Application of Emissions Quantification Tool(EQT) for Estimation of GHGs/SLCPs from waste sector

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Questions

1. *What are SLCPs?*
2. *Why is it important to reduce SLCPs in addition to Carbon?*
3. *How would SLCPs affect our life, economic activity, environment and climate?*
4. *How to reduce SLCPs emissions?*

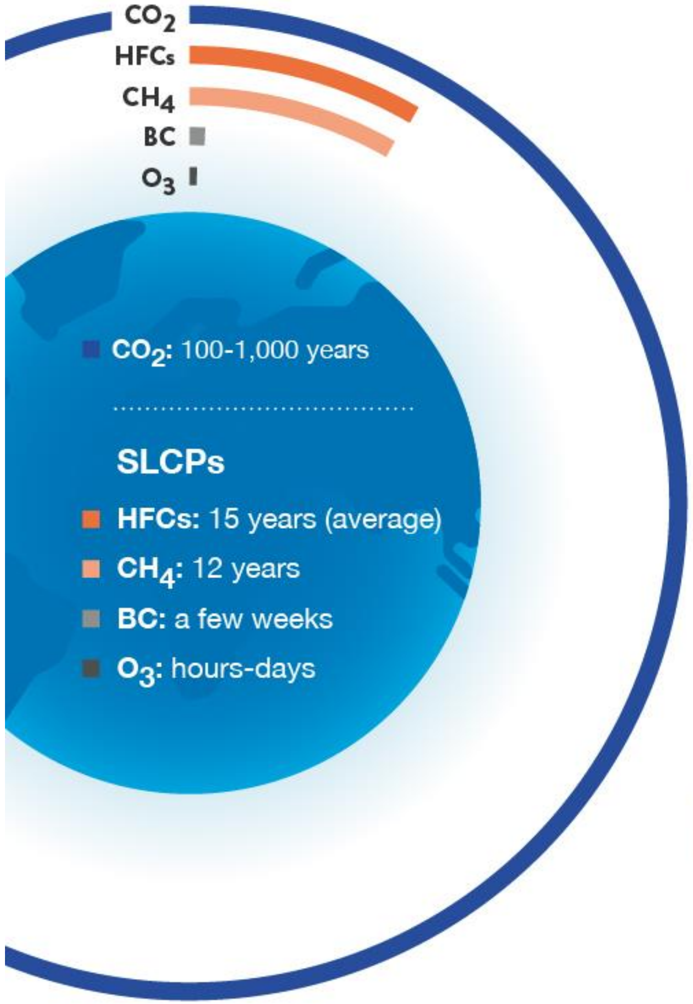
About SLCPs

name	Description	sources	Lifetime in atmosphere	impact
Black Carbon (BC)	- Product of the incomplete combustion of fossil fuels, biofuels and biomass. - Emissions are increasing rapidly in countries where air quality is not regulated and **open biomass burning** and solid fuel combustion often occurs - part of fine particulate air pollution ($PM_{2.5}$)		Days	
Methane (CH4)	- 2/3 emission is caused by human activities related to agriculture, including rice cultivation and ruminant livestock; coal mining; oil and gas production and distribution; **biomass burning**; and **municipal waste landfilling**.		12 years	
Hydrofluorocarbons (HFCs)	- Industrial chemicals used in air conditioning, refrigeration, solvents, fire extinguishing systems, and aerosols.		15 years (weighted by usage)	
Tropospheric ozone (O3)	- It is formed when sunlight interacts with different pollutants such as methane (CH4), carbon monoxide (CO), nitrogen oxides (NOx) and so on. - Major component of urban smog.		weeks	

SHORT-LIVED CLIMATE POLLUTANTS

Short-lived climate pollutants (SLCPs) are powerful climate forcers that remain in the atmosphere for a much shorter period of time than carbon dioxide (CO_2), yet their potential to warm the atmosphere can be many times greater.

