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1. Introduction

1.1. Background

Emphasis on low carbon mobility and clean air is becoming the central theme in urban development. Successful and widespread deployment of Electric Vehicles (EVs) and its supporting infrastructure is crucial to reducing greenhouse gas emissions. As per various studies including the projection of International Energy Agency, Electric Vehicles are expected to have 35% to 45% lower emission in comparison with conventional IC engines.

In the above context, along with the importance of Electric vehicles (EVs) in reducing the intensity of emission, the Ministry of Heavy Industries (MoHI), Government of India (GoI) launched the National Electric Mobility Mission Plan (NEMMP) in 2013. The National Electric Mobility Mission Plan 2020, is one of the most important and ambitious initiatives undertaken by the Government of India, and has the potential to bring about a transformational paradigm shift in the urban mobility in India. The figure below lists out various incentives planned to achieve the goals of NEMMP 2020.

Demand Side Incentives

- Focus on creating demand through incentivizing consumers

Supply Side Incentives

- Focus on createing supply of affordable vehicles in the market

R &D

- Focus on creating technology capability to achieve localization and promoting domestic manufacturers.

Charging Infrastructure

- Focus on creating conducive environment for mass adoption of Electric Vehicles

Pilot Projects

- Focus towards creating awareness, kick start adoption, test market condition, developing conducive business models and product feedback from customers

In continuation with theNEMMP, the Government of India recently announced its electric mobility vision 2030.The Government aspires for a nation with 100 per cent Electric Vehicles (EVs) by 2030. In this regard,the Department of Heavy Industry recently revised its incentive scheme, known as the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India, to aggressively encourage EV adoption, including electric buses for public transportation and E-rickshaws for last mile connectivity.In spite of these initiatives, there exist numerous barriers in moving towards electric mobility at the envisaged pace.

Tackling the above scenario, the public transport and IPT sectors provide the initial opportunity to showcase the potential and benefits of electrification under urban mobility. Such initiatives will also increase the confidence of users to shift towards EVs.

1.2. Electrification of Shared mobility:

The public transport and IPT sector provides the easiest opportunity to acceleratethe shift towards electric mobility. Currently, India has one of the highest percentages of public transport use in the world, averaging to almost 25% (excluding non-motorized transport) across major cities . Additionally the IPT sector dominated by three-wheelers, makes up 11% of the mode share . Auto rickshaws and electric rickshaws provide alternate mobility as well as first- and last-mile solutions in the cities depending upon average trip length.

Therefore, any successful pilot to promote the electrification of the IPT sector will tend to have an overreaching replication impact throughout Indian Cities. With the above reasoning, the CapaCITIES Project is assisting the Udaipur Municipal Corporation(UMC)in moving towards low carbon IPT system with a focus on electric 3 wheelers. The strategy for the shift towards low carbon IPT sector consists of a pilot to demonstrate and validate the workability of the Electric rickshaw in Udaipur.

IPT in Udaipur consists of auto rickshaws running on traditional internal combustion engines (diesel and petrol), which lead to higher emissions and vehicular pollution . Vehicular pollution increases the risk for various respiratory diseases and other health risks, which are a major public health concern across India's cities.The number of IPT vehicles in the cities is gradually increasing and over 40 per cent of auto rickshaws are more than ten years old , contributing substantially to the pollution. There is increasing consensus among planners that a range of additional measures will be required, beyond the existing policies, to mitigate the adverse impacts of transportation on these sustainability indicators.

1.3. CapaCITIES Project

The CapaCITIES project funded by the Swiss Agency for Development and Cooperation (SDC), is assisting Udaipur in developing and implementing a pilot to evaluate the technical capacity and workability of E-rickshaws in the context of Udaipur. The results from this initial pilot will assist the city in developing its city wide deployment plan for E-rickshaws. The goal of the Capacities project is 'lower greenhouse gas emissions growth path achieved and resilience to climate change increased in selected Indian cities'. The project aims to strengthen the capacities of Indian cities to identify, plan and implement measures for reducing GHG emissions and for enhancing resilience to climate change in an integrated manner.

