Study of Health Impact of Low Carbon Power Sector in India

The Energy & Resource Institute
New Delhi, India

This study is ongoing, results are preliminary

Background

- Rapid economic growth in India has led to growing energy demands, emissions of GHGs, and air pollution emissions loads.
- Strategies to reduce GHGs can reap significant co-benefits of reducing air pollution.
- Consideration of co-benefits strengthens the case for proposed climate actions by tilting the overall cost to benefit ratio towards the latter.
- At local scale, co-benefits are viewed as more meaningful objectives to pursue rather than outright climate mitigation.
- This study analyzed the co-benefits of various mitigation policies using consistent modelling framework(s) and a set of quantitative tools/models.
- The study will help policymakers, civil society, and other stakeholders to understand opportunities to strengthen India's policy portfolio.

Power Plant in India

- Coal is the most important energy source for the electricity generation in India.
- Coal consuming thermal plants generate 56.9% of the total power production (CEA 2018).
- Coal based thermal power plants contributed 32% rise in ambient SO_2 level and 34% in ambient $PM_{2.5}$ level and 44% in total CO_2 emissions in 2016 (Greenpeace-India Report 2017, IEA 2016, Enerdata 2017).
- The Economic Survey 2017 of India stated that the pollution from thermal power plants has been a cause of approximately 1,15,000 deaths and the resulting total economic loss was of Rs. 29,500 crore.

Air Pollution & Health Impact

Air Pollution	Major causes of air pollution	Health Impacts of air pollution
• SO_2 • NO_x • PM_{10} and $PM_{2.5}$ • CO and CO_2 • NMVOC	• Vehicular emissions • Industries • Power Sector • Domestic combustion • Construction activities	• Cardiovascular diseases • Chronic respiratory diseases • Lower respiratory diseases • Lung cancer

- **Studies have established concrete relationship between PM and health (Xie 2009) and economic loss (WHO; Ho and Jorgenson 2007).**
- **Air pollution had caused around 18,229 excess deaths in Delhi in 2010 and 26,525 excess cases of hospitalization in 2010 (Nagpure, 2014)**
- **Adhering to the WHO air pollution guidelines can avoid around 7,50,000 deaths annualy (23%) (Apte et al. (2015) .**

- **Air pollution is the second leading cause of adverse health conditions prevailing in India (ICMR). Evidently, it has been a major cause of around 2750 deaths per lakh people in 2016, out of which 41 deaths were estimated to be due to cardiovascular diseases arising from air pollution followed by chronic respiratory diseases (22 deaths) and other lower respiratory diseases (14 deaths).**

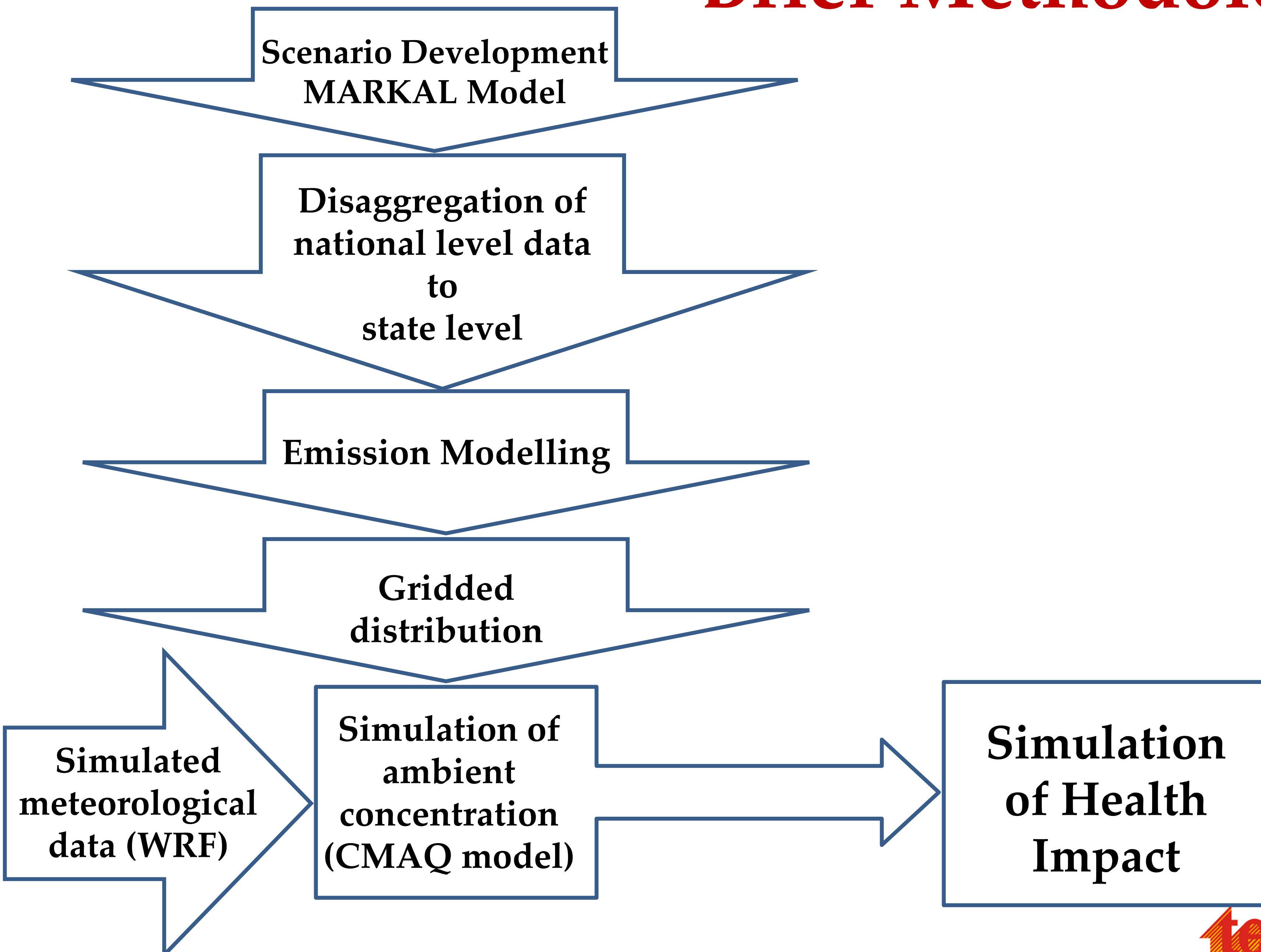
- **According to the WHO (2018) Air Pollution Report, ambient air pollution was behind around 1.1 million deaths in 2016 in India and out of which 89% deaths were due to non-communicable diseases.**

- **Chronic respiratory disease, largely caused due to air pollution, is the second largest cause of death after cardio-vascular diseases (Bhattacharjya, 2018, ICMR, 2016).**

Objectives

- **Preparation of high-resolution air pollutant emission inventory based on the energy modelling results of the MARKAL model for low carbon scenarios**
- **Simulate ambient concentration of particulate matter.**
- **Estimating the impacts of ambient particulate matter concentration on human health**

Brief Methodology



Energy Modelling Approach

- TERI's existing MARKAL database was built upon and model runs were carried out to develop appropriate scenarios.

- Reference and the Alternative scenarios were designed and set up based on a consultative process to decide on what the broad scenario storylines should reflect, and to represent updated data and inputs on the understanding related to these storylines.

