FINANCIAL FEASIBILITY FOR ELECTRIC 3 WHEELERS & CHARGING INFRASTRUCTURE IN KOCHI

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Abbreviations

ANERT	Agency for Non-conventional Energy and Rural Technology
BCS	Bulk Charging Stations
CPO	Charge point operator
DAY-NULM	Deendayal Antyoday Yojana – National Urban Livelihood Mission
EESL	Energy Efficiency Services Limited
EVs	Electrical Vehicles
EVES	Electrical Vehicles Equipment Suppliers
E 2-W	Electric 2-Wheeler
E 3-W	Electric 3-Wheeler
GoI	Government of India
GoK	Government of Kerala
KMC	Kochi Municipal Corporation
KSEBL	Kerala State Electricity Board Ltd.
NPA	Non Performing Asset
NULM	National Urban Livelihoods Mission
OEM	Original Equipment Manufacturer
PSL	Priority Sector Lending
RBI	Reserve Bank of India

1. Background

In India E-rickshaws are zero tailpipe emission modal option used as first/last mile connectivity and other short trips in cities. Due to their characteristics of being demand responsive, affordable, flexible, and convenient these E-rickshaws are welcomed by commuters and operators. It has become popular in Indian cities for last mile connectivity and ferry nearly 60 million people daily. It is estimated that almost 11000 e-rickshaws hit the street every month.

This large-scale unorganized growth of mode had resulted into a set of challenges, such as the absence of standardization of parts, electricity thefts, negative externalities due to inferior batteries, sub-par driving, to name a few. If a planned approach is followed to introduce e-rickshaws in mobility system of a city, it may result in effective inclusion and operation. This requires transforming the current operational model into more sustainable.

2. Description of the Project

As part of initiative, ICLEI South Asia would develop pilot in two Indian cities to demonstrate the possibility and potential through planned operations of E-rickshaws. The proposed demonstration approach includes creating conditions for planned inclusion of E-rickshaws into city mobility system. The approach would address the root causes of the key barriers such as ad-hoc growth of mode, the lack of information and awareness, the policy and planning challenges, limited institutional capacity, and charging infrastructure and range anxiety. The outcomes of these efforts will be the multiple environmental benefits of reduced GHG as well as reduced externalities from this mode. The deployment of city pilot shall be part of a larger initiative by Climate Works Foundation to promote sustainable growth of E-Rickshaws in Indian cities. The initiative includes, landscape assessment and Multi-Stakeholder Engagement followed by city pilots

3. Objective of engagement

Kochi has operational E-rickshaws in the city (especially along few metro stations) for over two years. Moreover, the electric vehicle policy by Government of Kerala, envisaged deployment of 50000 Electric three wheelers in the state. However, there is need for official charging stations to target wider shift from Internal combustion engine-based Auto rickshaws. Therefore, ICLEI South Asia has been in discussion with Kochi Municipal Corporation and Kochi Metropolitan Transport Authority to demonstrate the financial feasibility of E Rickshaws/E-IPT and Charging solutions.

3.1. Specific Objectives

- Validate and demonstrate the financial feasibility of E-rickshaw, E-Auto along with Charging stations to assist city to promote E-rickshaws rapidly. The promotion of charging infrastructure shall assist city in planned inclusion of E-rickshaws into city mobility system.
- Strengthen engagement of stakeholders in the process of electrification of IPT sector
- Support cooperation among national and local governments to advance the development of financial solutions for charging station

4. Policy Environment for E-Rickshaws, E-Autos and Charging Stations

Policy Environment / framework in India for E-Rickshaws, E-Autos and Charging Stations (public and bulk) include one, FAME II Scheme of GoI, started in April 2019 and now extended till March 2024; two, schemes framed by under E-Vehicle Policy by each State Government to complement FAME II Scheme, Banks, NBFCs and manufacturers of Electric 3-Wheelers.

In 2015, the Department of Heavy Industry, Government of India, launched its flagship incentive programme, the FAME India Scheme, to accelerate EV adoption. The FAME I Scheme supported 2.8 lakh electric and hybrid vehicles, with demand incentives totalling about INR970 crore (USD130 million)—saving nearly 7 crore litres of fuel and abating over 17.2 crore kg of CO2.

The FAME II scheme, introduced to drive greater adoption of EVs in India, was launched with a massive budget outlay of Rs 10,000 crore in April 2019, to support 7,000 e-buses, 5,00,000 e-three-wheelers, 55,000 e-passenger vehicles and a million e-two-wheelers. However, it seems to have missed its desired outcome by a huge count.

As of June 26, 2021, only 78,045 vehicles have benefited under the scheme. This includes 59,984 electric two-wheelers, 16,499 electric three-wheelers and 1,562 electric four-wheelers. In terms of state-wise registrations, Karnataka (17,438 EVs), Tamil Nadu (11,902 EVs), Maharashtra (8,814 EVs), Uttar Pradesh (5,670 EVs), Rajasthan (5,562 EVs) and Delhi (5,632 EVs) are the leading states to avail benefits under the scheme.

The FAME II Scheme is applicable only to vehicles, which are registered as "Motor Vehicle" as per the Central Motor Vehicle Rules (CMVR) and are used for public transport or those registered for commercial purposes 3 W, 4 W and Bus Segments. However, privately owned registered 2Ws will also be covered under the scheme as a mass segment.

At the start of the Scheme uniform demand incentive @ Rs. 10000/- per kWh for all vehicles (including PHEV and Strong Hybrid) except Buses. Recently from 1st April 2022 this incentive has been increased to Rs. 15000 pe kWh for E-2W.

Important addition in FAME II is announcement that Energy Efficiency Services Limited (EESL) will be responsible for aggregating and leasing 3 lakh electric 3-wheelers (e-3W) as well as electric buses (e-buses) available under FAME II.[1]

Production-Linked Incentive (PLI) scheme worth INR 18,100 crores (US$2.4 billion) approved for investments in advanced chemistry cell (ACC) battery manufacturing and worth INR 26,058 crore (US$3.5 billion) approved for automotive manufacturing focusing on EVs and hydrogen fuel cell vehicles.[2]

Most of the States, following EV policy of GOI, have adopted complementary EV policy for their states giving various incentives and facilitation for quick adoption of EV. Government of Kerala has also adopted EV Policy vide Department of Transport GO (Ms) 24 / 2019/Trans dated 10th March, 2019 to have 1 million EV by end of 2022, but like all India picture, Kerala State has also missed its EV Policy target by very huge margin. There were 470 EV cars registered in 2019, at the end of 2022 figure has increased to 8000 according to 'Vahan' national e-registration portal.

EV policy of GoK has proposed exemption from road tax to EV for initial period of three years, capital subsidy for Electric 3-Wheelers and for setting up public charging stations (PCS) and bulk charging stations (BSC). Beside these other incentives provided are exemption from state tax, free permits to fleet drivers, toll charges and free parking.

[1] Ministry of Heavy Industries and Public Enterprises (Department of Heavy Industry), S.O. 2258(E), Gazette of India, 11 June 2021.

[2] "Government has approved Production Linked Incentive (PLI) Scheme for Auto Industry and Drone Industry to enhance India's manufacturing capabilities," PIB, September 15, 2021. https://pib.gov.in/PressReleasePage.aspx?PRID=1755062.

5. Financing Ecosystem for Electric 3 Wheelers, EV Charging Stations

After policy environment or framework for what matters most for development of any sector and successful implementation of any policy created is financing ecosystem. Beside certain technological issues it is lack of robust financing ecosystems for Electric Vehicles which is responsible for poor rate of adoption of all types EVs (and especially E 3-Wheelers) in India. This is in spite of the fact that India adopted sound and progressive EV Policy.

NITI Aayog estimate regarding required cumulative investment in India's electric vehicle (EV) transition of INR 19.7 lakh crore ($US266 billion) between 2020 and 2030, The projected size of the annual loan market for EVs is INR 3.7 lakh crore in 2030[3]. These figures clearly highlight the enormous size of funding requirements and the need for higher liquidity and lower cost of capital for EV assets and infrastructure.

The recently announced first-loss risk-sharing instrument led by NITI Aayog and the World Bank has the potential to meet this gap some extent, but various other steps will be required by the stakeholders of EVs. Multistakeholder collaboration and innovative solutions are needed to access low-cost financing at this scale. Financial institutions, industry players, government bodies, and civil society must work together.

5.1. Stakeholders

The stakeholders of a finance Ecosystem for EVs include –

- Central and State Governments providing various types of production linked (supply side) and user/consumer linked incentives (demand side) and adopting EVs in its day to-day working. State EV policies can galvanise OEMs, aggregators, and e-commerce through the establishment of state-level targets. Interest rate subvention schemes can create an early learning curve for financiers, especially on high-risk segments such as e-3Ws. Incentives for OEMs to assure buybacks and warranties can also be offered.
- Banking Institutions – to provide credit to manufacturers, distributors, retailers, consumers of EVs
- Non-banking financial institutions (NBFC) - to provide credit mainly to consumers of EVs
- Reserve Bank of India – Taking complementary regulatory measures that support the risk-sharing instrument and provide an incentive for FIs to finance EVs that is providing Priority Sector Lending (PSL) status to EVs has a potential to institutionalize the role of finance in India's EV transition.
- Stakeholders beyond the financial industry can enable greater financing for EVs:
    - OEMs: Product guarantees from OEMs can assure financiers of the product quality and performance of EV models. Warranties for OEMs can cover the repairs and replacement of parts, ensuring buyers are not presented with additional costs. Buyback programmes where OEMs guarantee repossession and resale can create clarity around resale value. Battery OEMs can similarly lead in the creation of battery repurposing and recycling programs.
    - Aggregators and e-commerce providers: Fleet aggregators, delivery companies, and e-commerce providers can provide credit guarantees and utilisation guarantees to driver-partners. This can enhance the confidence of financiers in providing loans for this use case. More broadly, electrification targets through initiatives such as EV100 can create ambitious market signals for policy, manufacturing, as well as financing.

5.2. Sources of finance for EVs

At present sources of finance for EVs include

- Central and State Government's Scheme that reduce upfront cost of EVs (FAME II, State EV policies)
- Credit / Loans from Banking Institutions
- Credit / Loans from Non-Banking Financial Institutions (NBFC)

[3] Mobilising Finance for EVs in India: A Toolkit of Solutions to Mitigate Risks and Address Market Barriers, NITI Aayog and Rocky Mountain Institute, January 2021, https://rmi-india.org/insight/mobilising-finance-for-evs-in-india/

- Credit / Loans from financing arm of OEMs

But all these sources of finance suffer from various issues as discussed in the next session. The upcoming sources of finance to overcome some of the issues with present are as follows -

NITI Aayog and the World Bank are setting up a $US300 million first-loss risk-sharing instrument. The instrument is intended to act as a hedging and guaranteeing mechanism that banks and NBFCs can access in the event of payment delays on EV loans. The programme is expected to bring down the financing costs for EVs by 10–12 percent. Up to $US1.5 billion could be mobilised as a result of the instrument.[4] This availability of credit will greatly enhance liquidity for EVs. Simultaneously, there is a need for complementary regulatory measures that support the risk-sharing instrument and provide an incentive for FIs to finance EVs.

Companies including Ashok Leyland, Mahindra & Mahindra, Omega Seiki Mobility, Simple Energy, and Tata Motors made announcements to invest a total of over INR 48,000 crores (US$6.5 billion) in electric vehicles, components, and battery manufacturing; electric vehicle supply equipment (EVSE); research and development (R&D); and deployment in 2021.[5]

Start-ups including Hero Electric, Magenta, and Ola Electric raised venture funding of nearly INR 3,307 crores (US$446 million) for EV/component/battery manufacturing and EVSE in 2021.[6]

Axis Bank and the United Kingdom's Private Infrastructure Development Group (PIDG) announced a capital financing guarantee of INR 1,500 crores (US$200 million) towards manufacturing, distribution, and servicing of EVs, batteries, components, and charging infrastructure.[7]

5.3. Financing Models for Electric 3 Wheelers, EV Charging Stations

There can be three broad business/finance models for financing EVs, EVES and Charging Infrastructure, categorized by the stakeholder group responsible – the government-driven model, the consumer-driven model, and the service provider-driven model.

The Government – Driven Model – Provisioning of EVs, EVSE and public charging infrastructure can be led by government agencies such as municipal corporations, urban transport authorities, State Electricity Boards, State Transport Corporations etc in several ways – owning and operating by the government agencies or owning by government agencies and operation by private agencies or owning and operating by government and private sector under various forms of PPP. For example, Central and Various State EV policies have given clear mandate to its agencies to set up, own and lease EVs and EV charging facilities on self-owned basis and on revenue sharing basis (PPP basis).

The Consumer-Driven Model - is employed for private and semi-public EVs, EVSE and EV charging facilities at malls, commercial or institutional establishments, retail shops, restaurants etc., and by private EV owners and fleet operators that have space available to run EVs or have parking available on their premises to host EV charging facilities. These institutions will most commonly partner with a Charger Point Operator (CPO).

The Service Provider Model – here it is the EVs, EVSE, Charge Point owner who drives EVs, EVSEs and charging provision for public and semi-public charging. Under the model private enterprise owns and operates – EVs, EVSE and EV Charging Stations.

[4] Lijee Philip and Saloni Shukla, ET Auto, "Niti Aayog, World Bank ready electric vehicles financing push," The Economic Times, November 01, 2021, https://economictimes.indiatimes. com/industry/renewables/niti-aayog-worldbank-ready-electric-vehicles-financing-push/articleshow/87448054.cms.

[5] Shruti Mishra, ETAuto, "Putting EV at forefront, Indian auto inc proposes USD 13 bn investment in 2021," The Economic Times, January 08, 2022, https://auto.economictimes.indiatimes.com/news/auto-technology/bringing-ev-techto-the-fore-indian-auto-sector-invests-usd-13bin-2021/88514223.

[6] Shruti Mishra, ETAuto, "EV funding hits all-time high in 2021 as investors bet big on support systems," The Economic Times, January 04,2022, https://auto.economictimes.indiatimes.com/news/industry/ev-funding-scales-newpeak-in-2021-as-investors-bet-big-on-supportsystems/88674432.

[7] The Print, November 17, 2021, https://theprint.in/ani-press-releases/axis-bank-andguarantco-through-pidg-announce-guaranteeplatform-with-a-programme-size-of-usd-300-million-to-accelerate-transition-to-electric-vehicle-eco-system-in-india/767296/.

These models are explained in details in EV Charging Stations Section.

5.4. Issues, Challenges and Risks experienced in financing of EVs in India

The public and private sector investments and initiatives in the EV ecosystem are accelerating capital deployment towards India's electric mobility transition. However, in terms of sales, EVs represent a little over 1 percent of the market. At the same time, retail lending to support consumers and institutions in financing EVs has been slow to pick up. Financial institutions (FIs) have not yet increased lending to the level that would be required—an estimated INR 40,000 crores ($US5 billion) by 2025 and INR 3.7 lakh crores ($US50 billion) by 2030[8].

Given the nascency of EV technology and adoption, FIs such as banks and non-banking finance companies (NBFCs) are not lending to EVs especially to E 3-Wheelers due to associated asset and business model risks (see Figure - 1).

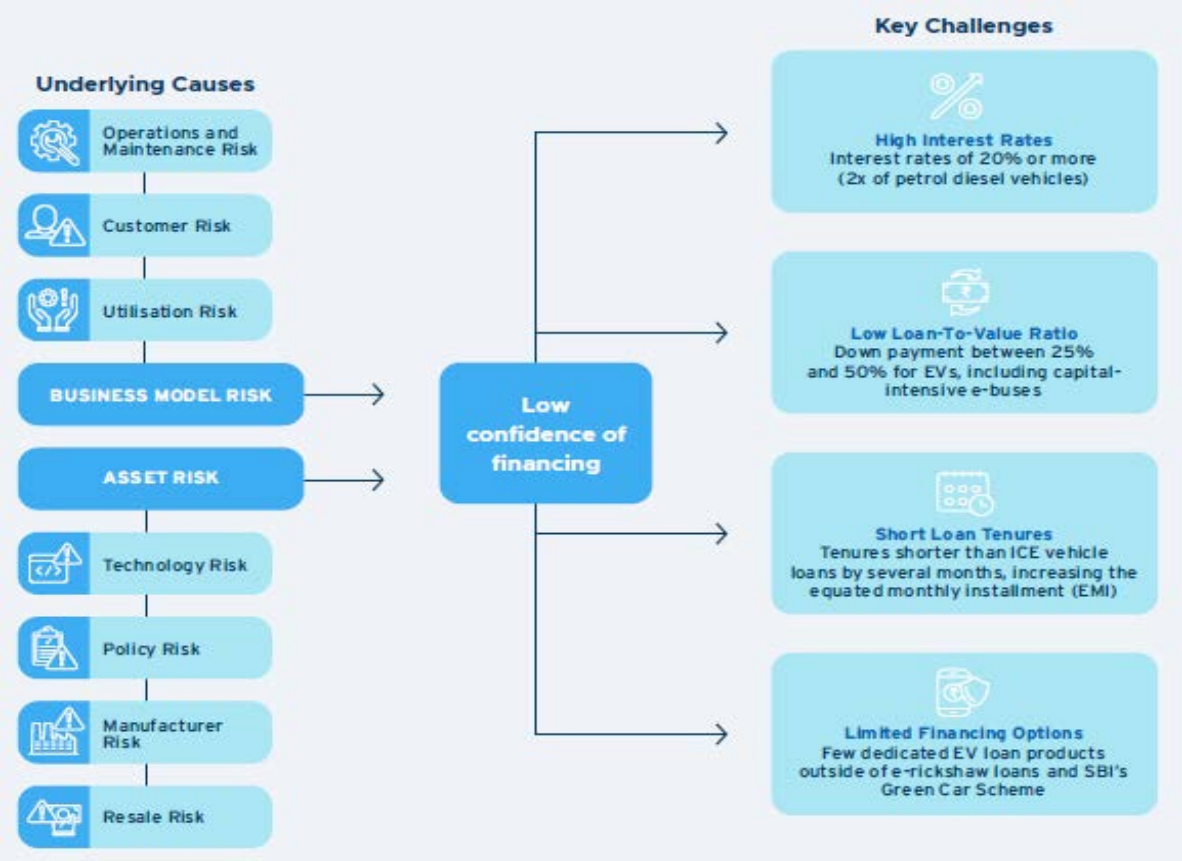

Figure 1: Challenges and Risks of Financing EVs

These risks are both real (e.g., uncertainty of resale value) and perceived (e.g., product quality). As a result, even if financing is available, EV buyers are unable to obtain terms (i.e., interest rates and tenures) that are comparable to ICE vehicles.