1.4. E-rickshaw pilot for Udaipur

The city of Udaipur has expressed explicit interest in the measure and would like to implement it on a large scale. The Government of India is also promoting electric vehicles and has a vision of complete electric mobility by the year 2030. The strategy was therefore to develop a pilot in line with local as well as national policies that have high visibility impact. Since IPT is a very common mode of transport in Indian cities, a successful pilot deployment could uncover the benefits and guide wider replication.

The pilot includes following core steps:

Pilot Phase Deployment and Monitoring

→ **Assessment of E-rickshaw Operations in Delhi and Siliguri**

→ **E-rickshaw/E-Auto Road Map for Udaipur**

2. E-rickshaw Pilot in Udaipur and Assessment of Existing Operations in Delhi and Siliguri

The pilot in partnership with the Udaipur Municipal Corporation included procurement and deployment of E-rickshaws of different types (passenger and freight) and technology (lead acid and lithium-ion battery) in the city (refer table below), with close monitoring (see Annex for details specification).

Table 1: Details of E-Rickshaw fleet monitored as part of Pilot

Manufacturer	Type	Battery Type	Capacity	No of Rickshaws
Goenka Motors	Passenger	Lead acid, Lithium ion	4+1 passengers	6
Goenka Motors	School Van	Lithium-ion	6+1passengers	2
Goenka Motors	Freight	Lead acid,Lithium-ion	500 kg	4
Lohia Auto	Passenger	Lead Acid	4+1passengers	3
Electrotherm	Passenger	Lead Acid	4+1passengers	3
Kinetic	Passenger	Lead Acid	4+1passengers	3

Data was collected on conventional rickshaws as well as E-rickshaws, including data about technology and batteries available as well as the financial information. This was further complemented with stakeholder assessments. The pilot phase had a duration of around 3 months. The data from this stage was useful to validate technical, economic and financial feasibility of E-rickshaws. To substantiate the pilot, the existing operation of E-rickshaws in Delhi and Siliguri, where they exist in sizeable numbers, was documented. The figure below details out the main parameters/aspects monitored from March 2017 to August 2017 during the pilot in Udaipur, as well as the assessment in Delhi and Siliguri.

