reduce carbon dioxide emissions, which we know remain the principal contributor to climate change and last in the atmosphere for generations. And countries and people around the world, like Sweden and Norway and Denmark, where I just visited, are taking bold actions. ****

And while we continue to work on bringing down carbon dioxide emissions and finalizing an international agreement, let's also deliver a blow to methane, black carbon, and HFCs. We are poised to do both, and we should.

Now, I began my day yesterday in the high north, in Tromso, Norway, where we saw some breathtaking views and where we toured the waters on a research vessel, listening to marine biologists and sea ice experts and others explain the changes that have come to the Arctic. The waters don't freeze, even in the dead of winter. The ice shelves that have crumbled no longer protect coastlines from erosion. Species are at risk. And it's such a reminder to be in a beautiful place like Stockholm, or yesterday in Tromso, that we inherited a fragile, marvelous planet, and it's our duty to protect it.

So we're very grateful, once again, to be working hand in hand with Sweden. We've already made progress on the Climate and Clean Air Coalition in less than four months. And we're going to continue working closely with Sweden and our other partners. And we are determined to take aggressive action in the months ahead. We can do no less. Thank you all very much. (Applause.)

Remarks by Secretary Hillary Rodham Clinton and Norwegian Minister Jonas Gahr Støre (Tromso, Norway, 2 June 2012):

[T]he United States and Norway are committed to ... do all we can to prevent and mitigate the effects of climate change. I'm highlighting a new partnership that I started called the Climate and Clean Air Coalition, and we're very pleased that Norway is a member. And it is to focus on what are called short-lived climate pollutants – methane, black carbon, hydrofluorocarbons – which make up at least 30 – somewhere between 30 and 40 percent of the greenhouse gas emissions.... [W]e just heard the

impact of burning (inaudible) fuels and putting all that black carbon and soot into the air. It then lands on the ice and you know rest.

So I want to thank Norway for joining the Climate and Clean Air Coalition and making an initial commitment of one and a half million dollars, and also a pledge by Norway of one million dollars specifically to target black carbon across the Arctic. I'm very grateful that we had a chance to meet with the head of Statoil and representative of new Norwegians and ExxonMobil to talk about ways that oil and gas companies are already reducing methane and black carbon emissions from their own production, what more they believe can be done, and how we can bring other companies into this effort to capture your vented, leaked, and flared natural gas, and to cut emissions by up to one-third with no net cost at all. That would make a significant impact on climate change without hurting any oil or gas company's bottom line, and it's exactly the kind of private and public cooperation we need to pursue and that this new coalition is determined to try to bring about.

Remarks by Secretary Hillary Rodham Clinton at the launch of the Green Partnership for Growth (Copenhagen, Denmark, 31 May 2012):

[T]his year we launched the Climate and Clean Air Coalition, which brings together governments, the private sector and key organizations around the world to work toward reducing short-lived climate pollutants, which cause more than 30 percent of near-term warming. Reducing short-lived pollutants is an important complement to the work we must do to reduce carbon emissions. And I'm delighted, Prime Minister, that Denmark has agreed to join the Climate and Clean Air Coalition.

G8 Camp David Declaration (Camp David, USA, 19 May 2012):

14. Recognizing the impact of short-lived climate pollutants on near-term climate change, agricultural productivity, and human health, we support, as a means of promoting increased ambition and complementary to other CO₂ and GHG emission reduction efforts, comprehensive actions to reduce these pollutants, which, according to UNEP and others, account for over thirty percent of near-term global warming as well as 2 million premature deaths a year. Therefore, we agree to join the Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants.

Fact Sheet: G-8 Action on Energy and Climate Change (Camp David, USA, 19 May 2012):

Address Climate Change, Including By Reducing Short-Lived Climate Pollutants

- In the spirit of increasing mitigation efforts, we agree to collectively join the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, launched on February 16, 2012. This new initiative will enhance our collective ambition in addressing climate change by complementing efforts to address CO₂ emissions. By developing strategies to reduce short term pollutants – chiefly methane, black carbon, and hydrofluorocarbons – we can help reduce global warming, improve health, and increase agricultural productivity, as well as energy security.*
- Commission the World Bank to prepare a report on ways to integrate reduction of near-term climate pollution into their activities and ask the World Bank to bring together experts from interested countries to evaluate new approaches to financing projects to reduce methane, including through pay-for-performance mechanisms.*

In its role as 2012 Chair of the G-8, the United States intends to work with G-8 partners to develop mechanisms for following up these actions over the course of 2012.

UNEP Press Release, New Climate and Clean Air Coalition Expands to 13 Members (Stockholm, Sweden, 24 April 2012):

Further momentum was catalyzed with the announcements of Colombia, Japan, Nigeria, Norway and the European Commission that they are joining the Coalition along with the World Bank.

It brings to 13 the number of partners who have joined, expanding the initial membership founded by Bangladesh, Canada, Ghana, Mexico, Sweden and the United States and the UN Environment Programme (UNEP)....

Delegates took forward five to be approved for rapid implementation by Ministers on the final day.

Outcome Document, Stockholm +40 – Partnership Forum for Sustainable Development (Stockholm, Sweden):

13. Showing by example is a powerful tool for achieving sustainable development. The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants is a valuable example where a number of actors have decided on joint actions to raise awareness, develop measures and improve the scientific understanding of short-lived climate pollutants.

Press Release, European Commission joins Climate and Clean Air Coalition (25 April 2012):

Connie Hedegaard, European Commissioner for Climate Action, said: "This initiative should complement the efforts needed under the UN climate change convention to cut global greenhouse gas emissions to a level that will limit global temperature increase to below 2°C. The Commission is willing to consider further support to concrete projects in developing countries to reduce emissions from short-lived climate pollutants."

