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ROLE OF ELECTRIC VEHICLES IN URBAN ENERGY TRANSITION– A STOCKTAKING

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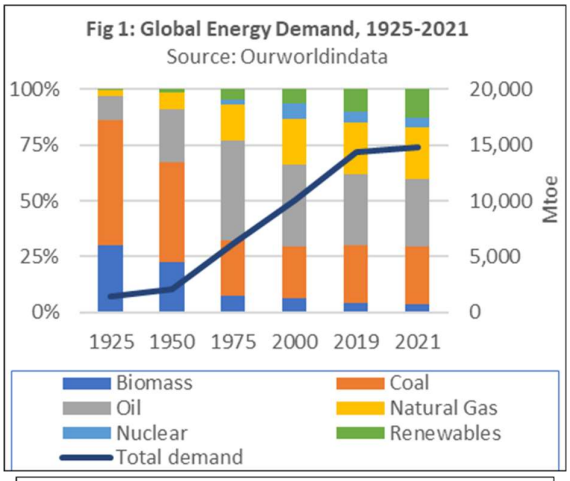
Abstract

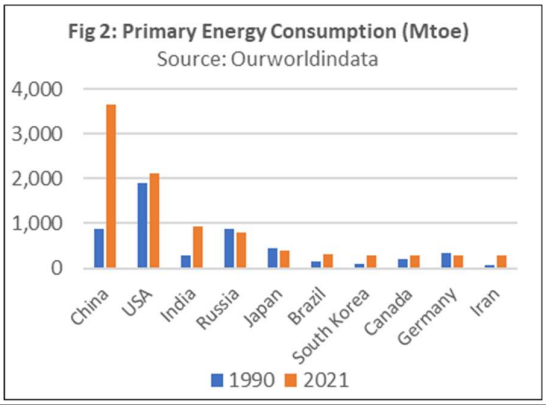
Cities account for about three fourth of global primary energy use and 70% of energy related greenhouse gas (GHG) emissions (IRENA, 2021). Energy Transition (ET), through uptake of low carbon energy efficient technologies in cities across the globe is very crucial. Amongst the end use sectors, the transport sector accounting for about 29% of final energy consumption and 25% of the global energy-related CO_2 emissions (REN21, 2021), calls for urgent attention.Globally, electrification of transportation is identified as a key option for sustainable energy transition (Yuan et al, 2021). In this context, this paper attempts to examine the status of electric vehicle adoption worldwide.

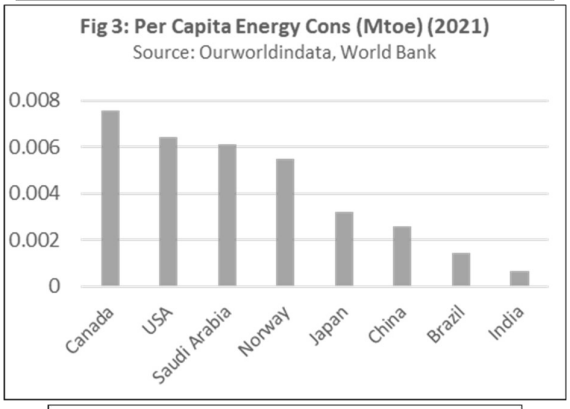
Keywords: Electric Vehicles, Energy Transition, Cities

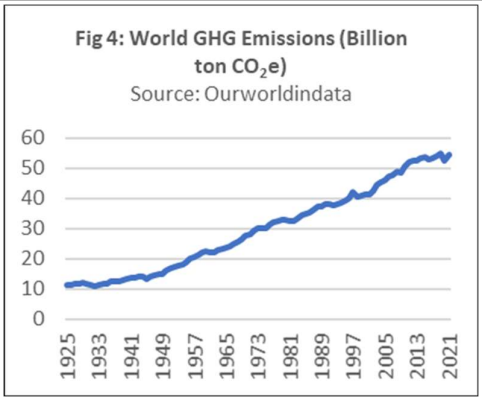
1. Introduction

Global energy demand has grownat a very high rate since 1925, from1,420 Mtoe to 14,803Mtoe during 1925-2021. As seen in Figure1, fossil fuels constitute the major demand and that of renewables has increased in recent years.The top five energy consuming countries are China, USA, India, Russia and Japan; their respective energy consumption in 1990 and 2021 is indicated in Figure 2. In terms of per capita energy consumption, the top 3 consumers include Canada, USA and Norway (Figure 3).









