Electric Buses in Indian Cities as Public Transport

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Emission Challenges in Indian Cities

Major Pollution Sources
- Transport
- Industries
- Construction Dust , etc.

- Transport Sector
  contributes 10-15% of total pollu

- Vehicular Pollution
  70-75% by road traffic (old vehicles+
  Diesel /Petrol vehicles + etc.)
  due to combustion of fuels.

- CO2 Emission
  Bus > Cars, TW, etc.

  Diesel buses > CNG buses

  CNG buses emits : CO, Nox, e

Thrust Areas for Solutions

-Vehicle Technology (VT)

-Fuel Technology (FT)

- Vehicle Technology (VT)

Vehicles without internal combustion engine are required.

Example: Electric Vehicles / Passenger Electric Buses

- Fuel Technology (FT)

Vehicles without fuels burning are required hence zero emission.

Example: Electric Vehicles / Passenger Electric Buses work on chargeable battery.

Crucial Points:

- Electricity is required to charge the batteries. Coals/fossil fuel /oils, etc. are burnt for electricity.
- Source of electricity generation emits certain emissions but those are only at one point and easy to control through various measures.

According to Bloomberg (in 2017)

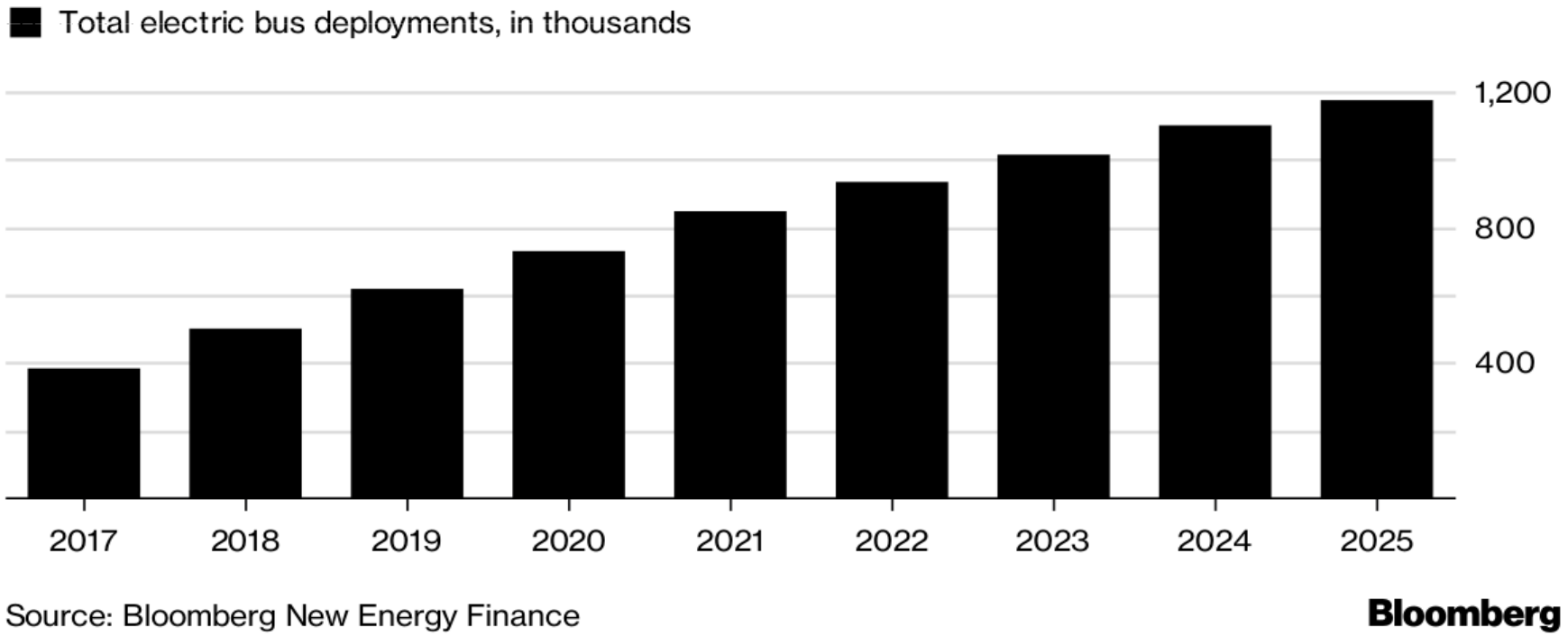
- No. of Electric Buses : 3,85,000 (China had 99% of electric buses on the road world wide.)
- China add approx. 1900 electric buses per week.

