



Emission Inventory and mitigation potential of GHGs and harmful air pollutants from household cooking in Nepal

Technological and Socio-economic solutions to reduce indoor air pollution in Nepal (SmokeFreeHomes-Nepal)
(Funded by Ministry for Foreign Affairs of Finland)

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Square Hotel, Lalitpur, Nepal

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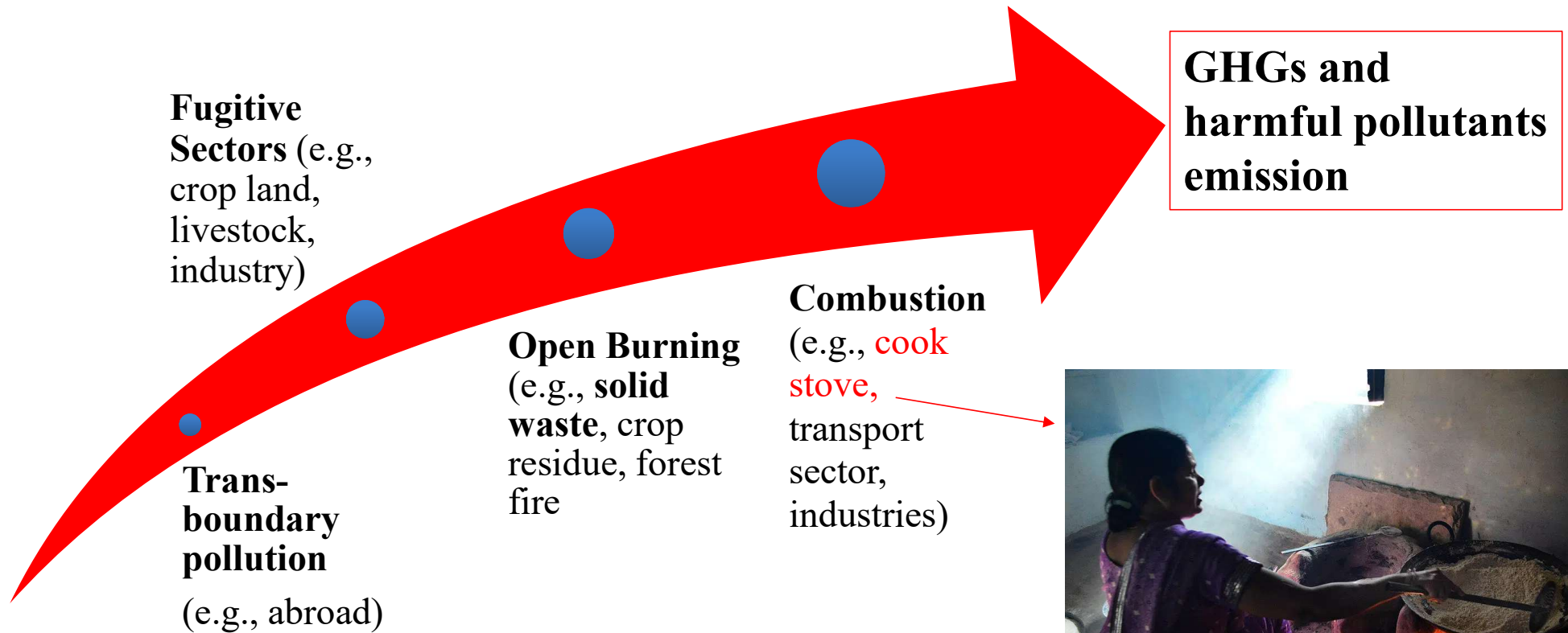


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Introduction

- ❑ Energy is crucial for economic development globally and nationally, with studies showing its usage interlinked with various aspects of development, including those in developing countries like Nepal (Lloyd, 2017).
- ❑ Nepal's energy resources are categorized into traditional, commercial, and alternative sources, with traditional energy consumption dominating at 64.17%, followed by commercial at 28.35%, grid electricity at 4.966%, and renewables at 2.52% (WECS, 2023).
- ❑ Clean fuel adoption in urban areas has increased by over 40%, while solid fuel use remains relatively constant in rural areas (Paudel et al., 2021).
- ❑ Despite the implementation of technologies like ICS, biogas, and LPG in cooking scenarios, electricity and solar cooking technologies are less frequently utilized (AEPC, 2019; NEEDS/AEPC, 2019).
- ❑ Nationally Determined Contributions (NDC) and Clean Cooking emission targets foresee emission reduction of 465,000 tCO₂e by 2030.
- ❑ The Alternative Energy Promotion Center (AEPC), supported by GCF, is promoting clean cooking solutions in Nepal's Terai region to reduce greenhouse gas emissions.

