REPORT ON

EVALUATION OF RETRO-FITMENT OF 2-WHEELER & 3-WHEELER VEHICLES WITH ELECTRIC DRIVE AS AN OPTION FOR IMPROVEMENT IN AIR QUALITY IN NCR

FOR

COMMISSION FOR AIR QUALITY MANAGEMENT (CAQM), DELHI

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EXECUTIVE SUMMARY

Name of the Project:	Evaluation of retro-fitment of 2-wheeler & 3-wheeler vehicles with electric drive as an option for improvement in air quality in Delhi NCR
Approved Project Cost:	Rs. 105 Lakhs
Date of Commencement:	21st February 2023
Date of Completion:	31st July 2024
Commissioning Authority:	Commission for air quality management (CAQM), Delhi

Objective:

The main objective of this project is to carry out the technical assessment of retro fitment of IC-engine based 2-Wheeler (hereafter used interchangeably with 2W) & 3-Wheeler (hereafter used interchangeably with 3W) using electric powertrain through a pilot exercise on 6 number each 2W and 3W vehicles.

Background:

The transport sector is a major contributor to air pollution, particularly in urban areas. A joint study conducted by ARAI and TERI in 2018 on the Delhi-NCR region reported that vehicle exhaust contributes approximately 25% to PM2.5 emissions. Furthermore, vehicles account for 60% of NOx emissions and 35% of CO emissions in the region. Although the use of compressed natural gas (CNG) is widespread in 3-wheelers in Delhi, about 90% of 3-wheelers in neighbouring states such as Punjab, Rajasthan, and Haryana still run on diesel, significantly contributing to air pollution in the region.

Electric vehicles (EVs) present a cleaner alternative to reduce tailpipe emissions, particularly in densely populated and highly polluted areas. Retrofitting existing 2-wheelers and 3-wheelers used for passenger and goods transport with electric drive systems can play a crucial role in demonstrating the environmental benefits of EVs. The Government of India's National Electric Mobility Mission Plan 2020 and NITI Aayog's BREATHE action plan emphasize the need for widespread EV adoption. These initiatives also promote retrofitting existing internal combustion engine (ICE) vehicles as an integral part of the strategy to improve air quality.

To address the objectives and challenges outlined in background, the Commission for Air Quality Management (CAQM) in the Delhi-NCR region awarded a project to ARAI for evaluating the feasibility of retrofitting 2-wheelers and 3-wheelers with electric drive systems. This project also aimed to deliver the technical feasibility, user feedback, and pollution reduction potential of electric retro-fitment kits.

Outcomes of the project:

1. List of the components of a Retro-fitment kit

The table below provides a list of components for the typical retro-fitment kit for both 2W and 3W Vehicles.

Sr. No.	2W Vehicles	3W Vehicles
1	Hub / traction type motor	Traction type motor
2	Motor controller unit	Motor controller unit
3	DC-DC converter	DC-DC converter
4	MCB (DC)	Contactor
5	Junction box	Junction box
6	Wiring harness	Wiring harness
7	--	Fuse Box
8	Throttle	Throttle
9	Chain Sprocket (Only for Traction Type Motor)	Gear Box & Transmission shafts
10	Battery pack SOC Meter	Kit Integrated Display
11	Drive switch box (f/r, mode, on-off)	Drive switch box (f/r, mode, on-off)
12	Mounting Structures (Motor Kit Mounting)	Mounting Structures (Motor Kit Mounting)
13	Li-ion Battery pack, charger and mounting structure	Li-ion Battery pack, charger and mounting structure

For more details refer **section 2.2 on page no. 9** of this report.

2. Guidelines for retro-fitment

2.1 2W retro-fitment

The table below highlights the broad-level, step-by-step guidelines to be followed for the retro-fitment of a 2W vehicle.

1. Removal of unwanted parts from ICE 2W vehicle.	2. Alterations to the vehicle frame for mounting electric drive components.
3. Mounting of motor kit on vehicle.	4. Mounting and assembly of other electric drive components on vehicle.
5. Fitment of battery mounting structure and integration of battery.	6. Routing and fixing of wiring harness on vehicle frame.
7. Connection of wiring harness with electric drive components and auxiliary supply systems.	8. Functional testing of vehicle to ascertain smooth functioning of all electric drive systems.

For more details refer **milestone 3, section 3.2, page no. 19 -20** of this report.

2.2 3W retro-fitment

The table below highlights the broad-level, step-by-step guidelines to be followed for the retro-fitment of a 3W vehicle.

1. Removal of unwanted parts from ICE 3W vehicle.	2. Alterations to the vehicle frame for mounting of electric drive components.
3. Assembly of Motor kit & gearbox for 3W kit.	4. Installation of mountings for integration of electric drive components.
5. Mounting and assembly of other electric drive components on vehicle.	6. Fitment of battery mounting structure for holding the battery pack onto the vehicle & then battery placement in the mounting structure.
7. Routing and fixing of wiring harness on vehicle frame.	8. Connection of wiring harness with electric drive components and auxiliary supply systems.
9. Functional testing of vehicle to ascertain smooth functioning of all electric drive systems.	

For more details refer **milestone 3, section 3.2, page no. 21-22** of this report.

3. Certification requirements for retro-fitment

The standard AIS 123 outlines the certification compliances required for the retro-fitment of 2W and 3W vehicles. These compliances are mandatory to ensure the retro-fitment is valid and legally approved. The certifications include kit and vehicle-level testing approvals. For more details, refer to **Table 44 of Section 6.6 (page nos. 52-53)**.

4. Recommended specifications for retro-fitment of 2W & 3W based on testing and evaluation under this project (for Delhi & NCR)

Based on the testing and evaluation conducted during this project, the recommended motor power and battery specifications required for the retro-fitment of 2W and 3W to achieve the specified range and gradeability are outlined in the table below. The specified motor power and battery capacity are recommended for specified GVW only for each category of the vehicle for Delhi NCR.

Category	**Recommendation**			
	Motor Power (kW)	**Battery Capacity**	**Range (km)**	**Gradeability**
2W Scooter (GVW – 200 to 270 kg)	Rated: 2 - 2.5	40 Ah	85-95	$>7^{o}$
2W Motorcycle (GVW – 200 to 270 kg)	Rated: 2 - 2.5	40 Ah	85-95	$>7^{o}$
3W Passenger (GVW – 900 to 950 kg)	Rated: 4 - 4.5	200 Ah	90-100	$>7^{o}$
3W Cargo (GVW – 1000 to 1050 kg)	Rated: 4 - 4.5	200 Ah	90-100	$>7^{o}$

The motor power and battery capacity will vary depending on the different Gross Vehicle Weight (GVW), range, and gradeability requirements.

5. Key considerations and measures to be taken to make retro-fitment a success

The table below outlines essential measures to ensure safety, compliance, operational efficiency, and environmental sustainability before and after retrofitting vehicles with an electric system.

Retro-fitment Measures and Safety	1. Pre-retrofit Vehicle Assessment needs to be done. 2. Certified kits should be installed to ensure operational safety.
Safety standards and battery swapping concerns	1. Retro-fitment kits should meet safety standards as per AIS 123. 2. Retro-fitment of vehicle should be done only on authorised conversion centre for safety and reliability. 3. Proper cooling systems if required must be integrated to prevent overheating of battery pack, especially in case of 3W. 4. Implementing swappable battery systems for 2W is feasible, but for 3W, further R&D is needed.
Environmental measures and compliance	1. Ensure retro-fitted vehicles meet local emission standards and adhere to environmental regulations viz-a-viz state RTO norms. 2. To address scrapping of removed unwanted parts from ICE vehicle, policies detailing measures should be framed for authorised scrapping centres. 3. Initiatives should be fast-tracked for battery recycling/scrapping.
Operational issues and Supply chain management	1. To address maintenance issues, including the lack of standardized components, availability of trained technician and supply chain management should be looked into. 2. Developing fast-charging infrastructure is crucial to reduce vehicle halt timings.
Standardization of Batteries	1. Battery pack shape and size standardization is essential for the adoption of swappable systems and efficient recycling.
Training requirements	1. Local mechanics should be trained for retro-fitted vehicle repairs and regular maintenance. 2. End users should be educated to tackle on-road minor issues with the vehicle electric drive system.

6. Guidelines to start an Authorised Retro-fitment/conversion centre

The process for registering a business entity and ensuring compliance with regulations for retrofitting vehicles, especially in the context of hybrid and electric vehicle retrofitting, involves multiple steps. Here is a breakdown of the key rules, regulations, and procedures:

6.1 Registration of the Business Entity

Register the company under the appropriate business structure, such as a Limited Liability Partnership (LLP) or Private Limited Company (Pvt Ltd), as per the business goals and legal requirements.

6.2 Application for Retrofit Kits Approval

- **Retro-fitment Design Submission:** Submit the retrofitting design and kits for approval to certification agencies following guidelines like **AIS 123**, **CMVR (Central Motor Vehicles Rules)**, and **MoRTH (Ministry of Road Transport and Highways)**.
- **Compliance Certificates:** Ensure that components such as **batteries, motors, and controllers** are certified for safety and performance.

6.3 Compliance with MoRTH Guidelines

- Ensure that the retrofit kits and all vehicle modifications comply with the **MoRTH notifications** to meet safety, performance, and environmental standards for electric and hybrid vehicles.

6.4 Infrastructure Setup

- **Workshop Establishment:** Set up a workshop equipped with all necessary tools and machinery to perform retrofitting processes.
- **Environmental Compliance:** Ensure that the workshop adheres to environmental norms, particularly in areas like **waste management**, **disposal of hazardous materials**, and other environmental concerns.

6.5 Personnel and Training

- **Certified Technicians:** Hire skilled and certified technicians who are trained in the retrofitting process, electric vehicle technology, and safety procedures.
- **Ongoing Training:** Ensure that technicians undergo periodic training to stay up-to-date with the latest technologies, regulatory changes, and safety standards.

6.6 RTO Registration and Certification

- **Centre Authorization:** Seek authorization from the **local Regional Transport Office (RTO)** for the retrofitting centre.
- **Vehicle Registration:** After completing the retrofitting process, ensure the vehicle is re-registered according to **state RTO guidelines**, including any tests required by the RTO.

6.7 Quality Assurance

- **Record Maintenance:** Maintain detailed records of all retrofitting work performed, which may be required for audits or compliance checks.
- **Testing Protocols:** Adhere to stringent **testing protocols** to ensure that the retrofitted vehicle complies with all performance, safety, and emissions standards before delivering it to customers.

6.8 List of Rules and Regulations

Follow the following key standards and regulations:

  - **AIS 123 (Automotive Industry Standards):** Specific to electric and hybrid vehicles, this standard sets out guidelines for retrofitting conventional vehicles with electric drivetrains.

- **CMVR (Central Motor Vehicle Rules):** These are comprehensive rules that cover the registration, construction, and modification of vehicles in India.
- **MoRTH Guidelines:** Ensure that the modifications comply with Ministry of Road Transport and Highways' requirements, including performance, emissions, and safety standards.
- **BIS (Bureau of Indian Standards):** Follow BIS standards for components like batteries, motors, controllers, and charging equipment.

Project accomplishments:

1. Identification and procurement of 2W & 3W vehicle make/model for retro-fitment

The table below highlights the category-wise selected vehicles for retrofitting, based on a physical and sales database survey of the available vehicles on the road.

Category	Selected Vehicle Model	
2-Wheeler	Scooter (Activa)	Motorcycle (Splendor)
3-Wheeler	Passenger (Bajaj RE, Piaggio Ape City, Xtra)	Cargo (Piaggio Xtra LD, Bajaj Maxima)

2. Procurement of components for retro-fitment kit

Based on motor sizing, simulation and a market survey, multiple kits with different specifications were procured to validate and compare their performance against the requirements. The table below categorizes the kits procured for comparison.

Category	Vehicle	Retro-fitment Solution 1	Retro-fitment Solution 2	Retro-fitment Solution 3
Motorcycle	Splendor	Motor: 2 kW Battery pack: 2.8 kWh	Motor: 2.65 kW Battery pack 2.5 kWh	Motor: 2 kW Battery pack: 2.5 kWh
Scooter	Activa	Motor: 1.2 kW Battery pack: 2.8 kWh	Motor: 2 kW Battery pack: 2.5 kWh	Motor: 2 kW Battery pack: 2.5 kWh
3-Wheeler (Passenger)	Bajaj RE, Piaggio Ape xtra, Piaggio Ape City	Motor: 3 kW Battery pack: 4.8 kWh	Motor: 4 kW Battery pack: 9.6 kWh	Motor: 4.4 kW Battery pack: 9.6 kWh
3-Wheeler (Cargo)	Bajaj Maxima, Piaggio Ape Xtra Ld	Motor: 3 kW Battery pack: 4.8 kWh	Motor: 4 kW Battery pack: 9.6 kWh	Motor: 7.5 kW Battery pack: 9.6 kWh

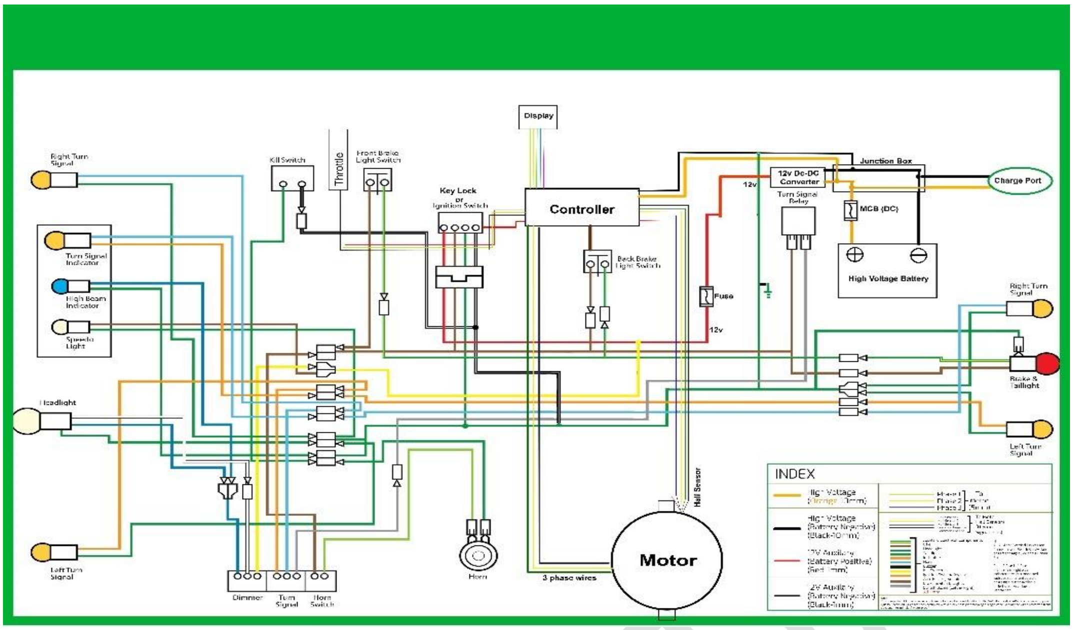
3. Integration of electric drive components with vehicle

3.1 Mechanical Integration of electric drive system

Mechanical integration of electric drive system for both 2W & 3W should be done as per guidelines mentioned in **milestone 3, section 3.2, (page nos. 19 to 23)** of this report.

3.2 Wiring architecture for 2 & 3-Wheeler category

Following image shows the wiring architecture of 2W & 3W retro-fitted vehicle. The architecture for both categories remains the same with just the change in battery pack that is being integrated with the vehicle's electric transmission kit.



For details of Wiring harness integration guidelines of 2W & 3W refer **milestone 3, section 3.3, (page no. 23 – 24)** of this report.

4. Running and operational data acquisition of retro-fitted vehicles in real-life for 5000 to 6000 km in (Delhi NCR)

The table below mentions the overall kilometres for which the vehicles with different integrated solutions were tested (across Pune & Delhi NCR).

Tested km's data of retro-fitted vehicles				
Solution\Category	**2-Wheeler**		**3-Wheeler**	
	Scooter	**Motorcycle**	**Passenger**	**Cargo**
Solution 1	6613	6340	6604	6352
Solution 2	5201	6688	5054	6274
Solution 3	5553	5604	7414	6702

5. Evaluation and certification of retro-fitment solutions

5.1 Technical Feasibility Summary

The table below shows the technical feasibility of retro-fitment kits with 2W and 3W category.

Aspect	2-Wheeler	3-Wheeler
Compatibility with Vehicle	Minor frame/mounting modifications needed.	Significant frame/mounting modifications required.
Electrical System Integration	• Main supply line drives motor system. • Aux. supply line (12V) for auxiliaries with minor wiring modifications.	New wiring harness required for both main and aux. supply line systems.
Battery Pack & Mounting	Mounted in engine compartment (motorcycle) or under seat (scooter) with some alterations.	Securely mounted with proper casing; location depends on vehicle type.

Range	55-100 km (60V 42Ah to 72V 42Ah).	55-100 km (48V 100Ah to 48V 200Ah).
Charging & Thermal Management	Household AC charging (5-6 hrs), no fast charging, battery temperature below 42°C.	Household AC charging (5-6 hrs), no fast charging, battery temperature below 42°C.
Motor, Shock Absorber, Drivetrain	Specific mounting required, especially for traction motors, minor drivetrain adjustments.	Major modifications required for traction motors mounting, drivetrain and shock absorbers.
Braking system	Compatible with existing system; hub motor kits with disc brakes may need adjustments.	Compatible with existing system.
Vehicle Performance	Top speed up to 80 km/h.	Top speed up to 60 km/h.
Maintenance & serviceability	Limited availability of skilled technicians and long service times for components.	Similar challenges with maintenance and long service times.

5.2 User/Driver Feedback During Testing (for Delhi NCR)

The table below mentions the average rating feedback received from drivers covering various performance aspects, as mentioned below:

Feedback aspect	**Avg. Rating**	**Feedback aspect**	**Avg. Rating**
Riding experience	4.6/5	Gear shifting (3 wheeler)	4/5
Comfort	5/5	Safety in Driving	4/5
Range	3.75/5	Charging Process	4/5
Acceleration	4/5	Maintenance Availability	2.5/5
Driving Experience on Gradients	3.5/5	Retro-fitment as Option	3.8/5

For more details refer **section 6.2 on page no. 48** of this report.

5.3 Pollution reduction potential (CO_2 emission savings per vehicle for 80,000 km)

The table below mentions the CO_2 emission comparison and savings for 80,000 km of vehicles from both categories. Data mentioned is specific for a unit vehicle.

Vehicle Category	**Fuel**	**CO_2 emissions from conventional vehicle (Tonnes)**	**CO_2 emissions from electrical vehicle (Tonnes)**	**CO_2 emissions savings for 80000 km of run (Tonnes)**
2W	Petrol	3.12	2.15	0.98
3W	Petrol	9.08	5.53	3.55
	Diesel	10.58	5.53	5.05

Retro-fitment of vehicles in mass number will make significant changes in the above data signifying greater pollution reduction potential.

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LIST OF ABBREVIATIONS AND SYMBOLS

Abbreviation/Symbol	Description
σ_u	Ultimate tensile strength
σ_y	Yield Strength
F_{tooth}	Force acting on sprocket teeth
T_r	Torque on rear sprocket
t_1	Number of teeth on driving sprocket
t_2	Number of teeth on driven sprocket
T_{motor}	Motor Torque
$F_{C\text{-}clamp}$	Force acting on C-Clamp
F_{jerk}	Jerking Force/Deceleration Force
P_{motor}	Motor Power
r_w	Radius of the wheel
n_w	Wheel Speed
T_{TF}	Total tractive Force
a	acceleration
F_a	Aerodynamic Force
ρ	Density of air
A	Frontal area
C_d	Coefficient of Drag
v	Vehicle Speed
F_{gr}	Gradient force
GVM	Gross vehicle mass
Θ	Angle of inclination with respect to the horizontal [degrees]
g	acceleration due to gravity
F_r	Rolling resistance force
C_{rf}	coefficient of rolling friction
F_{acc}	Acceleration Force
TCO	Total Cost of Ownership
HV	High Voltage (Battery)
LV	Low Voltage (Battery)
aux.	Auxiliary

PROJECT DETAILS

A. Objective of the project

The main objective of this project is technical assessment of retro fitment of IC-engine based 2-wheeler (hereafter used interchangeably with 2W) & 3-wheeler (hereafter used interchangeably with 3W) using electric powertrain through a pilot exercise on 6 number each 2W and 3W vehicles.

B. Introduction

Background

Transport sector is considered as one of the major contributors to the air pollution. ARAI-TERI study (2018) in Delhi-NCR reports contribution of around 25% from vehicle exhaust to PM2.5 emissions / concentrations. Share of vehicles in NO_x and CO emission load was about 60% and about 35% respectively. Share of 3-wheelers in the emission load is 3-4% in total emission load of Delhi. Although 3-wheelrs used for passenger transport predominantly operated on CNG in Delhi city, large number of 3-wheelrs (about 90%) in adjoining states (Punjab, Rajasthan and Haryana) which are part of NCR run on diesel and therefore are potential source of emissions from tailpipe to ambient air.

Electric vehicles (EVs) offer alternate mobility options that can help to redress adverse impacts of tailpipe emissions. 2-wheeler & 3-wheeler vehicles used for passenger / goods transport can be retro-fitted with electric drive for demonstration of benefits of deployment of electric vehicles on air quality.

Government of India has envisioned the future of electric vehicles through the National Electric Mobility Mission Plan 2020 and encourage the penetration of electric vehicles in the market. Further, NITI Aayog of India in their action plan for combating air pollution i.e. BREATHE, also emphasizes on increasing distribution of electric vehicles. This action plan also suggests to launch a scheme to convert existing IC engine autos into electric ones either by retrofitting or through incentives for new vehicles.

Environmental benefits

- All-electric vehicles produce zero direct emissions, which specifically helps improve local air quality and exposure to the population in the high vehicle density area.
- There is a huge emission reduction potential considering a total emission load of PM2.5 from 3-wheelers of about 10,300 T/year, in the year 2016, out of total transport sector emission load of about 68,600 T/year (ARAI-TERI report, 2018). A few percentages of vehicles retro-fitted with electric drive can accrue significant reduction in emission load of PM2.5 as well as NOx.

Benefits to user

- Reduced operational cost with the initial investment of 1.8 lakh (including battery cost) for 3-wheeler the payback period is about 2 to 2.5 years for a usage of 80 km per day. Payback period also depends on the daily running of vehicles. The investment cost is expected to reduce in future with mass production.

- With swappable battery option, initial investment can be reduced significantly with about similar payback period.
- Extended life of vehicle due to refurbishment and retro-fitment of electric drive.

