

Short-lived climate pollutants: Black carbon and methane

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Congressional Climate Camp: Non-CO2 Greenhouse Gases

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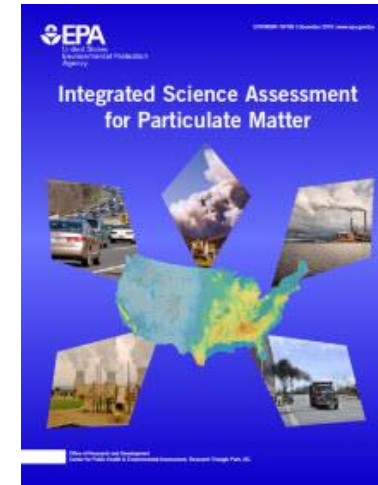
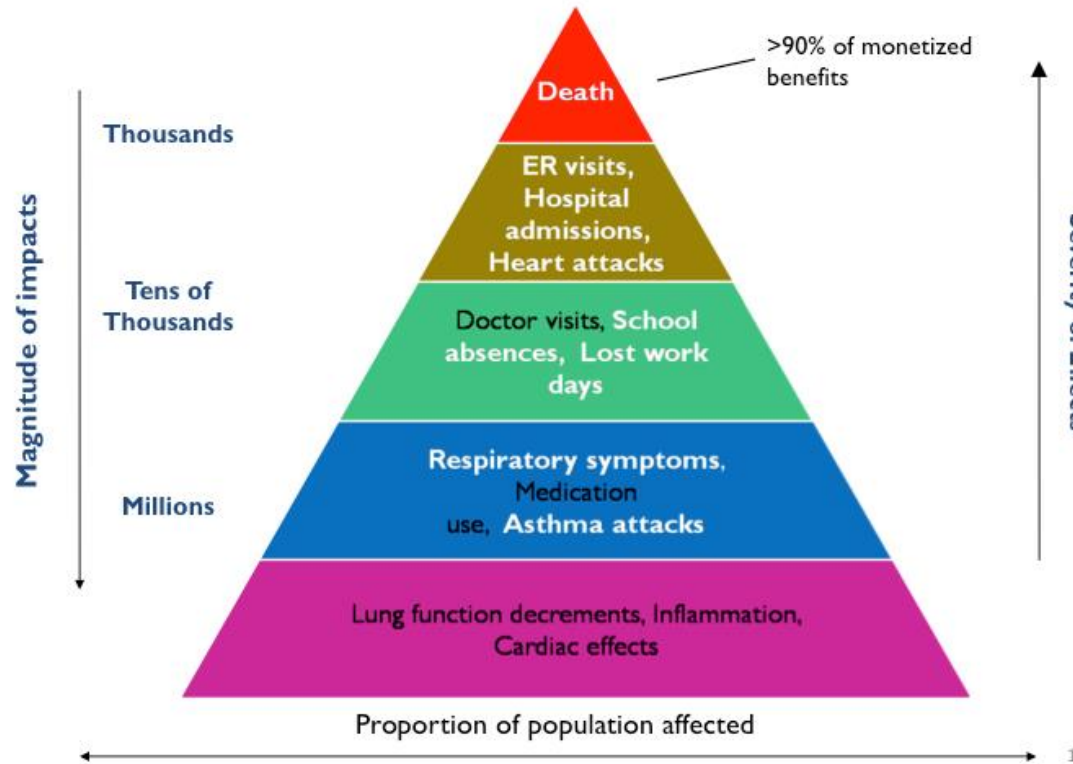
Short-Lived Climate Pollutants

- Short-lived climate pollutants refer to species that are *both* climate-warming agents and air pollutants.
- I will focus on two of many short-lived climate pollutants: black carbon (a component of PM_{2.5}) and methane (a precursor to ozone).

