U.S. Climate Action Plan Supplement

Overview of U.S. Near-term Short-lived Climate Pollutant Mitigation Strategies

Institute for Governance & Sustainable Development

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About the Institute for Governance & Sustainable Development (IGSD)

IGSD's mission is to promote just and sustainable societies and to protect the environment by advancing the understanding, development, and implementation of effective, accountable, and democratic systems of governance for sustainable development.

Beginning in 2005, IGSD embarked on a "fast-action" climate mitigation campaign that will result in significant reductions of greenhouse gas emissions and will limit temperature increase and other climate impacts in the near term. The focus is primarily on strategies to reduce non-CO_2 climate pollutants as a complement to cuts in CO_2, which is responsible for more than half of all warming. It is essential to reduce both non-CO_2 pollutants and CO_2. Neither alone is sufficient to limit the increase in global temperature to a safe level.

IGSD's fast-action strategies include reducing emissions of short-lived climate pollutants—black carbon, methane, tropospheric ozone, and hydrofluorocarbons. They also include measures to capture, reuse, and store CO2 after it is emitted, including biosequestration and mineralization strategies that turn carbon dioxide into stable forms for long-term storage without competing with food supply.

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This Working Paper also is available on IGSD's web site (http://www.igsd.org) with active links to the references and periodic updates. IGSD's Primer on Short-Lived Climate Pollutants also is available on IGSD's web site.

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I. Introduction

Reducing HFCs, black carbon, methane, and tropospheric ozone can cut the rate of global warming in half for the next 40 years (more than 0.6°C in cumulative warming by 2050 and up to 1.5°C by 2100).[1] This will significantly reduce near term climate impacts, including reducing the rate of sea-level rise, improving public health, and protecting agricultural yields. These four pollutants are referred to as "short-lived climate pollutants" or "SLCPs" because they are cleared from the atmosphere in a short period of time (a matter of days for tropospheric ozone, up to a week for black carbon, and up to a decade and a half for methane and most HFCs). This is in contrast to carbon dioxide, approximately a quarter of which remains in the atmosphere for thousands of years.[2]

Two of the SLCPs are also local air pollutants: black carbon soot and tropospheric (ground-level) ozone, the main component of urban smog. Methane contributes indirectly to air pollution as the principal precursor to tropospheric ozone; industrial era increases in methane are responsible for half of the increase in tropospheric ozone. [3] Reducing these pollutants will prevent millions of premature deaths every year, protect tens of millions of tons of crop yields, and contribute to sustainable development.[4]

President Obama recognized the importance of addressing SLCPs in his *Climate Action Plan*, announced on June 25, 2013.[5] The President's plan includes: using the Significant New Alternatives Policy Program, or "SNAP," to prohibit certain uses of high global warming potential (GWP) HFCs, directing government purchasing to cleaner alternatives to high-GWP HFCs, forming a group to develop an Interagency Methane Strategy, working with the agricultural industry to increase the adoption of methane digesters through loans, incentives, and other assistance, and building and upgrading gas pipelines to reduce methane emissions.[6]

In addition to the measures outlined in the President's plan, the U.S. has a number of other opportunities domestically to achieve rapid, low-cost reductions in SLCPs using a combination of Executive Orders and other existing authorities, as well as procurement policy, voluntary industry agreements, public-private partnerships, and other strategies described below.

These domestic measures would be complementary to the work the U.S. is already doing abroad on SLCPs. The U.S. State Department is leading international efforts to address SLCPs through the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollution (CCAC).[7] The CCAC is an international initiative to support fast action SLCP mitigation. The CCAC now has 72 partners including 33 country partners, the World Bank, the World Health Organization, U.N. Environment Programme (UNEP), and numerous non-governmental partners.[8]

The U.S. can continue to build on its work to address SLCPs by establishing an inter-agency Task Force on SLCPs to identify and implement domestic SLCP mitigation measures. Pursuing such SLCP mitigation at home will provide a set of good practices to share through the CCAC and strengthen U.S. leadership on SLCP mitigation.

II. Establish an Inter-Agency SLCP Task Force

The White House should establish an inter-agency SLCP Task Force to identify and implement rapid mitigation strategies for SLCPs.[9] Such a Task Force would build off of the process called for in the President's *Climate Action Plan* to develop an Interagency Methane Strategy among the Environmental Protection Agency (EPA), Department of Agriculture, Energy, Interior, Labor, and Transportation.[10] The SLCP Task Force would also help implement the *Climate Action Plan* and identify best practices to share globally through the CCAC.[11] Establishing the SLCP Task Force would demonstrate to the global community that the U.S. is undertaking at home the measures it is encouraging others to undertake in their own countries.

The Task Force proposal is supported by a broad range of U.S. non-governmental organizations (NGOs), including 181 foreign policy experts who sent a letter to President Obama in December 2012 calling for an SLCP Task Force along with other fast action climate mitigation strategies.[12]

The Task Force proposal is also supported by members of Congress and is a key component of the Super Pollutant Emissions Reduction Act (SUPER Act) of 2013, a bill introduced on May 9, 2013, by Congressman Scott Peters (CA-52), "To establish a task force to review policies and measures to promote, and to develop best practices for, reduction of short-lived climate pollutants, and for other purposes."[13]

The purpose of the Task Force, as outlined in the SUPER Act, would be to: coordinate and optimize the federal government's existing efforts to address short-lived climate pollutants; reduce overlap and duplication of such efforts; and to encourage federal operations, programs, policies, and initiatives to reduce short-lived climate pollutants. The Act suggests that this would be accomplished by ensuring that the coordinated federal programs are effective and forward-looking in their efforts to control short-lived climate pollutants, ensuring coordination of such federal operations, programs, policies, and initiatives with State, local, regional, tribal, and industry efforts, and supporting such State, local, regional, tribal, and industry efforts.[14]

III. Expand Executive Order 13514

In 2009, the President issued Executive Order 13514, called "Federal Leadership in Environmental, Energy, and Economic Performance".[15] The Order requires all agencies to develop sustainability plans that meet specific greenhouse gas (GHG) emissions, energy, water, and waste reduction targets while prioritizing a "positive return on investment for the American taxpayer."[16] Both HFCs and methane are included for reductions in E.O 13514 by federal agencies, but black carbon is not.[17] E.O 13514 targets a 28% reduction in direct GHG emissions from 2008 levels by 2020 and a 13% reduction in indirect emissions during the same period.[18] According to the GHG inventory for 2010, the federal government successfully reduced GHG pollution by 2.5 million tons of CO_2-eq below the 2008 baseline, and is on track to meet the full reduction commitment by 2020.[19]

While E.O. 13514 does address some SLCPs, and is producing significant reductions at federal agencies, it could be strengthened to include black carbon and to more directly target SLCPs. The White House could amend E.O. 13514 to explicitly cover rapid reductions of black carbon and include individual reduction targets for each SLCP emission source (e.g. HFC emissions from foam-blowing agents in building insulation). The Administration could also direct the Office of the Federal Environmental Executive, which is responsible for the implementation of E.O. 13514, to: determine the maximum technologically feasible and cost-effective SLCP reductions, develop guidance for federal agencies to support rapid reductions, and to develop an inter-agency SLCP Task Force to further support reductions.[20]

IV. HFC Mitigation

Non-CO_2 climate pollutants include hydrofluorocarbons (HFCs), synthetic gases that are the fastest growing climate forcers in many countries; in the U.S., HFC emissions grew nearly 9% between 2009 and 2010 compared to 3.6% for CO_2.[21] HFCs have a warming effect hundreds to thousands of times that of CO_2.[22] The average atmospheric lifetime of the mix of HFCs, weighted by usage, is 15 years.[23] HFCs are produced as substitutes for ozone-depleting substances (ODSs) in air conditioning, refrigeration, insulating foams, solvents, aerosol products, and fire protection.[24]

Over the last decade, HFC emissions increased dramatically as ozone depleting substances controlled under the Montreal Protocol, such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), were phased out.[25] In the U.S., HFC emissions increased by 432 times between 1990 and 2011 (0.3 to 129.7 million metric tons (MMt) CO_2-eq) due to their use as substitutes for ozone depleting substances.[26] In 2005, the U.S. was responsible for 34% of global HFC emissions.[27]

In various analyses published by the Montreal Protocol Technical and Economic Assessment Panel (TEAP), the Protocol Assessment Panel (SAP), and in the PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, leading scientists confirm that unless an international production and consumption phase-down of HFCs is implemented in the near-term, HFC emissions will increase dramatically and undermine efforts to curb the long-term driver of climate change—CO_2 emissions.[28] If not controlled, HFC emissions could correspond to up to 20% of CO_2 forcing under the IPCC business-as-usual scenarios in 2050.[29] If CO_2 was constrained from business-as-usual to a 450 ppm stabilization pathway, the radiative forcing of uncontrolled HFCs in 2050 could be as much as 40% of the CO_2 forcing, which would cancel nearly the entire benefit gained from controlling CO_2.[30]

To achieve HFC reductions globally, the U.S. together with Mexico and Canada, has proposed to amend the Montreal Protocol to strengthen climate protection by phasing down the production and use of HFCs under the treaty.[31] The proposal is similar to another made by the Federated States of Micronesia, the Kingdom of Morocco and the Maldives.[32] The amendment proposals would provide climate protection equivalent to preventing between 76-134 billion tonnes of CO_2 emissions by 2050.[33]

Consensus is growing to amend the Montreal Protocol to phase down HFCs. On June 25, 2013, President Obama announced his *Climate Action Plan*, which includes phasing down HFCs under the Montreal Protocol, as well as taking action in the U.S. to control HFCs.[34] At the Open-Ended Working Group meeting of the Montreal Protocol in Bangkok in July 2013, the Parties established a formal Discussion Group to consider the management of HFCs under the Protocol.[35]

On September 6, 2013, President Obama negotiated two separate agreements, one with the G-20 and one with China, to phase down HFCs. The *G-20 Leaders' Declaration* announced support for initiatives that are complementary to efforts under the UN Framework Convention on Climate Change, including using the expertise and institutions of the Montreal Protocol to phase down the production and consumption of HFCs, while retaining HFCs within the scope of the UNFCCC and its Kyoto Protocol for accounting and reporting of emissions.[36]

On the margins of the Summit, the President Obama and Chinese President Xi Jinping agreed to form a "contact group" to open formal negotiations on the details of an amendment to phase down HFCs under the Montreal Protocol. The agreement builds on an earlier agreement between President Xi Jinping and President Obama.[37] The Parties are will reconvene at the Meeting of the Parties in Bangkok in October.