C. Scope of the Work and Methodology

Scope of work to meet the objective of the project and methodology to be followed is presented below-

- Internal combustion (IC) engine-based 2-wheeler (6 nos.) & 3-wheeler (6 nos.) would be retro-fitted to run on electric drives
- Prototype development on
  - Vehicle fitness assessment for conversion.
  - Removing unwanted parts (engine etc.) and reconditioning vehicle existing parts related to EV drive-train to remove operational inefficiency.
  - Architecture and Wiring harness design and suitability of existing components (Lighting load, switches etc.).
  - Mechanical and Electrical Integration of drive-train with battery (designing structural parts for battery and drivetrain support) and actual fitment of parts.
  - System level trials and testing.
  - Prototype development of various mounting on vehicle.
- Retro fitment of 2-Wheeler and 3-Wheelers
  - Mechanical and Electrical integration of retrofit kit on 6 nos. of 2W & 6 nos. of 3W.
  - Deployment of vehicles for real world usage.
- Run-time data collection and improvisation
- Data collection
  - Fitment of IoT based device on vehicles.
  - Cloud-based system for data transfer and acquisition.
- Data on the performance of vehicles would be collected over a period of 5-6 months.
- Pollution reduction potential for the region will be evaluated.
- Maintenance and servicing of vehicles during filed trials (ensuring manpower, parts and assistance availability throughout pilot).
- Interpretation of data collected from vehicles, surveys and reporting.

D. Deliverables

- Carrying out the activities as mentioned in the scope of work.
- Successful completion of this phase will generate evidence, based on thorough scientific evaluation of the option of retro-fitment of 3-wheelers and 2-wheelers. A report containing information based on comprehensive data analysis would be carried out during the pilot demonstration in terms of-
  - Technical feasibility
  - User feedback
  - Pollution reduction potential

E. PERT Chart

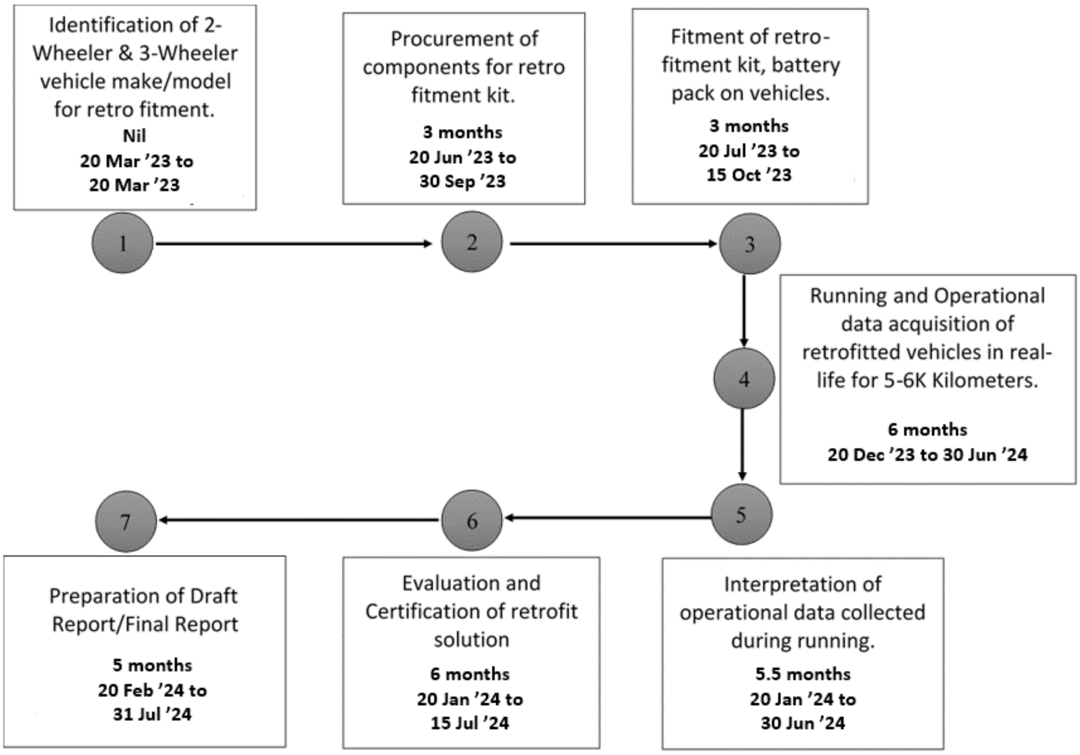


Figure 1 ***PERT Chart***

Milestone 1: Identification of 2-wheeler & 3-wheeler vehicle make/model for retro-fitment
This milestone covers the survey of vehicles in Delhi for finding out which are the common and most used 2-wheeler and 3-wheeler by public in Delhi-NCR for their daily commute or business purpose.

Milestone 2: Procurement of components for retro-fitment kit
This milestone covers the procurement process of components of retro-fitment kit based on the calculations and simulation results.

Milestone 3: Fitment of retro-fitment kit, battery pack on vehicle
This milestone covers the fitment/integration of retro-fitment kit components procured for 2-wheeler and 3-wheeler category including the battery pack & wiring harness integration.

Milestone 4: Running and operational data acquisition of retro-fitted vehicles in real-life for 5000 to 6000 km
This milestone covers the on-road testing phase of all 12 nos. of retro-fitted vehicles, identification of operational issues and resolving those, data acquisition with the use of DAQ system integrated into the vehicle for 5000 to 6000 kilometres.

Milestone 5: Interpretation of operational data collected during running
This milestone covers the interpretation/analysis of the data collected from the vehicle related to throttle, current, voltage and speed of vehicle during their testing trials at different loading and gradeability scenarios.

Milestone 6: Evaluation and certification of retro-fitment solutions
This milestone covers the evaluation of the retro-fitment solutions w.r.t the testing trails carried out on all 12 nos. of vehicles and suggesting the best performing solution based on the testing results achieved/analysed.

Milestone 7: Preparation of draft report/final report:
This milestone covers the preparation of final report containing the details of project execution.

MILESTONE 1: IDENTIFICATION OF 2-WHEELER & 3-WHEELER VEHICLE MAKE/MODEL FOR RETRO-FITMENT

1.1 Identification of 2-Wheeler & 3-Wheeler vehicles

The vehicles to be selected for retro-fitment, so as to cover a major share of existing vehicles being used in market, were identified based on the below mentioned approaches:

- Using Society of Indian Automobile Manufacturers (SIAM) sales data
- Physical survey

- **SIAM Sales Data**

Using SIAM sales data, we have approached 3 different method for collection of data i.e.
- Market sales of OEMS for year 2006 to 2017 (as retro-fitment will be done on old vehicles)
- Market sales of OEMS for year 2021-22 (is the trend being followed or not)
- Model-wise top sales in the same segment (to finalize which model should be considered for retro-fitment)

2-Wheeler Vehicle

A summarized version of SIAM sales data is provided into tabular format below.
Table 1 below provides a summarized analysis highlighting the popularity of specific vehicle models in 2-wheeler category.

Company/Type	Scooter	Motorcycle
Honda	Activa	NA
Hero	Na	Splendor

Table 1 ***Popular vehicle models in 2-wheeler category***

3-Wheeler Vehicle

Table 2 below provides a summarized analysis highlighting the popularity of specific vehicle models in 3-wheeler category.

Company/Type	Passenger	Cargo
Bajaj	Bajaj RE Compact	Maxima
Piaggio	Piaggio Ape City	Ape Xtra LDx

Table 2 ***Popular vehicle models in 3-wheeler category***

For a comprehensive overview of the popular vehicle sales data, please refer to the graphical representations and detailed insights provided in **SECTION 1 of 7.1 (ANNEXURE 1) Pg. no. 61** of this report.

- **Physical Survey**

A physical survey was carried out in Delhi and nearby cities to find out the majority of models used by public for their daily commute.

Table 3 below mentions the details of this physical survey carried out in multiple areas of Delhi and NCR.

State	City
Delhi	Delhi
Uttar Pradesh	Gautam Buddha Nagar (Noida), Ghaziabad, Meerut, Baghpat
Haryana	Faridabad, Gurgaon, Sonipat, Bahadurgarh.

Table 3 ***Survey of cities for presence of vehicles in majority***

For a comprehensive overview of city areas in which the physical survey was carried out, refer **SECTION 2 of 7.1 (ANNEXURE 1) Pg. no. 65** of this report.

1.2 Summary and Selection of Vehicle

Based on SIAM sales data from 2005 to 2016 and physical survey, following conclusions can be made:

- **Scooter segment:** Honda Activa in scooter segment is the most observed vehicle in use on Delhi and NCR roads.
- **Motorcycle segment:** Hero Splendor is the most observed vehicle in motorcycle segment.
- **3-wheeler passenger:** For CNG fuel type Bajaj Compact CNG was seen predominantly, while for diesel fuel type Piaggio Ape Xtra passenger and Bajaj Maxima passenger were seen on the roads of NCR; also, Bajaj Compact RE diesel was seen in some outskirts of Delhi NCR.
- **3-wheeler Cargo:** In this category, for both the fuel types of diesel and CNG, Bajaj Maxima and Piaggio Ape Xtra are seen to be in use, predominantly.

List of selected vehicles for 2W and 3W retro-fitment:

Table 4 below mentions the list of selected vehicle models for 2W and 3W category that will be retro-fitted with purely electric drive system with multiple motor and battery configurations (solutions) shortlisted from the available retro-fitment solutions in the market as per requirements.

Sr. No.	Category	Selected Vehicle Model
1	Scooter	Honda Activa
2	Motorcycle	Hero Splendor
3	3W Passenger	Bajaj Compact RE, Bajaj Maxima/ Piaggio Ape Xtra.
4	3W Cargo	Bajaj Maxima, Piaggio Ape Xtra

Table 4 ***Summary table of selected 2w & 3w vehicles for retro-fitment***

MILESTONE 2: PROCUREMENT OF COMPONENTS FOR RETRO-FITMENT KIT

This milestone covers the procurement process of components of retro-fitment kit based on the calculations and simulation results.

2.1 Procurement of vehicles

2-Wheeler vehicle

The ***Figure 2*** below shows the vehicles that were procured by ARAI (based on the findings of survey) for getting retro-fitted with electric conversion kits.

Figure 2 ***Procured 2-wheeler (motorcycle & scooter) vehicles***

<u>Vehicle fitness assessment</u>

To carry out the fitness assessment of 2-wheelers acquired for retro-fitment, a joint inspection of 2-wheelers was carried out by ARAI & Droom Technology Pvt. Ltd (platform involved in assessment and sale of old and new non-commercial vehicle).

Table 5 outlines the various parameters that were meticulously cross-verified to ensure vehicle fitness before procurement. This comprehensive assessment ensures that all vehicles meet the required standards for performance, safety and reliability.

Inspected fitness points of 2-wheeler (Scooter & Motorcycle)
Chassis & Body (Body panels, fibre, mud-flaps)
Wheel system (Wheel rim + hub, rim spokes tension)
Braking system (Brake pedal, brake lines, brake-shoe, liners)
Steering system (Bearing, T-bar)
Electricals (Wiring, headlamp, tail-lamp, indicators, horn)
Rims & Tyres (Rim & tyre condition)
Transmission (Engine, gearbox, chain-sprockets, CVT)

Table 5 ***Fitness check parameters for 2-wheeler***

Refer **SECTION 3 OF 8.1 (ANNEXURE 2) Pg. no. 69** of this report, for a comprehensive detail of the vehicle's condition, which has been converted into a rating format following the inspection. The rating scale ranges from 1 to 5, reflecting varying levels of condition for the parameters mentioned in ***Table 5.***

3-Wheeler Vehicle

The ***Figure 3*** below shows the vehicles that were procured by ARAI (based on the findings of survey) for getting retro-fitted with electric conversion kits**.**

Figure 3 ***3-wheeler's procured on lease (passenger & cargo) vehicles***

Vehicle Fitness Assessment

To carry out the fitness assessment of 3-wheelers acquired for retro-fitment, inspection of 3-wheelers was carried out by ARAI due to unavailability of any 3rd party inspection.

Table 6 outlines the various parameters that were meticulously cross-verified to ensure vehicle fitness before procurement. This comprehensive assessment ensures that all vehicles meet the required standards for performance, safety, and reliability.

Inspected fitness points of 3-wheeler (Passenger & Cargo)
Chassis & Body (Body panels, fibre, mud-flaps)
Wheel system (Wheel rim + hub, transmission shafts, drums, rims, mount plates, wishbone attachments)
Braking system (Brake pedal, brake lines, brake fluid, brake-shoe, liners)
Steering system (Bearing, T-bar)
Electricals (Wiring, headlamp, tail-lamp, Indicators, horn, wiper motor)
Rims & Tyres (Rim & tyre condition)
Transmission (Engine, gearbox, half Shafts)

Table 6 ***Fitness check parameters for 3-wheeler***

Refer **SECTION 4 OF 8.1 (ANNEXURE 2) Pg. no. 69** of this report, for a comprehensive detail of the vehicle's condition, which has been converted into a rating format following the inspection. The rating scale ranges from 1 to 5, reflecting varying levels of condition for the parameters mentioned in ***Table 6***.

2.2 Retro-fitment kit component details

The ***Table 7*** below provides a detailed list of components included in a conversion or retro-fitment electric kit for 2-wheeler and 3-wheeler category. These components are essential for converting a conventional ICE vehicle to an electric vehicle, ensuring optimal performance, efficiency and safety.

Sr. No.	**2-Wheeler**	**3-Wheeler**
1	Hub / traction type motor	Traction type motor
2	Motor controller unit	Motor controller unit
3	Dc-dc converter	Dc-dc converter
4	MCB (DC)	Contactor
5	Junction box	Junction box
6	Wiring harness	Wiring harness
7	--	Fuse box

Sr. No.	2-Wheeler	3-Wheeler
8	Throttle & grip	Throttle & grip
9	Chain sprocket (only for traction type motor)	Gear-box & Transmission shafts
10	Battery pack SOC meter	Kit integrated display
11	Drive switch box (f/r, mode, on-off)	Drive switch box (f/r, mode, on-off)
12	Motor bracket (only for traction type motor) Swing arm (only for motorcycle hub motor kit)	Mounting structures (motor & gearbox kit mounting)
13	Li-ion battery pack, charger & mounting bracket	Li-ion battery pack, charger & mounting bracket
14	Swing arm and shock absorber set (Only for scooter hub motor kit)	

Table 7 ***Components used in retro-fitment kit***

2.3 Motor sizing

Following mathematical equations are used for calculating multiple parameters to derive motor power and torque

- **Wheel Speed**

Vehicle speed to be considered as linear velocity

$$\text{Speed (m/s)} = \text{Speed (kmph)} * \frac{5}{18}$$

Wheel speed in rpm

$$n_w = \frac{V * 60}{2 * \pi * r_w}$$

where,
n_w= Wheel speed [rpm]
v = Vehicle speed [m/s]
rw = Radius of the wheel [m]

- **Aerodynamic force**

It is a resistive force acting on the vehicle, because of its frontal area, density of air, geometry of car & cars velocity. When the area of the vehicle is not present the aerodynamic force can be calculated by process called coast down test.

$$F_a = \frac{\rho * A * C_d * v^2}{2}$$

where,
F_a = Aerodynamic force [N]
ρ = Density of air [kg/m^3]
A = Frontal area [m^2]
C_d = Coefficient of drag
v = Vehicle speed [m/s]

- **Grade resistance force**

Gradient resistance force is the force acting on the vehicle when the vehicle is climbing an inclined surface.

$$F_{gr} = GVM * \sin(\theta) * g$$

where,
F_{gr} = Gradient force [N]
GVM = Gross vehicle mass
Θ = Angle of inclination with respect to the horizontal [degrees]
g = Acceleration due to gravity (9.81 m/s^2)

- **Rolling resistance force**

Rolling resistance, sometimes called rolling friction or rolling drag, is the force resisting the motion when a body (such as a ball, tire, or wheel) rolls on a surface. Rolling resistance force is the product of gross vehicle weight and the rolling resistance coefficient. The coefficient of rolling resistance, which has the dimension of length, is approximately equal to the value of the rolling resistance force times the radius of the wheel divided by the wheel load. The coefficient of rolling resistance value depends on the wheel and road material. This value differs for every road surface and tyre conditions.

Figure 4 gives an overview and understanding of rolling resistance force for different road surfaces and forces acting on a tyre of a moving vehicle.

C_{rr}	Surface
0.001 - 0.0025	steel wheels on steel rails
0.0015 - 0.0025	bicycle tires
0.006 - 0.01	truck tire on asphalt
0.01 - 0.015	ordinary car tires on concrete
0.03	car tires on tar or asphalt
0.2 - 0.4	car tire on loose sand

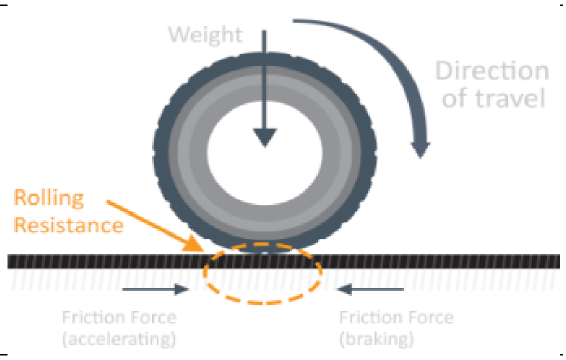


Figure 4 ***C_{rr} with respect to road surface and forces acting on tyre***

$$F_r = C_{rr} * GVM * g * Cos(\theta)$$

where,
Fr = Rolling resistance force [N]
GVM = Gross vehicle mass [N]
C_{rr} = Coefficient of rolling friction
Θ = Angle of inclination with respect to the horizontal [degrees]

g = Acceleration due to gravity (9.81 m/s^2)

- **Acceleration force**

Acceleration force is the force that helps the vehicle to reach a predefined speed from rest in a specified period of time.

$$\mathrm{F_{acc}} = \mathrm{GVM} * \mathrm{a}$$

where,
F_{acc} = Acceleration force [N]
GVM = Gross vehicle mass [kg]
a = Acceleration [m/s^2]

- **Total tractive force**

Total tractive effort is the total force that the vehicle needs to provide to the wheel in order to move the vehicle. The total tractive effort value does not represent for a single wheel, but it represents the total force that needs to be provided to move the vehicle.

$$T_{TF} = \mathrm{F}_a + \mathrm{F}_{gr} + \mathrm{F}_r + \mathrm{F}_{acc}$$

where,
T_{TF} = Total tractive force [N]
F_r = Rolling resistance force [N]
F_{gr} = Gradient force [N]
F_a = Aerodynamic force [N]
F_{acc} = Acceleration force [N]

- **Total tractive force with efficiency**

$$T_{TF} \text{ with Efficiency} = \frac{T_{TF}}{\text{Efficiency}}$$

- **Wheel torque**

The torque that is required on the wheel to produce the required drive characteristics is given by

$$\mathrm{T_W} = \mathrm{T_{TF}} \text{ with efficiency} * \mathrm{r_W}$$

where,
Tw = Torque of the wheel [Nm]
T_{TF} = Total tractive force [N]
r_w = Radius of the wheel [m]

- **Motor power**

Motor power is the power consumed by the motor.

$$P_{motor} = \frac{T_{TF} \text{ with efficiency} * v}{1000}$$

Where,
P_{motor} = Motor power [kW]
v = Vehicle speed [m/s]

2.4 Parameters considered while motor sizing

2-Wheeler parameters

Table 8 below mentions the parameters that were used to calculate the motor sizing requirements of 2-wheeler category. These standard parameters are selected based on the engineering handbooks like "Fundamentals of Vehicle Dynamics" or "Vehicle Dynamics and Control" after cross verification with the actual vehicle.

1. Parameters table

Parameters	Scooter	Motorcycle
Density	1.16	1.16
Area	0.75	0.75
Drag coefficient	0.7	0.9
Rolling resistance	0.015	0.015
Diameter of wheel	0.355	0.632
Efficiency	0.9	0.9
Mass (Case 1: Single seated)	200	200
Mass (Case 2: Double seated)	270	270

Table 8 ***Parameters considered for motor sizing of 2-wheeler***

Speed (Km/h)	Gradient (^{0})
0 to 6	12
8 to 10	7
11 to 12	5
13 to 15	3
15 to 22	2
23 to 28	1
29 to 60	0

Table 9 ***Speed & gradient consideration for 2-wheeler motor sizing***

Table 9 mentions the maximum speed a vehicle can achieve if the vehicle needs to climb certain gradient angle.

Refer **SECTION 5 OF 8.1 (ANNEXURE 2) Pg. no. 70** of this report, for detailed overview of performance goals, scenarios for sizing of 2-wheeler and 3-wheeler, **SECTION 6 OF 8.1 (ANNEXURE 2) Pg. no. 72** of this report, for motor sizing simulations of 2-wheeler (scooter and motorcycle).

Refer **SECTION 7 OF 8.1 (ANNEXURE 2) Pg. no. 72** of this report, for MATLAB generated model for powertrain calculation and battery pack power calculation.

Refer **SECTION 8 OF 8.2 (ANNEXURE 2) Pg. no. 74** of this report, for results of motor sizing for 2-wheeler category vehicle which are the outcomes achieved based on the parameters mentioned in **SECTION 5, 6, 7**, ***Table 8*** and ***Table 9.***

<u>3-Wheeler parameters</u>

Table 10 below mention the parameters that were used to calculate the motor sizing requirements of 3-wheeler category. These standard parameters are selected based on the engineering handbooks like "Fundamentals of Vehicle Dynamics" or "Vehicle Dynamics and Control " after cross verification with the actual vehicle.

2. Parameters table

Parameters	Passenger	Cargo
Density	1.16	1.16
Area	2.35	2.35
Drag coefficient	0.31	0.9
Rolling resistance	0.015	0.015
Diameter of wheel	0.48	0.632
Efficiency	0.8	0.9
Mass (Case 1: Unloaded)	380	450
Mass (Case 2: Fully loaded)	900	1000
Gear ratio	1:14	1:14

Table 10 ***Parameters considered for motor sizing of 3-wheeler***

Speed	Gradient (^{0})
0 to 6	12
8 to 10	7
11 to 12	5
13 to 15	3
15 to 22	2
23 to 28	1
29 to 60	0

Table 11 ***Speed & gradient consideration for 3-wheeler motor sizing***

The ***Table 11*** above mentions the maximum speed a vehicle can achieve if the vehicle needs to climb certain gradient angle.

Refer **SECTION 5 OF 8.1 (ANNEXURE 2) Pg. no. 70** of this report, for detailed overview of performance goals, scenarios for sizing of 2-wheeler and 3-wheeler, **SECTION 9 OF 8.2 (ANNEXURE 2) Pg. no. 85** of this report, for motor sizing simulations of 3-wheeler (Passenger and Cargo).

Refer **SECTION 7 OF 8.1 (ANNEXURE 2) Pg. no. 72** of this report, for MATLAB generated model for powertrain calculation and battery pack power calculation.

Refer **SECTION 10 OF 8.3 (ANNEXURE 2) Pg. no. 86** of this report, for results of motor sizing for 3-wheeler category vehicle which are the outcomes achieved based on the parameters mentioned in **SECTION 5, 9, 7**, ***Table 10*** and ***Table 11.***

2.5 Motor Sizing Summary

Overview

This report summarizes the performance testing results of various electric motors under different conditions for scooters, motorcycles, and three-wheeler vehicles. The data covers tests conducted under different drive cycles, scenarios, and gradients, providing insights into motor torque, power output, and availability in the market.