SUBSTANCE	ANTHROPOGENIC SOURCES	LIFETIME IN ATMOSPHERE	LOCAL REGIONAL GLOBAL
BLACK CARBON (BC)		DAYS	● ○ ●
METHANE (CH ₄)		12 YEARS	● ○ ●
TROPOSPHERIC OZONE (O ₃)		WEEKS	● ○ ●
HYDROFLUOROCARBONS (HFCs)		15 YEARS (WEIGHTED BY USAGE)	● ○ ●

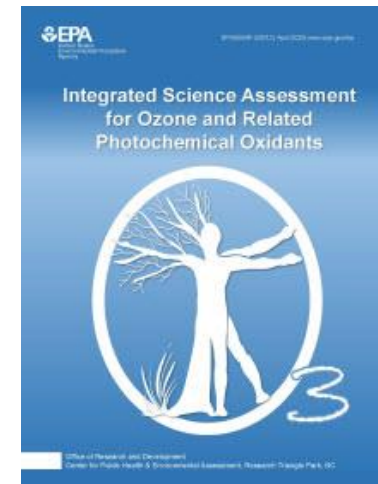
Health effects of major air pollutants

A “Pyramid of Effects” from Air Pollution



PM_{2.5}

- Cardiovascular effects
- Respiratory effects
- Nervous system effects
- Cancer
- Mortality