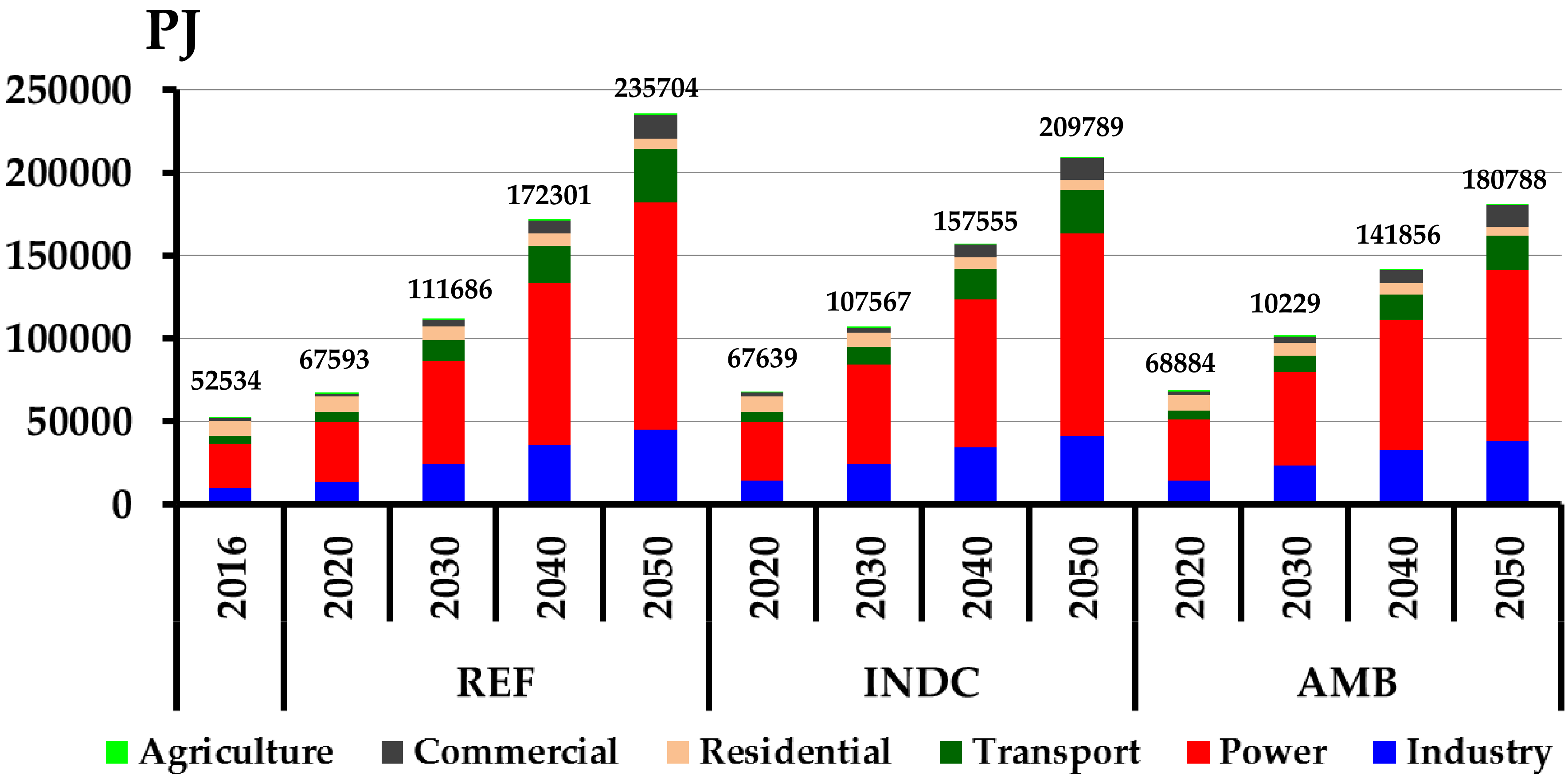
- National level results on fuel use and technology deployment were further disaggregated at a state level and fed into the emission model.

- Time frame : 2016, 2020, 2030, 2040 and 2050

Energy Scenario

- **Reference (REF):** Scenario representing climate policies rolled out till 2016, and an ambitious high GDP growth as envisaged by the Indian Government
- **INDC:** Scenario including various climate policies and targets formulated in India's INDC submission
- **Ambition (AMB):** Scenario with a high mitigation ambition (high renewables in the power sector & towards a well below 2 DC world) and keeping development at the forefront