3. Vehicle Categories and Testing Conditions

Table 12 below mentions the summary of required motor power (nominal) w.r.t the calculations carried out.

Vehicle Category	**Drive Cycle**	**Conditions**	**Gradients** (0^o - 12^o)	**Nominal Motor Power Required (kW)**
Scooter	MIDC & WLTP	Loaded & Unloaded	Zero & Combined	1.96
Motorcycle	MIDC & WLTP	Loaded & Unloaded	Zero & Combined	2.15
3-Wheeler Passenger	MIDC & WLTP	Loaded & Unloaded	Zero & Combined	3.7
3-Wheeler Cargo	MIDC & WLTP	Loaded & Unloaded	Zero & Combined	4.06

*Table 12 **Summary of vehicle categories, required motor power & torque***

Performance Analysis

- **Scooters**: Require motors with moderate power and torque. The market availability is generally sufficient, but the higher torque needs are well-met with up to 60 Nm available.

- **Motorcycles**: Demand higher power and torque. Market availability for high-torque motors is robust, with up to 70 Nm available.

- **3-Wheeler Passenger**: Moderate to high power and torque requirements. The market availability meets the moderate power needs but may be limited for higher power requirements.

- **3-Wheeler Cargo**: Highest power and torque requirements among the tested vehicles. The market availability is substantial, especially for high-torque motors.

2.6 List of Available retro-fitment kits and vendors in market (as of March-April 2024)

Table 13 below mentions the list of available retro-fitment kit in market. Fields highlighted in GREEN are the kits procured and tested under this project.

Category	Available Solutions	Motor Power		Battery Configuration	Battery Option	Transmission type	Range	Top Speed	Max. Gradeability (degrees)	Speed @ gradeability	Tentative Price
		Nominal	Peak								
2-Wheeler Motorcycle	1	2	3.94	72V 40ah	Fixed	Hub Motor	80-85	70	Upto 12	15-20	**1,05,500**
	2	2.65	5.6	72V 35ah	Fixed	Hub Motor	70-80	80	Upto 12	20-25	**1,00,500**
	3	2	3	60V 42ah	Fixed	Traction Motor	50-60	75	Upto 12	15-20	**77,300**
	4	1.5	2.5	60V 35Ah	Fixed	Traction Motor	50-60	50	NA	15-20	**54,900**
2-Wheeler Scooter	1	1.2	2.3	72V 40ah	Fixed	Hub Motor	90-100	55	Upto 3-5	05-10	**93,700**
	2	1.2	2.3	72V 21Ah	Fixed	Hub Motor	40-50	50	Upto 3-5	05-10	**59,000**
	3	2	3.5	72V 35ah	Fixed	Hub Motor	80-90	70	Upto 12	20-25	**87,500**
	4	2	3	60V 42ah	Fixed	Traction Motor	50-60	55	Upto 12	15-20	**77,300**
	5	1.5	2.5	60V 35Ah	Fixed	Traction Motor	50-60	50	NA	15-20	**54,900**
	6	3	5.5	48v 50ah	Portable	Hub Motor	60	75	NA	25-30	**67,500**
3-Wheeler Passenger	1	3	6.5	48V 100Ah	Fixed	2 speed gearbox	60	50	Upto 12	15-20	**1,88,000**
	2	4	7	48V 200Ah	Fixed	Single speed gearbox	100-110	55	Upto 12	25-30	**2,50,000**
	3	4.4	10	48V 200Ah	Fixed	2 speed gearbox	80-90	50	Upto 12	20-25	**2,47,000**
	4	3	6	60V 100ah	Fixed	2 speed gearbox	85	50	NA	15-20	**2,00,000**
3-Wheeler Cargo	1	3	6.5	48V 200Ah	Fixed	2 speed gearbox	60	55	Upto 12	15-20	**2,67,000**
	2	4	7	48V 200Ah	Fixed	Single speed gearbox	100-110	60	Upto 12	20-25	**2,50,000**
	3	4.4	10	48V 200Ah	Fixed	2 speed gearbox	80-90	50	Upto 12	15-20	**2,47,000**
	4	3	6	60V 100ah	Fixed	2 speed gearbox	75	50	NA	15-20	**2,40,000**

Table 13 ***Available retro-fitment kits***

*** The prices mentioned in above table are tentative & incl. of all taxes. This prices may vary based on market conditions in future.**

2.7 Kits procured as per proposed solution

Following 3 different retrofit solutions for all category of vehicles are proposed:

• **Retrofit Solution 1:** Integration of certified retro-fitment kit (as per AIS-123) available with kit manufacturer for 1 set of all finalized 2-wheeler as well as 3-wheeler vehicles.

• **Retrofit Solution 2 & 3:** Development of scalable retro-fitment kit. In these solutions, all components required for kit, were procured independently and integrated into the vehicle.

The ***Table 14*** **Proposed retro-fitment kit for all category of vehicles** below highlights the specifications of the variety of retro-fitment kits available in market for conversion of a conventional vehicle into electric vehicle. The table specifies the solutions opted for vehicles, category-wise.

Category	Vehicle	Retro-fitment Solution 1	Retro-fitment Solution 2	Retro-fitment Solution 3
Motorcycle	Splendor	Hub Type Motor: 2 kW (Peak 3.94 kW) Battery pack: 72V 40Ah (2.8kWh) (Certified Kit)	Hub Type Motor: 2.65 kW (Peak 5.6 kW) Battery pack: 72V 35Ah (2.5kWh) (Certified Motor Kit)	Traction Type Motor: 2 kW (Peak 3 kW) Battery pack: 60V 42Ah (2.5kWh) (Certified Battery pack Pack)
Scooter	Activa	Hub Type Motor: 1.2 kW (Peak 2.3kW) Battery pack: 72V 40Ah (2.8kWh) (Certified Kit)	Hub Type Motor: 2 kW (Peak 3.51 kW) Battery pack: 72V 35Ah (2.5kWh) (Not Certified)	Traction Type Motor: 2 kW (Peak 3 kW) Battery pack: 60V 42Ah (2.5kWh) (Certified Battery pack Pack)
3-Wheeler (Passenger)	Bajaj RE, Piaggio Ape xtra, Piaggio Ape City	Motor: 3 kW (Peak 6.5 kW) Battery pack: 48V 100Ah (4.8kWh) (Certified Kit)	Motor: 4 kW (Peak 7 kW) Battery pack: 48V 200Ah (9.6kWh) (Certified Battery pack Pack)	Motor: 4.4 kW (Peak 10 kW) Battery pack: 48V 200Ah (9.6kWh) (Certified Kit)
3-Wheeler (Cargo)	Bajaj Maxima, Piaggio Ape Xtra Ld	Motor: 3 kW (Peak 6.5 kW) Battery pack: 48V 200Ah (4.8kWh) (Certified Kit)	Motor: 4 kW (Peak 7 kW) Battery pack: 48V 200Ah (9.6kWh) (Certified Battery pack Pack)	Motor: 7.5 kW (Peak 12 kW) Battery pack: 48V 200Ah (9.6kWh) (Certified Kit)

Table 14 ***Proposed retro-fitment kit for all category of vehicles***

Refer **SECTION 11 OF 8.4 (ANNEXURE 2) Pg. no. 96** of this report, for images and details of kits (Solution-wise).

MILESTONE 3: FITMENT OF RETRO-FITMENT KIT, BATTERY PACK ON VEHICLE

This milestone covers the fitment/integration of retro-fitment kit components procured for 2-wheeler and 3-wheeler category including the battery pack & wiring harness integration.

3.1 Compliance and regulations

1. Homologation requirement and environmental resistance

Below mentioned homologation tests are required for a retro-fitment kit to be certified for use, in 2-wheeler and 3-wheeler category. These tests also involve conditions imitating environmental scenarios, so that the components are subject to water, dust and other environmental factors that the vehicle might encounter during real world use.

2. Noise and vibration

The retro-fitment kit components should be tested against safety, emission norms, vibration levels as mentioned in the ***Table 15*** **Homologation requirements** below. No additional noise or vibration is observed in the retro-fitted vehicle. But, in some cases, the chain drive mechanism noise can be heard clearly. Same noise is generated in an ICE vehicle as well, but is not discretely audible due to higher engine noise. Retro-fitment of a vehicle should comply to AIS-123 for optimum performance and safety.

3. Certification requirements for retro-fitment

Table 15 **Homologation requirements** highlights the types of certification requirement of a retro-fitment kit. All types of tests mentioned in below table comes under model level / component level certifications required for retro-fitment kit as per AIS-123 (Part 3).

Types of homologation testing	
Vehicle weighment	Code of practice for retro-fitment
Gradeability	Traction motor (measurement of net power & max. 30 min. power & speed)
Brakes	Measurement of electrical energy consumption
Pass-by noise level	Environmental validation tests for traction motor
Tell-tale symbols and controls (for switch box)	Thermal shock test
EMC	Media resistance test
Requirements for constructional and functional safety	Impact test
Requirements for rechargeable energy storage system (REESS)	Dust test
Wiring harness / Cables / Connectors	Water immerse test

Table 15 ***Homologation requirements***

3.2 Kit Integration and removal of unwanted parts

2-Wheeler

Table 16 lists out the components to be removed from 2-wheeler which are unwanted and will make it easy to get the vehicle retro-fitted with new electric kit.

Step	Sub-Step/Action	Description
1	**Preparation**	
1.1	Safety first	Ensure the bike is on a stable stand, wear safety gear.
1.2	Disconnect the battery pack (12V)	Disconnect it to avoid any electrical hazards.
2	**Removing unwanted parts**	
2.1	Fuel system	
2.2	Drain the fuel	Safely drain any remaining fuel from the tank.
2.3	Remove the fuel tank	Use a wrench to remove bolts securing the tank.
2.4	Remove carburettor	Disconnect and remove carburettor/fuel injectors.
2.5	Remove fuel lines	Remove any fuel lines and fuel pump.
2.6	Exhaust system	
2.7	Remove exhaust pipe	Unbolt and remove the exhaust pipe and muffler.
2.8	**Engine & wiring**	
2.9	Disconnect wiring	Label and disconnect all wiring connection.
2.10	Remove mounting bolts	Use a socket set to remove engine mounting bolts.
2.11	Remove engine	Carefully lift the engine out of the frame.
2.12	Powertrain controls	
2.13	Throttle & cable	Remove throttle and its cable gently.
2.14	Clutch & cable	Remove clutch cable.
2.15	**Air intake system**	
2.16	Remove air filter and intake	Remove the air filter box and intake tubing.
2.17	**Mountings/brackets**	
2.18	12V battery pack bracket	Remove the 12V battery pack bracket attached below the seat.
2.19	Engine bracket	Remove the engine bracket from the chassis.

Table 16 ***Steps of removing unwanted parts from 2-wheeler***

Table 17 **Process of integration in 2-wheeler** below highlights the process of integrating a 2-wheeler with the retro-fitment solutions provided.

Step	Sub-Step/Action	Description
1	**Preparation**	
1.1	Safety first	Ensure the bike is on a stable stand, wear safety gear.
1.2	Body parts	Ensure all body parts are removed so as to access the bike frame completely.
2	**Swing Arm (Solution 1 & 2)**	
2.1	Replacement	Replace the old swing arm of the vehicle with the new swing arm provided with the kit.
2.1	Motor	Mount the motor into the swing arm with the attachments provided in the kit. Tighten the motor with ny-lock or metal lock nuts only.
2.2	Controller & Dc-Dc	Mount the controller, Dc-Dc in the 12V battery pack compartment of the chassis, use of bolts is recommended instead of zip-ties.
2.3	Throttle, Switch Box	Mount the throttle and switch box on the handle bar firmly (provided with internal bolts).
2.4	Battery Meter (BM)	Mount the battery meter in the odometer; the fuel indicator needs to be removed and the BM needs to be fixed.
2.5	Battery pack box	Fix the battery pack box in the engine compartment (use of Ny-lock or metal lock nuts is recommended).
2.6	Battery pack	Place the battery pack inside the battery pack box and check for any loose fittings.
2.7	Wiring layout	Fix the wiring harness on the chassis of the vehicle with the use of zip-ties.
2.8	Connections	Follow the connection diagram provided with the kit and refer ***Figure 72*** for detailed architecture.
2.9	Battery pack connection	Connect the battery pack with the opposite connector on the wiring harness.
2.10	Ramp test	Start the vehicle on ramp and check for any faults; run the motor on ramp itself.
2.11	Physical testing	After ensuring everything to be normal test the vehicle on normal conditions for 1-2 km.
2.12	PDI	Pre-check everything before delivering the vehicle to the customer.

Table 17 ***Process of integration in 2-wheeler***

3-Wheeler

***Table 18* Steps of removing unwanted parts from 3-wheeler** lists out the components to be removed from 3-Wheeler which are unwanted and will make it easy to get the vehicle retro-fitted with new electric kit.

Step	Sub-Step/Action	Description
1	**Preparation**	
1.1	Safety first	Ensure the bike is on a stable stand, wear safety gear.
1.3	Disconnect the battery pack (12V)	Disconnect 12V battery pack to avoid any electrical hazards.
2	**Removing unwanted parts**	
2.1	**Fuel system**	
2.2	Drain the fuel	Safely drain any remaining fuel from the tank.
2.3	Remove the fuel tank	Use a wrench to remove bolts securing the tank.
2.4	Remove Carburettor	Disconnect and remove carburettor/fuel injectors.
2.5	Remove fuel lines	Remove any fuel lines and fuel pump.
2.6	**Exhaust system**	
2.7	Remove exhaust pipe	Unbolt and remove the exhaust pipe and muffler.
2.8	**Engine & wiring**	
2.9	Disconnect wiring	Label and disconnect all wiring connections.
2.10	Remove mounting bolts	Use a socket set to remove engine mounting bolts.
2.11	Remove engine	Carefully lift the engine out of the frame.
2.12	**Transmission**	If applicable.
2.13	Disconnect transmission	Unbolt and remove the transmission.
2.14	**Powertrain controls**	
2.15	Throttle & cable	Remove throttle and its cable gently.
2.16	Clutch & cable	Remove clutch cable.
2.17	Gear & cable	Remove gear cable gently.
2.18	**Air intake system**	
2.19	Remove air filter and intake	Remove the air filter box and intake tubing.

Table 18 ***Steps of removing unwanted parts from 3-wheeler***

Table 19 **Process of integration in 3-wheeler** below highlights the process of integrating a 3-wheeler with the retro-fitment solutions provided.

Step	Sub-Step/Action	Description
1	**Preparation**	
1.1	Safety first	Ensure the vehicle handbrake is fully pulled, wear safety gear.
1.2	Body parts	Ensure all body parts are removed so as to access the vehicle frame completely
2	**Component integration**	
2.1	**Motor bracket mounting & other required fabrication for component mountings**	For this process welding of bracket is recommended to avoid any further accidents: A. With reference to the detailed drawing and CAD diagrams mark out the mounting points of brackets to be welded on the vehicle frame. B. After marking, place the rear brackets on its position and check out for its inclination level with the help of digital or water level meter. C. Once the inclination in all axes comes to 0^o w.r.t the frame, fix the bracket firmly onto the frame with the help of c-clamps or any other tightening clamps available. D. Later, the rear bracket can be welded using MIG or TIG Welding (ARC welding is not recommended). E. Mount the front bracket of motor on the mounting points provided for engine in passenger vehicle. F. For cargo vehicle the front bracket of the motor needs to be welded to the frame. G. Once both the brackets are welded, mount the motor kit with the gearbox on the brackets to check for any faults; if everything is ok proceed further. H. After this, re-work in transmission shafts is required. I. Cut the old shafts of the vehicle from exact centre; attach the cut shafts with the output shaft of gearbox and the other one with the hub of the vehicle. J. Align both cut shafts to measure the required length; once the length of shafts gets finalised weld them using sleeve joining process (Refer ***Figure 82***) (Grinding of sleeve welds is not recommended in order to achieve smooth finish). K. Base support plates for battery pack need to be welded on the frame in the rear side above motor controller in case of passenger vehicle (similar to that of motor brackets). L. Cover or remove the motor controller kit before welding the battery pack base plates. M. In case of cargo vehicle, the battery pack needs to be mounted on the rear side of driver cabin under the cargo box.

Step	Sub-Step/Action	Description
		N. The cargo box mounting height needs to be raised 20mm above from the previous mounting height, for this, metal spacer (rectangular in shape) of 20mm needs to be welded on the previous mounting points matching the centroid of hole in spacer and hole of mounting point. O. Once motor, controller, transmission shafts and battery pack get mounted firmly on the vehicle, lay the wiring harness of the kit and the vehicle and tighten it with the frame using zip-ties. P. Connect the harness by following the process mentioned in ***Table 20***.
2.2	Throttle, Switch Box	Mount the throttle and switch box on the handle bar firmly (Provided with internal bolts).
2.3	Odometer	Mount the odometer provided with the kit in the dashboard of the vehicle.
2.4	Connections	Follow the connection diagram provided with the kit and refer ***Figure 72*** for detailed architecture.
2.5	Battery pack connection	Connect the battery pack with the mating connector on the wiring harness.
2.6	Ramp test	Power on the vehicle on ramp and check for any faults while running the motor on ramp itself.
2.7	Frame attachment	Attach the frame of the vehicle on the chassis once everything is cross checked and have no faults.
2.8	Physical testing	After ensuring everything to be normal, test the vehicle on normal conditions for 1-2 km.
2.9	PDI	Pre-check everything before delivering the vehicle to the customer.

Table 19 ***Process of integration in 3-wheeler***

Refer **SECTION 12 OF 9.1 (ANNEXURE 3) Pg. no. 98** of this report, for images of kits integrated on 2-wheeler and 3-wheeler (3D cad models).

3.3 Wiring architecture guidelines for 2 & 3-wheeler category

Table 20 **Guidelines for Integration of wiring harness for 2-wheeler and 3-wheeler vehicles** enumerates the guidelines needed to be considered for integration of wiring harness of 2-wheeler & 3-wheeler retro-fitment kit with aux. supply line (available on the 2 & 3-wheeler)

Step No.	Guidelines
1	Connect the phase wires of motor with the motor controller. Colour code (Green-Green, Blue-Blue, Yellow-Yellow).
2	Connect the hall sensor pin of motor to motor controller. Colour Code (Red-Red, Black-Black, Green-Green, Yellow-Yellow, Blue-Blue).
3	Connect the throttle with the motor controller. Colour Code: (Red-Red, Green-Green, Black-Black).
4	Connect the switch box socket with the controller matching socket.

5	Connect the key lock wire provided in the controller with the return line of key switch available in the vehicle.
6	Connect the red (input) line of dc-dc converter with the return line of key switch.
7	Connect the black wire of DC-DC with the common ground wire.
8	The main input line of MCB should be occupied with a connector compatible with the battery pack connector.
9	Connect the output of MCB with controller's positive terminal and then with the input wire of key switch.
10	Connect the common ground wire (Black) to controller's negative terminal and then with black wire of the connector connected with the MCB.
11	Connect the negative wire of 12V line with the common ground (usually green or black).
12	Connect the yellow wire of DC-DC with positive wire of 12V line.
13	Connect the input line of key switch with the output line of MCB.
14	Once all connections are done connect the battery pack connector with the connector on MCB side.
Note: In case of 3-wheeler replace the MCB with a contactor. Rest all connections remain same.	

Table 20 ***Guidelines for Integration of wiring harness for 2-wheeler and 3-wheeler vehicles***

Refer **SECTION 13 OF 9.2 (ANNEXURE 3) Pg. no. 102** of this report, for detailed architecture of wiring harness integration for 2-wheeler & 3-wheeler, and index details of wiring architecture.

3.4 Two-wheeler kit integration mountings/alterations

Retro-fitment Solution 3 (Motorcycle)

For the integration of the retrofit solution 3 into the vehicle, modifications to the body frame (secondary members) have been performed. These alterations include:
- Removing the engine mounting bracket.
- Reshaping the connecting plates.
- Welding the base structure onto the frame for motor mounting.
- Reshaping the engine support member into a rectangular shape to create space for a safe and sturdy placement of the battery bracket.

Refer **SECTION 14 OF 9.3 (ANNEXURE 3) Pg. no. 104** of this report, for images of integration & alterations performed on motorcycle for retro-fitment solution 3

Retro-fitment Solution 3 (Scooter)

For the integration of retrofit solution 3 into the vehicle, modifications to the body frame (secondary members) have been performed. These alterations include:
- Removing the engine mounting bracket.
- Adding a shock absorber mounting to the frame through welding.
- Attaching an external swing arm reconstructed with a motor mounting plate.
- Using a front wheel rim attached with a plate and a hub to integrate the chain sprocket mechanism on the rear wheel side of the vehicle.

- Minor material removal from plastic case below the seat for comfortable fitment of battery pack and facilitating easily locking of the seat.

Refer **SECTION 15 OF 9.3 (ANNEXURE 3) Pg. no. 106** of this report, for images of integration & alterations performed on scooter for retro-fitment solution 3

3.5 Three-wheeler kit integration mountings/alterations

Retro-fitment Solution 2 & 3 (Cargo Vehicle)

A series of similar alteration work is required for the 3-wheeler segment of cargo vehicles to facilitate the integration of EV components. Except for the retrofit kit mounting brackets, the common modifications needed include:

Increasing the height of the mounting point of the cargo box:

- To accommodate the battery pack under the cargo box, the height of the mounting point needs to be increased.
- This can be achieved by welding a rectangular spacer made of metal, with dimensions of 3 inches (L) x 1.5 inches (b) x 20 mm (h).

Accessing the battery pack for repairs:

- A rectangular cut on the base plate of the cargo box is required to create a cover for the battery pack, allowing easy access for repairs.

Modifying the transmission system:

- Once the transmission system is integrated into the vehicle, the length of the transmission shafts needs to be adjusted to connect the wheels to the gearbox output.
- This is accomplished by changing the previous transmission shaft length using the sleeve integration method.
- These alterations ensure that the components of the EV are easily integrated into the vehicle.
- The sleeve integration method is done by welding a bush having 2mm thickness and internal diameter equal to the external diameter of transmission shaft.
- The bush is welded in such a way that it holds the transmission shaft inline for optimum power transmission from gearbox to wheels.

Refer **SECTION 16 OF 9.4 (ANNEXURE 3) Pg. no. 108** of this report, for images of integration & alterations performed on cargo vehicle for retro-fitment solution 2 & 3.