The increasing energy consumption has resulted in consequent GHG emissions which increased from 11.18 billion tons to 54.59 billion tonsduring 1925-2021 (Figure 4). It has

further led to climate change and global warming concerns.

To abate this, countries and cities across the globe have pledged to reduce their energy and carbon intensity by 2040 –2050 under the Paris Climate Agreement 2021. This is a tall task which can only be achieved through an accelerated energy transition (ET) from fossil fuels to low carbon energy efficient (EE) and renewable energy (RE) technologies. Energy Transition (ET) includes(IRENA):

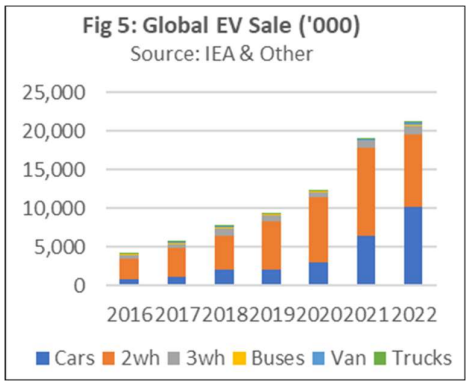
- Transformation of global energy sector from fossil-based to zero-carbon by 2nd half of the 21stcentury
- Reduce energy-related CO_2 emissions to limit climate changewithout compromising energy consumption for development

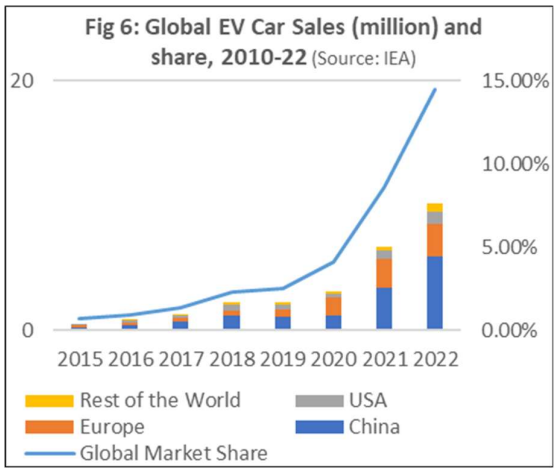
Thus, ET has become anurgent priority for countries and cities irrespective of their geographical, economic, social and political status.If the world is truly to achieve a state of zero carbon energy within the next three decades, its uptake needsleapfrogging.

The transport sector accounts for 29% of total final energy consumption and is responsible for 25% of global energy-related CO2 emissions (REN21, 2021).Amongst all the end-use sectors, transport has the highest reliance on fossil fuels; nearly 95% of world's transportation energy comes from petroleum-based fuels, mainly gasoline and diesel (USEPA), leading to pollution and health issues.Hence, addressing this sector needs urgent attention in the context of global energy, environment, public healthand energy security issues.

Globally, electrification of transportation has been identified as a key option for sustainable energy transition (Yuan et al, 2021). Electric mobility is found to be a promising technology to curb transport-related energy and emissions from conventional Internal Combustion Engine (ICE) vehicles (MIT, 2019). Several countries have progressed fast on the electric vehicles (EV) journey, some are embarking at a slower rate. Due to its charging infrastructure, servicing and other requirements, EVs predominantly operate in cities and not expanded to rural areas yet. With this backdrop, this paper attempts to examine the status of electric mobility worldwide.

2. Global Status of EVs





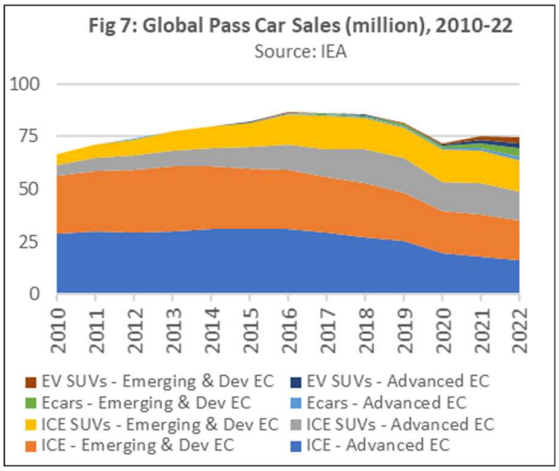
The global automotive sector is currently undergoing a paradigm shift from ICE vehicles to electric mobility. Electric cars and 2-wheelers constitute the major share of global EV sale (Figure 5). In 2022, the number of electric two-wheelers sold are nearly equal to that of electric cars.Electric car sales exceeded 10 million in 2022 andaccounted for nearly 15% of the global car market, up from less than 5% just two yearsearlier (Figure 6). In 2022, China represented nearly 60% of all electric cars and vans sold globally, followed by Europe (26%) and then the United States (1%).