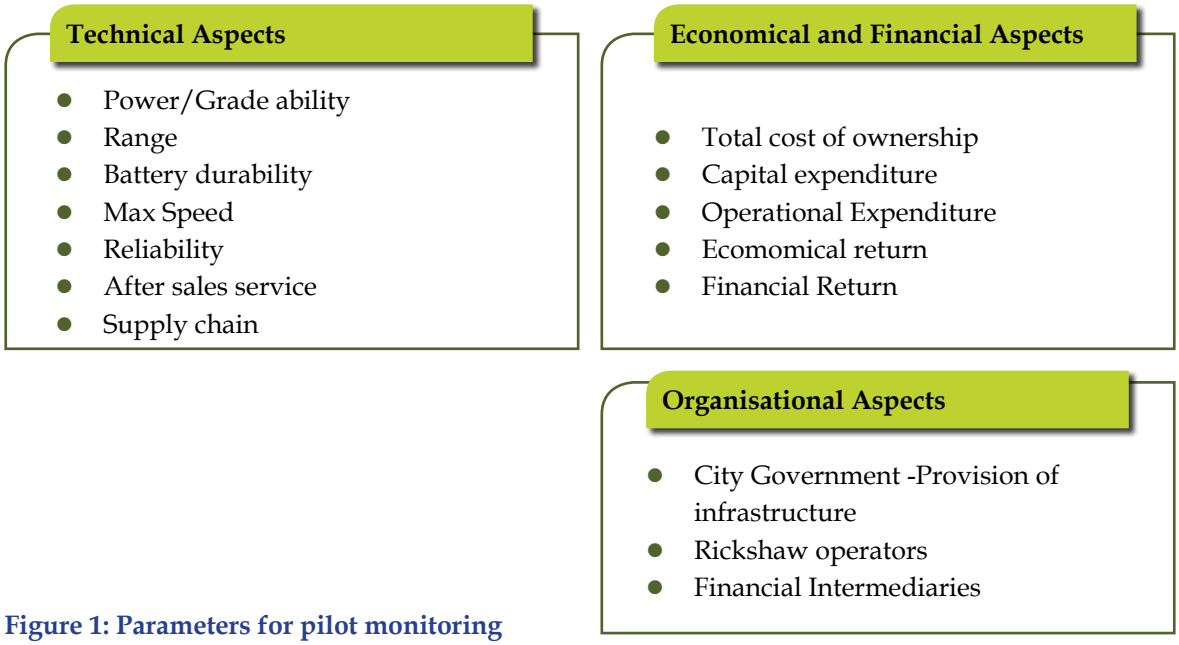


Figure 1: Parameters for pilot monitoring

2.1. Routes of monitoring

As part of pilot monitoring, major routes with different gradient, user-base and trip length, were covered. The details of the routes in all the three cities are given below:

Udaipur

In Udaipur, the routes were decided upon by the CapaCITIES implementing team in consultation with the Udaipur Municipal Corporation and the RTO. The routes were prioritised so as tocover the educational, public and semi-public, medical and major commercial locations of the city. Asthe UMC intends to replacethe IPT fleet, which requires validation of the E-rickshaws on different typologies, three different routes covering a total of around 20 kms distance were selected as shown in image below.

Figure 2: E-rickshaw routes monitored in Udaipur

Delhi and Siliguri

As part of documenting the on-going E-rickshaw operations, the team conducted detailed assessment at elevenmajor locations/routes in Delhi and Siliguri, each. As a part of the assessment, over 400 E-rickshaw drivers, 200 users, 10 dealers, 5 assemblers & garages were surveyed to collect information regarding E-rickshaw operations in both the cities. The images below represent the routes selected for assessment of E-rickshaw operations.