3.6 Integration of retro-fitment kits

2-Wheeler Segment

The ***Figure 5*** below shows the integration of retro-fitment kit into 2-wheeler segment, solution-wise:

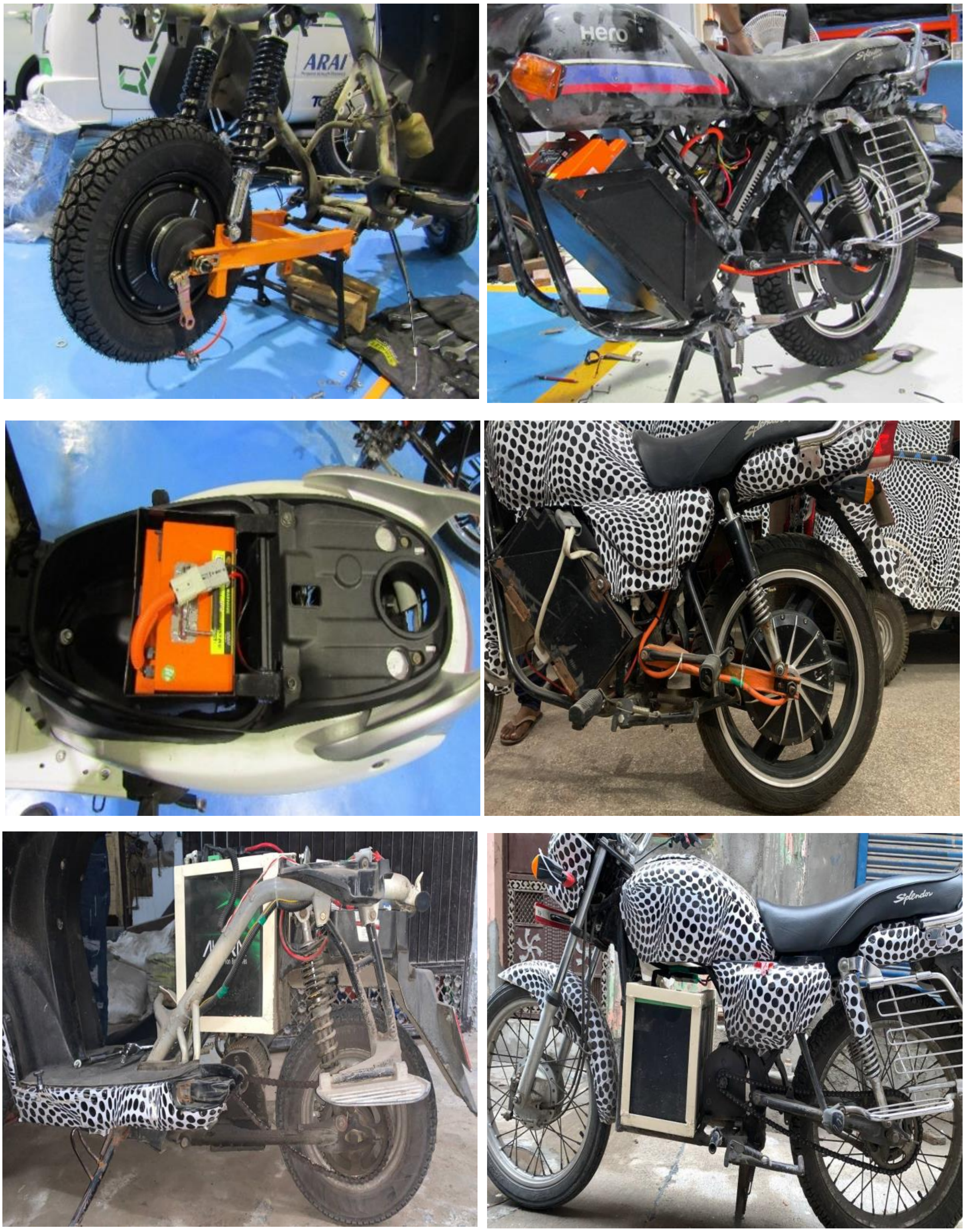


Figure 5 ***All retro-fitment solutions (2-wheeler)***

3-Wheeler

The ***Figure 6*** below shows the integration of retro-fitment kit into 3-wheeler segment, solution-wise:

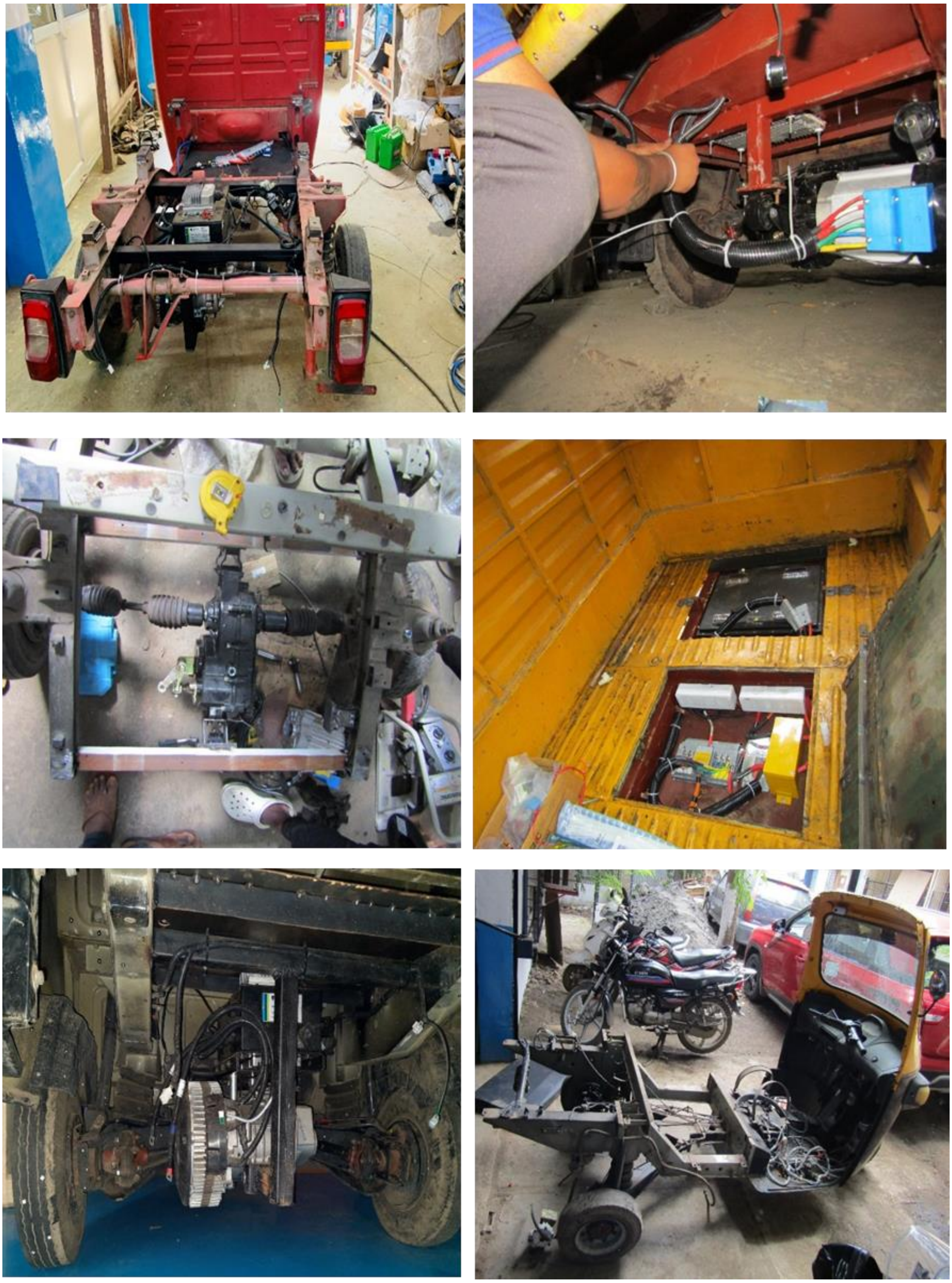


Figure 6 ***All retro-fitment solutions (3-wheeler)***

3.7 Force calculation and static analysis of motor kit bracket

Rear motor bracket jerk force analysis

To calculate the forces acting on the bracket and the c-clamp holding the motor gearbox assembly, we need to consider both static and dynamic conditions. Here's a step-by-step approach:

1. Static analysis

Firstly, let's analyse the static forces due to the weight of the motor gearbox assembly.

Weight of motor gearbox assembly (W):

$W = 50\ kg \times 9.81\ m/s^2 = 490.5\ N$

This weight acts vertically downwards through the centre of gravity of the motor gearbox assembly.

2. Dynamic analysis

Next, we need to consider the forces acting on the bracket when the vehicle experiences a jerk or sudden acceleration. This will depend on the acceleration/deceleration of the vehicle and the gravitational force.

Assumptions for dynamic analysis:

- The vehicle undergoes sudden deceleration or acceleration which can be considered as a jerk.
- We assume a maximum deceleration/acceleration (jerk) equal to the gravitational force (i.e., $1g = 9.81\ m/s^2$) for worst-case analysis.

Dynamic force due to jerk:

$F_{jerk} = \text{mass} \times \text{acceleration}$

$F_{jerk} = 50\ kg \times 9.81\ m/s^2 = 490.5\ N$

So, the total force acting on the bracket during a jerk would be the sum of the static force and the dynamic force:

$F_{total} = W + F_{jerk} = 490.5\ N + 490.5\ N = 981\ N$

3. Force acting on the c-clamp

The c-clamp is holding the motor gearbox assembly, and the forces acting on it will be transferred to the bracket. In case of a jerk, the force acting on the c-clamp can be considered the same as the total force acting on the bracket.

Force on c-clamp during jerk:

$F_{C\text{-}clamp} = F_{total} = 981$ N

Summary

- **Static force due to weight of motor gearbox:** 490.5 N
- **Dynamic force due to jerk:** 490.5 N
- **Total force acting on the bracket during jerk:** 981 N
- **Force acting on the c-clamp during jerk:** 981 N

Figure 7 below shows the generated cad model of motor mounting rear bracket common for solution 2 & 3.

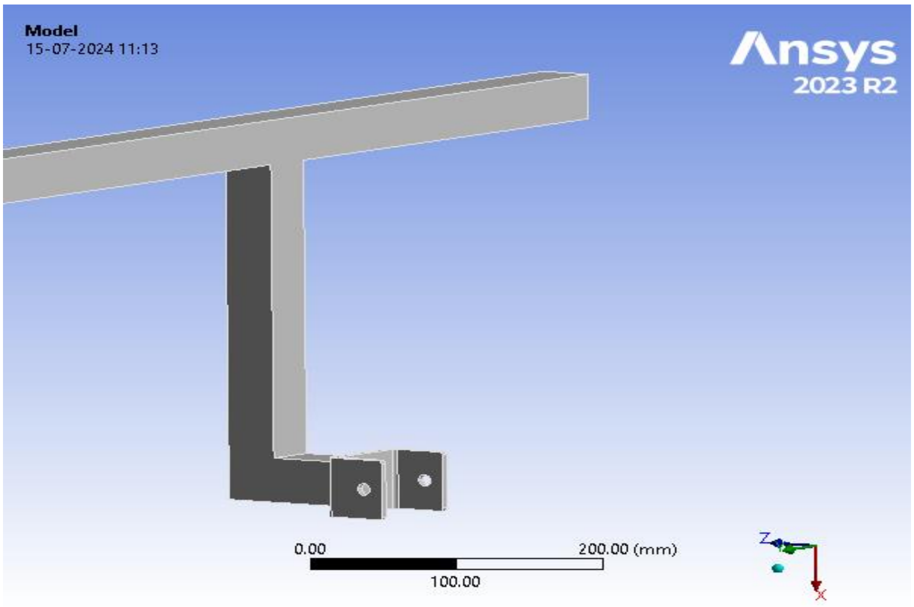


Figure 7 ***Motor mounting rear bracket for retro-fitment solution 2 & 3***

Refer **SECTION 17 OF 9.5 (ANNEXURE 3) Pg. no. 111** of this report, for results of deformation and stress analysis of motor mounting rear bracket.

Figure 8 below shows the motor mounting front bracket for solution 2:

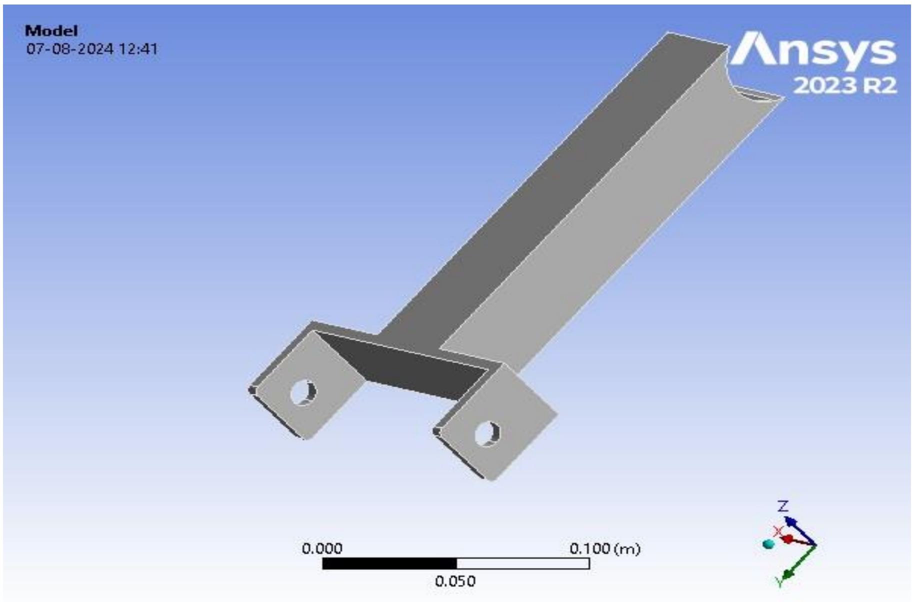


Figure 8 ***Motor mounting front bracket for retro-fitment solution 2***

Refer **SECTION 18 OF 9.6 (ANNEXURE 3) Pg. no. 113** of this report, for results of deformation and stress analysis of motor mounting front bracket.

3.8 Sprocket force calculation and analysis

To calculate the forces acting on the sprocket and determine the forces required for total deformation and stress analysis, we need to follow several steps involving the principles of mechanics and dynamics.

Step 1: Determine the torque on the sprocket

Given:

- Motor torque, $T = 31$ Nm
- Number of teeth on driving sprocket, $t_1 = 9$
- Number of teeth on driven sprocket, $t_2 = 43$

Using the gear ratio:

Gear ratio = $t_2 / t_1 = 43/9$

The torque on the rear sprocket:

$T_r = T\times(t_2/t_1) = 31\times43/9 = 148.11$ Nm

Step 2: Determine the chain tension

The chain tension F can be calculated using:

$F = t_1/r$

where r is the pitch radius of the sprocket. The pitch radius r can be approximated by:

$d = t_1 \times (p/\pi)$

where d is the diameter of the pitch circle. The pitch circle diameter for the driving sprocket is typically related to the number of teeth and the pitch p.

For a typical chain pitch (assuming p=12.7 mm for a standard bicycle chain):

$d = 9\times (12.7/\pi) = 36.4$ mm; $r = 36.4/2 = 18.2$ mm

So, the chain tension F is:

$F = 148.11/0.0182 = 8133$ N

Step 3: Calculate the forces acting on the sprocket teeth

The force acting on each tooth of the sprocket: $F_{tooth} = F/t_1 = 8133/9 = 903.67$ N

Stress analysis

For stress analysis, we have considered the material properties of EN9 steel:

- Yield strength (σ_y) of EN9: 465 MPa
- Ultimate tensile strength (σ_u) of EN9: 700 MPa

Figure 9 shows the cad model of sprocket for solution 3 (2-wheeler):

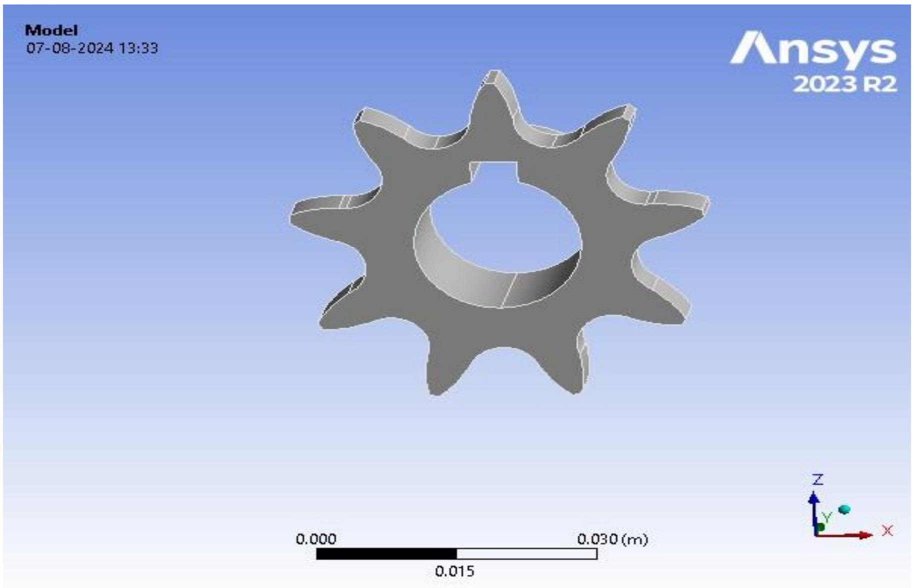


Figure 9 ***Sprocket for retro-fitment solution 3 (2-wheeler)***

Refer **SECTION 19 OF 9.7 (ANNEXURE 3) Pg. no. 115** of this report, for deformation and stress analysis of sprocket 2 for retro-fitment solution 3.

3.9 DAQ integration and configuration

As per scope of work, we had to integrate all vehicles with IoT based devices for gathering performance data and monitoring vehicle during run-time. Also, a cloud-based system for data transfer and acquisition was to be provided.
The data parameters to be captured to gauge the vehicle performance were finalized as:
a. Throttle – against driver input
b. Current and Voltage – to calculate power
c. Vehicle longitudinal speed
d. Geographic position with altitude – to capture terrains traversed
e. Ignition – to know vehicle on/off status

From the above parameters, throttle and ignition were to be tapped from the vehicle wiring connections, whereas, current and voltage were to be measured by sensors. The speed and geographic positions were to be provided by a data acquisition (DAQ) device, by using the GPS technology.

3.9.1 Selection of DAQ

Based on above considerations, a data acquisition device (DAQ) (shown in ***Figure 10***). Was selected with 4G (LTE Cat 1) network coverage including 3G (UMTS), 2G (GSM) fallback compatibility. Device is equipped with GNSS and LTE modules, external GNSS and LTE antennas. It has 4 digital inputs, 4 analog inputs, 3 digital outputs and provision for CAN inputs as well.

Figure 10 ***Sample DAQ product image***

Refer **SECTION 20 OF 9.8 (ANNEXURE 3) Pg. no. 117** of this report, for DAQ product specification.

3.9.2 DAQ configuration

The DAQ device was configured in subsequent sections to capture the various data parameters, at a set frequency, as per our requirements. Also, these records were sent to a cloud server set-up in ARAI premises.

Refer **SECTION 21 OF 9.9 (ANNEXURE 3) Pg. no. 120** of this report, for details of sections in which DAQ device was configured.

3.9.3 List of sensors

3.9.3.1 Current sensor - (Hall sensor based)

Figure 11 ***Current sensor***

Refer **section 22 pg. no. 122** of this report, for specifications of current sensor.

3.9.3.2 Stepdown Voltage Regulator (12 to 5V)

Figure 12 ***Stepdown voltage regulator***

Refer **section 23 pg. no. 123** of this report, for details of stepdown voltage regulator.

3.9.3.3 Voltage Detection Module

Figure 13 ***Voltage detection module***

Refer **section 24 pg. no. 123** of this report, for details of voltage detection module.

3.9.4 Wiring harness layout & DAQ pinout

Figure 14 shows the wiring harness architecture od DAQ system.

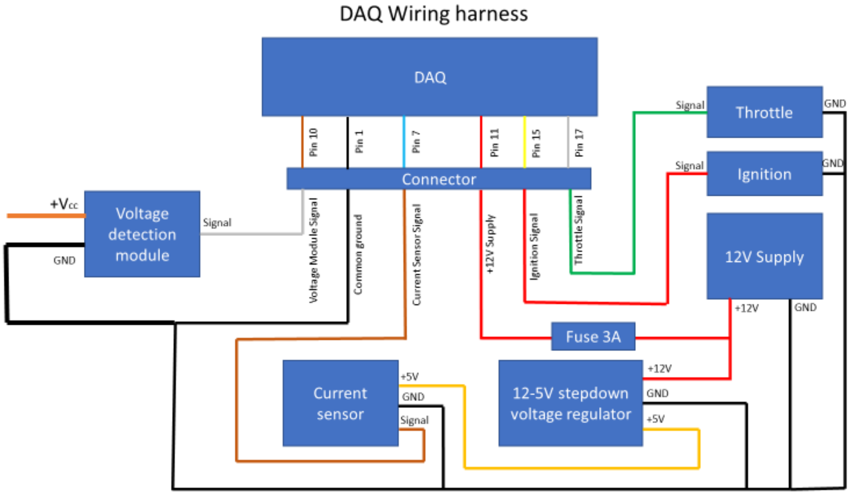


Figure 14 ***Wiring harness layout for DAQ system***

Refer **SECTION 22 TO 25 OF 9.9.1 (ANNEXURE 3) Pg. no. 122, 123** of this report, for an overview of **3.9.3.1 TO 3.9.3.3 AND 3.9.4**

3.9.5 DAQ Dashboard

Figure 15 shows the dashboard for tracking of vehicles and associated parameters. On the left, the parameter values of ignition, altitude, throttle, current and voltage along with geographic coordinates and time are displayed. While on the right we have a map showing the geographic location of the vehicle. The UI was used to track the live movement of vehicles.

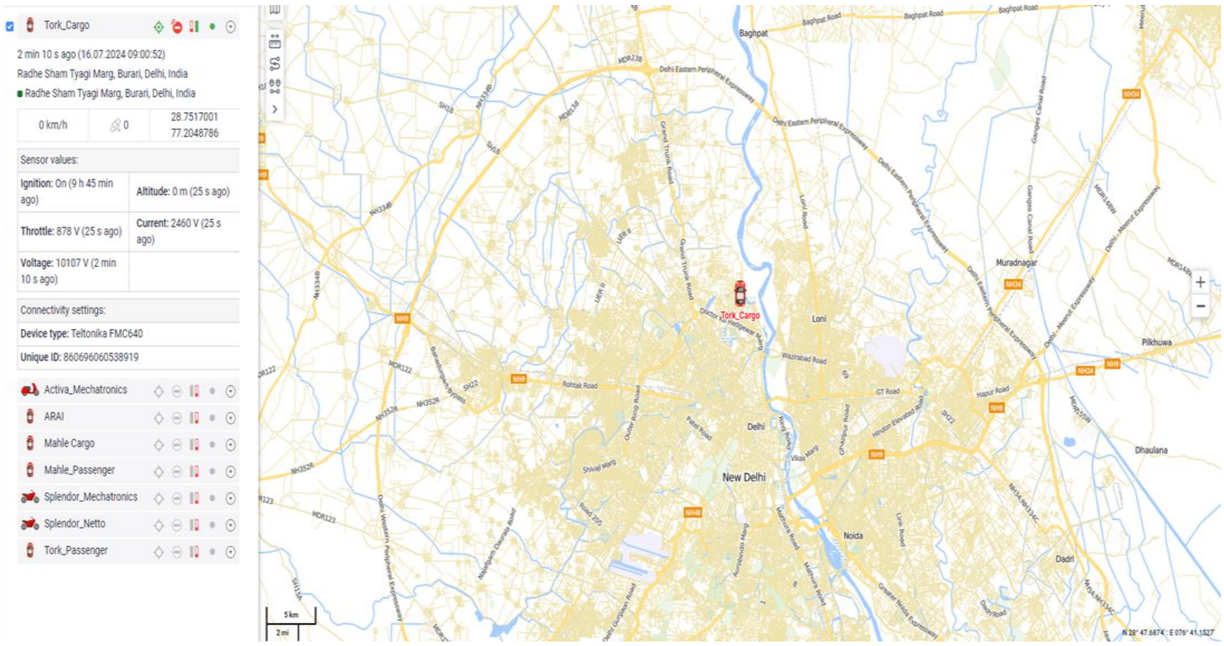


Figure 15 ***DAQ Dashboard***

Refer **SECTION 26 OF 9.10 (ANNEXURE 3) Pg. no. 124** of this report, for DAQ placement images in 2-wheeler and 3-wheeler.

