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SHORT-LIVED CLIMATE POLLUTANTS & USAID'S CLIMATE STRATEGY:

ACHIEVING FAST MITIGATION

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CONTENTS

EXECUTIVE SUMMARY

Short-lived Climate Pollutants (SLCPs) include methane, black carbon (BC) and several short-lived hydrofluorocarbons (HFCs). They are a form of air pollution that have a substantially shorter lifespan in the atmosphere compared to long-lived greenhouse gases (GHGs) like carbon dioxide (CO_2), yet they warm the planet significantly especially in the near-term. Reducing the emissions of SLCPs, in addition to reducing CO_2 emissions, is a priority for the US Government evident in the recent launch of the Global Methane Pledge and recommitment to the Clean Cooking Alliance.

The Intergovernmental Panel on Climate Change (IPCC) found that the only possible scenario for limiting global warming to 1.5°C and avoiding catastrophic impacts of climate change requires reducing emissions of both CO_2 and SLCPs. The US Special Presidential Envoy for Climate (SPEC) articulates SLCPs as providing an opportunity for "fast mitigation" to avoid near-term warming through 2050. The aim of this report is to provide programmatic guidance to USAID operating units and missions on reducing SLCP emissions due to improved understanding of their importance in meeting global climate mitigation goals. Also for many developing countries a key motivation for climate action is reducing air pollution, and reducing SLCPs can help countries meet local air quality priorities in order to help grow their climate ambition.

This guide identifies possible SLCP actions that can be taken across key sectors and USAID regions for advancing development and climate goals (Box 1). To date USAID has limited explicit programming on methane and black carbon mitigation, however USAID has significant presence across key emitting SLCP sectors and countries. This document aims to prepare USAID staff for the growing requests on SLCPs and clarify the SLCP component under USAID's new Climate Strategy 2022-2030 (Strategic Objective 1 and IR 1.1- *Catalyze urgent mitigation, including both emissions reduction and sequestration, from energy, land use, and other key sources*). In addition, the guide helps to accelerate and scale targeted SLCP action within the USAID portfolio, including actions on methane under the Global Methane Pledge.

The two primary climate change funding streams available to support methane and black carbon mitigation at USAID depending on context and source of emissions are **Clean Energy (EG.12)** and **Sustainable Landscapes (EG.13)**. Since each funding stream is governed by a set of guidelines due to the intent of the funding, not all SLCP work is achievable using these two earmarks alone, making mitigation co-benefits from other sectors critical. For instance, USAID staff should consider leveraging non-climate change directive funds, such as Agriculture, Feed the Future, Water and Sanitation, Ocean Plastic Pollution, Global Health, Education, and Democracy, Human Rights and Governance.

There are several activities across the USAID portfolio that can utilize existing program funding to achieve development gains while simultaneously reducing SLCPs. The priorities will vary by region given political, social and geographical factors that favor certain actions over others. Details on the specific measures are found in Chapter 2, Section C and regional detail is found in Section D.

Key SLCP Reduction Actions

METHANE

Oil/gas/coal production

- Recovery of vented and fugitive emissions of methane from coal, oil and natural gas production, including from deep coal mines, leaking pipelines and storage tanks.

Waste

- Expand collection and source separation of municipal waste to enable recycling, composting and waste diversion. When appropriate, design new sanitary landfills or rehabilitate unmanaged disposal sites (i.e. open dumps) with active methane recovery systems.
- Advance integrated solid waste management along with behavior change and strengthening institutional capacities on circular economy practices.
- Expand wastewater treatment with methane abatement technologies, where the enabling environment exists. Increase frequency of fecal sludge collection and transport where appropriate build methane abatement technologies in fecal sludge treatment, and support the enabling environment to ensure sustainability.

Agriculture

- Reduce enteric methane production through improved feeding practices of ruminant livestock, through increased quantity and quality of animal feed intake, support for fodder and forage production, rangeland management and development of other animal feed systems and advisory services to optimize animal nutrition.
- Improve health and management of livestock through strengthened capacities of public and private animal health, extension and advisory services to promote animal breeding, animal welfare and other management practices for increased livestock productivity coupled with governance mechanisms to protect high carbon landscapes.
- Undertake livestock manure management to supply organic fertilizer, through soil amendment to enhance soil carbon stocks and/or consider anaerobic digesters when appropriate.
- Implement rice paddy water management for alternate wetting and drying, promote dry direct seeded rice varieties, and follow a system of rice intensification.
- Encourage the use of better post-harvest techniques (e.g. Purdue Improved Crop Storage (PICS) bags and drying technologies) and agriculture product preservation (e.g. establishing food cold chains and improved transport containers to reduce damage to products).
- Expand and enforce efforts to reduce open burning of crop residues and find alternative, productive uses of crop biomass (e.g. animal feed, soil amendment or fuel source).

Food Systems

- Address demand-side interventions by: (i) reducing food loss and waste, (ii) strengthening food safety capacity and training to reduce contamination, and (iii) in contexts where diets are of sufficient quality (i.e. providing adequate macro and micro-nutrients), shifting diets away from high emission ruminant-based products and other dietary components to other nutrient dense, lower emission alternatives.

- Support circular economy in food systems to reuse unsafe/inedible food products as animal feed or for insect production to prevent products from ending as food waste.

BLACK CARBON

Transportation

- Advance adoption of stringent diesel engine emissions standards. This also requires fuel quality standards that reduce fuel sulfur levels to enable advanced control systems to function.
- Accelerate electrification of diesel fleets, anti-idling measures, green freight adoption or other measures (e.g. urban planning, travel efficiency measures) to reduce and shift away from the use of diesel and high-emitting gas engines.
- Identify and eliminate "high emitting" diesel and gasoline engines by enhancing inspection and maintenance programs with rigid enforcement.

Waste

- Support the creation of integrated waste management systems by expanding waste collection services, source separation, recycling and composting to reduce trash burning, and improve landfill management.

Residential

- Improve access to cleaner cooking, heating and lighting, paying particular attention to affordability, convenience and cultural acceptance of alternatives.
- Shift lump coal use to briquettes where clean fuel transition is impractical.

Industry

- Replace existing brick kilns and coke ovens with more efficient designs. Government action should include regulations and standards enforcement, legislative mandates, as well as private sector enticements, such as preferential permitting, access to markets, and concessional financing.
- Recovery and utilization of flared natural gas through finance of small modular electricity generation plants, truck-mounted, modular liquefied natural gas plants, integrated compressed natural gas systems and modular, remotely operated mini-gas-to-liquid plants.

Agriculture

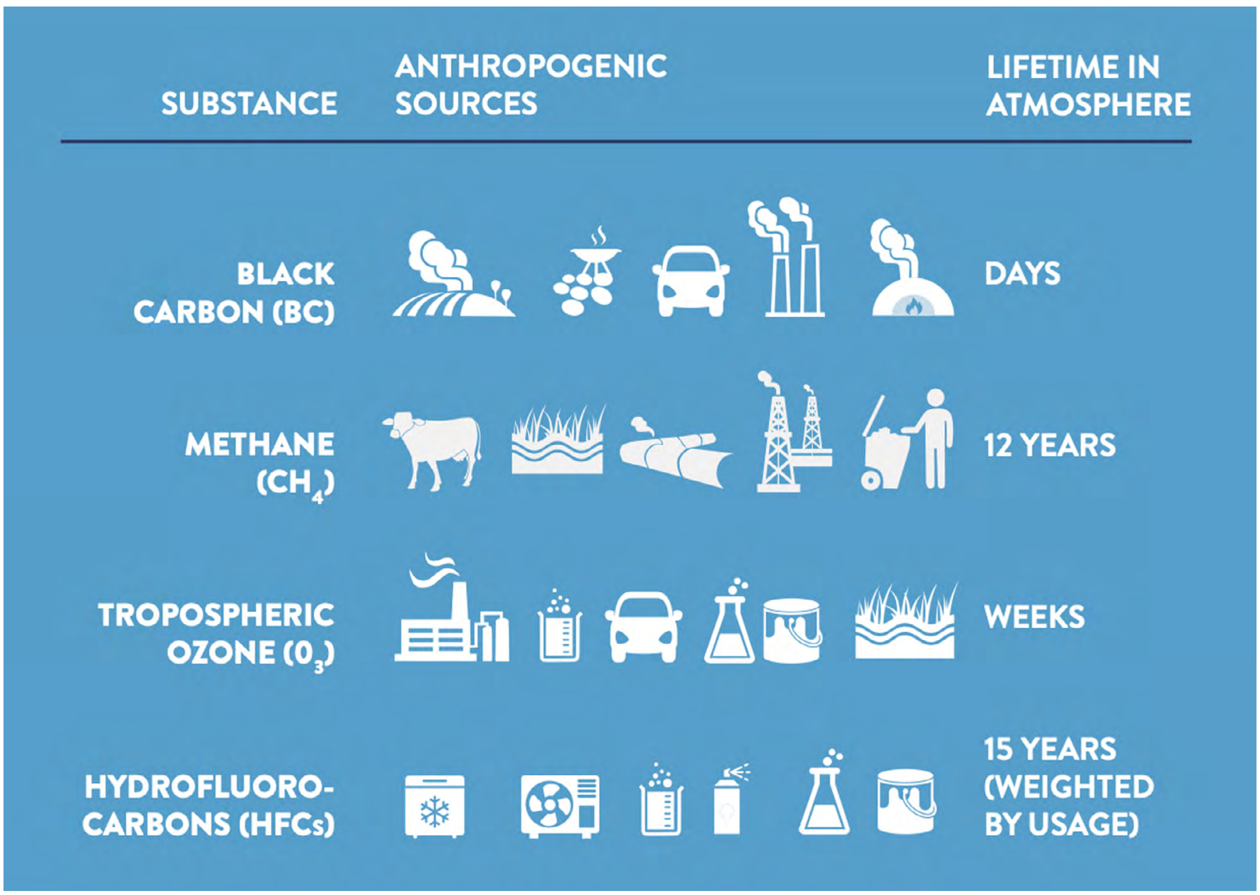
- Expand and enforce efforts to reduce open burning of crop residues through development of markets for crop waste or implement fire management practices to enhance combustion efficiency.

1. SLCPS REPRESENT A SIGNIFICANT OPPORTUNITY TO ACHIEVE FAST MITIGATION

1A. Short-Lived Climate Pollutants Provide "Fast Mitigation"

Short-lived Climate Pollutants, or SLCPs, are a form of air pollution that has a substantially shorter lifespan in the atmosphere compared to long-lived greenhouse gases (GHGs) like carbon dioxide (CO_2), yet they warm the planet significantly especially in the near-term. The Intergovernmental Panel on Climate Change (IPCC) found that the only possible scenario for limiting global warming to 1.5°C and avoiding catastrophic impacts of climate change requires reducing emissions of both CO_2 and SLCPs (IPCC 2018).[1] This report is designed to be an introductory resource for USAID staff on SLCP emission sources and solutions across USAID geographies (Box 1).

Figure 1. SLCP Pollutants (source: CCAC)



1 Not only have we failed to halt the growth of GHGs like CO_2, but recent efforts to decarbonize the energy sector and address air pollution have reduced sulfate aerosol (fine particulate) air pollution in some parts of the world. To date the warming impact of CO_2 is being offset by the reduction in cooling from co-emitted aerosols thereby quickening the pace of already dangerous global warming. Thus, while it is essential that we continue efforts to decarbonize as quickly as possible, the only way we can see immediate cooling impacts (e.g., to counter the reduction of sulfate aerosol) is through the fast cooling that can be achieved by eliminating SLCPs. This will slow warming immediately while carbon reductions - requiring transformational change - are phased in.

Box 1. Objectives for this guide

- Provide USAID staff with foundational understanding of short-lived climate pollutants (SLCPs) and their importance for global climate action and improved air quality
- Provide actionable guidance for USAID to make a measurable difference on reducing SLCP emissions over the next 8 years
- Understand key opportunities for incorporating methane and black carbon reductions into existing development programs (e.g. agriculture, land-use, health, energy, and waste/ sanitation)
- Support the tremendous ambition behind the Global Methane Pledge

SLCPs include methane (CH_4), black carbon (BC) and some of the shorter-lived hydrofluorocarbons (HFCs) (Figure 1). These pollutants have global warming potentials (GWPs) that are many times larger than carbon dioxide.[2] Pursuing a focus on pollutants with the strongest near-term warming potential (i.e., SLCPs) substantially reduces the health burden of air pollution (UNEP, 2011a,b; Anenberg et al., 2012) while reducing the risks of crossing the 1.5°C global temperature threshold (Shindell et al., 2012).

Box 2. Global Methane Pledge

The ***Global Methane Pledge*** was launched at COP 26 in November 2021 in Glasgow, Scotland by U.S. President Biden and E.U. President Von der Leyen on September 17 at the Major Economies Forum (MEF) meeting where they invited countries to support voluntary actions to contribute to a collective effort to reduce global methane emissions at least 30 percent from 2020 levels by 2030, which could eliminate over 0.2˚C warming by 2050. With over 100 countries on board, representing nearly 50% of global anthropogenic methane emissions and over two thirds of global GDP, we are well on our way to achieving the Pledge goal and preventing more than 8 gigatons of carbon dioxide equivalent emissions from reaching the atmosphere annually by 2030.

55 countries where USAID works have signed the Global Methane Pledge (see Annex A)

Source: Global Methane Pledge, https://www.globalmethanepledge.org.

2 The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO_2). The larger the GWP, the more that a given gas warms the Earth compared to CO_2 over that time period. CO_2, by definition, has a GWP of 1 (USEPA, 2022).

Methane is a very strong GHG and is among the six traditional pollutants considered as GHGs. Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices, land use and the decay of organic waste in landfills and wastewater. However, methane's shorter lifetime in the atmosphere (around 10-12 years) relative to carbon dioxide (CO_2 with a lifetime over 100 years) means that **eliminating methane emissions can cool the planet far more quickly than efforts to eliminate CO_2**. Reductions of both gases are absolutely needed to achieve climate stability. Methane is becoming increasingly important as it now is proliferating faster than any other time on record (UNEP and CCAC 2021). Relative to the temperature increase since pre-industrial times that can be attributed to CO_2 alone (roughly 1°C) methane accounts for an additional 28 percent of global warming (IPCC AR6, Ch.7, Fig. 7.7). Methane reductions will be critical for achieving USAID's 2030 climate goals and the goals of the Global Methane Pledge (UNEP and CCAC 2021), yet emissions continue to grow.