LIFETIME IN ATMOSPHERE



CLIMATE IMPACTS

HYDROFLUOROCARBONS (HFCs)
1,500x
(average)

BLACK CARBON (BC)
900x

METHANE (CH_4)
84x

CO_2 • **1x**

SOURCES

Over a 20-year period, SLCPs are many times more powerful than CO_2

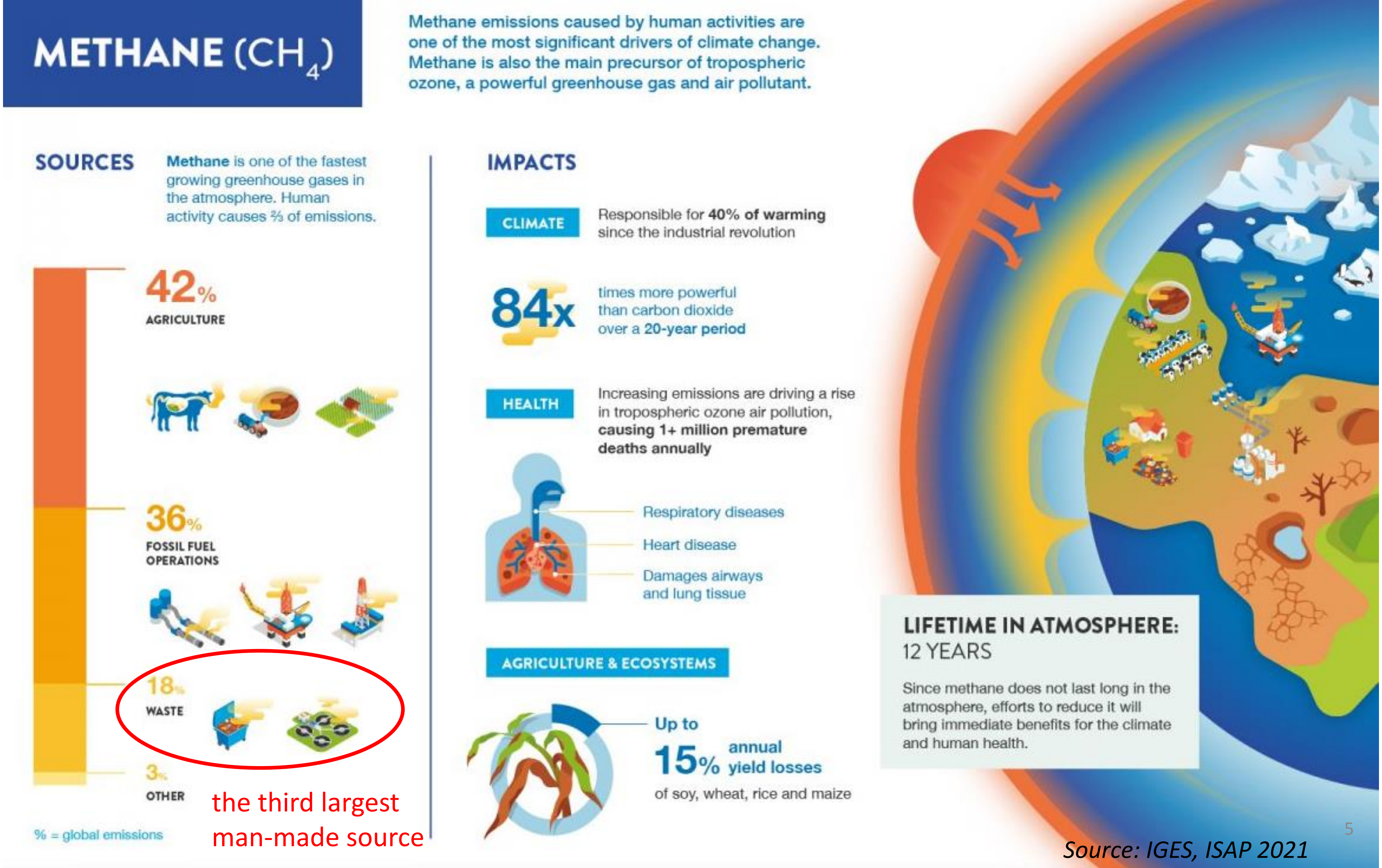
SLCP IMPACTS

- Warm the atmosphere
- Cause disease and premature deaths
- Reduce staple crop yields
- Damage ecosystems
- Accelerate melting of snow and ice
- Disrupt weather patterns

SLCP SOLUTIONS

Due to their relatively short lifetime in the atmosphere, reducing SLCPs can bring immediate climate and air quality benefits. Emissions can be cut quickly using cost-effective technologies and practices that exist today.