Press Release, World Bank Joins Climate and Clean Air Coalition (24 April 2012):

The Climate and Clean Air Coalition puts a practical new deal on the table – one that helps slow global warming while reducing the soot and smog that is damaging food crops and health worldwide, undermining growth and development, said Rachel Kyte, Vice President for Sustainable Development, The World Bank.

IPY 2012 Opening Keynote Address by Dr. Gro Harlem Brundtland (Montreal, Canada, 23 April 2012):

Now, even if we manage to slow down or turn around the rising global greenhouse gas emissions in the coming two decades, reductions will not occur quickly enough to conserve the polar and alpine environments, as we know them today.

We need rapid action, with rapid effects.... [R]educing short-lived climate forcers such as methane, black carbon, and ozone is one such promising avenue for rapid action. Recent research has shown that more than one third of current global warming is caused by short-lived pollutants. They also destroy millions of tons of crops every year and wreak havoc on people's health. Furthermore, methane, a greenhouse gas 20 times more potent than carbon dioxide, can be an abundant source of energy if we capture it instead of just venting it into the air or flaring it.

This is exciting new knowledge, and it is possible to reduce these short-lived climate forcers. In a report from November last year, UNEP, the United Nations Environmental Program, calculated that a package of 16 measures could, if fully implemented across the globe, save close to 2.5 million lives a year, avoid crop losses amounting to 32 million tons annually, and deliver near-term climate protection of about half a degree Celsius by 2040. Rapid effects will be even greater in the Arctic. They would reduce projected warming in 2040 by 0.7 degrees Celsius, which has important implications for the lives and livelihoods of Arctic peoples, biodiversity, and global sea level rise.

I welcome the announcement earlier this year by U.S. Secretary of State Hillary Clinton of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, as well as, the declaration from the Nordic countries last month, agreeing on measures to intensify their efforts to reduce short-lived climate forcers at national, regional, and global level[s].

Now many are involved in this effort, and I hope many more will follow. I do agree with the Executive Director of UNEP, Achim Steiner, that action on short-lived climate forcers does not take away attention from the fundamental challenges of global warming. On the contrary, it is buying back some of the time that we have already lost. (SLCPs at 5:57.)

Remarks by Secretary of State Hillary Rodham Clinton at the launch of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (Washington, DC, 16 Feb. 2012):

It's a very big honor for me to have you here for the purpose of launching the Climate and Clean Air Coalition, our new global effort to fight climate change, protect health, improve agricultural productivity, and strengthen energy security....

This coalition – the first international effort of its kind – will conduct a targeted, practical, and highly energetic global campaign to spread solutions to the short-lived pollutants worldwide. It will mobilize resources, assemble political support, help countries develop and implement a national action plan, raise public awareness, and reach out to other countries, companies, NGOs and foundations. (Clinton, 2012.)

Press Release, Remarks by UNEP Executive Director Achim Steiner on Reducing Short-Lived Climate Pollutants (Nairobi, Kenya):

Fast action on short lived climate forcers can deliver quick wins in a world often frustrated by the glacial pace at which sustainability challenges appear to be being addressed.

Selected Press on the Climate and Clean Air Coalition

1. *The Daily Beast*, Op-Ed by D. Victor, C. Kennel & V. Ramanathan, “[Hillary Clinton Plan to Get Serious About Global Warming](#)” (21 June 2012)
2. *The Hill*, Op-Ed by D. Zaelke & A. Light, “[Rio meeting can still produce a key climate outcome](#)” (20 June 2012)
3. *Forbes*, “[Researchers Argue For Action On Short-Lived Climate Pollutants](#)” (31 May 2012)
4. *Forbes*, “[G8 Takes On Short-Lived Climate Pollutants](#)” (30 May 2012)
5. *The Telegraph*, “[G8: Leaders open up vital new front in the battle to control global warming](#)” (12 May 2012)
6. *Green Conduct News*, “[The Climate And Clean Air Coalition To Reduce Short-Term Climate Pollutants](#)” (26 April, 2012)
7. *U-T San Diego*, Op-Ed by V. Ramanathan & D. Zaelke, “[Earth Day: Saving our planet, saving ourselves](#)” (21 April 2012)
8. *Washington Post*, Editorial, “[Ways to fight warming: Strategies that would reduce emissions](#)” (26 February 2012)
9. *The New York Times*, Editorial, “[A Second Front in the Climate War](#)” (17 February 2012)
10. *Nature*, “[Coalition launches effort on ‘short-lived’ climate pollutants](#)” (16 February 2012)
11. *The New York Times*, “[U.S. Pushes to Cut Emissions of Some Pollutants That Hasten Climate Change](#)” (15 February 2012)
12. *Washington Post*, “[U.S. will lead new effort to cut global warming from methane, soot](#)” (15 February 2012)
13. *The Hill*, Op-Ed by M. Molina & D. Zaelke, “[How to cut climate change in half](#)” (14 February 2012)

Appendix 2: Statements of support for reducing SLCPs from key international, regional, and bilateral policy meetings

Joint Statement issued at the conclusion of the 11th BASIC Ministerial Meeting on Climate Change (Johannesburg, South Africa, 13 July 2012):

Ministers ... identified the need for further scientific and technical analysis by experts of relevant issues, including ... short-lived climate forcers.

Remarks by Secretary of State Hillary Rodham Clinton at the Climate Clean Air Coalition and Green Embassy Event (Helsinki, Finland, 27 June 2012):

And last week, at the sustainability conference, Rio+20, the coalition launched a new initiative to reduce methane and other pollutants from landfills. We have encouraged and enlisted mayors from several major world cities. We also have the World Bank on board, and other countries are joining. In fact, all of the G-8 countries recently signed up to the coalition at the last meeting.