As indicated in Figure 7, higher number of electric cars (3.8 million) and electric SUVs (3 million) are sold in emerging and developing economies when compared to the advanced economies (1.5 and 2.5 million EVs respectively).

Table 1: % of EV cars out of total pass car sale (Source: IEA and Vahan Database)

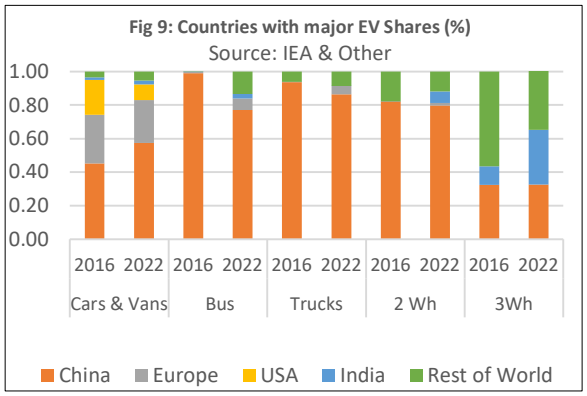
	2010	2015	2019	2021	2022
Norway	0.28	22	56	86	88
Iceland	0.31	3.6	22.6	71.7	70
Sweden	0.001	2.4	11	43	54
Netherlands	0.025	10	15	30	35
Germany	0.005	0.73	3	26	31
UK	0.013	1.1	3	19	23
China	0.01	1	5	15	29
India	0.021	0.017	0.13	3.7	5.4*
World	0.011	0.7	2.39	8.6	14

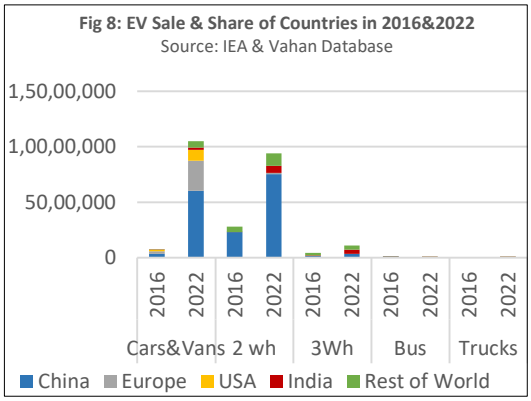
including BEV + hybrids



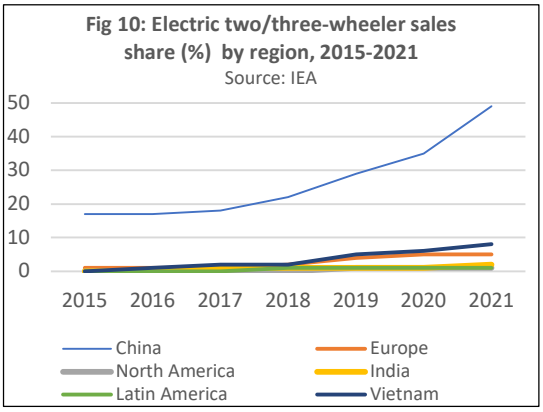
The share of electric cars amongst new carssold has been increasing at a high rate amongst many countries, especially Europe (Table 1). For example, in Norway, share of electric car of the total car sale increased from 0.28% in 2010 to 88% in 2022 and that in Sweden grew from 0.001 in 2010 to 54 in 2022.

Figure 8 indicates the country wise share of electric vehicle sale in 2022 vs 2016. Figure 9 shows that not only cars, China has the largest global share of electric two-wheeler, bus, and truck market as well. Other developing countries including Indiaare adopting electric two-wheelers at a fast rate (60% of total EVs sold in India in 2022 were two wheelers).Indiaalso holds a large share of the electric three-wheeler market, nearly equal to that of China. 52% of total three-wheelers sold in India in 2022 were electric (0.35 million), they outnumbered the electric (BEV plus hybrid) cars (0.2 million)(Vahan, 2023).