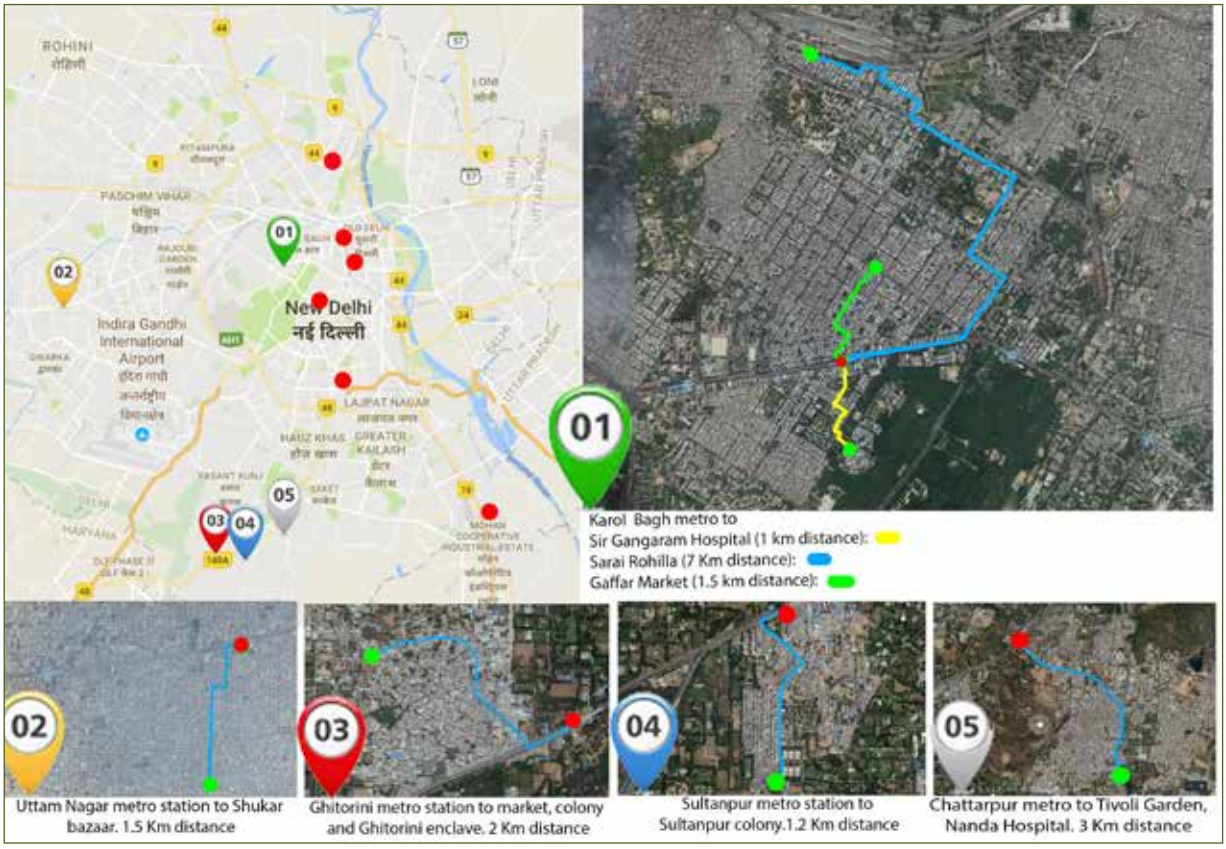


Figure 3: Routes selected for the assessment of E-rickshaw operations in Delhi