Governments across the world are recognising this challenge and are introducing supportive measures to facilitate easier financing of EVs. Exhibit 4 shows a few prominent examples.

In India, as mentioned earlier NITI Aayog and the World Bank are setting up a $US300 million first-loss risk-sharing instrument.

[8] Mobilising Finance for EVs in India: A Toolkit of Solutions to Mitigate Risks and Address Market Barriers, NITI Aayog and Rocky Mountain Institute, January 2021,

Priority sector lending (PSL) has the potential to institutionalize the role of finance in India's EV transition as The PSL guidelines by the Reserve Bank of India (RBI) would mandate scheduled commercial banks allocate specific levels of bank credit towards priority sectors (see the end section for more detail).

6. Status of Electric 3-Wheelers and Charging Infrastructure in Kochi

In the context of objectives of the ICLIE Project and policy cum financing background of the Electric Vehicles Sector a field study in Kochi to understand existing status of Electric 3 Wheelers and Charging Infrastructure was undertaken during the month of April 2022. Field visit to different stakeholders associated with Electric 3 Wheelers and Charging Infrastructure in Kochi indicated following -

- At present there are no passenger E-Rickshaws or E-Autos in operation in the Kochi.
- Regional Transport Office (RTO) data shows that till date in all total 85 Electric 3 Wheelers have got registered for Kochi City out of which 32 are cargo vehicles while 47 are passenger vehicles.
- In the recently completed year 2021-2022, only 36 Electric 3-wheeler got registered out which 18 were cargo vehicles while another 18 were passenger vehicles.
- The Electric 3-Wheeler passenger vehicles are purchased by the firms / corporate sector for their internal/private purpose (transporting employees) and are not used for public purpose.
- At present there is no Electric 3-Wheeler which is operating in the Kochi city as a public carriage.
- Secondary market for sale of Electric 3-Wheeler has yet not opened in Kochi as indicated by RTO data. Till date no sale or change of ownership has been registered with RTO – Kochi
- Financial institutions (Banks & NBFCs) are not financing Electric 3-Wheelers.
- At present there are in all 11 Type-3 DC fast charging stations in Kochi – Ernakulam out of which 7 are set up by KSEBL and 4 by private sector. (See Table --- for details)
- Though there is plan by KSEBL to set up Electric Pole mounted mini charging stations for E 2 and E 3 Wheelers but at present no such charging stations has been set up by KSEBL or any other public sector.

7. Technical, Operational and Financial Specifications of E-Auto by Piaggio and Mahindra

For working out Business Model cum Life Cycle Costing for E- Auto (Electric 3-Wheelers) products of two leading manufacturers - Mahindra and Piaggio were studied in detail by doing a field visit and referring secondary data –

7.1. Piaggio –

Piaggio started selling its Ape E City variants in Kerala State from August 2021 and in the seven months of 2021-22 /operations it has sold in all 80 Ape E City in Kerala State out of which 30 passenger variants. and 50 cargo variants.

Piaggio Ape E City Ex. Showroom price is 2.84 lakh in Delhi (In Kochi also its price is almost similar). it is a 3-wheeler commercial vehicle. It is available in 2 variants. The Ape E City Auto Rickshaw is compliant with the BS-VI emission standards. Other key specifications include wheel base of 1920 mm, Power of 7 hp. Vehicle and mainly its battery comes with a warranty of 3 years / 100000 kms. Its batteries can be charged anywhere as it comes with a 15 A portable charger. Detailed technical specifications of Ape E City are as follows –

Table 1: Technical Specifications of Piaggio E- Auto

Particulars	Piaggio Ape E City Passenger Model	Piaggio Ape E City Cargo Model	Piaggio Ape E City Swappable Battery Model
Battery type, Voltage-	Li-ion, 51.2V	Li-ion, 51.2V	Li-ion, 48V
Battery capacity-	7.5 kWh	8 kWh	4.5 kWh
Peak power-	5.44kW@3500rpm	9.55kW@3500rpm	5.4kW@3500rpm
Peak torque-	29 Nm	45 Nm	29 Nm
Total weight including battery	713kg	975kg	689 kg
Curb weight-	413kg	469kg	389 kg
Pay Load	300 kg	506 kg	300 kg
Top speed-	45km/h	45km/h	45km/h
Driving range-	105-115km	85-95km	68 km
Gradient climbing -	19%	17%	19%
Charger type-	48V/3000W off road charger	48V/3000W off road charger	Bulk Charging Station
Time for full charging -	3hrs 45mins	Time: 3hrs 45mins	

Piaggio has another lowest price model is 3-Seater/1920/Electric/Swappable batteries which costs Rs. 2.20 lacs (Rs. 2.5 lacs less Rs. 30000 GoK subsidy) but for that variant FAME II subsidy is not available. At present this swappable battery model is available only in Trivandrum (Thiruvananthapuram) and Calicut. To serve E-Autos with swappable battery model Piaggio has entered in agreement with Sun Mobility which has set up swappable battery charging facilities in both these cities. Trivandrum (Thiruvananthapuram) has 7 battery charging hubs while Calicut has 5 or 6 hubs. One swappable battery charging hub can charge and swap 15 batteries in a day.

The on-road price in Kochi (including benefit of FAME 2 subsidy of Rs. 73,250) is Rs. 3,16,000. Kerala State provides additional subsidy of Rs. 30000 or 25 % of cost whichever is lower on E-Auto, thus after deducting Kerala Government subsidy the on-road price of E-Auto is Rs. 286000. Application for this Kerala Government subsidy can be made by owner of the E-Auto only after the registration of the vehicle with RTO.

To work out business cum life cycle cost model following information was collected from the company representative during the field visit.

a. Piaggio has recently tied up with Sundaram Finance to provide loans to buyers- 13-14% interest rate for 36-42 months.
b. The operating cost of Ape E City passenger variant as claimed by Company is 49 paise/km.
c. Expected life is 5 ½ years-
d. Battery lasts for 4-4 ½ years- 1200 charging cycles, but company gives warranty of 3 years or 100000 kms.
e. The vehicle takes 3hr 45mins to be charged fully and consumes 8 units.
f. Cargo vehicle runs for 90km and passenger vehicle runs for 110 km when battery fully charged
g. Piaggio offers first service upon completing 10000 km- one service costs Rs. 10000
h. Low maintenance is required for electric vehicles compared to petrol or CNG based vehicles- only brake liners and tyres are required to be changed as per usage. Changing brake liners costs Rs. 500 while one tyre costs Rs. 2500.

7.2. Mahindra Treo

Treo electric auto-rickshaw is a product of Mahindra Electric. Mahindra dealer in Kochi informed that on an average 5 vehicles are sold per month in Kochi while around 35 E-Autos get sold per month across in the Kerala State. He further informed that 98 vehicles were sold in Kerala in the month of March 2022 as there are increased enquiries and purchase of E-Auto due to rising fuel prices.

The Treo has improved AC motor with 8 kw peak power and its top speed is increased from 45 km/h to 55 km/h and it accelerate from 0-20 kph in 2.3 seconds. It has a lithium-ion battery of 48 V capacity 7.37 kWh which gives a range of 130 km. Its batteries can be charged anywhere as it comes with a 15 A portable charger. It takes 3 hours 50 minutes of time to charge it. (See specification table below)

As per companies claim the running cost of Mahindra Treo is only 50 paise/km which can save up to ₹45,000 per year on fuel costs. It comes with a standard warranty of 3 years or 80,000 km whichever comes first; though warranty for battery is for 80000 kms company claims that battery can last for 150000 kms. As informed by the company representative a battery of Treo is made of 32 cells and after three years entire battery is not required to be replaced. It will be sufficient to replace weakened or damaged cells. The cost for replacement of a battery cell would be Rs. 2000 to Rs. 2500 maximum.

The ex-showroom price of Treo is 2.7 lakh rupees. The on-road price will be around 3 lakh rupees after road tax, licence and other taxes.

Table 2: Technical Specifications of Mahindra E-Auto - Treo

Particulars	Treo – passenger model	
Battery type, Voltage-	Li-ion, 48V	
Battery capacity-	7.37kwh	
Peak power-	8 kW@3500rpm	
Peak torque-	42 Nm	
Total weight including battery	875kg	
Curb weight-	387kg	
Pay Load	488 kg	
Top speed-	55km/h	
Driving range-	130-141 km	
Gradient / gradeability degree	12.7%	
Charger type-	48V/3000W off road charger	
Time for full charging -	3hrs 50mins	

The Treo is available with a low-down payment scheme of 50,000 rupees from Mahindra finance. Mahindra Finance provides loans to buyers- depending on their CIBIL score but interest rate is high (12 -14 % interest rate)

KFC (Kerala Finance Corporation) also provides loans- interest rate is very high- loan provided for 3 years- Union Bank of India and Canara Bank provide for 5 years at lower interest rate.

8. Business cum Life Cycle Cost Model of E-Auto

Based on all primary and secondary information collected for E-Auto models of Piaggio and Mahindra a business cum life cycle cost model has been worked out based on following assumptions.

1. E-Auto will run 100000 kms in 3 years that is within warranty period of 3 years / 100000 km, so there will no battery replacement costs during first three years.
2. There will no extra ordinary expenditure due to accidents, thefts or any other reasons etc.
3. Loan of Rs. 260000, down payment Rs. 30000 to Rs. 40000, rate of interest 10 % to 14 %, loan duration 36 months

4. 330 days working per year, 1000 Days in three years – per day 100 km running assumed = total 100000 km. every-day battery will be charged once.
5. Minimum life of E-Auto (Except Battery) assumed 6 years.
6. After 3 years of operation, though new battery is purchased with three years and 100000 kms warranty. The cost of battery replacement assumed Rs. 1,20,000.
7. For battery replacement Rs. 20000 down payment and Rs. 100000 loan for 36 months duration has been assumed.
8. Additional maintenance cost of Rs. 10000 per year is assumed in second three years life term of E-Auto
9. It is assumed that the owner of the E-Auto will be the driver and will drive E-Auto, so no salary payment to driver has been assumed.

Table 3: EMI calculation for the loan of Rs. 260000 at different rate of interest.

Particulars	@10%	@11 %	@ 12 %	@ 13 %	@ 14 %
On Road Price	Rs. 290000	Rs. 290000	Rs. 290000	Rs. 290000	Rs. 290000
Down Payment	Rs. 30000	Rs. 30000	Rs. 30000	Rs. 30000	Rs. 30000
Loan Amount	Rs. 260000	Rs. 260000	Rs. 260000	Rs. 260000	Rs. 260000
Loan Period	36 Months	36 Months	36 Months	36 Months	36 Months
EMI	Rs. 8389	Rs. 8512	Rs. 8638	Rs. 8760	Rs. 8886
Effective Cost of loan	10.47%	11.57 %	12.68 %	13.8 %	14.93

It can be observed from the working provided in the Table 4 that E-Auto owner-driver will be able to earn Rs. 1.73 lakhs to Rs. 1.78 lakhs per year that is Rs. 560 to Rs. 580 per day (Rs. 16000 to Rs. 17000 per month) after mitigating all kind of normal cost including loan repayment with interest associated with E-Auto for the period of 3 years. At the end of third year, he can replace his fixed battery and can run E-Auto for maximum 3 years as minimum expected life of E-Auto body is 5.5 or 6 years as per information given by the company. At the end sixth year he can scrap the vehicle.

Table 4: E- Auto Business Model – First three years of Life Cycle

Particulars	Per day cost & revenue	Monthly cost & revenue	Annual cost & revenue
Running assumed	100 kms	3000 kms	33000 kms
Charging assumed	Once	30	330
Loan interest & repayment EMI	Rs. 280 to Rs. 300	Rs. 8400 to Rs. 8900	Rs. 100800 to Rs.106800
Battery Charging Cost Once a day	Rs. 80	Rs. 2400	Rs. 26400
O&M Cost 50 paise / km including servicing	Rs. 50	Rs. 1500	Rs. 16500
Tyre Replacement cost	Rs. 23	Rs. 390	Rs. 7500
Total cost	Rs. 433 to Rs.473	Rs. 12690 to RS. 13190	Rs. 151200 to Rs. 157200
Receipts Rs. 10 /per km	Rs. 1000	Rs. 30000	330000
Net Income	Rs. 560 to Rs. 580	Rs. 16810 to Rs. 17310	Rs. 178800 to Rs. 172800

After three years of operations e-auto driver cum owner will be required to replace battery which cost Rs. 120000 at present but this cost is likely to come down in future. To replace the battery if a loan of Rs. 100000 is taken from financial institution then following would be the business model in another three years period of E-Auto.

It can be observed from the working provided in the Table 6 that E-Auto owner-driver will be able to earn much more amount of Rs. 2.21 lakhs to Rs. 2.24 lakhs per year or Rs. 670 to 680 per day (Rs. 20000 per month) in the second three years of life of E-Auto after mitigating all kind of normal cost including loan repayment with interest associated with purchase of new battery for his E-Auto. At the end of second third year term, owner-driver can scrap his E-Auto and can go for new E-Auto.

Table 5: EMI calculation for the loan of Rs. 100000 at different rate of interest.

Particulars	@10%	@11 %	@ 12 %	@ 13 %	@ 14 %
On Road Price	Rs. 100000	Rs. 100000	Rs. 100000	Rs. 100000	Rs. 100000
Down Payment	Rs. 20000	Rs. 20000	Rs. 20000	Rs. 20000	Rs. 20000
Loan Amount	Rs. 100000	Rs. 100000	Rs. 100000	Rs. 100000	Rs. 100000
Loan Period	36 Months	36 Months	36 Months	36 Months	36 Months
EMI	Rs. 3227	Rs. 3274	Rs. 3321	Rs. 3369	Rs. 3418
Effective Cost of loan					

Table 6: E- Auto Business Model – Second three years of E-Auto Life Cycle

Particulars	Per day cost & revenue	Monthly cost & revenue	Annual cost & revenue
Running assumed	100 kms	3000 kms	33000 kms
Charging assumed	Once	30 times	330 times
Loan interest & repayment EMI	Rs. 118 to Rs. 125	Rs. 3250 to Rs. 3450	Rs. 39000 to Rs. 41400
Battery Charging Cost Once a day	Rs. 100	Rs. 3000	Rs. 33000
O&M Cost 50 paise / km including servicing	Rs. 50	Rs. 1500	Rs. 16500
Tyre Replacement cost	Rs. 23	Rs. 390	Rs. 7500
Additional O&M Cost	Rs. 30	Rs. 900	Rs. 10000
Total cost	Rs. 321 to Rs. 328	Rs. 9630 to Rs. 9840	Rs. 106000 to Rs. 108400
Receipts Rs. 10 /per km	Rs. 1000	Rs. 30000	330000
Net Income	Rs. 679 to Rs. 672	Rs. 20370 to Rs. 20160	Rs. 224000 to Rs. 221600

Table 7: Total Life Cycle Cost of E- Auto over period of six years

Particulars	First Three years of Life Cycle of E-Auto (per year)	Second Three years of Life Cycle of E-Auto (per year)	Total Life Cycle Cost of E-Auto for six years
Running assumed	33000 kms	33000 kms	200000 kms
Charging assumed	330	330 times	2000 time
Loan interest & repayment EMI	Rs. 100800 to Rs.106800	Rs. 39000 to Rs. 41400	Rs. 419400 to Rs. 444600
Battery Charging Cost Once a day	Rs. 26400	Rs. 33000	Rs. 178200
O&M Cost 50 paise / km including servicing	Rs. 16500	Rs. 16500	Rs. 99000
Tyre Replacement cost	Rs. 7500	Rs. 7500	Rs. 45000
Additional Maintenance Cost	00	Rs. 10000	Rs. 30000
Total cost	Rs. 151200 to Rs. 157200	Rs. 106000 to Rs. 108400	Rs. 771000 to Rs. 796800
Rs. 10 /per km. 100 km running	330000	330000	Rs. 1980000
Net Income	Per year Rs. 178800 to Rs. 172800	Per year Rs. 224000 to Rs. 221600	Rs. 1183200 to Rs. 1209000

The total life cycle cost of E-Auto for six years' time duration is presented in the Table 7. It can be observed in total life cycle cost calculations E-Auto remains financially viable by a substantial volume even at a moderate running of E-Auto of 100 kms per day.

An alternative business model with running of 200 kms per day by E-Auto which will require battery charging two times a day (one in the night and one in the noon) and total life cycle cost model over six years with replacement of battery every two years is presented in Table 9 based on following assumption.

- At the end of second- and fourth-year battery will be replaced at the cost Rs. 120000 with a loan of Rs. 100000 for the period of two years. EMI for Rs. 100000 at various interest rates to be repaid in 24 months works out as follows

Table 8: EMI calculation for the loan of Rs. 100000 at different rate of interest.

Particulars	@10%	@11 %	@ 12 %	@ 13 %	@ 14 %
On Road Price	Rs. 100000	Rs. 100000	Rs. 100000	Rs. 100000	Rs. 100000
Down Payment	Rs. 20000	Rs. 20000	Rs. 20000	Rs. 20000	Rs. 20000
Loan Amount	Rs. 100000	Rs. 100000	Rs. 100000	Rs. 100000	Rs. 100000
Loan Period	24 Months	24 Months	24 Months	24 Months	24 Months
EMI	Rs. 4614	Rs. 4661	Rs. 4707	Rs. 4754	Rs. 4801
Effective Cost of loan					

Table 9: Total life cycle cost of E-Auto with running of 200 kms per day for six years' time duration

Particulars	First two years of Life Cycle of E-Auto	Second two years of Life Cycle of E-Auto	Second two years of Life Cycle of E-Auto	Total Six Years Life Cycle Cost of E-Auto
Running assumed	132000 kms	132000 kms	132000 kms	396000
Charging assumed times	1320	1320	1320	3960
Loan interest & repayment EMI of E-Auto	Rs. 201600 to Rs.213600	Rs. 100800 to Rs.106800	-	302400 to 320400
Loan interest & repayment EMI of Battery for E- Auto	-	Rs. 110736 to Rs. 115224	Rs. 110736 to Rs. 115224	221472 to 230448
Battery Charging Cost (Twice a day)	Rs. 105600	Rs. 105600	Rs. 105600	316800
O&M Cost 50 paise / km including servicing	Rs. 66000	Rs. 66000	Rs. 66000	198000
Tyre Replacement cost	Rs. 30000	Rs. 30000	Rs. 30000	90000
Additional Maintenance Cost	-	Rs. 20000	Rs. 20000	40000
Total cost	Rs. 403200 to Rs. 415200	Rs. 433136 to Rs. 443624	Rs. 332336 to 336824	1158672 to 1195648
Receipts Rs. 10 /per km.	Rs. 1320000	Rs. 1320000	Rs. 1320000	3960000
Net Income	Rs. 904800 to Rs. 916800	Rs. 876376 to Rs. 886864	Rs. 983176 to Rs. 987464	2601328 to 2764352
Per day Income				Rs. 1310 to Rs. 1390

It can be observed from the table that if E-Auto runs for 200 kms per day that is at a double rate then its profitability and financial viability increases at more than double even though replacement of battery and loan repayment with interest expenditure are much more compare to per day running of 100 kms of E-Auto.