Reducing methane has the added advantage of reducing a common air pollutant, ozone. As methane breaks down, it contributes to the formation of ground-level ozone, which is also an SLCP and a main ingredient in urban smog (Seinfeld and Pandis, 2016). Ground-level ozone exposure can lead to increased risk of cardiovascular and respiratory mortality (American Lung Association, 2022). Also maternal exposure to ground-level ozone is associated with preterm birth and low birthweight (Rappazzo et al. 2021). Lastly, ground-level ozone has shown to adversely affect crop production in highly polluted regions.

Black carbon (BC) is a component of fine particulate matter or PM2.5, resulting from the incomplete combustion of fossil fuels and biomass (Bond et al., 2013). Globally, BC only represents about 10-15% of total PM2.5 mass, but it can be substantially higher from specific sources (e.g. diesel engine exhaust). Similar to methane, BC is a much stronger warming agent relative to CO_2, however its lifetime is typically less than two weeks. This means **efforts to reduce black carbon emissions can also cool the planet right away**. Like methane, reducing the BC component of PM2.5 would have large health benefits, since PM2.5 is the air pollutant responsible for the greatest burden of disease (more than six million premature deaths, six million premature births, and almost 3 million underweight babies in 2019, HEI 2021; Ghosh et al. 2021) and the greatest economic costs to society (World Bank 2021a).

Black carbon can warm the planet in several ways. It directly absorbs sunlight thereby warming the atmosphere far more efficiently than CO_2. Pound for pound BC warms about 460 to 1,500 times greater than CO_2, depending on where it is emitted and over what length of time considered (CCAC, 2022). When BC lands on snow or ice, it accelerates the melting of glaciers and reduces reflective snow cover (World Bank and ICCI, 2013), leading to a powerful source of warming in the Himalayas and the Arctic.

Several of the **Hydrofluorocarbon** (HFC) compounds introduced in recent years to replace ozone depleting substances have a unique characteristic of being highly warming, but also short-lived in the atmosphere. The result is that the **further phase out of these replacement compounds with other alternatives (that do not warm the atmosphere) can also yield fast cooling**. USAID should work to help its partners adopt the Kigali Amendment of the Montreal Protocol to address these compounds[3]. In particular, there is interest within the Quadrilateral Security Dialogue among the United States, Japan, India, and Australia (The Quad) to work cooperatively on reducing HFCs in the Indo-Pacific region.

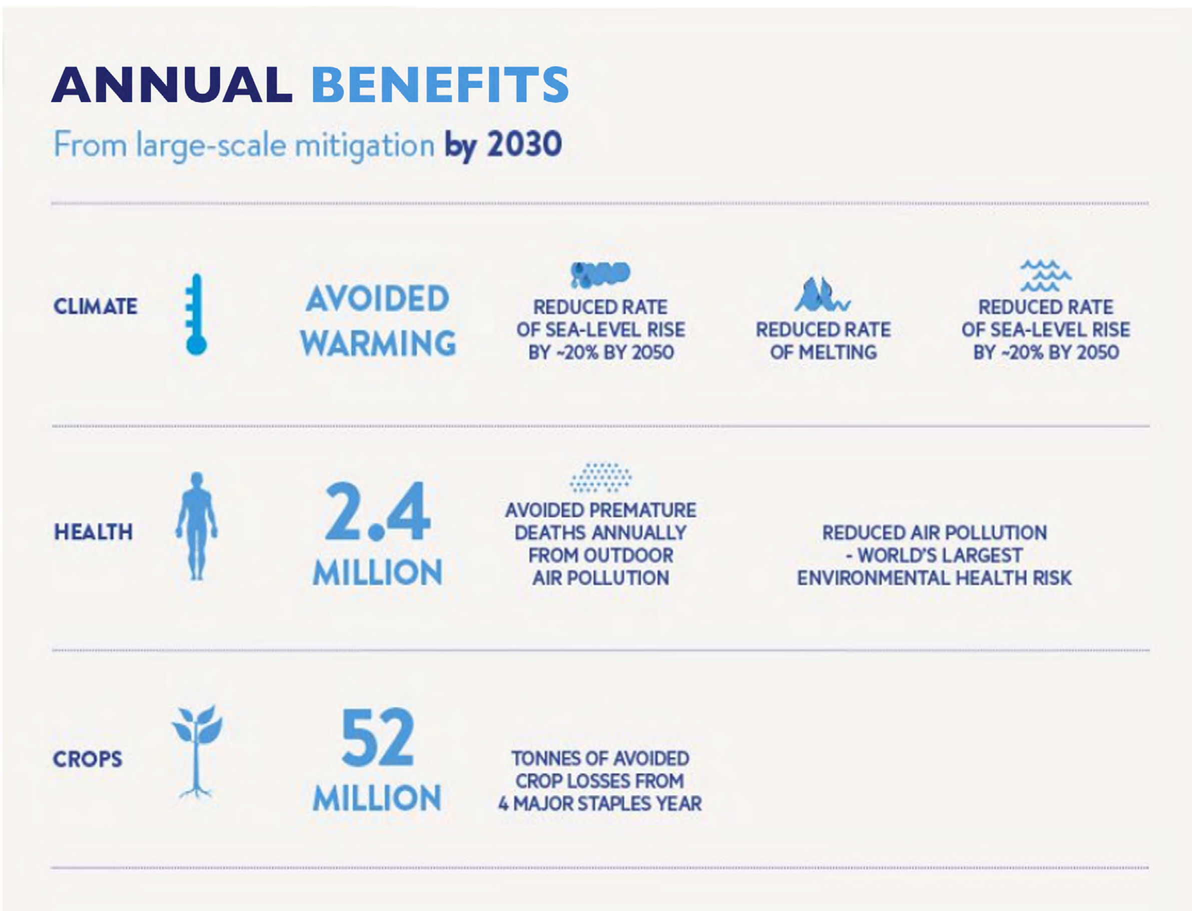
3 On October 15, 2016, with the United States' leadership, 197 countries adopted an amendment to phase down HFCs under the Montreal Protocol in Kigali, Rwanda. Under the amendment, countries committed to cut the production and consumption of HFCs by more than 80 percent over the next 30 years.

This guide focuses primarily on methane and black carbon due to their large cooling potential, the relevant opportunities within the USAID portfolio and the political feasibility of undertaking interventions. However, efforts to reduce ground-level ozone, or smog, as well as HFCs will also have important contributions to rapid cooling.

1B. Solutions have multiple benefits and advance development

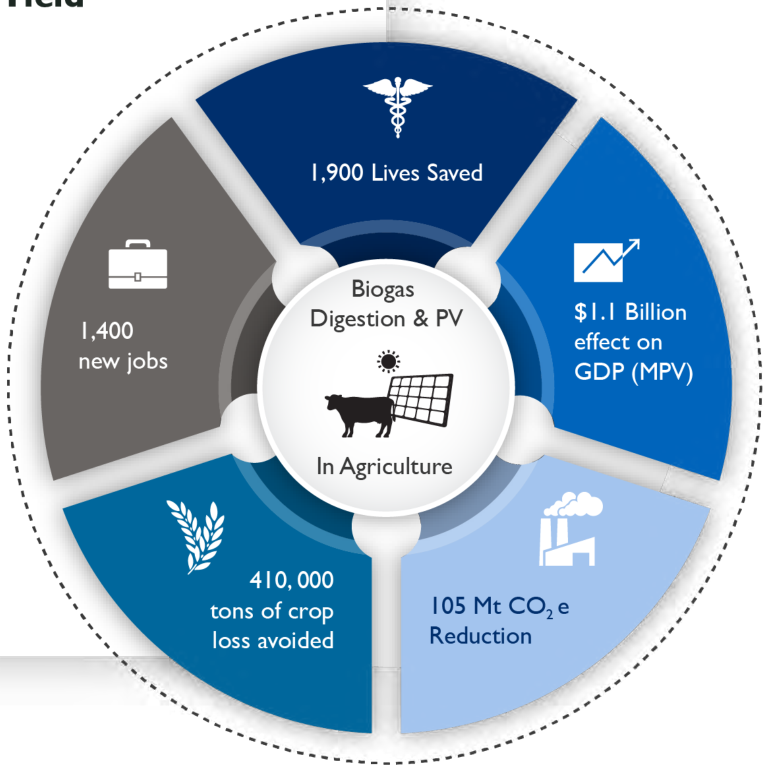
As mentioned, reducing SLCPs will have benefits for both public health through reduced air pollution as well as to provide near-term climate relief. However, the benefits of action don't stop there. Many of the interventions and policies that result in reduced emissions of SLCPs have other development benefits, such as enhancing biodiversity, energy security, food security and waste management and clean water, while potentially contributing to economic development.

Figure 2. Multiple Benefits of SLCP Emissions reduction (Source: CCAC)



Box 3. SLCP Reduction Measures Yield Multiple Development Benefits

In 2014, the World Bank assessed a scenario for co-funding pig and dairy farms across Mexico to add biodigesters to capture and reuse methane emissions from livestock waste and to add solar energy systems to service cooling demand at dairy farms. While the project would have stated development benefits of 424 Million (2010) USD, the report found a wide range of additional development benefits that are typical of SLCP reduction projects.



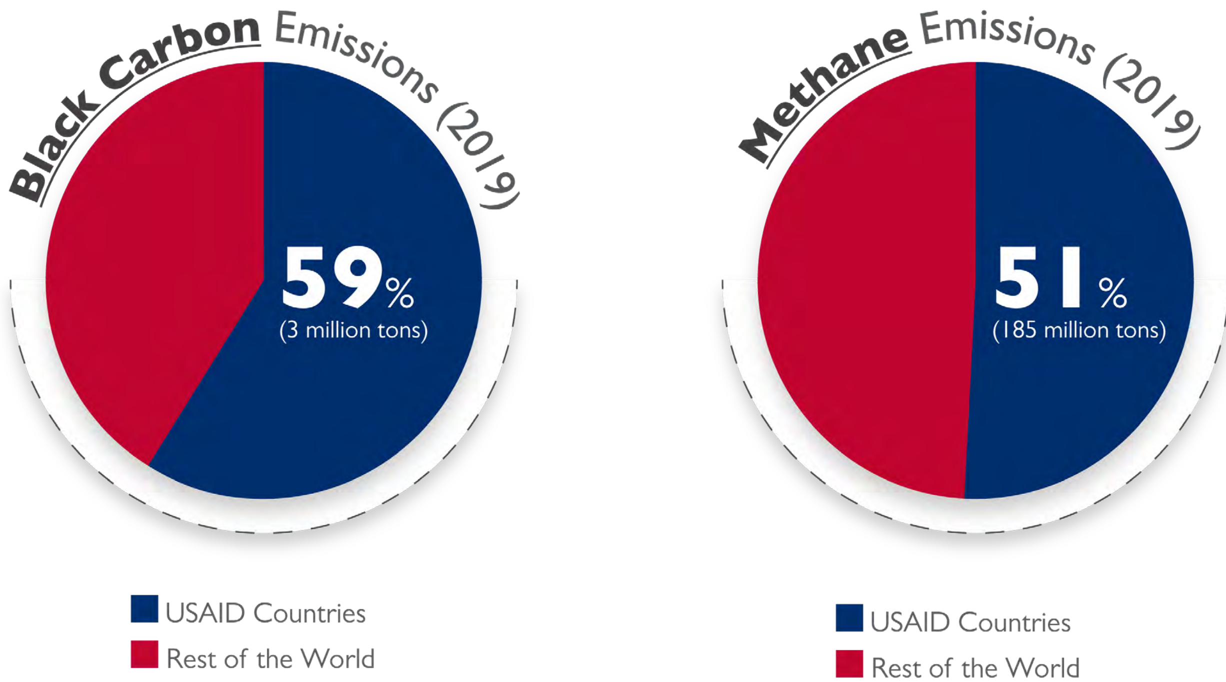
When economic cost-benefit analysis is broadened to consider the multiple impacts of SLCPs, we often find that benefits far outweigh the costs of the most common policies and interventions to reduce their emissions.

2. STRATEGIES WILL VARY BY SECTOR AND BY REGION

2A. Overview of potential

While emissions in any one country or sector may seem modest, when combined across USAID programs and USAID partner countries, the potential benefits are large. As Figure 3 (a and b) demonstrates, the fractional contribution of USAID country emissions of methane and BC relative to global totals are significant, representing 59 percent of global BC emissions and 51 percent of global methane emissions in 2019. Reducing methane emissions from USAID countries can substantially help USAID meet its Climate Strategy target (6 billion Mt CO_2e) while advancing the Global Methane Pledge.

Figure 3. Fractional contribution of global total (a) black carbon and (b) methane emitted by USAID countries. (Source: CEDS emission inventory)



2B. Existing commitments

Several countries have already recognized the multiple benefits of fast action on SLCPs and have either taken independent action or aligned SLCP policies and actions within their Nationally Determined Contributions (NDCs) under the Paris Agreement. A survey of countries' past or updated NDCs (see Annex A) demonstrates many USAID partners have acknowledged the importance of addressing these pollutants while seeking long-term decarbonization.

Table 1. Top emitting USAID countries for black carbon (BC), methane (CH_4) and carbon dioxide (CO_2) based on the CEDS global emission inventory (2019).

Top 10 Black Carbon Emissions	**Top 10** Methane Emissions	**Top 10** CO2 Emissions
India	India	India
Indonesia	Brazil	Indonesia
Nigeria	Indonesia	South Africa
Pakistan	Venezuela	Mexico
Brazil	Nigeria	Brazil
South Africa	Pakistan	Kazakhstan
Thailand	Mexico	Vietnam
Vietnam	Colombia	Thailand
Ethiopia	Vietnam	Egypt
Democratic Republic of Congo	Bangladesh	Pakistan

These data point to key sectors where commitments have been made and may represent opportunities where rapid progress can be achieved, such as in the transportation or waste management sector. In several of these countries, it may be possible to increase NDC ambition by focusing on solutions that meet development priorities (e.g. food security, solid waste management) while simultaneously reducing emissions of SLCPs.

While the overall emissions are large, the opportunities will vary by country and region. As Figure 4 and 5 show, there is scope to reduce methane and BC emissions in all regions. Disaggregating further shows that individual country and sector emissions will vary, but clearly the agriculture sector in Asia and Latin America, the oil and gas sector in the Middle East and waste and wastewater in most cities are ripe targets for methane abatement, whereas transportation emissions and open burning of waste are opportunities in almost all regions for BC. These opportunities are explored in greater detail in Section 2C.