About Sources of Emission

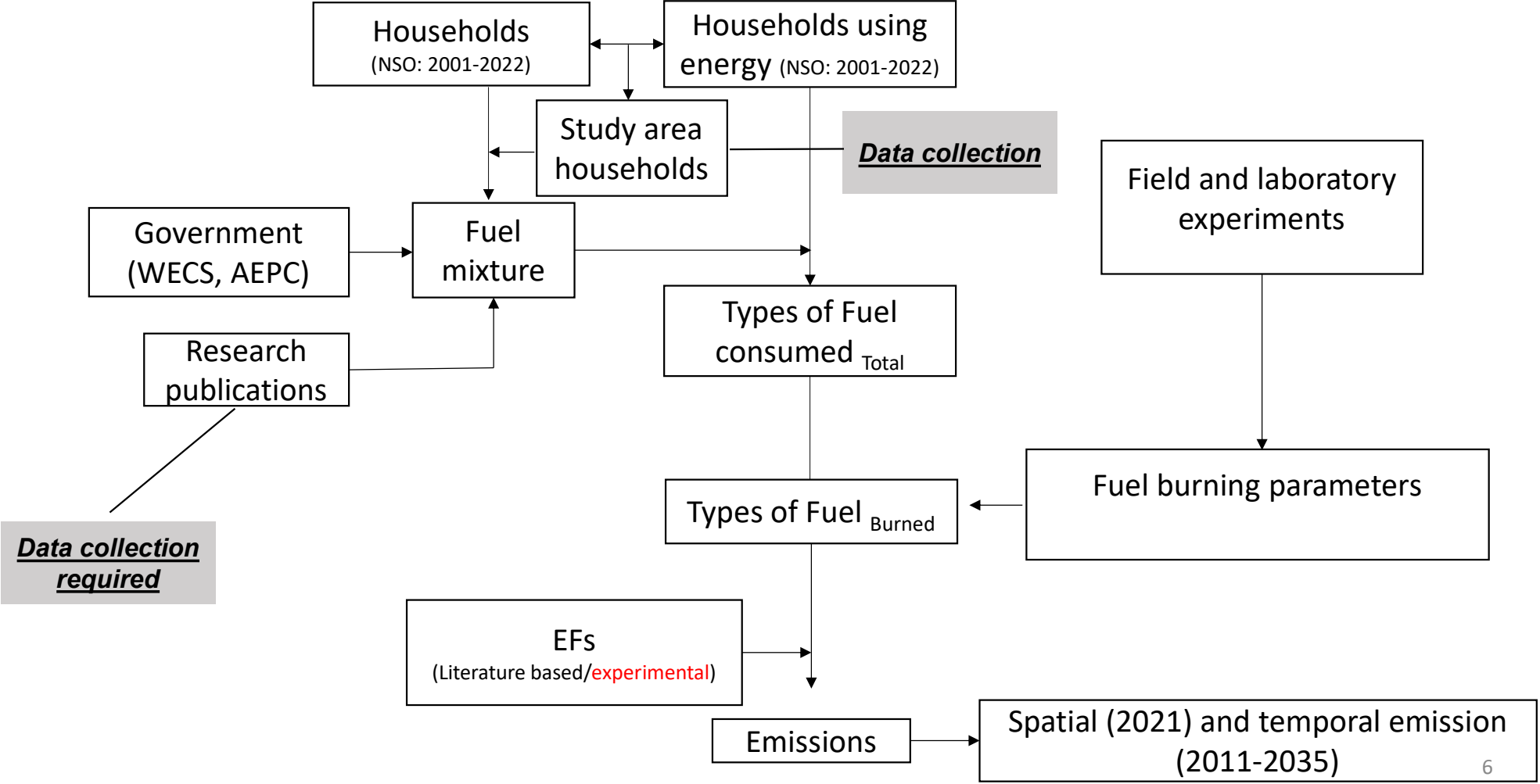


Source: <https://earth.org/what-is-indoor-air-pollution/>

Approach

1. Categorization and quantification of fuel-types.
2. Emission Factors (EFs) (from literature and experimental-based).
3. Estimation of GHGs and harmful pollutants emission.
4. Development of GHGs harmful pollutant scenarios.
5. Emission scenario from 2011-2035 in cooking sector of Nepal
6. De-carbonization trend (2026-2035).

