C40 CITIES
CLIMATE LEADERSHIP GROUP

BENEFITS OF URBAN CLIMATE ACTION

C40 Cities Technical Assistance Report

CHENNAI

CLIMATE, AIR QUALITY AND HEALTH

C40 and Johnson & Johnson are working in partnership to connect the dots between climate action, improved air quality in cities and better health amongst citizens.

C40 has undertaken cutting-edge research, working with 26 cities to date to measure the air quality and health benefits of climate action, and use this to make a stronger case for action.

The time for urgent climate action

Cities are responsible for about 70% of global CO_2 emissions and play a leading role in limiting global increases in temperature to 1.5°C, in line with the Paris Agreement. Simultaneously, cities need to take adaptation measures to protect themselves against current and future extreme weather events, such as extreme cold and hot weather, floods and droughts. Finally, cities need to attend local issues of air pollution, including pollutants and toxic compounds.

In order to tackle both air quality and climate change, cities need clean and efficient transport, buildings and industry solutions.

CHENNAI

Chennai is the capital of the state of Tamil Nadu, in Southern India. With an area of 426 km^2 and a population of approximately 7.5 million people, the city of Chennai is one of the largest and most populous in India.

Chennai's road transport sector represents the greatest contribution to greenhouse gas (GHG) emissions, accounting for 26% of the total Scope 2 GHG emissions in the city[1].

26% OF THE CITY'S GHG EMISSIONS COME FROM ROAD TRANSPORT

THE NEED TO TACKLE AIR QUALITY

In recent years, air pollution has become a serious problem in Chennai. Diseases that are directly correlated with poor air quality have been on the rise.

According to the World Health Organization (WHO), the annual average concentration of $PM_{2.5}$ should not exceed 10 µg/m^3. In Chennai, the annual average is around 31 µg/m^3, showing that people are exposed to very harmful levels of air pollution.

$PM_{2.5}$ CONCENTRATION IS 3 TIMES ABOVE THE WHO RECOMMENDED VALUE

THE HEALTH BURDEN

Pollutants such as $PM_{2.5}$ and NO_2 represent a major risk to people's health, particularly affecting children and older people. Often used as an indicator of air pollution, $PM_{2.5}$ can penetrate deep into lungs and is linked to respiratory and cardiovascular morbidity and mortality, even at low concentrations.

In Chennai, about 8,000 premature deaths every year are attributable to the current $PM_{2.5}$ levels.

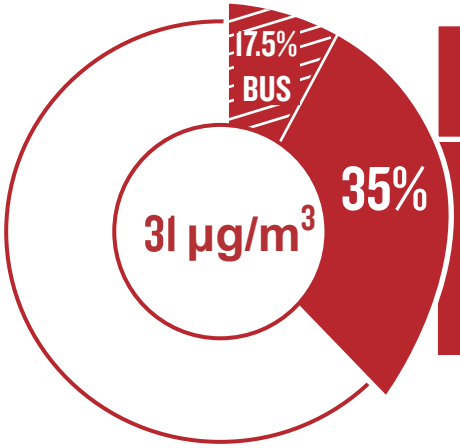
8,000 PREMATURE DEATHS EACH YEAR IN CHENNAI ARE DUE TO $PM_{2.5}$ LEVELS

Understanding the problem

35% OF PM2.5 CONCENTRATION COMES FROM THE ROAD TRANSPORT SECTOR

The road transport sector in Chennai is responsible for 35% of the total $PM_{2.5}$ concentration in the city. Within this sector, 17.5% of the total contribution is generated by buses.

The Metropolitan Transport Corporation in Chennai serves around 5.5 million passengers with around 4,000 buses. These buses, which operate on fossil fuels, are used very frequently and contribute significantly to poor air quality in the city. In addition, the fleet is planned to expand to a total of 6,000 buses in the next few years.



