An Accounting Framework for Implementing India's NDC using Key Policy Analysis[1]

Jyoti R Maheshwari[1], Debashish Prusty[2], Amit Garg[1]

[1]Indian Institute of Management Ahmedabad, India; [2]Manipal University Jaipur, India

Abstract

An accounting framework for implementation of India's nationally determined contributions (NDCs) using key policy analysis is proposed. The key category analysis (KCA) for accounting GHG inventory estimation at national level is used to identify and rank the key inventory categories under the provisions of the Paris rulebook. 'Key Category' can be defined as identifying all source or sink categories having a significant influence on a country's total GHG inventory in terms of the absolute level of emissions and/or removals and the trend in emissions and/or removals (changes over a base year). The GHG emission sources or sinks are sorted and summed in descending order of magnitude, which add up to 95% of the total level (latest year) or 95% of the sum of all changes (with respect to a base year) as per their corresponding contribution to national GHG inventory.

Various mitigation policies, implemented or adopted at national level, impacting the identified key emissions categories were mapped. The mitigation policies which have significant impact on key categories and/or those contributing to the avoidance/removal of emissions were validated by assessing their aggregate effect vis-a vis overall mitigation realized from all policies put together in the pre-NDC time frame. These policies were categorized as 'Key Policies (KPs)' as they significantly impact on both GHG emission removal/avoidance as well as key inventory categories of India. This accounting method is in consonance with the accounting provisions specified under the Paris Rulebook. Figure 1 reflects proposed accounting methodology framework for implementation of India's NDC using key policy analysis.

The key categories were identified and ranked, considering India's national GHG emission inventory data, by analysing the levels and trends in emissions using India's second national communications and three biennial update reports. The emission categories or subcategories were ranked based on both level and trend of KCA to capture 95% of the total GHG emissions from national inventory between base year (2005) and the latest year (2016) reported. The developing countries may prepare the common ranking of key emission categories to capture at least 85% instead of 95% of the total GHG emissions of the national inventory at both levels and trends under

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the provision of flexibilities. The national GHG inventory data were analysed to ascertain the level and trend of KCA over 2005–2016 (refer annexure table A1).