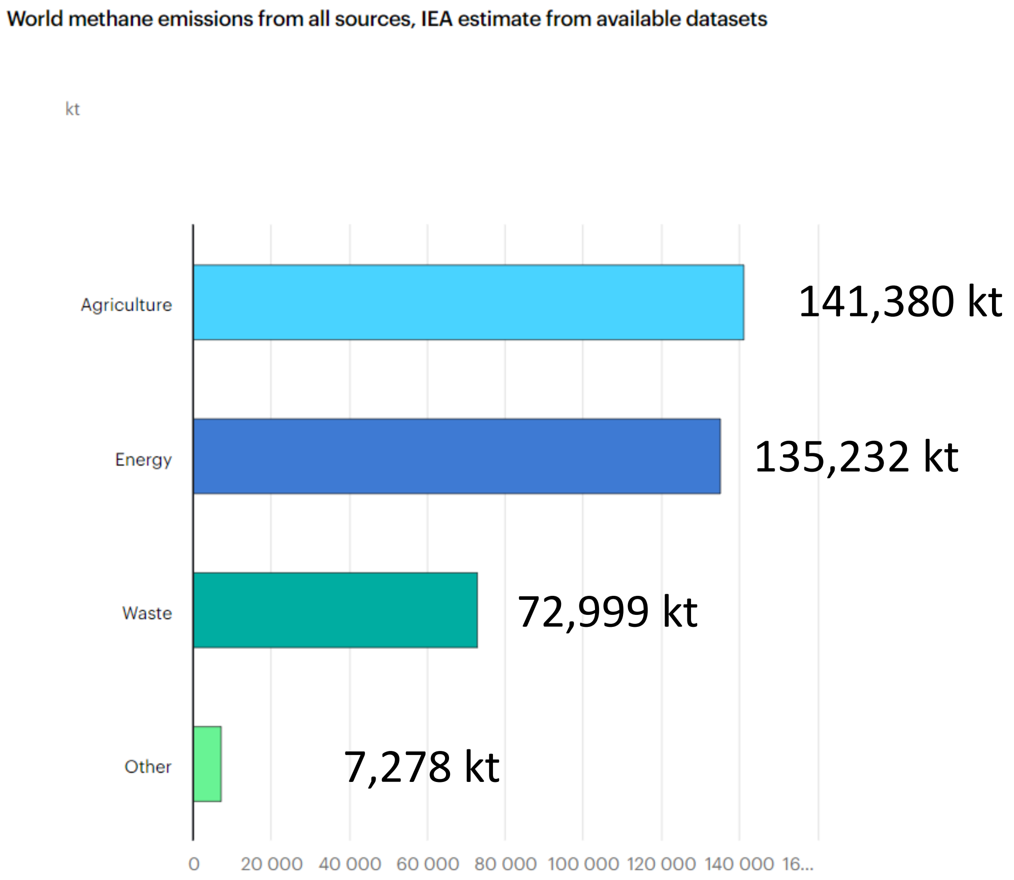
	Emissions reduction potential	
Black carbon	70%	by 2030
Methane	45%	
Hydrofluorocarbons	56%	