But we're not stopping there, because we formed this coalition for the purpose of taking action, and demonstrating globally that we can actually do things, that we can translate our concerns and our words into actions and results. In partnership with the UN Environment and Development Programmes, the European Commission, and key private sector companies, we are co-hosting a conference in Bangkok this July to showcase new technologies that can drastically reduce the need for HFCs in refrigeration and air conditioning.

Here is a perfect example of the problem: As you have a growing middle class in countries like India and China, where the climate can often get very, very hot, you have an increasing demand for air conditioning. The increasing demand for air conditioning in turn puts more HFCs into the air, thereby creating more of a problem from the short-lived pollutants. So what we want to do is try to get ahead of this, not to tell people – certainly, we in the United States are in no position to tell people, “Look, you’ve lived without air conditioning for thousands of years; you can keep doing it for the sake of the climate.”

No, instead we want to say, “Look, as you have developed, as your incomes have risen, we know that you want to take advantage of air conditioning, but let’s see if we can find a way to do that that is more climate-friendly.” And that is part of the mission that we have in this new coalition.

2012 Rio+20 Declaration *The Future We Want* (Rio de Janeiro, Brazil, 22 June 2012):

222. We recognize that the phase-out of ozone-depleting substances is resulting in a rapid increase in the use and release of high global-warming potential hydrofluorocarbons to the environment. We support a gradual phase-down in the consumption and production of hydrofluorocarbons.

Plenary Remarks by Secretary of State Hillary Rodham Clinton at Rio+20 (Rio de Janeiro, Brazil, 22 June 2012):

[E]arlier this year, I was privileged to host six countries in the United Nations Environment Program as we launched the Climate and Clean Air Coalition. The goal is to reduce short-lived climate pollutants that cause more than 30 percent of current global warming, as well as millions of premature deaths and extensive crop losses. We know we have to keep working together on CO₂, but we think that our Climate and Clean Air Coalition, to which many more countries are joining, and we welcome you, can take targeted action and produce results with respect to methane and black soot and HFCs.

CCAC Rio [Announcement](#) of Solid Waste Partnership with C40 cities network (Rio de Janeiro, Brazil, 19 June 2012):

[Former President Bill Clinton](#): *As we all know methane, black carbon, and hydrofluorocarbons clear the atmosphere much quicker than carbon dioxide. We need both these strategies, those that cut CO₂ and those that produce the fastest results by cutting other pollutions. If we focused on the methane, the black carbon, the hydrofluorocarbons we can reduce the rate of climate change for the next thirty years by half and reduce the change in the Arctic by up to two-thirds. That's why the Secretary of State has worked so hard on this issue and why she's coming to Rio to push it. (SLCPs at 28:45; full speech starts 22:55.)*

[U.S. Special Envoy for Climate Change Todd Stern](#): *This initiative encapsulates perfectly what we're trying to do with the newly launched Climate and Clean Air Coalition. Countries, cities, the World Bank, and civil society partnering together to make real-world, scaled-up reductions of 'short-lived climate pollutants,' which cause some 30% of current warming. With this solid waste initiative, we're making a big dent in the third-largest source of methane worldwide, and, at the same time, improving the health and environment of local communities.*

[C-40 Chair and New York City Mayor Michael Bloomberg](#): *Improving the management of city solid waste, including reducing the release of methane and other greenhouse gases is a top priority of many C-40 cities. The success of this partnership and of our new C40 network will move us a long way toward the greenhouse gas reduction goals we are setting.*

[U.S. Special Representative for Global Intergovernmental Affairs Reta Jo Lewis](#): *Urban areas contribute nearly 80 percent of global greenhouse gas emissions. At the same time, city-driven solutions can quickly reach billions. Quite literally, cities are where the rubber hits the road.*

Today we are announcing a groundbreaking partnership.....cities, countries, our Coalition, the World Bank, the Global Methane Initiative, and CCI/C-40 are all joining together to reduce climate pollutants from solid waste, the third largest source of man-made methane worldwide.

And remember that methane is a substance 20 times more potent a greenhouse gas than carbon dioxide. Moreover, left unaddressed, municipal solid waste is predicted to double by 2025.

We'll be working with cities to provide an array of common-sense, results-driven technical expertise and capacity building. And our Climate and Clean Air Coalition partner countries like Mexico, Canada, Bangladesh, the United States, Nigeria, and others will cooperate closely. We'll also be building a knowledge platform of best practices to share with cities around the world.

World Bank Group [Environmental Strategy](#) 2012-2022: Toward a Green, Clean and Resilient World for All (Washington DC, USA, 5 June 2012):

The emerging scientific evidence on the climate impacts of short-lived climate forcers (SLCFs) such as black carbon and ozone, which were until recently considered just local air pollutants, also provides a good opportunity to address climate change through WBG operations. It is increasingly evident that addressing SLCF emissions from transport, energy, and agriculture .can help “buy time” for climate actions, given the short atmospheric life span but very high warming potential of such emissions.... (at p. 60)

With the Montreal Protocol engaged in the phaseout of hydrochlorofluorocarbons through 2030, it is viewed as a key partner in addressing climate change. The WBG will promote alternatives to the use of ozone depleting substances that also maximize climate benefits through adoption of climate-benign substances where feasible and improvement of energy efficiency in related equipment. The World Bank will help developing country partners worldwide reduce and phase out both the production and use of ozone-depleting substances.... (at p. 58)

The World Bank will work with its partners and carbon finance funds to scale up use of a new generation of stoves to help reduce indoor pollution, benefit women and girls, and reduce pressure on the environment.... (at p. 56)

Remarks by Secretary of State Hillary Rodham Clinton and Swedish Minister for Environment Lena Ek at Climate and Clean Air Coalition Event (Stockholm, Sweden, 3 June 2012):

MINISTER EK: **** Much as happened in the short time since we met in Washington in February to launch the Climate and Clean Air Coalition to reduce SLCPs. We were proud to host the first formal meeting of the coalition here in Stockholm in April, where we were joined by new members, and the coalition has now grown from six to 16 countries, plus the European Commission, UNEP, and the World Bank. And we especially, of course, welcome the decision of all G-8 members to join at the recent summit in Camp David.*

Short-lived climate pollutants is a strange and maybe unfamiliar set of words to most, but SLCPs such as black carbon, soot, tropospheric ozone, methane, and short-lived HFCs all have some characteristics in common. They significantly contribute to global and regional warming. They also impact crop yields, deteriorate air quality, and affect human health across the globe. And they are short-lived. And just because of this, they represent a golden opportunity to slow down climate warming in the near term, even more so because they represent as much as a third of increases in average global temperature.