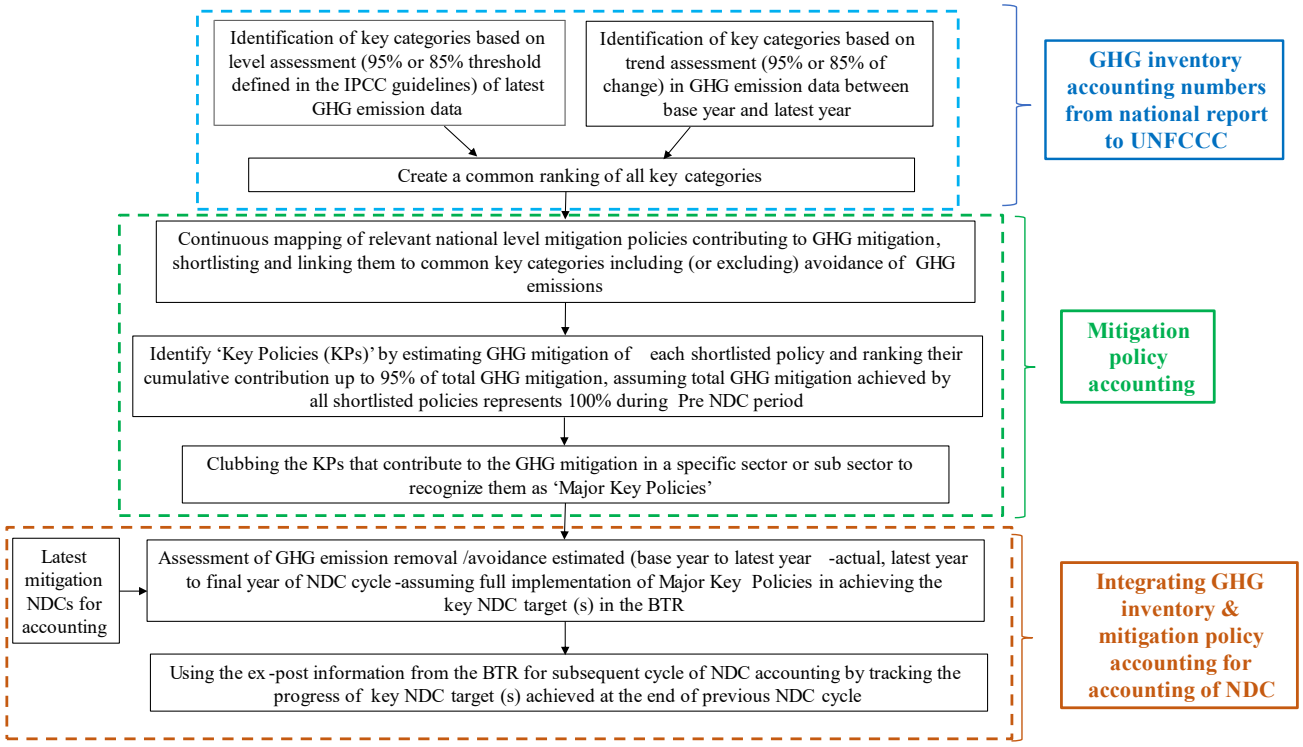

Figure 1. Proposed accounting framework for implementing India's NDC using Key Policy analysis

Source: Developed by authors

About 117 policies and measures, being implemented at national level and leading to GHG mitigation in India have been mapped with their objectives, targets, start year, sectoral coverage (energy, IPPU, transport, building, waste, etc. but excluding AFOLU), etc. Only 89 policies/measures were shortlisted from a total 117 policies/measures due to their significant impact on GHG emission mitigation for key categories. GHG emission mitigation for each of 89 policies was estimated from the start year a particular policy till 2020 and ranked these policies in descending order based on their % contribution to the GHG emission mitigation. Out of these 89 policies, 39 policies were categorized as KPs as they cumulatively contributed up to 95% of the total GHG mitigation, assuming 89 shortlisted policies contributed 100% of GHG mitigation. Furthermore, 39 KPs were systematically regrouped into 17 KPs (refer figure 1 & table 2) by merging one or more similar KPs into one generic policy, categorized as "Major Key Policies", for NDC accounting purpose. The 17 major KPs can be reported for contributing to the achievement

India's first NDC goal 3 i.e. to reduce the emissions intensity of its GDP by 33-35 percent by 2030, from 2005 level.