CHENNAI TRANSPORT CORPORATION

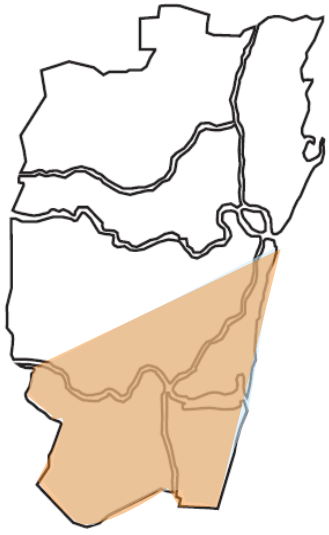
17.5% OF ROAD TRANSPORT SECTOR PM2.5 CONCENTRATION IS GENERATED BY BUSES	5.5 M PASSENGERS EACH YEAR	4,000 BUSES USING FOSSIL FUELS

The action

The city of Chennai is part of the Smart Cities Mission launched by the Government of India. This is aimed at promoting sustainable and inclusive development of areas within Indian cities by providing smart solutions for core infrastructure services, such as e-governance, waste, water and energy management, and urban mobility. Within this framework, the city is looking into improving air quality, energy efficiency and mobility of citizens through a number of actions across various sectors. This includes parking management, increasing walking and cycling and electrifying public transport.

In particular, Chennai is looking into upgrading 4,000 municipal buses from Diesel Bharat Stage (BS) IV (roughly equivalent to Euro IV) to BS VI (roughly equivalent to Diesel Euro VI) and procuring 2,000 electric buses.

The upgrade will involve the Southern area of Chennai, representing about a third of the total city area.



CHENNAI ELECTRIC BUSES

4,000 BUSES BSIV UPGRADED TO BSVI	2,000 ELECTRIC BUSES	1/3 OF THE TOTAL CITY AREA

The benefits

With support from C40, the city analysed the social and economic impacts of upgrading Chennai's municipal bus fleet with less polluting buses, including best practice diesel and electric vehicles. The results showed a massive improvement in air quality leading to health improvements for the city's population and a reduced economic burden.

There is an improvement in air quality, both within the intervention area and across the whole city, for the indicator studied ($PM_{2.5}$).

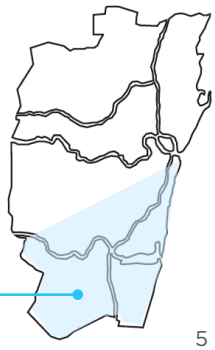
The improvement in air quality reduces the health burden of cardiovascular- and respiratory-related diseases and deaths. Hospital admissions are used as an indicator for morbidity, while the change in premature deaths, life expectancy and life years gained are used to quantify mortality impacts.

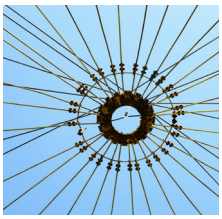
The economic impact is associated to the monetary value of averting a hospital admission and to gaining an extra year of life.

AIR QUALITY

3% $PM_{2.5}$ REDUCTION IN WHOLE CITY AREA

8% $PM_{2.5}$ REDUCTION IN INTERVENTION AREA





77 PREMATURE DEATHS AVERTED PER YEAR

+860 LIFE YEARS GAINED OVER THE WHOLE POPULATION

HEALTH

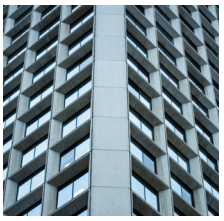
5 day increase in life expectancy for each citizen. For those living in the intervention area, it increases to 8 days.

+5 DAYS IN LIFE EXPECTANCY PER CITIZEN

82 AVERTED HOSPITAL ADMISSIONS PER YEAR

82 averted hospital admissions per year, including 63 for respiratory diseases, and 19 for cardiovascular diseases.