I believe this coalition owes to rapid success to two things. Firstly, it delivers a simple but powerful message based on science. By preventing SLCPs emissions, we can significantly reduce near-term climate change and at the same time save 2.5 million lives per year, increase crop yields and food security, and promote gender equality and women's rights across the globe.

Secondly, this is a coalition of action. All partners bring something to the table, and in joining have agreed to take action also at home. The coalition is structured around the basic idea that we need to act now, and countries are demonstrating their will and ability to reduce domestic emissions by agreeing to implement national reduction actions on SLCPs.

It's only through effective action on greenhouse gases that we can stop climate change. Researchers are telling us that without drastic CO2 emission reductions we are facing temperature increases that will be substantially higher than the two-degree target. Therefore, we are wholly committed to the UNFCCC negotiations and to making the necessary mitigation efforts at home. Measures to reduce CO2, such as the Sweden carbon tax of 150 U.S. dollars per ton CO2, are not only necessary but contribute to green growth and enable lower taxes in other areas and job creation in the economy....

SECRETARY CLINTON: **** The Climate and Clean Air Coalition is designed to get results for what are called – as the minister just said – short-lived climate pollutants, including methane, black carbon, and the hydrofluorocarbons. These pollutants are responsible for more than 30 percent of current global warming. And because they are also very harmful to human health and to agriculture, we can save millions of lives and tons of crops as well by acting now. This is what we call a win-win for sure.*

In February, Sweden, the United States, four other nations, and the UN Environmental Program launched the Climate and Clean Air Coalition, and since then, as the minister said, we've been growing, bringing on all G-8 countries, as well as Norway, Nigeria, Denmark, and Colombia. And we were pleased when the World Bank and the European Commission signed up as well. We've also increased our funding thanks in part to contributions from Sweden and Norway. We are setting up a science advisory panel. And just in April, Sweden hosted the coalition's first ministerial meeting, when we decided on a set of global action-oriented initiatives to implement immediately.

So we have built some strong initial momentum, but we need your help. Today, Sweden and the United

*States are beginning a global campaign to close the information gap about short-lived climate pollutants. Few people actually know about the impact we could have on global warming if we aggressively target them. And fewer still know that many cost-effective solutions already exist and are just waiting to be broadly implemented. ****

Now, included in the group that Minister Ek and I met with were leading Swedish companies also supporting this effort, because we know we cannot solve this crisis without the active cooperation and, indeed, the leadership of the private sector, particularly oil and gas companies, makers of diesel trucks, green tech companies that can help turn methane from landfills into clean energy. Today, for example, representatives from Volvo, Mack Trucks talked about how to cut down black carbon worldwide, 20 percent of which is emitted by the transportation sector.

Major reductions of short-lived pollutants can be done inexpensively and with existing technologies. Experts tell us, for example, that one third of all methane leaked and vented by oil and gas companies can be avoided at a net cost of zero dollars or zero kroner. So we need to convince decision makers everywhere, political leaders, CEOs, civil society leaders, investors, and students that this is one of those areas where we can show tangible progress almost immediately and that we can do it in a cost-effective way.

Here are just a few concrete examples. We're launching an initiative focused on hydrofluorocarbons. By 2050 – 2050 – at the current rate, these greenhouse gases could grow to nearly 20 percent of carbon dioxide emissions. So we will start by holding a technology conference in Bangkok in July to showcase new technologies that can eliminate the need for these potent greenhouse gases in refrigeration and air conditioning. At the upcoming sustainability conference in Rio, we'll launch an initiative working with cities to reduce methane and other pollutants from their waste systems, and we will be working with oil and gas companies to take advantage of all the currently available zero-cost options.

*Now, we're aware that reducing these short-lived pollutants by themselves will not solve the collective crisis facing the world. We must also aggressively reduce carbon dioxide emissions, which we know remain the principal contributor to climate change and last in the atmosphere for generations. And countries and people around the world, like Sweden and Norway and Denmark, where I just visited, are taking bold actions. ****

And while we continue to work on bringing down carbon dioxide emissions and finalizing an international agreement, let's also deliver a blow to methane, black carbon, and HFCs. We are poised to do both, and we should.

Now, I began my day yesterday in the high north, in Tromso, Norway, where we saw some breathtaking views and where we toured the waters on a research vessel, listening to marine biologists and sea ice experts and others explain the changes that have come to the Arctic. The waters don't freeze, even in the dead of winter. The ice shelves that have crumbled no longer protect coastlines from erosion. Species are at risk. And it's such a reminder to be in a beautiful place like Stockholm, or yesterday in Tromso, that we inherited a fragile, marvelous planet, and it's our duty to protect it.

So we're very grateful, once again, to be working hand in hand with Sweden. We've already made progress on the Climate and Clean Air Coalition in less than four months. And we're going to continue working closely with Sweden and our other partners. And we are determined to take aggressive action in the months ahead. We can do no less. Thank you all very much. (Applause.)