Historically, refrigerant transitions under the Montreal Protocol are accompanied by significant improvements in the energy efficiency of the refrigerators, air conditioners, and other products and equipment using the refrigerants.[38] The phase-out of CFCs under the Montreal Protocol, which began in the mid-1980s, catalyzed substantial improvements in air conditioning and refrigerant energy efficiency—up to 60% in some subsectors.[39] These efficiency improvements were the result of replacing old products and equipment with a new generation of higher efficiency machines utilizing next generation refrigerants.[40] When refrigeration and air conditioning manufacturers redesigned their systems to be CFC-free, many took the opportunity to improve the efficiency of their designs.[41] For example, the U.S. EPA estimated that CFC-free chillers were up to 50% more energy efficient in the U.S. and over 30% more efficient in India than the CFC-based machines they replaced.[42] Similar improvements are expected with an HFC phase down. Currently, low-GWP alternatives exist for all major sectors that achieve at least equal energy efficiency and more often result in energy savings.[43]

A refrigerant transition could be just the catalyst necessary to help the Obama Administration meet its goal of cutting in half the energy wasted in U.S. homes and businesses over the next 20 years.[44] It would also complement the *Climate Action Plan* goal of implementing efficiency standards for appliances and federal building that will reduce carbon pollution by at least 3 billion metric tons cumulatively by 2030 or "equivalent to nearly one-half of the carbon pollution from the entire U.S. energy sector for one year."[45]

Reductions can be facilitated by: removing high-GWP HFCs from the list of acceptable mobile air conditioning refrigerants as quickly as is practicable under its Significant New Alternative Policy (SNAP) program which evaluates and regulates substitutes for ozone depleting chemicals being phased out under the Montreal Protocol, amending federal procurement guidelines to phase down HFCs, aligning the timing and implementation of efficiency standards and incentive programs with HFC reductions, supporting HFC phase-down initiatives in private industry coalitions such as the Consumer Goods Forum, and ensuring that low GWP alternatives are accounted for and properly incentivized in green building certification programs, such as Leadership in Energy and Environmental Design (LEED). *See* Appendix A for a full list of suggested HFC measures.

Summary of HFC Mitigation Options (elaborated in Appendix A)

- *Develop HFC industry partnership/coalitions to support the adoption of low-GWP alternatives.*

The SLCP Task Force could develop public-private partnerships modeled after the *Industry Cooperative for Ozone Layer Protection (ICOLP)* with ad-hoc working groups of experts that can quickly identify, develop, perfect and implement substitutes for high-GWP HFCs worldwide.[46] This could include the *Consumer Goods Forum*, comprised of 400 retailers, manufacturers, and service providers who have committed to begin phasing out HFC refrigerants beginning in 2015, and Refrigerants Naturally!, comprised of global refrigerated beverage and food marketers, working to replace high-GWP HFCs with low-GWP substitutes for new purchases of point-of-sale units and large refrigeration installations.[47]

- *Update Environmentally Preferable Purchasing (EPP) standards to exclude high-GWP HFCs.*

The Environmentally Preferable Purchasing (EPP) program was created by the EPA in 1993 to help U.S. agencies meet their obligations for green purchasing.[48] The EPP program could update its list of designated green products and develop purchasing guidelines to help eliminate products made with and containing high GWP HFCs.

- *Update voluntary green certification and rating standards to eliminate high-GWP HFCs.*

The SLCP Task Force could work with certification programs, such as the Energy Star Building program and LEED, to reduce or eliminate the use of high GWP HFCs in new building construction and remodels.

- *Reduce HFC emissions from mobile air conditioning.*

The EPA could propose and finalize a rule to remove HFC-134a from the list of acceptable mobile air conditioning refrigerants as quickly as is practicable under its SNAP program, which evaluates and regulates substitutes for ozone depleting chemicals being phased out under the Montreal Protocol. Further reductions are available in the U.S. by improving refrigerant containment with better parts and manufacturing quality control, by shifting from do-it-yourself to professional refrigerant servicing, by requiring use of improved recovery and recycle machines, and by creating incentives for refrigerant destruction when vehicles are dismantled at the end of useful life.

- *Reduce HFC emissions from stationary refrigeration and air conditioning.*

The EPA could propose and finalize a rule to remove HFC-134a from the list of acceptable alternatives for use in domestic refrigerator and commercial stand-alone refrigerated display case refrigerants as quickly as is practicable under its SNAP program. The EPA could propose an amendment to the 2010 proposed rule under the Clean Air Act (CAA) to lower the leak rates that trigger repair requirements for comfort cooling, commercial refrigeration, and air conditioning to include HFCs.[49] For domestic refrigeration and air conditioning systems, high-GWP HFCs could be phased down and replaced with low-GWP refrigerants in new appliances. Since smaller appliances have higher probability of intentional venting, ways to increase end of life recovery of these gases could be identified (incentives, fees, etc.).

- *Prioritize utilization of low-GWP HFC insulation and refrigerants through Federal Housing and Energy Efficiency Loan Programs*.

The SLCP Task Force could work with these loan programs to ensure that, where possible, the programs eliminate the use of high-GWP HFCs and promote the adoption of efficient low-GWP alternatives in construction or improvements that they fund or support.

- *Reduce HFC emissions from thermal insulating foam.*

The EPA could remove HFCs as acceptable foam blowing substitutes under its SNAP program, except in cases where no acceptable substitute exists. This would effectively eliminate HFC use for foams in the U.S. and support expansion of low-GWP alternatives in countries still phasing out HCFCs.

- *Reduce HFCs in transport refrigeration.*

The EPA could remove HFCs as acceptable refrigerant substitutes in the transportation refrigeration sector under its SNAP program.

- *Replace HFC suppressants in fire protection systems*.

The EPA could remove HFCs as acceptable halon substitutes for total flooding fire protection systems under its SNAP program.

- *Reduce HFC emissions from supermarket refrigeration*.

The EPA could encourage more stringent voluntary standards for the maximum acceptable GWP for refrigerants in the supermarket sector, and work to expand the coverage of the GreenChill partnership, particularly within the companies that make up the Consumer Good Forum.

- *Reduce access to, and non-essential use of, HFC aerosol products.*

The SLCP Task Force could expand the list of prohibited non-essential and frivolous aerosol products and establish industry-government partnerships with manufacturers to agree on standardized warning labels highlighting concern for climate and permitting use of HFC aerosol products only where technically necessary.

- *Align minimum efficiency standards for refrigeration and air conditioning with HFC reductions under the SNAP program.*

The EPA and the Department of Energy (DOE) could work together to phase down HFCs and secure significant gains in energy efficiency in air conditioning and refrigeration by aligning their regulatory timetables.

- *Remove barriers to the adoption of low-GWP alternatives in the air conditioning and refrigeration sectors*.

The DOE could work to remove barriers to the adoption of low-GWP alternatives in the air conditioning and refrigeration sectors by supporting research and development, technical validation, and market introduction programs for low-GWP HFC alternatives.

V. Methane Mitigation

Methane is a powerful greenhouse gas with a 100-year global warming potential 21 times that of CO_2 and an atmospheric lifetime of approximately 12 years.[50]

In 2011, the U.S. is estimated to have emitted 587.2 MMt CO_2-eq of methane.[51] Methane accounted for approximately 8.8% of all U.S. CO_2-eq emissions in 2011.[52] Significant reductions of methane emissions can be achieved quickly and cost-effectively utilizing currently available technologies. In the U.S., the greatest opportunities for methane mitigation come from: 1) recovery of emissions from the oil and natural gas sectors; 2) landfill gas capture and utilization; and 3) the recovery of coal mine ventilation gases. Further emissions mitigation opportunities exist in the capture and utilization of emissions from manure, and the control of enteric fermentation. *See* Appendix B for a full list of suggested methane measures.

Summary of Methane Mitigation Options (elaborated in Appendix B)

- *Recover and utilize gas from the production and distribution of oil and natural gas.*

The EPA could expand its proposed new source performance standards regulating the emission of air pollutants from the natural gas and oil industries to include the natural gas distribution sector through its authority under the Clean Air Act and expand its Natural Gas STAR program to target the phase out of leaking and obsolete equipment.

- *Mandate methane capture for oil and gas production leases on public lands.*

Federal land management agencies and the Bureau for Land Management, in particular, could adjust permitting requirements to mandate the use of all technically and economically viable control technologies for oil and gas production, including hydraulic fracturing ("fracking"), on public lands.

- *Capture and utilize landfill biogas.*

The EPA could revise its rules under section 111 of the Clean Air Act and lower the threshold for regulated landfills required to manage landfill biogas to facilities with a design capacity of a minimum of 1 million metric tons from the current threshold.

- *Expand composting and zero-waste programs.*

The SLCP Task Force and the EPA could work with municipalities and businesses with existing zero-waste and composting programs that include methane capture to develop best practice models for expanding these programs and to support other municipalities and businesses setting zero-waste or composting goals.

- *Capture coal mine ventilation gas.*

The EPA could promote the capture of coal mine emissions by establishing federal standards for performance for coal mine emissions through its authority under Section 111 of the Clean Air Act.

- *Control methane emissions from anaerobic digestion of manure.*

The EPA could work to expand information exchanges with key stakeholders regarding the cost-effectiveness and availability of technologies to control and utilize emissions from the anaerobic digestion of manure, through its AgSTAR program. The EPA could also consider developing emissions standards under the Clean Air Act for key sources of manure methane emissions.

- *Remove regulatory barriers for development of methane-based renewable energy.*

The SLCP Task Force could work with expert organizations and agencies to remove regulatory barriers to deployment of methane-based renewable energy by continuing to expand and standardize grid interconnection rules and modern net metering laws for small clean energy generators.

- *Capture and combust methane emissions at dairies.*

The EPA could expand existing voluntary measures in the AgSTAR program to provide dairy farms with the technical expertise and information necessary to implement methane control technologies where they are effective.

- *Capture and utilize methane emissions from wastewater treatment.*

The Task Force could work with the Department of Energy Office of Energy Efficiency and Renewable Energy to expand energy production from biogas at all technically feasible wastewater treatment facilities and increase access to technology and financing through programs such as the Federal Energy Management Program's Super Energy Savings Performance Contracts (ESPC).

- *Improve rice field management to reduce methane emissions.*

Emissions of methane from rice fields can be reduced through a number of management techniques such as dry seeding and post-harvest rice straw removal and bailing. The EPA should develop a voluntary program, similar to the successful AgSTAR program, to educate farmers on cost-effective rice field management techniques.

- *Study anti-methanogen vaccines and feed supplements for livestock.*

To achieve near-tern reduction of methane emissions from livestock, the SLCP Tack Force could support research into safe and cost-effective methods for reducing enteric fermentation including anti-methanogen vaccines and modified feed mixes.

VI. Tropospheric Ozone Mitigation

Tropospheric ozone is an invisible and odorless gas, often known as "smog" in the lower atmosphere (troposphere). In the troposphere it is a major air and climate pollutant that causes warming and produces a highly reactive oxidant byproduct which harms human health and crop production.[53] Alternatively, in the upper atmosphere (stratosphere), ozone acts as a protective barrier absorbing excessive ultraviolet radiation. Tropospheric ozone lasts in the atmosphere typically a few weeks and is the third most important greenhouse gas behind CO_2 and methane, with an estimated direct radiative forcing of 0.35 W/m^2.[54]

Tropospheric ozone is known as a "secondary" pollutant because it is not emitted directly, but instead forms when precursor gases, react in the presence of sunlight.[55] The precursor gases include carbon monoxide (CO), oxides of nitrogen (NOx), and volatile organic compounds (VOCs), which include methane. NOx, VOCs, and CO are produced primarily when fossil fuels such as gasoline, oil, or coal are burned or when chemicals (i.e. solvents) evaporate.[56] Globally, increased methane emissions are responsible for approximately two thirds of the rise in tropospheric ozone.[57] According to one study, reducing emissions of methane will provide greater cooling per unit reduction in tropospheric ozone concentration, compared to 20% reductions in VOCs or CO.[58] However, outside of direct reductions in methane emissions, the U.S. could produce further near term reductions in tropospheric ozone concentrations by tightening existing ozone standards through the Clean Air Act. *See* Appendix C for a full list of suggested tropospheric ozone measures.

