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# Jakarta Bus Electrification : Health & Air Quality Impact Assessment

2021 Analysis –
C40 Benefits of Urban Climate Action

# Measuring air quality and health impact

| Context | Climate action | Output | Outcome | CRF/Multipliers | Impact |
|---|---|---|---|---|---|
| Jakarta data | E-buses data | Change in air pollution transport emissions | Change in the city air pollution concentration | $PM_{2.5}$ and $NO_X$ concentration-response functions **to quantify the health impacts of air pollution reduction** | **Health and health economic impact** |

# Measuring air quality and health impact

**Context**

**Climate action**

Output

**Outcome**

CRF/Multipliers

**Impact**

**Jakarta data**

- *Air quality*
- *Population*
- *Number of deaths per year*
- *Hospital admissions (respiratory & cardiovascular)*

**E-buses data**

- *Type and number of buses*
- *Km travelled*

**Change in air pollution transport emissions**

**Change in the city air pollution concentration**

$PM_{2.5}$ and $NO_X$ concentration-response functions **to quantify the health impacts of air pollution reduction**

**Health and health economic impact**

- *Reduction in premature deaths*
- *Increase in life expectancy*
- *Increase in life years*
- *Reduction in hospital admissions*
- *Value of statistical life (premature deaths)*
- *Healthcare costs*