Remarks by Secretary Hillary Rodham Clinton and Norwegian Minister Jonas Gahr Støre
(Tromso, Norway, 2 June 2012):

[T]he United States and Norway are committed to ... do all we can to prevent and mitigate the effects of climate change. I'm highlighting a new partnership that I started called the Climate and Clean Air

Coalition, and we're very pleased that Norway is a member. And it is to focus on what are called short-lived climate pollutants – methane, black carbon, hydrofluorocarbons – which make up at least 30 – somewhere between 30 and 40 percent of the greenhouse gas emissions.... [W]e just heard the impact of burning (inaudible) fuels and putting all that black carbon and soot into the air. It then lands on the ice and you know rest.

So I want to thank Norway for joining the Climate and Clean Air Coalition and making an initial commitment of one and a half million dollars, and also a pledge by Norway of one million dollars specifically to target black carbon across the Arctic. I'm very grateful that we had a chance to meet with the head of Statoil and representative of new Norwegians and ExxonMobil to talk about ways that oil and gas companies are already reducing methane and black carbon emissions from their own production, what more they believe can be done, and how we can bring other companies into this effort to capture your vented, leaked, and flared natural gas, and to cut emissions by up to one-third with no net cost at all. That would make a significant impact on climate change without hurting any oil or gas company's bottom line, and it's exactly the kind of private and public cooperation we need to pursue and that this new coalition is determined to try to bring about.

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[T]his year we launched the Climate and Clean Air Coalition, which brings together governments, the private sector and key organizations around the world to work toward reducing short-lived climate pollutants, which cause more than 30 percent of near-term warming. Reducing short-lived pollutants is an important complement to the work we must do to reduce carbon emissions. And I'm delighted, Prime Minister, that Denmark has agreed to join the Climate and Clean Air Coalition.

2012 G8 Camp David Declaration (Camp David, USA, 19 May 2012):

14. Recognizing the impact of short-lived climate pollutants on near-term climate change, agricultural productivity, and human health, we support, as a means of promoting increased ambition and complementary to other CO₂ and GHG emission reduction efforts, comprehensive actions to reduce these pollutants, which, according to UNEP and others, account for over thirty percent of near-term global warming as well as 2 million premature deaths a year. Therefore, we agree to join the Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants.

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- In the spirit of increasing mitigation efforts, we agree to collectively join the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, launched on February 16, 2012. This new initiative will enhance our collective ambition in addressing climate change by complementing efforts to address CO₂ emissions. By developing strategies to reduce short term pollutants – chiefly methane, black carbon, and hydrofluorocarbons – we can help reduce global warming, improve health, and increase agricultural productivity, as well as energy security.*
- Commission the World Bank to prepare a report on ways to integrate reduction of near-term climate pollution into their activities and ask the World Bank to bring together experts from interested countries to evaluate new approaches to financing projects to reduce methane, including through pay-for-performance mechanisms.*

In its role as 2012 Chair of the G-8, the United States intends to work with G-8 partners to develop mechanisms for following up these actions over the course of 2012.

2012 [Joint Statement](#) by the Danish EU Presidency and Commissioner Potocnik welcoming new international agreement to tackle air pollution (Brussels, Belgium, 7 May 2012):

Today the EU reached an international agreement to ... [amend] the Gothenburg Protocol [to the Convention on Long-range Transboundary Air Pollution], setting more ambitious targets to reduce trans-boundary air pollution. The revised objectives of the Protocol will see a reduction in EU emissions of around 60% for sulphur, 40% for nitrogen oxides (NOx), 30% for volatile organic compounds (VOCs), 6% for ammonia and 20% for particulate matter compared to 2005 levels. There's also agreement to act on so called 'Black Carbon', a pollutant with short-lived climate forcing characteristics.

"This is a significant step forward in protecting citizens' health and the environment. For the first time, we have an international agreement that acknowledges the link between air pollution and climate change. By agreeing to regulate one of the contributors to climate change, 'Black Carbon', we will see positive impacts at both local and international level", said Janez Potočnik, European Commissioner for the Environment.

The draft amendment approved by the Convention's Executive Body is [here](#).

IPY 2012 [Opening Keynote Address](#) by Dr. Gro Harlem Brundtland (Montreal, Canada, 23 April 2012):

Now, even if we manage to slow down or turn around the rising global greenhouse gas emissions in the coming two decades, reductions will not occur quickly enough to conserve the polar and alpine environments, as we know them today.

We need rapid action, with rapid effects.... [R]educing short-lived climate forcers such as methane, black carbon, and ozone is one such promising avenue for rapid action. Recent research has shown that more than one third of current global warming is caused by short-lived pollutants. They also destroy millions of tons of crops every year and wreak havoc on people's health. Furthermore, methane, a greenhouse gas 20 times more potent than carbon dioxide, can be an abundant source of energy if we capture it instead of just venting it into the air or flaring it.

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I welcome the announcement earlier this year by U.S. Secretary of State Hillary Clinton of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, as well as, the declaration from the Nordic countries last month, agreeing on measures to intensify their efforts to reduce short-lived climate forcers at national, regional, and global level[s].

Now many are involved in this effort, and I hope many more will follow. I do agree with the Executive Director of UNEP, Achim Steiner, that action on short-lived climate forcers does not take away attention from the fundamental challenges of global warming. On the contrary, it is buying back some of the time that we have already lost. (SLCPs at 5:57.)

2012 [Joint Statement](#) by North American Leaders (Washington DC, USA, 2 April 2012):

We also intend to deepen our trilateral cooperation and work with other interested partners to accelerate efforts aimed at reducing emissions of "short-lived climate pollutants," noting the recently launched Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants in which we are all actively engaged. Reducing our emissions of these substances, which include methane, black

carbon, and many hydrofluorocarbons (HFCs), offers significant opportunities to reduce the rate of global warming in the near term, in the context of our broader efforts to address climate change, while also yielding many health, agricultural productivity, and energy security benefits.