3.10 Vehicle validation (electrical and mechanical point of view) (checklist)

Checklists for validating a retro-fitted 2-wheeler and 3-wheeler from mechanical and electrical point of view are as shown below:

- **Mechanical validation checklist**

Table 21 **Mechanical validation checklist for vehicle** below mentions the mechanical validation checklist

Item	Description
Chassis and Frame	
Structural integrity	Inspect frame for any damage or stress fractures.
Mounting points	Verify all motor and component mounting points are secure.
Suspension and Steering	
Suspension	Check suspension components for wear and proper operation.
Steering mechanism	Ensure smooth and responsive steering.
Brakes	
Brake fluid	Check brake fluid levels and top up if necessary.
Brake operation	Ensure effective and responsive braking.
Wheels and Tires	
Tire condition	Inspect tires for wear and proper inflation.
Transmission	
Transmission mounting	Ensure transmission is securely mounted.
Gear operation	Verify smooth operation of gears.
General Mechanical	
Fasteners	Inspect all bolts, nuts, and fasteners for tightness and security.
Lubrication	Ensure all moving parts are properly lubricated.

Table 21 ***Mechanical validation checklist for vehicle***

- **Electrical Validation Checklist**

Table 22 **Electrical validation checklist for vehicle** below mentions the electrical validation checklist

Item	Description
Battery pack	
Battery pack mount	Ensure battery pack is securely mounted.
Battery pack connections	Check all connections are secure and properly insulated.
Battery pack voltage	Measure and confirm correct voltage.
Battery pack charging	Verify charging system functionality.
Motor and Controller	
Motor mounting	Ensure motor is securely mounted and aligned.
Motor connections	Check electrical connections are secure and insulated.
Controller mounting	Ensure controller is securely mounted.
Controller wiring	Verify correct wiring and secure connections.
Wiring and Cabling	
Wiring harness	Inspect wiring harness for damage and secure connections.

Insulation	Check all wires are properly insulated.
Routing	Ensure wiring is properly routed and secured.
Connectors	Verify all connectors are properly mated and secure.
Switches and Controls	
Throttle	Check throttle operation and response.
Switches	Verify functionality of all switches (e.g., power, lights, Horn).
Display panel	Ensure display panel is functioning and shows correct information.
Safety Systems	
Fuses	Check that all required fuses are in place and functioning.
Circuit breakers	Verify circuit breakers are installed and operational.
Emergency cut-off	Ensure emergency cut-off switch is operational.

Table 22 ***Electrical validation checklist for vehicle***

The checklists in ***Table 21*** and ***Table 22*** ensure comprehensive validation of both electrical and mechanical components in a retro-fitted 2-wheeler or 3-wheeler, enhancing safety and performance.

MILESTONE 4: RUNNING AND OPERATIONAL DATA ACQUISITION OF RETRO-FITTED VEHICLES IN REAL-LIFE FOR 5000 TO 6000 KM

This milestone covers the on-road testing phase of all 12 nos. of retro-fitted vehicles, identification of operational issues and resolving those, data acquisition with the use of DAQ system integrated into the vehicle for 5000 to 6000 kilometres.

4.1 On-Road Testing of Vehicles

All vehicles were prepared in a phase-wise manner. With the completion of integration on each vehicle, they were extensively tested in Pune under various conditions to know the performance and behaviour of kits and know the driver feedback in real world conditions. Based on inputs from driver and routine monitoring, changes if necessary, were made to the respective vehicles. Also, the data collected from these trial runs was worked upon to check the validity of the same and ascertain performance as per expected trends.

Upon successful completion of testing activities in Pune, vehicles were brought to Delhi in batches. Upon arrival, vehicles were rechecked for any transport related damages. Drivers were then briefed about the various vehicle parameters and safety considerations to be kept in mind while operating the vehicles. Also, they were accompanied for initial trials and occasionally to monitor driver behaviour and ascertain all rules and regulations are abided.

SECTION 27 OF 10.1 (ANNEXURE 4) Pg. no. 131 highlights the on-road running of all the retro-fitted vehicles in and around Delhi-NCR. All safety procedures and traffic rules were followed during the testing phase. For 2-wheeler vehicles the testing was carried out for loaded (with pillion) and unloaded (single rider) conditions. For 3-wheeler cargo vehicles the testing was carried out in the loaded (dead weights equal to GVW minus the kerb weight of the vehicle) and unloaded conditions. For 3-wheeler passenger vehicles, the weight for loading condition was considered equal to the weight of 3 passengers (considering average weight of 70-80 kgs).

4.2 Major Routes for Testing in Delhi & NCR

Table 23 **Major routes for testing in DELHI & NCR** mentions the major routes that were selected for testing trials of all retro-fitted 2-wheelers and 3-wheelers.

Route. No.	Route-map
1	Burari – Ghaziabad - New Delhi – Burari
2	Burari – Alipur – Murthal – Sonipat – Narela – Burari
3	Burari – Budhpur – Bahadurgarh – Paschim Vihar - Burari
4	Burari – RedFort – Noida – Ghaziabad – RedFort- Burari
5	Burari – Mangalpur – Gurugram – Vikaspuri – Burari
6	Burari – RedFort – Faridabad – Chhatarpur – Burari

Table 23 ***Major routes for testing in DELHI & NCR***

Refer **SECTION 28 OF 10.2 (ANNEXURE 4) Pg. no. 135** of this report, for Testing route-map direction images.

4.3 Test Summary

As per scope of work, all vehicles had to be trial tested for 5000-6000 kilometres. Vehicles were tested over a period of 6 months in Delhi-NCR with testing conditions ranging from no load to full load. The test summary is shown in ***Table 24***:

Total distance (km) tested as of 11.07.24						
Category	**Type**	**Vehicle**	**Solution**	**Pune initial trials**	**Delhi testing trials**	**Overall kilometres tested**
2-Wheeler	Motorcycle	Splendor	Solution 1	1200	5413	6613
			Solution 2	850	4351	5201
			Solution 3	1620	3933	5553
	Scooter	Activa	Solution 1	1100	5240	6340
			Solution 2	350	6338	6688
			Solution 3	1580	4024	5604
3-Wheeler	Passenger	Bajaj RE	Solution 1	1230	5374	6604
		Piaggio Ape Xtra	Solution 2	1250	3804	5054
		Piaggio Ape City	Solution 3	1625	5789	7414
	Cargo	Piaggio Xtra LD	Solution 1	980	5372	6352
		Bajaj Maxima	Solution 2	1120	5154	6274
		Bajaj Maxima	Solution 3	1150	5552	6702

Table 24 ***Vehicle total trial test km summary***

MILESTONE 5: INTERPRETATION OF OPERATIONAL DATA COLLECTED DURING RUNNING

5.1 Observations during testing

The vehicles that were retro-fitted underwent a rigorous testing phase covering distances of 5,000 to 6,000 kilometres. During this testing period, a number of mechanical and electrical issues were identified in several vehicles. These issues included, but were not limited to, performance anomalies, electrical malfunctions, and mechanical inconsistencies. Each identified issue was meticulously analysed and resolved by our technical team of Engineer's with the help of retro-fitment kit vendors whenever and wherever required to ensure that all vehicles met the required performance and safety standards. Despite these challenges, the testing process continued to ensure comprehensive evaluation and validation of the retro-fitted systems.

The following table provides a detailed account of the specific issues observed during the trials, along with the resolutions implemented to address them ***Table 25*** **Problems encountered in retro-fitted 2-wheeler during testing** and ***Table 26*** **Problems encountered in retro-fitted 3-wheeler during testin**

Vehicle category	Type	Retrofit solution 1	Retrofit solution 2	Retrofit solution 3
2-Wheeler	**Motorcycle**	No issues. Testing completed.	Battery cut off was observed during trials due to overcurrent protection. Later both batteries were sent to manufacturer for repairs. The manufacturer reported 1 cell series and BMS damaged due to incorrect BMS configuration. BMS with current rating lower than required current rating (motor requirement) was used originally.	Teeth of motor side sprocket wore out after 3500 km of testing.
	Scooter	While riding pillion on continuous gradients like fly-overs, motor is unable to provide necessary power. On pressing boost button, instantaneous power surge is obtained but is short sustained.	Battery cut off was observed during trials due to overcurrent protection. Later both batteries were sent to manufacturer for repairs. The manufacturer reported 1 cell series and BMS damaged due	Teeth of motor side sprocket started wearing out after 3500 km of testing.

Vehicle category	Type	Retrofit solution 1	Retrofit solution 2	Retrofit solution 3
			to incorrect BMS configuration. BMS with current rating lower than required current rating (motor requirement) was used originally.	

Table 25 ***Problems encountered in retro-fitted 2-wheeler during testing***

Vehicle category	Type	Retrofit solution 1	Retrofit solution 2	Retrofit solution 3
3-Wheeler	**Passenger**	Plastic enclosure surrounding controller negative terminal crumpled due to overheating.	1. Change of gearbox input shaft due to worn out teeth.	**1.** Controller changed THRICE (TWICE during initial trials in Pune & ONCE during Delhi trials) due to battery undercurrent issue & controller power limit during gradient climbing.
		No other failures occurred during trials.	2. Motor-Gearbox coupler replaced due to worn out teeth.	**2.** Change of DC-DC converter during trails in Pune.
			3.Change of DC-DC converter.	**3.** Change of Pre-Charge circuit due to inrush current.
	Cargo	1. Controller changed due to blown out internal fuse.	1. Change of gearbox input shaft due to worn out teeth.	1. Change of DC-DC converter during initial trails.
		2. Pins were changed on both transmission shafts.	2. Motor-Gearbox coupler replaced due to worn out teeth.	2. Change of Controller due to power limit.
		3. Change of SEM's unit during initial trials.		3. Motor phase wires and Controller terminals damaged due to overcurrent demand.
				4. Change of complete kit with 12KW motor kit due to underperformance.

Table 26 ***Problems encountered in retro-fitted 3-wheeler during testing***

5.2 Temperature Data

The battery temperature was observed over the testing duration for all vehicles with the help of temperature sensors and BMS feedback. ***Table 27*** summarizes the data capturing the average change in temperature over a test run.

Average change in battery temp during test cycle (in ºC)											
2-Wheeler						3-Wheeler					
Scooter			Motorcycle			Passenger			Cargo		
1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
5-6	7-8	9-10	5-6	7-8	9-10	8-9	7-8	9-10	9-10	9-10	9-10

Table 27 ***Change in temperature of battery over a test run***

5.3 Charging Summary

Over the test duration the vehicles underwent multiple charging cycles. The charging time, charge rate, number of charging cycles and battery charger specifications for each vehicle type have been detailed in ***Table 28*** **Summary of charging system for batteries of all 6 integrated solutions**

Vehicle Type	Solu-tion	Battery Rating	Charger Rating	C-rate for Charging	Charging Time (hr)	Charging Cycles	Charging method
2W Scooter	1	72V 40Ah	72V 10A	0.25	4-4.5	80-85	CC-CV
	2	72V 35Ah	72V 10A	0.28	4-4.5	80-85	
	3	60V 42Ah	60V 6A	0.14	6.5-7	55-60	
2W Motorcycle	1	72V 40Ah	72V 10A	0.25	4-4.5	80-85	
	2	72V 35Ah	72V 10A	0.28	4-4.5	55-60	
	3	60V 42Ah	60V 6A	0.14	6.5-7	55-60	
3W Passenger	1	48V 100Ah	48V 25A	0.25	4-4.5	85-90	
	2	48V 200Ah	48V 40A	0.2	4.5-5	50-55	
	3	48V 200Ah	48V 40A	0.2	4.5-5	85-90	
3W Cargo	1	48V 200Ah	48V 40A	0.2	4.5-5	80-85	
	2	48V 200Ah	48V 40A	0.2	4.5-5	65-70	
	3	48V 200Ah	48V 40A	0.2	4.5-5	80-85	

Table 28 ***Summary of charging system for batteries of all 6 integrated solutions***

MILESTONE 6: EVALUATION AND CERTIFICATION OF RETRO-FITMENT SOLUTIONS

As covered in the scope of work, a comprehensive data analysis of the collected data in terms of technical feasibility, user feedback and pollution reduction potential are to be carried out. The same has been discussed in subsequent sections.

6.1 Technical feasibility

6.1.1 Compatibility with existing vehicle architecture

Structural/Frame integrity

Structural integrity refers to the base frame of the vehicle and its mounting points generated/integrated onto the frame in considerations with the ICE vehicle. Therefore, this type of frame is best fit for the ICE components.

While getting the vehicle retro-fitted, the existing frame of the vehicle, either 2-wheeler or 3-wheeler, needs to be re-constructed/fabricated in consideration of the electric conversion kit which include the details as mentioned in ***Table 29*** and ***Table 30:***

2-wheeler structural integrity:

Removed part/component	2-Wheeler (Hub Type Motor)		2-Wheeler (Traction Type Motor)	
	Motorcycle	**Scooter**	**Motorcycle**	**Scooter**
Engine & its mounting	Makes space for battery pack mounting	Makes space for battery pack mounting	Makes space for battery pack and motor mounting	Makes space for battery pack and motor mounting
Fuel tank & mounting	No changes required	Makes space for controller and DC-DC placement and connections	Cutting of tank from bottom makes space for controller mounting beneath the tank	Makes space for controller and DC-DC placement and connections
Swing arm	No changes required	A fabricated swing arm needs to be integrated for Hub Type Motor mounting	No changes required	A fabricated swing arm with motor mounting needs to be integrated for Traction Type Motor mounting
Shock absorber	No changes required	Mountings to be fabricated on chassis w.r.t external swing arm shock absorber mounting	No changes required	Mountings to be fabricated on chassis w.r.t external swing arm shock absorber mounting
Air filter box				

Auxiliary battery pack & its mounting	Makes space for controller and DC-DC mounting	Makes space for HV battery pack placement	Makes space for controller and DC-DC mounting	Makes space for HV battery pack placement

Table 29 ***2W Structural integrity***

Summary of 2-Wheeler Structural Changes:

- Unwanted parts removed from the vehicle alternately makes space for mounting of multiple retro-fitment parts available in the kit.
- Structural changes made in the scooter category is majorly focused on the rear wheel side as an alteration needs to be done for mounting of swing arm in the scooter vehicle.
- Also shock-absorber mounting needs to be altered in the scooter category for retro-fitment.

3-Wheeler Structural Integrity:

Removed part/component	3-Wheeler (Traction Type Motor)	3-Wheeler (Traction Type Motor)
	Passenger	**Cargo**
Engine & its mounting	Makes space for motor-controller kit, transmission unit and battery pack placement/mounting	Make space for motor-controller kit and transmission unit placement/mounting
Fuel tank & mounting	Makes an extra space for mounting battery pack safely	Does not have a significant impact but needs to be removed
CNG tank (if applicable)	No significant impact but needs to be removed	Makes space for battery pack mounting beneath the cargo box.

Table 30 ***3W Structural integrity***

Summary of 3-Wheeler Structural Changes:

- Unwanted parts removed from the vehicle makes space for mounting of motor-controller kit of the retro-fitment components.
- Majorly no significate changes or alteration in the 3-wheeler category vehicle is required except mountings for motor-controller kit.
- Addition of height increasing blocks for raising the height of cargo box depends on the total height and mounting made for battery pack in 3-wheeler category.

6.1.2 Electrical system integration

Wiring and connector

2-wheeler

With the change in power source from engine to electric drive, in a retro-fitted vehicle, two voltage lines come into play. The high voltage line is the primary line that drives the entire vehicle. The auxiliary supply line (12V) is drawn from the high voltage line by using the Dc-Dc converter. The existing wiring harness of the vehicle need not be altered. The auxiliary battery pack may or may not be used to power the auxiliary lines.

3-wheeler

For a 3-wheeler vehicle also, two distinguished power lines come into effect. Here however, the auxiliary battery pack is used as the auxiliary load is higher relative to a 2-wheeler. The existing wiring harness also needs to be replaced with the new wiring harness provided with the kit. The new wiring harness comes with both voltage lines (main & aux.) integrated in a single conduit.

Summary of 2-W & 3-W wiring integration

- No major changes in wiring harness integration are required for both 2W & 3W as a separate wiring harness for retro-fitment kit is provided with the kit.
- A connection from DC-DC can be directly given to either 12V aux. battery supply or 12V/low voltage line already available with the vehicle.

6.1.3 Battery pack and its mounting

Table 31 **2W Battery pack placement and safety** highlights Battery pack placement and safety in 2-Wheeler Category

2-Wheeler	
Motorcycle	**Scooter**
The main battery pack integrated is placed within the engine compartment of the frame. The battery pack box provided by the vendor has mountings that can be bolted with the frame which further secures the battery pack within the specified space.	The main battery pack box and battery pack are mounted beneath the seat of scooter. For mounting this, the luggage space of scooter needs to be cut-down according to the size required. Later the battery pack box can be mounted onto the frame.

Table 31 ***2W Battery pack placement and safety***

Table 32 **3W Battery pack placement and safety** highlights Battery pack placement and safety in 2-Wheeler Category

3-Wheeler	
Passenger	**Cargo**
The main battery pack comes with mounting points provided with the battery casing. These mounting holes need to be aligned with the holes made on battery rest frame above the motor controller unit. Later, the casing is tightened using unlock nut & bolts as per standards.	The main battery pack mounting process is similar to that followed for passenger vehicle. However, here the battery pack is placed right behind the driver cabin, beneath the cargo box, away from the motor and controller unit.

Table 32 ***3W Battery pack placement and safety***

6.1.4 Range

The range of a retro-fitted vehicle depends on the battery pack configuration. Battery pack configuration commonly used in different solutions of retro-fitment and their range are mentioned in the ***Table 33*** **2W & 3W Range overview** below:

2-Wheeler	3-Wheeler
The current kit specification for 2-wheeler category (Motorcycle and Scooter) and range offered is as follows: **72V 42Ah**: 95-100 km (Approx.) **72V 36Ah**: 80-85 km (Approx.) **60V 42Ah**: 55-60 km (Approx.)	The current kit specification for 2-wheeler category (Motorcycle and Scooter) and range offered is as follows: **48V 100Ah**: 55-60 km (Approx.) **48V 200Ah**: 95-100 km (Approx.)

Table 33 ***2W & 3W Range overview***

6.1.5 Charging and thermal management/air cooling

Mode of charging and charge rating play an important role in maintaining a healthy battery life over a long run. Different modes, such as normal charging and fast charging, are used for battery pack. For this project we have used normal charging mode due to lack of infrastructure used for fast charging. However, if the infrastructure is developed, fast charging can also become possible. Details are as given in the ***Table 34*** **Charging and thermal cooling** below:

Parameter	Normal Charging
Operating input voltage (V)	120-240
Available at	Household applications
Type of operating current	Household AC supply
Impact on battery temperature	Less impact on battery temperature rise
Cooling system	Not needed (If surrounding temperature is below 42 ^{0}C)
Time required for charging	Approx. 5-6 hrs
Over-duration charging	Charger auto cut-off is mandatorily required
Battery life and performance degradation	Minimal impact on degradation

Table 34 ***Charging and thermal cooling***

6.1.6 Motor, Shock-absorber and Drivetrain compatibility

Table 35 **Shock-absorber, Motor and Drivetrain compatibilit** gives an overview of the motor type used, drive-train option and necessary alterations in shock-absorber mountings for getting integrated with the vehicle.

Parameter	2-Wheeler		3-Wheeler
	Motorcycle	Scooter	Passenger and Cargo
Motor Type	Hub type motor: No external adjustment or fabrication is required as the motor comes with a swing arm which is compatible to get directly fastened to the existing mounting points of swing arm available on the bike.	Hub type motor: No external adjustment or fabrication is required as the motor comes with a swing arm which is compatible to get directly fastened to the existing mounting points of swing arm available on the scooter.	Traction type motor: The traction motor gets mounted with the gearbox and the gearbox is then mounted with the mountings manufactured for integration.
	Traction type motor: The motor comes with a bracket which needs to be	Traction type motor: The motor comes with a bracket which needs to be	

	bolted on an external platform welded in the engine compartment with a height which will match the centre point of motor shaft with the axis of swing arm.	bolted on an external platform welded on the swing arm matching the base plane of the swing arm. (The chain slag should be maintained for effective transmission)	
Shock-absorber	The upper eye length of shock-absorber needs to be increased by 3 inches for 3 kWh motor only.	The upper eye length of shock-absorber needs to be increased by 3 inches to achieve clearance between battery base plane and motor mounted on swing-arm for Traction Type Motor only.	No changes needed
Drive-train	Traction type motor: A driving sprocket of 9 teeth (sprocket on motor side) needs to be integrated with the existing sprocket available on the rear wheel by using chain-drive mechanism. The sprocket should be of EN9 material grade and hardened Or Manufactured by vendor as per standards.	Traction type motor: A driving sprocket of 9 teeth (sprocket on motor side) needs to be integrated with the existing sprocket available on the rear wheel by using chain-drive mechanism. The sprocket should be of EN9 material grade and hardened Or Manufactured by vendor as per standards.	Existing transmission shafts with altered lengths as per requirement can be used for power transmission purpose.

Table 35 ***Shock-absorber, Motor and Drivetrain compatibility***

Summary of Integration compatibility

- For 2W motorcycle there are no major changes required to mount hub motor kit, but for traction motor mounting additional attachments are to be made both in motorcycle and scooter category vehicles.
- The sprocket ratio for 2W traction motor can be changed as per requirements but to meet the basic required torque and speed for both motorcycle and scooter, ratio should be 1:5
- For 3W, mountings to be manufactured for assembling and holding of motor controller kit for a justified retro-fitment.

6.1.7 Braking system

The existing braking system is compatible for use with the retro-fitment kit for both 2-wheeler and 3-wheeler vehicles. However, vendors also provide hub motor kits supported with disc brake system. If as an option a disk brake supported hub motor is used for retro-fitment of 2-wheeler or 3-wheeler, then an external adjustment of brake calliper on swing arm, master cylinder for rear brake lever is to be provided for mounting purpose of braking system.