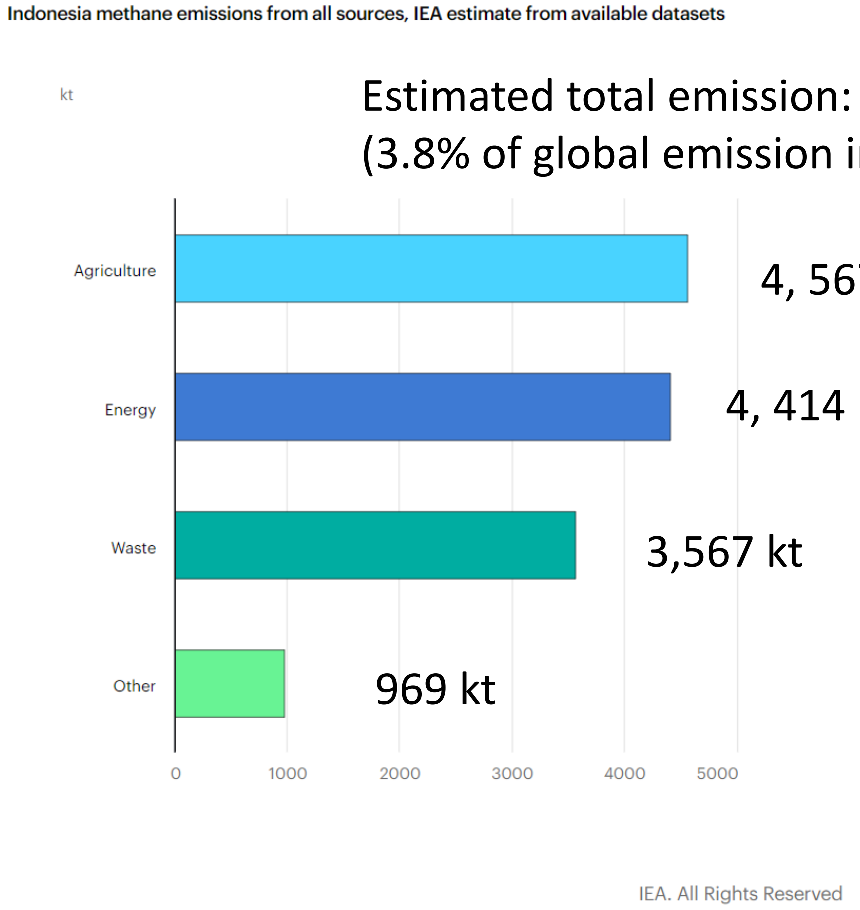


the third largest man-made source

Source: IGES, ISAP 2021

Methane emissions from all sectors (global vs Indonesia)





Estimated total emission: 13,517 kt
(3.8% of global emission in 2021)

https://www.iea.org/data-and-statistics/data-tools/methane-tracker

Impact / benefit

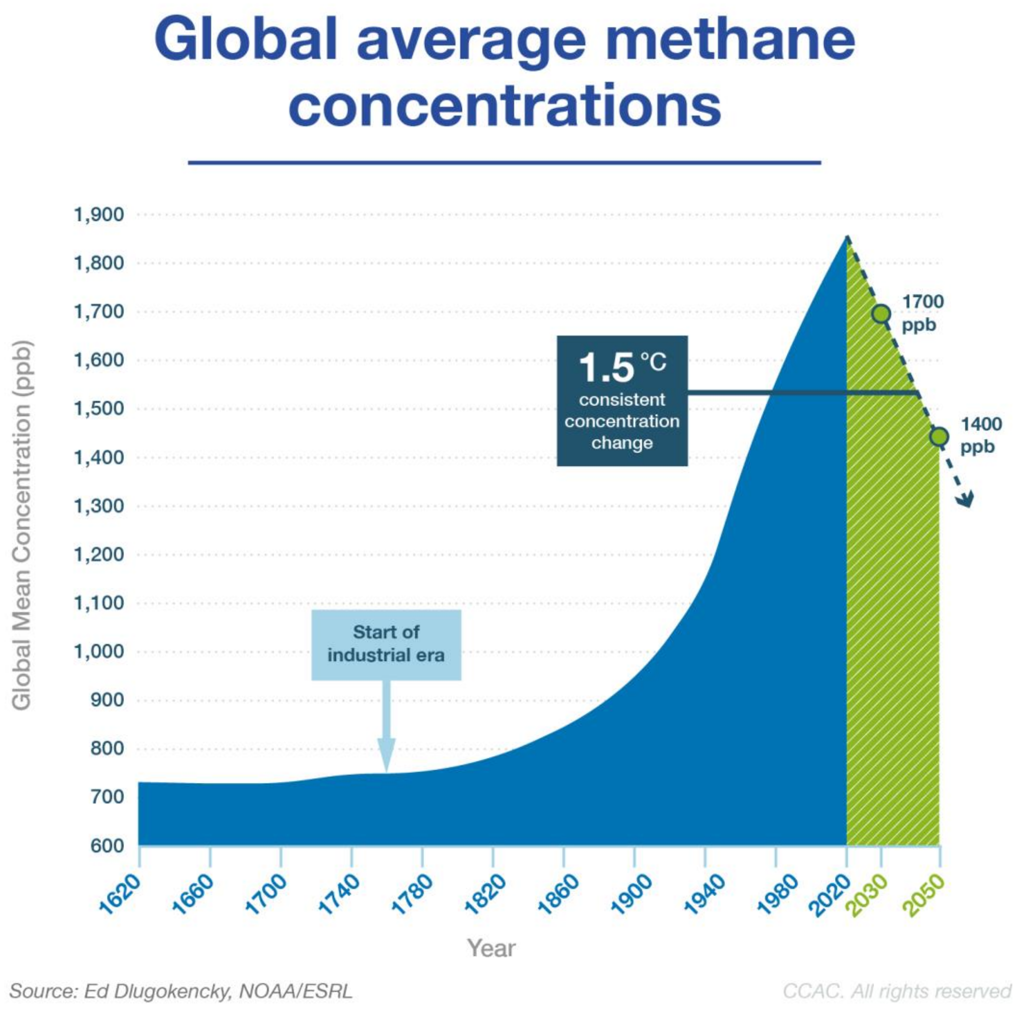
Areas	Description
Climate	Reduction of SLCPs emission has the potential to reduce the amount of warming by as much as 0.6 ° C.
Health	Nearly 7 million people die every year from the indoor and outdoor air pollution (O3, PM2.5) where SLPCs are largely responsible for.
Agriculture	- Tropospheric ozone exposure lower the yield by 12% for wheat, 16% for soybean, 4% for rice, and 5% for maize. - Through the collection of landfill gas or the recovery of methane emissions, there is a potential to avoid the annual loss of more than 50 million tons of crops.