Sectorial Energy under Different Scenario



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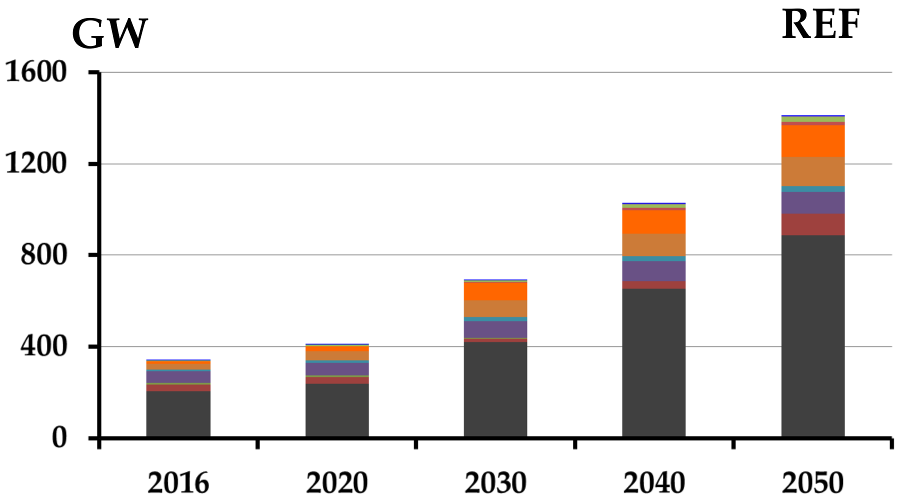
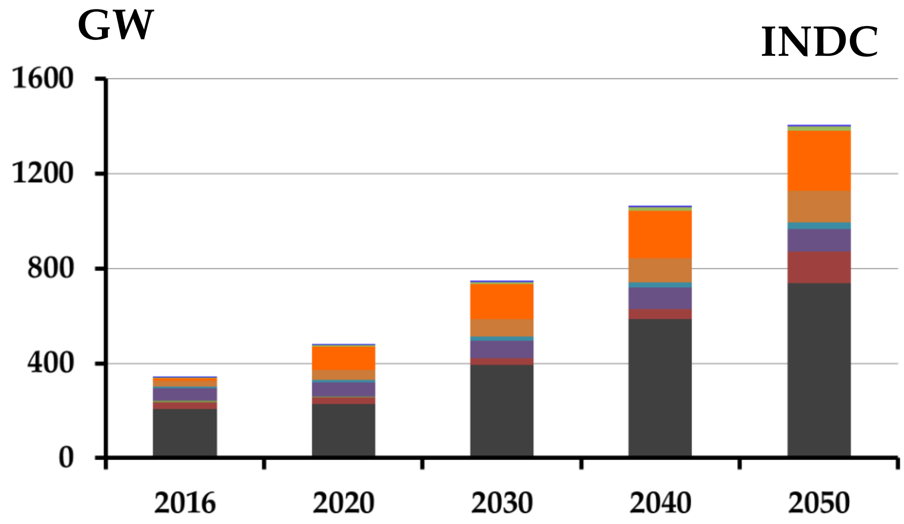
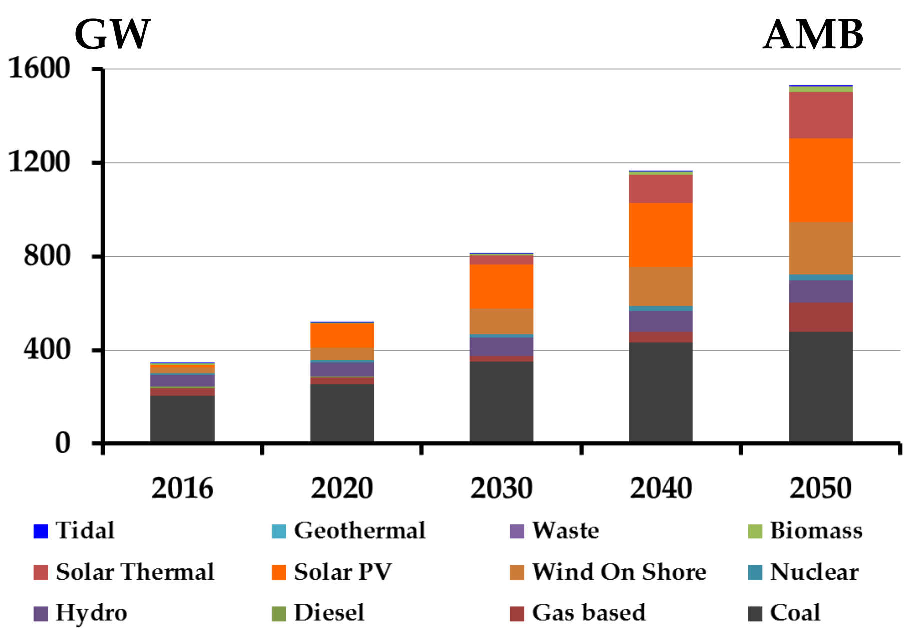
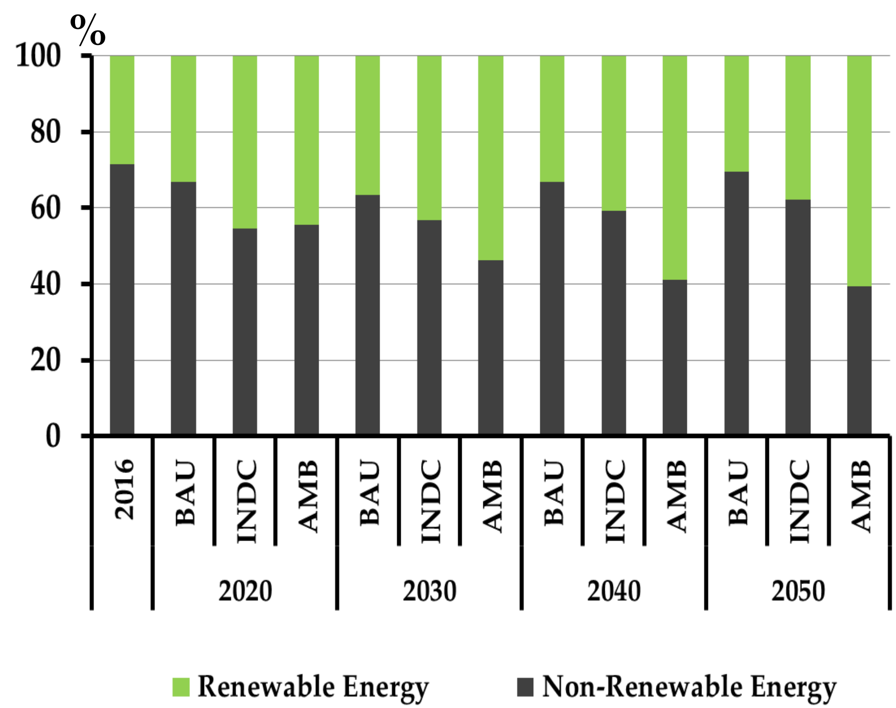
Power Scenario - India

