Mitigation and Adaptation Strategies to Minimise GHG Footprint in Transportation Sector, India

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India has a number of policies that contribute to climate mitigation but what is required to implement these into action is proper planning and allocation in the budget

Concentration of greenhouse gases (GHG) in the atmosphere has been increasing rapidly during the last century due to ever increasing anthropogenic activities resulting in significant increases in the temperature of the Earth causing global warming. Major sources of GHG are transportation (burning fossil fuel), forests (due to human induced land cover changes leading to deforestation), power generation (burning of fossil fuels), agriculture (livestock, farming, rice cultivation and burning of crop residues), water bodies (wetlands), industry and urban activities (building, construction, transport, solid and liquid waste). Aggregation of GHG (CO2 and non-CO2 gases), in terms of Carbon dioxide equivalent (CO2e), indicate the GHG footprint.

GHG footprint is thus a measure of the impact of human activities on the environment in terms of the amount of greenhouse gases produced. The study accounted the amount of three important greenhouses gases namely carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) and thereby developing GHG footprint of the major cities in India. This work was published in peer reviewed journal (Ramachandra T.V., Bharath H. Aithal, Sreejith, 2015. GHG footprint of major cities in India, Renewable and Sustainable Energy Reviews 44 (2015) 473–495, http://dx.doi.org/10.1016/j.rser.2014.12.036) and this publication received wide attention of media and organisations in India including couple of questions (during question hour) in the parliament.

GHG footprint (Aggregation of Carbon dioxide equivalent emissions of GHG's) of Delhi, Greater Mumbai, Kolkata, Chennai, Greater Bangalore, Hyderabad and Ahmedabad are found to be 38633.2 Gg (or 38.63 million tons), 22783.08 Gg, 14812.10 Gg, 22090.55 Gg, 19796.5 Gg, 13734.59 Gg and 9124.45 Gg CO2 eq respectively. The major contributors sectors are transportation sector (contributing 32%, 17.4%, 13.3%, 19.5%, 43.5%, 56.86% and 25%), domestic sector (contributing 30.26%, 37.2%, 42.78%, 39%, 21.6%, 17.05% and 27.9%) and industrial sector (contributing 7.9%, 7.9%, 17.66%, 20.25%, 12.31%, 11.38% and 22.41%) of the total emissions in Delhi, Greater Mumbai, Kolkata, Chennai, Greater Bangalore, Hyderabad and Ahmedabad respectively.

Emissions from the road transport sector are directly related to the quantities of petrol and diesel consumption and the increase in emissions has been due to an increase both in the number of motor vehicles on the road and the distance these vehicles travel. Traffic composition analysis of six mega cities of India (Delhi, Mumbai, Kolkata, Chennai, Bangalore and Hyderabad) shows that there is significant shift from the share of slow moving vehicles to fast moving vehicles and public transport to private transport.

In the major cities transportation sector is one of the major anthropogenic contributors of greenhouse gases. Emissions resulting from total vehicles registered within the city boundary and also from CNG fuelled vehicles present in few of the major cities are calculated. Navigational activities from the port cities are also included in the emissions inventory on the basis of fuel consumption. Delhi leads the emission chart among other cities due to higher emissions because of large number of vehicles. As per the statistics of Transport Department in Delhi, the total number of vehicles in Delhi is more than combined total vehicles in Mumbai, Chennai and Kolkata. Also Delhi has 85 private cars per 1000 population against 8 private cars per 1000 population on all India average. Delhi also has 3,44,868 CNG vehicles during the year 2009-10. In Delhi during the year 2009-10, total number of registered vehicles was 64,51,883, out of which there were around 20 lakhs of cars and jeeps and 40.5 lakhs of motor cycles including scooters and mopeds. CNG fuelled vehicles emitted 1527.03 Gg of CO2 equivalents whereas the remaining vehicles resulted in 10867.51 Gg of emissions contributing almost 30% of the total emissions in this sub category which is the highest among all the major cities. This is twice the earlier estimate of 5.35 million tons (5350 Gg) of CO2 emissions from road transportation sector in Delhi during the year 2007-08 or emissions of 7660 Gg using top down approach or 8170 Gg using bottom-up approach. The CNG vehicles are also present in two other cities: Greater Mumbai and Hyderabad. Emissions from CNG vehicles in Mumbai during the year 2009-10 are found to be 531.34 Gg of CO2 equivalents and for Hyderabad it is estimated that 21.55 Gg of CO2 equivalent was emitted from CNG vehicles during the study year. The emission inventories for transportation sector in all the major cities are given in **Table 1**.