National Emission Estimation from Cooking Sector



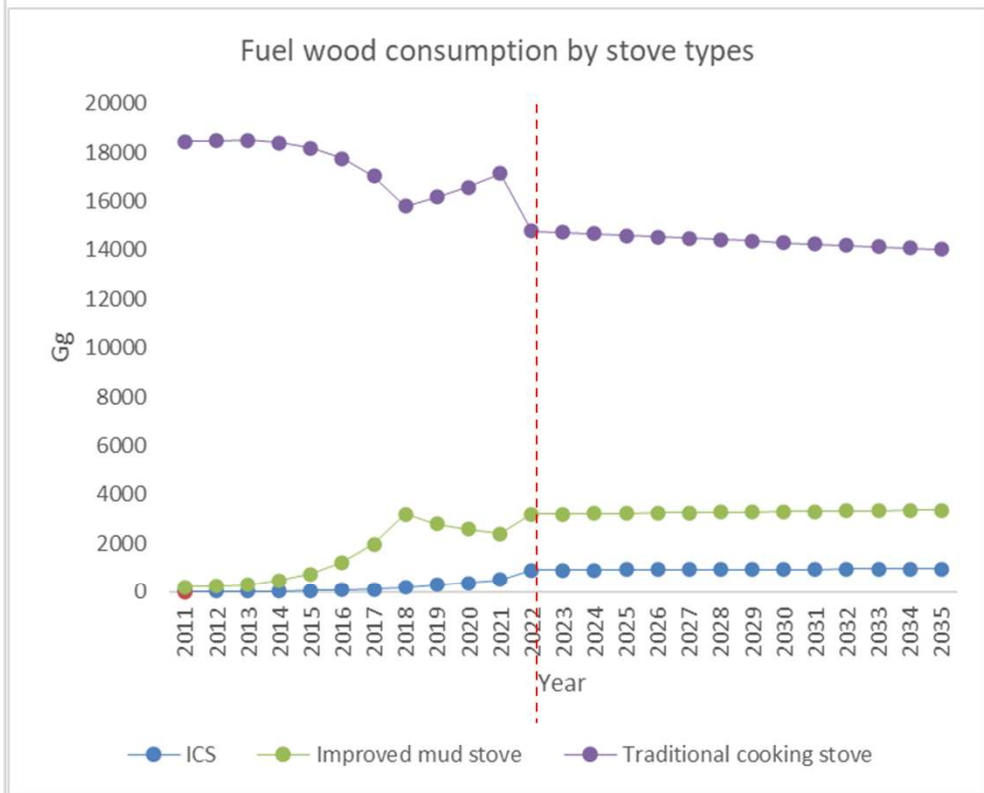
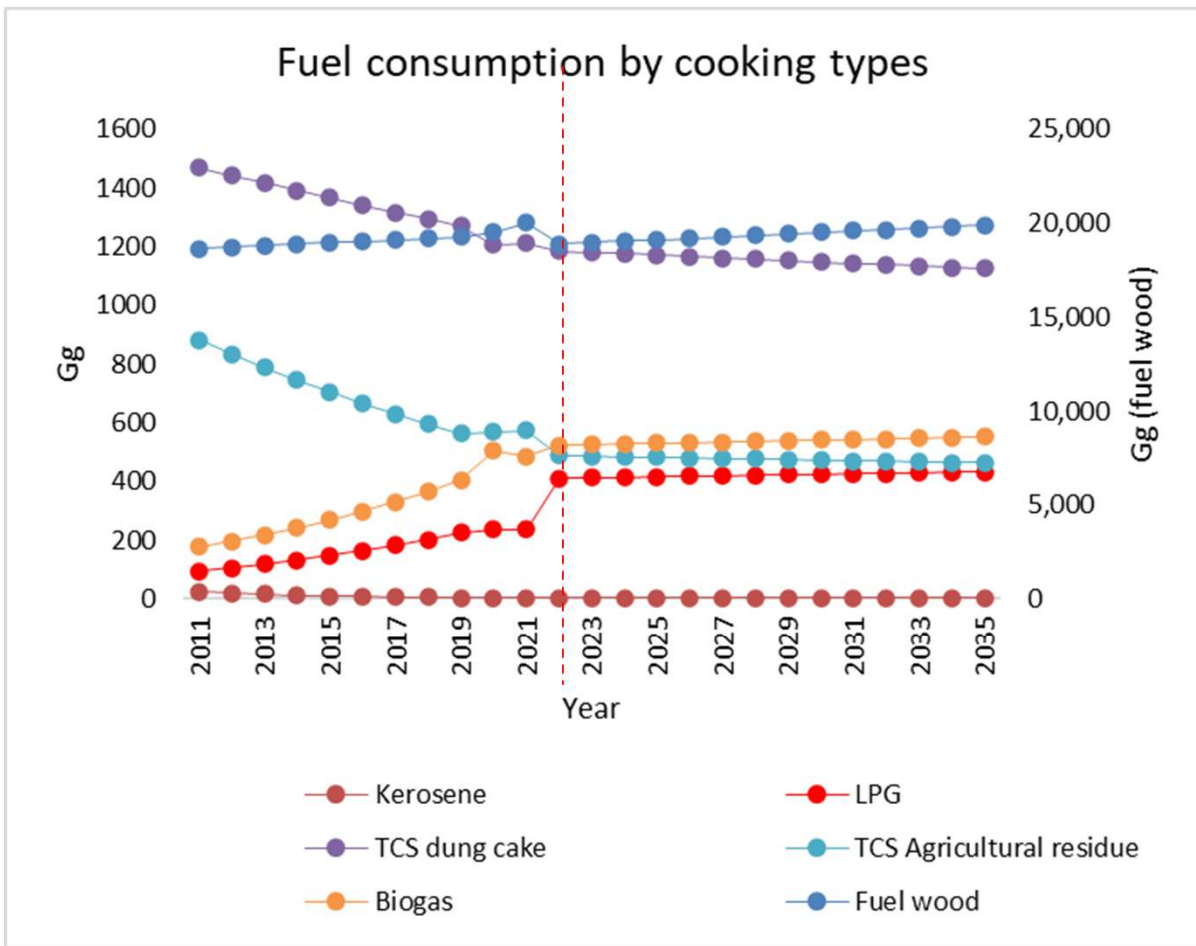
Emission Factors (kg/tons)

Emission Factor (kg/tons)									
CO2	CH4	N2O	NOx	CO	SO2	NMVOC	PM2.5	BC	OC

SN	Activities	Fuel type
1	Traditional cookstove	Fuelwood
2	Improved cookstove	Fuelwood
3	Kerosene stove	Kerosene
4	LPG stove	LPG
5	Traditional cookstove	Dung cake
6	Biogas stove	Biogas
7	Traditional cookstove	Agricultural residue
8	Electric/Induction stove	Electricity
9	Metallic stove	Fuel wood
10	Mud stove- ICS	Fuel wood