Summary of Tropospheric Ozone Mitigation Options (elaborated in Appendix C)

- *Tighten ozone National Ambient Air Quality Standards (NAAQS).*
  As part of its review of NAAQS secondary standards for ozone, the EPA could strengthen the standards, set in 2008, from 0.075 to 0.07 or 0.06 parts per million.

VII. Black Carbon Mitigation

Black carbon is a potent climate-forcing aerosol that remains in the atmosphere for only a few days or weeks.[59] Black carbon is a component of soot and is a product of the incomplete combustion of fossil fuels, biofuels, and biomass.[60] Black carbon contributes to climate change in several ways: it warms the atmosphere directly by absorbing solar radiation and emitting it as heat; it contributes to melting by darkening the surfaces of ice and snow when it is deposited on them; and it can also affect the microphysical properties of clouds in a manner than can perturb precipitation patterns.[61] Recent estimates of black carbon's radiative forcing confirm that it is the second leading cause of global warming after CO_2.[62] The total climate forcing of black carbon is 1.1 W m^{-2}, second only to CO_2 (1.7 W m^{-2}).[63]

The main sources of black carbon are open burning of biomass, diesel engines, and the residential burning of solid fuels such as coal, wood, dung, and agricultural residues.[64] In 2000, global emissions of black carbon were estimated at approximately 7.5 million tons, with a large uncertainty range.[65]

Thanks to modern pollution controls and fuel switching, black carbon emissions in North America and Europe were significantly curbed in the early 1900s.[66] However, the U.S. is still estimated to be the source of approximately 8% of all global black carbon emissions.[67] Approximately 50% of these emissions come from the transportation sector, primarily mobile diesel engines.[68] Open biomass burning constitutes the second largest source of black carbon in the U.S., at 35% of total emissions.[69] To address these and other sources of black carbon emissions in the United States, the SLCP Task Force could focus on: continuing to reduce transportation particulate emissions particularly from super-emitting on- and off-road vehicles; expanding the use of battery and grid power for parked highway trucks; encouraging a switch to low-lack carbon fuels; requiring shore-power for at-berth ocean-going vessels and vessel speed reduction (VSR) near port; and banning open burning of agricultural biomass. *See* Appendix D for a full list of suggested black carbon measures.

Summary of Black Carbon Mitigation Options (elaborated in Appendix D)

- *Reduce transportation particulate emissions.*

The Administration could support appropriations of all authorized funding for the Diesel Emission Reduction Act (DERA), including increasing funding beyond 2016, with an aim to produce a complete turnover of pre-regulation on- and off-road diesel vehicles well before 2030.

- *Eliminate super emitting on and off-road vehicles.*

The EPA could create a special carve out in the DERA program specifically targeting super emitting vehicles, with the intent of eliminating them entirely by 2020.

- *Expand the use of battery and grid power for parked highway trucks*.

The EPA could work with state and local authorities to identify and support additional funding opportunities for expansion of truck stop electrification projects and provide incentives for truck owners to retrofit existing trucks compatible with electrification technologies.

- *Require shore-power from at-berth ocean-going vessels.*

The EPA could work with State Port Authorities to support the implementation of at-berth short power regulations similar to California's.

- *Reduce port congestion.*

The SLCP Task Force could work with industry associations and port authorities to develop and implement best practices for improving on- and off-short port efficiency including expanding the use of virtual arrival systems.

- *Require vessel speed reduction (VSR) near port.*

The EPA could work with other coastal states and port authorities to facilitate the expansion of VSR regulations for all coastal waters, including the Great Lakes.

- *Ban open burning of agricultural biomass.*

The SLCP Task Force could develop training and outreach programs for farmers and land managers to educate them on techniques and best practices for eliminating the need to burn agricultural biomass, and develop tools to expand the use of biochar technologies.

- *Set stronger standards for wood-burning stoves and fireplaces.*

The SLCP Task Force should explore opportunities to expand the U.S. EPA BurnWise program, identify technical options to improve existing EPA standards both in the Residential Wood Heater New Source Performance Standard and through the voluntary Fireplace Partnership Program, and encourage states and local regulatory agencies to adopt equal or better standards for wood burning stoves and fireplaces.

- *Conduct EPA environmental endangerment findings on aircraft, marine vessels and off-road vehicle emissions.*

The EPA could conduct an environmental endangerment finding on aircraft, marine vessels and off-road vehicle emissions through its authority under the Clean Air Act.

VIII. Brief Introduction to the Science of SLCPs

The science of SLCPs dates back more than three decades to the 1970s.[70] In 1985, a major WMO-UNEP-NASA-NOAA report concluded that non-CO_2 greenhouse gases in the atmosphere are adding to the greenhouse effect by an amount comparable to the effect of CO_2.[71] This finding has been confirmed and strengthened in the following decades by hundreds of studies culminating in a series of Intergovernmental Panel on Climate Change (IPCC) reports starting in 1990.[72] In short, researchers have had several decades to carefully develop the science of SLCPs and assess the findings.

Successfully addressing climate change requires deep and immediate reductions of CO_2 emissions, which are responsible for 55% to 60% of radiative forcing since 1750.[73] But fast and aggressive action to reduce short-lived climate pollutants is also essential. SLCPs are responsible for the other 40-45% of present radiative forcing,[74] and they can be quickly reduced using already existing technologies, often through existing laws and institutions.

Reducing SLCPs has the potential to avoid 0.6°C global average warming by 2050[75] and more than 0.84°C in the Arctic by 2070.[76] This would cut the current rate of global warming by half, the rate of warming in the Arctic by two-thirds, and the rate of warming over the elevated regions of the Himalayas and Tibet by at least half.[77] By the end of the century, cutting SLCPs can prevent as much as 1.5°C of warming.[78] (For comparison, aggressive cuts to CO_2 can avoid 0.1°C in warming by 2050, growing to 1.1°C by 2100, the same avoided warming as mitigation of SLCPs provides).[79]

Using existing technologies and institutions to reduce the SLCP climate pollutants may offer the best near term opportunity for slowing the rate of climate change and reducing the near term impacts that the U.S. and world are already suffering, including extreme weather events.[80]

Fast action on SLCPs will also slow self-amplifying feedback mechanisms, and reduce the probability of passing catastrophic climate tipping points. For example, one vulnerable tipping point is the loss of the Arctic summer sea ice, now at a record low.[81] Losing this reflective ice sets off a feedback loop when it is replaced with darker water that absorbs more heat and increases warming.[82] Another feedback is starting as warming in the Arctic thaws permafrost, releasing stored CO_2 and methane.[83] Terrestrial permafrost contains nearly twice as much carbon trapped in frozen biomass as the entire atmospheric carbon pool; a release of only 1% of the reservoir of methane trapped in under-water permafrost could trigger abrupt climate change.[84]

When combined with CO_2 mitigation under a 440 ppm mitigation scenario, SLCP mitigation measures can stabilize global temperatures below 2°C through 2100.[85] For more details and citations to the science, *see* IGSD's *Primer on Short-Lived Climate Pollutants* (April 2013); *Primer on Hydrofluorocarbons* (September 2013), and *The Need for Speed* (February 2013).

IX. Key SLCP Resources

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Appendix A: HFC Mitigation Strategies

- ***Develop HFC industry partnership/coalitions to support the adoption of low-GWP alternatives to high-GWP HFCs.***

Public-private partnerships are an important tool for reducing HFC production, consumption and use, and for speeding development of cost-effective substitutes. Private industry often has the greatest level of expertise for implementing on-the-ground reductions and developing substitutes.[86] In the early 1990s, the Industry Cooperative for Ozone Layer Protection (ICOLP), a consortium of electronics and aerospace companies, proved incredibly successful at speeding the phase-out of CFCs under the Montreal Protocol.[87] ICOLP, with a membership including AT&T, Boeing, Ford, Honeywell, IBM, Motorola, Nortel, Texas Instruments, and the U.S. Air Force,[88] brought together the expertise of some of the best engineers in the world. These experts identified, developed, and perfected alternatives for CFCs and shared this information worldwide.[89] Once ODS alternative technologies were available, the ICOLP members rapidly deployed them and demanded that their global suppliers halt the use of ODSs.[90]

The SLCP Task Force could develop public-private partnerships modeled after the ICOLP with ad-hoc working groups of experts ("tiger teams") that can quickly identify, develop, perfect and implement HFC substitutes worldwide.

An opportunity also exists to reduce high-GWP HFCs through the Consumer Goods Forum (CGF), a global network of over 650 retailers, manufacturers, service providers, and other stakeholders from over 70 countries, including Coca-Cola, Carrefour, General Mills, Johnson & Johnson, and Wal-Mart.[91] Formed in 2009, the CGF provides a platform for its members to exchange knowledge and initiatives to support sustainability in the consumer goods industry.[92] The CGF Board of Directors, through the CGF Sustainability Steering Group, has committed to reducing members' carbon footprints by identifying supply chain hotspots: "links in the supply chains where GHG emissions are significant and where … business collaboration through the CGF could yield significant dividends."[93] Through supply chain analysis, CGF members can address emissions directly and understand the GHG impact throughout the lifecycle of their products. They can also share lifecycle GHG information with their customers to provide them with broader options for environmentally sensitive purchasing.[94]

One of the priorities for the CGF Sustainability Steering Group is limiting GHG emissions from refrigeration.[95] CGF members agreed to begin phasing out HFC refrigerants beginning in 2015, replacing them with low-GWP substitutes for new purchases of point-of-sale units and large refrigeration installations.[96] A number of CGF members already have programs in place to reduce HFCs, including Coca-Cola and Carrefour.[97]

The EPA and other relevant agencies could support the efforts of the CGF through the SLCP Task Force and independent agency action. This could include supporting the expansion of the forum to new manufacturers and retailers and suppliers, lending technical expertise, and providing financial assistance through grants and loans.

- ***Update Environmentally Preferable Purchasing standards to discourage and exclude HFCs.***

The Environmentally Preferable Purchasing (EPP) program was created by the EPA in 1993 to help U.S. agencies meet their obligations for green purchasing.[98] The federal government us one of largest consumers in the world and the largest in the United States; the EPP program gives provides the tools to exert its purchasing power to increase the availability of environmentally preferable products in the national marketplace.[99] The program defines environmentally preferable products or services as those that "have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, or disposal of the product or service."[100]

While substitutes for high-GWP HFCs with lesser or reduced effect on the environment exist, the EPP does not currently restrict the use of HFCs in environmentally preferable products. To speed the rapid expansion of low-GWP substitutes, the EPP program could amend its list of designated green products and develop purchasing guides to help eliminate products containing high-GWP HFCs.[101]

- ***Update voluntary green certification and rating standards to eliminate high-GWP HFCs.***

Certification programs such as the Energy Star Buildings program or the Leadership in Energy and Environmental Design (LEED) certification system can also be effective tools for reducing the use of high-GWP HFCs and speeding the uptake of low-GWP substitutes.