UK :191
Germany :176
Netherlands :296
Austria :164
Lithuania :192

Only 30 electric buses in operation in the country

-Himachal Pradesh (25) and
- Mumbai (05)

Source: NBT, Delhi Edition dt.



Faster Adoption and Manufacturing of Hybrid & Electric Vehicles (FAME), 2015

- Major Push : Early adoption and market creation of both hybrid and electric technologies vehicles in the country.

- Major Thrust : To allow hybrid and electric vehicles to become 1st choice for the purchasers so that these vehicles can
  - -replace the conventional vehicles and
  - -reduce liquid fuel consumption .

- 1st Phase of FAME (extended upto March 2018) : offered incentives to EVs and Hybrid EVs buyers. FAME-I was focused on Pvt. Vehicles.

- 2nd Phase of FAME : expected to incentivize electrification of public transport fleet of buses and taxis.

- It is more oriented towards public transport.

In September 2017, the Govt. extended FAME subsidy to electric buses.

- Incentive Level 1 (In case of localization of minimum 15% is achieved): 60% of purchase cost or INR 8.5 million, whichever is lower
- Incentive Level 2 (In case of localization of minimum 35% is achieved): 60% of purchase cost or INR 10 million, whichever is lower

Deptt. of Heavy Industries (DHI), Govt. of India

-Sanctioned : INR 4.37 billion (US$ 67 million)

-for procurement of : electric buses,

: e-taxis and

: e-autos in December 2017.

E-Buses in Mumbai

E-Taxis in Nagpur

E-Auto in Gurgaon

DHI selected:

- 11 cities with one million-plus population
- for the procurement of 390 electric buses, and
- provided funds to the tune of INR 10 million (US$ 150,000) per bus.

Sr. No.	Category	Subsidy (Per Vehicle)	No. of vehicles applied	No. of vehicles sanctioned	Cities selected
1	Electric Bus	INR 7,500,000 to 10,000,000 (60% of total cost)	3,144	390	Delhi, Ahmedabad, Bengaluru, Jaipur, Mumbai, Lucknow, Hyderabad, Indore, Kolkata, Jammu and Guwahati
2	Electric Taxi	INR 124,000 (10-15% of total cost)	2,430	370	Kolkata, Bangalore, Indore and Ahmedabad
3	Electric Auto	INR 37,000 to 61,000 (20% of total cost)	21,545	720	Bangalore, Indore and Ahmedabad

Under this Pilot Project, DHI sanctioned

40 buses (9 cities) : Delhi, Bengaluru, Mumbai, Hyderabad, Ahmedabad, Jaipur, Indore, Lucknow & Kolkata.

15 buses (2 cities) : Guwahati and Jammu.

Total : 390 buses (11 cities)

Procurement of buses are in progress.

Himachal Pradesh became 1st State in India to operate fleet of electric buses on the stretch from Manali to Rohtang (51 km).

Buses are procured from Goldstone-BYD (Model K7e Buzz - 9 meters) at the price of INR 17 million each.

BEST launched Electric Buses. Buses can run for 200 km. on a single charge and take three and a half hours to get fully charged.

Smart City Mission

Smart City :

- basic infrastructure,
- smart solution to make infrastructure and services better
- area based development

Electric Buses as Passenger Transport

Smart Solution PAN City level

Area based Approach i.e. intra city , inter city, etc.

ti , AP

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Mission Components :Urban Transport

- Ferry vessels for inland waterways (excluding port /bay infrastructure) and buses.
- Footpaths/walkways, side-walks, foot-over bridges, and facilities for NMT.
- Multi level Parking.
- Bus Rapid Transit System (BRTS)

Electric Buses under AMRUT in Jammu & Srinagar

Goa is seeking fund for electric buses under AMRUT

http://timesofindia.indiatimes.com/articleshow/65815341.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Electric Buses as Public Transport

Characteristics of PT

- Efficiently
- Reliably
- Safe
- Comfortably
- Affordability……

CNG based AC Bus : 70 lacs

Electric Vehicles (EVs) : Electric Buses

Hybrid Electric Vehicles (HEVs): Hybrid Bus

Battery Electric Vehicles (BEVs): BE Bus

Hybrid Bus :

ICE (internal combustion engine) + Battery with electric motor

gy

Parameters	BE Bus	Hybrid Bus	CNG Bus	Diesel Bus
Power source	Electricity	Electricity + fuel (Diesel or CNG)	CNG	Diesel
Power generator	Battery	IC engine + Battery	IC engine	IC engine
Costs (INR)	2.6 crores[3]	>3 crores[4]	20–88 lakhs[5]	20–88 lakhs[6]
Fuel efficiency	1.5 kWh/km[7]	2.75–4 km/L[8]	2–3 km/kg	2.2–3.3 km/L[9]
Fuel tariff	6.95 INR/kWh[10]	50 INR/L[11]	40 INR/kg	50 INR/L
Fuel cost[12]	INR 10/km	INR 13–17/km	INR 13–20/km	INR 15–23/km

Source: GGGI & CSTEP(2014), Electric Buses in India: Technology, Policy and benefits.