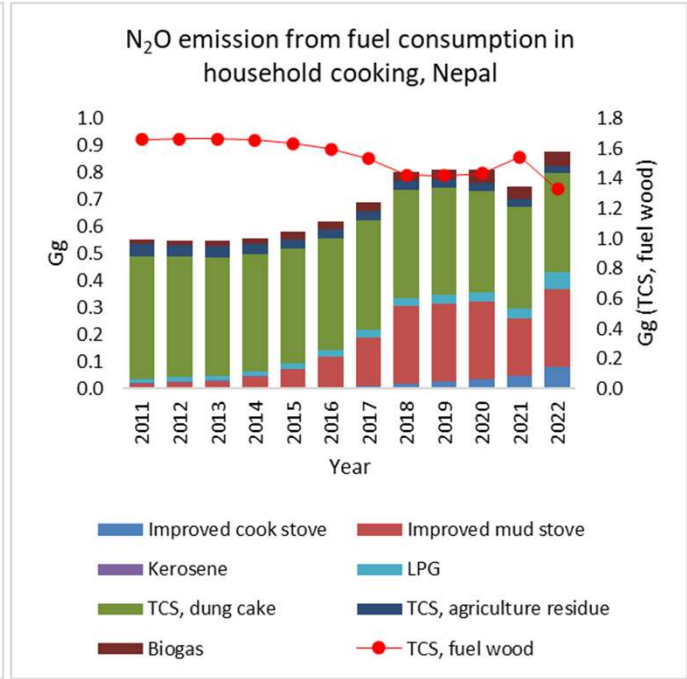
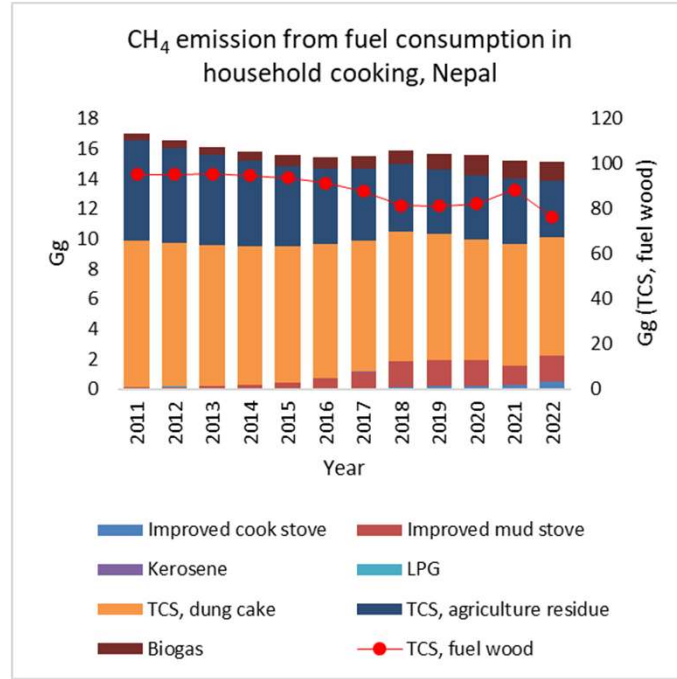
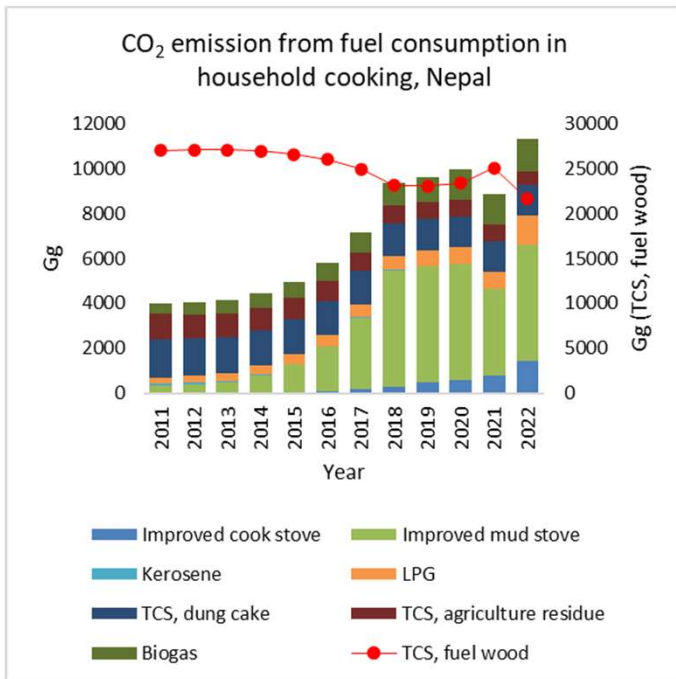
- Stockwell et al., 2016
- Jayarathne et al., 2018
- Zhang et al, 2000
- Sadavarte et al. (2019), For biogas, BC/PM and OC/PM assumed same as LPG"
- Habib et al., 2004
- Habib et al., 2008
- Smith et al, 2000
- MacCarty et al, 2008
- Sadavarte et al. (2019), SO2 based on sulfur content of the fuel
- Jaiprakash et al., 2016
- Pandey et al., 2017
- Saud et al., 2012"
- Roden et al., 2009
- Habib et al., 2004, Saud et al., 2011, Stockwell et al., 2015
- PEP, 2019