Energy Star was introduced by the U.S. EPA in 1992 as a voluntary-labeling program to identify and promote energy-efficient products to reduce greenhouse gas emissions.[102] The labeling program has also been expanded to certify energy efficient practices for new homes, commercial and industrial buildings.[103] In 2010 alone, increased energy savings from the Energy Star program avoided the GHG equivalent of 33 million cars and saved nearly $18 billion in reduced utility bills.[104] While one of the goals of the program is to reduce emissions of GHGs, Energy Star does not currently restrict the use of HFC refrigerants or foam-blowing agents in its certified products and buildings. The federal government as well as numerous state and local governments provide tax incentives for the purchase and implementation of energy efficiency products, which support the rapid expansion of these products in the marketplace.[105] Amending the Energy Star criteria for product certification to restrict or eliminate the use of high-GWP HFCs would allow this already effective program to speed the use of low-GWP substitutes. The Energy Star program could also be amended to require full lifecycle climate impact information in their product labels, to encourage companies to transition to the most energy efficient low-GWP alternatives and provide consumers with greater choices in purchasing.[106]

The LEED certification was developed by the U.S. Green Building Council in 2000, and is now an internationally recognized certification system that provides building owners and operators with the tools to identify and implement green building design, construction, operations and maintenance.[107] The LEED certification is used by thousands of building managers and owners, a number of federal, state and local governments and agencies and there are LEED projects in 120 different countries including India, Mexico and Brazil.[108] The LEED program could be amended to take greater consideration of or entirely eliminate products that contain HFCs. As an example, the base-level “Fundamental Refrigerant Management” certification requires only that new buildings and major remodels HVAC, refrigeration and fire suppression systems contain no CFCs, and phase-out plans be developed for existing buildings.[109] The higher level “Enhanced Refrigerant Management” certification takes into account the GWP and energy efficiency of refrigerants used in HVAC and refrigerant systems, and it completely excludes specific chemicals from use in fire suppression systems.[110] The LEED refrigerant certifications could be amended to require zero use of high-GWP HFCs in all projects and certain chemicals in fire suppression systems.

Other independent certification systems also exist, such as the Cradle to Cradle and Green Seal certification which could be amended to disallow use of high-GWP HFCs.[111] For example, the Living Building Challenge certification system includes a red list of chemicals that cannot be used in buildings, including CFCs and HCFCs.[112] This certification system could be updated to add high-GWP HFCs to the red list. Additionally, other certification systems could utilize this approach and “red list” all of these chemicals. The SLCP Task Force could amend those certification systems under their direct purview and work with independent certification systems to speed the phase-out and elimination of HFCs from the U.S. and global market-place.

The International Green Construction Code (IGCC) offers model building standards for green construction that can be adopted as enforceable regulation by local jurisdictions. The 2012 edition includes a performance based standard to reduce energy usage and demonstrate the associated reductions in carbon dioxide equivalent (CO_2e).[113] However, the IGCC does not include any provisions to reduce CFCs or HCFCs let alone HFCs in refrigerants or foam-blowing agents. These international building standards could be updated with similar provisions that are incorporated into the other certification and rating systems.

Working with green ranking systems such as the Newsweek Green Rankings is another avenue to address HFC emissions. The Newsweek Green Rankings, begun in 2009, produces an annual list of the 500 largest companies in the U.S. and another for the largest 500 companies in the world, and ranks them according to their environmental performance.[114] Companies use these rankings to highlight their green accomplishments and compete to move up in the rankings each year.[115] Newsweek works with two environmental research firms, Trucost and Sustainalytics, to compile each of the lists.[116] The SLCP Task Force support the development of best practices for considering HFCs in refrigeration, foams and other sources in environmental performance ratings and work with environmental firms such as Trucost and Sustainalytics to ensure their implementation.

- ***Reduce HFC emissions from mobile air conditioning.***

Mobile air conditioning (MACs) accounts for approximately 50% of HFC-134 consumption in developed countries,[117] and approximately 24% of total global consumption of all HFCs, primarily due to the acceptance of HFCs as substitutes for ODS refrigerants being phased out under the Montreal Protocol.[118] Under Section 612(c) of the Clean Air Act the U.S. EPA is authorized to identify and publish a list of acceptable and unacceptable substitutes for ODSs, which it does through the Significant New Alternatives Policy (SNAP) program.[119] HFC-134a is listed as an acceptable refrigerant substitute in MACs, and it now accounts for up to 50% of HFC use in the U.S..[120] HFC-134a is a greenhouse gas with a GWP approximately 1,430 times that of CO_2.[121]

In 2011, the U.S. EPA accepted a petition by NRDC, IGSD, and the Environmental Investigation Agency (EIA)[122] to remove HFC-134a from the list of acceptable alternative to ODS refrigerants for MACs.[123] The petition was made made in light of the approval of acceptable alternatives with lower GWP and the same or higher energy efficiency including: HFO-1234yf (GWP = ~4), HFC-152a (GWP = ~140), and CO_2 (GWP = 1).[124] However, the EPA has not taken any further action on HFC-134a and should propose and finalize a rule to remove HFC-134a as quickly as is practicable.

The delisting of HFC-134a on a planned schedule offers the advantage of an orderly transition to new technology with new investment in service equipment, training, and supply infrastructure with associated jobs and profits to those companies. The new SAE standards for HFC-1234yf air conditioners require improved containment of refrigerant, which reduces the frequency of repair and the vehicle ownership cost.[125]

In the U.S., do-it-yourself (DIY) owners lacking leak detectors and recovery/recycle equipment repair and recharge 10% of vehicles needing service, using half of the HFC-134a sold for MAC service while professional technicians service 90% of vehicles needing service use the other 50% of HFC-134a sold for MAC service. Environmental authorities wishing to avoid the climate damage of DYI recharge of leaking HFC-1234yf systems without first properly repairing leaks and also wish to avoid recharge f HFC-1234yf systems with lower cost HFC-134a will want to require refrigerant purchasers to be technically certified and have access to recovery/recycle equipment as was required in the U.S. and other countries for the purchase of CFC refrigerants.

The 2010 U.S. EPA greenhouse gas standard for model year 2012-2016 cars and light trucks provides credits to automakers that use refrigerants with a 100-year GWP below 1430 (the GWP of HFC-134a).[126] The program, adopted to provide compliance flexibility to manufacturers, particularly in the early years of implementation, allows manufacturers to generate credits for using low-GWP refrigerants, improving refrigerant containment, and improving MAC technical efficiency, which can be used to meet fleet average CO_2 standards applied under the rule.[127] New rules for model year 2017-2025 U.S. CAFE standards continue to provide credits for using low-GHG standards and include credits for improvements in mobile air conditioner efficiency.[128] In early 2012, the California Air Resources Board (CARB) modified its own mobile air conditioning credit scheme in its light-duty vehicle GHG standards, known as the Pavely regulation, to align with the EPA's new rulemaking.[129] The 2004 CARB regulation encouraged, but did not require, efforts to improve refrigerant containment in MAC systems using refrigerants.[130] Various auto manufacturers, including General Motors, Ford, Mazda, and Subaru, introduced vehicles with low-GWP HFC-1234yf in 2012, with most other manufacturers expected to follow.[131]

Additional large reductions are available in the United by shifting service from do-it-yourself to professional, and by creating incentives for destruction when vehicles are dismantled at the end of useful life.[132]

The U.S. EPA estimates that half of the refrigerants used to service MACs are sold in small cans that primarily supply the do-it-yourself market where car owners rarely have access to expensive leak detectors, refrigerant recovery machines, diagnostic instructions, and other special tools and training. As a consequence, do-it-yourselfers accomplish less than 10% of annual MAC repairs while consuming half the service refrigerant while professional service accomplishes 90% of repair with the same amount of new refrigerant.[133] When the transition was made from CFC-12 to HFC-134a, the EPA banned the sale of CFC-12 except to certified technicians, but allowed the sale of HFC-134a to anyone.[134] Technician certification should be a prerequisite for all refrigerant sales.[135]

Another regulatory approach is to require repair of leaking MAC systems prior to recharge and to classify MAC systems as part of emissions control. Requiring repair before recharge avoids the temptation to "top-off" leaking systems with low-cost refrigerant every few weeks. Making MAC systems part of emissions control would require the manufacturer to pay for repairs for the first 125,000 kilometers, creating an increased incentive for leak-tight reliability and assuring that replacement parts are equal or better than parts used in manufacture.

Another regulatory or voluntary approach is to work with refrigerant suppliers and distributors to provide logistical support and payment on delivery for unwanted or unusable refrigerants. Similar programs have been successfully implemented in California,[136] Australia, Sweden, and Germany and are equivalent to programs where companies selling batteries, tires and oil are required to take back the used products at agreed and fair prices in order to ensure their reuse, recycle and safe disposal.[137]

Labeling and consumer education approaches are also successful. For example, when Minnesota required automobile manufactures to estimate and publish the expected refrigerant leakage from MACs, manufactures upgraded the technology, significantly reducing emissions.[138] Emissions can also be reduced by educating vehicle owners to understand the long-term ownership cost savings of proper MAC service and the risks of do-it-yourself service.

- ***Reduce HFC emissions from stationary refrigeration and air conditioning systems.***

In 2015, stationary air conditioning is expected to account for 15% of all CO_2-eq HFC emissions, and commercial and domestic refrigeration, 45% and 1% respectively.[139] A California study estimated that approximately 1.25 MMt CO_2-eq could be abated by recovering refrigerants from pre-2000 refrigerators and freezers by requiring the units be upgraded to Energy Star standards or better.[140] According to the EPA there are already a suite of known refrigerant substitutes and more efficient technologies available to replace and significantly reduce emissions of HFCs from appliances.[141]

In 2010, the EPA proposed a rule within Section 608 of the Clean Air Act to lower the leak rates that triggered repair requirements for comfort cooling, commercial refrigeration, industrial process refrigeration and air conditioning equipment with ODS charges greater than 50 pounds.[142] The new proposed rule and the ODS phase out under Montreal Protocol is spurring the replacement of the regulated equipment with new units utilizing primarily HFCs. To spur a transition to equipment that utilizes other non-ozone depleting, low-GWP refrigerants, the EPA could propose an amendment of the proposed rule to include HFCs, thereby catalyzing the rapid implementation of low-GWP substitutes.

California has already adopted a statewide regulation, referred to as Refrigerant Management Program, which extends federal rule requirements to not only include HFCs but also requires all detected refrigerant leaks to be repaired.[143] Others states can follow California in adopting similar measures. As stated earlier, an even stronger impact can be made by including an HFC phase down in the Montreal Protocol as well.