Figure 4. Regional methane emissions USAID countries 2019. (Source: CEDS inventory)

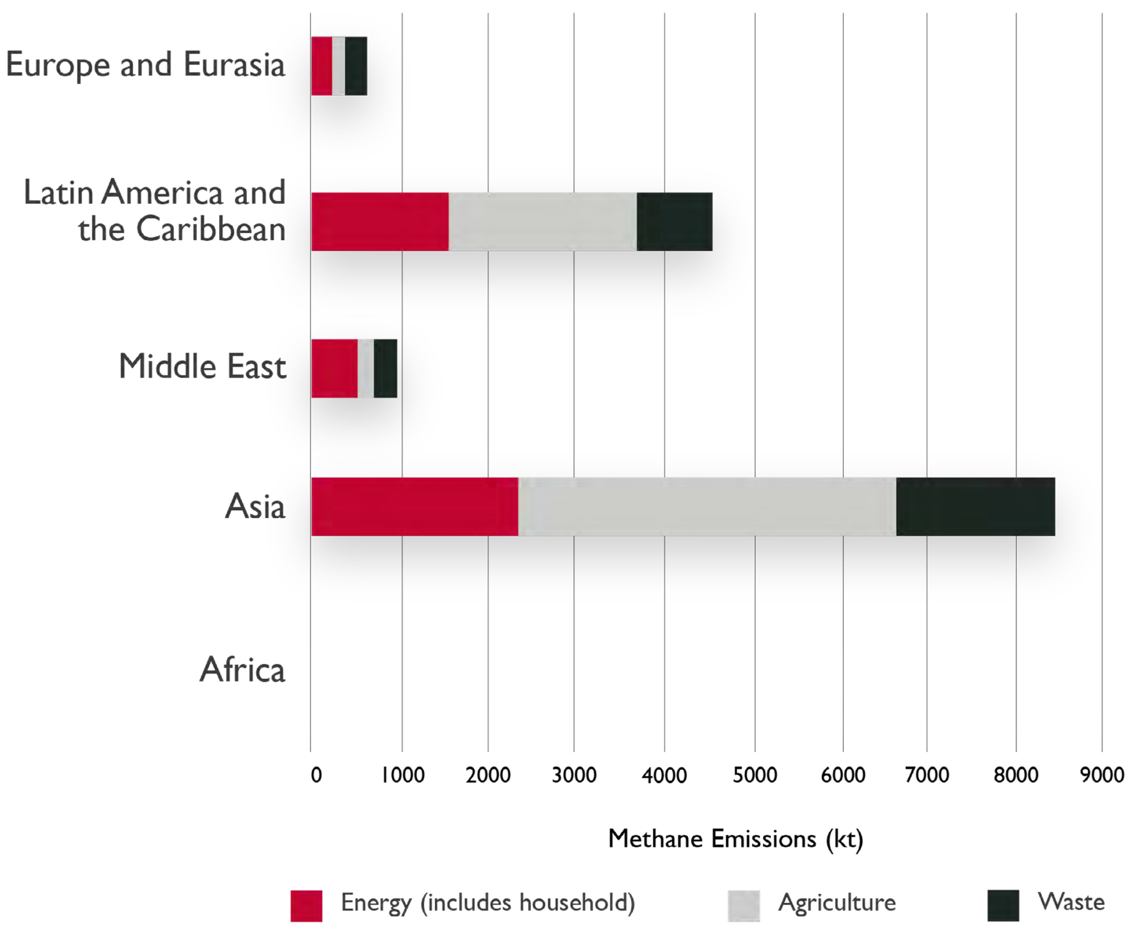
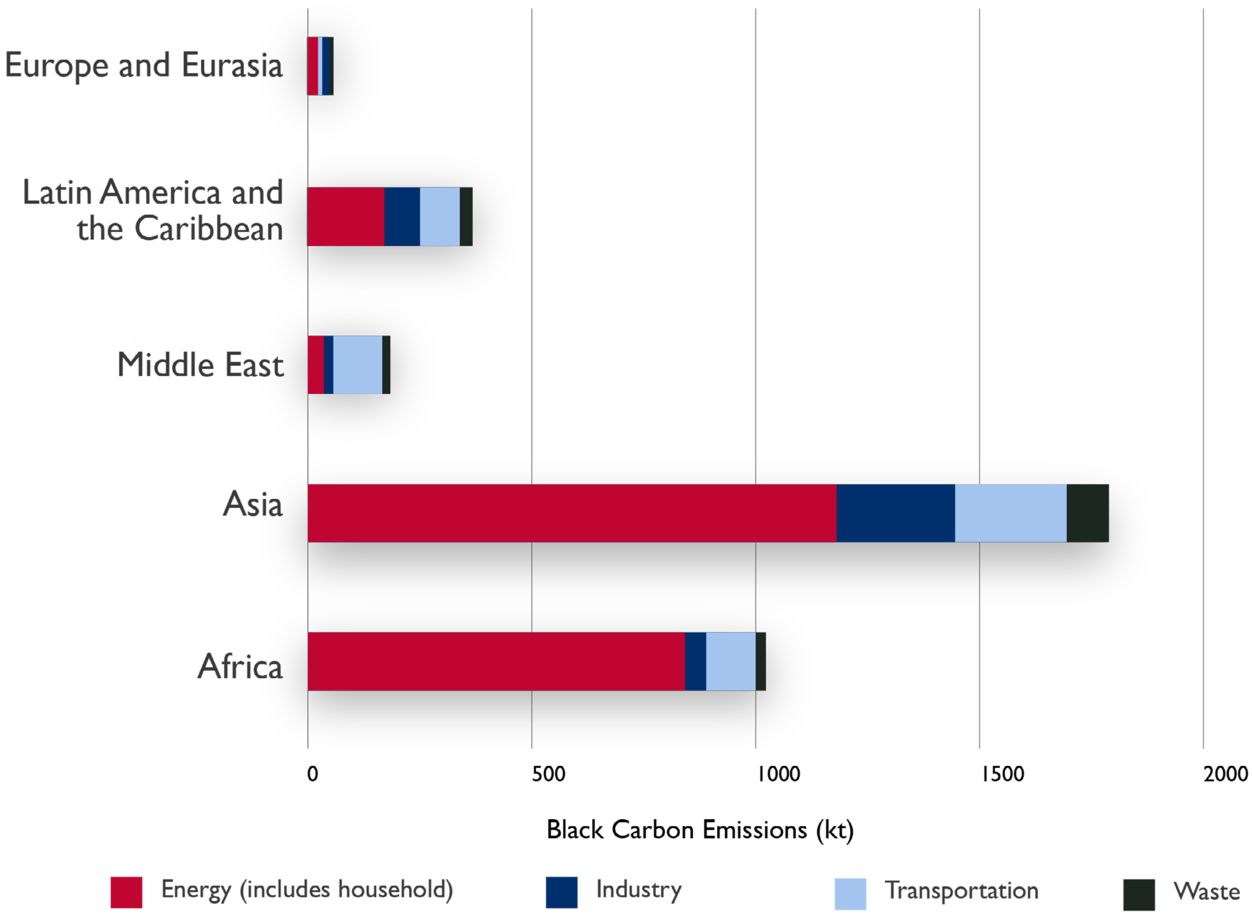


Figure 5. Regional black carbon emissions USAID countries 2019. (Source: CEDS inventory)



2C. Overview of opportunities

What are the abatement potentials within major sectors? What are the "quick win" opportunities for SLCPs (i.e., low cost and politically feasible)? Table 2 summarizes key sectors and actions where fast policy action will make a difference in reducing SLCPs. It is worth noting that efforts to reduce SLCPs – providing both rapid relief from global warming and health benefits through reduced air pollution[4] – span multiple sectors and are relevant to many low- and middle-income countries (LMICs) where USAID works.

4 The combined effects of ambient and household air pollution (including both fine particulate matter and ground-level ozone) lead to an estimated 7 million deaths each year (7.0 million according to the World Health Organization; 6.7 million according to the Global Burden of Disease project), including half a million infants in their first month of life (UNEP 2021).

Table 2. Overview of SLCP actions by sector, cost-effectiveness and feasibility.

Sector	Action	Cost-effectiveness	Favored regions
Methane			
Oil/gas/coal production	Recover/manage gas in coal mining	Medium	China
	Recover gas from oil/gas extraction (vented and fugitive gas)	Medium	Middle East, Africa, Central Asia
	Detect/repair upstream and downstream leaks	Medium-High	Middle East, Africa, Central Asia
Waste	Expand integrated solid waste management (+collection, separation)	Medium-High	All
	Enhance source separation w/ recycling, food waste composting	Medium-High	All
	Expand wastewater treatment/FSM	Medium	Cities
Agriculture	Animal nutrition, feeding and management practices and improved animal health coupled with governance mechanisms to prevent agricultural expansion into high carbon landscapes	High	Asia, Africa, Central Asia, small-holder LAC
	Livestock manure management	High	Soil amendment (Afr, Asia) biogas digestion (LAC, rope/Eurasia)
	Implement rice paddy water management	High	Asia, Africa, Central Asia, small-holder LAC
	Direct dry seeding for rice agriculture	High	Asia
	Improve post-harvest techniques and agriculture product preservation	High	Asia
	Reduce burning of crop residues	Medium	Possible for rice straw (Asia)
Food Systems	Reduce food loss & adoption of diets linked to low-emission food sources	Medium-Low	All
Black Carbon			
Transportation	Advance diesel engine standards/electrification and incentivize transition to low carbon public transportation services	High	11 major vehicle markets; LAC, Middle East
	Eliminate high emitting vehicles (I/M+scrappage)	High	Low-sulfur fuel + high emitters (LAC, Africa, Asia)
Waste	Expand collection and reduce trash burning with integrated solid waste management	Medium-High	All
Residential	Shift lump coal use to briquettes	Medium	China, Russia, Central Asia
	Improve sourcing of wood for pellet stoves	Medium	EU
	Improved cook stoves in LMICs	Medium	Asia, Africa, LAC
	Cleaner cooking, lighting and heating (LPG, biogas, induction cookers, solar lights)	Medium	Asia, Africa, LAC
Industry	Cleaner brick kilns	Medium-Low	South/East Asia, LAC
	Cleaner coke ovens	Medium-Low	China
	Eliminate gas flaring	Medium	Russia, Nigeria, Middle East
Agriculture	Reduce burning of crop residues	Medium	Africa, Asia
HFCs			
A/C, autos, industry	Replace with low-GWP alternatives for refrigerants, foams, medical aerosols, fire retardants and solvents	Medium	Globally, but especially Asia, Middle East

[Source: Authors descriptions adapted from UNEP 2011a,b and supplemented by McKinsey & Co. 2021, UNEP and CCAC 2021, USAID's Climate Change Agriculture and Food Security Program (https://ccafs.cgiar.org/research/projects/low-emissions-opportunities-usaid-agriculture-and-food-security-initiatives) and Bond et al. 2013]

METHANE

Oil, Gas and Coal Production

Underground mining accounts for more than approximately 85 percent of coal mine emissions, released primarily from ventilation, post-mining activities, degasification, and fugitive emissions from abandoned but vented mines. Put simply, the deeper the mine, the greater the amount of methane released (McKinsey 2021). Additionally, nearly 70 percent of this is from the thousands of abandoned mines in China, limiting the opportunity to achieve significant reductions from USAID countries. There are a variety of methods to capture methane that is released during (or after) the normal extraction of coal, gas and oil. The captured methane then can often be reused as a product for sale. For coal mines, ventilation and degasification of underground operational and abandoned coal mines can be more expensive because it requires further processing.

Research on fugitive emissions from oil and gas in Mexico found that the top two percent of sites were responsible for 20 percent of emissions — which could prove fruitful when targeting intervention (Yacovitch et al. 2020, Zavala-Araiza 2021). This work was validated using satellites to find that globally "ultra-emitters" are responsible for 12 percent of the emissions for the entire oil/gas sector (Lauvaux et al. 2022). The actions to abate these emissions include replacement of pumps, compressor seals, and other equipment to reduce process leakage. Operational changes can reduce venting of methane during routine extraction or during pipeline tests. Leak testing and repair of upstream and downstream equipment and pipelines can also save gas that can then be sold, recouping the cost.

Shifting energy to renewable sources and reducing overall energy demand is the ultimate aim since it reduces the demand for oil, gas and coal, thus enabling a transition away from fossil fuel extractive industries and their associated methane emissions.

Solid waste

Globally one third of all municipal solid waste is not managed in an environmentally safe manner (World Bank, 2018). The majority of this waste is organic material since every year, nearly a third of food is lost (i.e. prior to reaching consumers) or wasted (i.e. thrown away by consumers) globally (World Food Programme, 2020).The percentage of improper management of solid waste is far greater in LMICs who often rely on open dumping, such that 93% of waste is openly dumped in low-income countries (World Bank, 2018). Disposal of waste in open (surface) dumpsites often burns as a result of either spontaneous combustion due to discarded flammable materials or intentionally set fires to make space for more waste. This combustion is a source of CO_2 as well as small amounts of methane, but also a large source of fine-particulate air pollution (see discussion of BC emissions below). Methane is mainly generated from organic waste when it decays over time anaerobically (without access to oxygen), allowing methane-emitting bacteria to thrive. Accumulated waste creates the ideal conditions for anaerobic decay as older organic waste is buried. Therefore, most of the emissions today originate from waste produced several years ago (McKinsey 2021). The best practice for addressing emissions of air pollution, CO_2 and methane is to improve municipal waste collection services and source separation to divert organic waste from landfills through composting for fertilizer or specialized chemical conversion (biogas, chemical feedstock, etc). The next important practice is recycling and disposal of residual waste in sanitary landfills with landfill gas recovery and utilization. While not ideal, landfill gas flaring (emission as CO_2) is still better than venting landfill methane directly to the atmosphere. However, waste collection is typically expensive and straddles multiple government agencies thereby presenting cost and organizational barriers. In certain contexts, there may be opportunities to reduce the volume of organic municipal solid waste going into landfills and open dumps. This means reducing food and paper waste by changing individual behaviors (e.g. broad adoption of composting) and improving efficiency in supply chains (e.g. ensuring food does not rot in transit and reducing overstocking at supermarkets). USAID programming is centered on building the necessary enabling environment for municipal solid waste management and sustainable food systems, which will help reduce SLCP emissions and air pollution.