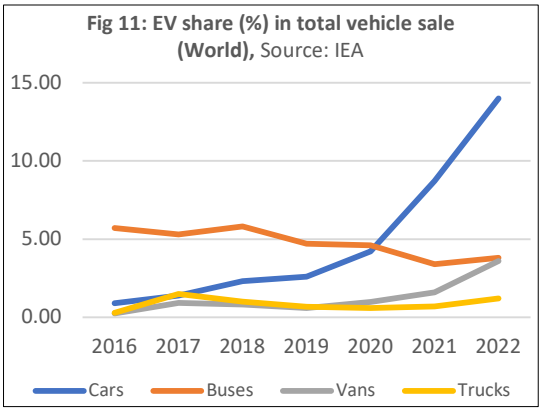




The global sales share of two and three-wheelers is shown in Figure 10. Amongst the developing countries, electric two and three wheelers are becoming popular in Vietnam. Figure 11 indicates the global sales share of electric cars, vans buses and trucks.



By 2022, the global stock of electric buses crossed 0.8 million worldwide, grew from around half a million in 2019. About 66,000 electric buses were sold worldwide in 2022, representing about 4.5% of all bus sales (IEA, GEVO, 2023). New electric bus registrations had declined by 20% in 2019 (relative to 2018), mainly due to China's gradual phase-out of subsidies, however, its sale has started picking up in 2022. As seen in Figure 9, China dominated the entire bus deployment in 2016 with 99% of global electric buses were plying there. The share reduced to about 77% by 2022.



Electric bus transport has expanded to countries including North America, Latin America, Europe, India and elsewhere.Their number is very high in cities where local governments have committed to reduce emissions from public transport. In Finland, for example, electric bus sales accounted for over 65% in 2022 (REN21, 2021). India's STUs (State Transport Undertaking) are plying about 4,500 electric buses procured with subsidy from Government's FAME (Faster Adoption and Manufacturing of Electric Vehicles) program.

About 60,000 medium and heavy-duty electric trucks were sold worldwide in 2022, representing about 1.2% of total truck sales. China still dominates the global electric trucks market with about 87% share. However, they are also expanding to other regions. Europe had 5% of global electric truck sale in 2022 (IEA, GEVO 2023).

3. Cities with High EV Penetration

EVs mostly operate in urban areas. Due to its charging infrastructure, servicing and other requirements, they predominantly operate in cities and not expanded to rural areas yet.

3.1 Electric Urban Passenger Transport

Electric cars are increasingly getting popular in cities across the world. The top cities with high electric car registrations include: Shanghai, Beijing, Shenzhen, Hangzhou, Guangzhou, Tianjin, Qingdao, Zhengzhou, Changsha, Liuzhou, Weifang, Wuhan, Chongqing, and Xi'an in China; Tokyo, Oslo and Bergen (Norway), Paris, London, Amsterdam,Stockholm, Los Angeles, San Francisco, San Jose, and New York(ICCT, 2020a).Severalother cities across the

world are adopting electric cars and vans.

Electric taxis have been in use for few years in cities including Columbus (USA), Hong Kong, Macao, Shenzhen, London, Nairobi, Delhi, and Montreal, Edinburgh, Medellín (Colombia), Montevideo (Uruguay) and Vitoria-Gasteiz (Spain) and New York City (REN 21, 2021).InShenzhen, its entire fleet of about 22,000 commercial taxis became battery-electric in 2019 (GIZ, 2022). Under India's National E-Mobility Programme, Energy Efficiency Services Limited (EESL) has procured 10,000 e-cars and given on lease/ outright purchase basis to different Government organizations towards replacing their existing petrol and diesel vehicles taken on lease (EESL India). India's REC Ltd in Gurgaon has set a target of replacement of all conventional staff vehicle fleet with EVs by 2024-25 (EVCI).

A large share of theElectric two and three-wheelers are concentrated in China. Also, electric scooters, electric-assist bicycles and electric mopeds were present in over 600 cities in more than 50 countries, including Europe, India and USA (REN21, 2021).Indiahas a large share of the global electric three-wheelers.In 2022, Pune and Delhi in India registered more than 23,000 and 34,000 two wheelers respectively. Delhi registered 21,000 threewheelers in 2022.

Electric Buses -Shenzhen has world's first and largest fully electric bus and taxi fleets; by 2018, all urban buses in Shenzhen (around 17,000) were electrified (Berlin et al, 2020). Bergen in Norway has achieved 100% fossil-free buses (Keolis).Othercities like Tianjin and Zhengzhou, also have achieved 100% of bus fleet electrification (Yiyang et al, 2022). Electric buses have been deployed worldwide in cities including Hamburg, London, Gothenburg, Milan, Utrecht, Gulfport (Mississippi), Kansas, Brampton, Santiago, Kolkata, Mumbai, Ahmedabad, Bengaluru, Delhi, Pune, Warsaw and many other cities (REN21, 2021).