This is why

- SLCPs (BC, CH_4, O_3, HFCs) are responsible for up to 45% of current **global warming** after CO_2.
- Open burning of waste in developing countries is a significant local source of **air pollution**, constituting a health risk for nearby communities.
- Reduction of BC and CH_4 in key sectors could reduce projected global warming by 0.5℃ by 2050, avoid millions of **premature deaths** from air pollution annually, prevent millions of tons of annual **crop losses**, and increase **energy efficiency** (CH_4 can be a source of electricity generation)

Global trend of methane emission

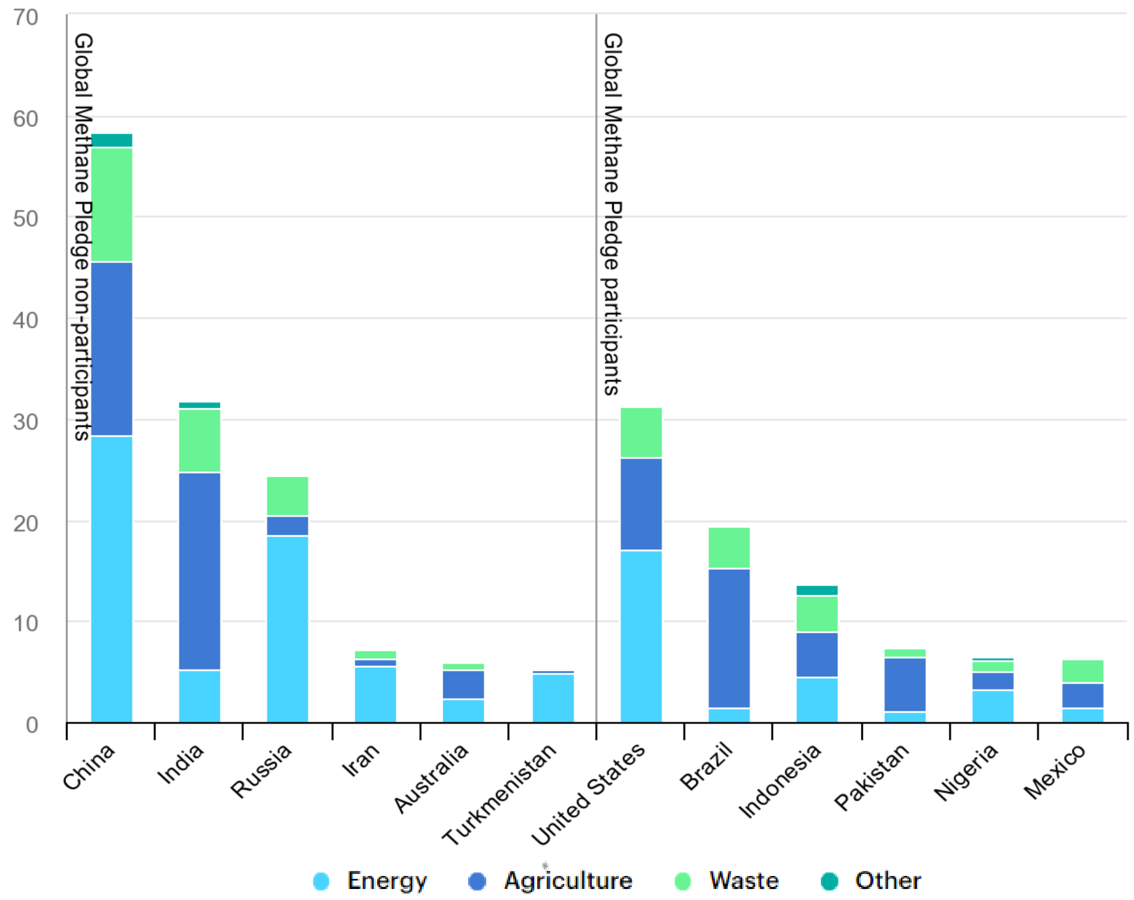
- The atmospheric concentration of methane is increasing faster now than at any time in the observational record.
- Methane emissions are projected to continue rising through at least 2040
- Current concentrations are well above levels in the 2°C scenarios used in the IPCC's 2013 Assessment
- The Paris Agreement's 1.5°C target cannot be achieved at a reasonable cost without reducing methane emissions by 40–45 per cent by 2030→ is it realistic target?