Wastewater/fecal sludge management

Methane can be produced from wastewater and fecal sludge over any part of the sanitation service chain: containment (fecal sludge only), transport, treatment, and final disposal. The most effective methane abatement approach is to reduce the time spent in containment, in combination with engaging either aerobic treatment or methane capture technologies. Access to safely managed sanitation results in an elimination of improper discharges of human waste into the environment through the formation of wastewater or Fecal Sludge Management (FSM) systems. In wastewater systems, methane abatement and resource recovery solutions are emerging through efforts to avoid costs associated with the transportation of biosolids, the tightening of environmental regulations, renewable energy qualifying credits, and technology improvements for low cost treatment methods. These include composting for fertilizers and the utilization of captured methane in combined heat and power (CHP) systems. An early example in Surat, India established a pilot program for biogas-based power plants at sewage treatment plants. Since the first pilot in the early 2000s, the government has been exploring expansion to five other sewage treatment plants under municipal control. While there are large global abatement opportunities in wastewater, there may be fewer opportunities in countries where USAID has active WASH programs. In FSM, which is the majority of USAID's sanitation programming, the focus should be on improving on-site containment as well as the frequency and quality of collection services while researching effective abatement measures for treatment facilities. As the body of knowledge and evidence for methane abatement processes in FSM grows, a trend of resource recovery, similar to that of wastewater, may emerge. In both FSM and wastewater systems, biogas and biosolids recovery from treatment plants can help reduce methane emissions. However, methane abatement infrastructure adds complexity and its sustainability depends on having an enabling environment that few high priority WASH countries currently possess, which includes a high level of technical capacity at the municipal level and sufficent markets for recovered resources.

Agriculture

The agricultural sector is the largest single emitter of methane globally, and ruminant animals contribute to more than half of the sector total. Beef cattle, buffalo, goats, sheep and other animals in this category have a multi-chamber stomach that enables bacteria to break down complex carbohydrates into simple sugars. The end products of enteric fermentation by bacteria include chemicals processed by the animal for energy as well as waste gases, such as carbon dioxide and methane. The amount of methane that animals emit can be controlled by feed processing to increase digestibility and operational changes to adjust the quality and quantity of feed. Certain additives can alter the chemistry of the fermentation process and block methane production in the rumen (Hegarty et al. 2021). This is an area of active research, including efforts to modify the rumen microbiome. Genetic selection and breeding of livestock can also play a role, but these actions are much more expensive than simple grain processing techniques and health monitoring of livestock.

Emissions intensity, the amount of GHG emitted per unit of output, is also a critical consideration when addressing enteric methane, particularly in lower productivity systems typical of USAID operating environments. Improvements in livestock productivity, through improved ration formulation, improved animal health, and animal management can significantly reduce emissions intensity. Furthermore, feeding interventions that specifically target direct reductions in enteric methane can reduce emissions intensity. Improving emissions intensity can provide co-benefits of improved availability of nutritious animal source foods and improved farmer revenues. Measures to improve productivity are often cost neutral or cost negative. Improved productivity is already driving down emissions intensity in USAID field programs by an estimated 30-40% (Climatelinks) as well as delivering substantial co-benefits in terms of livelihoods, nutrition, and resiliency. The primary aim for climate change mitigation, however, is reducing absolute GHG emissions, thus indirect GHG emissions from increased feed production and consumption should be considered.

Not all methane results from the digestion process and smaller quantities (approximately 10%) of methane remain in the manure that livestock produce. While capital intensive, the anaerobic digestion of collected manure to produce biogas creates a feedstock fuel for producing electricity and has been used on-farm to satisfy energy demands or sold back to energy grids. Alternatively, the manure can be used in regenerative agriculture to improve the health of soils and carbon storage.

Livestock expansion in many geographies is the principal driver of deforestation and forest degradation to create land for growing feed and grazing lands. Deforestation, in turn, is a major driver of carbon emissions and biodiversity loss. Where land clearing involves burning, incomplete combustion can also result in methane emissions. Increasing the productivity of livestock (as well as other agricultural commodities) theoretically reduces the amount of land needed, it also increases profitability, creating intense pressure to expand production and clear forests. Programs that improve productivity of ruminant livestock need to be coupled tightly with, or explicitly include, work that protects forests from encroachment or degradation ("produce and protect"). There is a strong need to address these challenges in tandem, taking a systems-level view that includes the imperatives to reduce methane emissions, protect high-carbon forests, and address food insecurity and poverty. To have meaningful climate change mitigation benefits, USAID programs that increase livestock productivity need to include or be tightly linked to activities that avoid agriculture-driven deforestation. For elaboration, see Agriculture's Footprint: Designing Investment in Agricultural Landscapes to Mitigate Tropical Forest Impacts.

There are sustainable livestock production systems that maintain and restore landscapes, ecosystems, and biodiversity while reversing land degradation. This includes silvopastoral systems and extensive pastoral and grassland production systems, which can increase soil carbon capture, maintain natural vegetation and promote reforestation where agroecologically appropriate while improving livelihoods. USAID needs to promote sustainable, low emission livestock systems and ensure there are effective policy and governance structures in place to incentivise sustainable approaches, prevent encroachment, and protect the environment.

Rice production is another important source of methane due to the long-established farming practices using flooded rice paddies. Methane can be reduced from rice paddies by applying new fertilization and water-management techniques, planting seeds directly in dry soil instead of transplanting young crops into flooded fields, and using aerobic rice varieties that can be grown without flooding and are more drought tolerant. The application of these options require careful water and nutrient management. A useful resource is the System of Rice Intensification , which takes into account plant, soil, and water management to increase productivity and reduce methane emissions.

USAID has funded assessments of GHG footprints of a number of USAID supported agricultural value chain investments, together with the development of analysis and tools to guide the identification of the most cost-beneficial GHG mitigation options in the agriculture sector (ClimateLinks).

Food Systems

Food loss and waste (FLW) also exacerbates the climate change crisis with its significant GHG footprint. According to the World Resources Institute, reducing FLW by 25 percent by 2050 would close the food gap by 12 percent, the land gap by 27 percent and the GHG mitigation gap by 15 percent. Reducing FLW is included in the USAID Climate Strategy and the U.S. Government Global Food Security Strategy (2022-2026). Key actions for reducing FLW are: supporting field processing, cold chain establishment, improved storage solutions (e.g. hermetic storage), applying circular economy principles, and scaling up digital technologies, and targeting consumers behavior change toward food purchase, preparation and consumption. Actions to reduce FLW should target supply chains that have high GHG emissions, such as ruminant dairy and beef.

Given the distributed nature of agriculture production and the length of the value chain, it is likely easier to target interventions towards upstream and midstream stakeholders, including distributors, seed cultivators, animal feed suppliers, animal health service providers and cattle breeders. It is easier to incentivize change among these few, large groups than among the millions of smaller or subsistence farming operations.

BLACK CARBON

Transportation

The black carbon actions with the greatest benefit for climate are diesel engine controls. This is because diesel exhaust contains higher levels of black carbon than those from other sources. Addressing diesel exhaust will have high public health benefits because most diesel exhaust is concentrated in urban settings where the greatest human exposure occurs. The technology is available with modern diesel particulate filters costing between USD 5,000-17,000, a small fraction of the cost of a new heavy-duty vehicle. Retrofitting old vehicles is considerably more expensive, so the best approach has been to encourage national governments to adopt more progressive standards that include diesel particulate filters and other modern pollution controls. This also requires availability of low-sulfur fuel since sulfur damages the catalysts used in the diesel particulate filters. However, low-sulfur fuel can be problematic in many developing countries, so complementary investment in refinery capacity is needed to make this work. Once in place, accelerated retirement and incentives for fleet turnovers can speed up the reduction of black carbon from the transportation fleet. While emission standards are technology neutral, client governments will have options between clean diesel engines, compressed natural gas vehicles or - increasingly - electric vehicles, depending on local context and access to various clean fuel choices. Consideration should also be given to the non-road diesel engines including diesel generators for backup power, marine ports, airport ground equipment, rail engines and construction equipment.

A significant contribution of overall diesel engine emissions come from poorly functioning vehicles with very high emissions called “high-emitters” or “super-emitters” (Bond et al, 2013). Klimont et al. have defined these vehicles as emitting 3 to 10 times the emissions of normal fleet vehicles. The fraction of vehicles meeting this category has been estimated at 10 percent in China, 15 percent in India and 20 percent for other Asian, African and Latin American countries (Klimont et al. 2017). To address these vehicles, scrappage programs are needed to accelerate fleet turnover, but replacements with diesel particulate filters will only be feasible in areas with low sulfur fuel. Concessional and results-based finance programs have been proposed to enable fleet vehicles to be upgraded, with hand-me downs to replace scrapped high-emitters (either retrofitted or at least cleaner than what they replace) (BCFSG 2015). While this is a win-win program, it would also incur program costs to monitor vehicle scrappage and incentivize maintenance of retrofitted vehicles since these issues can limit the reductions and reduce program effectiveness.

Waste

From generation, transportation and final disposal, solid waste management is associated with air pollution exposure that can increase the probability of adverse birth outcomes, specific cancers and respiratory diseases – particularly for people directly or indirectly involved in waste management or who live near waste sites (WHO 2021). Integrated solid waste management, that starts with enhanced collection - as an alternative to open burning - but also pays attention to the factors discussed above in the methane section, is key to reducing black carbon from open burning in urban centers that lack modern waste services.

Residential Biomass Combustion

Exposure to household air pollution – caused by the in- or near-home burning of solid fuels, such as wood, cow dung and crop residues – has been causally linked to a number of negative health outcomes and leads to approximately 2.3 million deaths each year (HEI 2021).   Household cooking and heating is also responsible for more than half of the black carbon emitted globally. In this context, access to cleaner methods of cooking and lighting is crucial.   Thought and care should be given to replacement fuels and technologies - especially those that include fossil fuel options.

However, the complexity does not end with fuel and technology choice. To truly address energy access, there is growing consensus among practitioners that the definition and measurement of access to clean fuels should reflect a continuum of improvement. The continuum should focus not only on fuels, but also on the influence of the cookstove users' experience and contextual factors, such as convenience, affordability, safety, fuel availability, exposure, and efficiency (ESMAP 2020). Using this more comprehensive definition of household energy access and cooking solutions, they find that only 10 percent of households in sub-Saharan Africa meet this standard.[5] While the history of clean cookstove programs is mixed, the evidence suggests that those that consider all six factors are having greater success than those addressing only cost and environmental performance (Bond et al. 2013).

Other opportunities to address residential coal combustion include switching from lump coal to briquettes, which emit lower levels of BC or fuel switching to well-controlled natural gas in Eastern Europe and Central Asia, and improved sourcing of biomass for pellets used in Northern Europe.

Industry

Brick is one of the major building materials in Asia. After China, which produces more than one trillion bricks per year, South Asia is the second largest brick producing-region in the world, producing 310 billion

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5 The World Bank's ESMAP defines access to modern energy cooking services (MECS) as a household context that has met the standards of 'Tier 4' or higher across all six measurement attributes of the Multi-Tier Framework: convenience, (fuel) availability (a proxy for reliability), safety, affordability, efficiency, and exposure (a proxy for health related to exposure to pollutants from cooking activities).

bricks annually. Combined, these countries contribute 88 percent of the global supply (Eil et al. 2020, Figure 1.1). Improving the efficiency of brick kilns could be key to managing BC throughout the region and reducing air pollution. One way to reduce the pollution involves shifting from relatively energy-intensive fixed chimney kilns to more efficient zig-zag, vertical shaft brick and tunnel kilns. Again, barriers are mostly due to longstanding practices based on fixed chimney kilns. These alternatives usually require complete replacement of the installation with more modern technology, thus requiring large capital outlays (at least USD 25,000) for a more energy efficient technology.

Coke production for steel and flaring in the oil and gas industry are other key sources of black carbon. However, coke production is not as major a source within USAID countries and flaring is a poorly understood source both in terms of activity and emissions. This source (flaring from the oil/gas sector) has been estimated at nearly four percent of the anthropogenic BC emissions total with the majority originating in Russia, Nigeria, and the Middle East (Bond et al. 2013).

Agriculture

The largest open burning emissions occur in Africa, Latin America, and Southeast Asia. Often agricultural residues are burned to clear cropland for re-planting. Burn management approaches, including drying and stacking can result in improved, more complete combustion, which reduces black carbon (from incomplete combustion) and methane emissions (from anoxic combustion, common in smoldering fires). Residue management can include re-use of residues through co-firing, processing as a fuel source, processing as an animal feed source, or use as a soil amendment to increase carbon storage.

2D. Regional Opportunities

Not all of the opportunities presented in the previous section will be applicable to every region. Each USAID mission may have unique circumstances that dictate which opportunities for reducing SLCP emissions will be most appropriate. The regional guidance provided below is intended as a starting point for missions and operating units to explore promising programming opportunities. The Climate and Clean Air Coalition, under UNEP leadership, has already undertaken a number of regional assessments that explore the SLCP reduction actions that are most appropriate in the African, Latin American and Asian contexts and has individual country pages that may yield additional insights.

AFRICA

Assessment of SLCP opportunities in Africa has been looked at within Nigeria's National Action Plan, which results in a 22 percent reduction in $PM_{2.5}$ by 2030 and Cote d'Ivoire's reduces $PM_{2.5}$ by 52 percent by 2030 while achieving more than half of their stated NDC ambition. A major assessment by the CCAC of SLCP opportunities in Africa is currently underway and other SLCP national action planning is happening in Ghana, Central African Republic and Kenya.

Key methane measures for Africa include:

- Improve health/husbandry of ruminant animals
- Expand integrated solid waste management
- Recover gas from oil/gas extraction

Key BC measures for Africa include:

- Eliminate high emitting vehicles
- Cleaner cooking and lighting
- Reduce burning of crop residues
- Expand integrated solid waste management

Source: CCAC forthcoming, McKinsey & Co. 2021, Bond et al 2013

Methane

Ruminant animals/Manure management/Regenerative agriculture - Improving animal health, strengthening disease control systems, improving pasture and rangeland management, improving the nutritional quality of feed, and grain processing are cost effective ways to reduce enteric fermentation (McKinsey 2021). In Africa, this will require programs that can engage many small-holder farmers, strengthening accessible public and private sector animal health and agricultural advisory services and training programs in herd health and animal nutrition. Anaerobic manure bio-digesters are capital intensive upfront and present a challenge to finance in sub-Saharan Africa (though a less expensive action when capitalized over equipment lifetimes). Use of manure as a soil amendment may be a more practical manure management strategy that also improves soil health and enhances soil carbon storage. To have meaningful climate change mitigation benefits, USAID programs that increase livestock productivity need to include or be tightly linked to activities that avoid agriculture-driven deforestation (see Section 2C).

