C40 CITIES
CLIMATE LEADERSHIP GROUP

BENEFITS OF URBAN CLIMATE ACTION

C40 Cities Technical Assistance Report - July 2020

BENGALURU

Electric buses

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 30 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 temperature rise 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 to 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.

BENGALURU

Home to 12.3 million citizens, Bengaluru is the capital of the state of Karnataka and one of the largest cities in India. The city has grown exponentially since the 1980's, welcoming workers, institutions and information technology universities, such that the city is known as the 'Silicon Valley of India'.

As the city's population has grown, the dependence on cars and public transport has also increased. With an observed annual growth rate of 10% in vehicle registration between 1980 and 2016, transport represents 44% of the city's greenhouse gas (GHG) emissions.[1,2]

44% OF GHG EMISSIONS FROM **TRANSPORT**

THE NEED TO TACKLE AIR QUALITY

Citizens are exposed to harmful levels of air pollution. The city's annual concentration of fine particulate matter ($PM_{2.5}$) is 43 µg/m^3, which is more than the national standard (40 µg/m^3) and four times above the World Health Organisation (WHO) guidelines.[3]

$PM_{2.5}$ CONCENTRATION 4 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 the lungs and is linked to respiratory and cardiovascular morbidity and mortality, even at low concentrations.

In India, about 1.2 million premature deaths every year are attributable to the current ambient air pollution levels.[4]

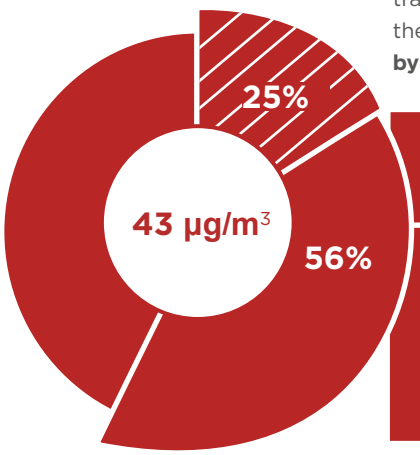
1.2 MILLION PREMATURE DEATHS EACH YEAR IN INDIA ARE DUE TO AIR POLLUTION LEVELS

Understanding the problem

Transport is the biggest source of air pollution in Bengaluru and is responsible for 56% of $PM_{2.5}$ emissions, including both exhaust and on-road dust emissions. While buses represent only 6% of vehicles in the city, they are responsible for 25% of $PM_{2.5}$ emissions.

The city's air pollution is also enhanced by traffic congestion and the poor condition of roads. The city needs to aggressively promote public and non-motorized transport as part of its urban development plan, along with the improvement of the road infrastructure. If no action is planned, **transport emissions may double by 2030**.[6]

56% OF EMISSIONS COME FROM TRANSPORT



BENGALURU TRANSPORT

25% OF PM2.5 EMISSIONS WITHIN THE ROAD TRANSPORT SECTOR **COMES FROM BUSES**

PM2.5 EMISSIONS COMING FROM TRANSPORT MAY **DOUBLE BY 2030**

The action

The city's growth has increased citizens' reliance on the transport sector. Public transport represents a third of the trips made in the city. The Bengaluru Metropolitan Transport Corporation (BMTC) is currently operating 6,634 buses on 2,842 routes. The C40 Cities Finance Facility (CFF) will help the city to kickstart its transition to clean transport by supporting the city to build the economic case for a transition to electric buses by 2030. The bus fleet is projected to increase from 6,634 in 2019 to 16,000 cleaner vehicles by 2031.[5]

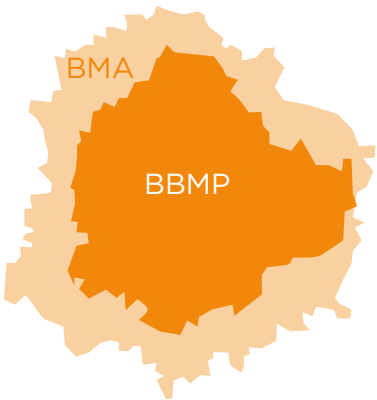
However, the BMTC bus fleet constitutes only 27% of the total number of buses in Bengalaru and therefore, working with private companies will be essential to effectively reduce bus emissions. In order to compensate the rise in energy consumption from electric buses, the city must ensure decarbonization of the energy grid to facilitate long term reduction of emission levels.