2012 [IGBP & IGAC Statement](#), Time to Act: The Opportunity to Simultaneously Mitigate Air Pollution and Climate Change (London, UK, 29 March 2012):

An integrated approach to addressing air pollution and climate change is essential if society desires to slow the rate of climate change and to protect human health, food/water security and ecosystems. ...

Control of air pollutants and their precursors that lead to warming (such as black carbon, methane and tropospheric ozone) would be a highly effective way to reduce the rate of climate change in the near-term, but would only be effective in the long-term if continued action to reduce long-lived greenhouse gases, notably carbon dioxide (CO₂), are taken in parallel.

2012 [Svalbard Declaration](#) on Shortlived Climate Forcers (Svalbard, Norway, 27 March 2012):

*We, the environment ministers of Denmark, Finland, the Faroe Islands, Iceland, Norway, Sweden and Åland, discussed what we can do to cut global and Nordic emissions of short-lived climate forcers, such as black carbon and methane ****

Based on our close co-operation and shared values, we, the Nordic environment ministers, will intensify our efforts to reduce emissions of SLCFs at national, regional and global level.

We will act as a driving force and work more closely together in international fora to advocate more ambitious international regulation of emissions of greenhouse gases and SLCFs.

2011 [Fact Sheet](#): The United States and Norway - NATO Allies and Global Partners (Washington DC, USA, 20 October 2011):

*President Obama hosted Norwegian Prime Minister Jens Stoltenberg for a meeting in the Oval Office on October 20... The leaders renewed their commitments in the following areas: ****

***The Arctic:** In the Arctic Council, the United States and Norway co-chair a task force examining the role of certain greenhouse gases (such as methane and hydrofluorocarbons) and aerosols (such as black carbon), known collectively as "short-lived climate forcers," in causing global climate change...*

2011 [Co-Chairs' Summary](#), Ministerial Meeting on Short-Lived Climate Forcers Near Term Climate and Air Quality Benefits (Mexico City, Mexico, 12 September 2011):

Because SLCFs are a large fraction of current warming they present an enormous near term mitigation opportunity.... Strong support was expressed during the meeting for a strengthened concerted approach that would support national and regional measures in the form of an action oriented initiative at global level. It was further stressed that any future initiative would need to consider existing work in the field, and it was particularly stressed that action on SLCF should be complimentary to efforts under the UNFCCC, particularly long term CO₂ mitigation. Participants noted the importance of including the private sector and civil society. Given the need to address SLCF, participants agreed to develop an inclusive and voluntary global initiative to increase the political awareness and support future cooperation for action on SLCF.

2011 [European Parliament Resolution](#) on Financing of Reinforcement of Dam Infrastructure in Developing Countries (Strasbourg, France, 27 September 2012):

30. Urges the EU to widely implement and promote emission reduction measures targeting black carbon, such as the recovery of methane from coal, oil and gas extraction and transport, methane capture in waste management and the use of clean-burning stoves for residential cooking, which will contribute to combating climate change and to reducing glacial retreat;

2011 [Chair's Summary](#), Eleventh Leaders' Representative Meeting of the Major Economies Forum (Washington DC, USA, 17 September 2011):

[T]he Major Economies Forum should recall its dual-mandate of helping to advance the negotiations, and to facilitate concrete action to cut emissions among this group – such as the cooperation on clean technology that led to the Clean Energy Ministerial – and noted recent interest in short-lived climate forcers.

2011 [European Parliament Resolution](#) on a Comprehensive Approach to Non-CO₂ Climate-Relevant Anthropogenic Emissions (Strasbourg, France, 14 September 2011):

2. Calls for a comprehensive European climate policy, which can benefit from considering all sources of warming and all mitigation options; stresses that in addition to considering CO₂ emission reductions, it should place emphasis on strategies that can produce the fastest climate response;

3. Notes that fast-action regulatory strategies are available to phase down production and consumption of HFCs and to reduce emissions of black carbon and the gases leading to the formation of tropospheric ozone, and that these can begin within 2–3 years and be substantially implemented within 5–10 years, producing the desired climate response within decades or sooner, in particular for some HFCs at a public price as low as 5 to 10 cents per tonne, whereas the carbon price is currently over EUR 13 per tonne;...

2011 [Nuuk Declaration](#), Seventh Ministerial Meeting of the Arctic Council (Nuuk, Greenland, 12 May 2011):

Welcome the Arctic Council reports on Short-Lived Climate Forcers (SLCF), that have significantly enhanced understanding of black carbon, encourage Arctic states to implement, as appropriate in their national circumstances, relevant recommendations for reducing emissions of black carbon, and request the Task Force and the AMAP expert group to continue their work by focusing on methane and tropospheric ozone, as well as further black carbon work where necessary and provide a report to the next Ministerial meeting in 2013, ...

Decide to establish a Short-Lived Climate Forcer Contaminants project steering group that will undertake circumpolar demonstration projects to reduce black carbon and other SLCF emissions....

2011 [Pontifical Academy of Sciences Working Group Report](#), Fate of Mountain Glaciers in the Anthropocene (Rome, Italy, 11 May 2011):

Possible mitigation by reducing the emission of non-CO₂ short-lived drivers: The second part of an integrated mitigation strategy is to cut the climate forcers that have short atmospheric lifetimes. These include black carbon soot, tropospheric ozone and its precursor methane, and hydrofluorocarbons (HFCs). Black carbon (BC) and tropospheric ozone strongly impact regional as well as global warming. Cutting the short-lived climate forcers using existing technologies can reduce the rate of global warming significantly by the latter half of this century, and the rate of Arctic warming by two-thirds, provided CO₂ is also cut.

2011 [Joint Statement](#), Conclusion of the Sixth basic Ministerial meeting on Climate Change (New Delhi, India, 27 February 2012):

HFC gases are not ozone depleting substances but some of these have high global warming potential. The Ministers felt that the issue of phase down of HFCs with high global warming potential required in-depth examination.