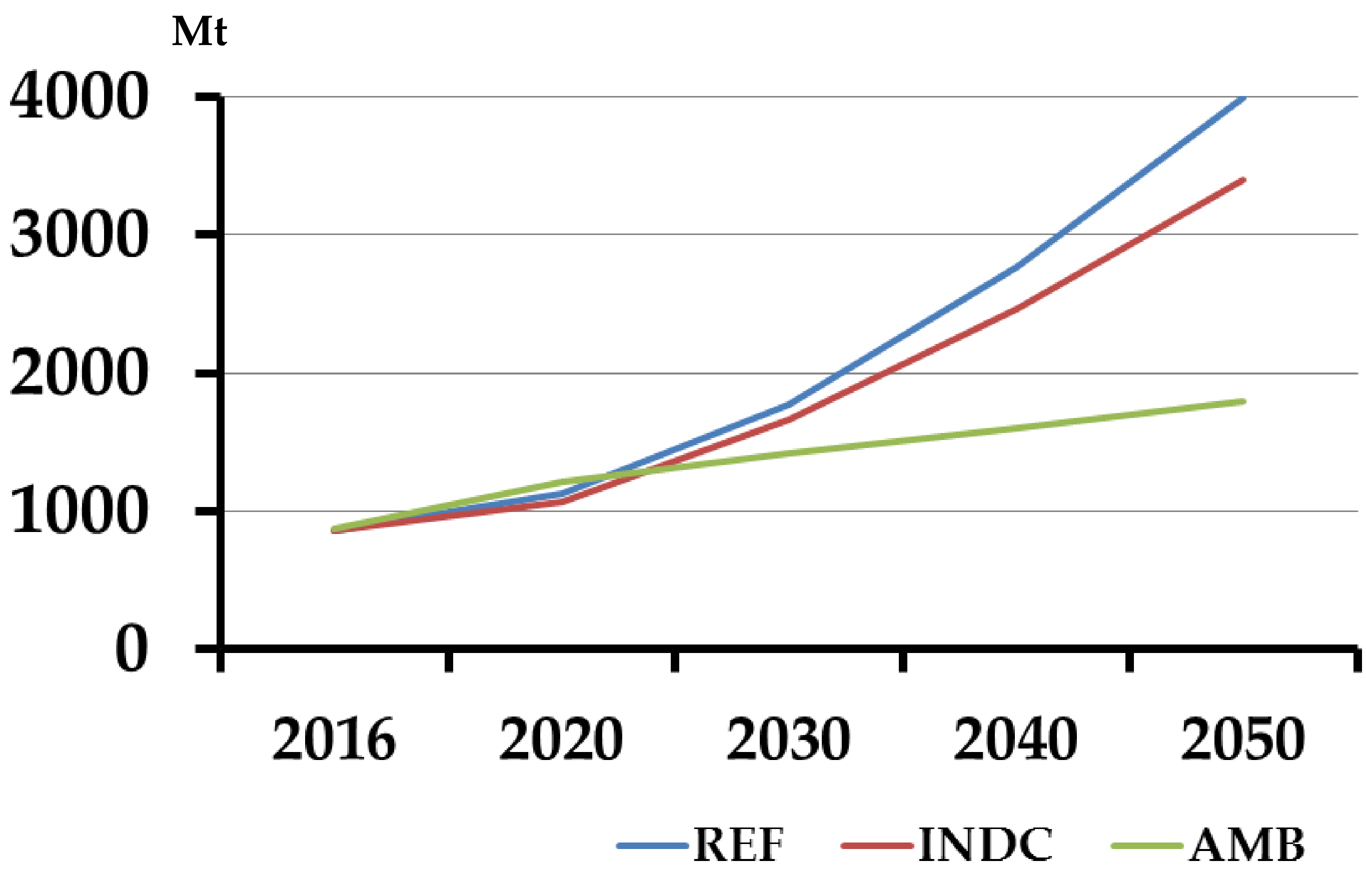








CO_2 Emission from Power Sector



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Energy & Emissions

Sector	Fuel							
	Coal	Biomass	Heavy Fuel	Diesel	Gasoline	LPG	Natural Gas	No Fuel
Industry (Comb)	√	√	√	√			√	
Industry (Proc)								√
Domestic	√	√				√		
Power	√	√	√	√			√	
Transport			√	√	√	√	√	√
Others	√		√	√				
MSW								√
OB								√
Mine								√

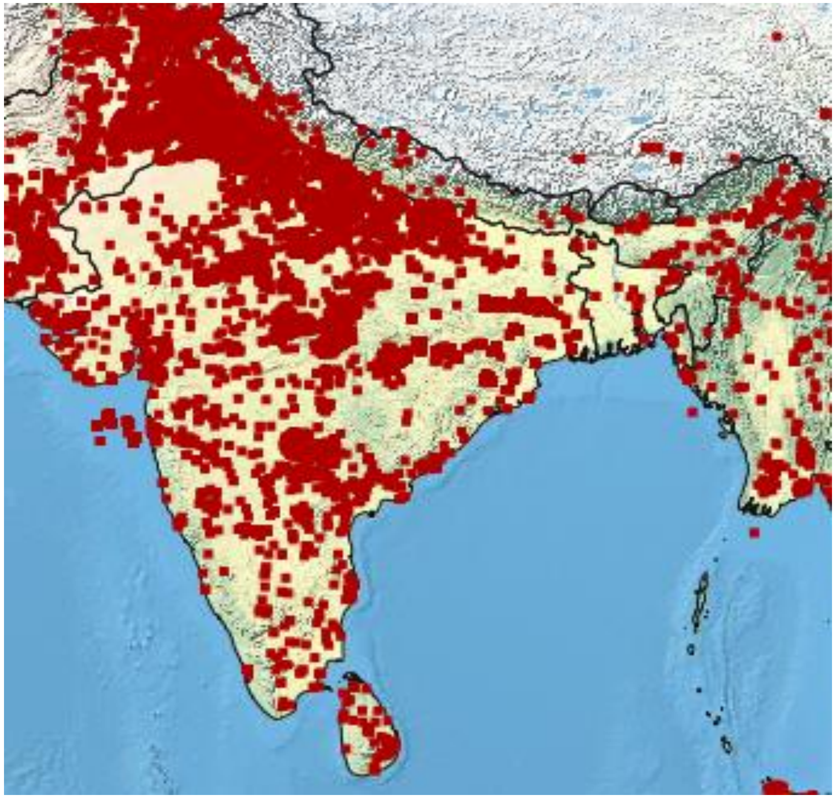
Emission inventorisation

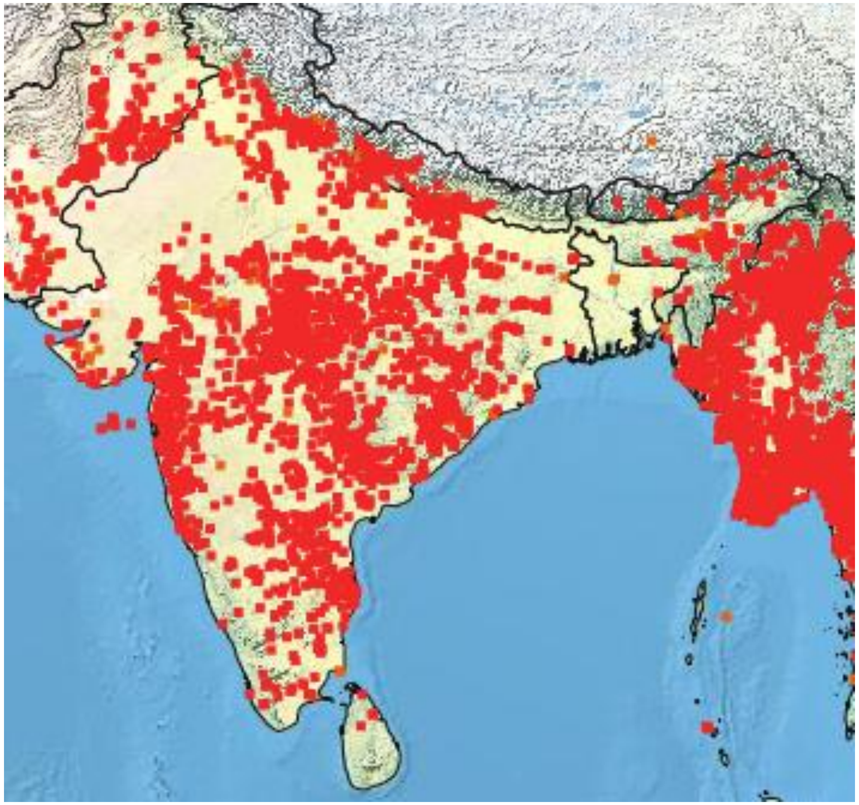
- **Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS-ASIA) model was used for estimation of emissions based on energy and non-energy sources.**