9. Charging infrastructure for Electrical Vehicles – Guidelines & Standards

India is a part of handful of countries that support the global EV30@30 campaign, which targets to have at least 30% new vehicle sales be electric by 2030. An accessible and robust network of electric vehicle (EV) charging infrastructure is an essential pre-requisite to achieving this ambitious transition. The Government of India has instituted various enabling policies to promote the development of the charging infrastructure network.[9]

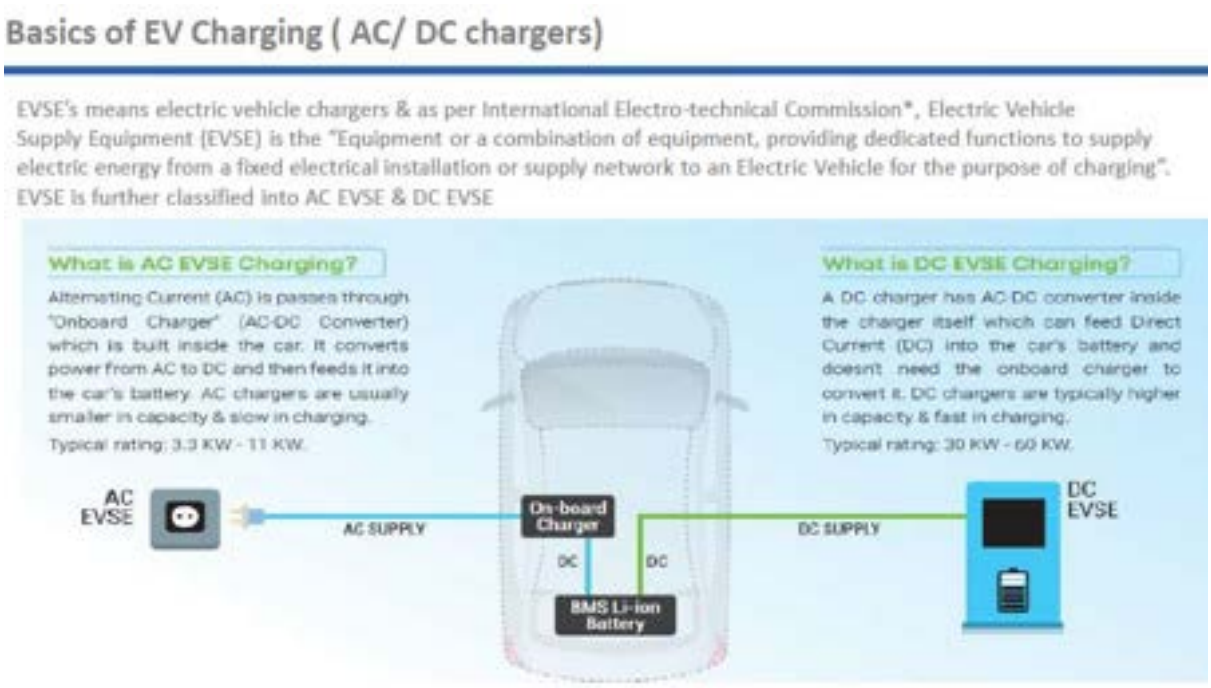

Figure 2: Basic of EV Charging

EV charging requirements depend on the specifications of EV batteries, as power must be supplied to the battery at the right voltage and current levels to permit charging. Typical capacity and voltage of EV batteries vary among the different EV segments, as shown in Table 10.

Table 10: Battery Capacity, Battery Voltage, Charger type for various EVs

Vehicle Segment	Battery Capacity	Battery Voltage	Charger Type
E 2-Wheeler	1.2 to 3.3 kWh	48 – 72 V	3 pin AC Type I and Type II
E 3-Wheeler	3.6 to 8 kWh	48 – 60 V	3 pin AC Type I and Type II
E 4 – Car - 1st generation	21 kWh	72 V	3 pin AC I, ACII, DC Type III
E 4 – Car - 2nd generation	30 to 80 kWh	350 – 500 V	AC I, ACII, DC Type III
Bus (L, Bus (M), Bus (H)	70, 124, 300 kWh		DC Type III

Electric vehicles (EV) can be charged in a variety of ways, depending on location and requirement. Electric vehicle supply equipment (EVSE) is the basic unit of EV charging infrastructure. Accordingly, charging infrastructure for EVs is of different types and designed for

[9] Niti Ayog - HANDBOOK of ELECTRIC VEHICLE CHARGING INFRASTRUCTURE IMPLEMENTATION

different applications. Specifications and standards for EV chargers, also known as electric vehicle supply equipment (EVSE), vary from one country to another.

Electric vehicle (EV) chargers are characterized by "levels" rather than grades. The levels describe how quickly a charger will recharge an EV's battery. In general, chargers are defined by the number of kilowatts (kW) they output. Each kilowatt-hour (kWh) received by a standard passenger-sized EV equates to about 4 miles (6.43 kms) of driving range. The higher the output from the charger, the faster the EV battery will recharge.

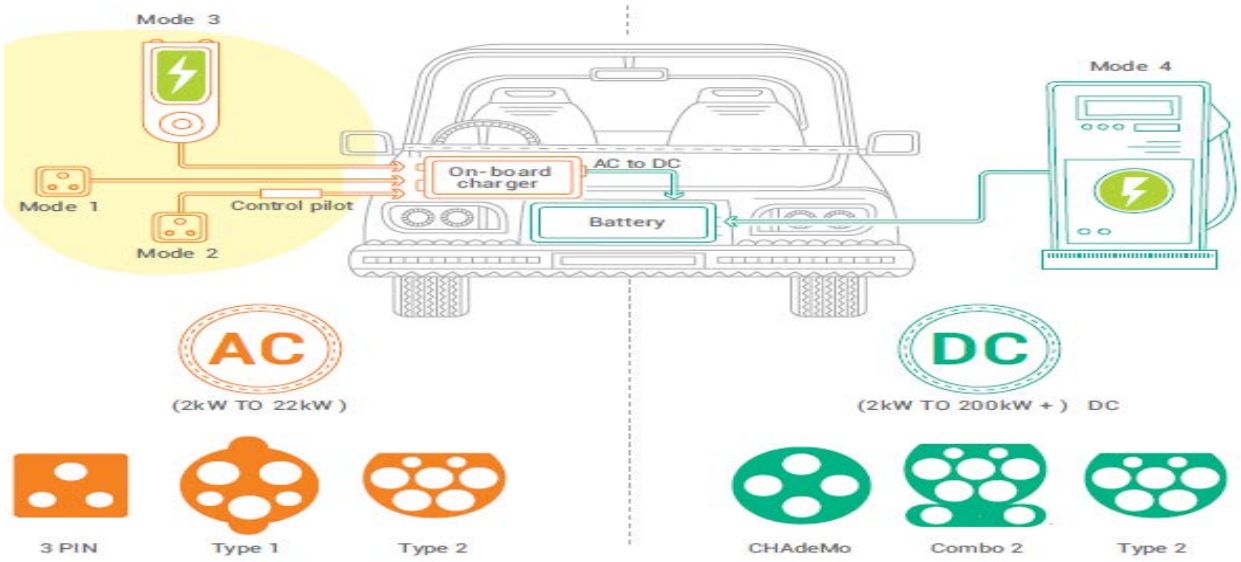

Figure 3: Various Types of Chargers for EVs

Under FAME II scheme flexibility of funding for establishment of charging infrastructure to the extent of 100% of cost depending upon the project proposal is available for promoting electric mobility. Projects for charging infrastructure can also include infrastructure projects required for extending electrification for running of vehicles like pantograph charging, flash charging etc. Inter-linking of renewable energy sources with charging infrastructure, smart grid, use of ICT etc. are encouraged under FAME II scheme.

Beside FAME II Subsidy Government of India has reduced GST from 18 % to 5 % for electric vehicle chargers. Ministry of Housing and Urban Affairs guidelines[10] states that 20 % of parking spaces should be EV Compatible.

To avail FAME II Scheme subsidy, the charging infrastructures need to be established as per Ministry of Power Notification vide No. 12/2/2018-EV dated 14th Dec 2018 on the subject "Charging Infrastructure for Electrical Vehicles -Guidelines and Standards" and as amended from time to time. Ministry of Power has revised its guidelines and standards recently on 14th January, 2022 and will be applicable till March 2025. (See Appendix -1).

The revised guideline of Ministry of Power GOI states that the fast-charging stations for long-range EVs and heavy-duty EVs (like trucks and buses) will have at least two chargers of a minimum of 100 kW (200-750 V or higher), each of different specifications (CCS/CHAdeMO[11] for above capacity or BIS standards for bus charging station) with single gun connector each. The charging stations

[10] Amendments have been made to relevant provisions of the Model Building Bye-laws and the Urban and Regional Development Plans Formulations and Implementation Guidelines (URDPFI – 2014)

[11] There is a compatibility problem Fame IIrequires chargers to be fitted with Chademo / DC 001 but vehicle manufacturers have yet not caught up with such advance technology.

will also have appropriate liquid-cooled cables for a high-speed charging facility for onboard fluid-cooled batteries (for long-range EVs). Other important points of revised guidelines are as follows -

- Provision of Separate transformer, if required
- 33KV/11 KV line/cable with associated equipment, if required
- Adequate space for charging & entry-exits of vehicles
- Tie up with online Network Service Provider (NSP)
- Charging station data sharing with DISCOM & data base access to Central & state nodal agency.
- The tariff for supply of electricity to EV Public charging station shall be determined by the appropriate commission in accordance with the tariff policy issued under electricity ACT 2003 as amended from time to time.
- Separate meter for recording the consumption so that PCS will be billed as per applicable concessional tariffs.
- The tariff for supply of electricity to public EV Charging Stations / Bulk Charging Stations shall be a single part tariff and shall not exceed the 'Average Cost of Supply' till 31st March, 2025.

Government of Kerala (G0K) EV Policy has given due importance to creation of charging infrastructure. The Kerala State Electricity Board ltd. (KSEBL) is designated as the State Nodal Agency (SNA) for establishing the charging infrastructure in the state. EV Policy states that KSEBL will be encouraged to set up Bulk charging stations (BCS), Fast and Slow / Medium charging station on its own or in public private partnership (PPP) mode. The State Government will also explore avenues for providing space in government buildings and public places where KSEBL will set up PCS and BCS in one of the two modes mentioned above. 20 PCS/BCS each and 150 Swapping Outlets for 2/3 wheelers shall be set up in the initial pilot districts in Thiruvananthapuram, Ernakulam and Kozhikode.

Kerala State Road and Transport Corporation (KSRTC) will set up Charging Stations in their depots, service of which will be extended to other fleet owners on payment basis.

Capital subsidy of 25 % of the value of the charging station equipment / machinery up to a maximum subsidy of Rs. 10,00,000 for Direct Current (DC) Chargers (100 V and above) for first 100 charging stations and Rs. 30000 for Direct Current chargers (below 100 V) for first 300 charging stations.

EV Policy of GoK further states that public parking places and public place will be mandated to have charging stations. These will be accessible to both Government as well as private vehicles. Existing private buildings such as malls and other commercial building will be incentivised to set up charging / battery swapping stations. All new permits for commercial complexes, housing societies and residential townships with a built-up area 5000 sq. mt. will be mandated to have public charging stations.

All new and renovated non-residential buildings with more than 10 equivalent car spaces (ECS) will need to have at least 20 % EV ready ECS spots with conduits installed. All new and renovated residential complexes and colonies with more than 10 ECS parking space will need to make 100 % demarcated ECS parking, EV ready with conduits installed.

Kerala EV Policy has also provided for giving electricity to Public / Bulk Charging Stations at a rate less than average during the initial three years. The rate during off peak hours (22.0 to 06.0 hours) and during the peak hours will be 75 % and 150 % respectively of the normal energy charges.

10. Business Models for developing charging infrastructure / stations

There are three broad business/finance models for charging infrastructure, categorized by the stakeholder group responsible for charging infrastructure procurement – the government-driven model, the consumer-driven model, and the service provider-driven model.

10.1. The Government – Driven Model

Public charging infrastructure provision can be led by government agencies. They include local authorities such as municipal corporations and urban development authorities, or state nodal agencies (SNAs) responsible for public charging infrastructure or state agencies like State Electricity Boards, State Transport Corporations etc. Public land, aggregated from different government and public sector bodies, is provided for the installation of charging facilities. The charging equipment may be owned by government or by a Charge Point Operator (CPO) that is contracted to own and operate the charging services.

For self-owned EV charging facilities, public sector agencies procure the EVSE equipment through an EPC contract with a partner. Charging services may be self-managed or outsourced to a CPO. Alternatively, government authorities may enter a PPP contract with a partner. Here, the relevant government agency invites CPOs to install and operate EV charging facilities for public use. In this model, governments offer financial subsidies, concessional land provision and/or energy supply to incentivize CPOs to reduce capital costs of implementation.

In this regard Central and Various State EV policies have given clear mandate to its agencies to set up EV charging facilities on self-owned basis and on revenue sharing basis (PPP basis) as follows –

The land available with Government / public entities shall be provided for installation of public charging stations to a government / public entity on a revenue sharing basis at a fixed rate of Rs. 1 /kWh (used for charging) to be paid to the land-owning agency from such PCS business payable on quarterly basis. Such revenue sharing agreement may be initially entered by parties for a period of 10 years. The revenue sharing model may also be adopted by public land-owning agency for providing land to a private entity for installation for public charging stations on bidding basis with floor price of Rs. 1/kWh[12]

The government-driven model is an important step to ensure the adequate availability of public charging. This model should be more dominant in the early years of EV ecosystem development, to set up a basic network of public charging facilities.

KSEBL, if plans are implemented timely and efficiently, will be one of the best examples of Government Driven model. As mandated by EV Policy of GoK, KSEBL has planned to set up 62 big public stations across the state in which 6 vehicles can charge at a time- over 100 vehicles a day (capacity). Out of these planned 62 public charging stations 30 will be submitted for FAME-II subsidy which will cover 70% of the equipment cost. Another 32 Public Charging Stations will receive subsidy from Kerala Government subsidy which will cover 100% equipment cost. 29 stations will be outfitted by Tyrex- latest state of the art hardware and software. These stations will be set up on the land owned by KSEB, also there are plans to incorporate PPP in setting and running these PCS. It is learned that GIZ will provide financial support for setting up 15 public charging stations. KSEBL reported that 13 PCS are already functioning out of that 8 are in Kochi – Ernakulam See Table -11.

A charging station set by KSEBL at --------- was visited (see Figure 4). It has two chargers – 21 kWh with one gun and 63 kWs with two guns, so at a given time three vehicles can be charged. KSEBL charges Rs. 13 (plus service and GST) per unit consumed for charging. This is one of the lowest charges for EV charging in India. On an average E 4-Wheeler car takes one hour to one and half hour to charge and needs 25 to 30 units depending upon 80 % to full charge. Thus, total charge comes out to be Rs. 375 to Rs.450 for E 4-Wheeler.

[12] Ministry of Power - Consolidated EVCI Guidelines January 2022

Figure 4: Charging Station Set up and operated by KSEBL

Table 11: Charging stations set up by Government Agencies in Kochi - Ernakulam

Sr. No.	Agency Name	Location	No. of chargers (with capacity)	Manufacturer	Price (Rs.) per unit
1	ANERT	KTDC Parking, Marine Drive	2 with 2 guns each (60kW)	EESL	13+GST+service tax
2	KSEBL	Palarivattom	2 fast connectors (120kw)	GOEC	13+GST+service tax
3	KSEBL	Vyttila	2 fast and 2slow (157kW)	GOEC	13+GST+service tax
4	KSEBL	Gandhinagar	2 fast and 2+1 slow (172kW)	GOEC	13+GST+service tax
5	KSEBL	Kaloor	2 fast and 2+1 slow (172kW)	GOEC	13+GST+service tax
6	KSEBL	Kalamasseri	2 fast and 2+2 slow (194kW)	GOEC	13+GST+service tax
7	KSEBL	Angamaly	2 fast and 3+1 slow (187kW)	GOEC	13+GST+service tax

Note - CCS and Chademo (fast chargers) have max capacity 120kW (2 connectors). Most charging stations only have one connector of each (60+60). Slow chargers Type II is 22kW Bharat DC (GBT) is 15kW

10.2. The Consumer-Driven Model

The consumer-driven model is employed for private and semi-public charging facilities such as malls, commercial or institutional establishments, retail shops, restaurants, etc, that have parking available on their premises to host EV charging facilities. They will most commonly partner with a Charger Point Operator (CPO) to take care of EVSE supply, installation, and maintenance, as well as the management of service operations. While EVSE procurement by the private entity is typically through direct purchase, new models around leasing of EVSE equipment from suppliers or CPOs are also evolving.

Other consumers using this model include private EV owners and fleet operators. The implementation model is straightforward for EV owners, who may procure the EV charger from their automobile OEM, an EVSE retailer, a CPO or their DISCOM. Depending on the type of charger and power connection, software services may be available to the EV owner through a mobile application to control charging sessions, take advantage of ToD tariffs, etc. Fleet operators require charging facilities for their EV fleets. In this case, land is provided by the fleet operator, who may own or lease it. EVSE equipment supply, installation, and maintenance are through direct contracts with suppliers or CPOs, and charging management services may be handled in-house or contracted to a CPO.