Integrated solid waste management - Sanitary landfill capacity in Africa is limited. Kaza et al. (2018) point out that nearly 70 percent of African waste is disposed of in open dumps. As a result, several African cities have found solid waste contributes a very high fraction (e.g., 25-44 percent) of total GHG emissions (C40 2022). Working with municipal officials to improve solid waste collection (followed by source separation and treatment) while financing new landfills via public-private partnerships has proven an effective way for municipal governments to overcome the financial barriers to developing new infrastructure (see health-sector specific example in Uganda). Some countries (e.g. South Africa) have set future targets for zero waste to landfills, thus a "circular economy" approach may be preferred compared to new landfill infrastructure.

Wastewater/Fecal Sludge Management (FSM) - Expanding municipal and state capacity for urban fecal sludge and wastewater treatment systems. Improved household containment, and frequent use of improved collection systems for fecal sludge management are both important next steps towards methane abatement in the sector.

Oil and gas methane recovery - Oil and gas extraction are growing sources of income for many African countries, yet modern industry standards that prevent venting and flaring of natural gas (mostly methane) at extraction sites have not kept pace with industrial growth. For example, in Nigeria flaring occurs at oil and gas production facilities, gas processing facilities, liquified natural gas (LNG) and gas-to-liquids (GTL) plants as well as refineries. Nigeria alone accounts for nearly 24% of all energy sector-related methane emissions in sub-Saharan Africa. USAID/Power Africa supports the Nigerian Government's Nigeria Gas Flare Commercialization Program (NGFCP), which led to the development of a legal framework for Nigeria on gas flaring and GHG emissions reductions. Through USAID/Power Africa's support, the Government of Nigeria is in the process of issuing tenders to private oil and gas companies to capture and commercialize the flared and vented gas for productive uses, including for power generation, industrial application, clean cooking, and transportation. Apart from direct flaring, there are many oil tank farms in Nigeria, which emit methane due to lack of modern controls. This represents a high abatement potential with prospects for increased revenue (GoN, 2019). USAID could expand technical advisory support to upstream gas and oil companies and utilities in sub-Saharan Africa countries via Power Africa's existing regional energy implementing mechanisms.

Black Carbon

Eliminate high emitting vehicles - The West African adoption of the ECOWAS Clean Fuels and Vehicles Directive in January 2021 may provide an opportunity to advance both economy-wide efficiency and emissions standards as well as targeted scrappage schemes. Low-sulfur fuel is also available in portions of West Africa (i.e. Kenya, Tanzania, Mozambique). USAID has funded programs to advance electric vehicles in Africa, such as Ampersand in Rwanda and Zembo in Uganda to convert petrol boda-bodas to electric motorcycles.

Cleaner cooking and lighting - In Africa, 287,000 children under age five die each year from household air pollution (UNICEF 2016). While many lessons have been learned from past studies on the other factors that play a role in the success of clean cooking interventions (i.e. consumer preference/convenience, cultural factors, access/affordability of alternatives), this work has also demonstrated just how many barriers remain to achieve significant progress in this sector. More success has been found in Africa with cooking and lighting programs that replace kerosene wick lamps with solar lights and electric cookers that use pay-as-you-go microfinance schemes with e-payments based on remote monitoring of usage via cell phone networks (M-Kopa, Global LEAP RBF). USAID has funded programs to test and scale solutions for the coordinated delivery of solar home systems (SHS) and LPG cooking solutions to off-grid households and businesses in sub-Saharan Africa.

Crop residue management - National action plans for Nigeria, Ghana and Cote d'Ivoire all include actions to reduce agricultural burning, but tend to have low priority within overall SLCP action plans. Changing long-held agricultural practices are likely to take sustained coordination, enforcement and effort that will extend beyond 2030. However, the benefits for regenerating soil carbon, improving food security, and air quality benefits may make this effort worth pursuing (CCAC 2022a).

Solid Waste Open burning management - Where integrated solid waste management solutions as described above have been implemented, strict regulation on open burning of municipal waste should be implemented with support through green cities programs.

Reduce emissions from Brick Kilns - While there are Brick Kiln opportunities in Africa as in Asia (see below) these efforts have not gained sufficient traction, perhaps because their contribution to local air pollution is not as significant as in the Asian context.

ASIA

UNEP and the CCAC (2018) identified 25 policy actions that can significantly clean the air, while also affording major overall reductions in GHGs and SLCPs in Asia. By implementing these actions, the region can decrease expected warming by a third of a degree Celsius by 2050.This would also mean around one billion people could enjoy better air quality by 2030. It would also reduce estimated ozone-induced crop losses considerably – by 45 percent for maize, rice, soy and wheat combined. These actions will slow the melting of glaciers and snowfields, and help mitigate water insecurity for billions of people (UNEP and CCAC 2018).

Key methane measures for Asia include:

- Implement rice paddy water management
- Improve health/husbandry of ruminant animals
- Expand integrated solid waste management
- Expand wastewater treatment/FSM

Key BC measures for Asia include:

- Cleaner cooking and heating
- Cleaner Brick Kilns
- Advance diesel engine standards
- Reduce burning of crop residues

Source: CCAC 2018, McKinsey & Co. 2021, Bond et al. 2013

Methane

Coal - Outside of China, which is responsible for 70 percent of coal mine methane emissions (and the US another 6 percent), there is limited opportunity to reduce emissions from coal mining, however a way to reduce coal emissions entirely is to pursue renewable energy and energy efficiency projects in order to reduce demand, and transition off of coal as quickly as possible.

Rice paddy water management - Asia is unique in the opportunities to address rice paddy water management. Changing rice growing practices faces the challenge of a fragmented sector with many small agricultural producers, but successful examples in Japan and China, where mid-season drainage has resulted in increased yield can be used for awareness raising. Other options, such as incentivizing and aiding growers or producers to improve fertilizer management and consider alternatives (e.g sulfate fertilizers or manure amendment) as well as different varieties of rice which reduce methane emissions. Financing schemes can help growers to buy dry rice planters and have been combined with other elements in a program, resulting in increased food security and reduced methane (UNEP and CCAC 2018). The System of Rice Intensification, which takes into account plant, soil, and water management to increase rice productivity, helps to reduce methane emissions. USAID is also supporting the International Rice Research Institute (IRRI) in the development of rice varieties suitable for dry direct seeding as a means to mitigate GHG emissions.

Ruminant animals/Manure management/Regenerative agriculture - As in Africa, improving animal health, strengthening disease control systems monitoring, improving pasture and rangeland management, improving the nutritional quality of feed, and grain processing are cost effective, inexpensive ways to reduce enteric fermentation (McKinsey 2021). This will require programs that can engage many small-holder farmers to strengthen accessible public and private sector animal health and agricultural advisory services, provide training programs in herd health and animal nutrition, and support animal feed systems. Anaerobic manure bio-digesters are capital intensive upfront and present a challenge to finance in low-income Asia (though a less expensive action when capitalized over equipment lifetimes). Use of manure as a soil amendment may be a more practical manure management strategy that also improves soil health and enhances soil carbon storage. To have meaningful climate change mitigation benefits, USAID programs that increase livestock productivity need to include or be tightly linked to activities that avoid agriculture-driven deforestation (see Section 2C).

Waste management - As with Africa, municipalities in Asia offer an opportunity to address landfill methane by pursuing integrated solid waste management. Program funds for plastic management (i.e. solid waste management) can help reduce methane and plastic pollution simultaneously. For instance, USAID is providing grants and technical assistance for promising solid waste management and waste recycling efforts in urban and peri-urban areas in Asia. Increasing wastewater treatment through central systems with secondary treatment with proper maintenance and methane recovery or well-sealed FSM household systems is also an opportunity throughout Asia. USAID is supporting city wide sanitation planning processes with local governments to address fecal sludge management in Nepal.

Black Carbon Opportunities

Clean cooking and heating - Northern Asia (e.g. Mongolia) and high altitude countries (e.g. Nepal) offer opportunities to combine cleaner cooking and heating options. World Bank experience in Indonesia has shown that careful planning (via extensive stocktaking exercises), strict standards (stoves meet international testing and certification standards), and knowledge exchange (via community engagement events and long-term collaborations) are critical elements of successful interventions (Zhang and Adams 2016). Additionally, results-based finance can mobilize private sector participation and lead to scale up (Zhang and Adams 2015).

A regional program for South Asia could build on India's progress with liquefied petroleum gas (LPG) subsidies, bottle gas distribution and national economic reforms, which have expanded access by making safe, affordable, efficient stoves available and convenient. Formal access to LPG has doubled both consumption of LPG over the last decade and doubled the number of connections. India historically subsidized the cost of household LPG, but recently India capped the total volume of LPG qualifying for the subsidy, changed the eligibility criteria to add income-based exclusions (along with voluntary programs) to help target subsidies where most needed, and changed the level of subsidy. This has resulted in more targeted use of subsidized LPG to expand clean cooking access, but more work is needed to further target the available resources to the poorest and those who still use solid biomass. Nevertheless, as with other clean cooking efforts, this is not considered low-hanging fruit.

Cleaner Brick Kilns - Sector-wide solutions to the brick industry transition to cleaner and efficient technologies require government support. Government support can and must take many forms to be effective: regulations and standards (including prevention of burning of tires, plastic and other waste in kilns), enforcement, legislative mandates, and other enticements (e.g. preferential permitting, access to markets, and concessional financing). In particular, access to land, accessible and reasonably low-cost debt, and internalization of social and environmental costs in government policy are important considerations for the success of a brick sector transition. Given the concentrated number of brick kilns across the Himalayan step/Indo-Gangetic Plain region, there is significant scope for action in this sector.

Diesel Engines - New vehicles should be equipped with diesel particulate filters that meet strict emissions standards (e.g., Euro 6/VI). This requires sufficient regional supply of ultra-low-sulfur diesel (ULSD). However refinery investment/upgrades or importation are key to the availability of ULSD, but they can be expensive. South and East Asia now have several countries that require 50ppm or below sulfur content. Other programs targeting the existing fleet and addressing transportation demand can also provide significant benefits. Such programs include vehicle scrappage and replacement, inspection and maintenance, and vehicle retrofitting. For example, the Nepal government has recently introduced tax rebates for electric vehicles and exempted EVs from road taxes. Complementary policies to limit growth in travel demand and long-term growth in emissions, include fuel taxation, congestion charging, and logistics management. The CCAC Global Green Freight Action Plan and the Global Strategy to Introduce Low Sulfur Fuels and Cleaner Diesel Vehicles can support the region in designing strategies to reduce BC emissions from the existing fleets. In particular, diesel engines for freight associated with shipping/ports deserve attention as part of the overall 'moving goods and people' equation in Asia.

Diesel generators are increasingly used for backup power in South Asia, leading to significant impacts on air pollution locally. Thus, rigorous standards for generator sets, stabilizing power grids or deployment of hybrid-renewable backup energy supply is a critical action for many Asian cities.

Crop residue management - In the Asian context, introducing or expanding off-site uses for crop residues (instead of burning in the field) have also worked to provide win-win solutions that reduce methane and black carbon. Some examples include: co-firing to displace coal, production of biogas for household fuel or electricity generation, growing mushrooms, brick production or use as silage or animal bedding. CCAC's pilot projects in India have met with mixed results given the narrow window - approximately 20 days - between the harvesting and sowing of rice crops and the long-held traditional practice and relative ease of clearing fields for planting through burning (CCAC 2022b). In a rice-wheat cropping system in India, research results show that crop residue retention on the soil surface with zero tillage is beneficial for the sustainability and productivity of crops (https://doi.org/10.1080/00380768.2019.1683890).

Farmer awareness camps, creating 'no-burn' ambassadors and presenting awards for good practice have succeeded in raising awareness, but reductions have not yet been documented.

LATIN AMERICA & CARIBBEAN (LAC)

Methane

Finance farm-scale anaerobic digestion - The Clean Development Mechanism has created a strong incentive for biogas digesters (mainly for pork because of the more concentrated feedlots) where national governments (e.g., Brazil, Mexico, Chile, and Costa Rica) concerned with health/hygiene issues have partnered with various donor agencies to achieve compliance with local regulations while reducing methane emissions (UNEP and CCAC 2017). The expansion of feedlot systems for cattle production in Brazil, Argentina and northern Mexico may present opportunities to expand these systems among larger farms through climate Nationally Appropriate Mitigation Actions (NAMAs). Large pork farms are also common in the Yucatan and Guanajuato regions of Mexico. In contrast to other regions, LAC has had some success with small-scale biodigesters over the past 30 years and there may be opportunities to build off of the successes in Brazil and Mexico (e.g., Inicio - Sociedad Mexicana de Biotecnología y Bioingeniería (smbb.mx)) to establish coalitions between smaller farms, communities and research institutes specializing in these techniques.

Key methane measures for Latin America/Caribbean include:

- Finance farm-scale anaerobic digestion
- Improve health/husbandry of ruminant animals
- Expand integrated solid waste management
- Expand wastewater treatment/FSM
- Recovery of gas from oil/gas extraction

Key BC measures for Latin America/Caribbean include:

- Cleaner cooking and heating
- Cleaner Brick Kilns
- Advance diesel engine standards
- Eliminate high-emitting vehicles

Source: CCAC 2018, McKinsey & Co. 2021, Bond et al. 2013

Improve health/husbandry of ruminant animals - For many of the smaller farms slurry irrigation, composting and drying of manure to apply as fertilizer/soil amendment may be an option and is increasingly practiced in Brazil and Peru (UNEP and CCAC 2017). The practices for maintaining healthy herds and processing feed as described in Section 2C are especially applicable to the many smaller cattle herds in Central and Latin America, but as with manure management, awareness raising among smallholder farms may be the key to scaling interventions in LAC. To have meaningful climate change mitigation benefits, USAID programs that increase livestock productivity need to include or be tightly linked to activities that avoid agriculture-driven deforestation (see Section 2C).