- ***Prioritize utilization of low-GWP HFC insulation and refrigerants through Federal Housing and Energy Efficiency Loan Programs.***

The President's *Climate Action Plan* calls for a doubling of energy productivity by 2030 relative to 2010 levels through the establishment of new energy efficiency standards, increasing investment in energy efficiency, and research into new energy efficient technologies. To support the purchase and remodeling of energy efficient buildings and new homes, the federal government provides a number of loans, loan guarantees, and tax incentives to consumers and businesses. There are number of low-GWP alternatives used in insulating foams and refrigerants which provide equal or better energy efficiency to their high-GWP HFCs counterparts. The SLCP Task Force could work with these loan programs to ensure that, where possible, the programs eliminate the use of high-GWP HFCs in construction or improvements that they fund or support. Possible loan programs include: Federal Housing Administration Energy Efficient Mortgage Loan program;[144] Veterans Housing Guaranteed and Insured Loans; Native American Direct Loan Program;[145] Department of Energy Weatherization Assistance Program;[146] The Department of Agriculture Energy Efficiency and Conservation Loan Program;[147] The Department of Agriculture Rural Energy for America program.[148]The Task Force could also work with state, local and utility energy efficiency loan programs to eliminate high-GWP HFCs.

- ***Reduce HFC emissions from thermal insulating foam.***

In 2010, HFC consumption in the building and construction foam sector was the equivalent of ~38 MMt CO_2-eq.[149] HFC use in building and construction foam is expected to increase globally as developing countries are required to phase out HCFCs and as new energy efficiency standards are put into place. However there are a number of available low-GWP alternatives that are already being utilized by the market.[150] Thermal insulating foam can be manufactured with low-GWP HFCs and with not-in-kind foam blowing agents such as methyl formate, water, and CO_2.[151] Non-foam alternatives include mineral wool, fiberglass and cellulose.[152] Architectural solutions include less glass, solar orientation, landscaping, and reflectivity of roof and paint coatings.[153] Removing HFCs from the list of acceptable foam blowing substitutes under the EPA SNAP program would effectively eliminate their use in the U.S. and support expansion of low GWP alternatives in countries still phasing-out HCFCs. Where low-GWP substitutes may not be feasible or readily available, a phase down schedule can be established on a per application basis.

- ***Reduce HFCs in transport refrigeration,***

Refrigeration for railcars, vans, trucks, trailer-mounted systems, ships, and intermodal containers are significant potential sources of HFC emissions reductions, accounting for approximately 7% of global HFC consumption in 2010.[154] The EPA estimates that in 2010, HFCs were used for refrigeration in 40% of ships, 70% of road vehicles, and 95% of intermodal containers.[155] In the 1990s, in response to the ODS phase-outs under the Montreal Protocol, many manufacturers converted to HFCs in transportation refrigeration, primarily because these were the most widely available and studied alternatives at the time.[156] Today there are a number of low-GWP alternatives available on the market.[157] The EPA could spur a transition out of refrigerants in the transportation refrigeration sector by removing HFCs from the list of accepted substitutes in the SNAP program.[158]

- ***Replace HFC suppressants in fire protection systems.***

HFCs in total flooding fire suppression systems are a significant source of GHG emissions in the United States. These types of systems are typically used to protect large computer data management areas in commercial buildings, clean room manufacturing facilities, telecommunications equipment, museums and archives.[159] There are a number of low-GWP alternatives that can be used in fire suppression systems.[160] To reduce the use of high-GWP fire suppression agents, the EPA could remove HFCs from the list of appropriate substitutes for total flooding systems.[161] New requirements for total flooding systems could also require that all new systems use fire suppressants with a GWP below a specified threshold.

- ***Reduce HFC emissions from supermarket refrigeration.***

Supermarket refrigeration is one of the largest sources of HFC emissions in the U.S. as well as in many other countries.[162] According to the U.S. EPA, there are more than 35,000 supermarkets in the United States, each with a refrigeration system typically containing 3000-4000 pounds of refrigerant.[163] Typical refrigerants in the U.S. include HCFC-22, and HFCs, both potent greenhouse gases. Supermarket refrigeration systems can leak more than 20% of their charges every year.[164] Emissions from this sector can be reduced by installing new refrigeration technologies that significantly reduce leakage and the overall size of the refrigerant charge in the system. High-GWP refrigerants can also be replaced with low-GWP substitutes.[165]

There are a number of modern supermarket refrigeration system designs today that can significantly reduce the amount of refrigerant needed while reducing leaks.[166] Two such systems, distributed and indirect, have been available for more than 20 years. Distributed systems can reduce the refrigerant charge by up to 50%, and the indirect system by up to 80%.[167] In addition to implementation of modern designs, there are a number of low-GWP substitute refrigerants available today, and more are likely to come on to the market in the coming years.[168]

To support emissions reductions from the supermarket sector, the EPA instituted a voluntary partnership program called GreenChill. The program works with supermarkets to support the reduction of emissions and the replacement of inefficient refrigeration systems. In addition to providing technical support, the GreenChill program certifies participating supermarkets with Silver, Gold and Platinum certifications depending upon the level of emissions reductions in their refrigeration system.[169] To strengthen the program, the EPA could establish voluntary standards for the maximum acceptable GWP value for refrigerants.[170] The EPA could also work to expand the coverage of the GreenChill partnership, particularly within the companies that make up the Consumer Good Forum, which have pledged to begin phasing-out HFC refrigerants starting in 2015.[171]

- ***Reduce non-essential HFC use in aerosol products***

There are a number of products on the market today that unnecessarily contain HFCs. These include convenience and cosmetic aerosol products using HFCs as propellants.[172] For example, the use of pressurized gas to clean electronic products can blow the dust deeper into the product where it accumulates moisture and causes corrosion. The use of dust blowers on electro-optical devices (e.g. cameras and cell phones with cameras) can blow lubricants from bearings and moving surfaces onto the lens surface where focus is distorted and optical coatings are deteriorated causing unnatural color balance. Use on electro-mechanical devices (e.g. sewing machines) can blow lubricants from bearings and moving surfaces, which increases wear and requires more frequent tune-up and repair.

Alternatives to HFC dust blowers include vacuum cleaners, brushes (regular or charged particle), and alternative pressurized gas (e.g. air, nitrogen, or CO_2).[173]

Industry-government partnerships with electronic, optical, and mechanical product manufacturers can agree on standardized warning labels, combining the concern for climate and superior methods of cleaning.

- ***Align minimum efficiency standards for refrigeration and air conditioning with HFC reductions under the SNAP program.***

The EPA and Department of Energy (DOE) could work together to phase down HFCs and secure significant gains in energy efficiency in air conditioning and refrigeration by aligning their regulatory timetables. EPA has the authority to disallow the use of HFCs in air conditioning and refrigeration by removing them from the list of acceptable alternatives to ODS under its Significant New Alternative Policy (SNAP), described above. The SNAP program evaluates and regulates substitutes for ozone depleting chemicals being phased out under the Montreal Protocol.[174] HFCs are currently listed as acceptable alternatives for all major categories of use in the U.S.[175] Removing them from the list would force manufacturers to switch to alternative refrigerants and, at the same time, retool their systems.

In order to ensure the largest possible gains in product efficiency during the re-tooling process, DOE and EPA could work together to implement complementary increases in minimum efficiency requirements in the corresponding sectors. The DOE Building Technologies Office (BTO) implements minimum energy conservation standards for more than 50 categories of appliances and equipment, including residential and commercial refrigeration and air conditioning which often use HFCs as refrigerants.[176] DOE has the authority to promulgate standards for domestic and commercial refrigeration equipment, central air conditioners and heat pumps, residential room air conditioners, commercial package air conditioners and heat pumps.[177] DOE is required to maintain a schedule to regularly review and update all standards and test procedures. DOE and EPA could work together to synchronize a timetable for "un-SNAP-ing" HFCs with its efficiency standards schedule.

- ***Remove barriers to the adoption of low-GWP alternatives in the air conditioning and refrigeration sectors***

The DOE could work to remove barriers to the adoption of low-GWP alternatives in the air conditioning and refrigeration sectors by supporting research and development, technical validation, and market introduction programs for low-GWP HFC alternatives. For example, the DOE's Commercialization Team of the Office of Energy Efficiency and Renewable Energy (EERE) works to bridge the gap between research and development (R&D), and venture capital funding and marketing.[178] The team uses programs, license agreements, technology showcases, and other strategies to identify opportunities and interest investors.[179] The department provides joint funding for projects, develops business opportunities through competitive solicitations, and tracks both federal and state incentives.[180] In order to improve market penetration and large-scale commercialization, EPA, or EPA together with DOE, could put together a similar Commercialization Team for energy efficient, low-GWP HFC alternatives and technologies.

Appendix B: Methane Mitigation Options

- ***Recover and utilize gas from the production and distribution of oil and natural gas***

The natural gas sector is the most significant source of methane emissions in the United States, releasing approximately 215 MMt CO_2-eq in 2010.[181] Methane, which constitutes the largest portion of natural gas, is released through leaks in every stage of the production, transportation and distribution system, as well as intentional releases of gas.[182] Methane emissions from the natural gas sector have increased by approximately 31 MMt CO_2-eq since 1990, despite the successes of mitigation programs such as the EPAs voluntary Natural Gas STAR program.[183] In 2009 Natural Gas STAR's industry partners reported additional revenue of almost $376 million and the avoidance of approximately 38.1 MMt CO_2-eq emissions reductions from measure taken under the program.[184] In addition to its voluntary program, in 2011 the EPA proposed new source performance standards regulating the emission of air pollutants from the natural gas and oil industries.[185] The proposed standards do not target methane specifically, instead focusing on reducing smog forming pollutants known as Volatile Organic Compounds (VOC), but the standards will have the indirect effect of reducing methane emissions.[186] The EPA estimates that the rules, if finalized as proposed, could reduce methane emissions by 26%, or approximately 65 MMt of CO_2-eq, all at a net zero cost to the industry.[187]

While the proposed rules will produce significant emission reductions, further reductions are achievable. Distribution of natural gas, which accounts for approximately 11% of all methane emissions from this sector, is subject to regulation, the new proposed rules will not be applied to the distribution sector.[188] The proposed rules only affect new and modified sources as of August 2011 leaving previously existing systems unaffected.[189] The long operating lifetime of pumping and transmission equipment means that significant emissions will likely continue for decades. The EPA could propose rules for the natural gas distribution sector through its authority under the Clean Air Act, it could also directly regulate GHGs emissions from this sector, and expand its Natural Gas STAR program to target the phase out of pre-2011 equipment and monitor and repair leaking transmission lines.[190]

A number of recent reports have indicated that the implementation of existing technologies to control natural gas leakage could bring down fugitive emissions from this sector by another 30% and bring the total leakage rate from all natural gas systems to below 1% of total production.[191] The Task Force, with the EPA could also investigate the feasibility of implementing EPA regulations to mandate available emissions control technologies for all up-stream and down-stream natural gas systems. Recent studies by the World Resources Institute and the Natural Resources Defense Council, estimate that implementation of existing control technologies, all of which can pay for themselves within three years.[192] The Task Force could also work with the states and private industry to expand best practices, provide technical assistance, and support the expansion of research and technology for new emissions control technologies in the sector.[193]

- ***Mandate methane capture for oil and gas production leases on public lands***

According to the Bureau for Land Management (BLM), gas and oil production from public land accounts for 11% and 5% of domestic production respectively.[194] Federal land management agencies typically sell leases for oil and gas production on public land to the highest bidder, with standard leases lasting 10 years. Before development can begin, leaseholders must file an application with the BLM for a permit to drill, secure other necessary permits and generally produce an environmental assessment.[195] Federal land management agencies and the BLM in particular could adjust permitting requirements to mandate the use of all technically and economically viable control technologies for oil and gas production on public lands.[196] Performance levels for acceptable levels methane emissions from oil and gas production on public lands should also be established and leases should not be granted where planning and environmental reviews show that emissions cannot meet the performance standards.[197] The BLM could also require end of life capping and monitoring of abandoned wells that are no longer economically viable.