10.3. The Service Provider Model

In the service provider model, it is the CPOs that drive EV charging provision for public and semi-public charging. The key distinguishing features of the service provider model are:

- EVSE equipment is usually owned by the CPO
- Land is sourced from a variety of owners, including public and private entities (this is especially true for private CPOs), and
- Charging services are offered under the brand of the CPO.
-

Private CPOs aim to establish a network of charging facilities in strategic locations with high potential charging demand. They source land parcels in selected locations from public or private entities, install EVSE equipment supplied by manufacturing partners, and operate paid EV charging services for public or semi-public use. CPOs may enter revenue-sharing arrangements with host establishments or other landowners for the use of land.

DISCOMS (public and private) are also entering the charging infrastructure market as CPOs, as seen in Box L. These agencies typically use their own land to set up public EV charging facilities and operate them as paid services. DISCOMs may also provide bundled charging services for private EV owners, and recover the capital and operating costs through electricity tariffs. Other stakeholders driving the service provider model of EV charging implementation include industrial companies that are moving into charging infrastructure, and EV manufacturers that are setting up charging infrastructure networks as allied services.

Table - 12 provides information about PCS set up and operated by the private sector / service providers. At present there are only 4 such charging stations and they charge Rs. 20 per unit + GST+ Service Tax

Table 12: Charging Station Set Up by private sector service provider.

Sr. No.	Party Name	Location	No. of Chargers Capacity of chargers	Manufacturer	Price charged per unit
1.	PulsePower	Kakkanad - Mamala	1 with 1 gun (60kW)	PulsePower	19.9+GST and service tax
2.	Drivethru	Centre Square Mall M.G Road Pothys, Banerji Road	1 with 1 gun (60Kw)	V Power Ltd.	20+GST and service tax
3.	Zeon Charging	Gokul Ootupura restaurant, Padivattom Grand Mall	1 with 1 gun (60Kw)	Zeon	19.5+GST and service tax

4.	Ather Energy	Kacheripady, MG Road, Panampilly Nagar	1 with 1 gun (3.3kW)	Ather	

10.4. Business / Revenue Model of Charging Stations (common for Government Driven / Consumer Driven / Service Provider)

- No bank loan has been assumed.
- 16 hours working assumed
- A car would take 60 to 90 minutes for charging and would consume average 25 to 30 units. Thus in 16 hours 10 to 12 Vehicles can easily get charged. (See Table about various existing EV car model, battery capacity etc.)
- 1 Unit of Electricity = 1 kWh; 1kWh means 1000 watts X 1 hour; for example, an electric application of 1000 watts used for 1 hour;
- 30 kWh charger will dispense 30 kWh power in one hour that is 30 electric units will get consumed; for example, 30 kWh charger will dispense 30 kWh and thus will charge Tata Nexon EV with 30 kWh battery in one hour.

Table 13: EV Cars in India - battery capacity, type of charger, charging time and mileage per ARAI

Sr. No	Make	Model	Battery Capacity	AC charger	Approx. charging time (SOC 0-100%)	DC charger	Approx. charging time (SOC 0-80%)	Mileage As per ARAI(KM)
1	Hyundai	Kona	39 kwh	7KW Type-2	6 hours	CCS 50KW	57 mins	452
2	MG Motor	MG ZS	44.5 kwh	7KW Type-2	8 hours	CCS 50KW	50 mins	340
3	Tata	Nexon	30.2 kwh	3 KW Type-2	8 hours	CCS 30KW	60 mins	312
4	Mahindra	e2o+ P2	13.44 kwh	AC001	7.5 hours	DC 001	95 mins	140
5	Mahindra	e verito	13.91/ 18.55 kwh	AC 001 / (Type-2)	8.5/11.5 hours	DC 001	80/90 mins	110/ 140
6	Tata	Tigor	21.5 kwh	AC001	11.5 Hrs	DC 001	120 mins	213

Table 14: Basic Business/Revenue Model for 21 to 30 kWh Fast Charging DC Station

Cost and Revenue Particulars	No Land Cost	Land taken on rent	Revenue sharing with land owner
Total Cost of the Device	600000	600000	600000
Electricity Connection one time Cost	250000	250000	250000
Civil Work and other structural work	250000	250000	250000
Total Capital Cost	1100000	1100000	1100000
Maximum Dispensing Capacity per day Units	500 to 720	500 to 720	500 to 720
Number of Charging Guns	One	One	One
Total maximum Units Consumed per day (25 units per vehicle) (10 to 12 Vehicles)	(250 to 300)	(250 to 300)	(250 to 300)
Total Units Consumed during the month	7500 to 9000	7500 to 9000	7500 to 9000
Total Units consumed during the year	90000 to 108000	90000 to 108000	90000 to 108000
Per unit cost (KSEB) (Rs.)	6	6	6
Sales (Charging) Price Per unit to User (Rs.)	20	20	20
Annual Income (Rs.)	1800000 to 2160000	1800000 to 2160000	1800000 to 2160000

Cost and Revenue Particulars	No Land Cost	Land taken on rent	Revenue sharing with land owner
Annual Electricity cost	540000 to 648000	540000 to 648000	540000 to 648000
Annual Maintenance Cost	250000	250000	250000
Payment Gateway transactions, software cost @2.5 % of the total income	Rs. 45000 to Rs. 50400	Rs. 45000 to Rs. 50400	Rs. 45000 to Rs. 50400
Land Lease Cost / Rent for land	-	300000	-
Land cost – Revenue sharing mode @ Rs. 1 per unit of electricity consumed– as per Govt. Order	-	-	90000 to 108000
Operating Cost per year	Rs. 835000 to 948400	Rs. 1135000 to Rs. 1248400	Rs. 925000 to Rs. 1056400
Profit per year	Rs. 965000 to Rs. 1211600	Rs. 665000 to Rs. 911600	Rs. 875000 to Rs. 1103600
Profit per month (rounded off)	Rs. 80400 to Rs. 100900	Rs. 55400 to Rs. 75966	Rs. 72900 to 91966
Breakeven / Payback period (months)	11 to 14	15 to 20	12 to 15

Table 15: Basic Business/Revenue Model for 50/60 kWh Fast Charging DC Station

Cost and Revenue Particulars	No Land Cost	Land taken on rent	Revenue sharing with land owner
Total Cost of the Device	1000000	1000000	1000000
Electricity Connection one time Cost	300000	300000	300000
Civil Work and other structural work	400000	400000	400000
Total Capital Cost	1700000	1700000	1700000
Maximum Dispensing Capacity per day Units	1200 to 1440	1200 to 1440	1200 to 1440
Number of Charging Guns	Two	Two	Two
Total maximum Units Consumed per day (16 hours working) (25 units per vehicle) (20 to 24 Vehicles)	(500 to 600)	(500 to 600)	(500 to 600)
Total Units Consumed during the month	15000 to 18000	15000 to 18000	15000 to 18000
Total Units consumed during the year	180000 to 216000	180000 to 216000	180000 to 216000
Per unit cost (KSEB) (Rs.)	6	6	6
Sales (Charging) Price Per unit to User (Rs.)	20	20	20
Annual Income (Rs.)	3600000 to 4320000	3600000 to 4032000	3600000 to 4032000
Annual Electricity cost	1080000 to 1296000	1080000 to 1296000	1080000 to 1296000
Annual Maintenance Cost	500000	500000	500000
Payment Gateway transactions, software cost @2.5 % of the total income	Rs. 90000 to Rs. 100000	Rs. 90000 to Rs. 100000	Rs. 90000 to Rs. 100000
Land Lease Cost / Rent for land	-	600000	-
Land cost – Revenue sharing mode @ Rs. 1 per unit of electricity consumed– as per Govt. Order	-	-	180000 to 216000
Operating Cost per year	Rs. 1670000 to 1896000	Rs. 1435000 to Rs. 1548400	Rs. 1850000 to Rs. 2112000
Profit per year	Rs. 1930000 to Rs. 2424000	Rs. 1330000 to Rs. 1824000	Rs. 1750000 to Rs. 2208000
Profit per month	Rs. 160800 to Rs. 202000	Rs. 110800 to Rs. 152000	Rs. 145800 to 184000
Breakeven / Payback period (months)	9 to 11	11 to15	10 to 12

It can be observed from the Table - 14 and Table - 15 that Charging Infrastructure business is also financially viable even though expenses have been assumed liberally while revenue has been assumed conservatively (charges taken at Rs. 20 where in many places per unit

charge is Rs. 25). It can be noted that investment will get recovered in less than two years' payback period in case of 21 to 30 kWh chargers while investment will get recovered in less than one year in case of 50 to 60 kWh. Financial working presented in the tables also show that higher capacity fast chargers have higher financial viability as they can serve more vehicles in a day.

Though working shows charging stations can be a profitable and business, enough number of charging stations are not getting set up because there are not enough number of EVs that is there is inadequate business. Beside adequate business there are problems in getting loans from bank and financial institutions for setting charging stations, availability of land and getting electricity connection from electricity boards. If these three problems get sorted out then EV charging stations will get set up by private sector big way as this business can be financially remunerative.

11. Charging Infrastructure for E 3-Wheelers

E-Autos come with the batteries which can be charged anywhere as it comes with a 15 A portable charger. E-auto can be charged at residence or any place where 15 A electric point is available. This is called Level 1 charging. Level 1 chargers plug directly into a standard 120-volt (V) AC outlet supplying an average power output of 1.3 kW to 2.4 kW. Thus 7.5 / 8.0 kWh E-Auto will take average 6 hours to charge. This power output is equivalent to 3-5 miles (5 to 8 kms) of EV range per hour. An overnight charge will add 30-50 miles of range, which is sufficient for many commuters

Figure 5: Bharat AC 001

AC Type/Level 1 chargers does not require any or much capital investment but are very slow and take substantial time to charge while Type/Level 3 DC fast chargers are not suitable for charging E 2- Wheelers or E 3-Wheelers (E-Auto / E-Rickshaw). Public charging stations (PCS) for E 2-Wheeler and for E Auto need to be different than DC fast chargers discussed above. Consequently, public charging stations (PCS) for E-Auto are set up with AC Type / Level 2 chargers ranging from 2 kWh to 10 kWh.

Type / Level 2 chargers operate at 208-240 V and output anywhere from 3 kW to 19 kW of AC power. This power output translates to 18-28 miles of range per hour. An average EV (with 30 kWh battery) can be fully charged in 8 to 10 hours. E-Auto with 7.5 to 8.0 kWh battery gets charged in 2 to 2.5 hours. AC Type 2 charges come with single port, two ports or three ports thus allowing more than one vehicle to charge at a time.

Type/Level 2 is the most prevalent type of charger in many countries can be found in many popular public locations, including parking garages, grocery stores, malls, hotels and residential apartment. L2 chargers are popular at workspaces where employees can leave EVs

charging for long durations. Many EV drivers choose to purchase an L2 charger for home use as it allows them to fully charge their EV overnight.

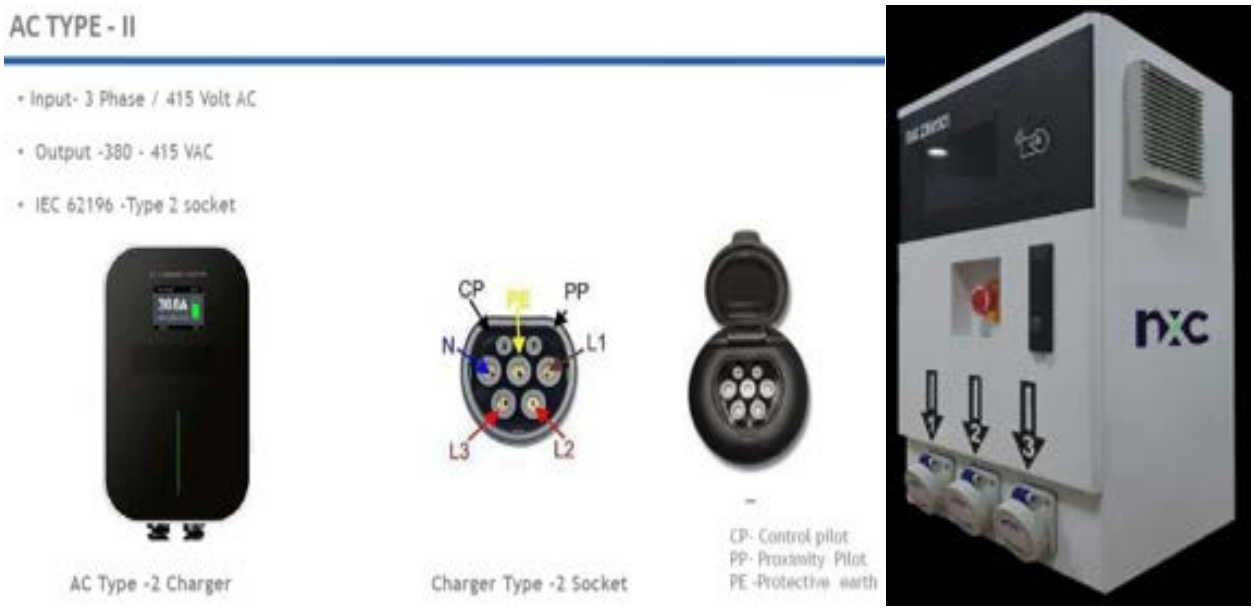

Figure 6L AC Type II Charger with one charging point and with three charging point

11.1. KSEBL Initiative - Charging Stations for E 2-Wheelers and E 3-Wheelers (E-Auto)

Taking into account peculiar charging station requirement of E-2 Wheelers and E 3-Wheelrs KSEBL has planned to set up 1140 Electric Pole mounted mini public charging stations with other supporting infrastructure like CCTVs, software, 24*7 internet service and with 5 years warranty, in the entire Kerala State and 39 mini stations in the Kochi – Ernakulam circle (125 in Kochi/Ernakulam District). KSEBL has made beginning of setting up such mini charging stations in the Kozhikode where E-Autos are in operations. (See Figure -7). The cost of such Electric Pole mounted chargers will be Rs. 27000 to Rs. 35000 without taxes. With other supporting infrastructure it will cost around Rs. 50000. KSEB will charge Rs. 9 per electric unit consumed to the consumer. E – Auto with 7 – 8 kWh battery would take two hours to charge fully and would consume 7 to 8 units of electricity. Beside pole mounted single user AC Type 2 charger, there can be public charging stations (stand alone or part of charging stations having Type 3 fast chargers for E 4-Wheelers) with two or three ports of 3.3 kWh allowing two or three E 2 / E 3 vehicles to be charged at a time. As cost of charging stations for E 2-Wheelers and E 3-Wheelers is different its business model is worked out separately (See Table - 16).

Figure 7:KSEBL Electric Pole mounted 3.3 kWh Charging Station

11.2. Business / Revenue Model of Charging Stations for E 2-W and E 3-W

It can be observed from the table that proposed electric pole mounted 3.3 kWh mini charging stations planned by for E 2-Wheeler and E 3-Auto will be profitable even for KSEBL even though it will be charging subsidised rate of Rs. 9 per unit. It has a payback period of less than a year. Similarly, 3.3 kWh or 3.3 kWh X 3 public charging stations run by private sectors will also be commercially viable and will recover their investment (payback period) within a year even if they charge Rs. 12 per unit (many places E-2-Wheelers and E- Autos have to pay price of Rs. 15 per unit) provided there are enough E 2-Wheelers and E-Autos in operation.

Table 16 Basic Business/Revenue Model for AC Type 2, 3.3 kWh Mini charging Station

Cost and Revenue Particulars	KSEBL Initiative pole mounted 3.3 kWh charger No Land Cost	Wall mounted or Stand mounted AC Type 2 3.3 kWh Charger PCS	3.3 kWh X 3 – AC Type II 10 kWh Charger PCS
Total Cost of the Device	50000	50000	100000
Electricity Connection one time Cost		5000	10000
Civil Work and other structural work		5000	10000
Total Capital Cost	50000	60000	120000
Maximum Dispensing Capacity per day Units	72	72	216
Number of Charging points	One	One	Three
Total maximum Units Consumed per day (16 hours working) (7 units per vehicle) (8 Vehicles)	54	54	162 (24 E-autos)
Total Units Consumed during the month	1620	1620	4860
Total Units consumed during the year	19440	19440	58320
Per unit cost (KSEB) (Rs.)	6	6	6
Sales (Charging) Price Per unit to User (Rs.)	9	12	12
Annual Income (Rs.)	174960	233280	699840
Annual Electricity cost	116640	116640	349920
Annual Maintenance Cost	5000	5000	10000
Payment Gateway transactions, software cost @2.5 % of the total income	5000	6318	17500
Land Lease Cost / Rent for land	-	-	-
Land cost – Revenue sharing mode @ Rs. 1 per unit of electricity consumed– as per Govt. Order	-	19440	58320
Operating Cost per year	126640	147398	435740
Profit per year (Rounded off)	48000	86000	264000
Profit per month	4000	7100	22000
Breakeven / Payback period (months)	12 to 13	8 to 9	6 to 7

Here also though charging stations for E 2-W and E 3-W can be financially viable and can be set up by small entrepreneurs as availability of land and bank loan is not a problem, still they are not getting set up in Kochi or at other places in India even though; simply because there is no business as number of E 2-W and E 3-W are inadequate and second E 2-W and E 3-W can be charged at home with simple 15 AMP three pin socket. At this juncture it is necessary that KSEBL should set up these charging stations.

12. Bulk Charging Stations (BCS) for Swappable Battery Electric Vehicles.

An alternative battery recharging method that is receiving global attention is battery swapping, in which a depleted EV battery is removed from the vehicle and replaced with a fully charged one. The technology is being tried out for various EV segments, including e-2Ws, e-3Ws, e-cars and even e-buses. On August 12, 2020, Ministry of Road Transport and Highways released a statement that electric 2Ws and EWs can be sold without a battery pack.

EV Policy of Kerala Government has given special attention to Bulk Charging Station for Swappable Battery Electric Vehicles stating that uncontrolled nature of charging facilities in a plug-in-mode could increase peak load and network congestion. Hence, although consumers are free to choose their preferred mode of EV Charging Technologies, two and three wheelers with swappable batteries which can be charged at Bulk Charging Stations (BCS) during off peak hours will have preferential treatment over conventional vehicles with build in batteries in the matter of State incentives for permits and allocation of power.

EV Policy of GoK has provided capital subsidy of 25 % of Fixed Capital Investment (for eligible assets excluding cost of battery inventory) up to a maximum subsidy of Rs. 10 lacs for swapping stations for the first 50 such stations.

Figure 8: Bulk Charging Station / Hub of Sun Mobility

12.1. Swappable Battery Solution (Bulk Charging Stations) Providers for E- Auto

Now various battery swapping solution providers have come up in India. (See Table ---) out of this Sun Mobility's initiative in partnership with Piaggio has been looked in to as it is located in two cities (Thiruvananthapuram and Kozhikode) of Kerala.