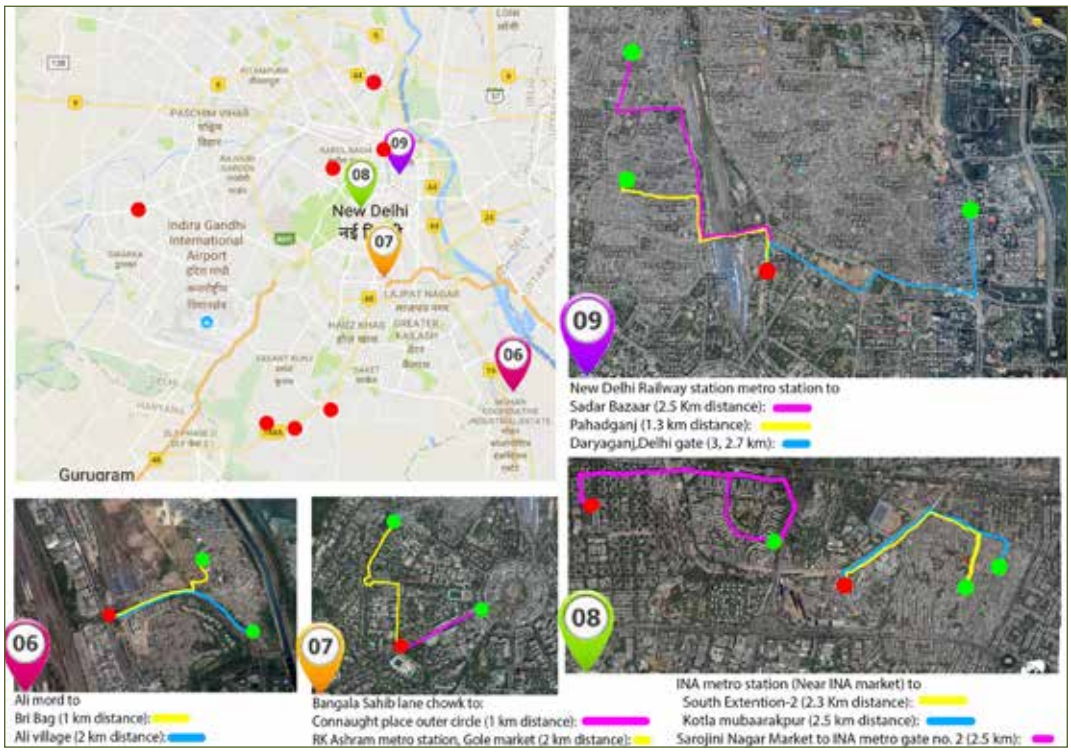


Figure 4: Routes selected for the assessment of E-rickshaw