Fuel Consumption Trend in Cooking Sector, Nepal



Based on WECS, 2023; NSO, 2023; Feld Survey

GHGs Emission from Cooking Sector, Nepal

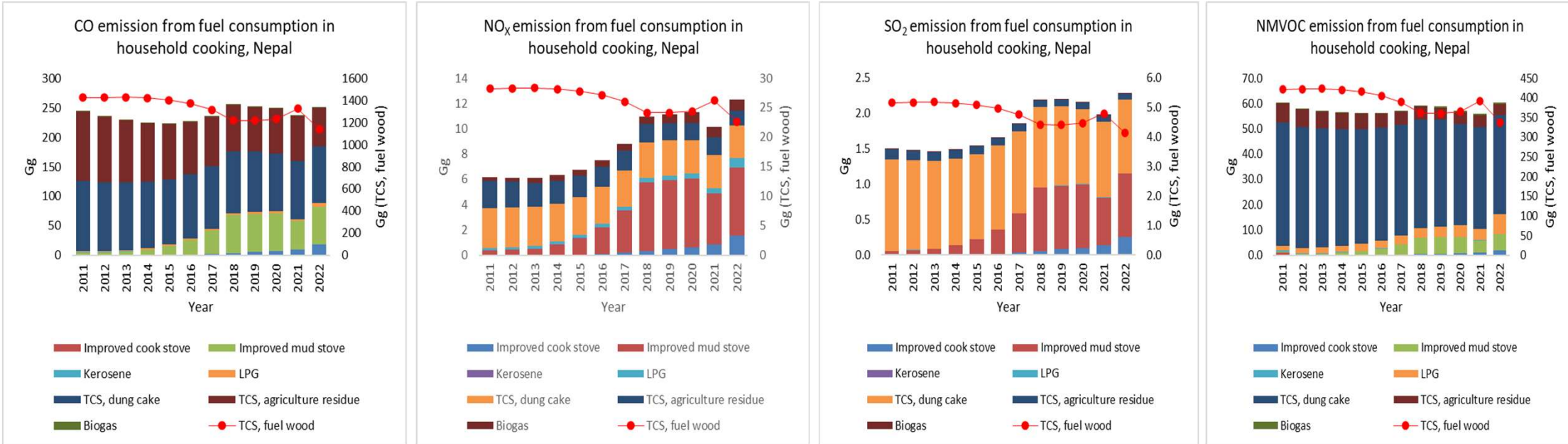


CO₂: Traditional cooking stove (TCS) fuel wood > followed by improved mud stove > TCS dung cake, etc.

CH₄: TCS fuel wood > TCS dung cake > TCS agriculture, etc.

N₂O: TCS fuel wood > TCS dung cake > improved mud stove, etc.

Harmful Gases from Cooking Sector, Nepal



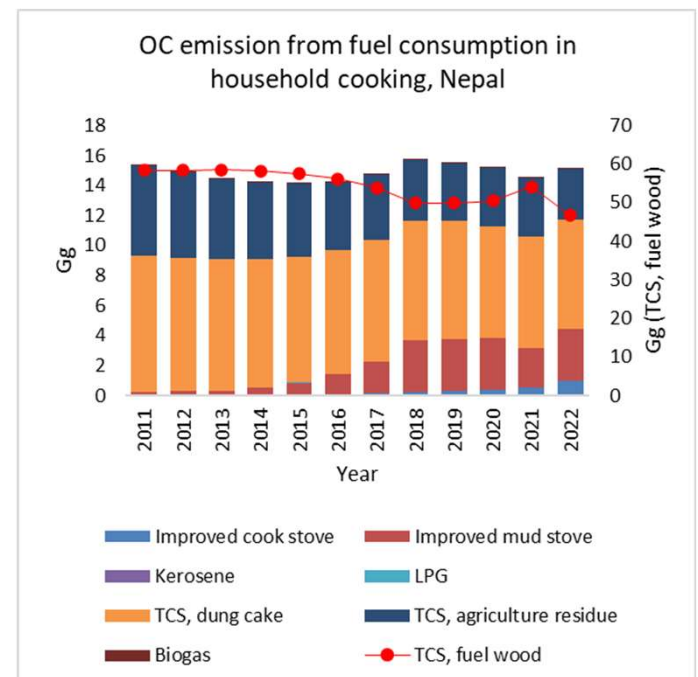
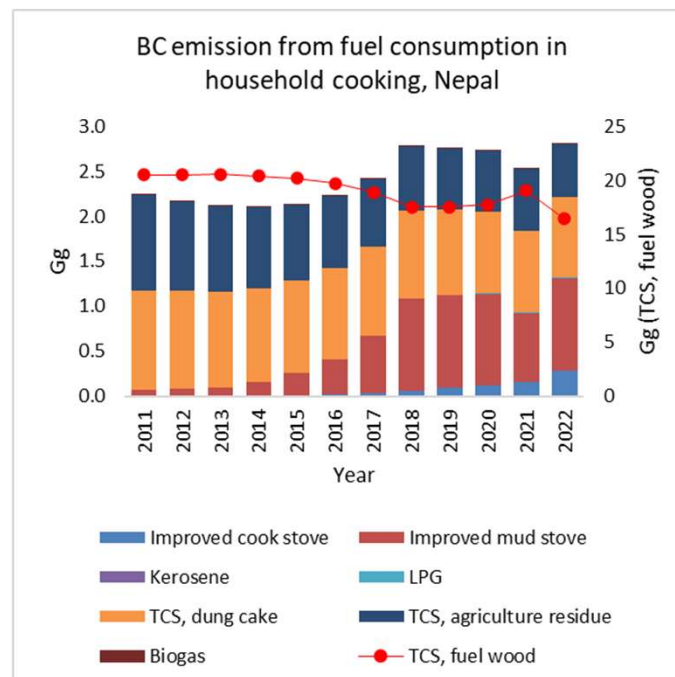
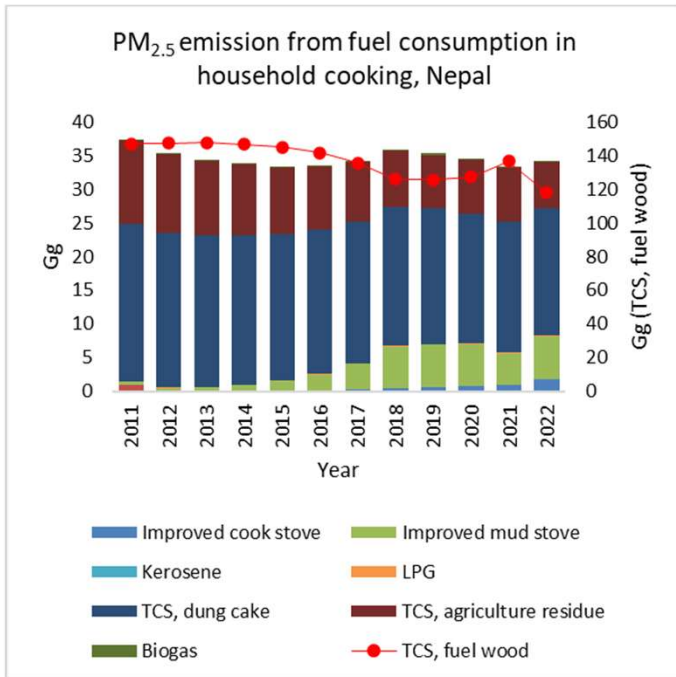
CO: Traditional cooking stove (TCS) fuel wood > TCS dung cake > TCS agriculture, etc.