Lessons on Electric Mobility from Shenzhen(China)

- Focus on Automobile industry but using buses to catalyze Electric Vehicles penetration. (*China as global leader in Electric Buses)*

- In Indian Scenario : Clarity in decision is required .

Lack of Clarity in Policy

Hybrid Model

Vs

100% pure electric buses.

Lack of Priority in Policy

Electric Cars

Vs

Public Buses

Case Study : Shenzhen(China) as World Largest Electric Bus

world's first 100% electrified bus fleet)

Shenzhen City Administration announced to electrify all of its 16,359 buses during Nov-Dec 2017.

Challenges :

- Shifting from diesel to e-buses cost 2 to 4 times more upfront than conventional diesel buses.
- Need of the Charging Infrastructure.
- Replacement of batteries at least once during lifetime (costly affair).
- Battery replacement is nearly half of a vehicle's price.

i. National and Local Subsidies

It played major role in closing the cost gap between e-buses and conventional diesel buses.

ii. Leases to reduce Upfront Investments

Instead of direct procuring e-buses ,

- some bus operators in Shenzhen leased vehicles from manufacturers.
- It saved operators' upfront investments.

iii. Optimized Charging and Operation

- Shenzhen adopted a type of e-bus where 5 hours charge supports 250 KM. of running. (almost one full day of operation).

Charging in night @ low electricity charge

Recharged at terminals @off-peak travel times.

charging facilities are also open to private cars, thereby improving the financial performance of the charging infrastructure.

iv. Lifetime Warranty of Batteries

bus manufacturers provide a lifetime warranty for vehicles and batteries. .

Manufacturers are better positioned than bus operators to manage financial risks because they can continuously innovate battery technologies.

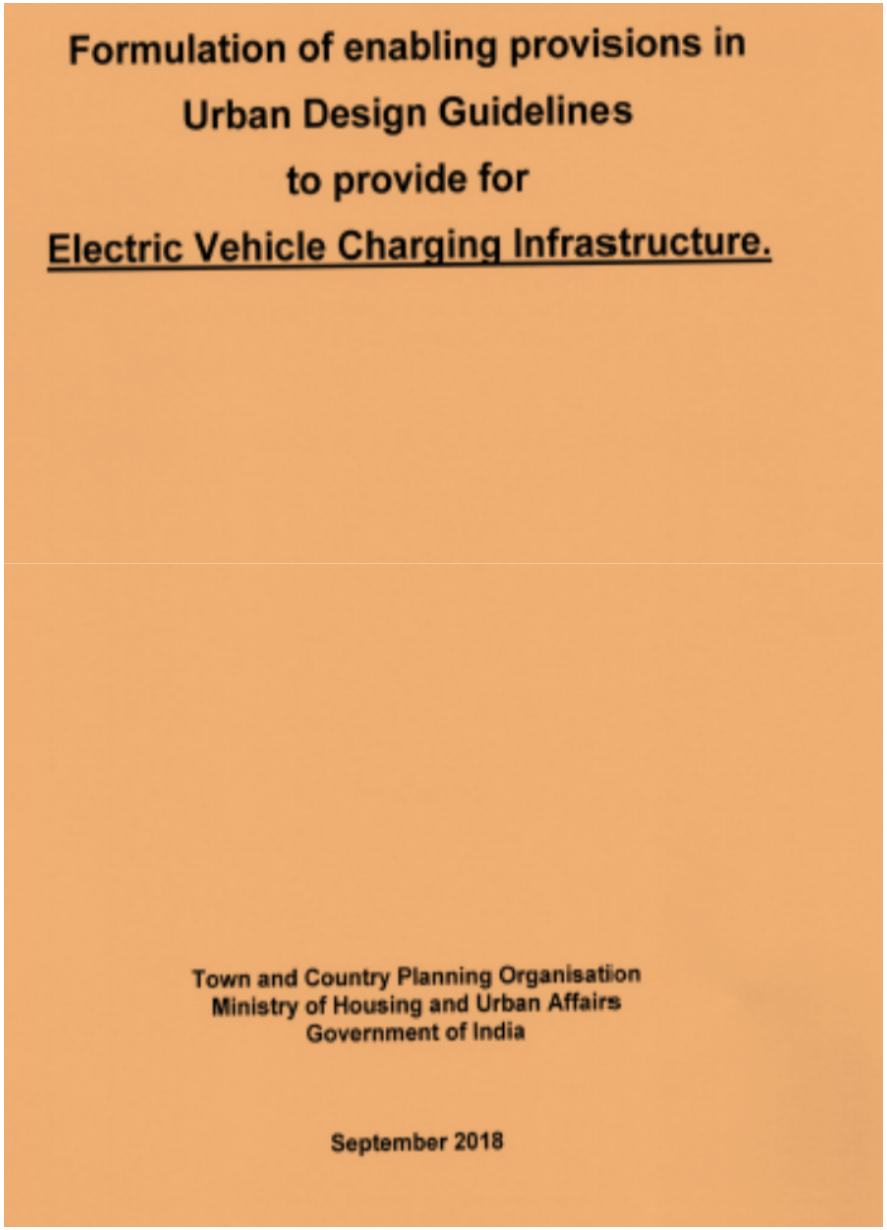
Lessons on Electric Mobility from Netherlands