Mumbai's STU Brihanmumbai Electric Supply and Transport (BEST) has procured 200 Double-decker air-conditioned electric buses (emobilityplus, 2023). Few similar buses will also be plyingon the tourism routesin Hyderabad (sustainable-bus, 2023).

3.2 Electric Urban Freight Transport

EVs are also procured for municipal delivery and refuse fleets. 500 electric refuse trucks were deployed in Shenzhen. Los Angeles, Sacramento, Seattle, Manchester, Adelaide, Casey and Yarra (Australia) began operating small fleets of electric refuse trucks. In 2020, local bodies of Leeds, Blue Mountains (Australia), Jersey City and New York City started pilot testing and integrating electric vans and refuse trucks in their municipal fleets (REN21, 2021).

Several light commercial vehicle (LCV) fleet owners are switching to EVs for delivery services. For example, the Royal Mail and retailer John Lewis in UK announced plans toshift their delivery fleets to electric. The Dutch supermarkets Albert Heijn and Picnic and the parcel delivery services DHL and PostNL are using EVs in Netherlands (TDA, 2019).

Amazon announced to become net-zero emissions by 2040 and DHL has targeted net-zero emissions logistics by 2050. FedEx plans transition to an all zero-emission vehicle fleet and carbon neutral operations by 2040. Ingka (IKEA) targets zero-emission deliveries in all cities

by 2025. Walmart has announced to electrify the entire vehicle fleet by 2040 (IEA GEVO, 2021).

The e-commerce players in India (Flipkart, Myntra, IKEA and Zomato) have started to deploy EVs (two wheelers, three wheelers, and small and medium commercial vehicles). Flipkart, running more than 2,000 EVs over 18 states and union territories and committed to transitioning to 100% EV fleets by 2030 (WBCSD, 2022, TOI, 2022).

3.3 E-mobility targets

EVs have increasingly been considered as a reliable low carbon environmentally friendly alternative to traditional ICE vehicles. Countries and cities worldwide have adopted e-mobility targets. The European Commission has passed a ban on newly registered passenger cars with internal combustion engines from 2035 onwards (GIZ, 2022). Norway mandates that all new passenger cars and light vans sold 2025 onwards shall be zeroemission vehicles. Spain has set goals for minimum share of EVs in total passenger cars sold which is to reach 100% by 2040. UK has targeted to stop sale of new conventional gasoline and diesel cars and vans including PHEVs and HEVs by 2035. Netherlands has decided that new passenger cars will be emissions-free by 2030 at the latest (ICCT, 2020b).Governmentof Indiahas set a target of 30% electric vehicle penetration by 2030(GIZ, 2021).

Individual cities have also set e-mobility targets. Kevadia in Gujarat targets to become India's first electric-vehicle-only city with only battery-based vehicles (buses, four wheelers, and two-wheelers) plying in future (TOI, 2021).Selectedcities with e-mobility targets are included in Table 2:

Table 2:Cities with e-mobility targets

City	**Country**	**EV target**	**Year**
Buenos Aires	Argentina	6,000 electric and hybrid light cars and utilities + 350 electric buses	2018
Canberra	Australia	Procure only zero-emission buses	2021
Brussels	Belgium	100% electric buses	2030
Rio de Janeiro	Brazil	Procure only zero-emission buses	2025
Vancouver	Canada	Procure only electric buses	2025
Santiago	Chile	Procure only zero-emission buses	2025
Beijing	China	70% of new sales and 50% of total vehicle stock	2030
Hong Kong		nonregistration of new fuel-propelled private cars, covering hybrid vehicles (Oswald, 2022)	By 2035
Copenhagen	Denmark	Procure only zero-emission buses and only zero-emission municipal cars	2025 2026
Quito	Ecuador	Procure only electric buses	2025
Tallinn	Estonia	All public transport to be electric	2035
Paris	France	100% clean bus fleet	2025