Summary of Integration compatibility

Braking system of both 2W and 3W remains unchanged as the standard braking system gets easily integrated with the retro-fitment kit.

6.1.8 Vehicle performance

***Table 36* Top speed of vehicles integrated with tested solutions (2 & 3-wheeler)** mentions the top speed achieved by vehicles category wise.

Tested Solution	2-Wheeler		3-Wheeler	
	Motorcycle	Scooter	Passenger	Cargo
Solution 1	70	55	50	55
Solution 2	80	70	55	60
Solution 3	75	55	50	50

Table 36 ***Top speed of vehicles integrated with tested solutions (2 & 3-wheeler)***

6.1.9 Maintenance and serviceability

4. Ease of maintenance

The after sales service and maintenance of a retro-fitted electric vehicle (2-wheeler or 3-wheeler) is not as easy as that for an ICE vehicle, for now. Several issues such as finding a local mechanic for minor mechanical issues or service time taken by vendors for repairing of damaged electrical component takes a lot of time due to unavailability of skilled technicians.

6.2 User/Driver feedbacks During Testing

The ***Table 37*** **User/Driver feedback summarized rating** below gives an overview summary of user feedback (Feedback of drivers). The feedback received from all drivers was converted into rating format for different conditions which they experienced while driving in Delhi-NCR.

Rating	5	4	3	2	1
	GOOD	**SATISFACTORY**	**NOT BAD**	**BAD**	**Needs Improvement**

Feedback duration
For **5000 kms** of test drive in Delhi-NCR

Category	Solutions	Riding Experience	Comfort	Range	Acceleration	Driving experience on gradients	Gear shifting (3-wheeler)	Safety in driving	Char-ging process	Mechanic for maintenance		Retro-fitment as an option
										Mechanical	**Electrical**	
2-Wheeler Motorcycle	**1**	5	5	4	5	4	NA	4	4	3	1	3
	2	5	5	4	5	4	NA	4	4	3	1	4
	3	4	5	2	3	3	NA	4	4	3	1	3
2-Wheeler Scooter	**1**	3	5	4	3	1	NA	4	4	3	1	2
	2	5	5	4	5	4	NA	4	4	3	1	5
	3	4	5	2	3	3	NA	4	4	3	1	3
3-Wheeler Passenger	**1**	5	5	3	4	4	3	4	4	3	1	4
	2	5	5	5	4	4	4	4	4	3	1	5
	3	5	5	4	4	4	5	4	4	3	1	4
3-Wheeler Cargo	**1**	5	5	4	4	4	3	4	4	3	1	4
	2	5	5	5	4	4	4	4	4	3	1	5
	3	5	5	4	4	4	5	4	4	3	1	4

Table 37 ***User/Driver feedback summarized rating***

Refer **SECTION 29 OF 11.1 (ANNEXURE 5) Pg. no. 138** of this report, for feedback forms of drivers/users involved in testing & trials of retro-fitted 2-wheelers and 3-wheelers.

Summary of feedbacks received

- The riding experience of driving all type of retro-fitment solutions **Good to Satisfactory.**
- Comfort of driving all the retro-fitment solutions at different driving conditions was **Good.**
- The range offered by all the solutions was up-to the expectations **(Good to Satisfactory)** but only for solution 3 for 2W it was below the expectations **(Bad)**.
- The acceleration offered by all vehicle's retro-fitted with different solutions lied between **Good to Satisfactory**.
- The feedback received for maintaining the vehicles for their basic operations such as removing puncture, or solving any on-road minor break downs ranged between **Not Bad to Needs Improvement.** The major reason behind this is unavailability of trained technicians which needs to be catered at the earliest.
- The feedback received from all drivers and also the locals from Delhi for retro-fitment as an option lied between **Not Bad to Good** but the only reason why people will not opt for this option is because of the **heavy cost included in retro-fitment.**

6.3 Pollution reduction potential

In an effort to understand the environmental benefits of transitioning from conventional ICE vehicles to electric vehicles (EVs) (retro-fitted or new), we used the E-Amrit website's calculation tool to assess the pollution reduction potential of electric two-wheelers (2Ws) and three-wheelers (3Ws). The tool uses the details such as vehicle travel details, vehicle category and model, fuel type, CO_2 emission factor, battery capacity, electricity CO_2 emissions factor and lifecycle of the vehicle. The life cycle of vehicle is considered to be 3 years, as after every 3 years the retro-fitted vehicle needs to be re-inspected for vehicle fitness test. The tool provides a detailed comparison across categories as mentioned in ***Table 38*** and ***Table 39*** below.

Firstly, it quantified the CO_2 emissions produced by conventional vehicles and contrasted them with the emissions from their electric counterparts. Secondly, it highlighted the CO_2 emission savings that can be realized when an electric vehicle is driven for 5,000+ kilometres. These findings offer valuable insights into the substantial reduction in carbon footprint that can be achieved by switching to electric vehicles, demonstrating their potential as a key solution in mitigating environmental impact and promoting sustainable transportation.

Table 38 **2W pollution reduction potential** summarizes the CO_2 emissions from ICE vehicle & electric vehicle (2-Wheeler)

Vehicle Category	Fuel	CO_2 emissions from conventional vehicle (Tonnes)	CO_2 emissions from electric vehicle (Tonnes)	CO_2 emissions savings for 5000+ km of run (Tonnes)
2W	Petrol	0.21	0.14	0.07

Table 38 ***2W pollution reduction potential***

Table 39 **3W pollution reduction potential** summarizes the CO_2 emissions from ICE vehicle & electric vehicle (3-wheeler)

Vehicle Category	Fuel	CO_2 emissions from conventional vehicle (Tonnes)	CO_2 emissions from electric vehicle (Tonnes)	CO_2 emissions savings for 5000+ km of run (Tonnes)
3W	Petrol	0.61	0.37	0.24
	Diesel	0.71	0.37	0.34

Table 39 ***3W pollution reduction potential***

Similarly, the CO_2 emission savings were calculated for 80,000 km per vehicle. ***Table 40*** summarizes the CO_2 emissions of 2W and 3W.

Vehicle Category	Fuel	CO2 emissions from conventional vehicle (Tonnes)	CO2 emissions from electrical vehicle (Tonnes)	CO2 emissions savings for 80,000 km of run (Tonnes)
2W	Petrol	3.12	2.15	0.98
3W	Petrol	9.08	5.53	3.55
	Diesel	10.58	5.53	5.05

Table 40 ***Pollution reduction potential for 80,000 kms***

Refer **SECTION 30 OF 11.2 (ANNEXURE 5) Pg. no. 174** of this report, for overview of pollution reduction potential calculated using e-AMRIT's CO_2 emission calculator.

6.4 Cost benefit analysis (TCO)

- **Total cost of ownership (ICE vehicle)**

2-Wheeler

***Table 41* TCO for ICE 2-wheeler** below shows the total cost of ownership if a consumer procures new 2-wheeler for his/her daily city commute. The TCO is calculated based on the current market prices and for operation of 80,000 km.

Category	I.C engine vehicle	Retro-fitted vehicle (including resale value)	New electric
Splendor	3,51,800	1,30,280	2,12,320
Activa	4,01,943	1,80,840	1,41,459

Table 41 ***TCO for ICE 2-wheeler***

3-Wheeler

***Table 42* TCO for ICE 3-wheeler** below shows the total cost of ownership if a consumer procures new 3-wheeler for his/her daily city commute. The TCO is calculated based on the current market prices and for operation of 80,000 km.

Category	Fuel types			Retro-fitted vehicle (including resale value)	New electric
	Petrol	Diesel	CNG		
Passenger	4,72,133	NA	4,51,467	3,05,000 to 3,85,567	3,04,800
Cargo	NA	6,03,600	5,92,000	3,85,567	5,56,954

Table 42 ***TCO for ICE 3-wheeler***

Refer **SECTION 32 OF 12.1 (ANNEXURE 6) Pg. no. 195** of this report, for details of TCO calculation.

Summary for Total Cost of Ownership

The total cost of ownership for owning a retro-fitted vehicle for a drive period of 80000 kms is much lesser as compared to that of owning as new electric or ICE vehicle for both category of vehicles. But the major drawback of people not intending to get their old vehicles retro-fitted is the higher price of retro-fitment which makes up-to 80% cost of a new electric vehicle. Providing subsidy options to the customers may increase the demand for retro-fitment.

6.5 Evaluation, recommendations and costing

***Table 43* Table of recommendations and unit pricing** mentions the recommended motor and battery specifications for each category of vehicle based on the outcomes of testing trials carried out in Delhi-NCR for 5000-6000 km.
It also mentions the Rated and Peak Motor power required to drive the vehicle at an average speed of 40-45kmph for different loading conditions. The battery capacity mentioned in the

Table 43 is based on the average range of 80+ km for 2-wheeler category and 90+ in case of 3-wheeler category under different loading as well as driving conditions across the city area.

Approximate price per unit (including taxes) of kit procured for lot sizes varying from 1000 to 10,000 nos. is mentioned based on the quotations collected from vendors. The price mentioned in the below table is for all those components mentioned in ***Table 7*** of section 2.2.

The prices mentioned in the below ***Table 43*** are based on the quotations as of July, 2024 and are subject to change based on future market scenarios.

Category	**Recommendation**		**Approx. unit price for different lot sizes**		
	Motor power (kW)	**Battery capacity**	**1 Nos.**	**1000 Nos.**	**10000 Nos.**
2W Scooter	Rated: 2.0 - 2.5 Peak: 3.5 – 4.0	40-42 Ah compatible (Range: 85 km)	Rs. 88,000/-	Rs. 74,000/-	Rs. 70,000/-
2W Motorcycle	Rated: 2.0 – 2.5 Peak: 4.0 – 4.5	40 Ah compatible (Range: 85 km)	Rs. 1,05,420/-	Rs. 84,000/-	Rs. 74,000/-
3W Passenger	Rated: 4 – 4.5 Peak: 7 – 7.5	200 Ah for 90+ Km range	Rs. 2,47,566/-	Rs. 1,99,570/-	Rs. 1,90,627/-
3W Cargo	Rated: 4 – 4.5 Peak: 7 – 7.5	200 Ah for 90+ Km range	Rs. 2,47,566/-	Rs. 1,99,570/-	Rs. 1,90,627/-

Table 43 ***Table of recommendations and unit pricing***

Refer **Section 31 OF 11.3 Vehicle Trials Test Data Result 5)** (**Pg. no. 180)** of this report, for detailed analysis of Data collected through test trials.

Aesthetical Changes in the retro-fitted vehicle:

- There are no such visible aesthetical changes into a retrofitted vehicle for both 2W & 3W categories as the retro-fitment kits available into the market needs a minor alterations/mounting to be done on the vehicle for getting retro-fitted.
- For traction motor category vehicle **(only in case of 2W)** mountings or alterations are clearly visible as it lies in the engine compartment. But, this has no effect on the vehicle aesthetics or driving behavior of the vehicle.
- Foe 3-W category vehicles it is hardly observed that the vehicle is retro-fitted as everything lies within the body of the vehicle making no visible changes as well as aesthetical changes onto the vehicle.

6.6 Applicable certification (component & model level)

Table 44 **Table of certification required** mentions the certification requirements for components used in retro-fitment of a conventional 2-wheeler & 3-wheeler. This includes the IS & AIS references considered for testing and certification at component level and model level.
These requirements are based on findings from AIS 123 (PART 3): CMVR Type Approval of Electric Propulsion Kit Intended for Conversion of vehicles for Pure Electric Operation.

Components	Certification Against (IS / AIS)
Vehicle weighment	IS: 11825-1986
Gradeability	AIS-003-1999
Brakes	IS:11852-2001 (Part 1 to 9)
Pass-by noise level	IS: 3028-1998
Tell-tale symbols and controls (for switch box)	AIS-071-2009 (Part 1 & 2)
EMC	AIS-004 (Part 3):2009
Requirements for constructional and functional safety	AIS-038(Rev. 1):2015
Requirements for rechargeable energy storage system (REESS)	AIS-048:2009
Wiring Harness / Cables / Connectors	AIS-123 (Part 3):2016
Code of practice for retro-fitment	AIS-123 (Part 3):2016
Traction motor (measurement of net power & max. 30 min. power & speed)	AIS-041 (Rev. 1):2015
Measurement of Electrical Energy Consumption	AIS-039 (Rev.1)/2015
Thermal Shock Test	IS: 3141: 2007
Media Resistance Test	IS: 3141: 2007
Impact Test	IS:9000 (Part 7)
Dust Test	IS: 3141: 2007
Water Immerse Test	IS: 8925: 1978

Table 44 ***Table of certification required***

6.7 Key Highlights

1. Finance options availability

- New EV**:** Many financial institutions offer loans for new electric vehicles with competitive interest rates and flexible repayment options.
- Retro-fitted EV: Currently, retro-fitted vehicles do not have any dedicated finance options available.

2. Feasibility of battery swapping option

- New EV: 1. Revolt motorcycle offers battery swapping option for their motorcycle only.
  2. No established company offers battery swapping in scooters.
- Retro-fitted EV: Battery swapping is less feasible due to the lack of standardized battery packs and infrastructure.

3. Noise Level Comparison

- New EV: Generally quieter due to better integration of components and advanced noise reduction technologies.
- Retro-fitted EV: Produce more noise due to less optimized integration techniques and potential for older mechanical components.

4. Incentives Offered by Govt.

- New EV: Typically, significant incentives, including tax rebates, subsidies, and reduced registration fees.
- Retro-fitted EV: No significant incentives, including tax rebates, subsidies, and reduced registration fees.

5. Registration Process/Tax/Fees

- New EV: Streamlined process with incentives; typically, lower registration fees.
- Retro-fitted EV: More complex process, registration needs to be done via authorised retro-fitment centre leading to higher cost.

6. Life Span

- New EV: Typically, 10-15 years, depending on usage and maintenance.
- Retro-fitted EV: Varies widely; usually shorter than new EVs. Re-fitness test required every 3 years.

7. Maintenance Cost

- New EV: Generally lower due to fewer moving parts and newer technology.
- Retro-fitted EV: Generally higher due to older components and less optimized integration.

9. Depreciation Value

- New EV: Depreciates faster initially but may retain value better in the long term due to increasing demand.
- Retro-fitted EV: Depreciates faster overall due to older base vehicle and less demand.

13. Warranty

- New EV: Comprehensive warranties, often covering 5-8 years or 80,000 km.
- Retro-fitted EV: Limited warranties, often only covering specific components like the battery and electric motor for a period of 1 year.

14. Service Availability

- New EV: Widely available through authorized service canters with trained technicians.
- Retro-fitted EV: Limited availability, often through specialized vendors or third-party service providers.

15. Break-even (ROI) Point

- New EV: Typically, 3-5 years, considering lower running and maintenance costs and government incentives.

Retro-fitted EV: Varies widely; generally, longer than new EVs due to higher initial retro-fitment costs and potential for higher maintenance costs.

6.8 Conclusion and Recommendations

Based on the observations and challenges encountered during the project activity, below conclusion and recommendations are evaluated to make retro-fitment a success.

Retro-fitment measures and safety

Table 45 below outlines the essential measures and standards that needs to be taken before carrying out the vehicle retro-fitment. In general, the retro-fitment of a vehicle should adhere to the standards mentioned in AIS-123. Following this will ensure that the retro-fitted vehicle assures optimum performance, safety and environmentally responsible.

Section	Measures and Safety	Reasons
Usage of certified kits only	Compliance with Certified Kits: Only use kits that are certified by recognized authorities.	Certified kits ensure that the components meet safety, performance, and environmental standards, reducing the risk of malfunctions and enhancing reliability.
	Verification of Certification: Verify the authenticity of the certification before purchasing or installing the kit.	Ensures that only legitimate and tested products are used, protecting against counterfeit or substandard kits that could compromise vehicle safety and efficiency.
Pre-retro-fitment vehicle assessment	Structural Integrity Check: Assess the vehicle's structural integrity before retro-fitment.	Ensures that the vehicle can safely accommodate the retrofitting components, preventing issues related to weight, balance, and mechanical stress.
	Electrical System Compatibility: Evaluate the compatibility of the vehicle's existing electrical system.	Compatibility checks prevent electrical issues that could arise from integrating new components with the existing system, reducing the risk of short circuits or failures.
Safety standards	Battery Safety Testing: Ensure that the batteries meet safety standards and is tested as per AIS 123 standards.	Prevents potential hazards such as battery fires or explosions, ensuring safe operation of the retro-fitted vehicle.
	Installation by Certified Technicians: Require that retro-fitment be performed by certified professionals.	Certified technicians ensure proper installation, which is critical for the safe and efficient operation of the retro-fitted vehicle.
Environmental compliance	Emission Standards Check: Verify that the retro-fitted vehicle will comply with local emission regulations.	Ensures that the retro-fitted vehicle contributes to environmental sustainability and avoids penalties for non-compliance with emission standards.

Warranty and after-sales support	Warranty on Retrofit Kits: Ensure that the kits come with a comprehensive warranty covering all major components.	Provides assurance to vehicle owners that any defects or issues with the retrofit kit will be addressed by the manufacturer, reducing the risk of additional costs.
	Availability of After-Sales Support: Verify that after-sales support is available for maintenance and repairs.	Ensures that vehicle owners have access to necessary support and parts after retro-fitment, maintaining the vehicle's performance and safety.

Table 45 ***Standards and measures to be followed for retro-fitment***

Operational Issues

a) Maintenance and Total cost of ownership (TCO):

During the retro-fitment process, several operational challenges were identified, particularly in maintaining the converted vehicles. The initial cost of retro-fitment is relatively high, and ongoing maintenance could further increase the TCO. Additionally, the lack of standardized components for retro-fitted vehicles complicates maintenance tasks, leading to higher costs and longer downtimes. Finding a local mechanic to repair mechanical issues also becomes difficult due to lack of awareness/knowledge of safety precautions to be taken while repairing mechanical issues of an electric vehicle in road-side mechanics.

b) Charging options and measures:

Currently, the primary method for charging the retro-fitted vehicles is through normal charging, as the infrastructure for fast charging is not yet in place. Although normal charging is feasible, it results in longer charging times, limiting vehicle availability. It is recommended that efforts be made to develop the necessary infrastructure to support fast charging options, which would significantly reduce charging time and improve vehicle usability. ***Table 46*** below mentions the requirements of fast charging method.

Parameter	Fast charging
Operating Input Voltage (V)	240 & above.
Available at	Charging station.
Type of Operating current	DC battery powered charger.
Impact on battery temperature	Increases battery temperature.
Cooling system	Effective thermal management (air or liquid cooling) is necessary to prevent overheating.
Time required for charging	Usually 45-60 mins. For full charge.
Over-duration charging	Charger is already having auto cut-off function.
Battery life and performance degradation	Can lead to slightly faster degradation as compared to that of slow charging.

Table 46 ***Requirements of Fast charging method***

Safety Concerns

a) Battery temperature management:

One of the critical safety concerns observed is the management of battery temperature during operation, particularly in hot climates. Effective cooling systems must be integrated into retro-fitted vehicles more specifically in passenger 3-wheelers to prevent overheating, which could lead to battery failure or safety hazards.

b) Swappable battery options and feasibility measures:

The implementation of swappable batteries could significantly enhance the efficiency of retro-fitted vehicles. However, to make this feasible, standardization of battery size and shape, connectors and configuration is essential. Additionally, dedicated stations for battery swapping should be developed to ensure quick and safe battery replacements. This would reduce downtime and extend the operational range of the vehicles. Whereas swapping of batteries is easily possible in case of 2-wheelers, for 3-wheelers it becomes difficult to do battery swapping for extended range. This issue can be resolved if some design and attachment changes are made in battery as well as retro-fitment kit setup on the vehicle. This will require a thorough R&D activity related to retro-fitment kit integration with battery swapping as an option in 3-wheeler category (split battery system can play a vital role in making battery swapping feasible for 3-wheeler category).

Environmental measures

a) Scrappage of old vehicle parts:

A significant environmental concern is the disposal of old vehicle parts that are removed during retro-fitment. It is crucial to establish a proper scrappage policy to ensure that these parts are recycled or disposed of in an environmentally friendly manner. Focus area on scrapping or re-using the engine of old vehicle which becomes unusable after retro-fitment should be done.

b) Battery scrapping:

As retrofitting involves replacing traditional fuel systems with electric batteries, the scrapping of used batteries presents an environmental challenge. A robust recycling program must be implemented to handle end-of-life batteries, reducing the environmental impact and ensuring that valuable materials are recovered and reused. To make battery scrapping more convenient the cell structure standardisation, battery assembly process standardisation, Overall battery shape and size standardization w.r.t the configuration need to be done.

c) Standardization of batteries

From the perspective of battery swapping and scrapping, standardization is a critical factor. Uniform battery specifications would facilitate the adoption of swappable battery systems and ensure that batteries can be recycled efficiently. This would not only reduce costs but also simplify maintenance and enhance the feasibility of widespread adoption of retro-fitted vehicles.

Training requirements

a) Training for local mechanics:

To support the transition to electric vehicles, it is imperative to provide training for local mechanics. This training should cover the specific needs that are required in maintenance of minor to major mechanical issues, minor electrical issues of an electric vehicle. It should also cover the safety precautions to be taken before and during repairs of an electric vehicle.

b) User training:

End users of retro-fitted vehicles should also be educated on the new systems installed in their vehicles. This includes instructions on safe operation, charging procedures, and routine maintenance. Proper user training will enhance vehicle longevity and ensure the safety of the operators.

c) Supply-chain management

Improving supply chain of spare parts is also important as this will help vendors to maintain a good inventory which eventually will reduce time of repairs for major electrical issues. This will lead to making the vehicle more usable. Currently the repair time taken by vendors for electrical issue varies between 5-6 days making the vehicle un-usable.

Summary of available retro-fitment kits in market (as of March 2024):

Table 47 below mentions the list of available retro-fitment kit in market. Fields highlighted in GREEN are the kits procured and tested under this project.

Category	Available Solutions	Certification	Motor Power		Battery Configuration	Range	Top Speed	Max. Gradeability (degrees)	Speed @ gradeability	Price
			Nominal	Peak						
2-Wheeler Motorcycle	1	Certified	2	3.94	72V 40ah	80-85	70	Upto 12	15-20	**1,05,500**
	2	Certified	2.65	5.6	72V 35ah	70-80	80	Upto 12	20-25	**1,00,500**
	3	Uncertified	2	3	60V 42ah	50-60	75	Upto 12	15-20	**77,300**
	4	Uncertified	1.5	2.5	60V 35Ah	50-60	50	NA	15-20	**54,900**
2-Wheeler Scooter	1	Certified	1.2	2.3	72V 40ah	90-100	55	Upto 3-5	05-10	**93,700**
	2	Certified	1.2	2.3	72V 21Ah	40-50	50	Upto 3-5	05-10	**59,000**
	3	Uncertified	2	3.5	72V 35ah	80-90	70	Upto 12	20-25	**87,500**
	4	Uncertified	2	3	60V 42ah	50-60	55	Upto 12	15-20	**77,300**
	5	Uncertified	1.5	2.5	60V 35Ah	50-60	50	NA	15-20	**54,900**
	6	Certified	3	5.5	48v 50ah	60	75	NA	25-30	**67,500**
3-Wheeler Passenger	1	Certified	3	6.5	48V 100Ah	60	50	Upto 12	15-20	**1,88,000**
	2	Uncertified	4	7	48V 200Ah	100-110	55	Upto 12	25-30	**2,50,000**
	3	Certified	4.4	10	48V 200Ah	80-90	50	Upto 12	20-25	**2,47,000**
	4	Certified	3	6	60V 100ah	85	50	NA	15-20	**2,00,000**
3-Wheeler Cargo	1	Certified	3	6.5	48V 200Ah	60	55	Upto 12	15-20	**2,67,000**
	2	Uncertified	4	7	48V 200Ah	100-110	60	Upto 12	20-25	**2,50,000**
	3	Certified	4.4	10	48V 200Ah	80-90	50	Upto 12	15-20	**2,47,000**
	4	Certified	3	6	60V 100ah	75	50	NA	15-20	**2,40,000**

Table 47 ***List of available (certified & uncertified) retro-fitment kits in market.***

Recommendations based on testing outcomes.