NO_x: TCS fuel wood > improved mud stove > TCS dung cake, etc.

SO₂: TCS fuel wood > TCS dung cake > improved mud stove, etc.

NMVOC: TCS fuel wood > TCS dung cake > improved mud stove, etc.

Particulate Pollutants from Cooking Sector



PM_{2.5}: Traditional cooking stove (TCS) fuel wood > TCS dung cake > TCS agriculture, etc.

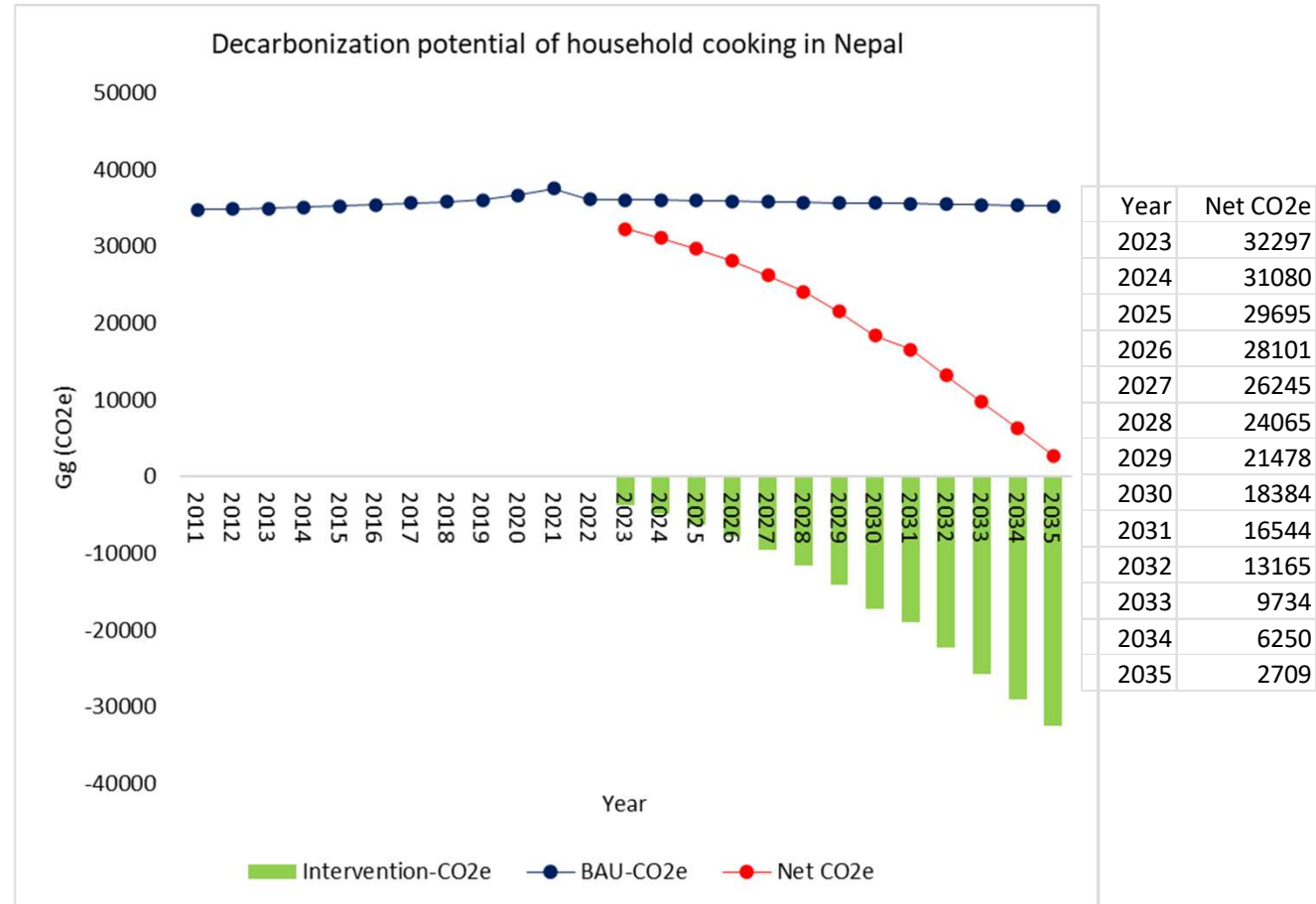
BC: TCS fuel wood > TCS dung cake > TCS agriculture, etc.

OC: TCS fuel wood > TCS dung cake > TCS agriculture, etc.