Expand integrated solid waste management - The LAC region is highly urbanized, having about 79 percent of its population living in cities. Approximately 50 to 70 percent of the solid waste management expense (collection, transport, processing, recycling and disposal) is used for collection operations. Therefore, a small percentage of improvement in collection activity can significantly affect savings in the overall management cost. Without resources for separation programs, a large informal sector in LAC is engaged in the unhygienic and often dangerous task of recovering valuable or recyclable material at landfills. Financing of integrated solid waste management has been achieved in LAC through onlending programs with national governments playing the intermediary to public-private entities to improve collection services and conduct source separation. With subsequent employment of various methods to generate revenue streams from recycling, biogas energy, composted fertilizer and carbon credits. USAID has reduced SLCP emissions from open dumps in the Dominican Republic through its Clean Cities, Blue Ocean program. USAID support led to the remediation of two open dumps in the Province of Samaná, which is now the national model for waste infrastructure in the Dominican Republic.

Expand wastewater treatment/FSM - 67 percent of the wastewater treatment plants in Latin America are small (design flow less than 25 L/s) and 34 percent are very small (less than 5 L/s) (UNEP and CCAC 2017), where flaring may make sense because the production value of methane is too small. Improved management and training should be the focus to minimize emissions. For larger systems, the impact of biogas recovery for electricity production is highly significant in terms of overall emissions. FSM may play a role in smaller villages and rural settings.

Recovery of gas from oil/gas extraction - Mexico has recently put a lot of effort into reducing emissions from their oil and gas refining industry, however, implementation is lagging and the industry is pretty old, so additional opportunities remain. Literature also points to large methane emissions from offshore oil platforms (Yacovitch et al. 2020), but even larger emissions from onshore oil and gas facilities. Inefficient flaring from onshore facilities is estimated to result in $200M in lost annual revenue (Zavala-Araiza et al. 2021). Indications are that despite intentions, there are lots of opportunities to reduce methane (and black carbon) from flaring.

Black Carbon

Cleaner cooking and heating - Latin America and Central America have relatively low access to clean cooking fuels for the majority of rural households. The same lessons relevant to stocktaking and implementing clean cooking programs in Africa and Asia will apply in LAC. Country-based regional campaigns are recommended to support awareness raising of the importance of transitioning to clean fuels. There are examples of success (Dominican Republic, Haiti) and lack of progress (Mexico) with some programs having introduced natural gas only to see large methane leaks. The 2019 PAHO Elimination Initiative may leverage momentum for action on solid fuels and kerosene use.

Cleaner Brick Kilns - While not as numerous as in South Asia, brick kilns are abundant in urban areas of LAC and suffer from the same lack of efficiency seen in South Asia. Given the lack of knowledge of harms or alternatives and the lack of finance, programs need to provide kiln owners with comprehensive support, including market analysis for the sector, financing and a clear regulatory/enforcement regime (UNEP and CCAC 2017). Integral to these programs must be a focus on poverty and inequality as past initiatives have not adequately addressed either. Colombia has had some successful intervention models in this sector.

Advance diesel engine standards - Chile adopted the most stringent vehicle standards in 2014 for heavy-duty vehicles and Mexico in 2018 (to take effect in 2025). Costa Rica and Brazil have similar targets. Most cities have low-sulfur fuel available while not all countries do at the national level. Nevertheless, significant progress could be made in advancing standards to include diesel particulate filters and reducing BC by 95 percent or more. Opportunities exist to shift municipal, transit and private fleets to e-mobility while local standards are tightened.

Eliminate high-emitting vehicles - Many LAC governments have experience with scrappage programs for light-duty vehicles that could translate into programs for inspecting and scrapping heavy-duty diesels (see last paragraph of 'History' section at link). Programs could target the many 'single-person occupancy' trucks that serve as some families' sole source of income for small lading businesses and therefore don't have the opportunity to participate in fleet renewal programs. These are often old and polluting and are critically important to inequality (sole source of family income). Some cities have piloted programs that consider the social and economic factors alongside environmental performance and are catalyzing deployment of all-electric urban delivery vehicles.

MIDDLE EAST AND NORTH AFRICA

Methane

Expand integrated solid waste management - A significant portion of municipal waste in the Middle East is burned in open dump sites (~15% for Egypt or Lebanon). Presenting residents with a viable alternative to dumping/burning their waste means strengthening integrated solid waste management, setting up strict enforcement mechanisms with penalties for noncompliance and ensuring these programs are effectively prepared and executed. This requires rigorous staff training and infrastructure investment to enable authorities to effectively enforce regulations as well as information campaigns to inform residents about the adverse effects of improper waste management.

Key methane measures for Middle East/North Africa include:

- Expand integrated solid waste management
- Reduce food waste
- Expand wastewater treatment/FSM
- Recovery of gas from oil/gas extraction

Key BC measures for Middle East/North Africa include:

- Cleaner cooking and heating
- Advance diesel fuel and engine standards
- Reduce gas flaring

Source: CCAC 2018, McKinsey & Co. 2021, Bond et al. 2013

Reducing Food Waste- "Food waste" is food thrown away later in the food supply chain at the retail and household level. The most important way to reduce food waste from households is through education campaigns and policy shifts. The most successful behavior change campaigns will consider the specific cultural barriers for reducing food waste. One way to frame conversations around policy shifts that address food loss and waste is through the "Target-Measure-Act" approach developed by the Champions 12.3 (a coalition of executives from governments, businesses, etc. working towards achieving Sustainable Development Goal 12.3, reducing global food loss and waste by 50%). "Target-Measure-Act" approach is a three-step approach that prioritizes aligning countries around a common goal, discovering where the biggest food loss and waste "hot spots" are in the region, and developing and implementing strategies for tackling these hot spots and utilizing public-private partnerships. Several USAID activities throughout the Middle East (e.g. Egypt, Jordan, Lebanon) are working to decrease food waste and increase composting.

Expand wastewater treatment - Water availability is a major challenge across the Middle East that is likely to get worse with increasing temperatures. Opportunities to expand central treatment system collection and treatment capacity with methane capture and water reuse (gray water systems for agriculture) to enhance water system efficiency could be an opportunity that would interest local governments. For example, wastewater recycling has a large potential of reducing the water security risks from climate change, yet only two percent of generated wastewater is recycled and reused in Egypt (Heger et al., 2022). Governments like Egypt have issued hundreds of millions of dollars in Green Bonds to finance wastewater infrastructure, including the recovery of methane from sludge.

Recovery of gas from oil/gas extraction - Among the highest emitters in the production value chain are vented or fugitive methane emissions in upstream oil and gas operations, which are plentiful in this region. Gas flaring is better than venting associated gas as methane, but represents resource loss that can payback immediately if captured and sold. According to the latest satellite data, Iraq flares over 16 billion cubic meters (bcm) of associated gas each year, making it the second-largest gas flaring country in the world (World Bank, 2017).

Black Carbon

Cleaner cooking - While not as widespread in the Middle East, several countries still burn solid fuels extensively in rural villages. Given the large solar potential, opportunities for solar microgrids powering electric induction cookers in rural areas are high, but require the same programmatic elements and supports to make these actions stick. COVID and increasing poverty have only exacerbated this issue in Lebanon, Iraq, Syria and other countries.

Advance diesel fuel and engine standards - In Cairo, Egypt where transportation is responsible for about 27 percent of local air pollution, the combination of removing fuel subsidies and opening a new metro transit line resulted in a seven percent reduction in air pollution, including a significant fraction of black carbon from diesel vehicles (Heger et al. 2018). The Middle East and North Africa generally lag behind other regions in setting comprehensive and appropriate fuel quality standards, which are critical to advancing engine standards (Heger et al. 2022).

Gas Flaring - Eliminating flaring and recovering the methane would eliminate this large source of BC emissions.

EUROPE AND EURASIA

Methane

Finance farm-scale anaerobic digestion - Transitioning off of coal power and Russian natural gas in the region, means there is ample opportunity for alternative energy sources. In the European Union, biogas production volume has increased from 2.5 billion m3 in 2000, to 18 billion m3 methane equivalent in 2015, representing half of the global biogas production (Scarlat et al. 2018). Larger cattle and livestock herds offer an opportunity for win-win investments in anaerobic bio-digesters that reduce methane emissions and add to non-fossil power generation.

Expand integrated solid waste management - As with South Africa, Europe and Eurasia are poised for utilizing a circular economy approach to integrated solid waste management. Focusing on resource efficiency, sorting and reuse, and waste diversion may be a better strategy in this region relative to landfill expansion.

Key methane measures for Europe/Eurasia include:

- Finance farm-scale anaerobic digestion
- Expand integrated solid waste management
- Expand wastewater treatment/FSM
- Recovery of gas from oil/gas extraction

Key BC measures for Europe/Eurasia include:

- Cleaner cooking and heating
- Reduce burning of crop residue
- Eliminate high emitting vehicles

Source: CCAC 2018, McKinsey & Co. 2021, Bond et al. 2013

Expand wastewater treatment - As mostly middle income countries with central sewage systems in place, the emphasis in this region should be on ensuring secondary and tertiary treatment systems, which include establishing well-functioning methane capture.

Recovery of gas from oil/gas extraction - As discussed above, Lauvaux et al. (2022) report that there are huge opportunities within this sector among "ultra-emitters" in terms of reducing fugitive emissions (e.g., leaks from pipelines and storage) in many former Soviet states due to obsolete gas infrastructure. Also many governments in the region have endorsed the World Bank's Zero Routine Flaring initiative (e.g. Russia, Uzbekistan, Turkmenistan), which are some of the largest players in the region.

Black Carbon

Cleaner cooking and heating - Residential heating with coal - in both residential coal stoves and through inefficient Soviet Era district heating plants - is particularly problematic in winter months where many cities are choked with soot. Expanding renewable power generation to enable a transition to air source heat pumps can significantly reduce black carbon, methane, and air pollution; however, most governments have turned to more affordable natural gas, which is often available domestically or from nearby via pipeline expansions (see oil/gas above).

Reduce burning of crop residue (regenerative agriculture) - Kazakhstan is a world leader in conservation agriculture (CA) with strong national policies, resulting in more than 2.5 million hectares under management, placing it 7th globally (Kassam 2018). Building on this practice to shift other Central Asian agro-economies toward conservation/regenerative agriculture can significantly enhance soil carbon storage and reduce crop residue burning.

Eliminate high-emitting vehicles - Many Eastern European governments within the EU are advancing vehicle emission standards, yet have very old fleets with many older, high-emitting vehicles. The Western Balkans in particular have a much higher transportation share of overall GHG emissions relative to peers and may be ideal targets for scrappage programs to accelerate fleet turnover. As described in Section 2C, concessional and results-based finance programs could target state-owned fleets or large private fleets, with hand-me-down vehicles used to eliminate the high emitters identified through inspection programs.

3. HARNESSING AIR QUALITY FRAMEWORKS FOR CLIMATE ACTION

Policy approaches to reduce SLCPs often lend themselves to integrated climate and air quality management. Many of the sources of climate pollution (both GHGs and SLCPs) are the same sources contributing to air pollution often resulting in synergistic benefits for both problems. However not all actions benefit air quality and climate in equal measure, thus USAID must assess for synergies and tradeoffs from different actions (see e.g. Peszko 2022). New guidance is available to help navigate these issues at the municipal (C40 2021) and national (Peszko 2022) levels.

SLCP actions will often be part of a city or country's air quality (AQ) management planning processes, but may also fit neatly into a country's NDC. For example, in Ghana, the government has developed a suite of clean air measures that simultaneously contribute to their NDC goals (GoG 2018). In this guide, emphasis is given to the many SLCP actions that are considered "quick-wins" and are complementary to both deep decarbonization and air quality improvement efforts. However, there may not be legal frameworks around NDC commitments and GHG action plans, which often remain voluntary or incentive-based in many countries. This guide has an intentional focus on actions that strive for policy coherence, and thus de-emphasizes some actions that may have benefits for either AQ (e.g. post-combustion control technology) or for climate (e.g. fuel switch to biofuels), but not both. The controlling legal framework for actions that address both issues may currently exist only under government mandates for air pollution. For example, in Egypt, pursuit of a new integrated climate and AQ action plan has led to a call for an integrated legal framework that enables swift action to achieve both objectives together.

A multi-level governance framework can help USAID mission staff overcome challenges in supporting governments in implementing and enforcing SLCP reduction policies and actions. A framework of multi-level governance (GIZ/UN-Habitat/ICLEI 2017) includes vertical and horizontal alignment. National ministries and departments as well as regional and local governments need to cooperate to align strategies and processes for collective coordinated efforts.

4. REPORTING AND FUNDING

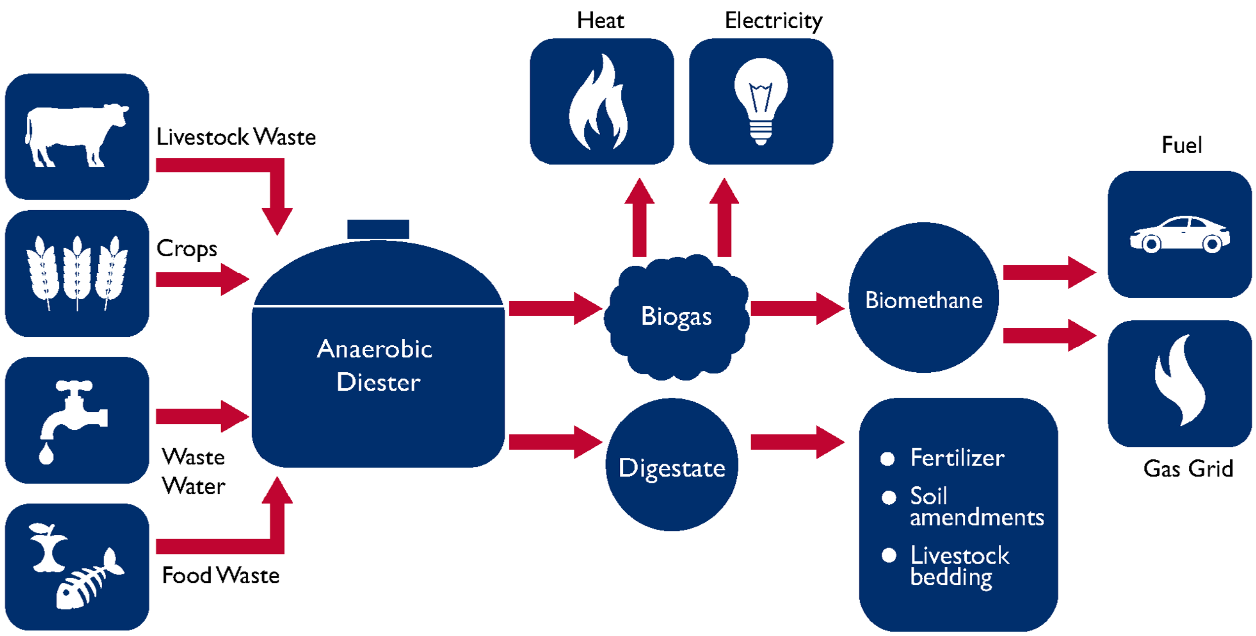
4A. Funding Methane and Black Carbon Mitigation at USAID

Currently, USAID possesses limited explicit programming on methane and black carbon mitigation, however USAID has significant presence, relevant in-country programming, and capacity across key emitting sectors and countries. USAID/Washington has identified key technical leads for each sector on SLCP reduction (see Annex B) to help support USAID missions and operating units.