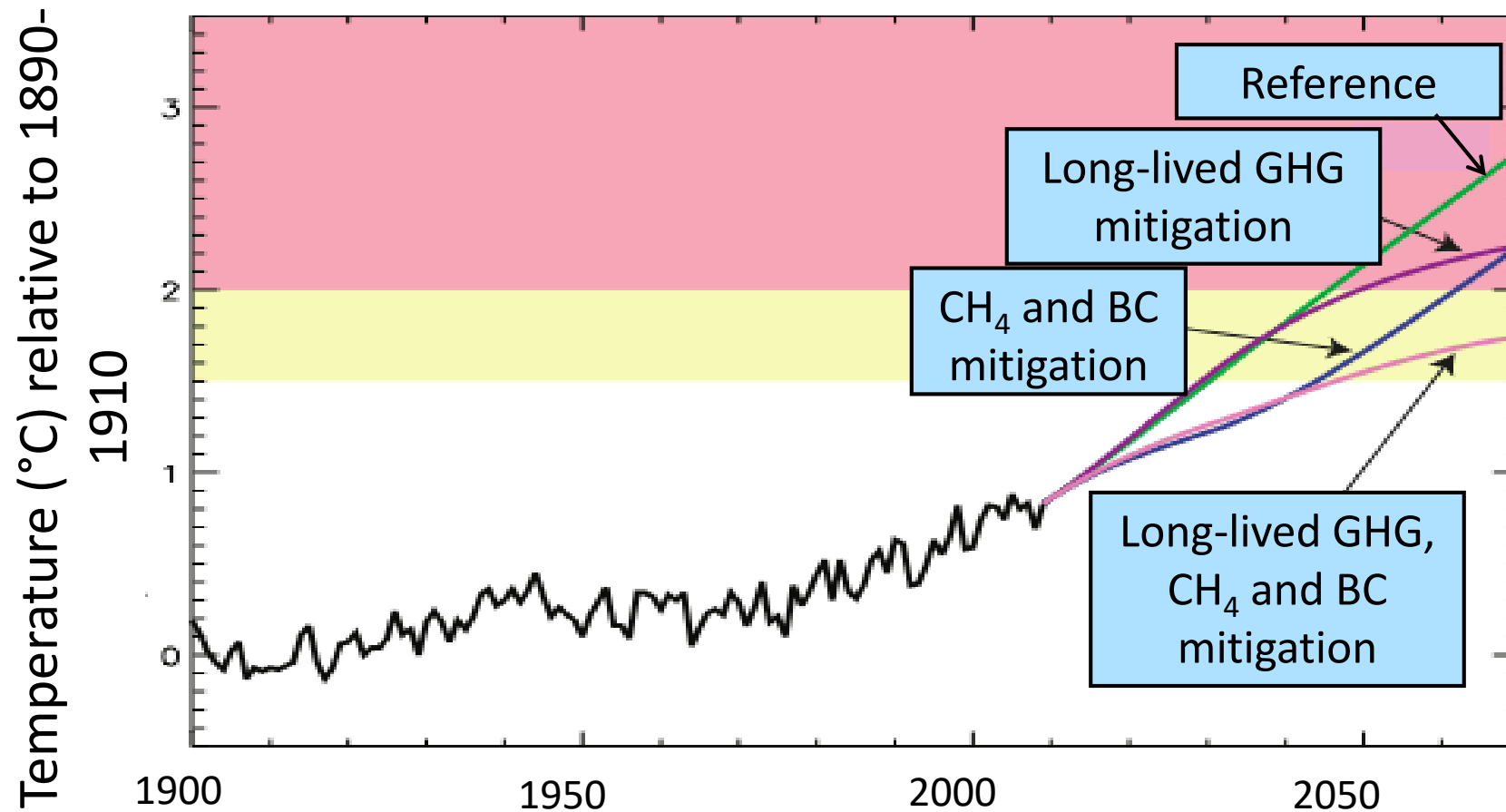


Ozone

- Respiratory effects
- Cardiovascular effects
- Mortality

<https://www.epa.gov/benmap/how-benmap-ce-estimates-health-and-economic-effects-air-pollution>

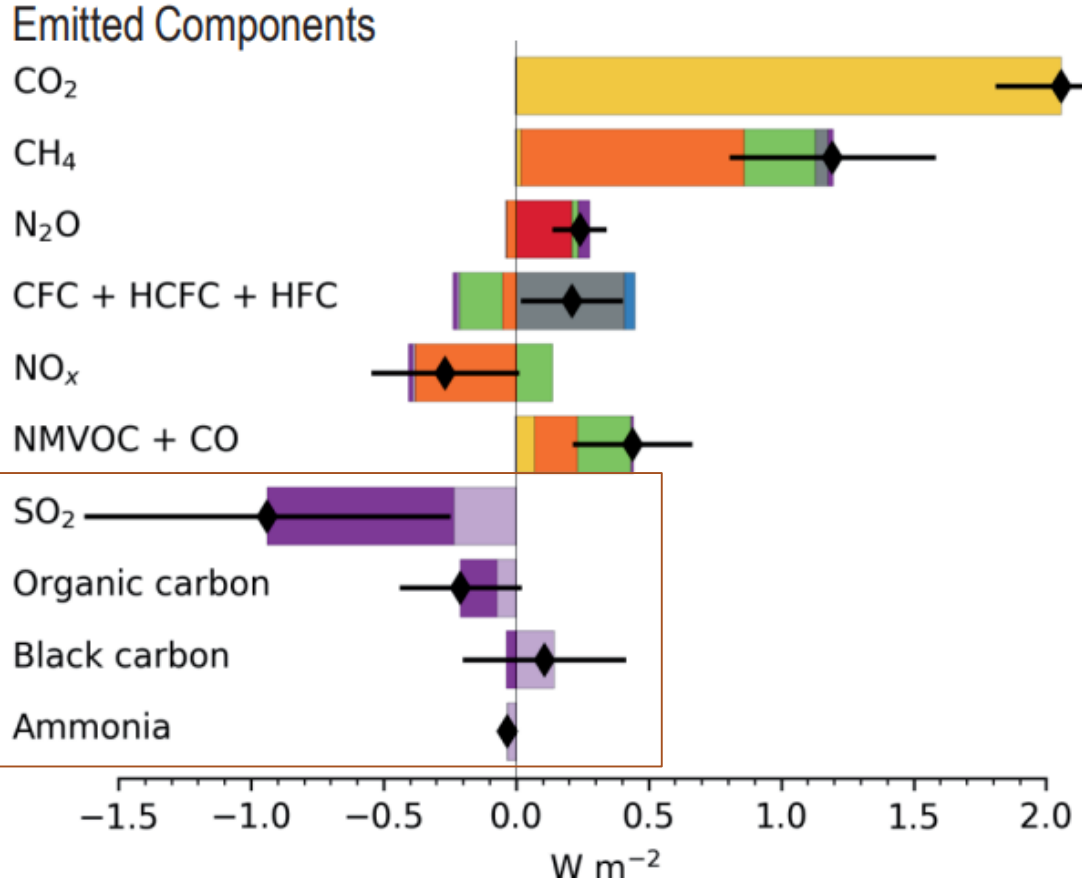
Which path will we take?