Sun Mobility company has set up 5 hubs (BCS) in Thiruvananthapuram set up in Piaggio Showrooms, Indian Oil Petrol Station and at Thampanoor Railway Station. Sun Mobility also has ---- BCS in Kozhikode. Each hub comes with 15 (14 filled at any given point + 1 empty) charging docs, thus at a time 14 swappable batteries can be charged. Each such hub costs Rs. 10 to Rs. 15 lakhs.

Figure 9: Swappable Battery of 1.5 kWh by Sun Mobility

Table 17: Bulk Charging Station Providers in India

Name of Provider	Foundation year – Headquarter	Partnerships	
Amar Raja Power	1985 – Tirupati	BPCL	Tirupati, Kochi, Lucknow
BatteryPool	2018 – Pune		50 + Swapping Stations across India
ChargeUP	2019 – Delhi		Mayur Vihar – Delhi / Delhi – NCR
CHARGE+ZONE	2018 – Vadodara	SmartE	Delhi–NCR 100 stations across India
Esmito	2018 – Chennai		Presence in six states
Lithion Battery	2016 – Delhi	With various OEMs	Delhi, NCR, Haryana
Numocity	2018 – Bengaluru	With various OEMs	
Race Enegry	Hyderabad		
Sun Mobility	2017 – Bengaluru	Piaggio, Microsoft, Uber, Smart-E, IOC	Ahmedabad, Bengaluru, Kozhikode, Thiruvananthapuram, eight other cities
Okaya Power	2002 – Delhi		Delhi – NCR
VoltUP	2019 – Mumbai	HPCL	Stations in Jaipur & Kolkata

12.2. Business Model of Bulk Charging Station (BCS)

Information with complete details is not available but based on following basic information received and assumptions business model of Bulk Charging Station has been worked out.

- Cost of 15 (14 + 1 battery) slots charging station of 30 kWh Rs. 7.5 lakhs + Ancillary Facilities 2.5 lakhs = Rs. 10 lakhs
- Cost of a 1.5 kWh battery Rs. 40000. Minimum inventory 30 batteries will be required. 15 batteries will get charged in 1 hours which will be taken out and next 15 will be put to charging. It assumed that during this one-hour adequate number of E-Autos will come to BCS and get those charged batteries from it and will provide 15 drained batteries to BCS to put in for charging in the next cycle.
- Batteries need to be charged below 27 degrees and it takes 15 minutes for temperature control and another 45 minutes to charge a battery which makes it a total of 1 hour.
- It is assumed that there are enough number of E-Auto which require battery swapping that is BCS can work to its fullest capacity.
- It is assumed that such one cycle of charging batteries and giving them to E-Autos will require one and quarter hours (in place of 1 hour time required technically)
- BCS will work for 16 hours (that is 7 am to 11 pm) so 12 cycles of battery charging can be done. In 12 cycles maximum batteries can be charged are 180.
- 1.5 kWh that 1.5 electric unit will be required to charge 1 battery, so if 180 batteries to be charged in a day then it will consume 270 units.
- Charging cost per battery is Rs. 53
- Cost of fund (investment) assumed at 12 % per annum
- Going by these assumptions it can be noticed that a BCS can serve 60 E-autos with swappable batteries per day.

Table 18: Business Model of Bulk Charging Station of 15 (14 + 1) battery slots (in Rs.)

Particular	Per day cost & revenue (annual cost/ 360 days)	Monthly cost & revenue (annual cost / 12)	Annual cost & revenue
Capital Cost			1000000
Cost of Batteries (inventory)			1200000
Operating Revenue (180 batteries X Rs. 53)	9540	286200	3482100
Operating Cost			
Rental Cost	2000	60000	720000
Employee Cost (two people)	1000	30000	360000
Cost of electricity electric 280 units per day X Rs. 6	1680	50400	604800
Cost of funds/investment assumed @ 12 % p.a.	733	22000	264000
O & M Cost Assumed @ 5 % of total investment	305	9167	110000
Total Operating Cost (Rs.)	5718	171567	2058800
Operating Profit Rs.	3822	114633	1423300
Payback period			19

It can be observed that a BCS is financially viable and entire capital cost / investment can be recovered with 12 % interest on investment in 19 months provided there is adequate demand that is there are enough number of E-Autos with swappable batteries.

12.3. Types of battery swapping

Manual - The battery swapping station is a standalone device, in which batteries are placed and removed manually from the individual slots, usually by hand. Manual swapping stations are modular and occupy a minimal amount of space. These are used for 2W and 3W battery applications, as the battery pack sizes are smaller and the weight can be handled by one or two persons.

Figure 10: Swappable Battery Charging System 1

Autonomous - A robotic arm is used in these types of swapping stations with the battery swapping process being semi/fully automated. Robotic swapping is used for 4W and e-bus applications as battery packs are larger and heavier, and require mechanical assistance. These swapping stations are also more expensive and have a higher land requirement.

Figure 11: Swappable Battery Charging System 2

12.4. Advantages and short coming of battery swapping

Battery swapping has some distinct advantages over plug-in charging but is also confronted with several challenges in its development as a mainstream charging method.

Advantages - EV recharging of vehicle (through battery swapping) is completed in minutes. Batteries can be charged away from swapping point, allowing more freedom in setting up swap facilities. Reduction in upfront cost of EV, as battery ownership is replaced by battery leasing. Greater number of batteries needed to power same number of EVs. Increased predictability of battery life due to controlled charging conditions.

Figure 12: Swappable Battery Charging System - 3

Barriers - Lack of standardization among EV batteries. Unsuitable battery pack design to enable ease of swapping (Weight, dimensions and ergonomics). Shorter commercial life of battery packs due to customer preference for new batteries with higher range. Slow adoption of charging method by OEMs. Higher costs of battery leasing over the life of the EV. Higher GST on separate battery (18%) vs battery sold with EV (5%)

Figure 13: Swappable Battery Charging System - 4

At present, battery swapping is considered a feasible solution for commercial EV fleets, especially in the e-2W and e-3W segments. The Ministry of Road Transport and Highways (MoRTH) has allowed the sale and registration of EVs without batteries, which provides a huge boost to battery swapping solutions. Further, industry stakeholders are making large investments in developing the battery swapping ecosystem. This indicates that battery swapping will emerge as a distinct part of EV charging networks in India in the coming years.

12.5. Business Model of E-Auto with a Swappable Battery

The cost of E-Auto with swappable battery is different compare to E-Auto with fixed battery, also the cost of charging swappable battery and the mileage it gives is different so business model of E-Auto with swappable battery is separately calculated on basis of assumptions as follows.

- Cost of E-Auto with Swappable Battery = Rs. 220000 (No battery in side but such vehicles are not entitled for FAME II battery-based input subsidy. Only Kerala government subsidy of Rs. 30000 will be available.
- 3 Swappable batteries – each of 1.5 kWh
- Cost of charging = Rs. 53 for one battery – full charging of all the three batteries = Rs. 160
- Full charge provides a mileage of 60-70km- an auto has to be recharged 3-4 times a day – Thus cost per km comes Rs. 2.40 to 2.60 = for model cost per kms assumed is Rs. 2.50
- Per day charging/ running kms assumed – 1. two times (150 kms); and 2. Three times (225 kms)
- 330 days working assumed during the year
- Rs. 200000 loan – 36 months – interest rate ranging from 10 % to 14 % p.a.

Table 19: EMI calculation for the loan of Rs. 200000 at different rate of interest.

Particulars	@10%	@11 %	@ 12 %	@ 13 %	@ 14 %
On Road Price	Rs. 230000	Rs. 230000	Rs. 230000	Rs. 230000	Rs. 230000
Down Payment	Rs. 30000	Rs. 30000	Rs. 30000	Rs. 30000	Rs. 30000
Loan Amount	Rs. 200000	Rs. 200000	Rs. 200000	Rs. 200000	Rs. 200000
Loan Period	36 Months	36 Months	36 Months	36 Months	36 Months
EMI (Rounded Off)	Rs. 6450	Rs. 6550	Rs. 6640	Rs. 6740	Rs. 6840
Effective Cost of loan					

Table 20: Business / Financial Model of E-Auto with Swappable battery.

Particular	Per day cost & revenue (annual cost/ 330 days)	Monthly cost & revenue (annual cost / 12)	Annual cost & revenue
Running assumed	140 kms & 210 kms	3850 kms / 5775 kms	46200 kms/69300 kms
Charging assumed	Twice / Thrice	55 / 83 times	660 / 990 times
Loan interest & repayment EMI	Rs. 235 to Rs. 249	Rs. 6450 to Rs. 6840	Rs. 77400 to Rs.82100
Battery Charging Cost	Rs. 320 / Rs. 480	Rs. 8800 / Rs. 13200	Rs. 105600 / Rs. 158400
O&M Cost 50 paise / km including servicing	Rs. 70 / Rs. 105	Rs. 1925 / Rs. 3025	Rs. 23100 / Rs. 34650
Tyre Replacement cost	Rs. 36 / Rs. 54	Rs. 1000 / Rs. 1500	Rs. 12000 / Rs. 18000
Total cost (rounded off)	Rs. 660 / Rs. 890	Rs. 18175 / Rs. 24430	Rs. 218100 to Rs. 293150
Receipts Rs. 10 /per km Running	Rs. 1400 / Rs. 2100	Rs. 38500 / Rs. 57750	Rs. 462000 / Rs. 693000
Net Income rounded off	Rs. 740 / Rs. 1210	Rs. 20325 / Rs. 33320	Rs. 243900 to Rs. 399850

It can be observed from the Table 18 and Table 19 that with swappable battery it will be possible for owner-driver of E-Auto to borrow less amount and to operate it for more kilometres as a result his per day/monthly/yearly earning can be more; but when compared to E-Auto with fixed battery it can be marginally less in overall terms on annual basis. This is because cost of charging swappable battery is much more compared to fixed battery (Rs. 2.30 per kms for swappable against Rs. 0.80 per kms for fixed battery). For this E-Auto need to be charged twice and should run 200 kms per day. Table - 20 Provides comparison between E-Auto with fixed and swappable batteries. One fact needs to be noted here clearly that E-Auto with Fixed Battery has marginally better profitability compare to

Swappable Battery if both types of E-Auto run every year 200 kms. But after two years Fixed battery of E-Auto will have to be replaced as it will have 1320 cycles of charging while it comes with life of 1200 cycles. Replacement of fixed battery will cost Rs. 120000 while such expenditure will not be required for E-Auto with swappable battery. Taking in to account these different requirements, if six years life cycle cost is taken in to account (See Table – 21) then E-Auto with swappable battery turns out to be marginally less profitable. Nonetheless both the E-Auto options are financially viable and can provide good return / revenue to driver – owner of E-Auto provided there exists adequate charging infrastructure at reasonable cost of charging; loans / credit facility are available easily and at an interest rate more than 14 % p.a.

Table 21: Comparison of business model of E-Auto with Fixed Battery and Swappable Battery

Particular / Annual Time Frame	E – Auto with Fixed Battery	E – Auto - Swappable Battery
Running assumed	66000 kms	69300 kms
Charging assumed	660	990 times
Loan interest & repayment EMI	Rs. 100800 to Rs.106800	Rs. 77400 to Rs.82100
Battery Charging Cost	Rs. 52800	Rs. 158400
O&M Cost 50 paise / km including servicing	Rs. 33000	Rs. 34650
Tyre Replacement Cost (life 30000 kms)	Rs. 15000	Rs. 18000
Total cost (rounded off)	Rs. 201600 to Rs. 207600	Rs. 288450 to Rs. 293150
Receipts Rs. 10 /per km running	Rs. 660000	Rs. 693000
Net Income rounded off	Rs. 458400 to Rs. 452400	Rs. 404550 to Rs. 399850

Table 22: Comparison of Life Cycle Cost model of E-Auto with Fixed Battery and Swappable Battery

Particular / Annual Time Frame	E – Auto with Fixed Battery	E – Auto - Swappable Battery
Running assumed	396000	415800 kms
Charging assumed	3960	5940 times
Loan interest & repayment EMI E-Auto	Rs. 302400 to 320400	Rs. 464400 to Rs.492600
Loan interest & repayment EMI Battery	Rs. 221472 to 230448	
Battery Charging Cost	Rs. 316800	Rs. 950400
O&M Cost 50 paise / km including servicing	Rs. 198000	Rs. 207900
Tyre Replacement Cost (life 30000 kms)	Rs. 90000	Rs. 108000
Additional maintenance cost	Rs. 40000	Rs. 40000
Total cost (rounded off)	Rs. 1158672 to 1195648	Rs. 1730700 to 1758900
Receipts Rs. 10 /per km running	Rs. 3960000	Rs. 4158000
Net Income rounded off	Rs. 2601328 to 2764352	Rs. 2427300 to Rs. 2300100

13. Renewable energy-based Charging Solutions/Stations

Renewable energy-based charging stations are those EV charging station where the electricity will entirely (or) partially be coming from the solar or other sources of renewable energy (Wind energy, Biogas, Hydropower plants, etc). Among various renewable energy sources except solar energy other renewable energy sources are either have less energy density or not compatible with the present market demand. It is the solar energy source which is good in density, abundant in India and advancement in solar power technology are happening very fast making it affordable. Solar energy and electric vehicle charging will combine and reduce the usage of fossil fuel dependence and will then become real green solution to transportation.

Figure 14: Solar Panel based EV Charging Station

Solar energy powered EV charging stations are of two types - On-grid and Off-Grid solar charging

On-Grid: in this solar system is connected to the main electricity grid and store a little amount of energy for backup and send the rest of the energy back to the grid when the system is not in use. The On-grid system is mainly used for real-time energy consumption purposes and its overall cost reduces because smaller batteries are used. such solar powered EV charging stations can be for private use or can be used in residential and office places.

Off-Grid: in solar system is not connected with the grid but have a larger battery to store the energy for evening or night (When there is no sun) usage. These types of solar systems are mainly used for commercial applications. A commercial solar charging station should be built upon an off-grid solar system.

Figure 15: Solar Panel based EV Charging Station

The main purpose of introducing electric vehicles for India is to control oil imports and to attain zero emissions, but electric vehicles at present are using electricity from gird 80% of which is made of non-renewable energy sources (Fossil fuels) in India. Thus, if India continues to use electricity produced through non-renewable energy sources to recharge EVs then instead reducing carbon emission it'll create more pollution than ICE vehicles. So, running electric vehicles on solar based charging stations is the real medium to long term solution for reducing carbon emissions. Solar based EV charges will offer following benefits.

Box 1 - ATUM CHARGE - SOLAR-POWERED EV CHARGING STATIONs

ATUM Charge is India's first 100% Green EV Charging Station. It is powered by ATUM Solar Roof, making it a completely sustainable alternative to existing EV charging units which use thermal power generation, one of the primary sources of pollution.

ATUM Charge stations are fabricated using Vnext Boards - a range of fibre cement boards which are excellent eco-friendly alternate to gypsum, wood, and plywood. Vnext products produce only 36 kg of CO2 emissions compared to 800 kg of CO2 produced by plywood; 1000 kg of CO2 by cement; and 2000 kg of CO2 by steel per tonne of production. It requires an area of 200 sq. ft. and a week's time to install.

To facilitate quick expansion across the nation, Visaka is looking at tying up with interested individuals who own a piece of land in prime areas of any towns or cities and are willing to let it out on a lease basis for a period of ten years and beyond. Beside generating a monthly income, on which Visaka will give a year-on-year increment, this would also contribute to making the planet cleaner and lead to the speedier adoption of EVs.

WHY ATUM CHARGE?

- 3.3-10 KW normal charging EVSE (Electric Vehicle Service Equipment)
- At least 2 EVSE per charging station; A CPO (Charge Point Operator)
- Less expensive, requires less electricity and less space, less capital; can be connected to low-voltage single and three-phase distribution networks, can be installed in buildings and public spaces where vehicles tend to park;
- Reduces the need for high power and ultra-high power charging points, which are more expensive and can be detrimental to EV battery health if overused.

Figure 16: ATUM Charge Solar Panel based EV Charging Station

- Reduces carbon emission (Not removed completely). A vehicle charged with solar-powered electricity emits 0.6 kg of carbon into the atmosphere whereas a gasoline-driven vehicle would emit 13 kg of carbon for every 100km ride.
- Charging cost will reduce. Solar power costs nearly 1.5 rupees for every kWh of electricity.
- India will reduce its dependency on fossil fuels for driving electric vehicles
- The load on the grid reduces.

Recent press report suggests that Atum Charge – A solar powered EV charging company has set up about 250 universal EV charging stations (mainly useful for E2-W and E3-W) across Maharashtra (36), Tamil Nadu (44), Telangana (48), Andhra Pradesh (23), Karnataka (23), Uttar Pradesh (15), Haryana (14), Odisha (24) and West Bengal (23) in Tire 1 and Tire 2 Cities. ATUM Charge has currently installed 4 kWh capacity solar panels that can charge 10 to 12 vehicles per day. The company also plans to install an additional 6 kWh capacity allowing it to charge 25 to 30 vehicles per day.

ATUM Solar Solution for EV Charging Station is based on 'ON GRID' System that is whatever units are produced by the Solar System is given in to grid (to the electricity company). So EV charging station provider or operator get credit of electricity units so generated and given to grid against the electricity he / she utilises for running EV charging stations. There no direct connect between capacity of solar panels and EV Charging Stations – EV Charging Stations can be of any type AC/DC or type 1, type 2 or type 3 or of any capacity ranging from 3.3 kWh to 100 kWh. What ATUM is providing is a Solar Power Generation solution to produce electricity to be supplied to Grid to get credit for the units so generated and sold to electricity company. This option will involve certain additional cost but at the same time it will reduce the electricity cost of running EV charging station for the service provider/operator and in larger context this solution will reduce the use of fossil – non-renewable based electricity and generation CO2.

ATUM CHARGE Models !

ATUM CHARGE - Different types of Models for Solar Powered Grid Connected systems.