The two primary climate change funding streams available to support methane and black carbon mitigation at USAID depending on context and source of emissions are **Clean Energy (EG.12)** and **Sustainable Landscapes (EG.13)**. Since each funding stream is governed by a set of guidelines due to the intent of the funding, not all SLCP work is achievable using these two earmarks alone, making mitigation co-benefits from other sectors critical. Because SLCP emission sources are quite diverse, there are opportunities to derive mitigation co-benefits from non-climate change directive funds, such as Agriculture, Feed the Future, Water and Sanitation, Ocean Plastic Pollution, Global Health, Education, and Democracy, Human Rights and Governance. Work on SLCP mitigation may entail measuring the SLCP co-benefits associated with ongoing programming (e.g. agricultural productivity and solid waste) or creatively using different funding streams to maximize our development and climate objectives. We also recommend using USAID's funding to elevate opportunities for reducing multiple climate forcers (CO_2, methane, N2O, black carbon, etc) and air pollutants jointly.

Direct Climate Funds:

- Sustainable Landscapes/Natural Climate Solutions programs must reduce, avoid or sequester land-based GHG emissions through the conservation, management, and restoration of terrestrial and coastal ecosystems (e.g. forests, mangroves, peatlands, grasslands), and managed systems (e.g. agricultural and other production lands). Programming must be informed by analyses and evidence to focus efforts on the highest potential for mitigation, taking into account the context and USAID's comparative advantage. When methane emissions from land-based sources meet the criteria above (e.g. methane from rice in a country where methane is a primary source of land-based emissions), sustainable landscapes funds may be used. All sustainable landscapes programs need to report on EG. 13 indicators, as applicable.
- Clean Energy funds can be used to reduce SLCP emissions through the development of policy reforms and implementation of clean energy practices. The funds can also be used for any non-land-use-based activity whose purpose is to reduce significantly and/or avoid GHGs and other climate-warming emissions while improving livelihoods. For methane abatement this could include reducing methane leakage from the oil, natural gas and coal sectors; waste-to-energy technologies that harness biogas (see Figure below); and other methane emission reduction across the entire solid waste and wastewater value chain, including but not limited to, waste reduction, organics diversion from the waste stream, solid waste management, landfill gas capture, and wastewater management improvements. Black carbon abatement often can be bundled with CO_2 mitigation measures, such as renewable energy, clean household energy, and clean transportation.



Adapted from EESI

Relevant Funding Streams:

- Agriculture directive funds can be used to improve livestock and rice productivity to drive down GHG emissions intensity, and create the enabling environment for sustainable food systems. Increased livestock productivity will be promoted through improved animal feeding, animal health and husbandry, improvements to herd, pasture and rangeland management, avoiding land use change, as well as effective manure management. Increased rice productivity will be promoted through alternate wet-dry systems, dry-seeded rice, improved straw management, more precise fertilizer use, and breeding of dry-direct seeded and higher-yielding, resilient rice varieties. For more guidance on methane mitigation for agriculture, food security, and food systems, see USAID's Climate Change, Agriculture and Food Security (CCAFS) Program; Feed the Future, and MItigation and Transformation Initiative for GHG reductions of AgriFood systems RelaTed Emissions (MITIGATE+).
- Water and Sanitation directive funds can be used to improve fecal sludge management and create the necessary enabling environment for proper wastewater and fecal sludge treatment which improves safely managed sanitation. It is possible that these efforts can also abate methane, but since methane abatement requires additional treatment technologies, we do not anticipate that WASH-directive funds can contribute significantly to methane abatement without additional funding.
- Solid Waste is being addressed using Feed the Future and Ocean Plastic Pollution funds, which aim to advance sustainable food systems and the reduction of ocean plastic pollution. Feed the Future funds can support advancement of solutions that reduce food loss and waste (FLW) and

GHG emissions across agricultural commodity supply chains. Ocean Plastic Pollution funds can be used to build the necessary capacity, commitment and regulatory framework for improved solid waste management (i.e. promotion of 3Rs- reduce, reuse, recycle, diversion of organic waste, prohibiting open burning, and remediation and closure of open dumps and promotion of sanitary landfills with methane capture). For more guidance on the links between methane mitigation and FLW and ocean plastic pollution, see USAID's Feed the Future's Commitment to Reducing FLW, and Clean Cities, Blue Ocean's work in the Dominican Republic.

- Global Health directive funds can be used to address black carbon and air pollution to improve maternal, newborn and child health. Poor air quality is a public health crisis in many cities. Interventions that directly address sources of air pollution will have a direct and immediate impact on health across the lifespan of an individual, including maternal, newborn and child health. These include reducing household pollution from indoor cooking and heating with polluting methods; reducing local sources of environmental toxins/air pollution from brick kilns and other polluting industries; and reducing biomass burning. Activities could also include interventions for educating mothers and families on how to protect themselves and their children from air pollution (e.g. monitoring air quality, timing outdoor activities, etc); and on how to identify and when/how to seek care for air pollution-related illnesses in children. Global Health Program funds can also be used to improve health systems and supply chains in ways that reduce environmental impacts, including emissions and pollution.
- Democracy, Human Rights and Governance directive funds can be used to advance participatory and accountable governance, rule of law, authentic political competition, civil society, human rights, and the free flow of information. All of these governance components are essential for reducing air pollution and climate emissions.
- Education funds can be used for activities that address the negative effects of air pollution and black carbon on children's learning. For instance, there have been school closures in countries like Nepal and India due to poor air quality. Education funds could be used for activities, such as assessing the impact of air pollution on school absenteeism; integrating clean air programs into school curricula and activities; and assisting municipal authorities, school administrators, and others to ensure standards and policies are in place that mitigate the effects of air pollution on children.

4B. Monitoring and Learning

For monitoring progress in USAID development programs whose primary aim often is not climate emission reduction, it is important to select a mix of standard and custom indicators that measure how the activity is working and ensure the program is learning from its experiences.

Four of USAID's Standard Indicators that may be particularly useful for measuring progress on SLCPs include: (see USAID Global Climate Change Standard Indicator Handbook for a more comprehensive list)

- **EG.12-6 Greenhouse gas (GHG) emissions, estimated in metric tons of CO_2 equivalent, reduced, sequestered, or avoided through clean energy activities supported by USG assistance**
- **EG.12-7 Projected greenhouse gas emissions reduced or avoided from adopted laws, policies, regulations, or technologies related to clean energy as supported by USG assistance**

- **EG.13-6 Greenhouse gas (GHG) emissions, estimated in metric tons of CO_2 equivalent, reduced, sequestered, or avoided through sustainable landscapes activities supported by USG assistance**
- **EG.13-7 Projected greenhouse gas emissions reduced or avoided from adopted laws, policies, regulations, or technologies related to sustainable landscapes as supported by USG assistance**

To use the above indicators, staff will need to convert emission reductions from SLCP mitigation actions into CO_2 equivalent (CO_2e). USAID's GHG indicators use CO_2e, which is also the dominant unit of measurement for international climate negotiations. A simple approach similar to currency conversion is used to convert different gases into CO_2e using **Global Warming Potentials (GWPs)**. Just as every currency has a different exchange rate, each gas has its own GWP for different time periods: **20 yrs (near-term warming)** and **100 yrs (long-term warming)**. The time period used for USAID reporting is 100 years. This is done using the GWP introduced in Chapter 1 and defined in Footnote 3. Box 4 provides formulas for that conversion and Annex C provides a rationale for the selected values used in this guidance. It is important to note not all scientists agree on the appropriate metrics for accounting SLCPs (i.e. GWP20, GWP100 or other metrics). GWP100 is the current standard, however it undercounts the near-term benefits of SLCP reduction. Given Administration priorities, it may become increasingly important for USAID programs to report SLCP reductions in tons of methane and black carbon given GWP100 undercounts SLCP impacts in the near-term (See Annex C for additional discussion).

BOX 4: How do we use GWPs to estimate CO_2e for methane and black carbon?

Methane:

- Methane (tons reduced) X GWP100 (methane's global warming potential factor for 100 years) = CO_2e (tons)
- 32,000 tons of methane X 28 = 896,000 tons of CO_2e
- Because black carbon is often co-emitted with organic carbon (OC) that can offset the impact of black carbon and other GHGs, we need to account for the contributions of BC and OC together. The conversion factor (GWP_{100}) for OC has a minus sign to indicate that it leads to potential cooling rather than warming.

Black Carbon:

- Black carbon (tons reduced) x GWP100 (black carbon's global warming potential for 100 years) + Organic Carbon (tons reduced) x GWP100 (organic carbon's global warming potential for 100 years) = CO_2e (tons)

Alternative, custom indicators could also be used for monitoring and tracking progress, such as:

- Number of governments who have implemented SLCP action plans
- Black carbon, methane and HFCs emissions [*from activities not currently captured under SL and Clean Energy*] reduced or avoided

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ANNEX A: USAID COUNTRY COMMITMENTS ON METHANE AND BLACK CARBON UNDER NDCS

Table A-1. Presents current USAID partner countries who have: (1) joined the Global Methane Pledge; (2) explicit NDC targets for methane, black carbon and HFCs; (3) NDC sectoral targets relevant for reducing black carbon emissions; (4) NDC sectoral targets relevant for reducing methane emissions (see Annex D for information on the methodology used to collect this data).

USAID Countries	Joined Global Methane Pledge	CH_4	BC	HFCs	CH_4 (Latest NDC)	BC (Lastest NDC)	HFCs (Latest NDC)	Transport (BC)	Residential (BC)	Industry (BC)	Agriculture (BC)	Fossil Fuel Prod./ Transport (CH_4)	Waste Management (CH_4)	Agriculture (CH_4)
Albania	x				x		x						x	x
Angola		x			x				x	x		x		
Antigua and Barbuda		x		x	x			x					x	
Armenia		x		x	x		x	x					x	x
Azerbaijan		x		x	x		x	x				x	x	x
Bangladesh		x		x	x		x	x	x	x			x	x
Barbados and Eastern Caribbean	x	x		x	x		x	x					x	
Belarus		x		x	x		x							
Benin		x			x	x	x	x	x		x		x	x
Bosnia and Herzegovina	x	x			x		x	x					x	
Botswana		x			x									x
Brazil	x	x		x	x		x							
Burkina Faso	x	x			x		x	x					x	x
Burma (Myanmar)									x	x			x	
Burundi		x			x			x	x		x	x	x	x
Cabo Verde		x			x		x	x	x			x	x	x
Cambodia		x			x			x	x	x	x	x	x	x
Cameroon	x	x			x		x	x		x			x	x
Central African Republic	x	x			x	x	x		x	x	x			
Chad		x			x				x			x	x	x
Colombia		x		x	x	x	x	x	x	x		x	x	x

USAID Countries	Joined Global Methane Pledge	CH_4	BC	HFCs	CH_4 (Latest NDC)	BC (Lastest NDC)	HFCs (Latest NDC)	Transport (BC)	Residential (BC)	Industry (BC)	Agriculture (BC)	Fossil Fuel Prod./ Transport (CH_4)	Waste Management (CH_4)	Agriculture (CH_4)
Cote d'Ivoire	×	×			×			×		×			×	×
Cuba	×	×			×			×	×					×
Cyprus	×	×		×	×		×							
Democratic Republic of the Congo	×	×			×			×	×		×	×	×	
Djibouti	×	×			×			×	×				×	
Dominica		×		×	×		×	×	×				×	
Ecuador	×				×		×		×			×	×	×
Egypt								×		×		×		
El Salvador	×				×			×			×			×
Equatorial Guinea					×			×		×				×
Eswatini		×		×	×	×	×	×	×				×	
Ethiopia	×	×			×			×	×	×			×	×
Gabon	×	×			×		×	×				×	×	
Gambia, The	×	×		×	×		×	×	×	×	×		×	×
Georgia	×	×		×	×		×			×		×		
Ghana	×	×		×	×	×	×	×	×			×		
Grenada	×	×			×		×							
Guatemala	×	×			×			×	×	×				
Guinea					×			×		×			×	
Guyana	×								×					×
Haiti		×			×				×				×	
Honduras	×	×			×		×	×	×				×	×
India								×	×	×			×	
Indonesia	×	×			×			×	×	×			×	×
Iraq	×				×			×		×		×	×	×
Israel	×	×		×	×		×	×		×			×	
Jamaica	×	×			×		×	×						×
Jordan	×	×		×	×		×	×		×			×	
Kazakhstan		×		×	×		×							
Kenya		×			×		×							
Kosovo														
Kyrgyz Republic	×				×		×	×	×			×	×	×

USAID Countries	Joined Global Methane Pledge	CH_4	BC	HFCs	CH_4 (Latest NDC)	BC (Lastest NDC)	HFCs (Latest NDC)	Transport (BC)	Residential (BC)	Industry (BC)	Agriculture (BC)	Fossil Fuel Prod./ Transport (CH_4)	Waste Management (CH_4)	Agriculture (CH_4)
Laos					X		X	X	X				X	X
Lebanon					X									
Lesotho		X			X			X	X	X		X	X	X
Liberia	X				X		X	X	X	X	X	X	X	X
Libya	X													
Madagascar		X			X				X				X	X
Malawi	X	X			X			X	X	X	X		X	X
Maldives		X			X			X					X	
Mali	X	X												
Marshall Islands	X	X			X			X	X				X	
Mauritania		X												
Mexico	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Micronesia	X							X	X					
Moldova		X		X										
Mongolia		X			X		X	X		X			X	X
Montenegro	X	X		X	X		X	X	X	X	X		X	X
Morocco	X	X												
Mozambique		X			X		X	X	X	X	X		X	X
Namibia		X			X		X	X	X	X			X	X
Nepal	X	X			X			X	X	X		X	X	X
Nicaragua					X									
Niger		X			X			X	X	X	X		X	X
Nigeria	X	X			X	X	X	X	X			X	X	X
North Macedonia	X													
Pacific Islands														
Pakistan	X				X			X	X	X	X	X	X	X
Paraguay		X			X									
Peru	X	X			X									
Philippines	X				X		X	X		X	X		X	X
Republic of the Congo	X													
Rwanda	X	X			X		X	X	X				X	
Saint Lucia		X			X						X		X	X