2009 [G8 Declaration](#), Responsible Leadership for a Sustainable Future (L'Aquila, Italy, 10 July 2009):

66. We recognize that the accelerated phase-out of HCFCs mandated under the Montreal Protocol is leading to a rapid increase in the use of HFCs, many of which are very potent GHGs. Therefore we will work with our partners to ensure that HFC emissions reductions are achieved under the appropriate framework. We are also committed to taking rapid action to address other significant climate forcing agents, such as black carbon. These efforts, however, must not draw away attention from ambitious and urgent cuts in emissions from other, more long-lasting, greenhouse gases, which should remain the priority.

2009 [Tromsø Declaration](#), Sixth Ministerial Meeting of The Arctic Council (Tromsø, Norway, 29 April 2009):

Urge implementation of early actions where possible on methane and other short-lived climate forcers, and encourage collaboration with the Methane to Markets Partnership and other relevant international bodies taking action to reduce methane and other short-lived forcers,

Decide to establish a task force on short-lived climate forcers to identify existing and new measures to reduce emissions of these forcers and recommend further immediate actions that can be taken and to report on progress at the next Ministerial meeting,

2009 [Remarks by United States Secretary of State Hillary Clinton](#), Joint Session of the Antarctic Treaty Consultative Meeting and the Arctic Council, 50th Anniversary of the Antarctic Treaty (Baltimore, USA, 6 April 2009):

There are also steps we must take to protect the environment. For example, we know that short-lived carbon forcers like methane, black carbon, and tropospheric ozone contributes significantly to the warming of the Arctic. And because they are short lived, they also give us an opportunity to make rapid progress if we work to limit them.

2009 [Co-chairs' Concluding Statement](#) at the High-Level India-EU Dialogue (Delhi, India, 4 February 2009):

3. We urge the governments of Europe and India to: . . . b) Recognise Black Carbon as a significant climate driver and develop a joint programme to:

- build international support for mitigation of the threat of Black Carbon to the glaciers of the Hindu Kush-Himalaya-Tibet area;*
- support a major clean cook stove initiative, including Project Surya and the application of pyrolysis and biochar.*

2008 [Declaration of Leaders](#), Meeting of the Major Economies on Energy Security and Climate Change (Toyako, Japan, 9 July 2008):

10. To enable the full, effective, and sustained implementation of the Convention between now and 2012, we will: . . . Continue to promote actions under the Montreal Protocol on Substances That Deplete the Ozone Layer for the benefit of the global climate system; ...

2007 [G8 Declaration](#) on Growth and Responsibility in the World Economy (Heiligendamm, Germany, 7 June 2007):

59. We will also endeavor under the Montreal Protocol to ensure the recovery of the ozone layer by accelerating the phase-out of HCFCs in a way that supports energy efficiency and climate change objectives. In working together toward our shared goal of speeding ozone recovery, we recognize that the Clean Development Mechanism impacts emissions of ozone-depleting substances.

2005 [G8 Declaration](#), Gleneagles Plan of Action: Climate Change, Clean Energy and Sustainable Development (Gleneagles, United Kingdom, 8 July 2005):

15. We will encourage the capture of methane, a powerful greenhouse gas, by:

- (a) supporting the Methane to Markets Partnership and the World Bank Global Gas Flaring Reduction Partnership (GGFR), and encouraging expanded participation; and*
- (b) working bilaterally to support an extension of the World Bank's GGFR Partnership beyond 2006.*

Appendix 3: Select press coverage of SLCPs

1. *The Montreal Gazette*, "[The vicious circle of air conditioning: The appliances that cool air also cause the planet to get warmer](#)" (23 June 2012)
2. *The Daily Beast*, Op-Ed by D. Victor, C. Kennel & V. Ramanathan, "[Hillary Clinton Plan to Get Serious About Global Warming](#)" (21 June 2012)
3. *The Hill*, Op-Ed by D. Zaelke & A. Light, "[Rio meeting can still produce a key climate outcome](#)" (20 June 2012)
4. *The New York Times*, "[Should Air-Conditioning Go Global, or Be Rationed Away?](#)" (21 June 2012)
5. *The New York Times*, "[My Air-Conditioner Envy](#)" (21 June 2012)
6. *The New York Times*, "[Relief in Every Window, but Global Worry Too](#)" (20 June, 2012); reprinted in *Business Standard*, India's leading business daily, and *New Delhi Television*.
7. *The New York Times*, "[Trapping Heat: Many of the gases that run air-conditioners are powerful agents of global warming](#)" (20 June 2012)
8. *The Economist*, "[Uncovering an ocean: Much of the change in the Arctic is understood; little of it is reassuring](#)" (16 June 2012)
9. *Forbes*, "[Researchers Argue For Action On Short-Lived Climate Pollutants](#)" (31 May 2012)
10. *Forbes*, "[G8 Takes On Short-Lived Climate Pollutants](#)" (30 May 2012)
11. *The Telegraph*, "[G8: Leaders open up vital new front in the battle to control global warming](#)" (12 May 2012)
12. *U-T San Diego*, Op-Ed by V. Ramanathan & D. Zaelke, "[Earth Day: Saving out planet, saving ourselves](#)" (21 April 2012)
13. *Yale Forum on Climate Change and the Media*, "[Picking Fight with CO2 Bully: OR...Near-Term Effort for Short-Term Gains](#)" (29 March 2012)
14. *Washington Post*, Editorial, "[Ways to fight warming: Strategies that would reduce emissions](#)" (26 February 2012)
15. *The New York Times*, Editorial, "[A Second Front in the Climate War](#)" (17 February 2012)
16. *Nature*, "[Coalition launches effort on 'short-lived' climate pollutants](#)" (16 February 2012)
17. *The New York Times*, "[U.S. Pushes to Cut Emissions of Some Pollutants That Hasten Climate Change](#)" (15 February 2012)
18. *Washington Post*, "[U.S. will lead new effort to cut global warming from methane, soot](#)" (15 February 2012)
19. *The Hill*, Op-Ed by M. Molina & D. Zaelke, "[How to cut climate change in half](#)" (14 February 2012)
20. *Nature*, "[Pollutants key to climate fix](#)" (17 January 2012)
21. *New York Times*, "[Climate Proposal Puts Practicality Ahead of Sacrifice](#)" (16 January 2012)
22. *Science*, "[A Quick \(Partial\) Fix for an Ailing Atmosphere](#)" (13 January 2012)
23. *National Public Radio*, "[To Slow Climate Change, Cut Down on Soot, Ozone](#)" (12 January 2012)
24. *Scientific American*, "[How to Buy Time in the Fight against Climate Change: Mobilize to Stop Soot and Methane](#)" (12 January 2012)
25. *Washington Post*, "[Study: Simple measures could reduce global warming, save lives](#)" (12 January 2012)
26. *Climate Central*, "[Groundbreaking New Study Shows How to Reduce Near-Term Global Warming](#)" (12 January 2012)
27. *Le Monde France*: "[A few simple steps to limiting global warming](#)" (12 January 2012)
28. *Agence France-Presse*: "[Cut back on soot, methane to slow warming: study](#)" (12 January 2012)
29. *Press Trust of India*: "[Simple measures could reduce global warming, save lives: NASA](#)" (12 January 2012)
30. *Nature*, "[More in Montreal: Momentum builds for ozone treaty to take on greenhouse gases](#)" (3 Nov 2011)
31. *EnviroLib*, "[European Parliament urges fast cuts in black carbon and ground-level ozone to reduce threats from dangerous glacial dams in Himalayas](#)" (11 Oct 11)
32. *The Economist*, "[Beating a retreat: Arctic sea ice is melting far faster than climate models predict. Why?](#)" (24 Sept 11)
33. *Sustainable Business News*, "[European Parliament calls for fast action to cut non-CO2 climate forcers](#)" (22 Sept 11)
34. *Washington Post*, "[Arctic Council to address role of soot in global warming](#)" (11 May 11)