Table 48 mentions the recommended motor and battery specifications for each category of vehicle based on the outcomes of testing trials carried out in Delhi-NCR for 5000-6000 km.

Category	**Recommendation**	
	Motor Power (kW)	**Battery Capacity**
2W Scooter	Rated: 2.0 – 2.5 Peak: 3.5 – 4.0	40-42 Ah compatible (Range: 85km)
2W Motorcycle	Rated: 2.0 – 2.5 Peak: 4.0 – 4.5	40 Ah compatible (Range: 85km)
3W Passenger	Rated: 4.0 – 4.5 Peak: 7.0 – 7.5	200 Ah for 90+ Km range
3W Cargo	Rated: 4.0 – 4.5 Peak: 7.0 – 7.5	200 Ah for 90+ Km range

Table 48 ***List of recommended solutions***

ANNEXURE 1

MILESTONE 1: IDENTIFICATION OF 2-WHEELER & 3-WHEELER VEHICLE MAKE/MODEL FOR RETRO-FITMENT

7.1 Identification of 2-Wheeler & 3-Wheeler vehicle with different methods

- Using Society of Indian Automobile Manufacturers (SIAM) sales data
- Physical survey

SECTION 1

2-Wheeler Vehicle (Scooter)

The ***Figure 16*** below provides a comprehensive analysis of the market share and model-wise sales within the 2-wheeler scooter category in India, based on data from the Society of Indian Automobile Manufacturers (SIAM). It includes:

- Historical market share data from FY 2006 to 2017, 2021-2022.
- A detailed breakdown of sales by specific scooter models in 2022.

This analysis highlights the dominance or showcases the popularity of specific scooter models such as the Honda Activa.

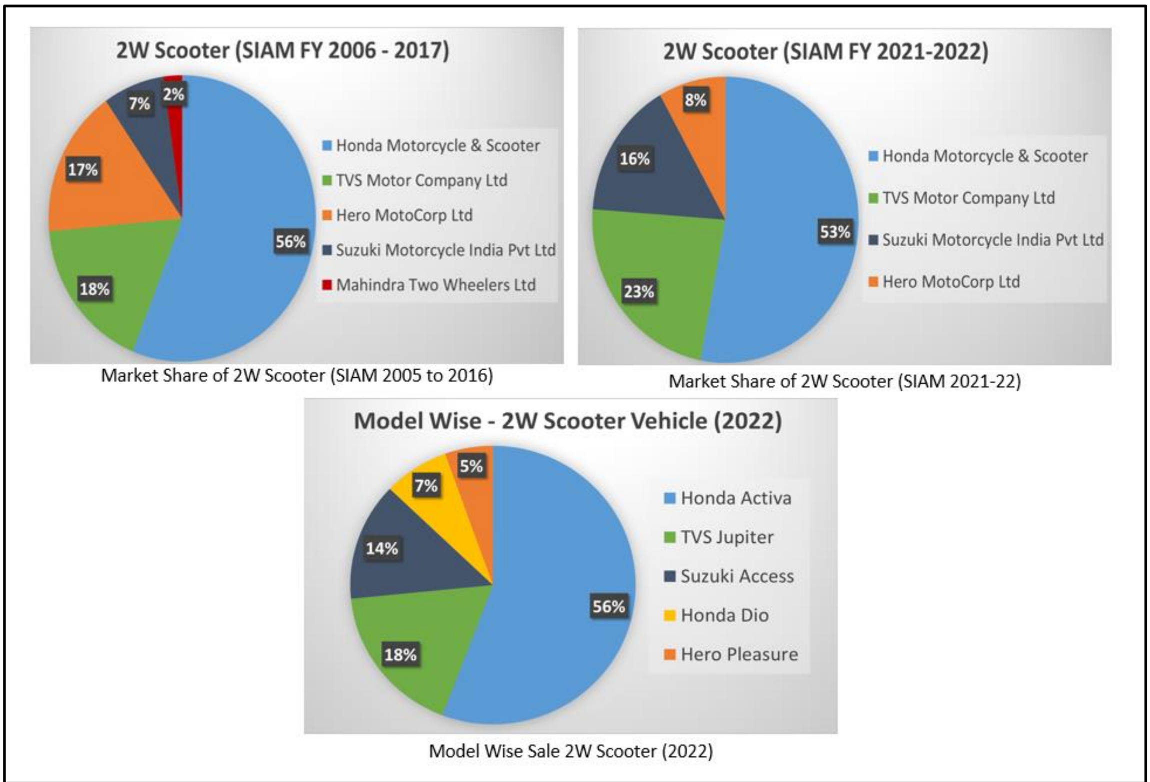


Figure 16 ***SIAM Sales Data for 2W scooter Category***

- Honda Motorcycle & Scooter covered 56% of the total 2-wheeler scooter market in FY 2006-2017 and 53% in FY 2021-22.
- Honda Activa is the model with the highest sales of 2W scooters in 2022 (56%), as also similar trend of sales of vehicle can be seen in previous years.

2-Wheeler Vehicle (Motorcycle)

The ***Figure 17*** below illustrates the market share and model-wise sales within the two-wheeler motorcycle category in India, based on data from the Society of Indian Automobile Manufacturers (SIAM). It includes:

- Historical market share data from FY 2006 to 2017, 2021-2022.
- A detailed breakdown of sales by specific motorcycle models in 2022.

This analysis highlights the dominance or showcases the popularity of specific motorcycle models like the Hero Splendor.

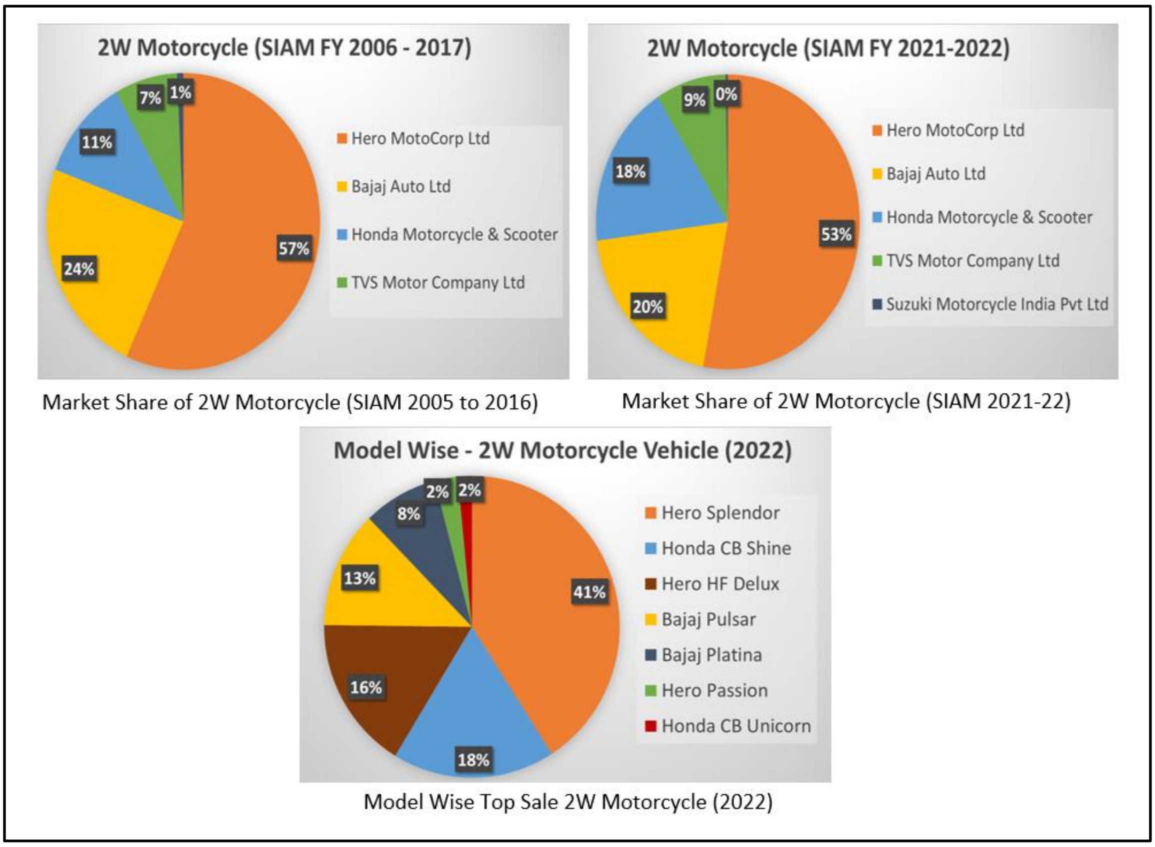


Figure 17 ***SIAM Sales Data for 2W Motorcycle Category***

- Hero MotoCorp Ltd. covered 57% of the total 2-Wheeler motorcycle market in FY 2006-2017 and 53% in FY 2021-22.

- Hero Splendor is the model with the highest sales of 2W scooters in 2022 (41%), as also similar trend of sales of vehicle can be seen in previous years.

3-Wheeler Vehicle (Passenger Carrier)

The ***Figure 18*** below presents a detailed analysis of the market share and model-wise sales within the 3-wheeler passenger vehicle segment in India, based on data from the Society of Indian Automobile Manufacturers (SIAM). It includes:

- Historical market share data from FY 2006 to 2017, 2020-2021.
- A detailed breakdown of sales by specific three-wheeler passenger vehicle models in 2021.

This analysis highlights the dominant positions of Bajaj Auto and Piaggio in the market, along with the popularity of specific models such as the Bajaj RE Compact and Piaggio Ape Auto.

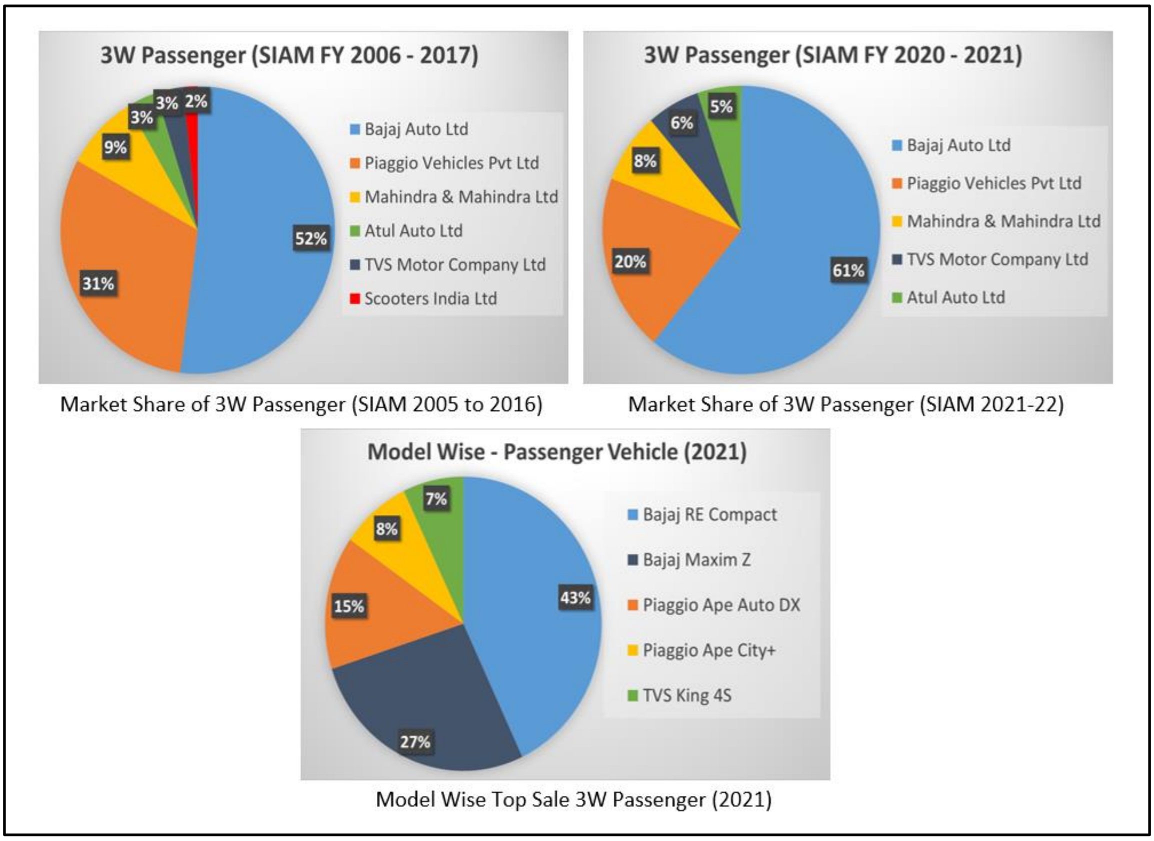


Figure 18 ***SIAM Sales Data for 3W Passenger Category***

- Bajaj Auto Ltd. covered 52% of the total 3-wheeler passenger vehicle market in FY 2006-2017 and 61% in FY 2021-22.

- Bajaj RE Compact is the model with the highest sales of 3W passenger vehicle in 2022 (43%), as also similar trend of sales of vehicle can be seen in previous years.

3-Wheeler Vehicle (Cargo Carrier)

The **Figure 19** below presents a detailed analysis of the market share and model-wise sales within the 3-wheeler cargo vehicle segment in India, based on data from the Society of Indian Automobile Manufacturers (SIAM). It includes:

- Historical market share data from FY 2006 to 2017, 2020-2021.
- A detailed breakdown of sales by specific three-wheeler cargo vehicle models in 2021.

This analysis highlights the dominant positions of Bajaj Auto and Piaggio in the market, along with the popularity of specific models such as the Bajaj Maxima and Piaggio Ape Xtra LDx.

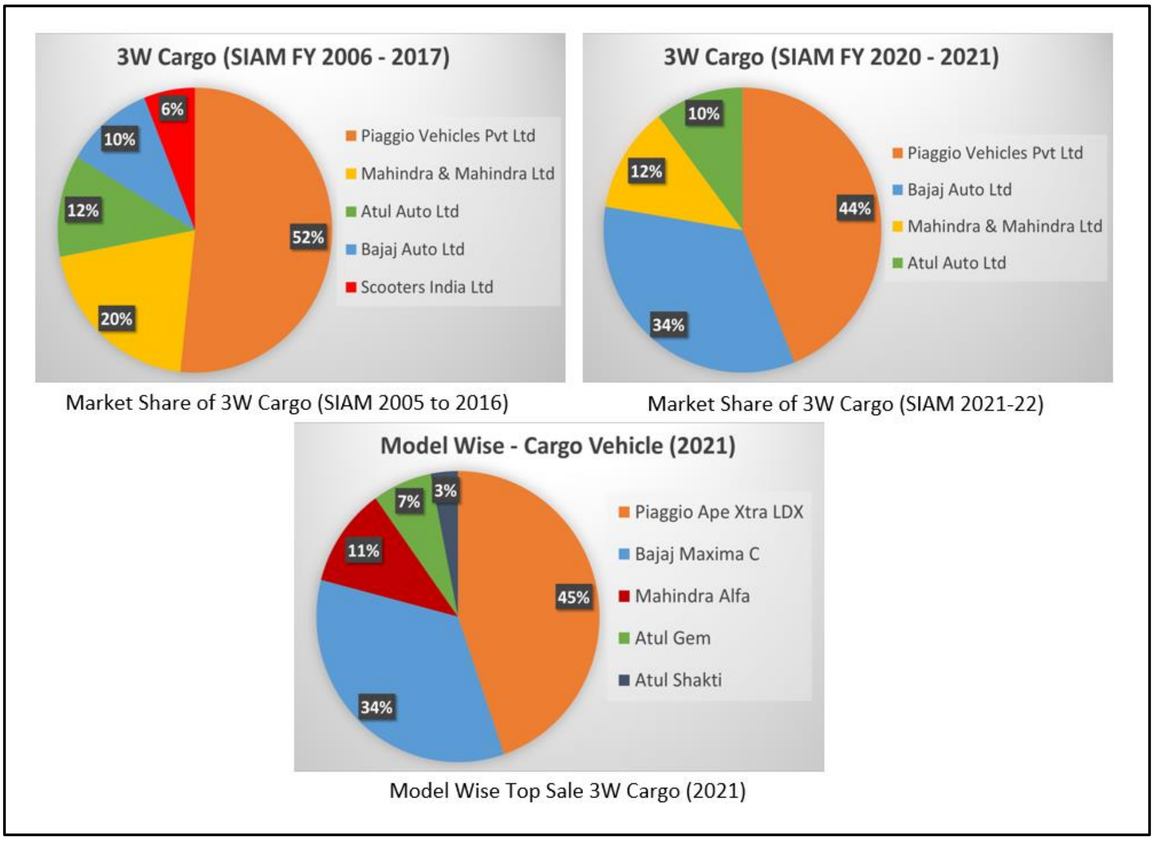


Figure 19 ***SIAM Sales Data for 3W Cargo Category***

- Piaggio Vehicles Pvt. Ltd. covered 52% of the total 3-wheeler cargo vehicle in FY 2006-2017 and 44% in FY 2021-22.

- Piaggio Ape Xtra LDX is the model with the highest sales of 3W cargo vehicle in 2022 (45%), as also similar trend of sales of vehicle can be seen in previous years.

SECTION 2

- **Physical Survey**

Table 49 below mentions the details of physical survey of city that was carried out in multiple areas of Delhi and NCR to check the presence of vehicles in majority, being used by public for their commute.

State	City	Places
Delhi	Delhi	Various public places like Connaught place, Akshardham, India Gate, Red Fort, Metro Stations
Uttar Pradesh	Gautam Buddha Nagar (Noida), Ghaziabad, Meerut, Baghpat	Various Public places like Civil Hospital, Malls, Railway Station, Subji Mandi, City Market, Bus Stop.
Haryana	Faridabad, Gurgaon, Sonipat, Bahadurgarh,	

Table 49 ***Survey of Cities for presence of vehicles in majority***

Findings done in the above survey are shown below:

2-Wheeler Vehicle

Figure 20 and ***Figure 21*** below shows the collected snaps from physical survey findings of the 2-wheeler vehicle category highlighting the most observed vehicles in this category that are being used by public for their daily commute.

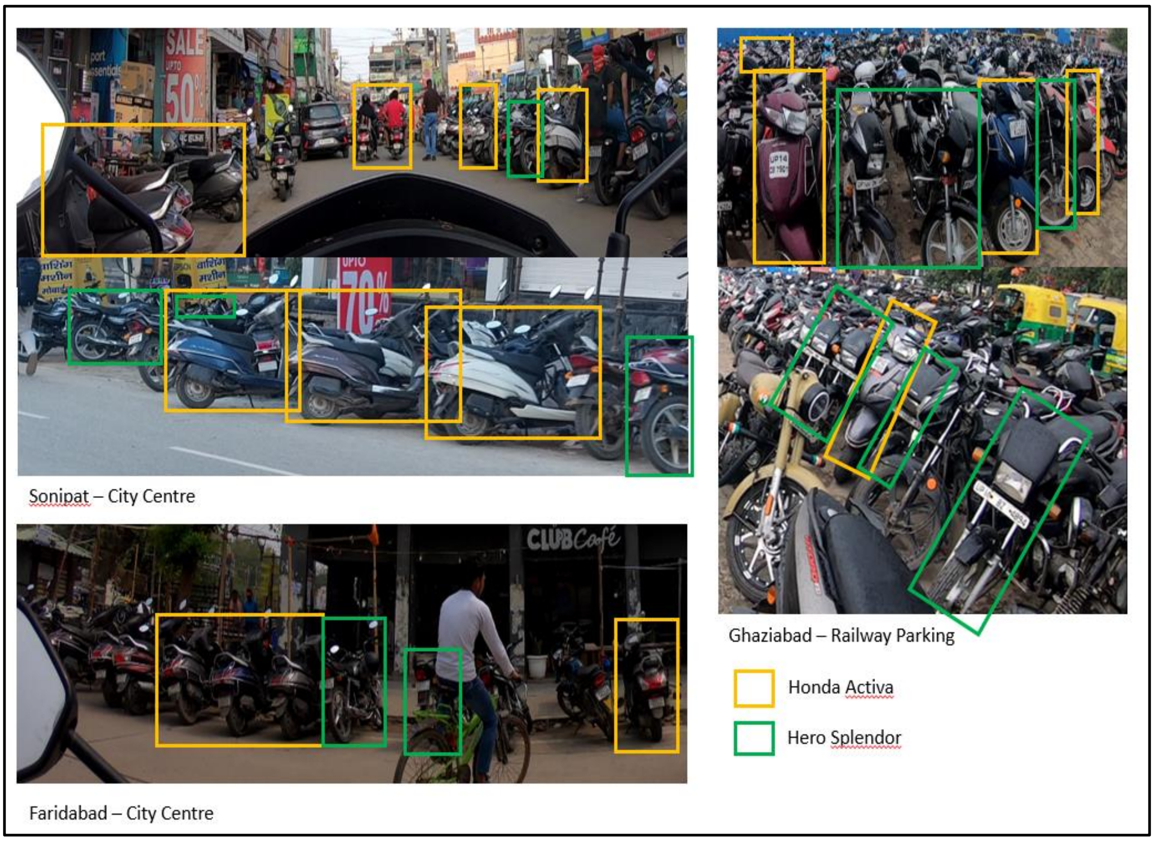


Figure 20 ***2-Wheeler Motorcycle & Scooter Vehicle survey***

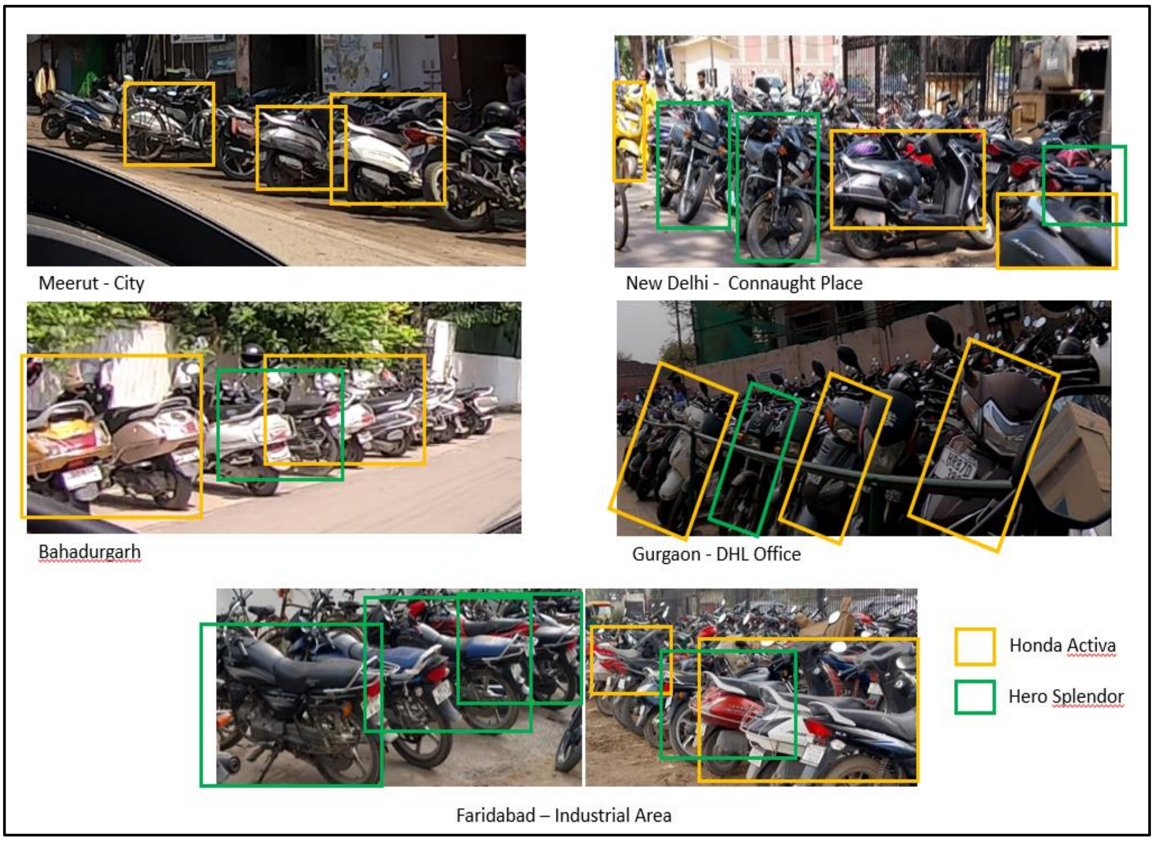


Figure 21 ***2-Wheeler Motorcycle & Scooter Vehicle survey***

3-Wheeler Vehicle

The ***Figure 22, Figure 23*** and ***Figure 24*** below show the collected snaps from physical survey findings of the 3-wheeler vehicle category highlighting the most observed vehicles in this category that are being used by 3-wheeler owners for their needs of passenger/cargo transports.