ATUM CHARGE

Annexure-I

ATUM CHARGE – MODELS & ITS APPLICATIONS				
Capacity Models (kWp)	Solar Panels (325Wp)	Area required (Sq. fts)	Avg. Units Generates (kWh/year)	EV Charger Connectivity (AC/DC chargers)
1.3kW	4	100	1900	3.3kWx3 Plug Points, AC Charger
2kW	6	150	2800	3.3kWx3 Plug Points, AC Charger
2.6kW	8	200	3900	3.3kWx3 Plug Points, AC Charger
4kW	12	300	5600	3.3kWx3 Plug Points, AC Charger
5kW	16	400	7500	3.3kWx3 Plug Points, AC Charger
7kW	20	500	9300	3.3kWx3 Plug Points, AC Charger
10kW	30	700	14000	3.3kWx3 Plug Points, AC Charger
13kW	40	900	18700	15kWp (2nosx7.5kW) AC Charger
16kW	50	1100	23400	20kWp, CCS type-2 AC Charger

Figure 17: ATUM Charge - Solar Panel Models of Different types

Based on information provided by ATUM which is placed in Figure 18 and Figure 19 and with an assumption that the electricity company will purchase solar electricity so produced and supplied to the grid at the same rate from the EV Provider/Operator at which it is selling he/she.

The business / financial model of using Solar Panel for running EV Charging Station is worked out on the basis of information provided by ATUM regarding electricity generation by the different size of solar panels and the possible saving in the cost of electricity.

Figure 18: Cost of installing 1.3 kWh Solar Powered EV Charging Station of ATUM Charge

Table 23: Comparison of Business model of Conventional and Solar Panel Based EV Stations

Cost and Revenue Particulars	3.3 kWh X 3 – AC Type II 10 kWh Charger PCS without Solar Panel	3.3 kWh X 3 – AC Type II 10 kWh Charger PCS with 1.3 kWh Solar Panel	3.3 kWh X 3 – AC Type II 10 kWh Charger PCS with 4 kWh Solar Panel
Total Cost of the Device	50000	50000	50000
Solar Panel Cost	0	130000[13]	400000
Electricity Connection one time Cost	20000	20000	20000
Civil Work and other structural work	20000		
Total Capital Cost	90000	200000	470000
Maximum Dispensing Capacity per day Units	216	216	216
Number of Charging points	Three	Three	Three
Total maximum Units Consumed per day (16 hours working) (7 units per vehicle) (8 Vehicles)	162 (24 E-autos)	162 (24 E-autos)	162 (24 E-autos)
Total Units Consumed during the month	4860	4860	4860
Total Units consumed during the year	58320	58320	58320
Total units generated per month / per year	0	158/1900	474/5700
Annual savings due to Solar Electricity Panels	0	Rs. 11400	34200
Per unit cost (KSEB) (Rs.)	6	6	6
Sales (Charging) Price Per unit to User (Rs.)	12	12	12
Annual Income (Rs.)	699840	699840	699840
Annual Electricity cost	349920	338520	315720
Annual Maintenance Cost	10000	10000	10000
Payment Gateway transactions, software cost @2.5 % of the total income	17500	17500	17500
Land Lease Cost / Rent for land	-	-	-

[13] Cost given by ATUM Charge representative through mail.

Cost and Revenue Particulars	3.3 kWh X 3 – AC Type II 10 kWh Charger PCS without Solar Panel	3.3 kWh X 3 – AC Type II 10 kWh Charger PCS with 1.3 kWh Solar Panel	3.3 kWh X 3 – AC Type II 10 kWh Charger PCS with 4 kWh Solar Panel
Land cost – Revenue sharing mode @ Rs. 1 per unit of electricity consumed– as per Govt. Order	58320	58320	58320
Operating Cost per year	435740	424340	401540
Profit per year (Rounded off) (264000+11400)	264000	275400	298200
Profit per month	22000	22950	24850
Breakeven / Payback period (months)Normal EV	4 to 5		
Breakeven/payback period(month) Solar EV		9	19

It can be observed from the business/financial model regarding solar panel based /supported EV Charging Stations that using solar panels does not improve financial viability of EV charging stations, in fact as one goes for higher kWh solar panels financial viability goes down. This is because solar panel of 1.3 kWh costs Rs. 130000 and it saves 1900 units per annum means Rs. 11400 per annum which means payback period solar panel investment is of 11 to 12 years. If one goes for 4 kWh then it will cost Rs. 400000 and will result in to savings of 5700 units that is Rs. 34200 per annum which translates in to payback period of 12 years.

Beside lack of financial viability of setting up solar energy powered EV charging stations they are not getting set in India because of following additional reasons –

1. Not enough EVs in operation – this is the main reason for absence of conventional electricity-based charging stations (even though financially viable in working) in India as at present there is no enough business to run EV charging station commercially.
2. Space constraint – solar based EV Charging Stations will require large space which is not available easily in Metro Cities. Getting space is quite costly in Metro and A Class Cities.
3. The technology hasn't arrived yet - companies and start-ups are experimenting but no country around the globe has succeeded a fully-fledged solar power charging station for all types of electric vehicles catering to a mass population.

14. In Sum - Issues and Recommendations

Various business / financial models worked out regarding charging infrastructure and E-Autos clearly indicate that both EV charging infrastructure and E-Autos are financially viable and capable of providing very good rate of return on investment. In spite of financial viability of EV charging infrastructure and especially of E-Autos both at national/state and local city level are not getting adopted. In following sections various issues and recommendations are summarised -

14.1. Issues – Macro / Micro (at Kochi level)

14.1.1. Macro Level General and Specific Issues

Lack of charging stations, higher cost even after various demand subsidies, concerns about the durability of battery, unavailability of spare parts, and lack of service and support are the reasons for peoples in general reluctance towards owning e-vehicles. Lack of financing in terms of availability of loans for purchasing e-vehicles, high interest rates, high insurance cost, lack of specialised finance options etc. are the specific reasons for non-adoption of EVs and non-working of E-Autos. As a result of all these reasons / issues (which have been discussed in the report) even though Government of India and Various State Governments including Kerala Government have provided incentives (FAME II and State Schemes) to reduced upfront cost of EVs, adoption of EVs has been far from the target.

The Kerala state budget for 2019-20 had proposed to increase the number of e-vehicles to one million by 2022. As per the data with the Motor Vehicles Department, the state has around 7,850 electric vehicles in August 2021.

14.1.2. Issues at Kochi Level with regard to E-Auto adoption

This report about E-Autos and Charging Infrastructure in Kochi, confirms/ validates five main issues / reasons for non-adoption of E-Autos in Kochi –

First, **lack of special concession for E-Autos –** Compare to all other types of EVs, E-Autos have additional dimension of livelihood. E-4W or E2W are for private consumption, while E-Buses form public transport service run by the public (government) sector, but E-Autos form livelihood option for people (especially for lower income group and poor people). In this context E-Autos should get additional concessions as they are going to owned and operated mainly for lower income and urban poor people as a livelihood option. Unfortunate E-Autos get same kind of subsidy under FAME II and GoK subsidy for EVs. This is a very important policy lacuna which need to be addressed.

Two, **lack of charging stations especially for E-Autos –** even at present there are no public charging stations specifically for E-Auto. In fact, it can be noted that in Kochi KSEBL has set up 7 (seven) fast charging stations and there 4 (four) private fast charging station but even though it was most appropriate at none of these charging stations a slow charger for charging E-Autos has been provided. This clearly indicates how E-Autos are not consideration. This is also true about CNG based Autos as observed by scoping report prepared earlier in 2019 by GIZ which stated that because of lack of CNG filling stations there were non-adoption of CNG based Autos even though CNG based Autos profitability was double compare to Petrol/Diesel based Autos. This observation holds true today for E-Autos.

Three, **lack of avenues for financing E-Autos for public transport –** Public and Private Scheduled Banks are reluctant to provide loans for E-Autos because of the risks that are both real (e.g., uncertainty of resale value) and perceived (e.g., product quality). As a result, even if financing is available, EV buyers are unable to obtain terms (i.e., interest rates and tenures) that are comparable to ICE vehicles. Few NBFCs and financing arm of OEMs (Mahindra Finance) are providing maximum 30 to 36 months loan at much higher interest rates (14 to even 20 %). High interest rate, shorter loan period and difficulties getting loans are disincentivising people to go for E-Autos.

Four**, lack of institutional and risk sharing mechanism –** any new technology adoption requires going beyond the demand and supply subsidies/incentives through innovative solutions which can be different from place to place and case to case. Such solutions can be financial or non-financial but mainly of institutional cum risk mitigating support in initial phase to facilitate adoption of new technology. This fact is also true for adoption of EVs and especially for E-Autos. Such a support was envisaged under GIZ – KMC initiative (see appendix ---) of piloting 100 E-Autos in Koch but unfortunately due to Covid 19 pandemic and later due to some structural/institutional issues this initiative has not got implemented. There is need for such initiative and the initiative which has been contemplated can be and should implemented with suitable changes.

Five, **Non-Application / non-resourcing of NULM support -** E-Autos are different from other EVs – E-Autos are livelihood option, E-Autos can be very good source of livelihood. GoI with the help of the State and Urban Local Governments (KMC) is running National Urban Livelihood Mission to skill and provide viable livelihoods to urban poor. It is very much possible to provide subsidised loans under NULM for E-autos without any change in mission guidelines or operations. KMC could have used NULM for overcoming E-Auto financing issues. This source can be and should be used to support E-Auto adoption by urban poor as a livelihood.

14.2. Recommendations

14.2.1. Micro Level

Two recent reports of the Niti Aayog with Rocky Mountain Institute have been with regard to issues in financing of EVs and what needs to be done to finance EVs adoption in India. These reports have suggested measures (with which this report also agrees) which need to implemented at earliest as these recommendations are very pertinent.

1. Priority Sector Status for EVs

The first and foremost important recommendation is according priority sector status for EVs by RBI. The Reserve Bank of India (RBI) requires 40 percent of net bank credit to be deployed towards priority sectors. Inclusion of EVs in PSL guidelines would incentivise banks to increase lending towards the sector.

Segment	Use case	Case study
 Two-Wheelers	Goods delivery	Electric 2Ws used for goods delivery are cheaper on a TCO basis than ICE equivalents.[27] With battery-as-a-service business models, upfront costs are lower as well.
 Three-Wheelers	Passenger (auto rickshaw)	Electric autos are close to TCO parity especially in tier 2 and tier 3 cities where shorter distances require smaller batteries.[28]
 Cars	Passenger (taxis)	In the case of Delhi, electric taxis travelling 160 km daily can achieve payback against diesel taxis in 1.9 years and against petrol taxis in 2.8 years.[29]

Figure 19: Total Cost of Ownership Comparison for example segments and use cases[14]

There is a **need for Priority Sector Status for EVs** because though policy reforms are making EVs more economical than ICE vehicles on a total cost of ownership (TCO) basis for several segments and use cases (See Figure 20) the high upfront cost still presents a barrier, as illustrated in Figure 21. This is because contrary to ICE vehicles which receive more affordable financing, EVs get financing at high interest rates, short tenures on low loan-to-value ratios are putting a significant burden.

Priority sector status to EVs can address the lack of availability of finance. There is a strong case for EVs as livelihood-generating and supporting assets across urban as well as rural India, especially for economically weaker sections of society. Beyond enhancing accessibility that increases the opportunities for jobs/accessing markets, the operational cost savings resulting from use of EVs over ICE vehicles enhance the income of users to utilise for other avenues such as healthcare, education, food, or housing. With greater financing for EVs supplementing the supply side push from the central government, localisation will also increase, generating jobs in EV and related manufacturing. As an increasing number of aggregators moving towards electric fleets, the ride hailing and delivery use cases are also expected to see an increase in employment opportunities. Simultaneously, electric vehicles present vast benefits to society, such as:

E-3W	E-rickshaws and e-carts	Auto-rickshaws (passenger)	Carriers (delivery)
Socio-economic potential	High	Medium	High
Livelihood generation potential	High	High	High
Scalability	High	Medium	High
Techno-economic viability	High	Medium	Medium
Stakeholder acceptability	Medium	Medium	High
Remarks	E-3W ownership supports job creation but presents high asset and business model risk, which banks may be less receptive to financing. 3W financing currently is dominated by moneylenders; hence, PSL inclusion would be critical to scaling the sector. While EESL plans to lease e-3Ws in the near term, it will be important to build the financing capacity of the market simultaneously.		

Figure 20: Justifications for inclusion of E – 3W in the priority sector guidelines

[14] Niti Aayog and Rocky Mountain Institute – January 2022 - Banking on Electric Vehicles in India

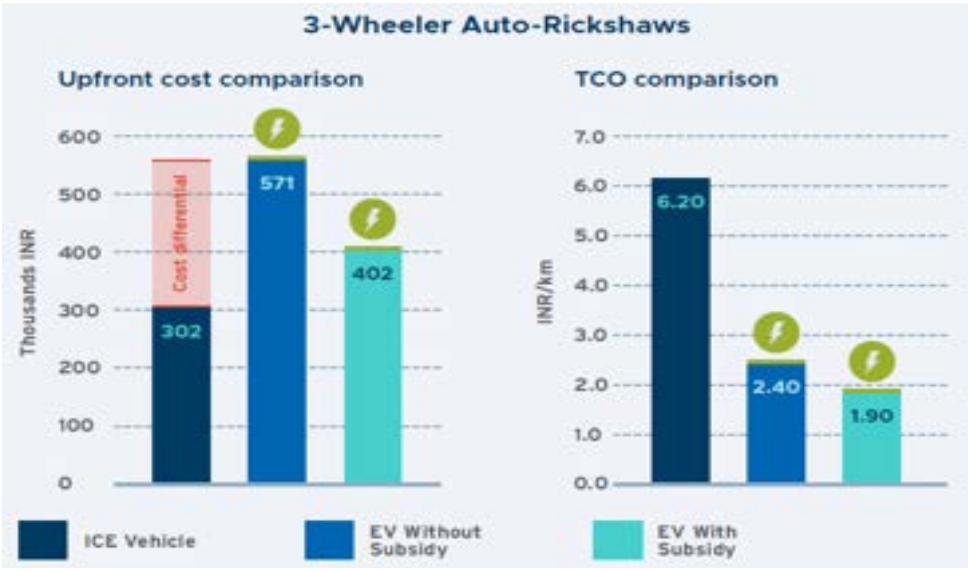

Figure 21: Upfront cost and TCO comparison for 3-Wheeler[15]

The Potential of PSL to Scale up EV Finance - PSL inclusion can be an important near-term solution to scaling EV finance in the following ways:

- **Incentivising banks to lend to EVs:** Inclusion can directly incentivise banks to enhance lending as a part of priority sector targets. Banks that have not yet ventured into financing EVs may consider doing so; banks that already finance EVs may be motivated to create specialised financing options with lower interest rates and longer loan tenures (e.g., SBI's Green Car Loan or Union Bank's Green Miles).34 Overall, a mechanism to encourage a higher supply of credit can motivate borrowers opting for informal sources of financing (e.g., e-auto rickshaw drivers) to seek bank financing.
- **Improving access to finance for NBFCs:** NBFCs will be important to expanding financing for EVs due to several factors. First, the vehicle finance market share of NBFCs has been increasing over the past five years, as illustrated in Exhibit 12. In 2016, NBFCs accounted for 43 percent of the formal vehicle financing market. By 2020, NBFCs had surpassed banks to account for 52 percent of market share. Second, NBFCs typically have a higher risk appetite and provide smaller pools of finance, many times in non-metropolitan areas. New fintech-based NBFCs have started enabling greater EV penetration in tier 2 and tier 3 cities. However, NBFCs have been facing a liquidity crunch since 2017 that has been worsened by the effects of COVID-19. This may translate to EV-first NBFCs struggling to access low-cost finance from banks. The PSL guidelines allow for co-origination of loans to the priority sector between banks and NBFCs.36 Both entities thus share risks and rewards. Through this "co-lending model," PSL inclusion for EVs could also benefit NBFCs, allowing them to leverage their greater on-ground presence while benefiting from banks contributing lower cost funds.
- **Institutionalising the importance of EVs in India's financial industry:** In addition to the direct impact of increasing formal supply of credit, constituting EVs as a priority sector can help institutionalise the asset class into the industry. As with any new regulation or provision, banks will be encouraged to build up their understanding of EV technology, policy, and business models. This will be important when considering that limited awareness of the EV industry has led to greater risk perception and thus underfinancing. Lending may be slower to pick up due to PSL inclusion, but the system-wide shift in mindset created could be a powerful catalyst in India's EV transition.

[15] Niti Aayog and Rocky Mountain Institute – January 2022 - Banking on Electric Vehicles in India

In 2019, public-sector banks led by State Bank of India (SBI) have requested priority sector recognition for retail lending to EVs. The Federation of Indian Chambers of Commerce and Industry (FICCI) and NITI Aayog have also advocated for the same as well.[16]

2. Interest rate subvention:
Subventions act as a subsidy on commercially offered interest rates, with the government bearing the balance through associated banks. Such schemes would substantially improve the affordability of loans. They have already been enacted in other sectors and at a state level for EVs in Delhi.

3. Product guarantees and warranties:
Reducing the uncertainty associated with EV models will improve their bankability. Original equipment manufacturers (OEMs) can provide assurances in the form of guarantees (to FIs) and warranties (to buyers) on the performance of their products.

4. Risk-sharing mechanism (government and multilateral-led):
Mechanisms and facilities that partly or entirely cover possible losses associated with financing EVs (due to their unclear resale value) can be capitalised at the national or multilateral level. These would distribute risk and provide FIs with an opportunity to build their trust in the sector.

5. Risk-sharing mechanism (fleet operator-led):
Fleet operators and final-mile delivery companies can leverage their existing FI relationships to provide partial credit guarantees and utilisation guarantees to driver-partners. They could share the risk between stakeholders in case of default and enhance loan availability for delivery drivers.

6. Secondary market development:
Industry-led buyback programmes and battery-repurposing schemes will help OEMs and the central government catalyse a secondary market for EVs. This would improve the residual value of EVs, providing FIs with an avenue for resale in case of borrower default.

7. Providing loans for E-Autos under Deendayal Antyodaya Yojana - National Urban Livelihood Mission (DAY-NULM)

Any adult urban poor (male or female) under Self Employment Program (SEP) of DAY-NULM can get maximum loan of Rs. 200000 from the bank for livelihood purpose at effective interest rate of 7 % (there is an interest subvention incentive so difference of interest above 7 % is paid by DAY-NULM to the bank or to the financial institutions directly.

Getting loan of Rs. 200000 without any collateral requirement at 7 % would mean monthly interest cost going down by half. For example, EMI of Rs. 200000 loans at 7 % interest under SEP of DAY-NULM will be Rs. 6175 against EMI of Rs. 6840 at the 14 % interest rate that is every month income of E-Auto owner-driver will go up by Rs. 650.