City	Country	EV target	Year
Berlin	Germany	Procure only zero-emission buses	2025
Heidelberg		Procure only electric buses	2025
Delhi (Source: DDC)	India	25% of all new vehicle registrations are EVs 70% of the public transport bus fleet is EV 8000 pure electric buses 100% of delivery service fleet to be electric 100% of all Delhi govt official fleet to be electric	2024 2025 2025 2025 2023
Pune (Source: RMI India, 2022)		25 per cent of all new vehicle registrations by 2025	2025
Jakarta	Indonesia	Procure only zero-emission buses; 400,000 EV sales; 41,000 e-bus sales; 2,000 e-2 wh sales	2025
Milan, Rome	Italy	Procure only zero-emission buses	2025
Tokyo	Japan	Procure only zero-emission buses; 50% zero-emission vehicles	2025
Seoul	Korea, Rep.	100% electric bus fleet	2025
Ulsan		Replace all existing buses with fuel cell e-buses	2035
Montréal	Canada	100% of new vehicle sales to be EVs	2025
Mexico City	Mexico	Procure only electric buses	2025
Auckland	New Zealand	30-40% EVs	2025
Amsterdam	The Netherlands	Procure only zero-emission buses	2025
Rotterdam		100% zero-emission buses	2029
Utrecht		Zero-emission bus transport	2028
Warsaw	Poland	Procure only zero-emission buses	2025
Lisbon	Portugal	Shift 150,000 motorists to more sustainable modes	2030
Moscow	Russian Federation	Procure only zero-emission buses	2025
Oslo		Procure only zero-emission buses	2025
Singapore	Singapore	28,000 chargers at public car parks	
Cape Town	South Africa	Procure only zero-emission buses	2025
Barcelona	Spain	100% zero-emission buses	2025
Gothenburg	Sweden	100% electric buses	2030
Stockholm		Be one of world's leading clean vehicle cities, with major role of EVs	2030
Birmingham Cardiff Liverpool, Oxford, Manchester	United Kingdom	Procure only zero-emission buses	2025
		Zero-emission light vehicle fleet	2022
		Procure only zero-emission buses	2025

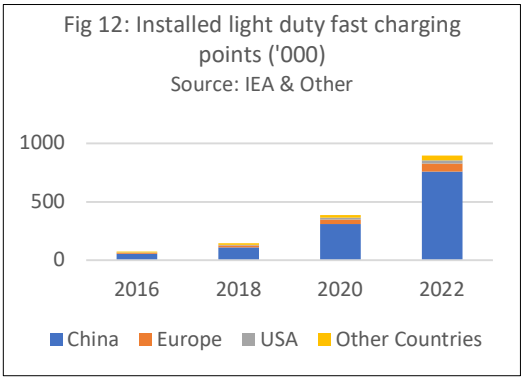
City	Country	EV target	Year
London		100% zero-emission transport	2050
Dubai	UAE	Minimum share of hybrids and EVs in annual vehicle procurement - 10% by 2024, 20% by 2029 and 30% from 2030 onwards	
Austin, Honolulu,	USA	Procure only zero-emission buses	2025
Los Angeles, New York		100% zero-emission vehicles	2050
Portland		15% EVs	2050
San Francisco		Electrify all private forms of transport	2040
Washington, DC		100% electric buses	from 2029

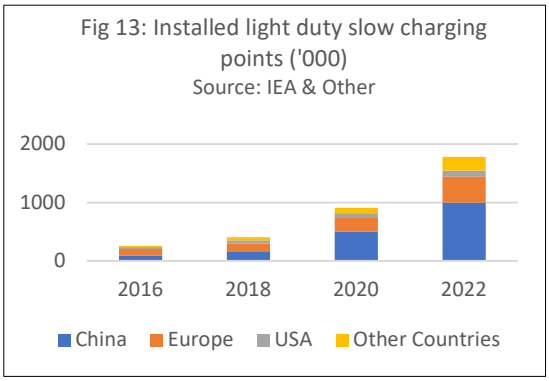
Source: REN21,2021 & Others

4. EV Charging Infrastructure

A strong public charging infrastructure is crucial for transitioning to electric mobility. Network of adequatecharging facilities is one of the key prerequisites for faster EV adoption. Range and charging time anxieties are critical challenges for consumers.

By 2022, about 2.7 million publicly available chargers (9 million fast chargers and 1.8 million slow chargers) have been deployed globally (IEA GEVO,2023). China has the highest share, accounting for about 85% of fast chargers and 55% of slow chargers (Figures12and 13). Europe has deployed about 7% of fast and 25% of slow chargers and USA has 3% of fast and 5% of slow chargers.





Building codes, urban planning and zoning regulations wrt EV charging stations are adopted by various cities like Cairo, Dunedin (New Zealand), Johannesburg, Los Angeles, Oslo, Portland (USA) and others.

Also, along with the fast expansion of the EVs, integrating the charging infrastructure within

the electricity supply system remains extremely vital. In order to address the possible grid constraints arising due to growing electricity demand from EVs, many cities are incentivising charging during off-peak hours to discourage charging during peak times. Lower electricity tariff is offered for charging outside the peak demand window.