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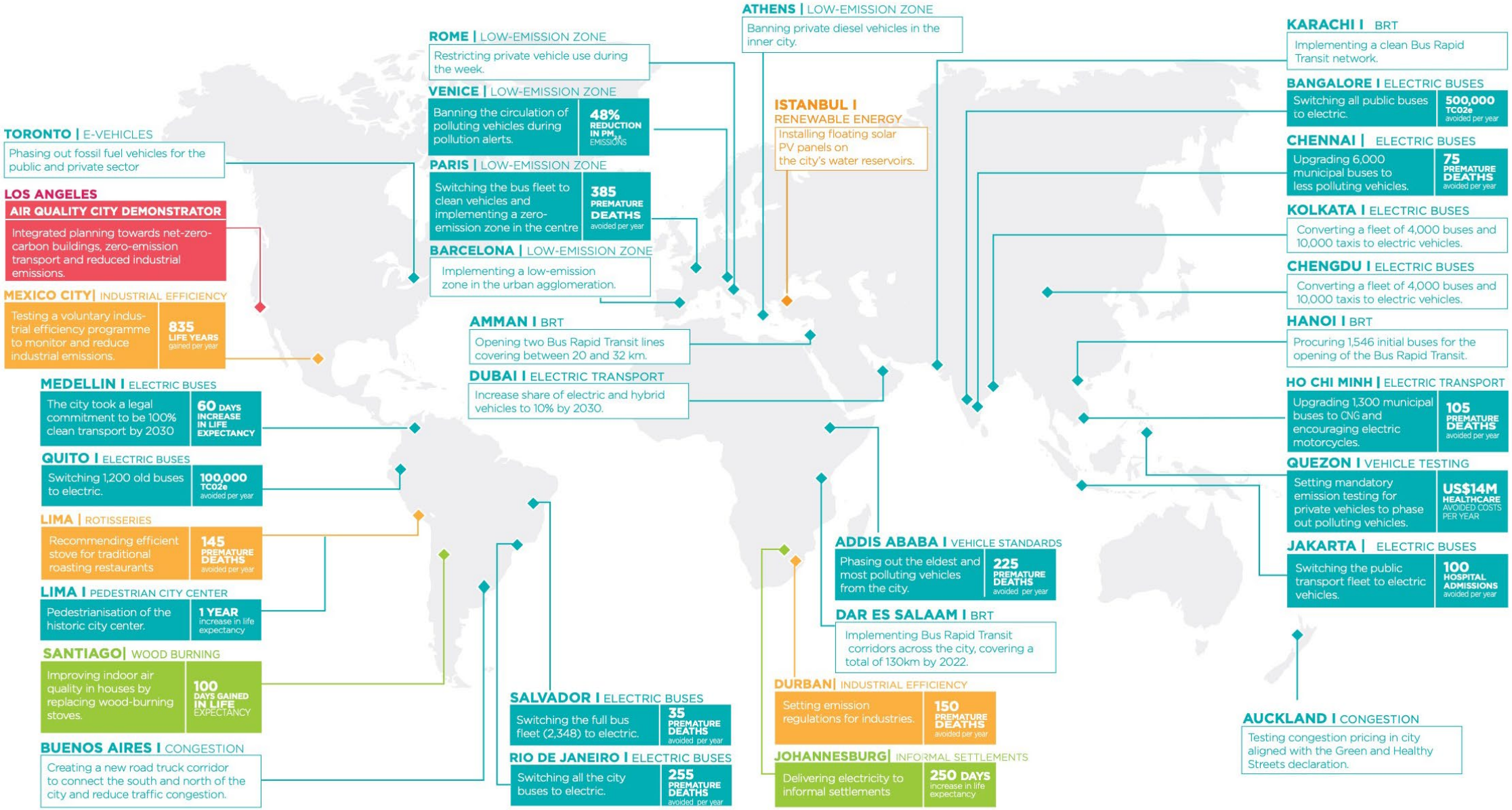
ATHENS | LOW-EMISSION ZONE
Banning private diesel vehicles in the inner city.
ROME | LOW-EMISSION ZONE
Restricting private vehicle use during the week.
VENICE | LOW-EMISSION ZONE
Banning the circulation of polluting vehicles during pollution alerts.
48% REDUCTION IN PM10 EMISSIONS
PARIS | LOW-EMISSION ZONE
Switching the bus fleet to clean vehicles and implementing a zero-emission zone in the centre
385 PREMATURE DEATHS avoided per year
BARCELONA | LOW-EMISSION ZONE
Implementing a low-emission zone in the urban agglomeration.
ISTANBUL | RENEWABLE ENERGY
Installing floating solar PV panels on the city's water reservoirs.
KARACHI | BRT
Implementing a clean Bus Rapid Transit network.
BANGALORE | ELECTRIC BUSES
Switching all public buses to electric.
500,000 TC02e avoided per year
CHENNAI | ELECTRIC BUSES
Upgrading 6,000 municipal buses to less polluting vehicles.
75 PREMATURE DEATHS avoided per year
KOLKATA | ELECTRIC BUSES
Converting a fleet of 4,000 buses and 10,000 taxis to electric vehicles.
CHENGDU | ELECTRIC BUSES
Converting a fleet of 4,000 buses and 10,000 taxis to electric vehicles.
HANOI | BRT
Procuring 1,546 initial buses for the opening of the Bus Rapid Transit.
HO CHI MINH | ELECTRIC TRANSPORT
Upgrading 1,300 municipal buses to CNG and encouraging electric motorcycles.
105 PREMATURE DEATHS avoided per year
QUEZON | VEHICLE TESTING
Setting mandatory emission testing for private vehicles to phase out polluting vehicles.
US$14M HEALTHCARE AVOIDED COSTS PER YEAR
JAKARTA | ELECTRIC BUSES
Switching the public transport fleet to electric vehicles.
100 HOSPITAL ADMISSIONS avoided per year
AUCKLAND | CONGESTION
Testing congestion pricing in city aligned with the Green and Healthy Streets declaration.
TORONTO | E-VEHICLES
Phasing out fossil fuel vehicles for the public and private sector
LOS ANGELES
AIR QUALITY CITY DEMONSTRATOR
Integrated planning towards net-zero-carbon buildings, zero-emission transport and reduced industrial emissions.
MEXICO CITY | INDUSTRIAL EFFICIENCY
Testing a voluntary industrial efficiency programme to monitor and reduce industrial emissions.
835 LIFE YEARS gained per year
AMMAN | BRT
Opening two Bus Rapid Transit lines covering between 20 and 32 km.
DUBAI | ELECTRIC TRANSPORT
Increase share of electric and hybrid vehicles to 10% by 2030.
MEDELLIN | ELECTRIC BUSES
The city took a legal commitment to be 100% clean transport by 2030
60 DAYS INCREASE IN LIFE EXPECTANCY
QUITO | ELECTRIC BUSES
Switching 1,200 old buses to electric.
100,000 TC02e avoided per year
LIMA | ROTISSERIES
Recommending efficient stove for traditional roasting restaurants
145 PREMATURE DEATHS avoided per year
LIMA | PEDESTRIAN CITY CENTER
Pedestrianisation of the historic city center.
1 YEAR increase in life expectancy
SANTIAGO | WOOD BURNING
Improving indoor air quality in houses by replacing wood-burning stoves.
100 DAYS GAINED IN LIFE EXPECTANCY
BUENOS AIRES | CONGESTION
Creating a new road truck corridor to connect the south and north of the city and reduce traffic congestion.
SALVADOR | ELECTRIC BUSES
Switching the full bus fleet (2,348) to electric.
35 PREMATURE DEATHS avoided per year
RIO DE JANEIRO | ELECTRIC BUSES
Switching all the city buses to electric.
255 PREMATURE DEATHS avoided per year
ADDIS ABABA | VEHICLE STANDARDS
Phasing out the eldest and most polluting vehicles from the city.
225 PREMATURE DEATHS avoided per year
DAR ES SALAAM | BRT
Implementing Bus Rapid Transit corridors across the city, covering a total of 130km by 2022.
DURBAN | INDUSTRIAL EFFICIENCY
Setting emission regulations for industries.
150 PREMATURE DEATHS avoided per year
JOHANNESBURG | INFORMAL SETTLEMENTS
Delivering electricity to informal settlements
250 DAYS increase in life expectancy