Source: IGES, ISAP 2021

How much do we need to reduce methane emission?

Top twelve emitters of methane with breakdown by sector, 2021



The participant countries in the Global Methane Pledge which was launched at COP26 in 2021 commit to work together to collectively reduce methane emissions by at least 30% below 2020 levels by 2030 to eliminate over 0.2℃ warming by 2050.

GHGs/SLCPs emission from waste sector

- **GHGs:** Carbon dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) .
- **SLCPs:** Methane (CH_4) and Black Carbon (BC)

- Post-consumer waste is a small contributor to global GHG emissions (<5%) with total emissions of approx. 1,300 MtCO2-eq in 2005
- Major GHG emissions from waste sector
  - Landfill methane CH4 through anaerobic decomposition of organic waste
  - CH4 and Nitrous oxide (N2O) from wastewater transport, sewage (incl. human waste) treatment, and leakage
- Minor GHG emissions from waste sector
  - CO2 and N2O from incineration of plastic, synthetic textiles (CO2 emission from biomass sources are not taken into account in GHG inventories)
  - 40% of waste is said to be openly burned globally. Open burning and the use of polluting collection vehicles emit black carbon.
- Indirect contribution to GHG emission
  - CO2 reduction from 3R (reduce, reuse, recycle)

To reduce emissions from waste sector, we need to..

1. Identify current emission level
2. Find out where, what, and how much to reduce with scenario analysis for whole life cycle of waste from collection until the fate of waste
3. Analyze cost-benefit, co-benefit and side effect of each option
4. Find out how to reduce emissions (technology) with supportive policy and effective control (regulatory and financial incentive and disincentive).

* recycling, composting, and anaerobic digestion can provide large potential emission reduction but further implementation depends on reducing the cost of separate collection and establishing local markets of the products made with recycled materials