UNEP/WMO Integrated Assessment of BC and Ozone, 2011
Shindell et al. Science, 2012

Particulate Matter Impacts on Climate

(a) Effective radiative forcing
1750 to 2019



Black Carbon



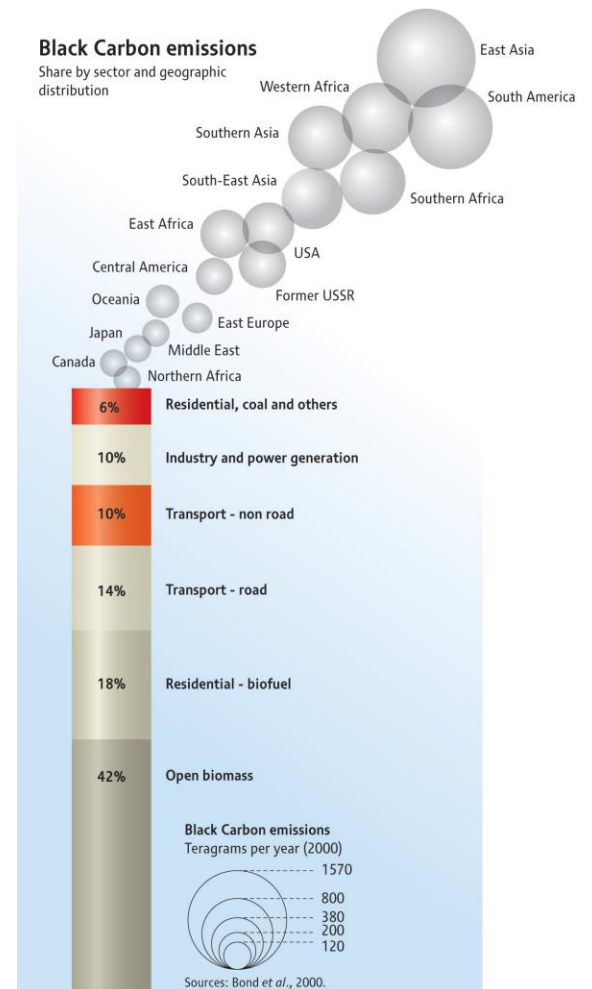
Diesel vehicles emit black carbon (soot) into the atmosphere.

Photo: US Environmental Protection Agency



Black Carbon Sources

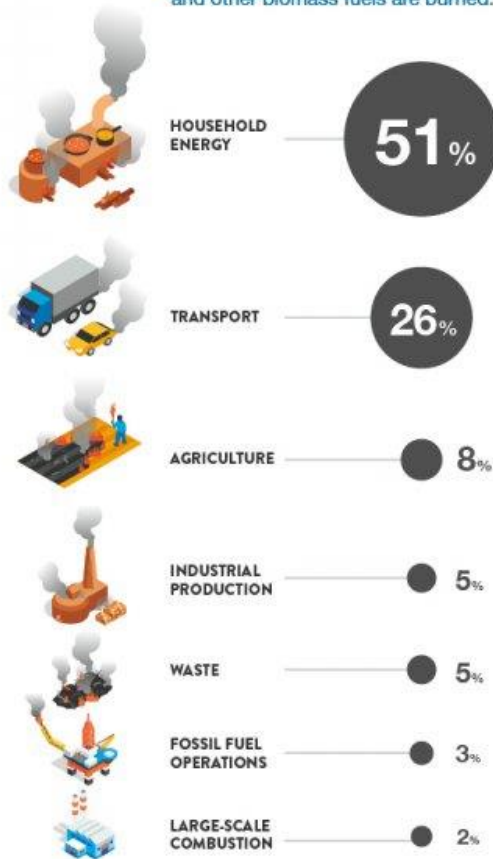
- Black carbon, a component of PM_{2.5}, is an important short-lived climate pollutant and is emitted by diesel exhaust, biomass for cookstoves, and the burning of coal and biofuels.
- Developing nations are the highest emitters of black carbon.
- Black carbon particles are strong absorbers of solar radiation, and the global warming potential of black carbon over 100 years ranges between 1,055–2,020 (relative to a global warming potential of 1 for CO₂).