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# **Understanding the benefits:** Medellin electric buses

The city assessed the impact of electrifying all buses within the city (6,980), which are responsible for 21% of transport $PM_{2.5}$ emissions.

**11,960 premature deaths** each year in Colombia are due to $PM_{2.5}$ levels

**BUSES represent 21%** of road transport sector $PM_{2.5}$ concentration


**-8.3%** of $PM_{2.5}$ non-background concentration

**37 deaths** avoided per year

**+6 days** in life expectancy per person

**24** hospital admisssions avoided

**COP $24 MIL** avoided healthcare costs

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# **Understanding the benefits:** Bangalore electric buses

The city assessed the impact of electrifying all the private and public buses, which currently represent 25% of the transport $PM_{2.5}$ emissions.

**PM2.5 emissions coming from transport may double by 2030**

**-4.8%** **of $PM_{2.5}$** non-background concentration

**1,325** **deaths** avoided per year

**+32 days** in life expectancy per person

**1,815** hospital admisssions avoided

**INR 67M** avoided healthcare costs

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# **Understanding the benefits:** Jakarta electric buses

In Jakarta, the annual average concentration of fine particulate matter is more than four times greater than the World Health Organization recommended safe level.





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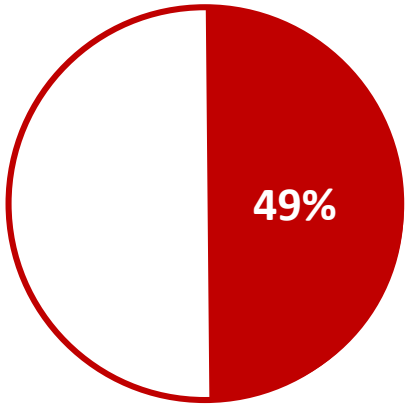
# **Understanding the benefits:** Jakarta electric buses

Transport is a major source of both $PM_{2.5}$ and Greenhouse Gas (GHG) emissions in the city, with more than 17 million vehicles registered in the city.