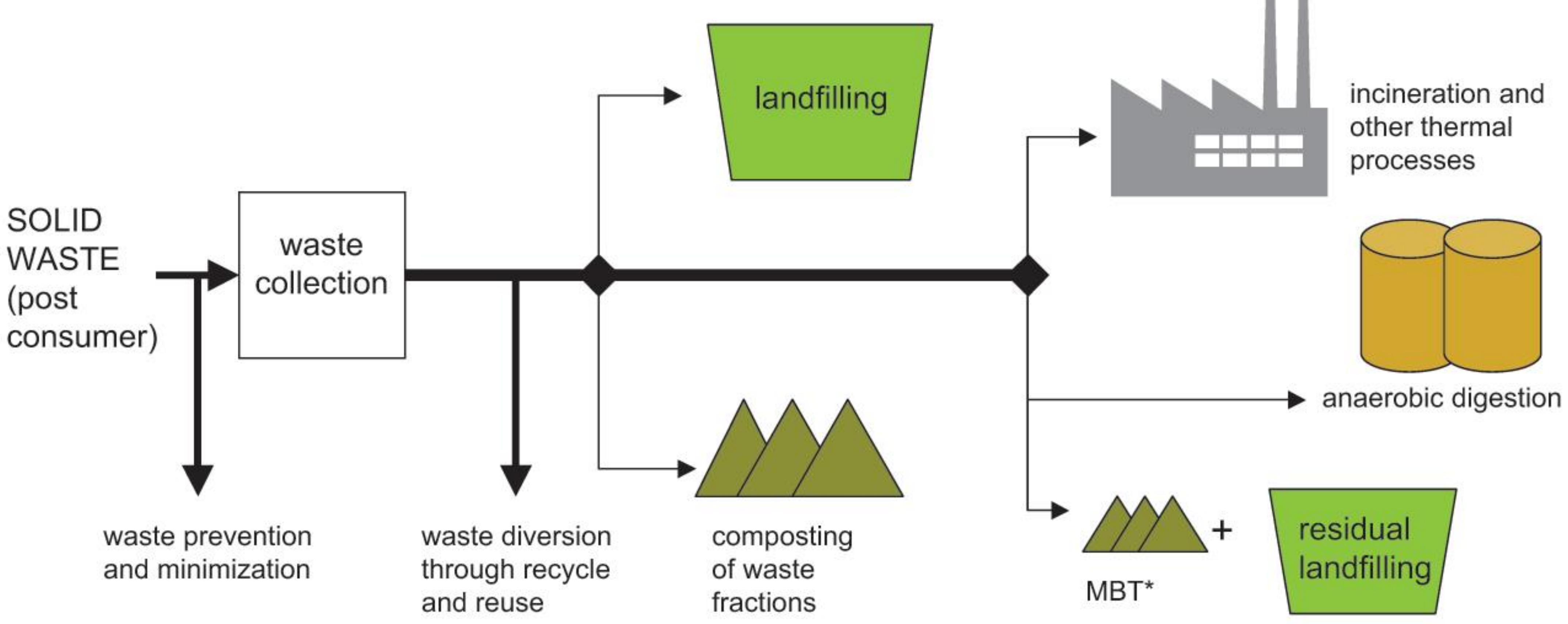
Major Challenges

- National data are not available or uncertain and definitions of waste management terminology are non-uniform and proxy to be used are variable to quantify and estimate GHG/SLCPs emissions from waste sector
- Mitigation of GHGs/SLCPs emissions from waste sector are not fully addressed in the context of integrated waste management
- Absence of Life Cycle Assessment (LCA) which is an essential too for consideration of both the direct and indirect impacts of waste management technologies and policies (Thorneloe et al., 2002; 2005)
- Unclear definition of system boundaries and selection of models with correct baseline assumptions
- Post-consumer waste that is a significant energy source is underestimated / undervalued
- Diffusion of variety of technologies are limited in developing countries due to lack of finance, policies, available land and support from general public

Available technologies for solution

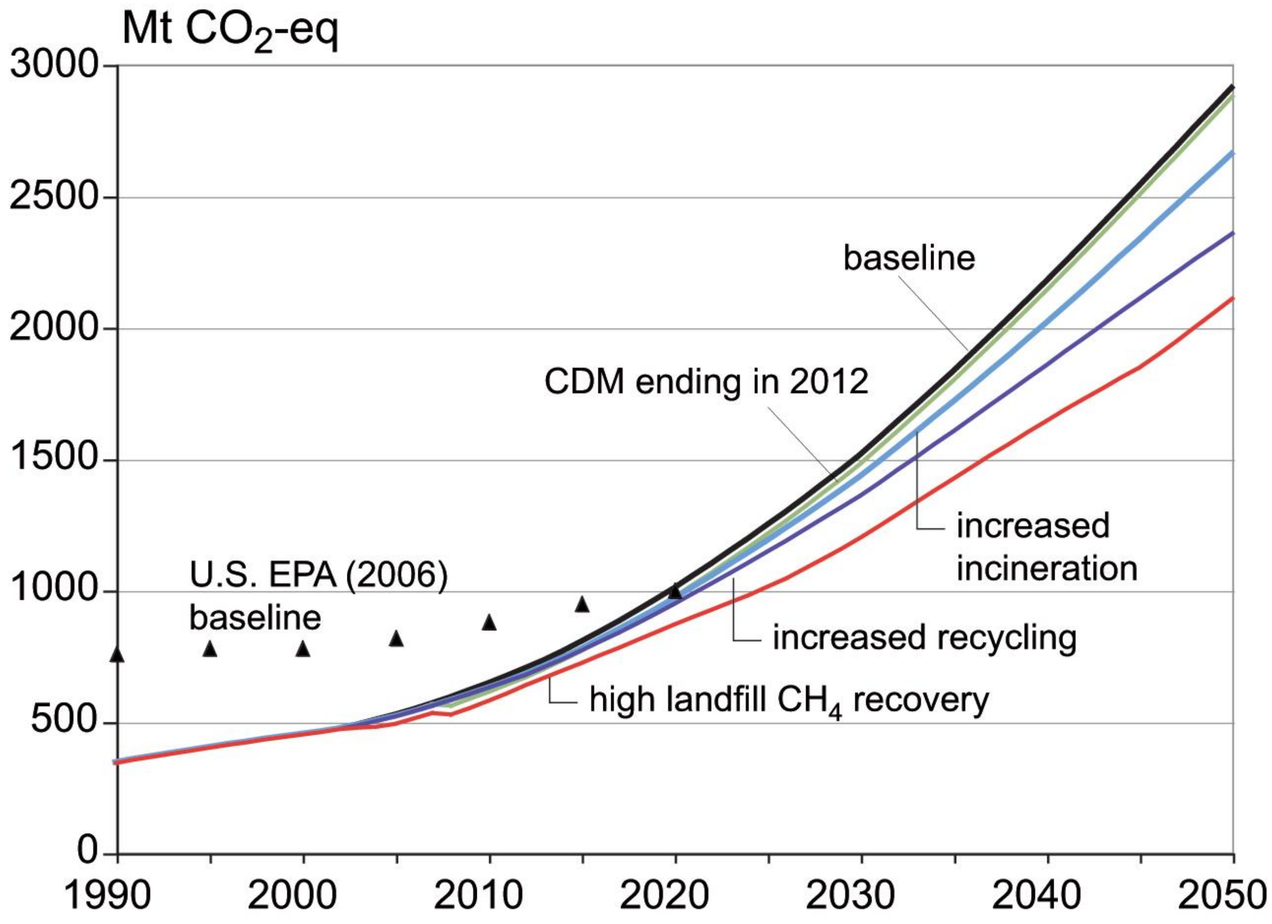
- **Organic Waste Diversion with Composting:** Minimizing the food waste sent to landfills to avoid methane generation
- **Landfill Gas Capture and Use:** Capturing or oxidizing landfill CH4 to prevent methane from entering the atmosphere.
- **Prevention of Open Waste Burning :** Promoting alternatives to open burning to reduce black carbon emissions
- **Thermal treatment:** pollution-free Incineration, RDF, industrial co-combustion, MBT with landfilling of residuals, anaerobic digestion