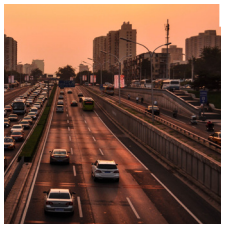
C40 Cities Finance Facility (CFF) *is bridging the gap between cities and finance. The CFF facilitates access to finance for climate change mitigation and resilience projects in urban areas by providing technical assistance to develop cities' sustainability priorities into bankable investment proposals. The CFF aims to deliver project preparation and capacity development, and to widely share knowledge and establish partnerships between cities and financiers. Learn more here.*

BMTC BUSES

13,500 ZERO-TAILPIPE EMISSION BUSES BY 2030

BHARAT 6 PROCURED BY THE CITY FOR THE REMAINING VEHICLES





The benefits

With support from C40, the city analysed the social and economic impacts of switching the 6,634 BMTC buses from diesel Bharat 4 (BS4) to 13,500 electric vehicles and 2,500 Bharat 6 (BS6) buses in 2030. It also shows the impact of switching the old private bus fleet to BS6 vehicles. The model calculates the direct impact from the reduced exhaust emissions. The model does not illustrate the impact of the mode shift to increased public transport use, which may provide additional benefits.

The results showed a reduction in $PM_{2.5}$. The air quality improvement leads to a reduction in 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 represents the monetary value of averting a hospital admission on public healthcare costs.

Target 2030: BMTC operated 13,500 electric buses and 2,500 BS6 diesel buses. The private sector procures 30,000 BS6 buses.

AIR QUALITY & CLIMATE

REDUCTION IN NOISE COMING FROM BUSES

1,325 PREMATURE DEATHS AVERTED PER YEAR

0.35 MtCO2 FEWER **GHG EMISSIONS PER YEAR**

4.8% $PM_{2.5}$ REDUCTION IN THE CITY'S NON-BACKGROUND CONCENTRATION

+32 DAYS IN LIFE EXPECTANCY PER CITIZEN

The 13,500 electric buses will produce 0.35 $MtCO_2$ less than BS4 diesel buses each year. This can lead to 1.75 µg/m³ reduction in the city's non-background $PM_{2.5}$ concentration, improving the air quality of Bengaluru citizens.

1,325 lives and 1,815 hospital admissions (1,355 from respiratory and 460 from cardiovascular diseases) could be prevented each year. Citizens can expect an increase of their life expectancy by 32 days.