**$PM_{2.5}$ CONCENTRATION 4 TIMES HIGHER** THAN THE WHO RECOMMENDED VALUE

**123,700 PREMATURE DEATHS EACH YEAR** IN INDONESIA ARE DUE TO AIR POLLUTION




Half of Jakarta's air pollution ($PM_{2.5}$ concentration) comes from the **transport sector**

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# **TransJakarta:** 83% electrification scenario

12,172 buses expected to operate in the TransJakarta fleet in 2030. This analysis will quantify the air quality and health benefits of electrifying 83% of these, compared to rolling out 100% diesel Euro 2.

| | 83% electric | | 100% diesel (euro 2) | |
|---|---|---|---|---|
| | Large | Medium/small | Large | Medium/small |
| Diesel buses (euro 2) | 883 | 1,186 | 5,195 | 6,977 |
| Electric buses | 4,312 | 5,791 | - | - |
| **Total emissions ($t\ PM_{2.5}$/ year)** | **78** | | **239** | |
| **Total emissions (t NOx/ year)** | **1,800** | | **10,700** | |

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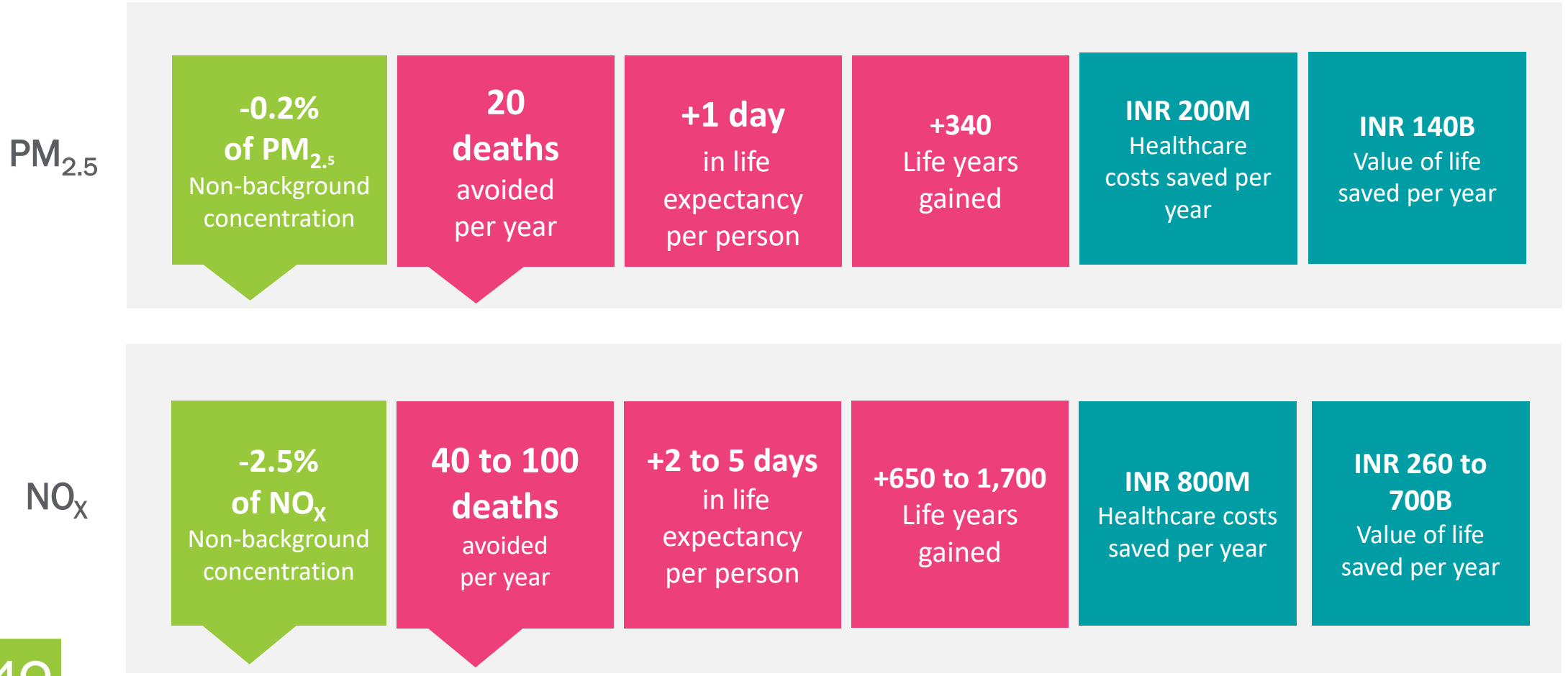
# **Results:** 83% electrification by 2030