Table 1

GHG (CO_2 equivalent) emissions from transportation sector in different cities.

Cities	Road transportation emissions (Gg)		Navigation emissions (Gg)
	Vehicles using fuel other than CNG	CNG vehicles	
Delhi	10,867.51	1527.03	–
Greater Mumbai	3,320.66	531.34	114.18
Kolkata	1,886.60	–	83.06
Chennai	4,180.28	–	127.37
Greater Bangalore	8,608.00	–	–
Hyderabad	7,788.02	21.55	–
Ahmedabad	2,273.72	–	–

Source: Ramachandra T.V., Bharath H. Aithal, Sreejith, 2015

GHG footprint (carbon dioxide equivalent emissions, Gg) of different cities

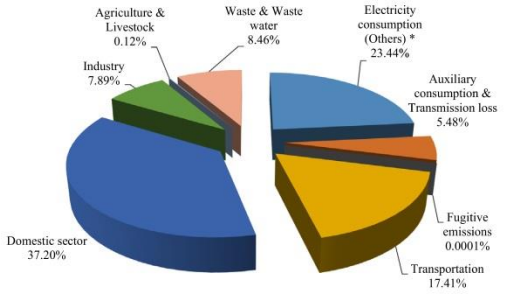

Fig. 13. GHG footprint (carbon dioxide equivalent emissions, Gg) of Greater Mumbai.

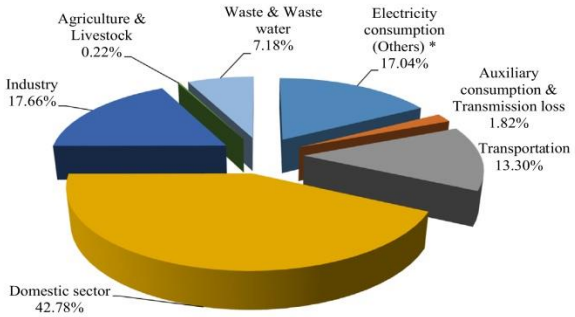

Fig. 14. GHG footprint (carbon dioxide equivalent emissions, Gg) of Kolkata.

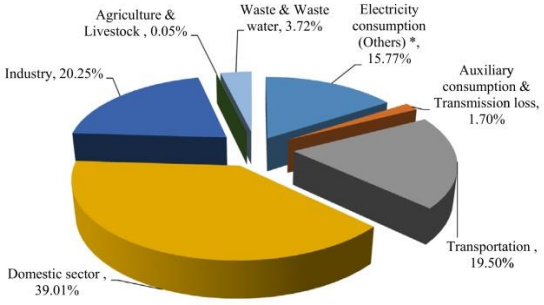

Fig. 15. GHG footprint (carbon dioxide equivalent emissions, Gg) of Chennai in 2009–2010.

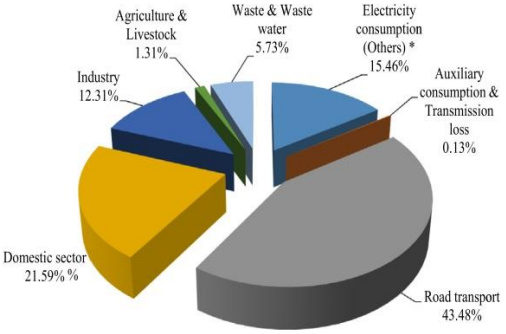

Fig. 16. GHG footprint (carbon dioxide equivalent emissions, Gg) of Greater Bangalore.

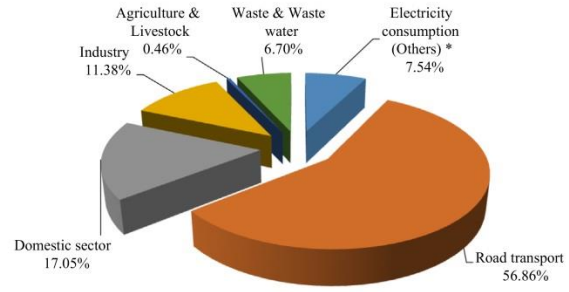

Fig. 17. GHG footprint (carbon dioxide equivalent emissions, Gg) of Hyderabad.