- The Dutch Govt. promoted Electric Vehicles by focusing on "Charging Infrastructures" (Netherlands as global leader in vehicle charging).

- Installed charging stations : 3000 (2009-2014) led by consortium of Public and Pvt.

Charging Stations are centrally managed and serve as a country-wide 'Living Lab' for smart charging.

It provided a platform for local R&D for Pvt., Academics , Energy Companies, local & regional Govt. to innovate on several products and services.



- Electricity Subsidization …… ?????????

Financial burden on Govt

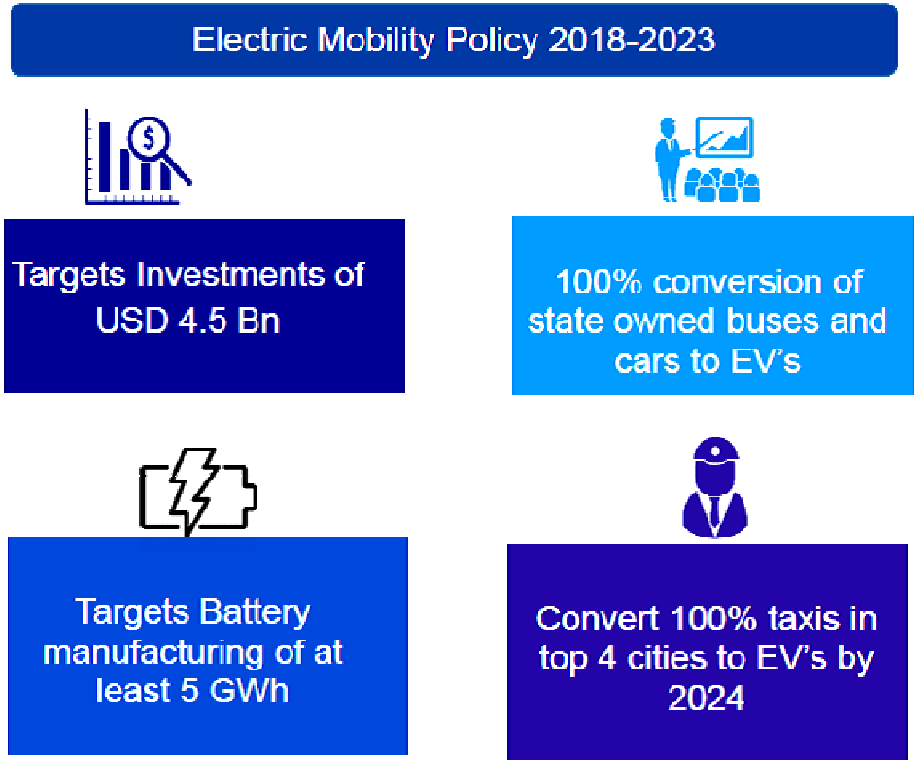
Solar Panel Charging System

Solar-Powered Electric Vehicle Charging Station, Debut, Portland.

State Govt. Political Commitment

Example: The Govt. of Andhra Pradesh passed "Electric Mobility Policy 2018-2023".

Aim : to roll out 10 lakh Electric Vehicles(EVs) by 2023.