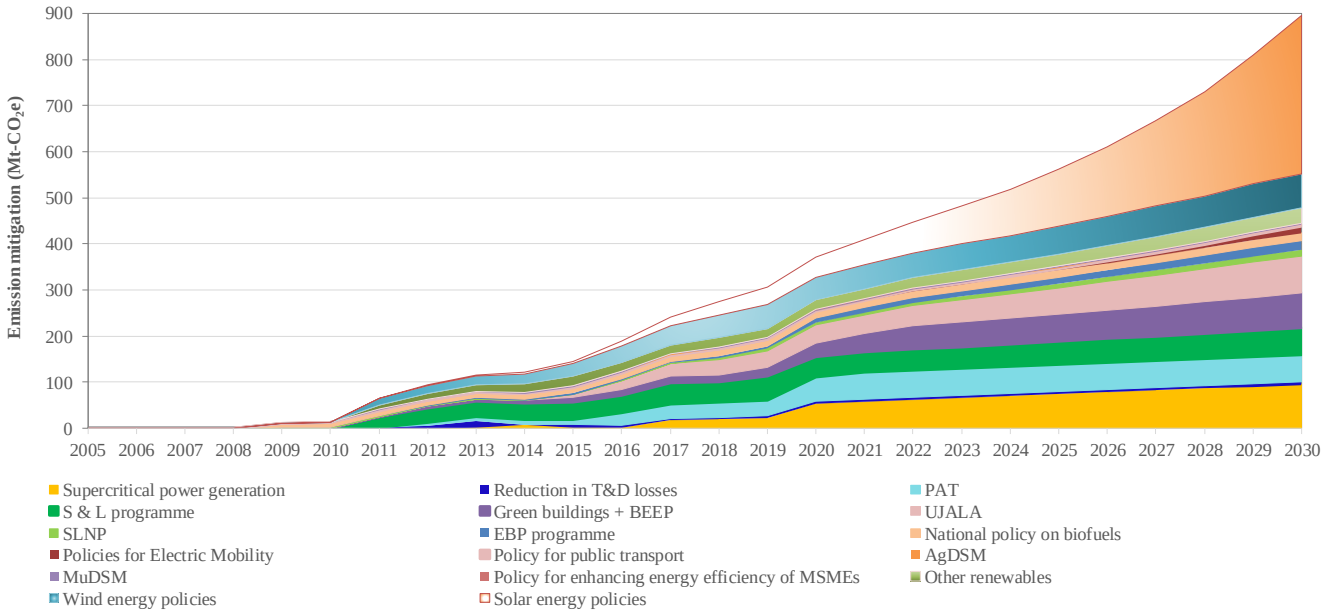

Figure 2. Mapping emission mitigation ($MtCO_2e$) of 17 major KPs from 2005 to 2030

Source: Authors' estimates

Figure 2 represents emission mitigation of 17 major key policies from 2005 to 2030 (refer Annexure 2) while table 1 presents details of these policies i.e. GHG coverage, start year, sectors affected, emission mitigations achieved by each major KPs during 2005-2020, their emission mitigation projections between 2021-2030 and cumulative mitigation during 2005-2030. The cumulative GHG emission mitigation achieved due to implementation of 17 major KPs from their respective start year to 2020 was 1.95 billion tCO_2e and mitigation projections estimated during 2021-2030 was 6.13 billion tCO_2e. Total cumulative GHG mitigation for entire NDC cycle (2005 to 2030) was about 8.08 billion tCO_2e.

Table 1. Estimated emission mitigation (avoidance) for 17 major KPs during NDC period of India

Sr. No.	Major key policy	GHG coverage	Start year	Sector affected	Emission mitigation from start year till 2020 ($MtCO_2e$)	Emission mitigation projection from 2021 to 2030 ($MtCO_2e$)	Cumulative emission mitigation from 2005 to 2030 ($MtCO_2e$)
1	Solar energy policies	CO_2, CH_4, N_2O	2010	Energy	151.7	1610.6	1762.2
2	Wind energy policies	CO_2, CH_4, N_2O	2010	Energy	328	624.4	952.4
3	Other renewables	CO_2, CH_4, N_2O	2010	Energy	170.9	271.3	442.2
4	Reduction in transmission & distribution losses	CO_2, CH_4, N_2O	2009	Energy	56.9	65.0	121.9
5	Supercritical power generation	CO_2, CH_4, N_2O	2012	Energy	125.0	761.7	886.7
6	Unnat Jyoti by Affordable LEDs for All (UJALA)	CO_2	2015	Energy	163.9	601.3	765.2
7	Street Light National Programme (SLNP)	CO_2	2015	Energy	15.6	89.4	105.0
8	Perform Achieve Trade (PAT)	CO_2, CH_4, N_2O	2012	Energy	215.5	576.1	791.6
9	Agriculture Demand Side Management (AgDSM)	CO_2, CH_4, N_2O	2008	Energy	2.4	4.0	6.4
10	Municipal DSM (MuDSM)	CO_2, CH_4, N_2O	2008	Energy	23.2	25.0	48.2
11	Green buildings & Building Energy Efficiency Programme (BEEP)	CO_2	2001/ 2017	Energy	118.8	602.6	721.4
12	Standards & Labelling (S&L) programme	CO_2	2006	Energy	381.4	513.2	894.6
13	Policies for enhancing energy efficiency of MSMEs	CO_2	2015	Energy	3.7	5.0	8.7
14	Ethanol blended petrol programme	CO_2	2009	Transport	43.7	155.6	199.3
15	National policy on biofuels	CO_2	2009	Transport	137.80 (7)	148.1	285.9
16	Policies for public transport	CO_2, CH_4, N_2O	2002/ 2006	Transport	9.1 (14)	21.2	30.3
17	Policies for electric mobility	CO_2, CH_4, N_2O	2015	Transport	2.7 (16)	55.1	57.8
	Total				**1950.2**	**6129.6**	**8079.7**

Source: Authors' estimates

As the transparency is one of the key principles of NDCs accounting, the overlaps between policies that result in double counting of mitigation GHG were identified and eliminated appropriately. The estimated double counting of GHG mitigation was approximately 2.6 $MtCO_2e$ (~0.03%) which was eliminated from cumulative GHG emission mitigation during 2005–2030.