HEALTH

INR 10 BILLION OF FUEL COSTS SAVINGS PER YEAR

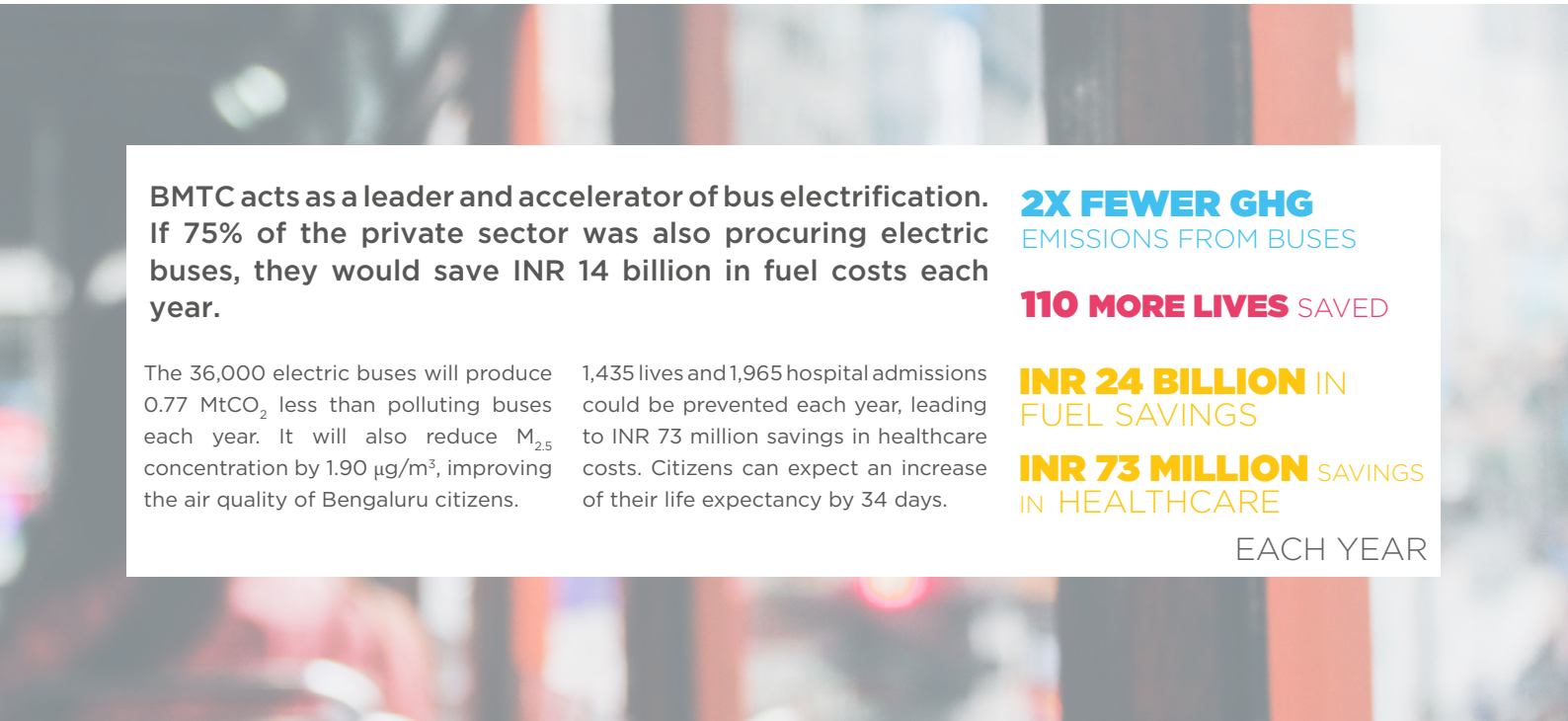
Energy costs were based on 2020 data. The high variation of diesel prices can impact the resilience of the bus system.

The city can also expect savings in healthcare costs from hospital admissions avoided.

ECONOMY

1,815 AVERTED HOSPITAL ADMISSIONS PER YEAR

INR 67 MILLION HEALTHCARE COSTS AVOIDED PER YEAR



BMTC acts as a leader and accelerator of bus electrification. If 75% of the private sector was also procuring electric buses, they would save INR 14 billion in fuel costs each year.

The 36,000 electric buses will produce 0.77 $MtCO_2$ less than polluting buses each year. It will also reduce $M_{2.5}$ concentration by 1.90 µg/m³, improving the air quality of Bengaluru citizens.

1,435 lives and 1,965 hospital admissions could be prevented each year, leading to INR 73 million savings in healthcare costs. Citizens can expect an increase of their life expectancy by 34 days.

2X FEWER GHG EMISSIONS FROM BUSES

110 MORE LIVES SAVED

INR 24 BILLION IN FUEL SAVINGS

INR 73 MILLION SAVINGS IN HEALTHCARE

EACH YEAR

DRIVING ACTION

RE-EVALUATE FARES MODEL	POWER PROCUREMENT	TECHNICAL CAPACITY
BMTC is incurring losses with inadequate revenue and high operating costs, mainly due to the constant fares over the past 6 years.	To meet the increased energy demand, BMTC will create a Power Procurement Plan from renewable sources.	The city needs capacity development to improve procurement processes, as well as technical capacity for operating and maintaining e-buses and charging Infrastructure.