- **Pollutants : PM_{10}, $PM_{2.5}$, NO_x, SO_2, CO, NMVOC**

- **Resolution : 36x36 km^2**

Open Burning of Crop Residues in India





686 Mt of crop residue are produced in India from 26 crops

686 Mt of from cereal crop (rice 154Mt & wheat 131 Mt) 111 Mt from Sugarcane

234 Mt of crop residue is available as surplus

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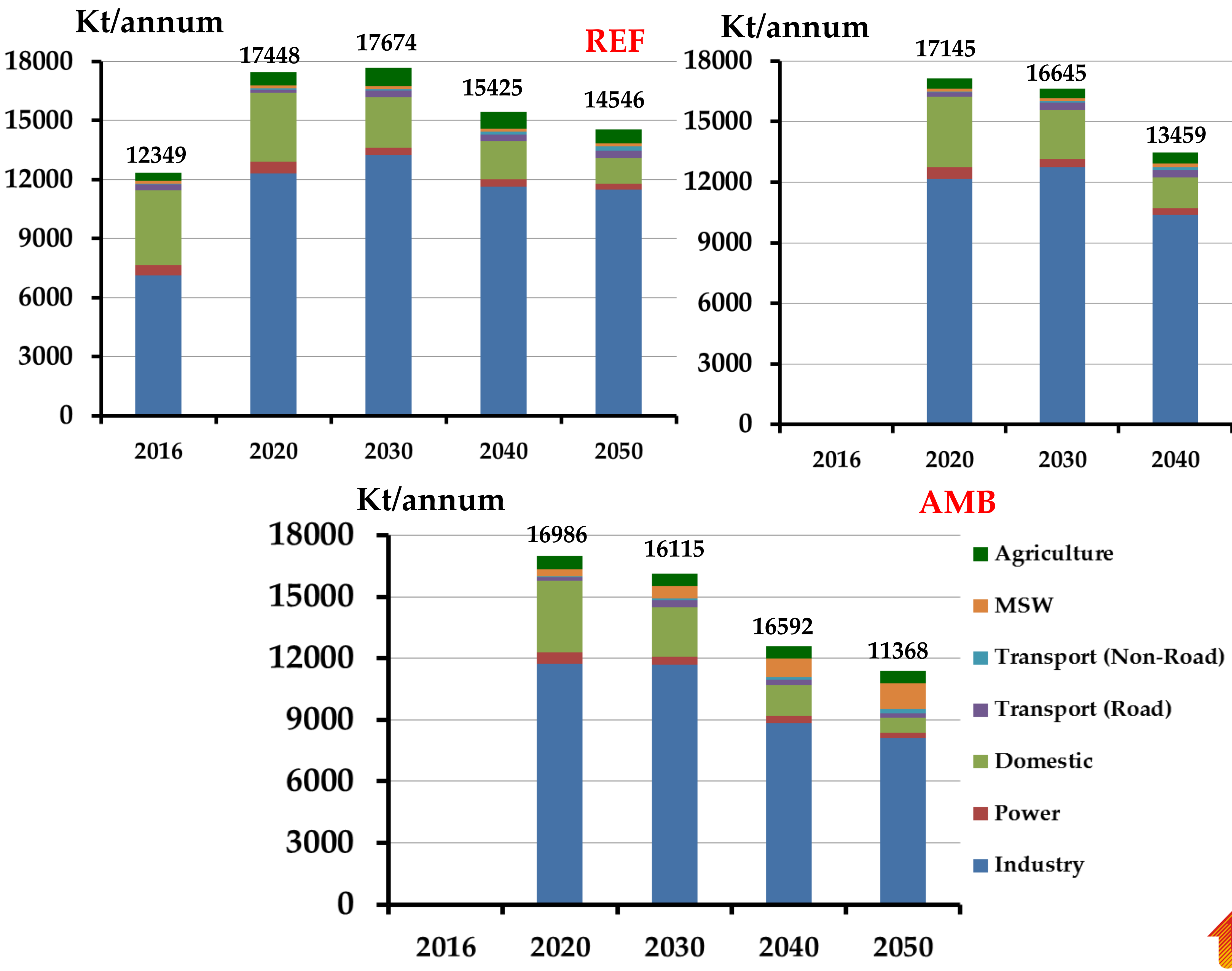
PM$_{10}$ emissions



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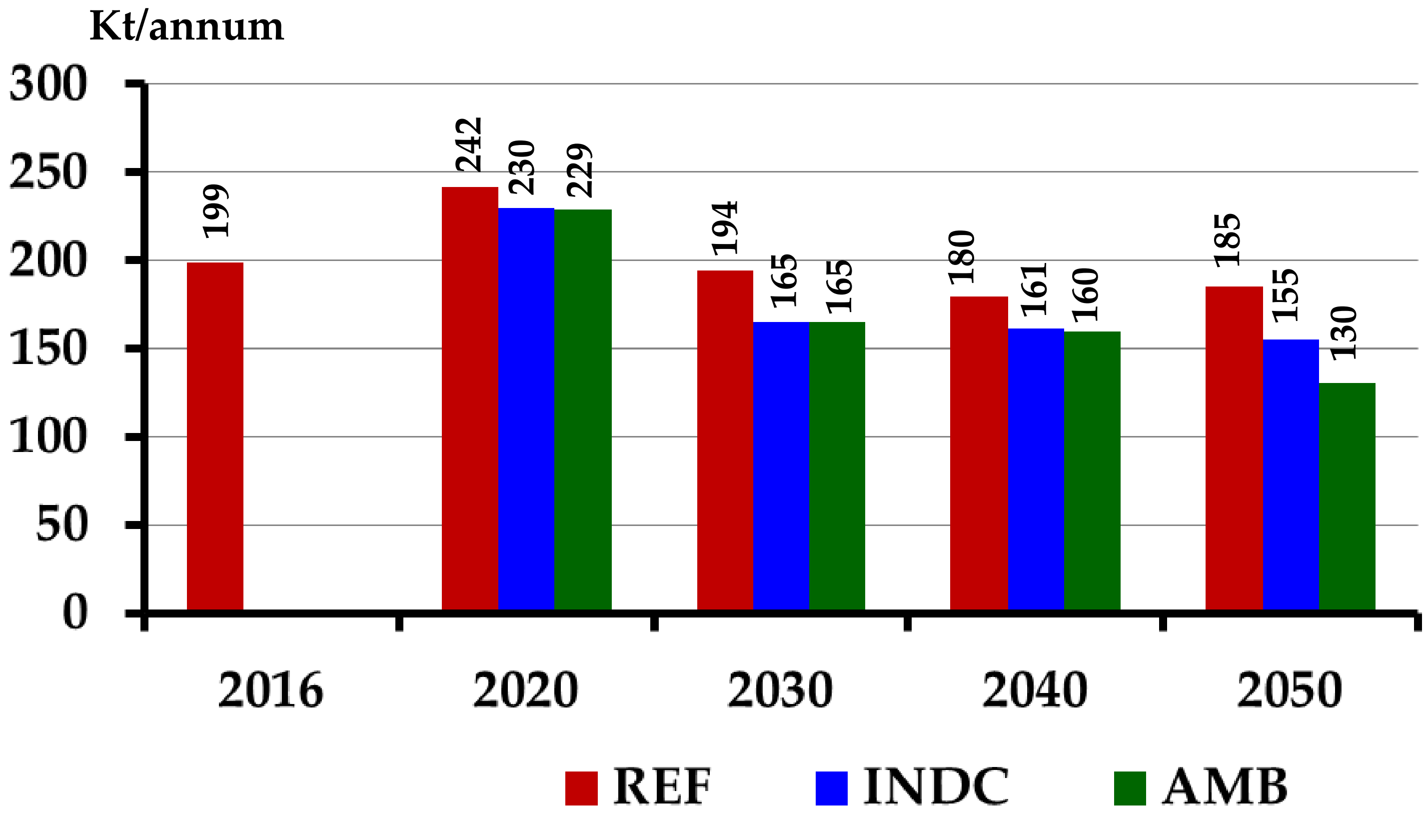
$PM_{2.5}$ emissions from power sector