BLACK CARBON (BC)

SOURCES

Black carbon is one of many particles and gases that are emitted when diesel, coal, and other biomass fuels are burned.



Black carbon, or soot, is part of fine particulate air pollution (PM_{2.5}) and contributes to climate climate.

IMPACTS

CLIMATE

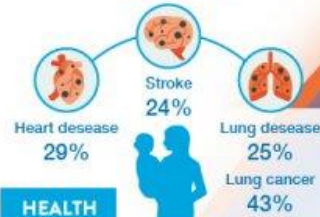
Absorbs sunlight and converts it to heat



LIFETIME IN ATMOSPHERE: UP TO 2 WEEKS

Since black carbon does not last long in the atmosphere, efforts to reduce it will bring immediate benefits for the climate and human health.

Deaths from



HEALTH

7 million pollution-related deaths every year

WEATHER

- Prevents clouds from being formed
- Alters regional weather patterns and rainfall

SNOW & ICE

Accelerates the melting of snow and ice

AGRICULTURE & ECOSYSTEMS

- Reduces sunlight
- Affects plant health and productivity

Black Carbon: Mitigation Options

HOUSEHOLD ENERGY

- Replace traditional cooking to clean burning modern fuel cookstoves
- Replace traditional cooking and heating with clean-burning biomass stoves
- Eliminate kerosene lamps
- Replace lump coal with coal briquettes for cooking and heating
- Replace wood stove and burners with pellet stoves and boilers

INDUSTRIAL PRODUCTION

- Modernize traditional brick kilns to vertical shaft brick kilns
- Modernize coke ovens to recovery ovens

TRANSPORT

- Use diesel particulate filters for road and off-road vehicles
- Fast transition to Euro VI/6 vehicles and soot-free buses and trucks
- Eliminate high-emitting diesel vehicles