Decarbonization Potential

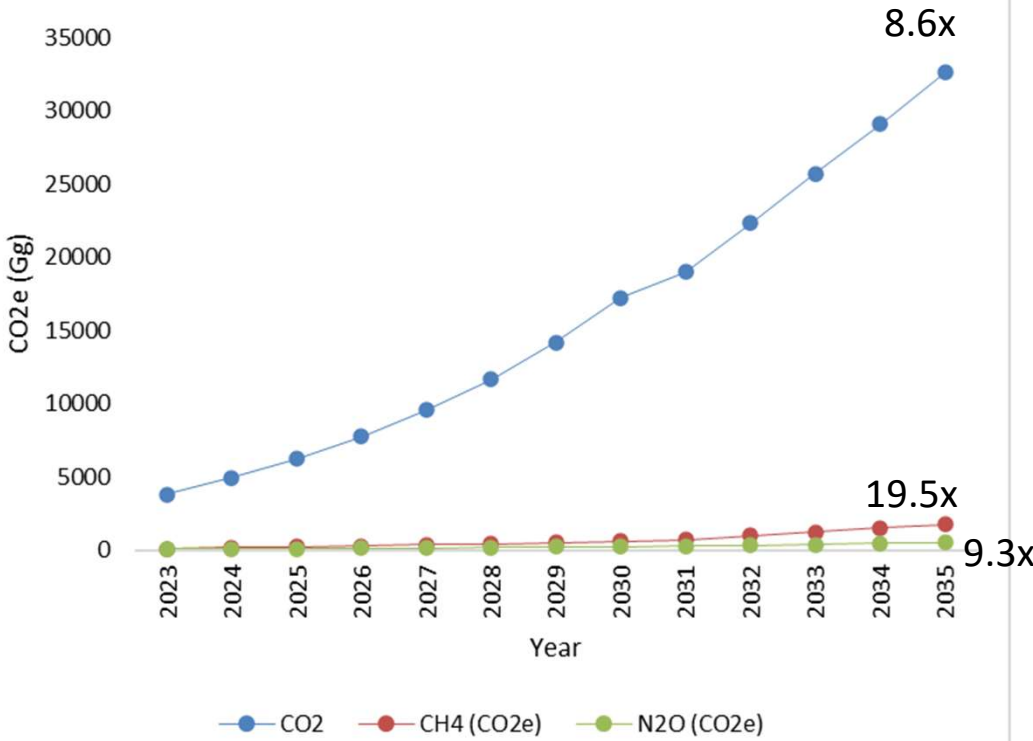
Considering NDC/international target, electricity stove, biogas, and higher tier stove (>3 tier) are kept as higher priority in each year.

	Unit	2030	2035	Source
Electric Cook stove	HHs	500000	2100000	NDC 3, 2025
ICS	HHs	798,068	1100000	NDC 3, 2025
Biogas	HHs	500000	652770	NDC 3, 2025