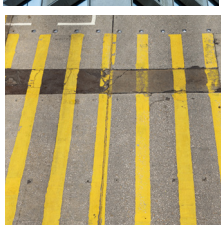
The value of averted hospital admissions is ₹5.5 million in Indian Rupees (55 lakhs) for respiratory and ₹1.6 million (16 lakhs) for cardiovascular diseases.

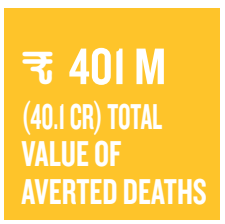


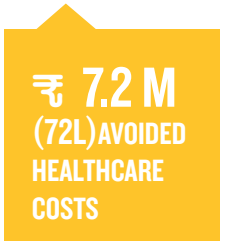
₹ 401 M (40.1 CR) TOTAL VALUE OF AVERTED DEATHS

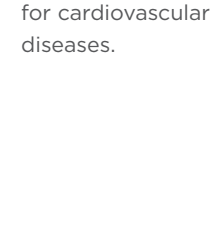
₹ 7.2 M (72L) AVOIDED HEALTHCARE COSTS

ECONOMICS









DRIVING ACTION

BRING FINANCIAL SUPPORT

While the city has strong public and political support, financial constraints have been identified when implementing the action. Electric buses have high upfront costs but the total cost of ownership is lower than conventional buses. The current batch of electric buses will be funded by the German development bank KfW and the first round of funds is expected in the second quarter of 2019.

BOOST COLLABORATION

Preliminary results have already been communicated within the city and helped to promote collaboration within various departments (e.g. Health, Environmental, Air Quality and Transport departments) to provide the necessary data to complete the analysis.

DRIVE ACTIONS FOR AIR QUALITY

The action described in the report is only the first step in a set of actions aiming to improve the air quality in Chennai. In fact, this project falls within the framework of the Tamil Nadu State Action Plan on Climate Change and the future electrification of the bus fleet is also included in the National Green Mobility Plan.

NEXT STEPS

In order to secure full support, the city will also organize meetings with private vendors to engage with them and increase their awareness about the benefits of abandoning highly polluting vehicles and shifting to electric.

The city will disseminate the results of the analysis to make the case for additional financial support from donors and the Government.

The city is planning to use this methodology to study the benefits of private vehicles' electrification in the city.

METHOD AND ASSUMPTIONS

Methodology available here.

Key assumptions:

- *The distribution of population in the southern area of the city reflects the average distribution in the city;*
- *The analysis considers a circulating bus fleet of 6,000 BSIV opposed to the actual 4,000 BSIV, assuming the fleet would have been expanded independently of the electrification action. $PM_{2.5}$ concentration data was not available in any monitoring stations, so the values were converted from PM_{10} to $PM_{2.5}$ using WHO data;*
- *Distribution by age and by gender of local hospital admission obtained by assuming a constant relation between population and hospital admissions;*
- *Proxy data from Colombo (Sri Lanka) used for VOLY and VHA and converted from 2016 USD using the relevant PPP exchange rate;*
- *Burden of air pollution on mortality was calculated by using the relative risk from published studies relating air pollution concentrations to health outcomes. This was applied to the difference between city-wide annual average $PM_{2.5}$ concentration and the GBD's theoretical minimum exposure (5.8 $\mu g/m^3$), and to the mortality rate in the local population. This is assuming impacts only in adults (ages 30+).*

The analysis has been carried out following the methodology outlined in the BUCA Guidance Manual.

Next steps for the analysis:

Future data collection activities based on the data gaps in the analysis include:

- *Update with latest mortality data*
- *Improving data collection for NOx, NO_2 and $PM_{2.5}$*
- *Collection of hospital admission data by gender and age*
- *Development of a local VOLY.*

***Notes**: [1] C40 Cities, Global Protocol for Community-scale GHG Emission Inventories (GPC), 2015-16. https://www.c40.org/other/gpc-dashboard*

Cover page picture: Adityan Ramkumar, unsplash.

Johnson & Johnson

BUROHAPPOLD ENGINEERING

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