Lower interest will motivate urban poor / beneficiary to take E-Auto loan but the main benefit of loans under DAY – NULM will be availability of the finance or a loan which at present is not available particularly for E-Autos. This is because for any E-Auto loan given, banks can approach Credit Guarantee Fund Trust for Micro and Small Enterprises (CGYMSE) or any other appropriate Guarantee Fund for the purpose of availing guarantee cover for SEP loans as per the eligibility of the activity for guarantee cover. Such a guarantee covers to loans given for E-Autos will take away non-performing assets (NPA) apprehension of the banks in giving loans for E-Autos and will motivate banks to provide such loans.

Loans for E-Autos are fully admissible under DAY-NULM, but only fact is that this route is not approached because neither urban poor knows such loan can be availed for E-Auto, nor ULBs and DAY-NULM functionaries/units which function under ULBs knows that such loans can be given. For example, even Kochi Municipal Corporation which has a DAY-NULM unit functioning under its control, still has

[16] "FICCI Urges Govt to Extend FAME-II Scheme Till 2025 to Boost Electric Vehicle Demand," Press Trust of India, News 18, July 04, 2020, https://www.news18.com/news/auto/ficci-urgesgovt-to-extend-fame-iischeme-till-2025-toboost-electric-vehicle-demand-2698069.html; and "NITI Aayog Reviews EV-related Policies, Recommends Bringing Financing Under Priority Sector Lending," Money control, August 24, 2020.

not tried to give E-Auto loans to urban poor under DAY-NULM. Even at present KMC can dovetail DAY-NULM loans for proposed GIZ-UN Habitat initiative to make 100 E-Autos operational in Kochi.

Beside these seven targeted recommendations regarding financing of EVs there is need to undertake following additional measures as suggested by Niti Aayog's report –

8. Inclusion of EVs as an infrastructure sub-sector:

The Harmonised Master List of Infrastructure Subsectors, compiled by the Department of Economic Affairs, Ministry of Finance, provides financing and taxation benefits to predetermined subsectors in order to lower cost of credit and improve flexibility for investors.

Inclusion of electric mobility as an infrastructure subsector would create an enabling environment for large investments in the sector such as EV and battery manufacturing, charging infrastructure deployment, and electric bus rollout. With greater availability of financing upstream, the capital cost associated with EV ownership can be lowered, improving the economic viability and affordability of EVs.

9. Inclusion of EV loans as a reporting category:

Currently, no data is available regarding number of EV loans advanced, outstanding advances, or NPAs. This information asymmetry in the industry is a barrier to understanding financing patterns and thus improving the flow of finance. To solve this problem, RBI can incorporate EV loans as a unique reporting category under personal loans in the Basic Statistical Returns (BSR).

14.2.2. Micro / Kochi Level / City Level Recommendations

Government of India and State Governments including Kerala Government has taken various initiatives for faster EVs adoptions, still there is need to undertake macro level various reforms discussed in earlier section. Beside macro level there is a need to undertake following actions specifically for faster adoption of E-Autos in the Kochi city and for that matter in city by the urban local body and other local offices various state government agencies like state electricity board, state and city level transport authorities etc.

First, provide additional subsidy for E-Autos – As discussed earlier E-Autos are different class of EVs, they can be very good source of livelihood for lower income group and urban poor people. Adoption of E-Autos is not only important from point of environment and climate change but it is important from livelihood aspect also, so GOI, GoK should provide additional subsidy for E-Autos. KMC has taken a step in this direction of providing Rs. 50000 subsidies for E-Auto, which is really commendable[17].

Second, **set up and make operational charging stations for E-Autos –** KSEBL has planned to set up 1140 Electric Pole mounted mini public charging stations in the entire Kerala State and 39 mini stations in the Kochi – Ernakulam circle (125 in Kochi/Ernakulam District) but till date no such public charging stations for E-Auto have been set and become operational. As discussed in the report such mini charging stations are easy to set up and use, require very less cost. The business model workings provided in the report show that such mini charging station will not cause any financial loss to the provider, but private provider may not set up such charging stations as there are not much E-Autos in the City, but government agencies like KSEBL and KMC should take lead to provide such mini-charging station which will create a confidence in public that if E-Auto or EV is purchased there will be no problem regarding charging of it. KSEBL should decide these pole mounted charging points in consultation with KMC, Traffic Police and KMRL. Also, KSEBL and all other Public and Private players should adopt a policy and practice of compulsorily installing/providing a slow charger for charging E-Autos whenever and wherever fast charging stations is set up.

Third, **create avenues for financing E-Autos for public transport –** It is a fact that Public and Private Scheduled Banks are reluctant to provide loans for E-Autos because of the risks that are both real (e.g., uncertainty of resale value) and perceived (e.g., product quality). To overcome this issue Kerala Government has planned to provide loans through state financial agencies, this decision should be

[17] In stakeholder consultation **Mr. P.R. Ranish (Chairman, Development Committee)** stated that there is a proposal (which when approved from the Council) will enable E-auto buyer to receive a total subsidy of INR 75000 including INR 50000 from the Corporation under plan funds and INR 25000 from the state government. The FAME-II subsidy will be additional to this subsidy.

implemented at earliest. KMC can take lead to have discussions with the banks, NBFCs and other government financing agencies to reduce their risk perceptions and to work out joint informal mechanism to ensure recovery of loans given for E-Autos.

Fourth**, innovative institutional and risk sharing mechanism –** KMC has rightly contemplated with the help of GIZ and other stakeholder an innovative project of piloting 100 E-Autos in Kochi which need to be taken to logical end with necessary suitable changes at earliest. If 100 E-Autos or even if a smaller number of E-Autos become operational under this initiative it will have sizeable positive demonstrative effect on E-Auto adoption. It is the view of this report that the proposed initiative can be improved by going for individual ownership of E-Auto to claim all types of incentives and subsidies under various scheme with a strong institutional, logistic and risk sharing support from the KMC and the Auto Drivers Society.

Fifth, **Avail NULM Framework and Resources -** E-Autos can be very good source of livelihood specially for Urban Poor. GoI with the help of the State and Urban Local Governments (KMC) is running National Urban Livelihood Mission to skill and provide viable livelihoods to urban poor. NULM framework and resources can be used to overcome bank financing issue plugging E-Autos. KMC has all powers to use NULM framework and resources to provide loans and other support to urban poor to own and adopt E-Auto as a livelihood option. This source should be used in a big way to support E-Auto adoption by urban poor.

15. Appendix 1 – Charging Stations for EV – Guidelines and Standards

The Ministry of Power originally issued these guidelines in 2018, and it was revised in October 2019. Then in 2020, the Ministry of Power had issued an amendment to its guidelines and standards for the charging infrastructure of electric vehicles (EVs). Recently it has issued consolidated final guidelines in January 2022 which aim to enable faster adoption of EVs in India by ensuring safe, reliable, accessible, and affordable charging infrastructure and ecosystem. Another objective is to provide affordable tariffs for charging station operators/owners and EV owners and proactively support the creation of EV charging infrastructure. The new guidelines also aim to promote energy security and reduce the emission intensity in the country.

15.1. Public charging stations

As per the new guidelines, owners may charge their EVs at their residences and offices using their existing electricity connections. An entity will be free to set up public charging stations provided such stations meet the technical, safety, and performance standards and protocols laid down by the Ministry of Power, Bureau of Energy Efficiency, and Central Electricity Authority.

The public charging station may apply for electricity connection. The distribution licensee will provide the connection for EV public charging station according to the timelines stated in the Electricity (Right of Consumers) Rules, 2020.

As per the new guidelines, public charging stations will be provided with connectivity within seven days in metro cities, 15 days in other municipal areas, and 30 days in rural areas.

The public charging station will be required to have a tie-up with at least one network service provider to enable advanced remote/online booking for charging slots by EV owners. EV owners will have access to information regarding location, types, the number of chargers installed/available, and service charges of EV charging on the booking platform.

Also, the EV Supply Equipment (EVSE) should have been tested by an agency or lab accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL). Captive charging infrastructure for 100% internal use for a company's own or leased fleet will not require installing all types of chargers and having network service provider tie-ups.

15.1.1. Open access power for public charging stations

According to the new guidelines, the public charging stations can procure power from any generating company through open access. Open access will be provided for this purpose within 15 days of receipt of the application. They will be required to pay the applicable surcharge – equal to the current level of cross-subsidy (not more than 20 percent, as per the Tariff Policy Guidelines), transmission charges, and wheeling charges.

15.1.2. Public charging infrastructure for long-range EVs and heavy-duty EVs

Fast charging stations for long-range EVs and heavy-duty EVs (like trucks and buses) will have at least two chargers of a minimum of 100 kW (200-750 V or higher), each of different specifications (CCS/CHAdeMO for above capacity or BIS standards for bus charging station) with single gun connector each. The charging stations will also have appropriate liquid-cooled cables for a high-speed charging facility for onboard fluid-cooled batteries (for long-range EVs).

Fast charging stations for 100% in-house and captive utilization would be free to decide the charging specifications between two charging points.

15.1.3. Location of public charging stations

At least one charging station will be available in a grid of 3*3km. Further, one charging station will be set up at every 25 km on both sides of the highways.

There will be at least one fast-charging station with charging infrastructure at every 100 km, one on each side of the highways for long-range and heavy-duty EVs.

Also, the central and state governments may prioritize existing retail outlets of oil marketing companies to install public charging stations to meet the listed requirements.

15.1.4. Tariff for the supply of electricity to EV public charging stations

The tariff for electricity supply to public charging stations will be a single part tariff and will not exceed the average cost of supply until March 31, 2025. The same tariff will be applicable for battery charging stations.

Also, the tariff applicable for domestic consumption will be applicable for domestic charging. There will be a separate metering arrangement for public charging stations so that the consumption may be recorded and billed as per the tariffs for EV charging stations.

The DISCOMs may leverage funding from the revamped distribution sector program for the general upstream network augmentation necessitated due to the upcoming charging infrastructure in various areas.

15.1.5. State governments to fix the ceiling of service charges

As electricity is being provided at concessional rates and the central or state governments are giving subsidies for setting up public charging stations, the state government will fix the ceiling of service charges to be levied by such charging stations.

15.1.6. Provision of land for public charging stations

As per the new guidelines, land available with the government or public entities will be provided to install public charging stations to a government or public entity on a revenue-sharing basis at the fixed rate of ₹1 (~$0.0135)/kWh.

15.1.7. Priority for the rollout of EV charging stations

The public charging stations will be rolled out in the following phased manner:

Phase I (1 to 3 years): In all megacities with a population of more than four million, all existing expressways connected to these megacities and important highways connected with each of these megacities will be taken up for coverage.

Phase-II (3-5 years): Big cities, state capitals, and headquarters of union territories will be covered for distributed and demonstrative effect. Highways connected with these megacities will be taken up for coverage.

15.1.8. Implementation mechanism for rollout

The Bureau of Energy Efficiency (BEE) will be the central nodal agency for EV public charging infrastructure rollout. All relevant agencies, including CEA, will support the central nodal agency.

Every state government will nominate its own nodal agency for setting up the charging infrastructure. The state DISCOM will be the nodal agency for such a purpose.

16. Appendix 2 - GIZ – UN Habitat – KMC joint initiative – Launching e-Autos18 in Kochi

GIZ and UN Habitat are collaborating with Kochi Municipal Corporation and six auto rickshaw unions to provide subsidy of 500 Euros per E-Auto to get 100 E-Autos running in Kochi City. In this GIZ will provide subsidy for 80 e-autos while UN Habitat will provide subsidy for 20 e-autos. Both GIZ and UN Habitat will provide subsidy funds to Kochi Municipal Corporation which will then pass on to Auto Drivers Society.

For this initiative six auto rickshaw unions (trade unions) have come together and have formed Auto Drivers Society under Co-Op Societies Act. Any member of trade unions can become a member of Auto Drivers Society. Auto Drivers Society is managed by a board of six members elected by the members of the Society. Though the Society formed is a collective of six trade unions, at present it has more representation of CITU.

This initiative was conceived in the year 2018-19 and in the second part of the year 2019 project scoping study with field survey was carried out. The findings and recommendation of the detailed scoping study were as follows –

- 70: 30 was the ratio of self-owned vs rented autos
- Around 79 % of the total surveyed auto drivers were using diesel as fuel
- Average Km travelled per day 86 to 99 kms
- Average passenger per day 62 to 66
- Average Earnings per day Rs. 663 to Rs. 900
- Average Fuel Cost per day Rs. 217 to 237
- Average Rental Cost per day Rs. 240 to 275
- It can be observed from the table A2.1 that a self-owned auto driver earns higher than an auto driver operating on a rental model even after EMI.

Table A2.1 – ICE Auto Operation Financials for Existing Autos (Rs. Per month)

Particulars	Fort Kochi Area	Kadavanthra Area	Panampilly Area
Earnings (A)	17732	23400	17238
Fuel Cost (B)	5980	6162	5642
Maintenance Cost (C)	806	754	676
EMI for Self-Owned (D)	4660	4660	4660
Total Cost (E = B+C+D)	11446	11576	10998
Net Surplus (for Self-Owned Auto) (A – E)	6286	11824	6260
Rental Cost (for rented Auto) (F)	6240	7150	7500
Net Surplus (for Rented Auto) (E + R – D)	5512	10088	5096

The scoping study also worked out financials for the autos including e-rickshaw using different fuels (see Table A2.2) which indicates higher profitability of CNG and Electric Autos. Scoping study further concluded that in Fort Kochi area is environmentally sensitive, the average trip distances are shorter, and there exists service gap, so switching to e-autos could double income of auto drivers in Fort Kochi area. It also made one very important conclusion that is CNG auto earns almost double his diesel or petrol counterpart and perhaps the only reason stopping rapid switchovers to CNG is the poor CNG fuelling pumps network in Kochi. For the drivers in CBD area, the switch to a CNG auto makes more sense as CNG would provide range flexibility and hence he would not be incentivized sufficiently to move to electric.

[18] Report suggested E-Auto in place of E-Rickshaw

Table A2.2 – ICE Auto Operation Financials for Existing Autos Drivers based on Fuel Type

	Diesel	CNG	Petrol	Electric in Fort Kochi **
Earnings (A)	**17992**	**23946**	**17082**	**17628**
Fuel Costs (B)	5902	6032	6266	780
Maintenance Costs (C)	858	702	520	500
EMI (for self-owned) (D)*	4660	5147	4500	4840
Total Costs (E=B+C+D)	**11420**	**11881**	**11286**	**6120**
Net surplus (For self-owned) (A-E)	6572	12065	5796	11508
Rental (For Rented autos) (R)	6318	7462	-	6500
Net Surplus (for Rented) (E-B-R)	**5772**	**10452**	**-**	**10348**

(All units in Rs/month)

**Amortization of Down Payment (Equity) to avail the loan is not drawn into analysis as it can be set off against resale value / salvage value of the vehicle.*

*** **Estimates for a Fort Kochi Diesel auto switching to Electric**. Average income of Fort Kochi Diesel auto drivers doing less than 90 km per day used as Earnings. Capital Cost for the E auto is assumed at Rs. 1,75,000 per vehicle, available at down-payment of 20% (Rs 35,000) and loan for 36 months at 10% pa. Rent of Rs 200 per day assumed under rental model. Battery is expected to last 36 months during the period of loan. Charging cost @Rs 50 per day (90 km per day will require 6 kWh @15 km /kwh x Rs 7.5 per kwh commercial rate). The model does not account for any loss of business due to downtime for charging as full charge is likely to be done overnight followed by top ups as required during lean hours.*

Scoping study report examined four models for introducing and enhancing e-auto operations in Kochi

1) Only charging and parking infrastructure to be provided by the government
2) Rent Model where OEM provides autos for operations (as Kochi Metro initiative with Kinetic
3) OEM / Aggregators operate their own e-autos in cluster
4) A Society of Auto Drivers procures e-autos through subsidy as down payment and KMC provides land for parking. A society then has two options one, to rent e-auto to the auto driver members of the society and two, society employs auto drivers on a monthly salary.

Report recommended fourth option and then provided detailed financials for two sub-options – renting e-autos to driver members of the society and employee driver members of the society to run e-autos. It can be observed from the Table A2.3 and Table A2.4 that under rental model society is likely to generate surplus of around Rs. 2150 per auto per month. Under employment model if society pays Rs. 8000 per month to Auto it can generate a higher surplus of Rs. 4000per auto per month. For 25 autos it could generate Rs. 50000 to Rs. 100000 which could be used to hire a manager and meet other administrative expenses of the scheme.

Table A2.3 - Estimate of Financials for Society Under Rental Model

Particulars	Estimate (Rs)
Capital Cost of E Auto at FAME II prices	160,000
Subsidy /Down Payment for loan	25,000
Loan Amount	135,000
Interest Rate for loan (% pa)	10%
EMI on loan (36 months) (A)	4356
Rental per day per auto (Rs)	250
Earning of Society through rentals (Rental per day x 26 days) (B)	6500
Net Surplus to Society (B-A)	2144

Table A2.4 - Estimate of Financials for Society Under Employee Model

Particulars	Estimate (Rs.)
Earnings per month	17628*
Charging Cost @Rs. 30 per day (90 km per day will require 6 kwh@FE of 15 km /kwh x Rs 5 per kwh) for 26 days	780
Maintenance cost pm	500
Driver Salary	8,000
EMI on loan	4356
Net Surplus to Society per Auto	4000

On the basis of scoping report GIZ, KMC, and workers unions decided to go for a model in which a Society of Auto Drivers will procures e-autos through subsidy (GIZ/UN Habitat) as down payment and KMC will provide a land for parking. Two other factors also supported this option –

a. Due to low CIBIL scores of 95% drivers, banks were hesitant to provide loans to drivers. Even if they provide loan, it will be for short duration 30 to 36 months as a result banks will charge high interest rates which will make repayment difficult. Auto Drivers society will form a single point of accountability and will make it easier to secure a loan at reasonable interest rate
b. Auto Drivers Society will also form a single point of contact for consumers. It will also facilitate integration and aggregation of E-Auto drivers to create a digital platform and enable digital payments. Such society will make it easier to implement further initiatives.