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# Assumptions and data inputs

## Population and health

- Population and death data is from the Health Department of DKI Jakarta Province for the latest date available (2018 for population, 2016 for death rates). An increase of 21% (Oxford Economics) to the 2018 population was used to account for the population in 2030.
- No hospital admission rates are available – the current ones are proxy from the UK in 2018. This means it may be a conservative estimate as the air pollution in the UK (London for this data) is lower than the air pollution from Jakarta. Another aspect to consider is that behaviours to go to hospital related to diseases may be different across countries. More  nationally/regionally specific data would improve the robustness of the study.
- The cost of hospital admission is based on influenza hospital admissions (2019), and used as a proxy for the cost of respiratory and cardiovascular hospital admissions. In its current form, it likely underestimates the savings.
- The Value of a Statistical life used to calculate the economic value of life saved uses a proxy value from Thailand, taken from the OECD database. This refers to the amount a sample of the population is willing to pay (in monetary terms) to reduce their risk of mortality.
- $PM_{2.5}$ and NOx concentrations are based on the average across all air pollution monitoring stations in 2019 in the city.
- The background concentration is based on the national average concentration of $PM_{2.5}$ in 2016 as no other local data or source apportionment was available to account for air pollution outside the city boundaries.
- The emission factors are generic from the European Environment Agency (euro), and do not reflect the traffic congestion nor the state of the roads.
- Emissions coming from the increase in electricity-use for the new buses are not counted in the analysis: the increase in energy demand compared to energy demand from buildings and industry will not be significant enough to reflect on the city concentration. However, shifting to renewable energy is essential to ensure a clean air for all citizens.

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# Assumptions and data inputs

## Source apportionment

- The share of $PM_{2.5}$ and NOx emissions attributed to TransJakarta's buses was calculated based on the number of vehicles in the city, their average distance travelled per year and an average emission factor from Euro 2. Information on the vehicle fleet is based on Statistik Transportasi DKI Jakarta 2017 (data from 2016), as being the latest public data available.
- The share of PM2.5 attributable to transport in the city concentration is from the Breathe Easy study. NOx source apportionment is from the WHO database (2013).

## 2030 Electric vs Diesel scenario

- The daily average kilometres travelled per bus is assumed to be the same in 2030 as in 2020.
- The average kilometres travelled by large buses is 239 kilometres per day, as currently covered by the BRT system (Rencana Implementasi document from Transjakarta, 2021). For medium buses, they average 159 to 181 kilometers per day, and an average value of 170 has been used for this study. Medium and small buses have the same average kilometres travelled per day.
- For the electric scenario, 83% of the planned large and medium/small buses are presumed to be electric in 2030. The remaining buses in the fleet are assumed to be Euro 2 standard, to compare to the current level of the bus fleet. The number of buses has been provided in the Rencana Implementasi document from Transjakarta, 2021.
- For NOX, the reduction in NOX due to bus electrification is 100%. Electric buses have no exhaust emissions from PM2.5 and NOX, as there is no engine combustion. However, all buses still have remaining PM2.5 emissions from non-exhaust sources such as tyres, road dust and brakes. This means that 100% of NOX emissions from buses can be reduced with electrification, and up to 75% of PM2.5 emissions (for electric buses against euro 2 diesel buses).

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# Thank you

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