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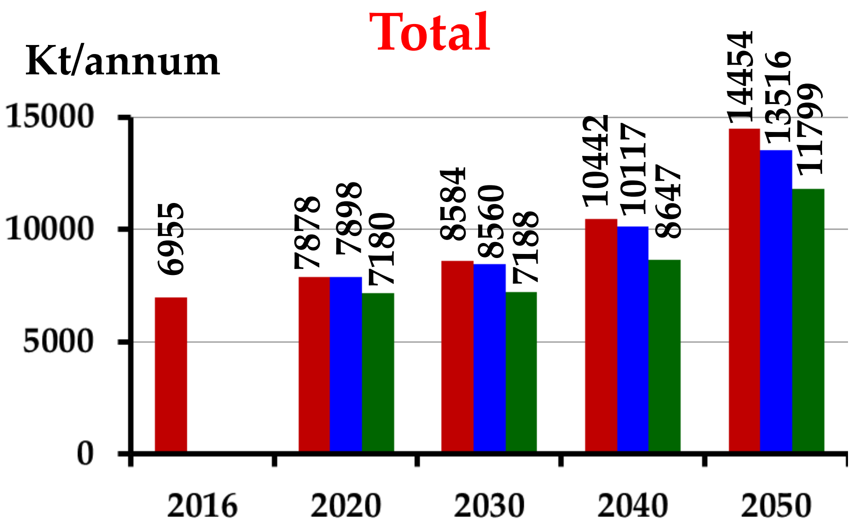
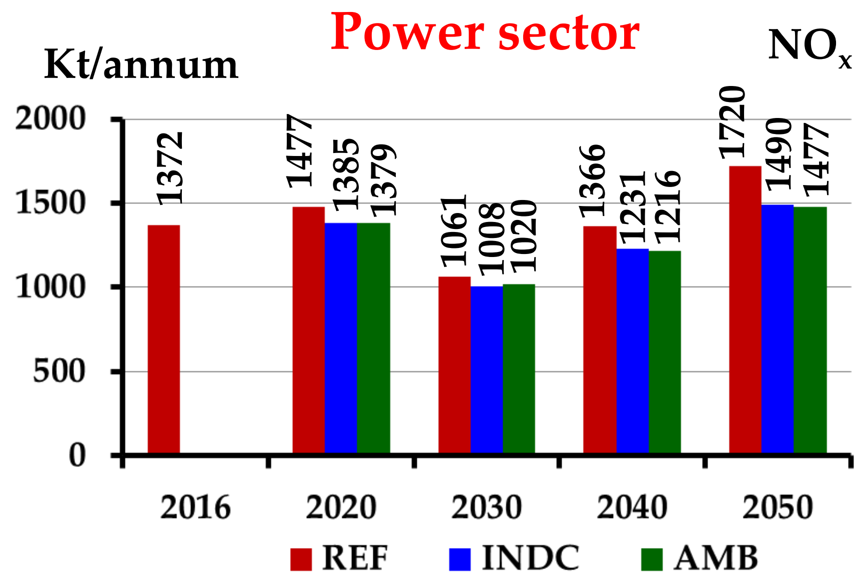
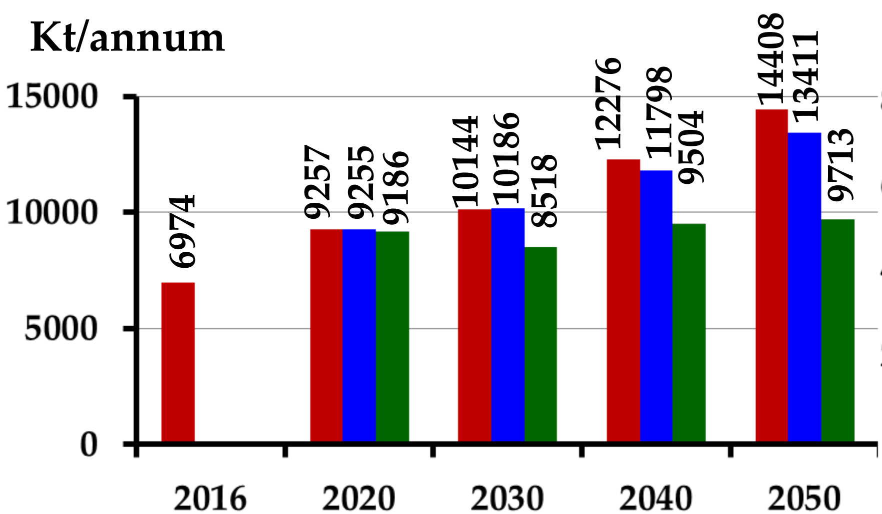
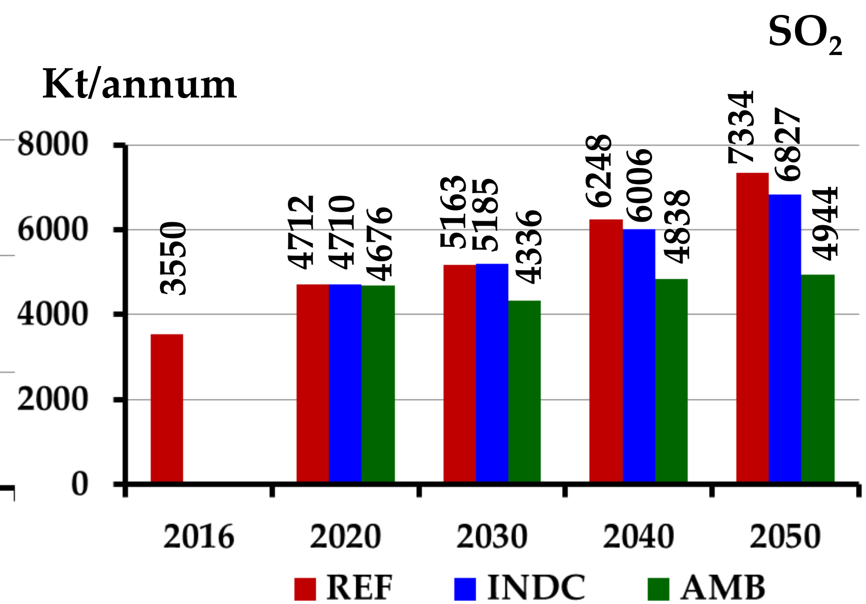
NOx & SO_2 emissions