operations in Delhi

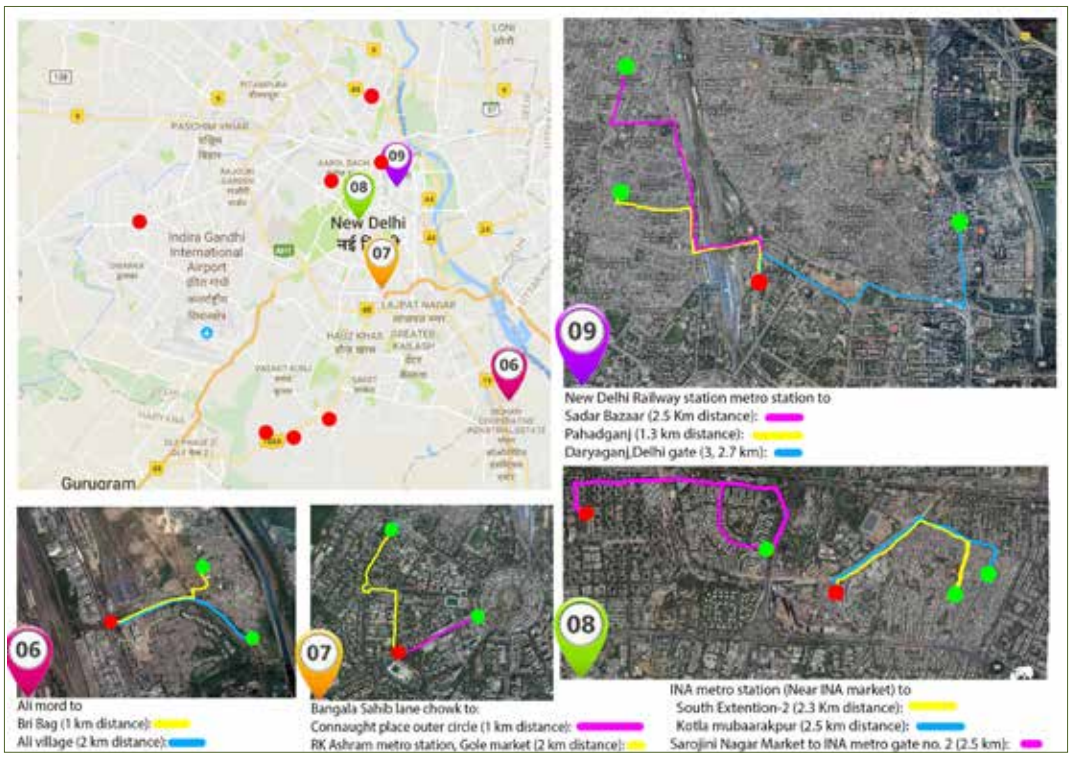
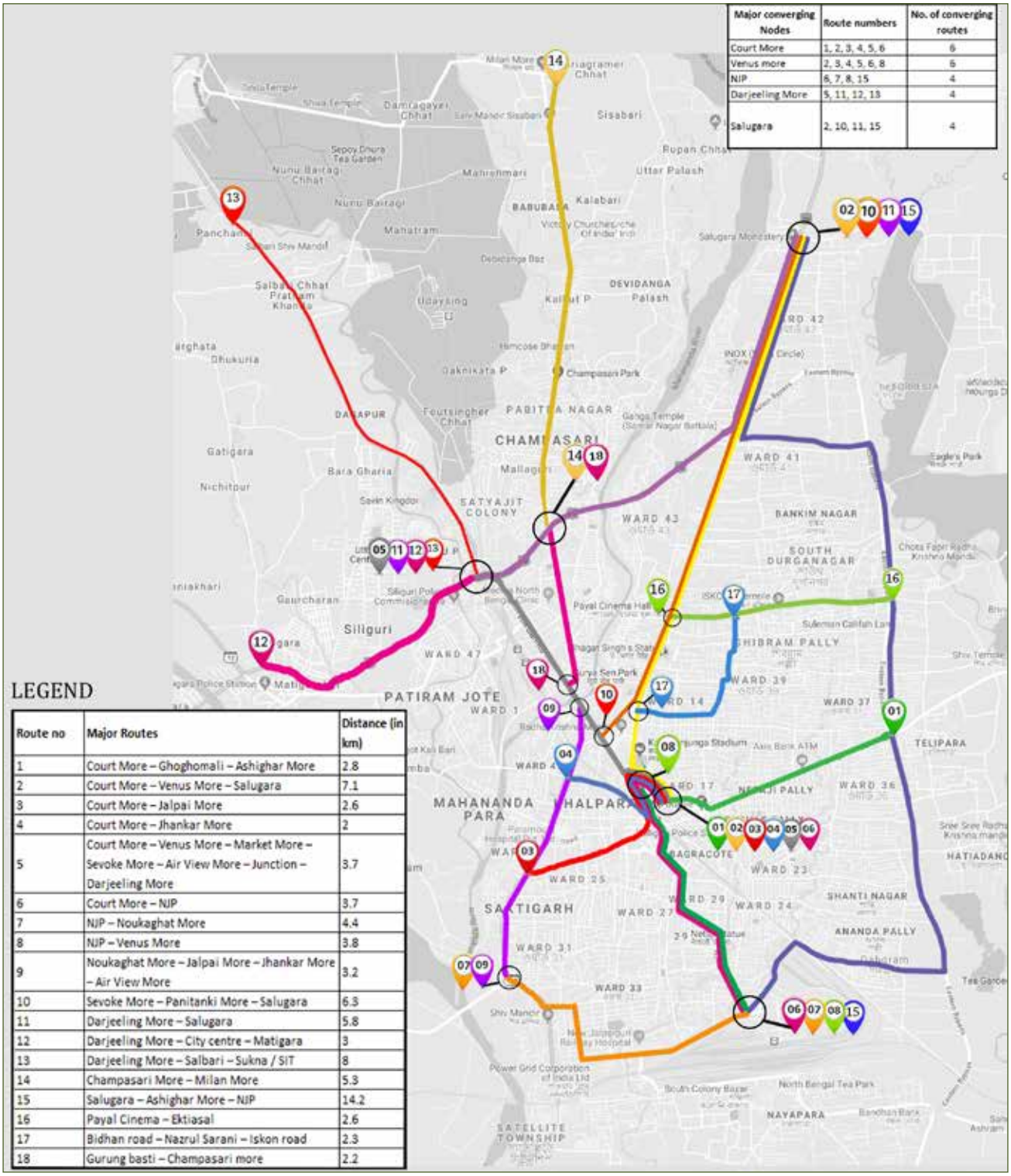