AGRICULTURE

- Ban open-field burning of agricultural waste

FOSSIL FUELS

- Capture and improve oil flaring and gas production

WASTE MANAGEMENT

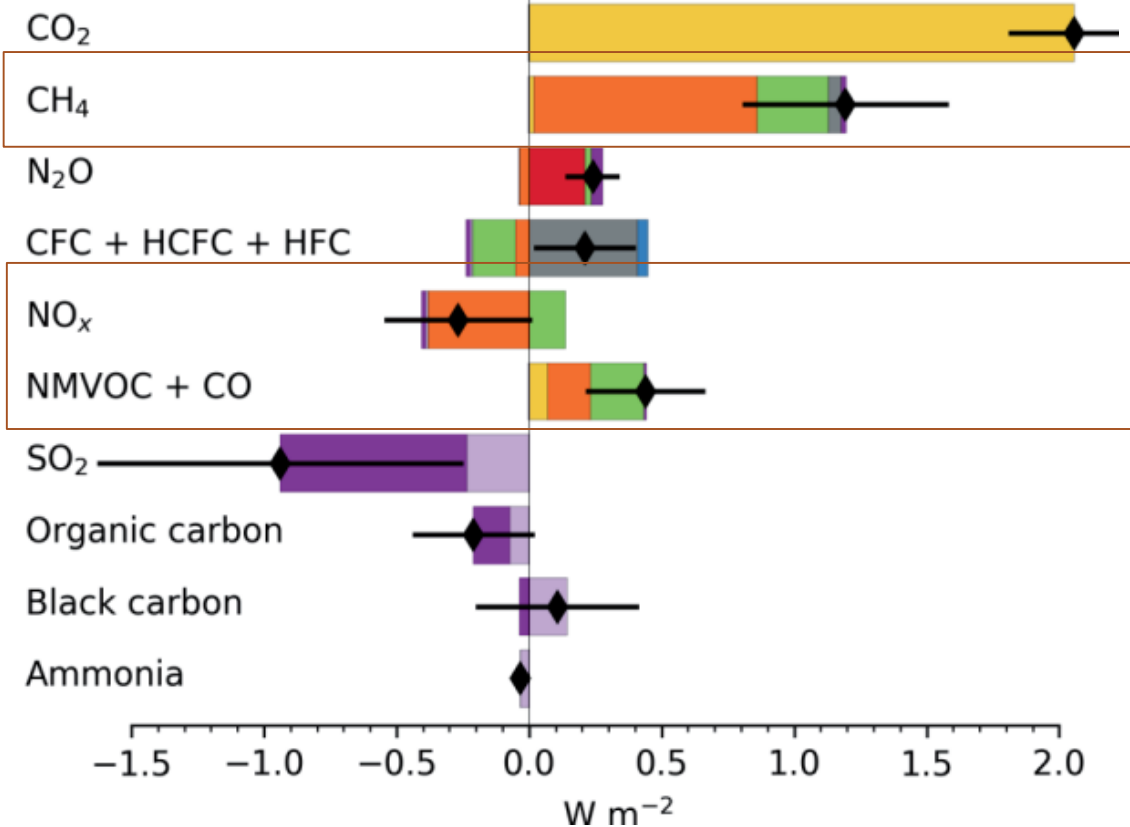
- Ban open burning of municipal waste

Ozone Precursors and Radiative Forcing

(a) Effective radiative forcing

1750 to 2019

Emitted Components



Climate effect through:

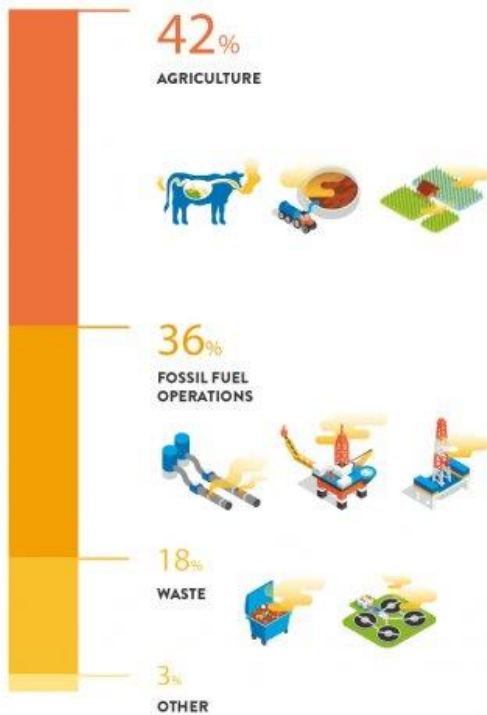
- Carbon dioxide (CO₂)
- N₂O
- CFC + HCFC
- HFC
- Methane (CH₄)
- Ozone (O₃)
- H₂O (strat)
- Aerosol-radiation
- Aerosol-cloud
- Sum

METHANE (CH₄)

Methane emissions caused by human activities are one of the most significant drivers of climate change. Methane is also the main precursor of tropospheric ozone, a powerful greenhouse gas and air pollutant.

SOURCES

Methane is one of the fastest growing greenhouse gases in the atmosphere. Human activity causes 2/3 of emissions.



% = global emissions

IMPACTS

CLIMATE

Responsible for 40% of warming since the industrial revolution

86x

times more powerful than carbon dioxide over a 20-year period

HEALTH

Increasing emissions are driving a rise in tropospheric ozone air pollution, which causes 1+ million premature deaths annually. Methane is responsible for roughly 1/2 of these deaths.



Respiratory diseases
Heart disease
Damaged airways and lung tissue

AGRICULTURE & ECOSYSTEMS



Up to 15% annual yield losses of soy, wheat, rice and maize

LIFETIME IN ATMOSPHERE: 12 YEARS

Since methane does not last long in the atmosphere, efforts to reduce it will bring immediate benefits for the climate and human health.