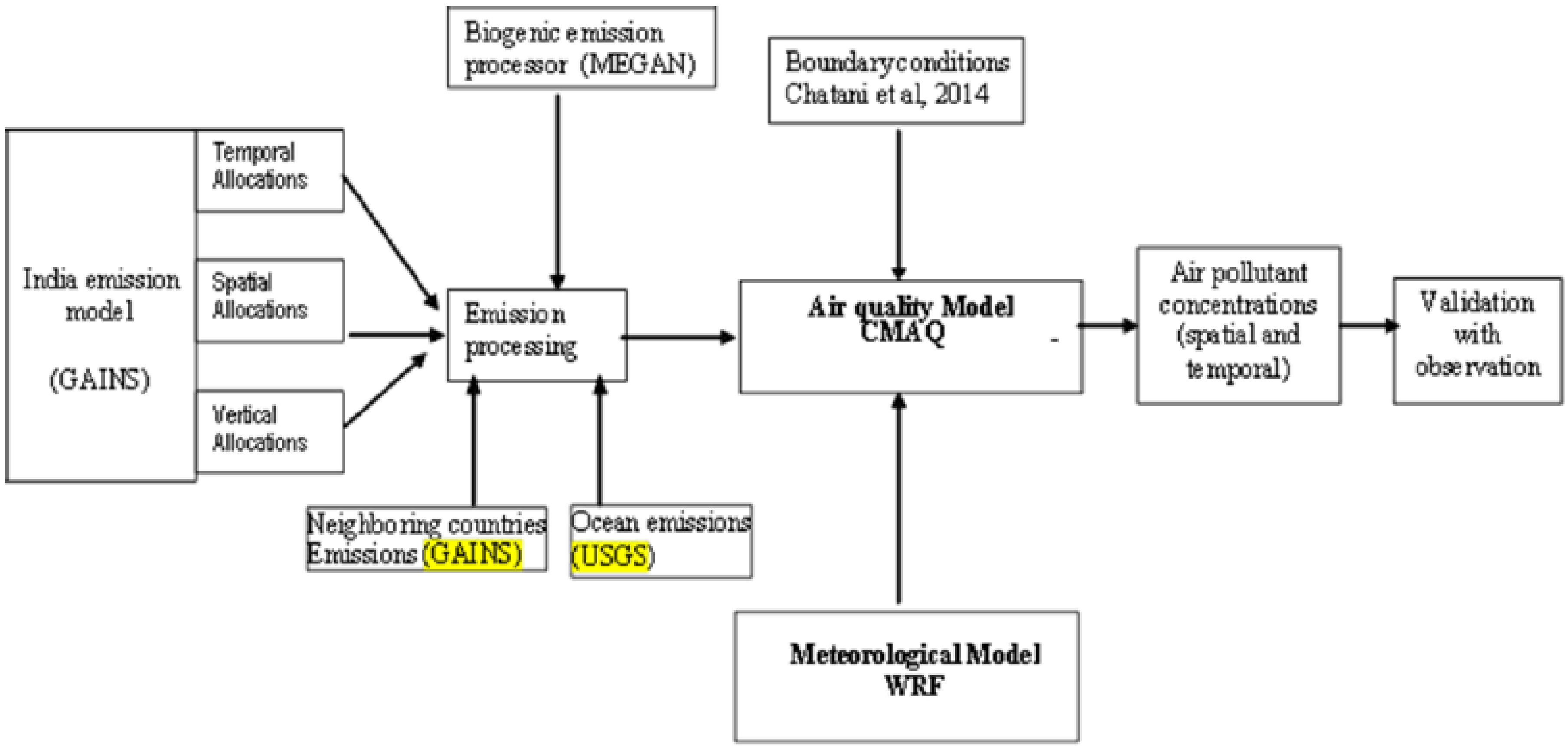








Air Quality Modelling



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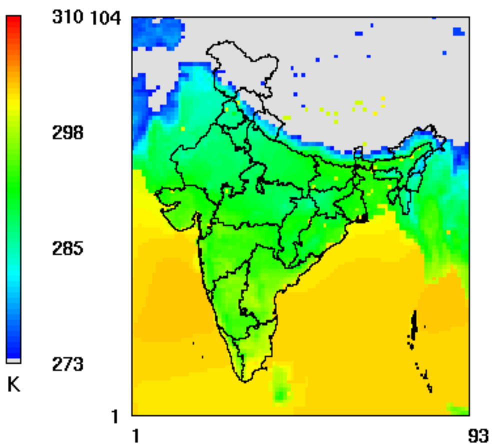
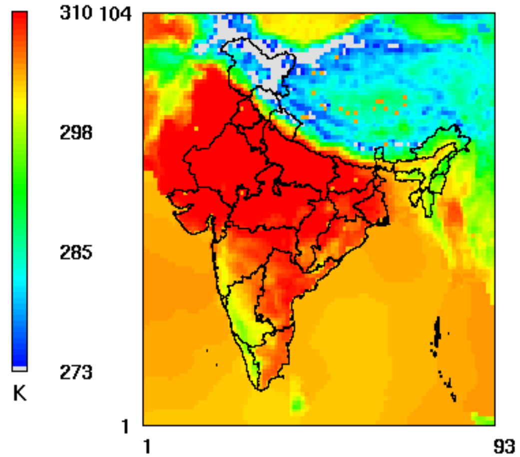
Meteorological modelling