The mitigation of GHG emissions from waste depends on local, regional, and national drivers for both waste management and GHG/SLCP mitigation.



Technology:	Low to Intermediate	Low to Intermediate	High
Unit Cost: (per t waste)	Low to Intermediate	Low to Intermediate	High
Energy Balance	Negative to positive	Negative to positive *Composting: negative to zero* *Landfill CH_4 utilization: positive*	Negative to positive *MBT (aerobic): negative* *MBT (anaerobic): positive* *Anaerobic digestion: positive* *Incineration: positive (highest)*

Global baseline scenario of CH4 emissions from landfills compared to the several mitigation scenarios



Converting uncontrolled dumpsites to engineered / sanitary landfill sites in developing countries is one of the environmentally acceptable and less costly solutions that would significantly contribute to mitigation of climate change and crop loss through methane reduction, and improvement of public health by minimizing pollution at the same time.

https://www.ipcc.ch/report/ar4/wg3/waste-management/ Data in 2006 used

Waste disposal management strategies

Country, region	Management Strategy
EU	- landfilling of organic waste is being phased out via the landfill directive. - As a result, post-consumer waste are now diverted to WtE incineration and MBT before landfilling to 1) recover recyclables and 2) reduce organic carbon content by a partial aerobic composting or anaerobic digestion
Japan	- Both recycling and incineration are practiced at high rate due to limitation of the land availability - Semi-aerobic landfills (Fukuoka method) to avoid methane generation
USA, Canada, Australia and New Zealand	- Controlled landfilling is a dominant method for large-scale waste disposal with mandated compliance to both landfilling and air-quality regulations assisted by national tax credits and local renewable-energy /green power initiatives - Incineration is not implemented widely due to low landfill tipping fees, negative public perceptions, and high capital costs
Developing countries	- Restricting open dumping of waste and reducing waste that is transported to the final disposal site - Controlling disposal sites to be engineered /sanitary landfill site

Quiz 1

- Is methane GHG or SLCP?
    1. GHG
    2. SLCP
    3. both

Quiz 2

- The atmospheric concentration of methane is increasing faster now than at any time in the observational record. How much % of methane needs to be reduced by 2030 from waste sector according to Global Methane Pledge?
  1. 10-30%
  2. At least 30%
  3. More than 60%
  4. Country can decide the target

Quiz 3

- What are the sources of black carbon emission from the waste sector? Select multiple answers.
  1. Burning waste
  2. Burying waste
  3. Dumping waste at open area
  4. Transport of waste
  5. Composting
  6. Incinerator