The suggested accounting framework adopted in this study can be used for other developing country to prioritize and assess the progress of implementation of major key mitigation policies during their respective NDC period. This accounting framework should provide a level playing field to the developing countries to communicate the *ex-post* accounting-related information of the mitigation component of their NDCs and simultaneously provide them a structured framework to report their capacity-building requirements through the Biennial Transparency Reports (BTRs) in a consistent and transparent manner.

The present study has the limitation in identifying how many major Key Policies of a developing country like India require international support in terms of accessing to additional finance, international collaboration for deployment of commercial scale technologies, and reporting their capacity building gaps for support. NDC monitoring, using proposed accounting methodology, need the assessment of actual implementation of each key policy at regular interval until the current year. However, in this study it was considered that all major key policies in India will be fully implemented from the current year status to NDC end year with available domestic finance and support received from developed country parties in terms of international climate finance, technology development and transfer and capacity building.

Keywords: NDC; Key Policy; Key Category Analysis; GHG Mitigation; India

ANNEXURES

Annexure 1: Key category assessment of GHG emissions for base year and the latest year

Table A1. KCA for 2005 (base year) and 2016 (the latest year reported)

2005-Level KCA*		**2016-Level KCA**		**Trend KCA (2005–2016)**	
1A1a Electricity production, CO_2	35.05 %	1A1a Electricity production, CO_2	39.53 %	1A4a Commercials/Institutional, CO_2	23.19 %
3A1 Enteric fermentation, CH_4	11.48 %	1A3b Road transport, CO_2	8.57%	1A1a Electricity production, CO_2	19.28 %
1A3b Road transport, CO_2	8.61%	3A1 Enteric fermentation, CH_4	7.84%	3A1 Enteric fermentation, CH_4	9.49%
1A2m Nonspecific industries, CO_2	6.27%	1A2m Nonspecific industries, CO_2	6.37%	1A1b Refinery, CO_2	5.66%
1A2a Iron and steel, CO_2	3.87%	1A2a Iron and steel, CO_2	4.75%	1A4b Residential, CO_2	5.29%
3C7 Rice cultivation, CH_4	3.82%	1A4b Residential, CO_2	4.47%	1B2b Venting and flaring, CH_4	4.75%
3C4 Agricultural soils, N_2O	3.64%	2A1 Cement production, CO_2	3.75%	1A2a Iron and steel, CO_2	4.08%
1A4b Residential, CO_2	3.41%	3C4 Agricultural soils, N_2O	2.74%	2C3 Aluminum production, CF	3.39%
2A1 Cement production, CO_2	3.35%	1A1b Refinery, CO_2	2.53%	3C7 Rice cultivation, CH_4	3.28%
1A2f Cement, CO_2	2.10%	3C7 Rice cultivation, CH_4	2.51%	3C4 Agricultural soils, N_2O	2.58%
1A1b Refinery, CO_2	1.59%	1A4a Commercials/Institutional, CO_2	2.42%	2A2 Lime production, CO_2	2.53%
1B2b Natural gas, CH_4	1.20%	1A2f Cement, CO_2	1.88%	1A2b Nonferrous metals, CO_2	1.81%
4D2 Industrial wastewater, CH_4	1.18%	2C3 Aluminum production, CF	1.18%	2A1 Cement production, CO_2	1.73%
1A2c Chemicals, CO_2	1.11%	2A2 Lime production, CO_2	1.00%	2E Production of halo carbons and sulfur hexafluoride, HFC	1.57%
1A4b Residential, CH_4	0.97%	3A2 Manure management, N_2O	0.87%	3A2 Manure management, N_2O	1.16%
1A4c Agricultural/ fisheries, CO_2	0.82%	4D1 Domestic and commercial wastewater, CH_4	0.80%	1B2b Natural gas, CH_4	1.13%