Source: A Report on Andhra Pradesh : Trade & Investment -A Land of Unlimited Opportunities.

Lesson on "Smart City EV Pilot Project – Nagpur"

1st Multi-modal EV Pilot Project the Govt. of Maharashtra launched in Nagpur in May 2017.

Agencies: Municipal Corporation of Nagpur in collaboration with Pvt. Players.

Investment :INR 200 million for EVs and Charging Infrastructure.

Maharashtra Chief Minister Devendra Fadnavis and Union Minister Nitin Gadkari and others flag off during the inaugurate the India's first OLA Multi Modal Electric Vehicle Project in Nagpur.(PTI Photo).

Source: Indian Express dated May 27, 2018

Actions :

- Network of 10 fast charging stations.
- Waiver of road tax, registration of EVs by State Govt.

Key components of the Nagpur EV pilot

Vehicles deployed	Charging infrastructure
Around 200 EVs deployed across Nagpur	Public charging stations spread across the city (fixed distance gap)
OEMs involved: BYD, Kinetic, Mahindra Electric, Tata Motors and TVS	Battery swapping stations set up for 3Ws
Category of vehicles: ▶ 100 cars ▶ 100 e-rickshaws ▶ 2-3 buses	▶ Single point, multiple chargers ▶ All EVs come back to base for charging

Battery Technology

More than half of a vehicle cost goes to battery pack.

Reduce Battery Cost

-No manufacture lithium-ion batteries in India
-import lithium-ion cells from China

Investment in R&D

ISRO's lithium technology is a game changer for electric vehicles: How satellite tech will help car manufacturers

ISRO's lithium technology is a game changer for electric vehicles: How satellite tech will help car manufacturers

This initiative by ISRO will boost the development of indigenous electric vehicles in India and local cars and two-wheeler manufacturers will get access to top technology to help them gain pace in developing batteries required for EVs.

Lithium-ion cells is a big boon and are widely adopted in many consumer and industry applications including mobile phones, cameras, laptops, cars, aeroplanes and aerospace equipment. Going forward, with the advancement in battery technology, it is expected that these lithium-powered batteries will replace petrol/diesel as the source of power in vehicles. Source:www.financialexpress.com/auto/car-news/isros-lithium-technology-is-a-game-changer-for-electric-vehicles.

Affordable Battery Technology

- Size of the battery pack depends on drive range of vehicle.
- Battery size influences the cost of the battery.
- Big battery size (wt. & vol.) complicates the body and chassis design of BE buses.
- Battery Electric buses are considerably more expensive w.r.t. petrol/diesel bus.

- US$1000/Kwh (2004),
- US$ 500/Kwh (2017).
- Benchmark price of USD 150/Kwh (in future).

Segment	Diesel Buses		CNG	Hybrid Electric Bus	Pure Electric Bus
Model	Volvo 8400 [16] (AC)	Tata STARBUS SLF 44 [17] (AC/non-AC)	Tata STARBUS LE CNG 18 [18] (AC/non-AC)	Tata Starbus Hybrid [19] (AC/non-AC)	BYD K9 [20] (AC)
Seats	32	44	18	32	31
Length	12.3 m	12 m	12 m	12 m	12 m
Width	2.5 m	2.5 m	2.55 m	2.55 m	2.55 m
Height	3.2 m	3.2 m	3.35 m	3.35 m	3.49 m
Gross weight	16,200 kg	16,200 kg	16,000 kg	16,200 kg	18,500 kg
Costs (INR)	88 lakhs	33 lakhs	30 lakhs	1.2–1.4 crores	2–3 crores
Fuel efficiency	2.2 km/L	3.5 km/L	2–3 km/kg	2.2–4km/kg	1.5 kWh/km
Fuel cost	INR 23/km	INR 15/km	INR 13–19/km	INR 10–17/km	INR 10/km
Range (km)	484	560	260–390	286–520	249
Fuel tank size	220 L	160 L	720 L	720 L	-
Charging time	-	-	-	-	3–6 h
Max power	290 BHP	177 BHP	230 BHP	230 BHP engine 44 kW battery	180 kW
Max torque	1,200 Nm	685 Nm	687 Nm	678 Nm	700 Nm
Battery type	-	-	-	Li-ion batteries	Li-ion Iron (300 kWh)
Emission standard	EURO III	BS III	BS IV	EURO III	Zero tail pipe emission

(Source: Electric Buses in India: Technology, Policy and Benefits, Global Green Growth Institute, 2016)

Thanking you For

kind attention