This initiative which was to go operational by March 2020 got delayed because of pandemic. At present following is the course of action this initiative has envisaged / and by end by July 2022 it has achieved following progress -

- The Society will own all 100 electric vehicles, will receive subsidy from KMC, will take loan from the financial institutions/banks, will undertake charging and maintenance of these vehicles and will rent out these vehicles to the members of the society on basis of daily/ monthly fixed rent.
- Currently the Society is planning to operate the vehicles in 2 shifts of 12 hours. The Society will rent of E-Auto to its members for a rent of Rs 300 per shift (rent has been arrived on basis of Rs. 175 loan cost, Rs. 40 GST, Rest battery and vehicle maintenance cost). If the model works well and more drivers show interest to take part in the initiative, then the shifts will be increased to 3 (each shift of 8 hours).
- The Society has selected swappable E-Autos manufactured by Piaggio. The cost of one vehicle is around 2.4 Lakhs exclusive of GoK subsidy which is Rs. 30000 and Rs. 50000 will be donor (GIZ, UN Habitat) subsidy thus net cost of a E-Auto will be Rs. 1.6 lakhs. This being Swappable Battery model it will not get FAME II subsidy.
- Sun Mobility will set up five Bulk Charging Stations to serve swappable battery E-Autos procured by the Society and others.
- The loan for the project is still under process and they are waiting for approval. A total sum of 1.57Cr. has been agreed by SBI to be loaned to the society for the project with 11 per cent interest for a period of 5 and half years.
- As part of this initiative a subsidy of Rs. 50,000, a total of Rs. 67 Lakh will be contributed by the donor agencies.
- It is yet not decided but KMC may provide parking place for this initiative.
- GIZ will partly fund the setting up of the Charging Stations / points in collaboration with Kerala State Electricity Board (KSEB). A 1400 KV sub stations will have to be set up to support the project.

17. Appendix 3 – Stakeholder Meeting in Kochi (Minutes of Meeting)

ICLEI SA's initiative – Financial feasibility assessment of Electric 3-Wheelers and charging infrastructure in Kochi

17.1.1. Background and Introduction

The Government of Kerala has been making efforts to mainstream electric mobility since the past few years. The Kerala EV policy was approved and notified by the Transport Department of Kerala on 10th March 2019. The policy targeted to register 1 million EVs by 2022 and pilot fleet of 200000 2W, 50000 3W and 1000 goods carriers, 3000 buses and 100 ferry boats, it further included inclusion of 6000+ E-buses by 2025. The policy included investment targets and create employment opportunities in EV/EV parts manufacturing. The grid baseload, electrification of 3W and buses as priority and other strategic initiatives for creating charging infrastructure, addressing viability gap, awareness and capacity building are also mentioned in the policy.

However, to achieve any realistic transition towards zero-emission vehicles, cities need to play important roles. It is known that a majority of cities in general lack the capacity and extensive experience related to electric mobility at present. There is a need to focus on long term actions and ways to sustain the existing push by the Government and other stakeholders for a sustainable transition to EVs.

Kochi is working proactively towards electrification of vehicles through inclusion of 18 Electric freight vehicles (3-wheeler) and 100 E-rickshaws in the mobility ecosystem.

In the above context, a stakeholder discussion was organised on 21st July 2022 at 10:00 am to 11:30 am at the Council Hall, Kochi Municipal Corporation, by the Kochi Municipal Corporation and ICLEI South Asia. The meeting focused on discussing the need for a **long-term planning** for transitioning towards EVs, study and outcomes of **financial feasibility assessment of Electric 3-Wheelers and charging infrastructure in Kochi** and further discussion with the stakeholders.

The discussion with Hon'ble Mayor focused on the possibility of integration of pilot - 18 E-Auto (freight) with the Samriddhi Scheme, including freight vehicles in the parking policy, KSEB developing charging points along with the project of supporting cities in India to take leadership on EVs and Financial feasibility of e-autos. Hon'ble Mayor stated that the E-2W are more preferred by the private users and since the technology is volatile, the users are reluctant to buy an EV due to high upfront cost. He also mentioned that the KMRL may include E-buses while KSEB is developing the charging stations.

Thirty-two participants attended the meeting which included the Adv. M. Anil Kumar (Mayor, KMC), Ms. K.A. Ansiya (Deputy Mayor, KMC), representatives from other government officials (Cochin Smart Mission Limited (CSML), Kerala State Electricity Board Limited (KSEBL), Agency for New and Renewable Energy Research and Technology (ANERT), Kochi Metropolitan Transport Authority (KMTA), Kochi Metro Rail Limited (KMRL), Kleen Smart Bus Limited (KSBL), Regional Transport Office (RTO) and LSGD Planning, Ernakulam), representatives from C-HED and private sector representatives (Piaggio Vehicles Pvt. Ltd., SYSTRA, GIZ, Ernakulam Jilla Auto-Rickshaw Drivers' Co-Operative Society (EJADCS) Ltd. and the Indian National Trade Union Congress (INTUC)) and ICLEI team including Mr. Ashish Rao Ghorpade, Mr. Vijay Saini, Ms. Nandini Shandilya and Mr. E.M. Sooraj.

The meeting started with a presentation by Mr. Ashish Rao Ghorpade and Dr. Ravikant Joshi followed by the discussion with officials. The main points of discussion were as follows:

Mr. Ashish Rao Ghorpade(Deputy Director, ICLEI South Asia) introduced the project with key focus on following points:

- Project's background and the existing status of EV deployment in India
- Need for a long-term approach/ roadmap/strategy
- Strategies related to electrification which a city may adopt for transitioning towards EVs.
- Discussion on IPT Electrification and financial feasibility of the same.

Dr. Ravikant Joshi discussed on the financial feasibility assessment of Electric 3 Wheelers and Charging Infrastructure in Kochi with a focus on the following:

- Fixed vs swappable battery in E-autos
- Economic comparison of types of EV charging station options which a city may adopt as per their requirements.
- Present status of E-autos and charging stations in Kochi.
- Issues and recommendations (Micro and macro level for the city)

The officials provided following insights on the above discussion:

Mr. Gokul T.G (Senior DGM, KMRL) discussed about ongoing initiatives related to electric mobility in the state and focused on the following points: -

- Kozhikode and Malappuram have larger number of EVs registered as compared to Kochi which may be due to favourable topographic features in those cities.
- Lack of demand-based analysis is a major challenge in EV transition.
- Lack of strategy to finalise the locations of charging stations being setup by the KSEB. Spatial analysis should be a part of finalising the charging locations.
- Charging points have been developed at some metro stations also.
- Lack of clarity on Commercial General Liability (CGL) which is related to the cost of the vehicle at the end of 5 year. There is a need to anticipate this cost to create a second-hand market for EVs.
- The life of fuel-based vehicle is usually 15 years but the warranty attached to EVs is around 3 years, extending the life of EVs may encourage more users to shift to the same.
- FAME II subsidy is not available if the government is procuring the vehicles even for commercial purposes.

Mr. Clipson Mathew (DGM, CSML) mentioned the following points: -

- Charging infrastructure is being developed for EVs which is being integrated in smart roads.
- About 1600 charging sockets are being installed at the electric poles where the chargers can be used to charge the EVs
- CSML is preparing tenders to replace push carts by E-rickshaws which are targeted to be operated by female drivers. Capacity building and eligibility (licence for driving vehicles) is a concern.
- CSML wish to procure electric vehicles with speed more than 20 kmph, which may have a mandate to be registered, this requires more understanding.
- KSEB has the role to develop supporting electricity supply infrastructure for expected rise in demand with EV rise. The production may have to be increased from 4kW to 7kW.

Adv. M. Anil Kumar (Mayor, KMC), acknowledged the need of KSEBL to focus on the expected rise in electricity demand and cater through generation and also emphasised on the need of updation of master plan by the planning department by including EV charging infrastructure location.

Ms. Sunitha Jose (EE, KSEBL) responded to the above points as follows:

- 1000 charging stations for E-autos (to be installed at street poles in Kerala), 10 locations identified in the city including the KMC, High Court, KSEB, open stadium, etc. The design of these poles has to be finalised.
- The locations of these charging stations can be changed as per the demand for charging infrastructure if required.
- 32 public charging stations have been developed in Kochi.

Mr. P.R. Ranish (Chairman, Development Committee) stated that there is a proposal (which when approved from the Council) will enable E-auto buyer to receive a total subsidy of INR 75000 including INR 50000 from the Corporation under plan funds and INR 25000 from the state government. The FAME-II subsidy will be additional to this subsidy.

Mr. P.M Shabeer (RTO, Motor Vehicles Department)

- Major challenge in EV adoption is lack of confidence in EVs.
- Currently E-autos are owned by corporate and bulk owners but the number of individual owners is almost nil.
- Option of retrofitting may be more suitable for individual owners of E-autos as the cost will be comparatively less and subsidy can be provided if required.
- The diesel autos are not allowed to operate after 15 years of operation, these can be converted into EVs. This will help in building confidence in buyers and users.
- According to the registration trends, the number of E-2 wheelers registered is very high, number of E-autos registered for commercial purpose is very less and E-4 W numbers are also not high (maybe due to high upfront cost).
- A chain of connected charging stations can encourage users to shift to EVs.

Mr. Ashish Rao Ghorpade (Deputy Director, ICLEI South Asia) emphasised on the need of clarity related to EV policy and its implementation. The organisations helping the city in procuring EVs should interact and improve the capacity of the city related to EVs.

Mr. Simon Edapally (Director Board Member, EJADCS) and Mr. Binu Varghese (Director, EJADCS) stated the following points:

- EJADCS is working towards upliftment of quality of life of auto drivers.
- In 2016, KMRL had floated a contract for 16 E-rickshaws which were operational in the city for 2 years and their operation was stopped after the duration of 2 years. There is a lack of even feeder autos in the city.

Mr. G.P Hari (Executive Officer, KMTA) mentioned the following points:

- Kochi Connect Limited is incorporated, aggregation of 3 IPT Modes (vans, taxis and autorickshaws) are clubbed in a single company and its ownership will be transferred to the citizens and union of vehicles in Kochi.
- One of the major challenges in electric bus operation is that the fare is fixed. The fares of metro can be regulated/changed by them whenever they require but the revision of fares of the government buses in the city require prior approval from the government. He suggested that the fares of E-buses can be kept dynamic and the operators may be allowed to change it as per their need, atleast in the KMTA area.
- The voltage fluctuations in electricity supplied to poles where EV chargers are planned to be installed may damage the EV batteries.
- The locations of charging points should be finalised considering the availability of space for parking the vehicles.
- Roadside parking is not allowed in the city so there is a need to identify the rule/notification for parking and charging at these roadside pole charging points.
- Increase in number of EVs will increase the electricity load as majority of EV owners may prefer domestic charging (at home). Grid readiness is an important consideration.

Ms. Sunitha Jose (EE, KSEBL) responded to the above points as follows:

- The existing electricity demand is 50% to 60% of the load at transformer, so increase in electricity demand may not create an issue as domestic charging is from slow charger.
- No separate meter required for domestic EV charging i.e. at residences, no separate tariff.
- The transformer will be required to be updated for supplying electricity to fast charging stations.
- Tariff of electricity for charging EVs should be dynamic i.e. more during the peak hours.
- The tariff for charging e-autos from KSEBL pole charging points is INR 7-10/unit.

Mr. Clipson Mathew (DGM, CSML) mentioned the following points:

- Renewable energy may be useful to cater to the expected rise in demand for electricity.
- Smart grid is inevitable, there is a need to understand the experiences related to the same.

Ms. Haseena C.H. (Deputy Town Planner, LSGD Planning, Ernakulam) stated that LSGD planning has included charging stations at different part of the city.

Dr. Ravikant Joshi

- Mentioned the example of Maharashtra where there is a separate incentivised tariff for domestic EV charging also to which Ms. Sunita Jose responded that there is no such provision in Kochi at present.
- Suggested to include slow charging for e-rickshaws/e-autos in KSEBL proposal to setup charging points at locations where there is space available for parking these vehicles to which Ms. Sunita Jose agreed.

Mr. Gokul T.G (Senior DGM, KMRL) mentioned the following points related to tariff for charging EVs:

- Maximum tariff which a government charging operator can charge for slow charging is INR 10.5/unit and INR 15/unit for fast charging (if the electricity is from KSEBL)

Dr. Ravikant Joshi suggested that the private operators should also have separate electricity connection for slow and fast chargers and separate tariffs for both.

Mr. Manoharan .J. (Head, E-mobility division, ANERT) mentioned the following points:

- The battery warranty is a concern in case of fixed battery EVs and not in the case of EVs with swappable batteries.
- Gradeability is one of the major problems in EVs.
- In Kerala, there are about 60 charging stations powered by Solar, these have a payback period of around 6-8 years. Subsidy is also provided to the developer for installing solar panels.
- If the government is willing to invest in RE based charging stations, then ANERT can also consider investing in the same.

Mr. Gurusyam V.S. (A.S.M- Kerala and Tamil Nadu, Piaggio) mentioned the following points:

- Piaggio E-3W have been supplied to some cities under Swachh Bharat Mission.
- Fear and anxiety of users related to the after use of batteries (after 1200 cycles), for which the dealers also don't have any solution currently but can be addressed with time.
- The option of changing the damaged cells in the battery instead of entire battery is being provided by the manufacturers.
- Raised concern over the safety issue of charger during rainy season, which are being planned to be installed on poles.
- Need for awareness of consumers related to the locations of charging points in the city. Communication and awareness are an important aspect of EV transition.
- The reason of a greater number of EVs in Malappuram and Kozhikode is that the majority of users have witnessed/used the same technology abroad and are comfortable to use it here also.
- In ICE based vehicles, about 70%-80% vehicles are purchased by existing ICE based vehicle or someone who has already used it, while in case of EVs (E-Autos) about 60% of the buyers are first time users (FTUs) who buy it to experience its operation.
- Sometimes people defer from buying EVs due to lack of confidence related to performance and safety.
- Raised the issue of high land rent for swapping station developers and also the tedious process of seeking approval from KSEBL for supportive transformer capacity.
- Suggested that the government can also consider an option of providing preferred spaces for EV swapping/ charging stations as Indian railways are providing.

Mr. Ashish Rao Ghorpade (Deputy Director, ICLEI South Asia) acknowledged the need for a two-way discussion between the private stakeholders and the city.

Dr. Ravikant Joshi suggested that the salvage value for ICE based vehicles and EVs should be same. The manufacturing company can announce a guarantee stating the approximate salvage value which can be decided by the OEMs. Usually the warranty of the battery of EV is 3 years so the life of EVs is also considered as 3 years, inspite of the fact that the body may still be usable.

Mr. Gurusyam V. S. (A.S.M- Kerala and Tamil Nadu, Piaggio) responded to the above points as follows:

- The resale market is already in place for ICE based vehicles but the same market for EVs is still developing so the banks also provide funding for 3 years, same as the warranty of 3 years.
- The manufacturers are partnering with local manufacturers which are offering purchase cost of batteries after 3 years.
- The project for possible solutions for utilising the body of the vehicle is also under consideration.

Ms. K.A. Ansiya (Deputy Mayor, KMC), appreciated the project. She is a part of Auto operators' family so was happy to join for the discussion on transport activities.

Ms. Adv. Priya (Chairperson, KMC) expressed her gratitude and mentioned the following points:

- Cities have to look forward to the sector of E-mobility and its integration. An SPV is being formulated in Kochi.
- Maintenance of E-autos is a concern which needs to be addressed as the KMC is planning to procure about 100 e-autos under a project in association with GIZ.
- Training and awareness are an important aspect to encourage people to transition to EVs.
- CSML indicated that they are planning to procure e-tricycles to be operated by females but licencing is an issue but the female drivers are already being trained under the Kudumbashree initiative so this concern may be resolved.
- Parking space may be a concern where KSEBL is planning for charging points at poles. KSEBL responded to this by mentioning that the charging points are being installed at the auto parking areas for E-autos.

The discussion was concluded with a vote of thanks and way forward for EVs in Kochi

17.1.2. Picture gallery

Glimpses of meeting with Adv. M. Anil Kumar (Mayor, KMC)

Glimpses from the stakeholder meeting in Kochi.

Mr. M. Anil Kumar (Mayor, KMC), Dr. Ravikant Joshi and Ms.K.A. Ansiya (Deputy Mayor, KMC) in the stakeholder meeting in Kochi. (Right to left)

17.1.3. List of participants

The list of stakeholders who were a part of the discussion in Kochi are as follows:

Name	Designation and organisation/department
Mr. M. Anil Kumar	Mayor, KMC
Ms.K.A. Ansiya	Deputy Mayor, KMC
Mr. Clipson Mathew	DGM, CSML
Mr. Louis Oswald D'Souza	Asst Motor Vehicle Inspector, Regional Transport Office, Ernakulam
Mr. P.M. Shabeer	RTO, Motor Vehicles Department
Mr. G.P Hari	Executive Officer, KMTA
Mr. Adarshkumar	Executive Officer, KMTA
Mr. Gokul T.G.	Sr. DGM, KMRL
Mr. Boban. K	SE, KMC
Dr. Rajan	C-Hed
Chinnu Mary	Environment Engineer, C-Hed
Mr. Awasthy Murali	Environment Engineer, C-Hed
Ms. Sunitha Jose	EE, KSEBL
Mr. Anthony B.J.	MD, KSBL, Kochi
Mr. Manoharan.J	Head, E-mobility, ANERT
Mr. P.R. Ranish	Chairman, Development Committee, KMC
Ms Ambily T.A	EE, KMC
Adv. Priya	Chairperson, KMC
Ms. Haseena C.H	Dy. Town Planner, LSGD Planning, Ernakulam
Ms. Ananya Lia Joe	Planner Associate. LSGD Planning, Ernakulam
Mr. Gurusyam V.S.	ASM Kerela and Tamil Nadu, Piaggio Vehicles Pvt.Ltd.
Mr. Binu Basu	Sales Manager, Kuttakaren Green Pvt.Ltd, Ernakulam.
Mr. Arun Savi	Lead Transport Planner, Systra
Mr. Simon Edapally	Director, Board Member, EJADCS Ltd.
Mr. Binu Varghese	Director, EJADCS
Ms. Christy Ann Cheriyan	Transport & Infrastructure Advisor, GIZ, SMART-SUT
Dr. Ravikant Joshi	Consultant, ICLEI South Asia
Mr. Ashish Rao Ghorpade	Deputy Director, ICLEI South Asia
Mr. Vijay Saini	Manager- Urban, ICLEI South Asia
Dr. Alex C. J.	Asst. Manager, ICLEI South Asia
Mr. E.M. Sooraj	Senior Project officer, ICLEI South Asia
Ms. Nandini Shandilya	Project Officer, ICLEI South Asia

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