Figure 5: Routes selected for the assessment of E-rickshaw operations in Delhi



Route no	Major Routes	Distance (in km)
1	Court More – Ghoghomali – Ashighar More	2.8
2	Court More – Venus More – Salugara	7.1
3	Court More – Jalpai More	2.6
4	Court More – Jhankar More	2
5	Court More – Venus More – Market More – Sevoke More – Air View More – Junction – Darjeeling More	3.7
6	Court More – NJP	3.7
7	NJP – Noukaghat More	4.4
8	NJP – Venus More	3.8
9	Noukaghat More – Jalpai More – Jhankar More – Air View More	3.2
10	Sevoke More – Panitanki More – Salugara	6.3
11	Darjeeling More – Salugara	5.8
12	Darjeeling More – City centre – Matigara	3
13	Darjeeling More – Salbari – Sukna / SIT	8
14	Champasari More – Milan More	5.3
15	Salugara – Ashighar More – NJP	14.2
16	Payal Cinema – Ektiasal	2.6
17	Bidhan road – Nazrul Sarani – Iskon road	2.3
18	Gurung basti – Champasari more	2.2

Figure 6: Routes selected for the assessment of E-rickshaw operations in Siliguri

3. Observations from Pilot

As the eventual intention of the pilot was to help the city authorities deploy E-rickshaws on a larger scale, the results/observations from the initial monitoring of the pilot were helpful in identifying the practical, technical, infrastructural, market, and policy related barriers in the electrification of IPT sector. The table below presents some key observations regarding the status of E-rickshaw operations in three cities; Udaipur, Delhi and Siliguri.

Table 2: Status of E-rickshaw Operations in Udaipur, Delhi and Siliguri

	Udaipur	Delhi	Siliguri
Operations starting	**2017**	**2010**	**2013**
Number of operational E-rickshaw	The pilot began with18 E-rickshaws in March 2017(through CapaCITIES) ,and the number increased to more than 80 in October 2017	More than 1,00,000	8000 to 10000
Status of registration	All operational E-rickshaws are registered	Approximately 29,123are registered	Registration process not started
Policy framework	Updated in 2015	Vibrant policy framework with frequent revisions and updates	Updated in 2015
Applicable rules	Motor Vehicles (Amendment) act, 2015	Motor Vehicles (Amendment) act, 2015	Motor Vehicles (Amendment) act, 2015
Policy framework	Operations are regulated as per the provision of Motor vehicles (Amendment) act, 2015	Vibrant policy framework to regulate the operations	City yet to initiate registration as per Motor vehicles (Amendment) act , 2015
Average daily income	INR 500 (Approx.)	INR 1000 (Approx.)	INR 400 to 600 (Approx.)
Supporting infrastructure	It is gradually developing	Does not exist	Does not exist
Tariff policy - electricity use for charging	No	Notified in August 2017	No
Promotional Subsidy by City/State government	No	Subsidy of INR 30000 per E-rickshaw	No
Nature of operations	E-rickshaws operational on routes approved by UMC	E-rickshaws are mostly plied as a mode of last mile connectivity for public transport	No regulation on E-rickshaw routes. Due to which E-rickshaws are functional as parallel mode of public transport
Tariff policy	Yes	Yes	No

	Udaipur	Delhi	Siliguri
Availability of service stations	Absence of service station	Easily available	Large number of unauthorised service stations
User response	Happy with E-rickshaw operations	Happy with E-rickshaw operations	Happy with E-rickshaw operations
Technical issues	High	High	High
Access to finance	No	No	No
Major Barrier	Poor after sales service and absence of service station and spare parts	Absence of charging infrastructure	The city is yet to initiate registration process as per , the Motor vehicles (amendment) act ,2015

3.1. Identified Barriers

Announcing and implementing the FAME scheme is a much required initial step in promoting shared electric mobility, however there needs to be an enabling ecosystem that promotes the organic growth of electric mobility in the IPT sector. Based on the pilot monitoring in Udaipur for three months and successive assessment of existing E-rickshaw operations in Delhi and Siliguri, the project team identified various on-ground practical barriers which need to be addressed in order to ensure faster adoption of electric mobility in the IPT sector. The identified barriers are related to technical, financial, legal and infrastructure aspects. The table below enlist some of the key identified barriers.