4D1 Domestic and commercial waste water,CH_4	0.81%	4D2 Industrial wastewater, CH_4	0.72%	4D2 Industrial wastewater, CH_4	1.06%
1A4a Commercials/Institutional, CO_2	0.69%	2E Production of halocarbons and sulfur hexafluoride, HFC	0.68%	1A2f Cement, CO_2	0.75%
2C3 Aluminum production, CF	0.67%	1A3a Civil aviation, CO_2	0.57%	2B1 Ammonia production, CO_2	0.53%
3A2 Manure management, N_2O	0.64%	4D1 Domestic and commercial wastewater, N_2O	0.56%	1A5a Biomass burned for energy, N_2O	0.50%
4A Managed waste disposal on land, CH_4	0.63%	4A Managed waste disposal on land, CH_4	0.56%	4D1 Domestic and commercial waste water,N_2O	0.48%
2B1 Ammonia production, CO_2	0.62%	1B2b Natural gas, CH_4	0.52%	1A1c Manufacturing of solid fuel, CO_2	0.45%
2A2 Lime production, CO_2	0.60%	1B1aii Above-ground mining, CH_4	0.41%	1A2m Nonspecific industries, CO_2	0.39%
1A3a Civil aviation, CO_2	0.53%			1B1ai Underground mining, CH_4	0.34%
1A1c Manufacturing of solid fuel, CO_2	0.47%			1A2m Fertilizer, CO_2	0.33%
4D1 Domestic and commercial wastewater, N_2O	0.46%				
2E Production of halocarbons and sulfur hexafluoride, HFC	0.42%				

Sources: *SNC* (2012); *BUR 1* (2015); *BUR 2* (2018); *BUR 3* (2021).

Annexure 2: Assumptions and methods used for estimation of mitigation by major Key Policies for achieving India's key NDC mitigation target

Due to the limited scope of the study in identifying how many major Key Policies of India require international support in terms of accessing to additional and predictable finance, deployment of commercial scale technology, and addressing the capacity building constraints taking into account the existing and evolving gaps in these three pillars of means of implementation we have assumed that the contribution of all 17 major key polices towards achieving the key NDC target will be only with the available domestic resources , technology and capacity building support

- **S & L Programme**

S&L programme has included EE labelling for 28 appliances, of which 10 appliances are under mandatory labelling to date. The GHG emissions saved from sales of star-labelled appliances are taken from BEE reports (BEE 2020, 2021). The energy savings increased at an 8% average annual growth rate during 2011–2017 for this program. The GHG emission mitigations are projected by assuming the same rate for energy savings during 2018–2030.

The avoidance of GHG emissions is considered for the target for renewables(175 GW by 2022) set by the Government of India (GoI), i.e., power generation from solar, wind, and other renewable sources (small hydro, biomass, and bagasse-based power).The GHG emissions avoided because of electricity generation from RE sources are estimated using equation-1 (*BUR 3*, 2021a):

Total CO_2 emission avoided (saved) = Electricity generation from RE source × Baseline CO_2 emission factor

Where,

- Electricity generation (MWh) is from RE sources of solar, wind, small hydro, biomass, and bagasse,
- Baseline CO_2 emission factor is approximately0.78–0.83 (t-CO_2/MWh) (CEA, 2018).

- **Methods for solar energy policies, wind energy policies and other renewables**

Programs and policies associated with RE sources contribute to avoidance of GHG emissions—the assumption is that since RE generation capacity was built, these sources replaced grid-based fossil fuels. 75% operating margin and 25% build margin of the national power grid are assumed to represent the GHG emissions avoided by RE, as per the approved methodology by the Central Electricity Authority (CEA)

of GoI (CEA, 2018). The annual electricity data for both generation capacity and actual generation for solar, wind, and other renewables are compiled for 201–2020 from RE generation reports and other relevant reports published by CEA. The GHG emissions avoided during 2011–2020 because of RE generation are estimated using equation1. The installed capacity projections are assumed similar to those per RE generation targets by 2022 set by GoI, such as 100GW of solar power, 60 GW of wind power, approximately 15 GW of other renewables, etc. (*BUR 3*, 2021). The equivalent electricity generation and resultant GHG emissions avoided from these RE sources areprojectedfor2021–2030.

- **Supercritical power generation**

Supercritical-technology-based coal power plants are relatively efficient than subcritical-technology-based power plants. The total installed capacity of supercritical power generation has increased from 2.12 GW to 56.81 GW during 2012–2020. Supercritical-technology-based power plants of approximately 43.2 GW capacity are under construction as of September 2020 (*BUR 3*, 2021). A supercritical-technology-based power generation capacity of 43.2 GW is projected to be available during 2021–2030. The carbon emission reduction from the adoption of supercritical technology over subcritical-technology-based power generation is estimated using equation-2 (*BUR 3*, 2021). The removal (reduction) of CO_2 due to supercritical power generation is estimated using equation-2 (*BUR 3*, 2021):