35. *Politico*, "[Hot-button issues at Arctic summit](#)" (11 May 11)
36. *Climatewire*, "[Green Smoke Is Sighted as Vatican Releases Glacier Report](#)" (6 May 11)
37. *Washington Post*, "[Global warming rate could be halved by controlling 2 pollutants, U.N. study says](#)" (23 Feb 11)
38. *New York Times*, "[A Stopgap for Climate Change](#)" (22 Feb 11)
39. *The Economist*, "[Climate change in black and white](#)" (17 Feb 11)
40. *The Economist*, "[Piecemeal possibilities](#)" (17 Feb 11)
41. *The Telegraph*, "[Action speaks louder than hot air](#)" (10 Dec 10)
42. *Nature*, "[Dispute over carbon offsets continues in Cancun](#)" (8 Dec 10)
43. *Washington Post*, "[New front opens in war against global warming](#)" (29 Nov 10)
44. *New York Times*, "[To Fight Climate Change, Clear the Air](#)" (28 Nov 10)
45. *New York Times*, "[Support Grows for Expansion of Ozone Treaty](#)" (12 Nov 10)
46. *Nature*, "[Ozone Talks Delay Action on Climate](#)" (12 Nov 10)
47. *New York Times*, "[A Novel Tactic in Climate Fight Gains Some Traction](#)" (9 Nov 10)
48. *Nature*, "[Ozone Treaty Could Be Used for Greenhouse Gases](#)" (9 Nov 10)
49. IISD's *MEA Bulletin*, "[A Proposal to Change the Political Strategy of Developing Countries in Climate Negotiations](#)" (15 July 10)
50. *ClickGreen*, "[US Climate Bill 'breaks the mould' of CO2 climate policy](#)" (12 May 10)
51. *Science for Environment Policy*, "[Four fast-action strategies to tackle abrupt climate change](#)" (11 Feb 10)
52. *LA Times*, "[Climate negotiators eye the 'forgotten 50%' of greenhouse gas pollutants](#)" (14 Dec 09)
53. *The Economist*, "[Unpacking the problem](#)" (3 Dec 09)
54. *The Guardian*, "[CO2 is not the only cause of climate change](#)," (11 Sept 09)
55. *The Washington Post*, "[CO2 replacements intensify climate concerns](#)" (20 July 09)
56. *Nature*, "[Time for early action](#)" (1 July 09)
57. *Financial Times*, "[Black-and-white answers to motley puzzle](#)" (18 May 09)
58. *Nature*, "[Time to act](#)" (29 April 09)
59. *Science*, "[New Push Focuses on Quick Ways To Curb Global Warming](#)" (17 April 09)

Appendix 4: Additional background on SLCPs

Molina, M., Zaelke, D., Sarma, K. M., Andersen, S. O., Ramanathan, V., and Kaniaru, D., [*Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO₂ emissions*](#), PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (2009).

Shindell, D. *et al.*, [*Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security*](#), SCIENCE (2012).

Velders G. *et al.*, [*Preserving the Climate Benefits of the Montreal Protocol by Limiting HFCs*](#), SCIENCE (2012).

Victor D., Kennel C., and Ramanathan V., [*The Climate Threat We Can Beat: What It Is and How to Deal With It*](#), FOREIGN AFFAIRS (2012).

Anenberg S. *et al.*, [*Global Air Quality and Health Co-Benefits of Mitigating Near-Term Climate Change through Methane and Black Carbon Emission Controls*](#), ENVIRONMENTAL HEALTH PERSPECTIVES (2012).

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Lenton, T., [*The potential for land-based biological CO₂ removal to lower future atmospheric CO₂ concentrations*](#), CARBON MANAGEMENT (2010).

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