- ***Capture and utilize landfill biogas***

Solid waste landfill gas emissions account for approximately 23% of total methane emissions in the United States.[198] Landfill gas emissions have been on a decline in the United States since the 1990.[199] Between 1990 and 2010, landfill gas emissions of methane in the United States decreased approximately 26%, from 147.7 to 107.8 MMt CO_2-eq.[200] This reduction in emissions is due primarily to increased capture and utilization of landfill gas driven by current rules requiring landfill gas recovery and the success of voluntary programs such as the EPA's Methane Outreach Program.[201] Due to the combination of regulatory and voluntary regimes, the U.S. accounts for approximately 60% of all methane captured worldwide, while only accounting for 24% of total worldwide emissions.[202] While progress has been made, there are still significant opportunities for even greater near-term methane reductions.

Under the existing EPA rules governing landfills, only those facilities that have a design capacity of more than 2.5 million tons and more than 2.5 million cubic meters of waste are required to collect and combust their gas emissions.[203] Only 4% of landfills in the United States meet these requirements, even though current technologies for capturing landfill gas can be cost-effective in facilities with a design capacity of only 1 MMt.[204] A number of international studies indicate that methane emissions from landfills can be decreased by approximately 70% using existing technologies, and in many cases at a societal benefit of ~\$5/TCO_2-eq.[205] According to the Methane Outreach Program, approximately 500 additional landfill sites in the United States, with a capacity below 2.5 million tones, are good candidates for low cost methane capture.[206] The California EPA has proposed rules mandating the installation of landfill gas collection and control systems for facilities with as few as 450,000 tons of waste.[207]

To quickly realize the benefits of this opportunity, the EPA could revise its rules under Section 111 of the Clean Air Act and lower the threshold for regulated landfills to facilities with a design capacity of a minimum of 1 MMt.[208]

- ***Expand composting and zero-waste programs***

Methane emissions from landfills can also be controlled by reducing landfill waste through composting programs and waste reduction or zero-waste programs.

Composting programs separate organic waste and manure from inorganic waste, diverting the organic waste away from landfills thereby reducing methane emissions from these sources. In the U.S. Organic waste including food scraps, leaves, brush, grass clippings and other yard trimmings make up approximately 25% of all municipal solid waste, paper products make up another third.[209] This organic waste can be separated and diverted to composting facilities that allow the waste to break down naturally producing CO_2 instead of methane, or taken to facilities designed to produce biogas.[210] Composting facilities are cheaper and faster than landfills to construct and to site, and could represent one of the fastest and cost-effective means of reducing emissions from landfills.[211]

Compost soil can also be used as a covering for existing landfills where capture technologies cannot be used because they are either too small or not cost-effective. Studies have shown that, under the right conditions, placing a compost layer over a landfill can reduce methane emissions by up to 100%[212]

Zero-waste programs go further than composting programs by setting a goal of diverting 100% of municipal waste away from landfills. A number of municipalities have instituted zero waste programs. In 2002 the city of San Francisco set a zero waste goal by 2020, and in 2009 Zero Waste Zones (ZWZ) were announced for downtown Atlanta, GA and Austin, TX.[213]

The SLCP Task Force and the EPA could work with municipalities and businesses with existing zero-waste and composting programs to develop best practice models for expanding these programs and to support other municipalities and businesses setting zero-waste or composting goals.[214] However, expansion of zero-waste and composting programs will decrease the amount of bio-waste available for landfill bio-gas production, so such programs should consider the relative cost and environmental benefits of diverting bio-waste.

- ***Capture coal mine ventilation gas***

Coal mine emissions are the fourth largest source of methane in the United States.[215] Since 1990 methane emissions from coal mines have decreased slightly from 84.1 to 71.0 MMt CO_2-eq thanks in large part to the EPA voluntary U.S. Coalbed Methane Outreach Program (CMOP).[216]. However, significantly larger reductions are possible, in many cases at little or no cost. The EPA estimates that approximately 55% of coal mine methane emissions can be reduced at zero net cost, and 90% at a cost of less than $15 per ton CO_2-eq.[217] Captured coal mine emissions can even produce a profit.[218] According to the CMOP, between 1994 and 2009 gas sales from captured coal mine emissions generated between $150 and $350 million in revenue.[219]

To quickly capture the benefit of this mitigation opportunity, the U.S. EPA could establish federal standards for performance for coal mine emissions through its authority under Section 111 of the Clean Air Act.[220]

- ***Control methane emissions from anaerobic digestion of manure***

Animal manure is the fifth largest source of methane emissions in the United States, accounting for 52.0 MMt of CO_2-eq emissions in 2010.[221] Emissions from this sector have increased by over 60% since 1990, primarily due to a trend towards larger farm facilities utilizing liquid manure management systems, which release more methane than dry manure.[222] Methane can be cost-effectively captured from liquid manure slurries, typical in industrial farm facilities, through the use of anaerobic digesters, which collect and convert methane into electricity.[223] The EPA and U.S.D.A. voluntary AgSTAR Partnership program has been encouraging adoption of anaerobic digestive technologies in the U.S. since 1994.[224] There are currently 162 operating digester systems in operation in the United States.[225] However, according to the U.S. agricultural methane emissions Action Plan, over 6,800 swine farms and 7,000 dairy farms in the United States have the potential to utilize methane biogas systems with a total methane mitigation potential of over 2 million tons CO_2-eq per year.[226]

High up-front costs of anaerobic digester systems are a key barrier to their adoption, as is the lack of knowledge about the technology and the lack of uniformity amongst animal feeding operations.[227] To capture the mitigation benefit from this technology, the EPA could work to expand information exchanges with key stakeholders through its AgSTAR program. The EPA could also consider developing emissions standards under the Clean Air Act for key sources of manure methane emissions.

- ***Remove regulatory barriers for development of methane-based renewable energy***

Deployment of many methane capture and utilization technologies including for landfills, coal mines and farm biodigestors can be accelerated by removing regulatory barriers. Two major regulatory barriers to widespread deployment are uneven use of "net metering" laws and difficult grid interconnection rules for renewable energy projects.

Many methane capture and utilization technologies can provide a profit to operators where local and state laws allow for the sale of surplus electricity to the grid. Biodigesters, for example, particularly on larger farms, can provide farmers with an additional source of revenue from electricity sales creating a greater incentive to adopt biogas collectors.[228] "Net metering" laws allow small generators the ability to receive full retail value for electricity that they send to the grid.[229] According to the Department of Energy, 43 states, the District of Columbia, the Virgin Islands, Puerto Rico, Guam, and American Samoa have implemented net metering laws.[230] However, not all states' net metering laws allow for the sale of energy from all sources, targeting only a few specific sources such as solar or wind.[231] The Department of Energy could work with the remaining states without net metering laws and states with current programs to disseminate best practices and provide technical support to ensure that the programs support the rapid expansion of farm biodigesters.

Difficulties with grid interconnection rules can provide significant disincentive to deployment of methane capture technologies.[232] Interconnection standards vary significantly from state to state and this lack of consistency is a significant challenge for deployment.[233] Additional legal and procedural interconnection issues include: liability insurance, utility practices and timelines, interconnection applications, expedited vs. study track procedures, and fees and charges.[234] Excessive delays, fees or confusion in the application process for the interconnection new systems can significantly retard deployment of these systems.[235] A number of model interconnection procedures have been developed to address these barriers including California's Rule 21 Interconnection standard,[236] FERC's Small Generator Interconnection Procedures (SGIP),[237] and IREC's Model Interconnection Procedures.[238] The SLCP Task Force could work with expert organizations and agencies in this field to continue to expand and standardize interconnection rules.

- ***Capture and combust methane emissions at dairies***

Another method of reducing methane emissions from enteric fermentation is to require the capture and control of emissions in housing and milking barns at dairies. Emissions can be captured by enclosing barns and venting the gas to an incinerator or biofilter/bioscrubber.[239] According to the California Air Resources Board, incinerators can reduce methane emissions by 90%, and biofilters/bioscrubbers have been shown to reduce emissions of volatile organize compounds (VOCs) by up to 80%.[240] However, the associated costs and benefits for capturing methane emissions from dairies while in housing and milking barns need to be further studied to determine if they are economically feasible.

The EPA could expand existing voluntary measures in the AgSTAR program to provide dairy farms with the technical expertise and information necessary to implement methane control technologies where they are cost-effective.

- ***Capture and utilize methane emissions from wastewater treatment***

U.S. methane emissions from wastewater treatment was 16.3 MMt CO_2-eq in 2010 and has been decreasing since 2006 by an average of just over half a percent per year.[241] According to the U.S. Department of Energy, there are more than 16,000 wastewater treatment plants in the U.S., approximately 3,500 of which utilize anaerobic digestion as a stage in the treatment process.[242] While many of these facilities use the methane gas produced during anaerobic digestion to produce heat to aid in the water treatment process, only approximately 2% also produce electricity with the gas.[243] While the cost and utilization of biogas gas produced from wastewater treatment can vary significantly, a number of plants have shown an ability to offset capital costs completely through income and savings from the generation of heat and electricity.[244] New low-cost systems are also currently in development.[245]

The Task Force should work with the Department of Energy Office of Energy Efficiency and Renewable Energy to expand energy production from biogas at all technically feasible wastewater treatment facilities and increase access to technology and financing through programs such as the Federal Energy Management Program's Super energy savings performance contracts (ESPC).[246]

- ***Improve rice field management***

The cultivation of rice is the eighth largest source of methane emissions in the U.S..[247] Estimated U.S. methane emissions from rice cultivation increased by ~20% between 2005 and 2010, reaching 8.6 MMt CO_2-eq.[248] Emissions of methane from rice fields can be reduced through a number of management techniques such as aerating or regularly draining flooded rice paddies, dry seeding and post-harvest rice straw removal and bailing.[249] The EPA should develop a voluntary program like the successful AgSTAR program to educate farmers on cost-effective management techniques.

- ***Study anti-methanogen vaccines and feed supplements for livestock***

Enteric fermentation is the second largest source of methane emissions in the United States, equaling approximately 24% of total emissions and more than 75% of emissions from agricultural sources.[250] These emissions occur as a result of gases produced in the digestive system in cattle, sheep, and other similar animals.[251] Total emissions from his sector have increased from 133.8 MMt CO_2-eq in 1990 to 141.3 MMt CO_2-eq in 2010.[252] A number of mitigation technologies have been identified for reducing emissions from enteric fermentation, including feed supplements or anti-methanogen vaccines.[253] Many of these technologies like anti-methanogen vaccines are a relatively new and untested although one early Australian study using vaccines on sheep produced a 23% reduction in methane production with no adverse effects on the animals.[254]

To achieve maximum near-term reductions of methane emissions from livestock, the EPA could prioritize research into safe and cost-effective methods for reducing enteric fermentation.