Government of India announced Charging Infrastructure Guidelines in 2022(Ministry of Power, 2022) and Amendments in Model Building Bye-Laws for Electric Vehicle Charging Infrastructure (TCPO, 2019). As per Delhi's Electric Vehicle Policy, 2019,parking spaces of all new residential and office spaces are to designate EV charging spaces.Delhi provides EV charging to end-users at the lowest cost in the world at ₹2 per unit (USD 3 cents/ unit (DDC)).

India released a draft policy on battery swapping in 2022 (Niti Aayog, 2022). GOI has allowed sale and registration of EVs without batteries, thereby facilitating battery swapping option and also reducing upfront cost of EVs. A Unique Identification Number (UIN) for each battery is proposed to allow centralised tracking and efficient swapping.

Table 3: Public EV Charging Stations& % RE share in selected EV capitals 2019

City (Country)	**No of public chargers/ million population**	**% of renewables in city's electricity mix**
Asia		
Shenzhen	4,800	28%
Beijing	1,920	
Shanghai	1,690	
Europe		
Oslo	3,000	98%
Amsterdam	2,750	18%
Stockholm	717	69%
London	405	37%
Paris	307	22%
North America		
San Jose	1,200	48%
Los Angeles	590	32%

Source: REN21, 2021

5. Charging EVs with RE

EV charging with RE meet both goals of ET. Currently, majority of the existing chargers are not RE powered, however, stakeholders around the world are making efforts towards the same. Austin (Texas, US) introduced a membership-based service where drivers can access more than 1,000 100% RE powered public charging stations by paying @USD 4.17/ month (Austin Energy).Delhi has taken an initiative has been taken in Delhi for integrating solar energy for residential EV charging in India and came up with a guidebook (DDC, 2022).

Sao Paulo and Utrecht started charging electric buses with solar power. Portland in USAaims to charge their electric buses with wind-power. The city bus network in Bergen runs exclusively on renewable energies (Keolis).

In cities of Cartago, Grecia, and Guanacaste in Costa Rica, entire electric mobility system is RE powered. Over 99% of the country's electricity is generated from renewable sources of hydro, wind, geothermal and solar (ITA, 2021). Electric buses also increased in number (IRENA, 2021).

Philippines introduced 90 electric jeepneys with integrated solar PV in the city of Tacloban in 2019 (Meniano, 2019).The number has increased to about 7,000 now (Robles, 2023). Aggregator companies like 'WeShare' in Berlin, and, 'We Drive Solar' in Utrecht procure renewable electricity for charging their electric fleets (Hanley, 2019, Smart Solar Charging, 2022).EVcharging in Poznan (Poland) and Caithness County (UK) is from electricity generated from local organic waste and biogas respectively (Mayor.eu, BBC, 2020).

In a small but growing number of cities, electric two and threewheelers are being charged using renewable energy. Solar-powered hybrid rickshaws were introduced in the Indian Institute of Technology's Delhi campus in 2019 (TBS).Ugandaand Namibia are working towards solar powered motorcycle taxis and electric bicycles (DW, 2020).

Oslo and Stockholm have high shares of renewables in the national electricity mixes and hence moat of their EV charging is with RE.Dubai's Clean Energy Strategy (in force since 2015) aims to grow the share of RE powered EV charging from 7% in 2020 to 25% in 2030 and 75% by 2050 (Zawya, 2020).EVcharger mandates in new buildings have become common. Cities including Chicago, San Mateo (USA) and Vancouver, require certain new buildings to instal RE powered EV charging.

Globally, the share of RE in transport was 3.7% in 2018, most of which was biofuels (3.7 exajoules(EJ)) followed by renewable electricity (0.3 EJ) (IEA, 2019). With many developments since 2018, use of RE in transport sector is likely to increase substantially.

6. Overall Enabling Environment

Cities of Amsterdam, Oslo, Stuttgart, Barcelona, Berlin and Bucharest have passed bans and/or restrictions on fossil fuel vehicles. Reykjavik (Iceland) pledged in 2019 to halve the number of petrol stations in the city by 2025 in an effort to phase out ICE vehicles.

Low-emission vehicle zones (LEZs) within cities are increasingly becoming common. They are established in Krakow (Poland), in Chinese cities such as Foshan, Guilin, Huiaan, Shanghai, Suzhou and Zhengzhou, Haifa (Israel), Jerusalem. LEZs are planned in Stockholm, Madrid, Barcelona, Milan, Paris and in UK cities of London, Aberdeen, Bath, Birmingham, Dundee, Edinburgh, Leeds, Leicester and Southampton (REN 21, 2021).