USAID Countries	Joined Global Methane Pledge	CH_4	BC	HFCs	CH_4 (Latest NDC)	BC (Lastest NDC)	HFCs (Latest NDC)	Transport (BC)	Residential (BC)	Industry (BC)	Agriculture (BC)	Fossil Fuel Prod./ Transport (CH_4)	Waste Management (CH_4)	Agriculture (CH_4)
Sao Tome and Principe		×			×			×					×	×
Senegal					×					×	×		×	×
Serbia	×	×		×	×		×			×	×		×	×
Sierra Leone		×			×									
Somalia					×						×			×
South Africa		×		×	×		×	×		×	×		×	×
South Sudan					×			×	×				×	×
Sri Lanka		×						×	×	×	×		×	×
St. Kitts and Nevis	×													
St. Vincent and the Grenadines		×		×										
Sudan		×			×			×	×				×	
Suriname	×				×			×	×	×	×			
Syria								×	×				×	
Tajikistan		×			×			×			×		×	×
Tanzania					×			×	×				×	
Thailand		×		×	×		×	×	×	×	×		×	×
Timor-Leste	×							×	×	×	×		×	×
Togo	×	×			×	×	×	×	×	×	×		×	×
Trinidad and Tobago		×			×			×		×				
Tunisia	×	×			×		×			×			×	
Turkmenistan		×			×					×	×		×	×
Uganda								×	×	×				×
Ukraine	×	×		×	×		×			×	×		×	×
Uzbekistan					×		×			×	×			×
Venezuela								×	×	×	×	×	×	×
Vietnam	×	×		×	×		×	×	×	×	×		×	×
West Bank and Gaza														
Yemen														
Zambia	×	×			×			×	×	×			×	
Zimbabwe		×			×	×	×	×	×	×	×		×	×

ANNEX B: ADDITIONAL RESOURCES

USAID is starting to develop a coordinated approach for reducing SLCPs, and the following individuals listed below in Table B-1 are key USAID points of contact (POCs) for methane, air quality, and/or sectoral programming.

Table B-1. USAID Technical Leads for Short-Lived Climate Pollutants

Sector/Topic	Name	Operating Unit	Email
USAID Methane Coordinator	Malick Haidara	DDI/EEI/Energy	mhaidara@usaid.gov
Air Quality	Katie Swanson	DDI/EEI/Green Cities	kswanson@usaid.gov
Agriculture (Livestock)	Andrew Bisson	RFS/Center for Resilience	abisson@usaid.gov
Agriculture (Rice)	Hailu Wordofa	RFS/ Center for Agriculture	hwordofa@usaid.gov
Agriculture/Land-Use	Noel Gurwick	DDI/EEI/Natural Climate Solutions	ngurwick@usaid.gov
Energy (Coal, Oil & Gas)	Dorian Mead	DDI/EEI/Energy	dmead@usaid.gov
Energy (Transportation)	Andrew Fang	DDI/EEI/Energy	anfang@usaid.gov
Municipal Solid Waste	Silvia Petrova	DDI/EEI/Green Cities	spetrova@usaid.gov
Food Loss & Waste	Ann Vaughan	RFS/Center for Resilience	avaughan@usaid.gov
Water, Sanitation, and Hygiene	Emily Bondank	RFS/Center for Water	ebondank@usaid.gov
Monitoring, Evaluation and Learning	Kate Faulhaber	DDI/EEI/Climate and Cross-Cutting Strategies	kfaulhaber@usaid.gov

Table B-2, below, lists a variety of external resources where you can learn more about specific programs and policy initiatives to further SLCP mitigation in USAID partner countries.

Table B-2 Additional External Resources

Name of Resource	Institution/Contact	Website	Description
CCAC Resources for Action/Solutions Centre	Climate and Clean Air Coalition	https://www.ccacoalition.org/en/content/resources-action	A resource library, expert assistance service and research and analysis on SLCP reduction measures
Megacities partnership	USEPA	https://www.epa.gov/air-quality-management-process/megacities-partnership	A framework by which to develop and implement comprehensive action plans to address air quality and improve public health in cities, including video tutorials, templates and examples of partner accomplishments
Clean Air Catalyst	World Resources Institute (funded through USAID)	https://www.cleanaircatalyst.org	A global partnership of organizations led by World Resources Institute and Environmental Defense Fund focused on building capacity for locally tailored solutions that curb air pollution, tackle climate change and improve human health
Global Health Observatory Air Pollution Data Portal	World Health Organization	https://www.who.int/data/gho/data/themes/air-pollution	A collection of global databases, model results, interactive tools and resources related to ambient air pollution, household air pollution and the burden of disease associated with each
C40 Knowledge Hub	C40 Cities Global Leadership Group	https://www.c40knowledgehub.org/s/?language=en_US	A collection of policy briefs, research reports and implementation guides for climate action planning, resilience and nature based solutions guides as well as integrated climate and AQ planning focused on municipal-scale action
State of Global Air 2020	Health Effects Institute/ Institute of Health Metrics and Evaluation	https://www.stateofglobalair.org	Updated statistics on ambient air pollution, household air pollution and the burden of disease associated with each by country globally. Database is updated each year based on the latest release of the Global Burden of Disease project
State of California SLCP reduction strategy	California Air Resources Board	https://ww2.arb.ca.gov/resources/documents/slcp-strategy-final	Tehcnial assessment documentation of the CA SLCP reduction strategy
World Bank SLCP webpage	The World Bank	https://www.worldbank.org/en/topic/climatechange/brief/short-lived-climate-pollutants	Several technical reports on aspects of SLCP reduction policies and how SLCPs are being addressed within the Bank's portfolio
ICCT 2019 Progress update on Soot-free vehicles	International council on clean transportation (ICCT)	https://theicct.org/publication/global-progress-toward-soot-free-diesel-vehicles-in-2019/	This report assesses global progress in 2019 toward reducing black carbon emissions from diesel on-road light-duty and heavy-duty vehicles.

ANNEX C: GLOBAL WARMING POTENTIALS FOR CONVERTING SLCPS TO CO_2-EQUIVALENT

As discussed in Chapter 1, the Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO_2). The larger the GWP, the more a given gas warms the Earth compared to CO_2 over that time period. CO_2, by definition, has a GWP of 1 (USEPA, 2022). Calculated GWPs for SLCPs demonstrate that SLCPs typically contribute much greater warming of the planet, relative to an equivalent mass of CO_2 over a 100-year tie period. Since they have short lifetimes, their warming influence GWP is even greater - sometimes hundreds of times greater - when calculated over a 20-year time period. The time horizon over which impacts should be calculated, like a choice of economic discount rate, is to some extent a value judgment and selecting a longer time horizon places more value on a pollutant's contribution to long-term climate stability versus a shorter time horizon that gives greater weight to a pollutant's ability to achieve near-term cooling. Both goals are critical, but given the policy communities familiarity with the GWP_{100}, that is the metric that is most appropriate for crediting SLCP reductions toward USAIDs climate goals expressed in CO_2e.

GWP for Black Carbon

As Table 3 demonstrates, black carbon GWP values range between 345 - 3200 (depending on time horizon, geography and the range of effects considered). **It is important to note that there is currently no internationally accepted standard for reporting black carbon in CO_2e.** We recommend when providing any illustrative CO_2e measurements for black carbon that USAID staff **use the most conservative GWP value of 345 to track progress against climate goals**. To be consistent with USAID accounting methodologies for CO_2, only the 100-year time horizon should be used, even though SLCPs are most potent over shorter time horizons. In instances where black carbon is co-emitted with organic carbon, then staff can account for the cooling influence of co-emitted organic carbon by also using the conservative assumption for the GWP100 of -46 and calculate the net climate impact of OC and BC together, where possible. The GWP100OC is negative to reflect the fact that OC emissions offset the warming of BC emissions, when co-emitted. This represents a conservative approach based on the most recent estimates in the IPCC AR5 report.[6]

6 The IPCC chose not to provide a GWP value for black carbon in AR6, which may - in part - be a reflection of the uncertainty in estimating long-term radiative and temperature impacts of aerosol species relative to CO_2.

Table C-1. Global Warming Potential (GWP) for Black Carbon and Organic Carbon from literature over a 20-year and 100-year time horizon (Adapted from IPCC, AR5, Chapter 8, page 740, Table 8.A.6).

	GWP	
	H = 20	H = 100
BC total, global[c]	3200 (270 to 6200)	900 (100 to 1700)
BC (four regions)[d]	1200 ± 720	345 ± 207
BC global[a]	1600	460
BC aerosol–radiation interaction +albedo, global[b]	2900 ± 1500	830 ± 440
OC global[a]	–240	–69
OC global[b]	–160 (–60 to –320)	–46 (–18 to –19)
OC (4 regions)[d]	–160 ± 68	–46 ± 20

Notes:

a) Fuglestvedt et al. (2010)

b) Bond et al. (2011); Uncertainties for OC are asymmetric and presented as ranges

c) Bond et al. (2013); Metric values are given for total effect

d) Collins et al (2013); the four regions are East Asia, EU + North Africa, North America and South Asia (as also given in Fry et al., 2012). Only aerosol-radiation interaction is included.

GWP for Methane

For methane, the GWP has been updated in successive iterations of the IPCC working group I reports. The value reported in the fourth assessment report (AR4) was 25 and is still the value that the UNFCCC asks parties to use for reporting methane emissions under the Framework. For reporting year 2024, they will ask parties to move to the GWP100 of 28 for methane, which is the lower end of the range reported in the fifth assessment report (AR5) of 28 - 36. Most recently the IPCC sixth assessment report (AR6) reported a range between 27.2 and 29.8. The authors recommend that USAID staff **use a value of 28 for converting methane mass reductions to CO_2e to track progress against climate goals**. However, USAID staff are also encouraged to track tons of methane reduced as well as CO_2e, so that either 20-year or 100-year GWPs can be used for indicating progress under the Global Methane Pledge.

ANNEX D: DATA ANALYSIS METHODOLOGY - USAID COUNTRIES SLCPS DATASET

The USAID target countries are broken down into six regions, including **Africa**, **Asia**, **Latin America & Caribbean**, **Middle East**, and **Europe and Central Asia**, utilizing data compiled as of February 2022. Therefore, any updates to the nationally determined contributions (NDC) in USAID target countries since then have not been recorded. The USAID target countries were identified based on the programs that were allocated funding in fiscal year 2021.

Baseline emissions for each USAID target country were collected from the 2019 Community Emissions Data System (CEDS) dataset (McDuffie et al. 2020) for black carbon, methane, and total emissions of short-lived climate pollutants. This analysis calculates the potential emissions reduction for USAID target countries relative to the CEDS baseline measurements; however, it is important to note that individual countries base their NDC emissions reduction targets on their own greenhouse gas and short-lived climate pollutant (SLCP) inventories.

Data for SLCPs in each target country's NDCs was first collected from existing reports. A checkbox method was used to identify USAID partner countries with NDCs that include targets for hydrofluorocarbons (HFC), black carbon (BC), and methane (CH_4). This SLCP data was collected from two sources:

1. The World Resources Institute working paper, ***Strengthening Nationally Determined Contributions to Catalyze Actions That Reduce Short-Lived Climate Pollutants*** (Ross et al., 2018); and

2. The Global Environmental Strategies report, ***Integrating Short-Lived Climate Pollutants (SLCPs) into Nationally Determined Contributions (NDCs) in Asia: A Survey with Recommendations*** (Akahoshi et al., 2016).

SLCP data was then collected directly from each country's latest NDC submission to the UNFCCC (as of February 2022). A checkbox method was used to identify USAID partner countries — with the exception of 20 countries (see below) — with conditional and unconditional NDCs that include HFCs, BC, and/or CH_4 in the scope of coverage OR for countries that mention specific targets for one or more of these SLCPs within their NDCs. NDCs submitted in a language other than English were translated and subsequently identified in the dataset.

The Climate and Clean Air Coalition (CCAC) provided a separate database identifying SLCPs in NDCs (CCAC forthcoming). Using the CCAC database, the SLCP in NDC research for the final 20 USAID target countries was completed based on the CCAC data. These countries include: South Africa, South Sudan, Sudan, Suriname, Syria, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Trinidad and Tobago, Tunisia, Turkmenistan, Uganda, Ukraine, Uzbekistan, Venezuela, Vietnam, Zambia, and Zimbabwe.

In addition to the investigation into SLCP targets in NDCs, data was collected with regard to specific sector and subsector emissions reduction targets that are known to reduce SLCPs. Again, this data was collected using a checkbox method to determine which countries have listed emissions reduction targets for each sector and subsector. The sectors and subsectors assessed for their contributions to BC reduction include: Transportation, Residential, Industry, and Agriculture. The sectors and subsectors assessed for their contributions to CH_4 reduction include: Fossil Fuel Production and Transport, Waste Management, and

Agriculture. The list of interventions, policies or actions used to identify appropriate sector and subsector emissions reduction targets include:

Transportation Sector (BC) – fuel switching, mode switching, fuel efficiency standards/targets, and electric vehicle adoption.

Residential Energy Use Subsector (BC) – efforts to reduce the use of biomass, switching to clean burning stoves, and residential energy efficiency measures such as installing heat pumps for heating and cooling or standards for building materials.

Industry Sector (BC) – the implementation of energy efficiency measures, replacing traditional technology and machinery, and fuel switching.

Agriculture Sector (BC) – mitigation of the open burning of crop fields and agricultural waste.

Fossil Fuel Production and Transport Subsectors (CH_4) – various measures to reduce or eliminate leaks or fugitive emissions. (Since targets for renewable energy generation have tended to be additional to fossil fuel production, it is not considered an appropriate measure under Fossil Fuel Production/ Transport).

Waste Sector (CH_4) – landfill gas recovery, waste-to- energy measures, composting, and more efficient waste management techniques.

Agriculture Sector (CH_4) – livestock food switching, manure management, biogas collection measures, and improvements in rice production. (A focus on resilience or increased yield alone does not suffice as an appropriate measure under Agriculture).

Quantitative emissions reduction targets for SLCPs or sectors and subsectors that contribute to SLCP emissions reduction were recorded along with the target year (see here for full dataset).