Methane: Mitigation Options

AGRICULTURE

- Improve manure management and animal feed quality
- Apply intermittent aeration of continuously flooded rice paddies
- Improve animal health and husbandry by combining herd and health management, nutrition and feeding management strategies
- Introduce selective breeding to reduce emission intensity and increase production
- Promote farm-scale anaerobic digestion to control methane emissions from livestock
- Adopt guidelines on healthy dietary choices

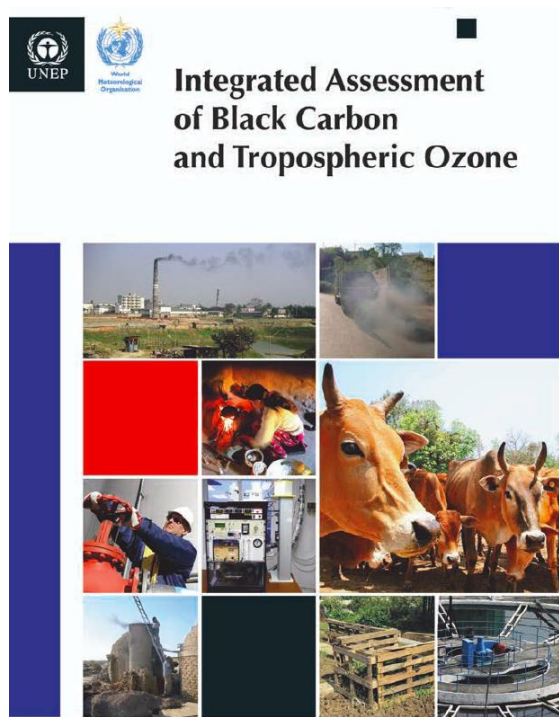
FOSSIL FUELS

- Carry out pre-mining degasification and recovery and oxidation of methane from ventilation air from coal mines
- Reduce leakage from long-distance gas transmission and distribution pipelines
- Extend recovery and utilization from gas and oil production
- Recover and use gas and fugitive emissions during oil and natural gas production

WASTE MANAGEMENT

- Separate and treat biodegradable municipal waste, and turn it into compost or bioenergy
- Upgrade wastewater treatment with gas recovery and overflow control
- Improve anaerobic digestion of solid and liquid waste by food industry
- Upgrade primary waste water treatment
- Divert organic waste
- Collect, capture and use landfill gas

Key Resources



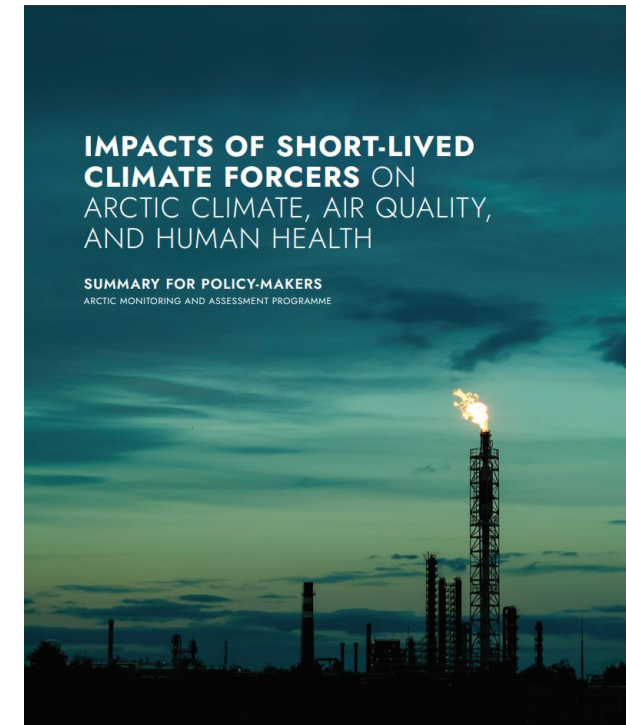
2011



2012



2021



2022

Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants



**CLIMATE &
CLEAN AIR
COALITION**

TO REDUCE SHORT-LIVED
CLIMATE POLLUTANTS

77 countries

78 non-state partners



National Planning Hub

Black carbon Methane
Tropospheric ozone
Hydrofluorocarbons (HFCs)



Cooling Hub

Black carbon
Hydrofluorocarbons (HFCs)



Household Energy Hub

Black carbon Tropospheric ozone



Heavy-Duty Vehicles and
Engines Hub

Black carbon



Agriculture Hub

Black carbon Methane



Fossil Fuels Hub

Black carbon Methane