Total CO_2 reduced = Total electricity generation from supercritical power plants × (Emission factor of the subcritical power plant – Emission factor of the supercritical power plant)

- **Reduction in T & D losses**

T&D losses of the Indian electricity grid have reduced from 23.97% to 20.66% between 2011 and 2018 and decreased by 1.8% per year during 2016–2018. T&D losses are assumed to decrease by 2.5% per year between 2019 and 2030 sothatthe15% target set for T&D losses is achieved by 2030. The removal (reduction) of CO_2emission saved from the reduction in T&D losses is estimated using equation- 3 (*BUR 3*, 2021b).

Total CO_2 reduced = Total electricity generation × Reduction in T&D losses for the current year from those in the previous year × Baseline CO_2 emission factor

- **Perform, Achieve and Trade (PAT) scheme**

PAT scheme aims to enhance EE in energy-intensive industries. The total number of designated consumers (DCs) for PAT cycleI (2012–2015) was 478, covering eight sectors, namely aluminium, cement, chlor-

alkali, fertilizer, iron and steel, pulp and paper, textile, and thermal power plants. Three more sectors, namely petroleum refinery, railways, and electricity distribution companies, were added in PAT cycle II, with 621 DCs from 2016 to 2018. The emission mitigations achieved during PAT cycles I and II were approximately 31 $MtCO_2e$ and 61 $MtCO_2e$, respectively. Six PAT cycles with 1073 DCs in 13 sectors are planned, with projected emission mitigations of 70 $MtCO_2e$,by March 2023(BEE, 2021). These emission mitigations are assumed to remain unchanged until 2030 for the PAT scheme, which we note is on a conservative side since industrial outputs are expected to increase with expanding production due to Government's 'Make in India' and 'Atma Nirbhar Bharat' programs. Because of PAT, the energy efficient measures in the industry, could contribute more to GHG mitigation than our conservative estimates.

- **Policies for enhancing energy efficiency of MSMEs**

Ministry of Micro, Small and Medium Enterprises (MSME), GoI, has initiated several programs and projects for enhancing EE in MSME sector since 2015,leading to emission reductions of 0.124 $MtCO_2e$ in 2018–19 (*BUR 3*, 2021b). The GHG emission mitigations in the MSME sector are projected to remain constant during 2019–2030 while considering conservative mitigation assumptions.

- **Unnat Jyoti by Affordable LEDs for All (UJALA)**

UJALA scheme, initiated by GoI in 2015, aimed at replacing 770 million conventional and inefficient light bulbs with LED bulbs. While SLNP, started in 2015, aimed at replacing conventional streetlights with smart and 50% more energy-efficient LED streetlights. The number of units installed during 2015–2021 and per unit CO_2 emission reduction are sourced from UJALA and SLNP dashboards (EESL, 2019a, 2019b). Approximately 367 million LED bulbs have been distributed under UJALA as of June 19, 2021. Approximately, 403 (770 − 367) million LED bulbs will be replaced from 2022 to 2030.The emission mitigations are estimated from 2015 to 2021 and projected during 2022–2030.

- **Street Light National Program (SLNP)**

Under SLNP, 12 million LED street lights have been installed as of June 19, 2021(EESL, 2020). The number of street light installations increased at an 8% average growth rate during the last two years. The same rate is assumed for projections during 2022–2030 since the total requirement is huge for India's growing population in the cities. The emission mitigations are estimated from 2015 to 2021 and projected during 2022–2030.

- **Green Building Programme and BEEP**

Emission mitigations from the building sector are mapped for two main programs: Green Building Programme and BEEP for retrofits of commercial buildings. The green building footprints in India have increased from a mere 20,000 ft^2 in 2003 to 7 billion ft^2 as of September 2019, which is projected to increase by 10 billion ft^2 by 2022[2]. It was assumed that 1000 ft^2 of green building footprint would save 3 tons of CO_2 emission from energy savings until 2022. The emission mitigations with an increase in green building footprints are projected to increase by 5% per year from 2023to 2030 (IGBC, 2019). For BEEP, CO_2 emissions mitigation values are taken from an international report and BEEP dashboard for 2020 and 2021(EESL, 2021; *BUR 3*, 2021b). Because of BEEP, the emission mitigation was increased by 20% during 2020–21. The same rate is assumed for yearly projections from 2022to 2030 for our assessment.