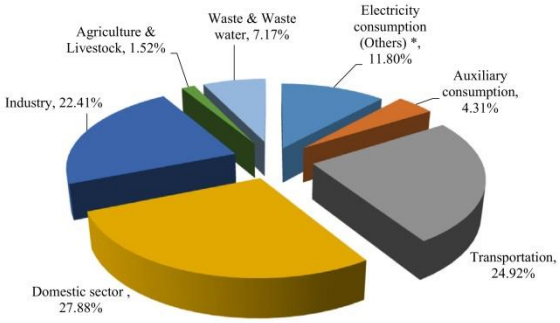

Fig. 18. GHG footprint (carbon dioxide equivalent emissions, Gg) of Ahmedabad.

Source: Ramachandra T.V., Bharath H. Aithal, Sreejith, 2015.

Aggregation of GHG emissions of all sectors reveal that GHG emissions in major cities in India ranges from 38633.20 Gg/year (Delhi), 22783.08 (Greater Mumbai), 22090.55 (Chennai), 19796.60 (Greater Bangalore), 14812.10 (Kolkata) to 13734.59 (Hyderabad).

Sector wise GHG footprint analysis for Delhi city reveals that transport sector leads the carbon emission (32.08%) followed by domestic sector (30.26%). The sector-wise carbon emissions analysis show the relative higher share for transportation sector in IT (Information Technology) giants of India – Bangalore and Hyderabad. Emissions from transport sector ranges from 43.83% (Greater Bangalore) and 56.86% (Hyderabad) due to lack of appropriate public transport system in these Cities and haphazard growth due to unplanned urbanisation has led to large scale usage of private vehicles.

Bangalore faced bundh on April 18 and ambient noise and air pollution levels at various locations in Bangalore was low (compared to the previous day, that is April 17), as per the data of Karnataka State Pollution Control Board (KSPCB): Residual suspended particulate matter (RSPM) reduced by as much as 55 % in some areas, while nitrogen dioxide (NO2) and sulphur dioxide (SO2) went down to 64 % and 16 % respectively. This highlights the role of transportation sector in higher GHG levels in major cities of India and the need for policy interventions and effective implementation.

Mitigation Strategies:

- Reduce emissions from vehicles, including prescription of emissions targets for new vehicles;
- A strategy to reduce heavy duty vehicle fuel consumption and CO2 emissions;
- A target to reduce the greenhouse gas intensity of fuels;
- Rolling resistance limits and tyre labelling requirements with mandatory tyre pressure monitoring;
- Legislation encouraging hybrid and electric vehicles; and,
- Accounting life time energy use and CO2 emissions while procuring vehicles (mandatory disclosure in vehicles information brochure).
- Appropriate taxation regime to discourage private vehicles, phasing out out-dated inefficient vehicles,
- Automation of public transport system to reduce idle time and improve commute efficiency.

Comprehensive GHG reduction strategies addressing the following:

- Appropriate urban planning with thresholds on regional growth (such as FAR fixation based on the infrastructure – width of the lane, etc.)
- Transport demand: integration of land use and mobility planning targeting land use, improvement of load factors and changes in patterns and scale of transport demand, where appropriate;
- Improvements in public transport system (with apt share of commuter trains and user friendly buses.
- Mode share: measures facilitating less GHG intensive modes such as public transport and non-motorised transport (like Namma cycle in Bangalore). Public transport needs to be user friendly and economically competitive; train services for cargo and commuter movement.
- Innovations in vehicle design – smaller and light vehicles (for example in public transport) to reduce fuel consumption and improve use efficiency

- Fuel choice: measures aiding the development and dissemination of technologies for alternative fuels (hybrid, electric); and
- Fuel efficiency: development and dissemination of technologies for vehicles (including test cycle measures for vehicle components and accessories) and traffic management, traffic congestion abatement measures, eco-driving, awareness among public about implications of increases in GHG's, etc.

This also highlights the need for research and innovations focussing on mitigation and adaptation mechanisms to reduce GHG emissions in transport sector.

The earlier plan proposed by the PMC had pegged the total cost of implementation of the Plan at around Rs 3,500 crore. The final Plan approved by the city corporators has cut the Plan size to Rs 2,932 crore. Only around 23 per cent of this is going to be spent on the development of the entire city; within that, the focus is going to be on development of a smart public transport system and a 24x7 water supply system. The major chunk, 75 per cent, of the expenditure is going to be for the development of the Aundh–Baner–Balewadi area as a Smart City (Rs 2,196 crore)—including spending on smart grid and solar energy projects, smart metering, rainwater harvesting projects, solid waste management, e-governance, establishing.

Reference:

Ramachandra T.V., Bharath H. Aithal, Sreejith, 2015. GHG footprint of major cities in India, Renewable and Sustainable Energy Reviews 44 (2015) 473–495, http://dx.doi.org/10.1016/j.rser.2014.12.036