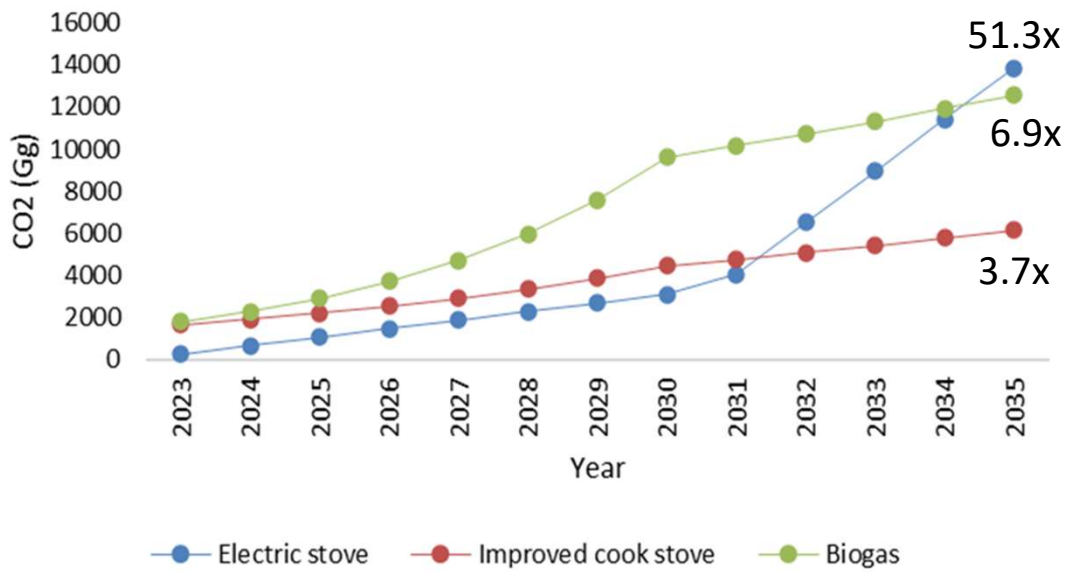


Decarbonization emission trend

Decarbonization emission trends



Decarbonization by cook types

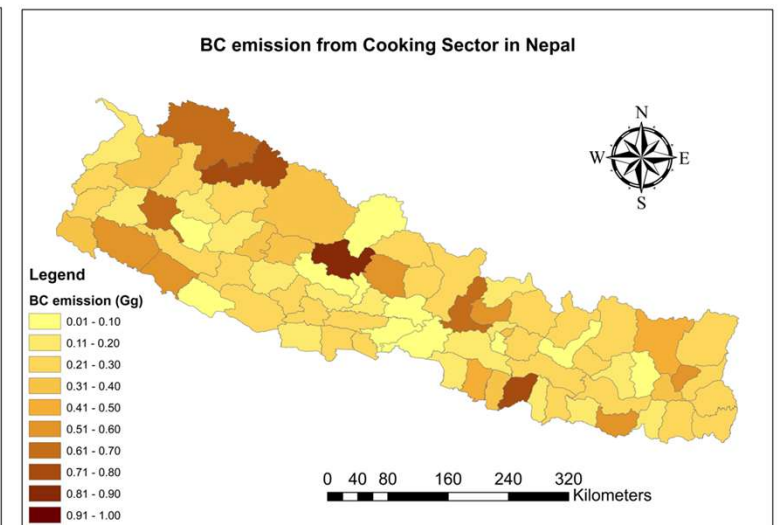
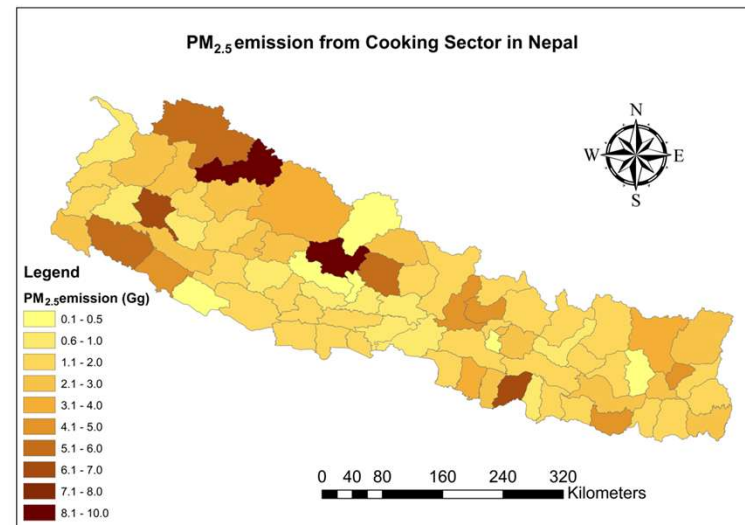
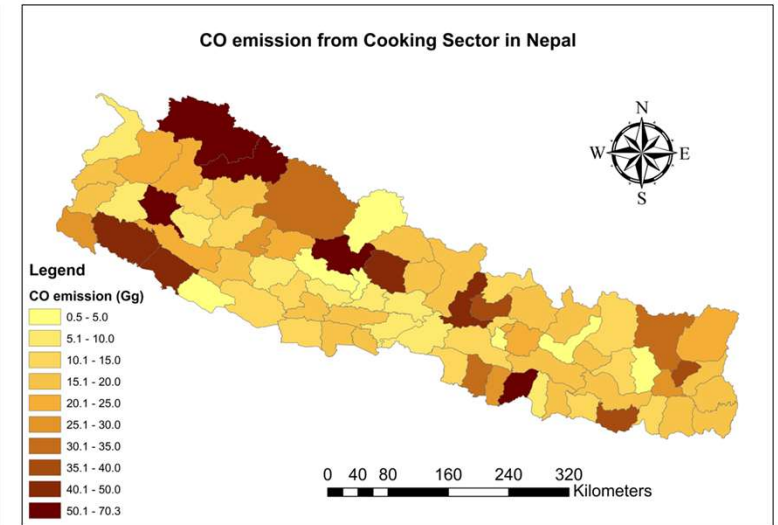
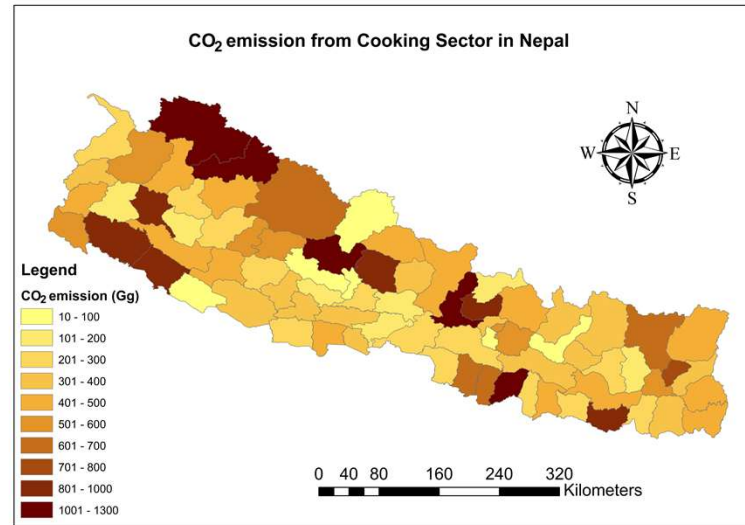


The highest decarbonization is due to electric stove > biogas > ICS

Emission from Cooking Sector

The pollutants from household cooking follows following sequences:

- Higher mountain > Mid mountain > Terai region
- Dominance of TCS fuel wood: higher and mid mountain region
- TCS dung cake and agriculture residue: Terai region.



Conclusion

1. The trend of emission increases significantly.
2. Higher mountain and mid mountain have significantly higher emission from cooking sector. Dominance of TCS fuel wood is in the higher and mid mountain region, whereas, TCS dung cake and agriculture residue in the Terai region.
3. Electricity cook stove/induction cook showed significant decarbonization, as per NDC-3 implementation.
4. To lower emissions from residential cooking sector, electric induction, followed by biogas and ICS are strongly recommended.

Way forward

1. Lab-based EFs from the University of Eastern Finland are still on progress.
2. Data validation.
3. Scientific publication.

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Progress-update2-CDES-TU-Smoke free homes

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