- **EBP programme and National policy on biofuels**

The GHG emission mitigation from the transport sector is mapped for the EBP programme, national policy on biofuels, policies for public transport. The data for petrol consumption, ethanol blending (%), diesel consumption, and biodiesel blending (%) is taken from statistics reports of the Ministry of Petroleum and Natural Gas, GoI ("MoPNG", 2021). The net calorific value and CO_2 emission factor for petrol and diesel are taken from the IPCC report (Garg et al., 2006). The emission mitigations are estimated using the quantity (5%) of ethanol blended in petrol for the EBP Programme and the quantity of biodiesel blended (5%) in diesel for the biodiesel program during 2009–2019. The consumption of petrol is assumed to increase by 8% (following the past few years' trends) per year, with 10% of ethanol blending assumed during 2020–2030. The diesel consumption was increased by 2% per year (following the past few years' trends), with 5% biodiesel blending assumed during 2020–2030. The CO_2 emission mitigated because of these programsisestimatedfor2009–2019 and projected from 2020 to 2030.

- **Methods for public transport policies**

The emission mitigations for public transportation systems, e.g., BRT, MRT, light rail, monorail, metro rail, implemented in a few Indian cities are taken from published reports during 2011–2016 (*BUR 2*, 2018; *BUR 3*, 2021b). Following the past few years' trends, emission mitigations per year are assumed to increase by 9% for metro rail/light rail/monorail and 7% for the BRT/MRT system during 2017–2030.

- **AgDSM and MuDSM**

[2] https://www.thehindubusinessline.com/news/real-estate/india-aims-green-buildings-footprint-of-10-bn-sqft-by-2022/article29531384.ece

The data for removal of CO_{2e} emission from AgDSM and MuDSM policies were mapped by referring to relevant government sources(*BEE*, 2020)and international (BUR) reports (*BUR 1*, 2015; *BUR 2*, 2018; *BUR 3*, 2021).

- **Policies for electric mobility**

The removal of CO_{2e} emission due to various policies promoting electric mobility were mapped and the required data were mapped through interviewing industry experts as well as relevant ministry personnel.

References

BEE. (2021), "PAT-Read more", *Bureau of Energy Efficiency (BEE), Ministry of Power, GoI*, available at: https://beeindia.gov.in/content/pat-read-more.

CEA. (2018), *CO2 Baseline Database for the Indian Power Sector User Guide (Version 13.0)*, Central Electricity Authority (CEA), Ministry of Power, GoI, New Delhi, India, p. 33.

EESL. (2019a), "National Ujala Dashboard", *Energy Efficiency Services Limited (EESL), Ministry of Power, GoI*, 22 September, available at: http://www.ujala.gov.in (accessed 22 September 2019).

EESL. (2019b), "About UJALA", *Energy Efficiency Services Limited (EESL), Ministry of Power, GoI*, available at: https://eeslindia.org/en/ourujala/.

EESL. (2020), "SLNP - Dashboard", *Energy Efficiency Services Limited (EESL), Ministry of Power, GoI*, available at: https://slnp.eeslindia.org/ (accessed 5 August 2021).

EESL. (2021), "BEEP: National Building Energy Efficiency Program", *Energy Efficiency Services Limited (EESL), Ministry of Power, GoI*, available at: https://beep.eeslindia.org/.

IGBC. (2019), *Indian Green Building Council Annual Review: 2018-2019*, Annual, Indian Green Building Council (IGBC), India, p. 60.

India: First Biennial Update Report to the United Nations Framework Convention on Climate Change, No. Biennial. (2015), Ministry of Environment, Forest and Climate Change, Government of India, India, pp. 1–240.

India: Second Biennial Update Report to the United Nations Framework Convention on Climate Change. (2018), Ministry of Environment, Forest and Climate Change, Government of India, India, pp. 1–240.

India: Third Biennial Update Report to the United Nations Framework Convention on Climate Change. (2021), Ministry of Environment, Forest and Climate Change, Government of India, India, pp. 1–501.

"Indian PNG Statistics". (2021), *Ministry of Petroleum and Natural Gas, Government of India*, Government, available at: https://mopng.gov.in/en/petroleum-statistics/indian-png-statistics (accessed 5 August 2021).