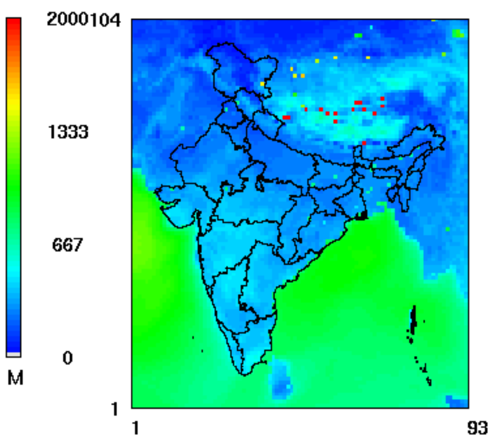
Temp- December



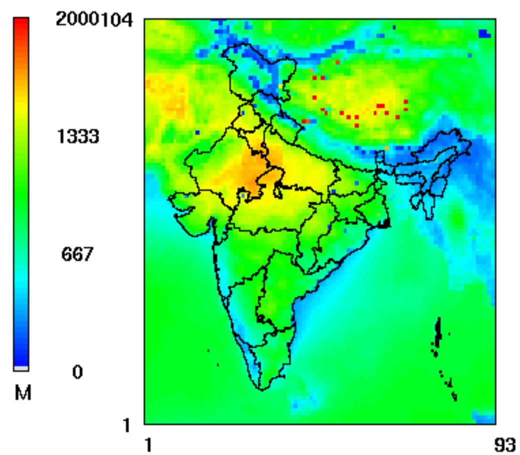
Temp- June



PBL- December



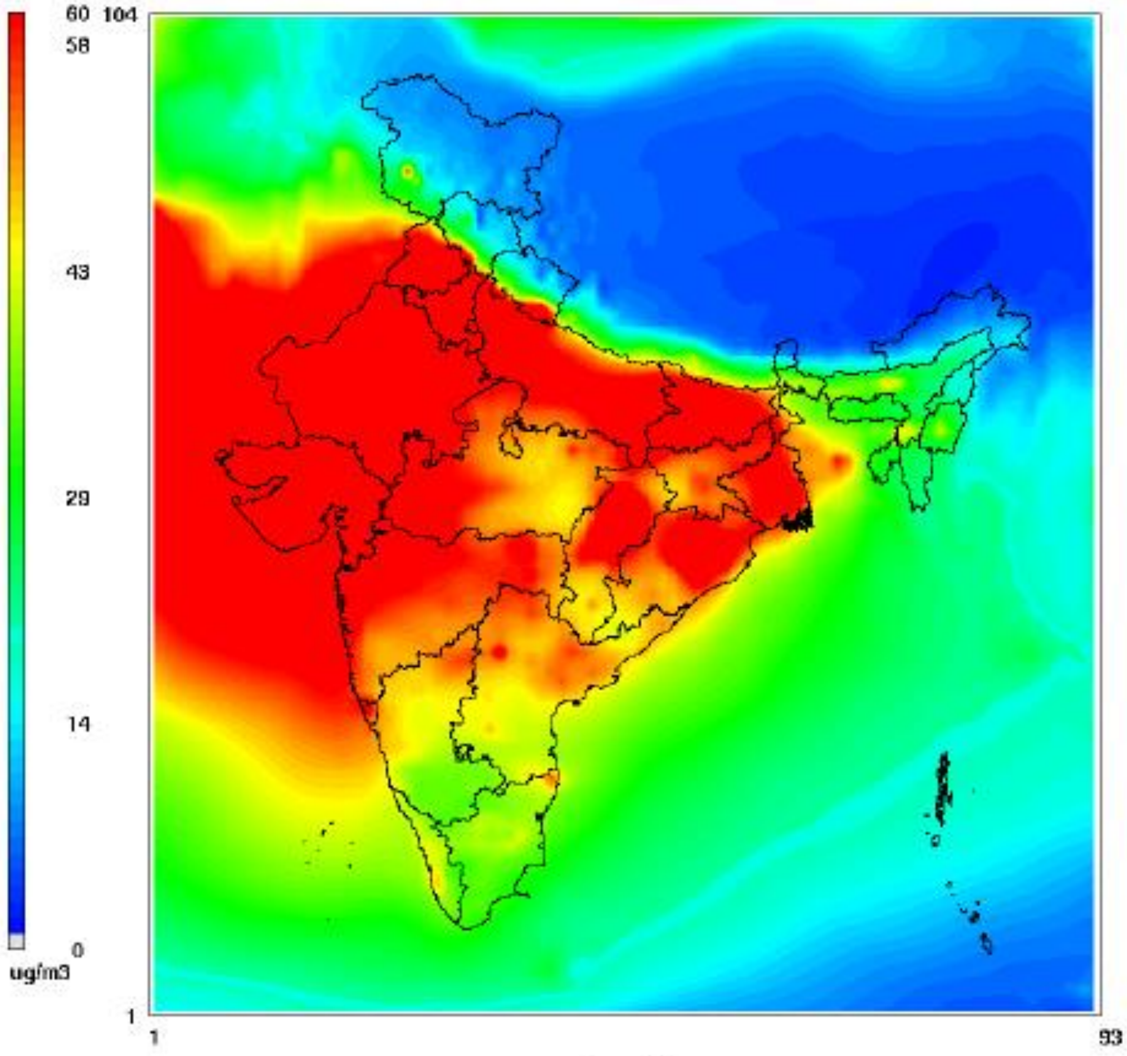
PBL- June



WRF models was used to prepare 3-dimensional meteorological fields over the study domain and act as an input to the air quality models.

Simulated ambient $PM_{2.5}$

2016



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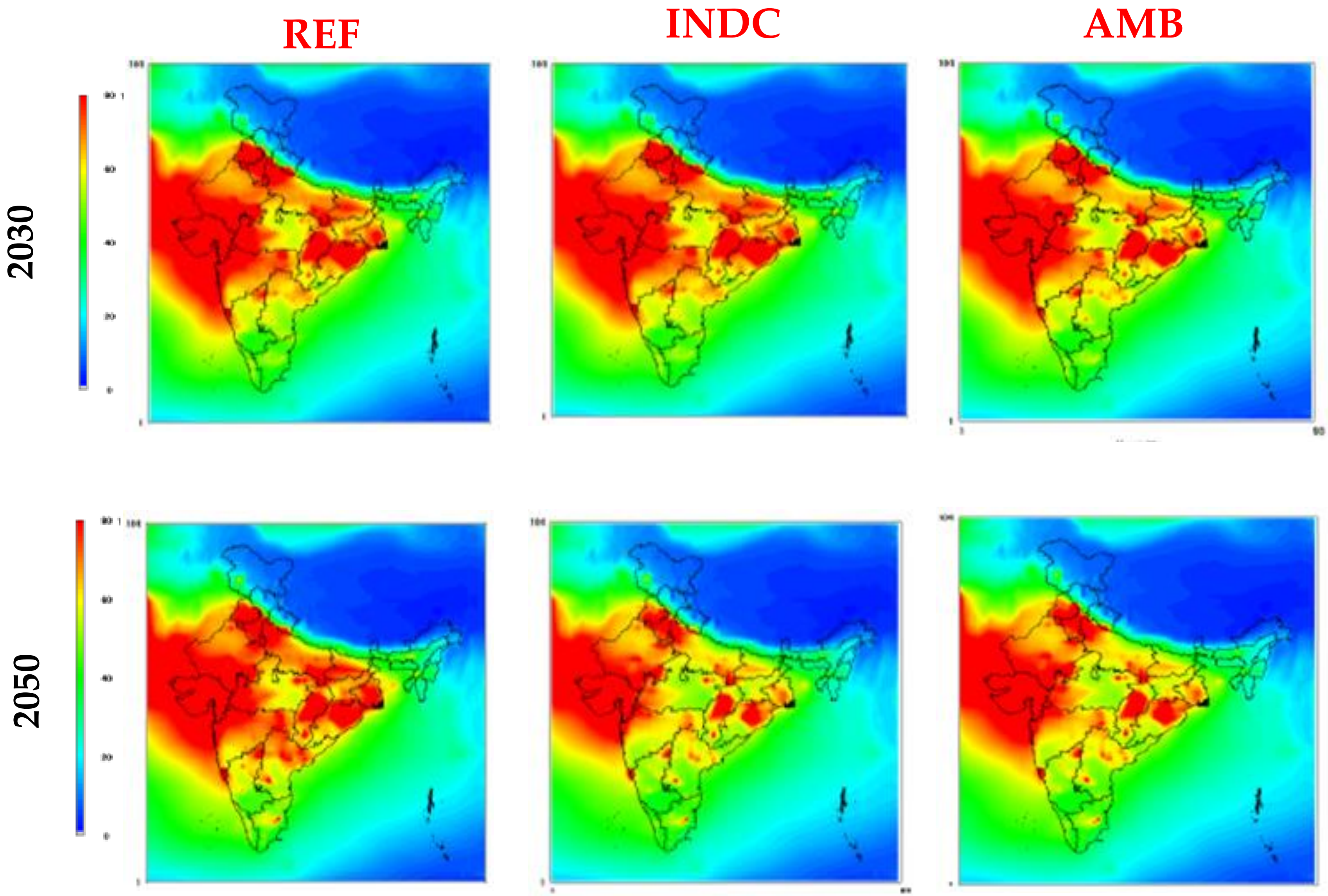
Simulated ambient $PM_{2.5}$



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Methodology of Health Impact Assessment

Ambient air quality

- Input data: $PM_{10}/PM_{2.5}$ concentration data from CMAQ model

Relative Risk functions

- Input data: Exposure response functions (Ostro 2004) and exposure response coefficients (β) disease wise

Weighted Risk arising from air pollution

- Input data: Relative Risks (RR) functions

Morbidity and Mortality

Methodology of Economic Loss Assessment

Average Income

- Input data: GSDP per capita, Labor force participation rate, Labor Income share of GDP

Value of Statistical Life (VSL)

- Input data: GSDP per capita, VSL to GDP per capita

Value per disability Adjusted Life year

- Input data: GSDP per capita, DALY to GDP per capita

Total Economic Loss

Preliminary Findings

Outcomes (2016)				
Disease	YLDs	YLLs	DALYs	Total Economic Loss
COPD	794467.9	88388.8	882856.7	INR 771 Billion
LC	572373.2	9736.8	582110.1	INR 196 Billion
LRI	553285.5	17156.8	570442.1	INR 214 Billion
Total	1920127	115282.2	2035409	INR 1,181 Billion

COPD has the highest share in YLDs (41%), YLLs (77%), DALYs (43%) and hence in the total economic loss (65%).

Project Team

Anju Goel

Arindam Datta

Isha Khanna

Seema Kundu

Souvik Bhattacharjya

Swapnil Shekhar

and

Sumit Sharma

Suggestions!!!