Appendix C: Tropospheric Ozone Mitigation Options

- ***Tighten ozone National Ambient Air Quality Standards (NAAQS)***

Section 108 of the Clean Air Act (CCA) directs the EPA to identify and list certain pollutants that in the Administrator's "judgment; cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare," … "the presence of which in the ambient air results from numerous or diverse mobile or stationary sources" and "for which … [the Administrator] plans to issue air quality criteria…."[255] Further, CCA Section 109 directs the EPA to propose and promulgate 'primary' and 'secondary' National Ambient Air Quality Standards (NAAQS) for those pollutants identified under Section 108. Legislative history indicates that the primary standards is to be set at 'the maximum ambient air level which will protect the health of any [sensitive] group…."[256] The secondary standard is to be set at a level of air quality the attainment and maintenance of which… is required to protect the public welfare from any known or anticipated adverse side effects associated with the presence of [the] pollutant in the ambient air [such as effects on soil, water, crops, vegetation, wildlife, climate, negative economic effects, etc.]."[257]

The EPA first set NAAQSs for tropospheric ozone in 1971, at a 1 hour maximum of 0.08 ppm.[258] The standards were adjusted again in 1979 and 1997.[259] On 27 March 2008 the EPA published its final decision revising the level of the 8-hour primary tropospheric ozone standard from 0.08 ppm to 0.075 ppm, and the adjusted the secondary standards to be identical to the primary standard.

On 23 July, 2013 the D.C. Federal Court of Appeals held that the 2008 NAAQS for ozone violated the CAA by not setting a secondary standard, in a suit brought against the EPA by twelve states, six NGOs, the District of Colombia, and New York City.[260] The court remanded the question of the secondary standard to the EPA for further explanation or reconsideration.[261]

The EPA, in reviewing the NAAQS secondary standard for ozone, could tighten the regulations beyond 0.75 ppm. According to EPA research, reducing the NAAQS to 0.070 ppm could result in a benefit in 2020 of $13 to $37 billion, with 1.5 and 4.3 thousand less early deaths, and approximately 0.6 million less school days missed.[262] Reducing the NAAQS further to 0.065 ppm could result in a benefit in 2020 of between of $22 to $61 billion, with 2.5 and 7.2 thousand less early deaths, and approximately 1.1 million less school days missed.[263]

Appendix D: Black Carbon Mitigation Options

- ***Reduce transportation particulate emissions***

Recognizing the importance of reducing particulate matter (PM) emissions from the transportation sector, the U.S. has already taken significant steps to mitigate emissions. The Highway Diesel Rule, also known as the "2007 Highway Rule" requires a 97% reduction in the sulfur content of highway diesel fuels, which allows for the use of new particulate filters in model year 2007 diesel cars, trucks and buses capable of reducing black carbon emissions by more than 90%.[264] The regulation has been estimated to have reduced soot emissions from on-road diesel vehicles by 110,000 tons per year and produces more than $70 billion annually in environmental and public health benefits at a cost of $4 billion per year.[265] The Clean Air Non-road Diesel Rule is similar to the 2007 Highway Rule in that it requires a reduction of sulfur content of off-road diesel fuel by 99% and institutes new lower emissions standards for new vehicles starting in model year 2008.[266] The rule is estimated to have reduced PM emissions from off-road vehicles by 129,000 tons annually.[267]

While both of these regulations reduce black carbon emissions from new on-road and off-road vehicles by more than 90%, they leave existing vehicles untouched.[268] The EPA estimates that vehicle turnover will allow for a majority of diesel fleets to be updated to the new standards by 2030.[269] However well maintained diesel vehicles can last between 20 to 30 years and some off-road vehicles can last up to 40 years.[270] This means that a significant amount of black carbon will continue to be emitted from these pre-2007 vehicles for decades to come. Retrofitting existing on- and off-road diesel vehicles with particulate filters is the most effective means of lowering emissions in the near-term.

The EPA-managed Diesel Emission Reduction Act (DERA) provides funds to the states to retrofit pre-regulation diesel engines.[271] However, the program has historically been deeply underfunded.[272] While Congress authorized $1 billion for DERA for FY 2007-2011 only between $50 and $60 million per year have actually been appropriated for the program.[273] DERA has also been significantly oversubscribed.[274] Between 2008 and 2010 the EPA received applications for funding seven times greater than available funds during that period.[275] In 2010 Congress authorized appropriations of up to $100 million annually ($500 million in total) for programs aimed at reducing diesel emissions for fiscal years 2012 through 2016.[276] The White House eliminated funding for the DERA program in the FY2012 budget, but Congress did eventually appropriate $30 million for the program, $20 million less than in FY2011.[277]

According to the Diesel Technology Forum, by the end of 2011 the DERA program will only have replaced or retrofitted 50,000 of the estimated eleven million pre-regulation diesel vehicles in the United States.[278] The DERA program has been reinstated in the President's budget request for FY2013, but at $15 million, a 50% reduction from FY2012 levels.[279] To ensure the continued rapid reduction of black carbon emissions from pre-regulation vehicles, the Administration could support funding for DERA beyond 2016 with an aim to produce a complete turnover of pre-regulation on- and off-road diesel vehicles well before 2030.[280]

- ***Eliminate super-emitting on and off-road vehicles***

Super-emitting heavy-duty, on- an off-road vehicles, make up only an estimated 5% of the U.S. diesel fleet but produce up to eight times more emissions than their modern counterparts.[281] While a majority of these super-emitters are expected to be replaced by 2030 due to regulations under the Clean Air Non-road Diesel Rule[282] and the 2007 Highway Rule[283] the disproportionate emissions from these vehicles require that they receive special attention to phase them out on a faster timeline. The EPA could create a special carve-out in the DERA program specifically targeting super-emitting vehicles, with the intent of eliminating them entirely by 2020. One option for targeted DERA funding is the development of new financing options for leasing clean diesel vehicles specifically targeting small businesses and other operators that may not be able to obtain traditional financing or otherwise afford to replace their super-emitting diesel vehicles. [284]

- ***Expand the use of battery and grid power for parked highway trucks***

Trucks parked at road-side rests or at staging areas to load and unload have traditionally operated truck or auxiliary diesel engines to heat and cool the drivers' and sleeping cabins and to heat and cool cargo.[285] Key technologies for reducing emissions from idling trucks include: retrofits to allow shore-power, battery packs, or auxiliary power generators, and the addition of truck stop electrification systems to allow trucks to plug into the land-based grid.[286] These technologies reduce roadside noise and pollution and have the side benefit that drivers are more rested when they sleep and relax without the sound, vibration, and fumes of diesel.

In 2006 a California study estimated that truck stop electrification could reduce 2025 state fuel use by 250 million gallons per year.[287] The Shorepower Truck Electrification Project (STEP), funded by the American Recovery and Reinvestment Act (ARRA) and the U.S. Department of Energy is expected to install electrified truck parking at 50 locations nationally while providing over $10 million in product purchase rebates for truck owners to upgrade their equipment to utilize the service.[288] The 1-5 corridor on the West coast is the first of 10 intestate corridors targeted by the project with six new facilities by the end of 2012.[289]

The EPA could work with state and local authorities to identify and support additional funding opportunities for the expansion of electrification projects, and incentives for truck owners to retrofit existing trucks with electrification technologies. An example includes the 2006 Washington State Senate Bill 6512, which provides business and occupation tax deductions and sales tax exemptions for on-board or stand-alone truck electrification systems.[290]

- ***Require shore-power from at-berth ocean-going vessels***

Reducing particulate emissions from ocean-going vessels is a small but important black carbon mitigation opportunity. In 2009 California passed regulations requiring fleet operators to significantly reduce at-berth emissions of NO_X and diesel particulate matter.[291] The regulations require fleet operators to reduce emissions by steadily increasing targets reaching 80% by 2020.[292] Fleet operators are required to either switch to on-shore power when at berth or use any available alternative techniques to meet the reduction requirements.[293] The EPA could work with other State Port Authorities to support the implementation of broader at-berth regulations similar to California's.

- ***Reduce port congestion***

Congestion for vessels queued to enter port increases emissions of GHGs and black carbon near-port, is economically inefficient, and increases other hazards. In many cases ocean going vessels race to port knowing of the congestion because many ports utilized a first-come, first-served basis for prioritizing the queue. This procedure contributes to increased congestion at port and increases ship fuel use at sea because the rate of fuel consumption of a vessel increases as its speed increases.[294] For off-shore congestion, ports can change their entry procedures to stop incentivizing "hurry-up and wait" behavior, and instead work with ships to use a "virtual arrival" system.[295] A virtual arrival system would allow vessels to plan for arrival congestion at the arrival ports while still at the port of origin, and decrease speeds at sea to arrive when their slot becomes available in the virtual queue, thus reducing fuel use and emissions at sea and reducing congestion and emissions at destination ports.[296] Switching to a virtual arrival system would require a change in shipping contracts as well as port procedures to utilize more efficient systems and deemphasize first-come, first-served queuing. [297] The SLCP Task Force could work with industry associations and ports to educate industry and expand the use of virtual arrival systems and shipping contracts that utilize them.

Ports can also work to improve on-shore efficiency to reduce freight congestion. The non-profit company PierPASS has worked with the ports of Los Angeles and Long Beach since 2005 to move more truck traffic in and around ports to non-peak traffic hours, which reduces idling time and congestion.[298] On-shore congestion can also be improved by developing more ship-to-rail infrastructure like the plans at the Port of Oakland.[299] The SLCP Task Force could work with other port authorities to develop best practices and facilitate the expansion of on-shore efficiency practices for all U.S. ports, including on the great lakes.

- ***Require vessel speed reduction (VSR) near port***

Requiring ocean-going vessels to reduce speeds as they enter coastal waters has been shown to significantly reduce the emission of black carbon as well as other GHGs. In 2007 California estimated that the implementation of VSR rules within 24 nm of the entire coast-line could reduce emissions of diesel particulate matter, NOx and sulfur oxides (SOx) by 30%.[300] The Port of Los Angeles and the Port of Long Beach already require that all ocean-going vessels reduce their speed to 12 knots beginning 40 nms off shore.[301] The added cost to the vessels due to the delay caused by reduced speeds is offset through the Green Flag Program, which offers reduced dockage fees for those vessels that reach 90% compliance with the VSR.[302]

The EPA could work with other coastal states and port authorities to facilitate the expansion of VSR regulations for all coastal waters, including the great lakes.

- ***Ban open burning of agricultural biomass***

A complete ban on open burning of agricultural biomass in the United States would decrease domestic black carbon emissions from biomass, estimated at approximately 225,000 tons per year.[303] According to the U.S. EPA approximately 90% of all black carbon emissions from biomass come from open biomass burning, 6% of which is attributed to agricultural burning.[304]

A number of options exist as an alternative to open biomass burning including converting to biochar or biofuels.[305] In many cases conversion of biomass to fuel or biochar can be performed at a profit.[306] Conversion of biomass into biochar creates the added benefit of sequestering carbon in a stable form that can be used as an agricultural additive to increase soil nutrient retention.[307] Where possible crops can also be converted from those that require burning to those that do not.[308] The SLCP Task Force could develop training and outreach programs for farmers and land managers to educate them on techniques and best practices for eliminating the need to burn agricultural biomass, and develop tools for expanding the use of biochar technologies.