The city of Pune in India also plans to create LEZs where pedestrians, cyclists, low-emission

vehicles, and vehicles meeting other criteria (e.g., shared mobility) are free to enter whereas higher-emission vehicles are restricted or charged a fee to enter (RMI India, 2022).

Cities includingAmsterdam, Eindhoven, The Hague, Rotterdam, Lisbon and Utrecht offer free public EV charging. Dubai and Lisbon also offer free EV parking, while at least 12 Chinese cities, including Hefei and Shenzhen, offer reduced EV parking fees (REN 21, 2021).

In 2021 several automakers announced plans towards electric mobility. Selected ones include, Volvo becoming a fully electric car company by 2030, Mercedes announcing that all newly launched vehicles to be fully electric from 2025, General Motors to introduce 30 EV models and BEV production capacity of 1 million units in North America by 2025, plus carbon neutrality in 2040 (IEA, 2022).

7. Recycling of Batteries

The increasingelectric mobility has led to a high demand of production and use of EV batteries. The life of an EV battery generally ranges between six to eight years and needs replacement when its capacity starts falling below 80%. With increasing EV penetration, over five terawatt hours (TWh) per year of gigafactory capacity is expected globally by 2030 and over 100 million vehicle batteries are expected to be retired in the next decade (McKinsey, 2023).

There are three options post utilization of batteries for EV/ traction purposes; i) re-use/ repurpose the battery for secondary applications e.g., stationary batteries for grid storage systems or standby use, ii) recycle - recover the materials in the battery such as Cobalt, Nickel, Iron, Copper etc and iii)landfill disposal (GIZ Battery Recycling Report, 2022).

Owing to the hazardous nature and high cost of the batteries, mandates like extended producer responsibility (EPR) legislation are introduced in different countries. EPR focuses on the end-of-use treatment of the products and aims to increase the amount and degree of product recovery to minimize the cost of product and environmental impact of waste materials (Johnson, et al, 2014). Following EPR concept, manufacturers and battery importers are responsible for collecting, storage, transportation, recycling, and disposal of spent batteries.

Various countries includingUSA, Canada, Chile, Colombia, Japan, south Korea, Singaporehave implemented extended producer responsibility (EPR) legislation. EU mandates 50% of a battery's weight to be recycled, increasing to 70% 2030 onwards (Subramaniyan, 2022).In India, the Ministry of Environment, Forest and Climate Change notified the Battery Waste Management Rules, 2022 (MoEFCC, 2022). The rules cover all types of batteries, including Electric Vehicle batteries, portable batteries, automotive batteries, and industrial batteries.

8. Conclusion

By the end of the first quarter of 2022, there were approximately 1.45 billion vehicles in the world (Bonnici, 2022) of which only about 1.4% were EVs. The share of EVs is likely to

grow rapidly in the coming years, however the majority of the vehicles will continue to be fossil fuel driven for some more years to come.

The availability of fossil fuels is limited, and their use is destroying our planet. In addition to the global pollution and climate change issues, toxic emissions from petrol and diesel vehicles, often within densely populated cities, lead to long-term, adverse effects on public health.Infants, children and teens are most susceptible to health risks from the fine particle pollution from the vehicle tailpipe emissions(Malmgren, 2016). The World Health Organization and UN Health Agency classifies diesel exhaust as a carcinogen (UN, 2012).

Compared to ICE vehicles, EVs are less polluting, convenient to drive, no complicated controls, and just needs plugging in for charging. They are quiet, so they reduce noise pollution (Niti Aayog). EVs have lower maintenance costs and do not require oil changes and other routine maintenance checks (Sperling et al, 2009).

Thus, decarbonising the transport sector will improve urban air pollution, improve energy security and protect public health. Charging a vehicle through renewable energy will further improve the impacts and many cities are working towards the same.

Nonetheless, despite cities across the world moving in the direction of electric mobility, the share of EVs in the total on road vehicles is still miniscule and the rate of transition is outpaced by overall energy demand growth in the sector. The UN Emissions Gap Report 2022finds that the world is still falling short of the Paris climate goals, with no credible pathway to 1.5°C in place. Only an urgent system-wide transformation can avoid an accelerating climate disaster (UN, 2022). Faster adoption of EVs worldwide can play amajor role in avoiding the disaster, if this transformation journey is carefully planned and designed, thereby ensuring a sustainable, beneficialand successful transition to electric mobility.

9. Limitations

This paper includes presents a broad scenario of the global electric mobility status. Attempt is made to include all cities with high penetration of EVs. However, some cities may have got excluded due to lack of information in the public domain.

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