Technology-manufacturing capacity

- Lack of technology adaptation to local Indian context
- Reliance on lead acid battery with low energy capacity
- Limited technical capacity to use modern battery technology -Lithium ion battery
- Lack of quality control, post sales service and limited availability of spare parts
- Limited variants eligible for the FAME scheme

User /Driver Acceptance

- User still sceptical of performance
- Limited range & gradeability of E-rickshaws
- Power and Features-Incomparable to Equivalent IC engine vehicles
- High charging time compared to Zero fuelling time for IC engines
- Lack of quality - frequent breakdowns of electric components especially wiring

Policy Framework

- Absence of policy framework for electric mobility
- Limited support from urban local bodies
- No framework for pricing of electricity for charging - Exception of Delhi

Enabling Ecosystem

- Absence of infrastructure such as fast charging stations, parking spaces and service stations
- Technology yet not developed-especially batteries
- Limited access to finance from the organised sector

Affordability

- High battery cost-approx one third of the total ownership cost
- Absence of special promotional policies

Figure 7: Identified barriers from the pilot in Udaipur and assessment of existing operations in Delhi and Siliguri

4. Way Forward

The table below presents steps for various stakeholders i.e. Government (National, State and city) as well as the industry to create an ecosystem conducive for faster adoption of electric mobility:

National Government

Policy

- Effective policy to promote ecosystem for electric mobility
- Promote R & D and manufacturing capacity
- Regulation for electricity sales for charging

Infrastructure

- Ensure reliable supply chain
- Standardisation of charging technology and battery swapping options

Facilitate

- Promotion through various government media houses
- Extend preferential financing from organised sector
- Nodal agency for faster implementation of electric mobility pilot projects.

Industry

Develop Technology

- Promote new and reliable technology such as E-Auto, lithium ion battery
- Ensure quality control
- Ensure reliable after sales service for entire life-cycle of vehicles

State and /or City Government

Policy/Action plan

- Develop multi year action plan to strategically phase out polluting vehicles
- City specific policy for electric mobility to embrace new technology such as E-Auto and E-carts, roles and responsibilities of the stake holders involved
- Ensure procurement from reliable manufacturer using means such as long term supply contract.

Infrastructure - Create Enabling Infrastructure

- Provision of charging infrastructure, parking space and service station
- Assess impact of EV charging on Power Grid

Facilitate

- Create low emission zones with exclusive access to clean vehicles
- Create awareness about benefits of shift towards electric mobility
- Organise training for drivers
- Create awareness regarding cost savings and carbon footprint reductions

Figure 8: Aspects of ecosystem for faster electrification of IPT sector

4.1. Conclusion

There are many barriers to EV adoption in India. To promote and accelerate the faster adoption of electric mobility, the IPT sector provides the easiest opportunity as it creates a visible impact with a potential for large scale replication. The Government needs to focus on simultaneous strategies to develop enabling infrastructure as well as creating demand for electric vehicles. Any increase in demand for electric mobility without creating the requisite infrastructure or vice versa may not produce the desired impact. In 2010, the Ministry of New and Renewable Energy (MNRE) launched an incentive program to promote EVs and led to a remarkable increase in the sales of two-wheeler EVs. But in the subsequent years, a large number of two-wheeler electric vehicle manufacturers in India have shut down their businesses because of the receding demand. The owners of these electric two-wheelers were left with no replacement parts for their vehicles. One of the major factors that led to the failure was that the push was mainly from the industry with limited participation from the Government. They were unable to provide the supporting ecosystem (policy environment as well as infrastructure) and the sustained encouragement required to build on the initial success.

Additionally, since technology is evolving constantly, any over ambitious shift towards electrification of IPT sector may leave the cities stuck with out-dated/less efficient technology in the near future. Therefore, it is suggested that the cities formulate a five to ten year action plan which provides the flexibility of gradual phasing of polluting three wheelers and replacing them with newer variants of electric vehicles. The action plan shall include options to integrate the IPT system with public transport and recommend possible funding options to support it. They should also outline the need for infrastructural requirements such as parking areas, maintenance facilities, along with institutional structures to check vehicle specifications, performance monitoring schedules, fare structures/revisions etc, which will help in the absorption of newer vehicles such as E-autos.

The author (CapaCITIES IA) team recommends you go through the attached reports.

For more information, please contact:

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