- ***Set stronger standards for wood-burning stoves and fireplaces***

Although black carbon emissions from wood-burning stoves and fireplaces have decreased significantly in North America over the past century, residential wood burning continue to be among the top 15 black carbon source sectors in the United States.[309] In 1988 the EPA implemented regulations on the manufacture and sale of wood stoves and certified wood burning fireplace inserts called the Residential Wood Heater New Source Performance Standard.[310] Wood burning stoves and fireplace designs that meet these performance standards produce on average between 2 and 7 grams of smoke per hour compared to 15 to 30 grams per hour from older uncertified designs.[311]

The EPA also administers a voluntary Fireplace Partnership Program with manufacturers to encourage the manufacture and sale of cleaner fireplaces.[312] The EPA qualifies fireplaces and fireplace retrofit devices from participating manufacturers, which are approximately 70% cleaner than older fireplace models. Qualified units are affixed with a white tag to indicate to consumers that these fireplaces and fireplace retrofit units are cleaner burning.[313]

Finally the EPA manages the BurnWise program, which provides resources to participating states and local agencies for improve air quality through change-out programs and public education.[314] The BurnWise program also provides information to consumers regarding safe burning practices, issues relating to energy efficiency, and health, and appliance buying guides for modern wood burning stoves and fireplaces certified and qualified through its programs.[315]

To expand on the EPA's existing work in this sector, the Task Force should explore opportunities to expand the U.S. EPA BurnWise program, identify technical options to improve existing EPA standards both in the Residential Wood Heater New Source Performance Standard and through the voluntary Fireplace Partnership Program, and encourage states and local regulatory agencies to adopt equal or better standards for food burning stoves and fireplaces.

- ***Conduct EPA environmental endangerment findings on aircraft, marine vessels, and off-road vehicles***

While emissions from aircraft, marine vessels and off-road vehicles are small compared to large source sectors like power plants and on-road vehicles, conducting EPA endangerment findings in these sectors will still provide significant SLCP mitigation opportunities. According to the Center for Biological Diversity these three sectors account for 25% of U.S. GHG emissions from mobile sources.[316] An environmental endangerment finding in these sectors will give the EPA the ability go beyond voluntary initiatives and regulate emissions through its authority under the Clean Air Act. Between 2007 and 2008 the EPA was petitioned three times to conduct such findings in these sectors, but has not yet done so, arguing that it has the discretion to prioritize limited resources to focus on larger source sectors like power plants.[317] While the EPAs discretion has been upheld in a recent D.C. District Court ruling, the EPA could endeavor to conduct the endangerment findings without delay.[318]

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[1] Xu Y., Zaelke D., Velders G., Ramanathan V., *The role of HFCs in mitigating 21st century climate change*, ATMOSPHERIC CHEMISTRY AND PHYSICS 13:6083-6089, 1 (2013). .

[2] Solomon S. *et al.*, CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2007); *see also* Archer D *et al.*, *Atmospheric lifetime of fossil fuel carbon dioxide*, ANNU. REV EARTH PLANET. SCI. 37:117-34 (2009); *and* Matthews H. D. & Caldeira K. *Stabilizing climate requires near-zero emissions*, J. GEOPHYSICAL RES. 35:4 (2008); *and* Hansen J. *et al.*, *Climate change and trace gases*, PHIL. TRANS. R. SOC. 365:1925-1954 (2007).

[3] UNEP/WMO (2011) INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE, 57; *see also* UNEP (2011) NEAR-TERM CLIMATE PROTECTION AND CLEAN AIR BENEFITS: ACTIONS FOR CONTROLLING SHORT-LIVED CLIMATE FORCERS ("Methane contributes around 50 per cent of the increases in background ozone, with smaller contributions from non-methane volatile organic compounds and carbon monoxide"); *and* Royal Society (2008) GROUND-LEVEL OZONE IN THE 21ST CENTURY: FUTURE TRENDS, IMPACTS AND POLICY IMPLICATIONS: SCIENCE POLICY REPORT.

[4] Shindell D. *et al.*, *Simultaneously mitigating near-term climate change and improving human health and food security*, 335 SCI. 183, 183 (2012); *and* UNEP/WMO, INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE (2011); *see also* Lim S. *et al.*, *A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010*, 380 THE LANCET 9859 (2012) ("The joint effects of air pollution are also likely to be large. Household air pollution from solid fuels accounted for 3.5 million (2.7 million to 4.4 million) deaths and 4.5% (3.4–5.3) of global DALYs [disability-adjusted life years] in 2010 and ambient particulate matter pollution accounted for 3.1 million (2.7 million to 3.5 million) deaths and 3.1% (2.7–3.4) of global DALYs…. The effects of ambient ozone pollution, which increases the risk of chronic obstructive pulmonary disease, were smaller than those of household air pollution from solid fuels or ambient particulate matter pollution (0.2 million [0.1 million to 0.3 million] deaths and 0.1% [0.03–0.2] of global DALYs in 2010).") Total annual deaths from air pollution is 6.8 million.

[5] Executive Office of the President, THE PRESIDENT'S CLIMATE ACTION PLAN (2013).

[6] Executive Office of the President, THE PRESIDENT'S CLIMATE ACTION PLAN, 10-11 (2013).

[7] Executive Office of the President, THE PRESIDENT'S CLIMATE ACTION PLAN, 17 (2013).

[8] The Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants, *Communiqué*, Third Meeting of the High Level Assembly, Oslo, HLA/SEP2013/7rev2 (2013); *see also Climate and Clean Air Task Force to Reduce Short-Lived Climate Pollutants*, website (2013).

[9] Subtitle C of the American Power Act proposed the establishment of an inter-agency process to study and report to Congress on "existing and potential policies and measures that promote fast mitigation of greenhouse gas emissions focusing on noncarbon dioxide climate-forcing gases,. The proposed taskforce could build off of this proposed model. American Power Act of 2010, 111th Cong. § 2231 (2010) (unenacted).

[10] Executive Office of the President, THE PRESIDENT'S CLIMATE ACTION PLAN, 10 (2013).

[11] *Climate and Clean Air Task Force to Reduce Short-Lived Climate Pollutants*, website (2013).

[12] Bachmann J. & Seidel S., DOMESTIC POLICIES TO REDUCE THE NEAR-TERM RISKS OF CLIMATE CHANGE (2013) ("As a first step under this initiative, the Administration could issue a new Executive Order, direct agencies to begin advancing the regulatory and program actions identified below, and establish an interagency Short-Lived Climate Pollutant Task Force to coordinate and monitor implementation of this effort and to identify additional actions going forward."); s*ee also* World Resources Institute (2013) CAN THE U.S. GET THERE FROM HERE? USING EXISTING FEDERAL LAWS AND STATE ACTION TO REDUCE GREENHOUSE GAS EMISSIONS.

[13] Super Pollutant Emissions Reduction Act of 2013, H.R. 143, 113th Congress,1st Session (2013).

[14] Super Pollutant Emissions Reduction Act of 2013, H.R. 143, 113th Congress,1st Session (2013).

[15] Exec. Order No. 13514, 74 F.R. 52117 (2009).

[16] Exec. Order No. 13514, 74 F.R. 52117 (2009).

[17] Exec. Order No. 13514, 74 F.R. 52117, 19(i) (2009) (""greenhouse gases" means carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.").

[18] U.S. DEPT. OF ENERGY, *Sustainability Performance Office*, website (2013) ("Secretary Chu established definitive GHG emissions reduction targets for the agency. Specifically, DOE is committed to meeting the following targets by fiscal year (FY) 2020: Reduce scope 1 and scope 2 GHG emissions by 28% compared to a FY 2008 baseline. Reduce scope 3 GHG emissions by 13% compared to a FY 2008 baseline; *see also* Exec. Order No. 13514, 74 F.R. 52117 (2009).

[19] U.S. EXEC., *Leading by Example in Environmental, Energy, and Economic Performance*, website (2013) ("he Federal Government's GHG inventory for 2010 was 66.4 metric tons of carbon dioxide emissions (MMTCO2e). The 2010 GHG inventory shows that the Federal Government successfully reduced GHG pollution by 2.5 million metric tons of carbon dioxide emissions (MMTCO2e) since its 2008 baseline, and is on track to meeting the 2020 Federal GHG pollution reduction target.").

[20] *Office of Federal Environmental Executive*, website (2013) ("Housed within the White House Council on Environmental Quality, the Office of the Federal Environmental Executive was created by Executive Order in 1993. The Office oversees implementation of President Obama's Executive Order on Federal Sustainability (EO 13514) and the GreenGov initiative, working collaboratively with the Office of Management and Budget and each of the Federal agencies.").

[21] U.S. Envtl. Prot. Agency, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990 – 2010, online database (2012), *see also* Velders G., *et al.*, *Preserving Montreal Protocol Climate Benefits by Limiting HFCs*, 335 SCI. 922 (2012); *see also* U.S. STATE DEPT, U.S. CLIMATE ACTION REPORT 2010: FIFTH NATIONAL COMMUNICATION OF THE UNITED STATES OF AMERICA UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE 30 (2010);. *and* Velders G., *et al.*, *The Large Contribution of Projected HFC Emissions to Future Climate Forcing*, 106 PROC. NAT'L ACAD. SCI. 10952 (2009).

[22] Hodnebrog Ø. *et al.*, *Efficiencies Of Halocarbons And Related Compounds: A Comprehensive Review*, rev. geoPHyS, 333 (2013).

[23] UNEP, HFCS: A CRITICAL LINK IN PROTECTING CLIMATE AND THE OZONE LAYER, 10 (2011).

[24] UNEP, HFCS: A CRITICAL LINK IN PROTECTING CLIMATE AND THE OZONE LAYER, 10 (2011).

[25] U.S. State Dep't., U.S. CLIMATE ACTION REPORT 2010: FIFTH NATIONAL COMMUNICATION OF THE UNITED STATES OF AMERICA UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE 5 (2010); *see also* Technology and Economic Assessment Panel, TEAP Decision XX/8 Report at 127-129; Montreal Protocol on Substances That Deplete the Ozone Layer, opened for signature Sept. 16, 1987, 26 I.L.M. 1550 (1989) (as amended 32 I.L.M. 84) (1992) at Arts. 2A and 2F.

[26] U.S. State Dept., U.S. CLIMATE ACTION REPORT 2010: FIFTH NATIONAL COMMUNICATION OF THE UNITED STATES OF AMERICA UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, 30 (2010); *and* U.S. Envtl Prot. Agency, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990 – 2011 (2013).

[27] World Resource Institute, *Climate Analysis Indicators Tool*, online tool (2013).

[28] Velders G., *et al.*, *Preserving Montreal Protocol Climate Benefits by Limiting HFCs*, 335 SCI. 922 (2012); *see also* TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL, TASK FORCE DECISION XX/8 REPORT, ASSESSMENT OF ALTERNATIVES TO HCFCS AND HFCS AND UPDATE OF THE 2005 TEAP SUPPLEMENTAL REPORT DATA 2009); and Velders G., *et al.*, *The Large Contribution of Projected HFC Emissions to Future Climate Forcing*, PROC. NAT'L. ACAD. SCI. Early Ed. (2009).

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