NEXT STEPS

BMTC will thus need to have an annual automatic fare revision policy based on cost indices and a review of the policy every 5 years. It also needs to reconsider how to subsidise poorer communities.	Business models for renewable energy (solar) generation and transmission within BMTC land assets could be considered, in order to become self-sufficient in energy generation.	The standardisation of e-bus technology for the Indian market will enable a push for production capacity and delivery.

METHOD AND ASSUMPTIONS

Methodology available here.

Data sources:

• The air quality monitoring is based on the average of the city's manual monitoring stations for the year 2017-2018.

• The background concentration is modelled from past academic studies (Sarath K. Guttikundaa, 2019), representing 15.7% of $PM_{2.5}$ concentration.

• Mortality and population data are based on the national census (2011, projected to 2030 with a 3% augmentation of the population), scaled down to the city.

• Due to the lack of data on hospital admissions, the rate of hospital admission per age and gender is from London for the year 2018. Hospital admission costs are from India Stastistics 2018 - Urban Area - Avg Total Medical Expenditure per Hospitalisation-2018 (ref Table A-25, page 841 (no. A-674). Average for male and female.

• Transport emissions, emission factors and projections are based on past academic studies (Sarath K. Guttikundaa, 2019). The model illustrate the change of exhaust emissions between electric and diesel buses. All buses have the same averaged exhaust and non-exhaust emission factors taking into consideration the type of buses, age of the fleet and road congestion. The change in mode share has not been modeled. $PM_{2.5}$ emissions from the grid are not modeled, and the success of the action is underpinned by the grid decarbonisation.

• 43,000 buses are registered in the city, but only 50% of the registered private buses actually circulate in the city, Public buses represent 37% of the circulating bus fleet (18,000 vehicles in 2019), and are planned to be 30,000 vehicles in 2030.

• GHG emission reductions have been calculated comparing the emissions from BS4 buses in 2020, BS6 and electric buses in 2030. The electricity grid factor is decreasing from 0.7 in 2020 to 0.55 in 2030.

• The burden of air pollution on mortality was calculated by using the relative risk from published studies that relate air pollution concentrations to health outcomes. This was applied to the difference between city-wide annual average $PM_{2.5}$ concentration and the Global Burden of Disease's theoretical minimum exposure, 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.

• Energy costs were based on the 2020 electricity prices (INR 7.2 per kWh) and diesel prices (INR 76 /liter). Fuel consumption of the current fleet is based on BMTC presentation on physical and financial performance for 2018-19 showing 3.74 km per liter consumption. Electricity consumption is based on a three-month trial run of BYD e-buses by BMTC (range of 1.17 to 1.35 KwH/Km).

Report Notes

[1,6] Air quality, emissions, and source contributions analysis for the Greater Bengaluru region of India, Sarath K. Guttikundaa, K.A. Nishadha, Sudhir Gotaa, Pratima Singhc, Arijit Chandac, Puja Jawahara, Jai Asundic, Article in Atmospheric Pollution Research, May 2019.

[2] GHG footprint of major cities in India, T.V. Ramachandra, Bharath H.Aithal, K.Sreejith, 2015.

[3] Concentration of PM2.5 annual average over 16 manual monitoring stations for 2016-2017.

[4] IHME (2019) Global Burden of Disease for India, data from 2017.

[5] MOTOR, India Statistical Yearbook, 2017. The planned number of electric buses by 2030 is likely to vary between 6,634 and 13,500, due to capacity issues. The city is committed to procure BS6 buses from 2025, for the remaining buses.

***Cover page picture** : Image by Bishnu Sarangi from Pixabay*

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