Figure 22 ***3-Wheeler Passenger Vehicle survey***

Figure 23 **3-Wheeler Passenger Vehicle survey**

Figure 24 ***3-Wheeler Cargo Vehicle survey***

ANNEXURE 2

MILESTONE 2: PROCUREMENT OF COMPONENTS FOR RETRO-FITMENT KIT

8.1 Procurement of Vehicles

SECTION 3

2-Wheeler Vehicle

Vehicle Fitness Assessment

Table 50 represents a comprehensive detail of the vehicle's condition, which has been converted into a rating format following the inspection. The rating scale ranges from 1 to 5.

Parameter	2-Wheeler Scooter			2-Wheeler Motorcycle		
	1	2	3	1	2	3
Chassis & Body (Body Panels, Fibre, Mud-Flaps)	5/5	5/5	5/5	5/5	5/5	5/5
Wheel System (Wheel Rim + Hub, Rim Spokes Tension)	5/5	4/5	5/5	4/5	4/5	5/5
Braking System (Brake Pedal, Brake Lines, Brake Shoe, Liners)	4/5	5/5	4/5	5/5	5/5	4/5
Steering System (Bearing, T-bar)	5/5	5/5	5/5	5/5	5/5	5/5
Electricals (Wiring, Headlamp, Tail-lamp, Indicators, Horn)	4/5	3/5	5/5	5/5	3/5	4/5
Tyres (Tyre Condition)	5/5	4/5	5/5	4/5	4/5	3/5
Transmission (Engine, Gearbox, Chain-Sprockets, CVT)	5/5	5/5	5/5	5/5	5/5	5/5

Table 50 ***Fitness Check Parameters for 2-Wheeler***

SECTION 4

3-Wheeler Vehicle

Vehicle Fitness Assessment

Table 51 represents a comprehensive detail of the vehicle's condition, which has been converted into a rating format following the inspection. The rating scale ranges from 1 to 5.

Parameter	Passenger Vehicle		Cargo Vehicle	
	Piaggio Ape City	**Bajaj Re**	**Piaggio Ape Xtra Ld**	**Bajaj Maxima**
Chassis	5/5	5/5	5/5	5/5
Wheel System (Hub, Shafts, Drums, Rims, Mount Plates, Wishbone Attachments)	5/5	5/5	5/5	5/5
Braking System (Brake Pedal, Brake Lines, Brake Fluid, Brake Shoe, Liners)	5/5	5/5	5/5	5/5
Steering System (Bearing, T-bar)	5/5	5/5	5/5	5/5
Body (Body Panels, Fibre, Mud-Flaps)	5/5	5/5	5/5	5/5
Electricals (Wiring, Headlamp, Tail-lamp, Indicators, Horn, Wiper Motor)	5/5	5/5	5/5	5/5
Tyres (Tyre Condition)	3/5	5/5	5/5	5/5
Transmission (Engine, Gearbox, Half Shafts)	5/5	NA	5/5	5/5

Table 51 ***Fitness Check Parameters for 3-Wheeler***

SECTION 5

<u>Performance Goals and Scenarios for sizing</u>

Driving Cycles Considered: Modified Indian Driving Cycle (MIDC), Worldwide Harmonized Light Vehicles Test Procedure (WLTP).

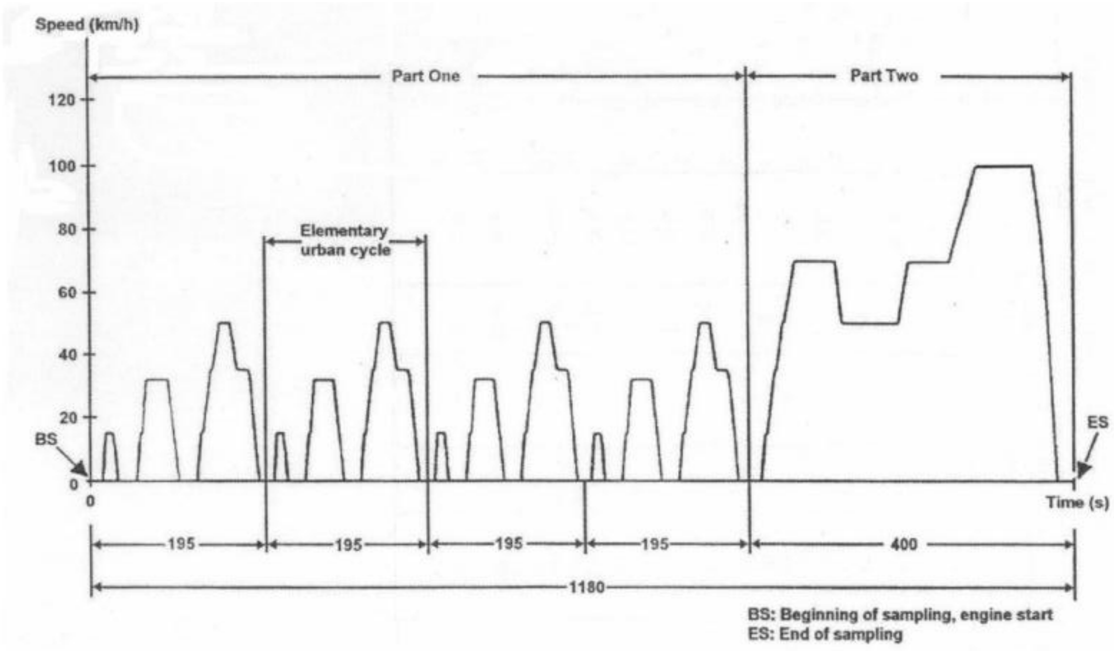


Figure 25 ***Modified Indian Driving Cycle (MIDC)***

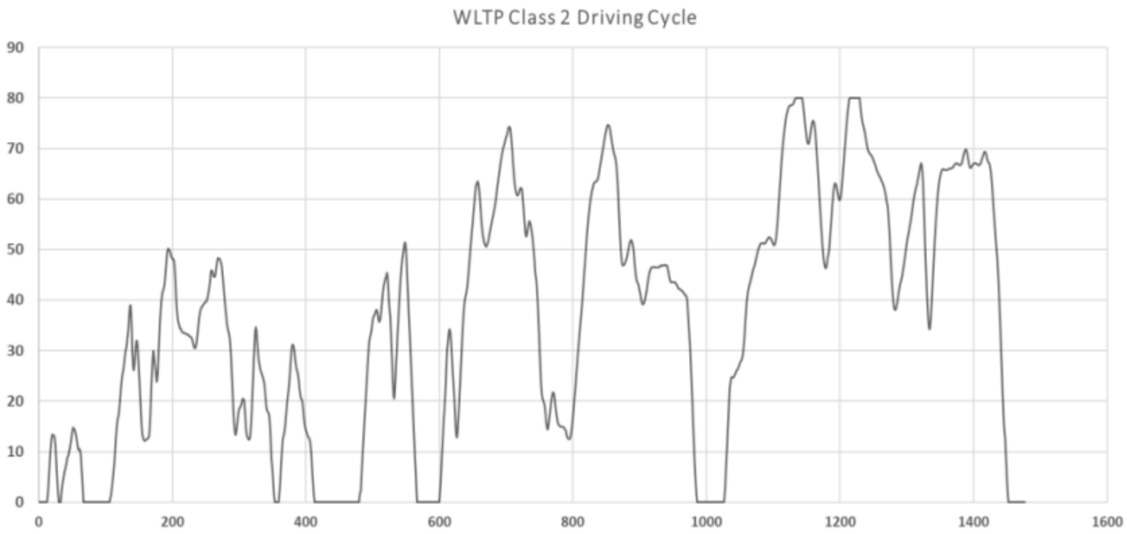


Figure 26 ***Worldwide Harmonized Light Vehicles Driving Cycle (WLTP)***

- **Max Speed:** Top speed is limited to 80 kmph, considering general driving scenarios.
- **Gradient Scenario:** Considering a harshly steep gradient of 12° or 21 % for speeds below 15 kmph.
- **Loading Condition:** Both loaded and unloaded conditions have been considered.

SECTION 6

Motor Sizing Simulation

2-Wheeler (Motorcycle & Scooter)

Figure 27 below shows an overview of results obtained after performing a virtual simulation of motor sizing using MATLAB software for a 2-wheeler vehicle. It shows the output required (Motor power & Energy) for a vehicle to achieve certain required velocity against the given input parameters.

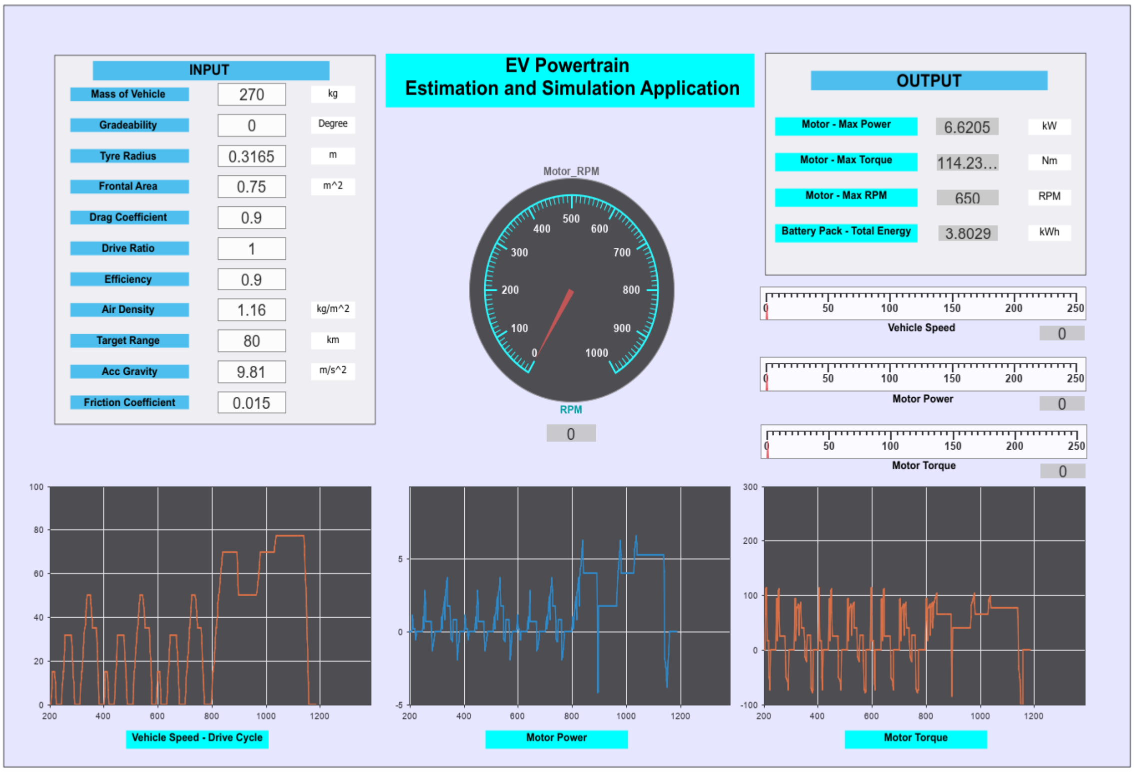


Figure 27 ***EV Powertrain Estimation and Simulation for 2-Wheeler***

SECTION 7

To determine Max power of the Electric motor

For the given base specification of the vehicle and with a goal to be able to drive certain road conditions, standard MIDC and WLTP driving cycles were considered to derive the max power.

The sizing of Electric Motor is derived from the tractive forces required for the vehicle to execute the standard driving cycles with loaded and unloaded conditions.

- Modified Indian Drive Cycle (MIDC).
- Worldwide Harmonized Light Vehicle Test Procedure (WLTP).

In the initial phase of sizing, we conduct a simulation of the entire vehicle model using MATLAB. This simulation helps us determine the maximum torque and power values of the electric motor during the drive cycles. Additionally, the simulation assesses whether the vehicle can meet the velocity requirements of the pre-determined drive cycles. Through the simulation, we gather data on the torque and power demanded by the motor at different RPM and speed values. Then we plot the maximum torque and power values at specific RPM to establish the necessary characteristics of the electric motor. Based on these simulation results, we generate a typical electric motor profile using the MATLAB/Simulink toolbox.

Figure 28 below shows the model created in MATLAB for calculation of powertrain (Motor) sizing.

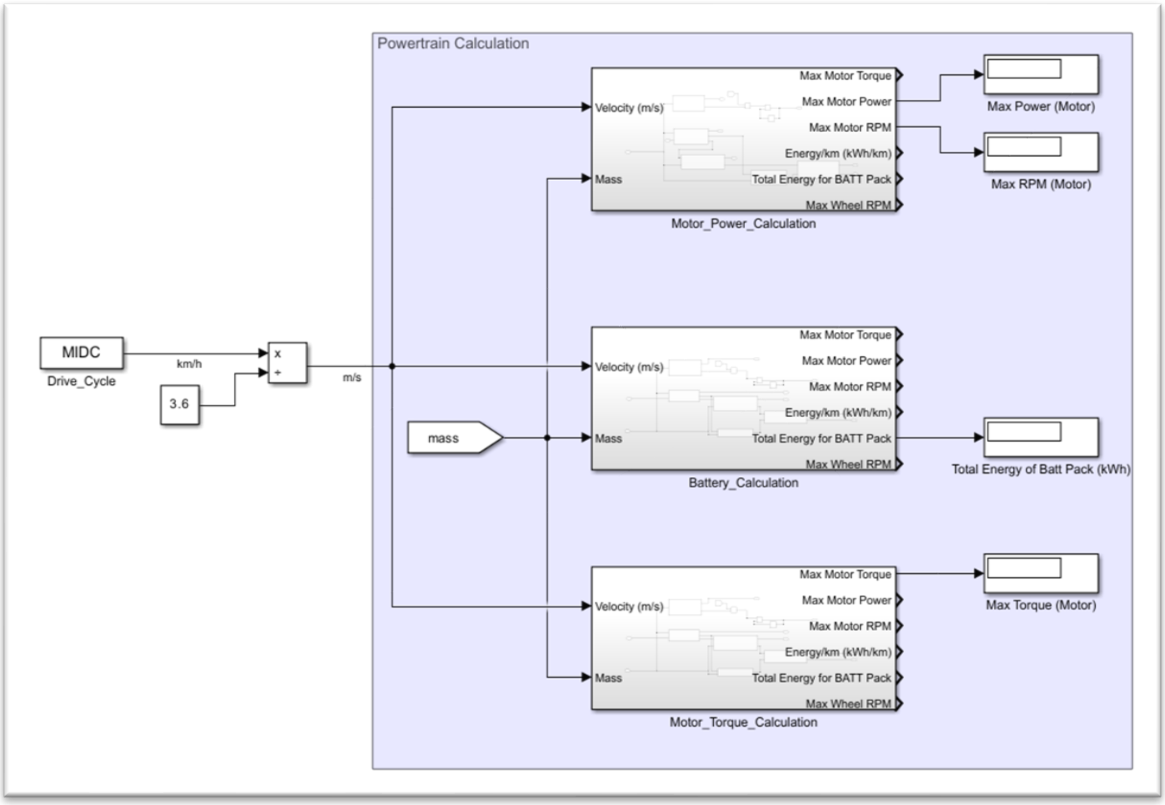


Figure 28 ***MATLAB Model for Powertrain Calculation***

Figure 29 below shows the model created in MATLAB for calculation of battery-pack capacity required by a vehicle to achieve a certain range of 80-100 kms per charge.

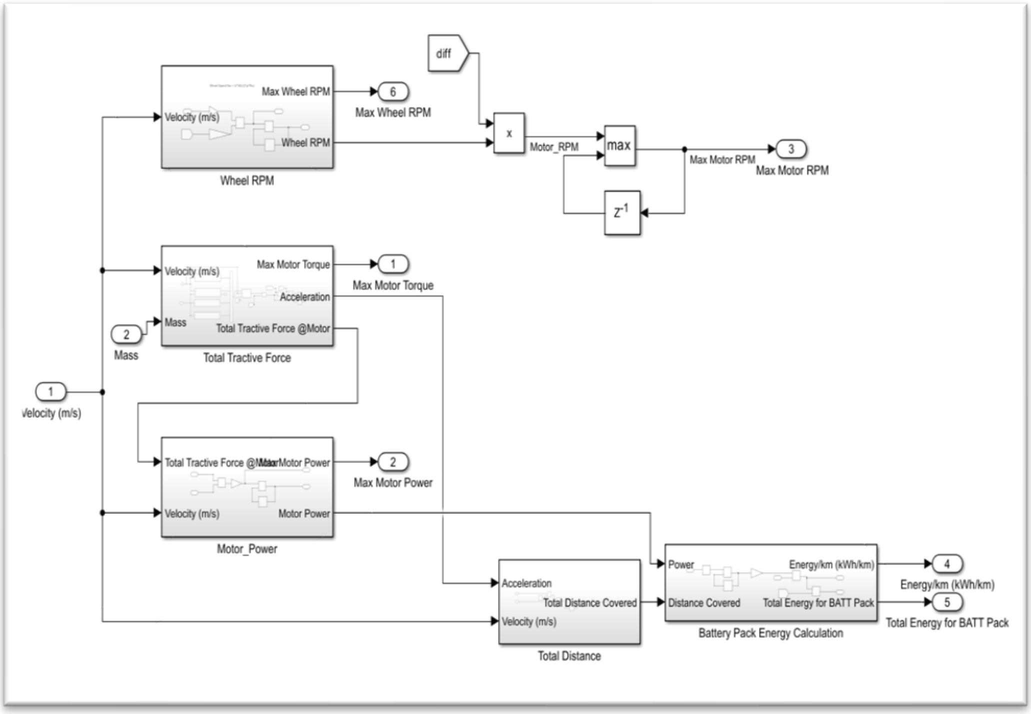


Figure 29 ***MATLAB Model for Battery Power Calculation***

8.2 Results: 2-Wheeler Motor Sizing

SECTION 8

Based on the mathematical expressions for motor sizing in 2.3 and the parameters provided in the ***Table 8*** and ***Table 9***. The calculated power and torque, under various conditions and drive cycles required to drive the vehicle are presented in the images below.

<u>2-Wheeler Scooter</u>

Figure 30 below shows the graph of values of power-torque-speed for MIDC driving cycle for loaded condition and zero gradient

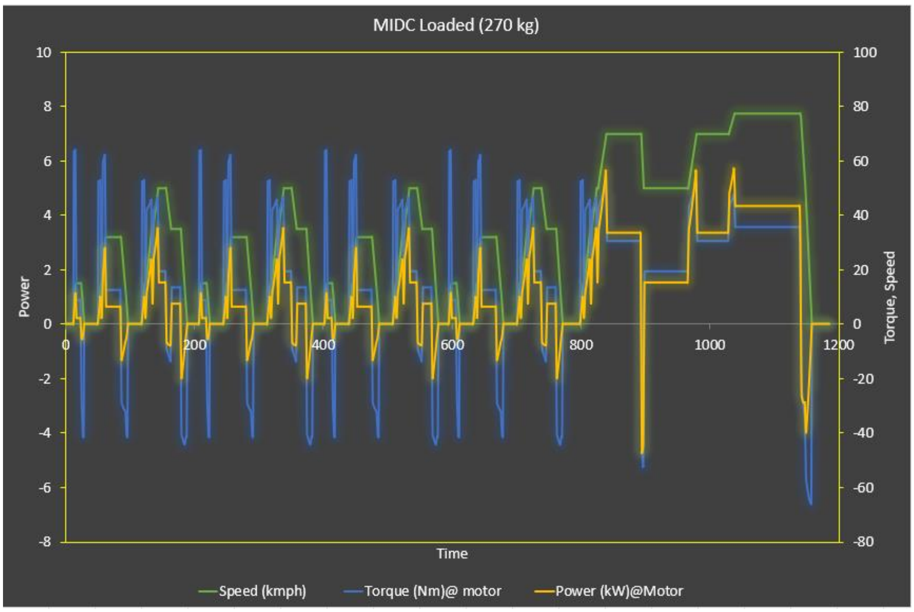


Figure 30 ***MIDC Loaded Zero Gradient***

Figure 31 below shows the graph of values of power-torque-speed for MIDC driving cycle for unloaded condition and zero gradient

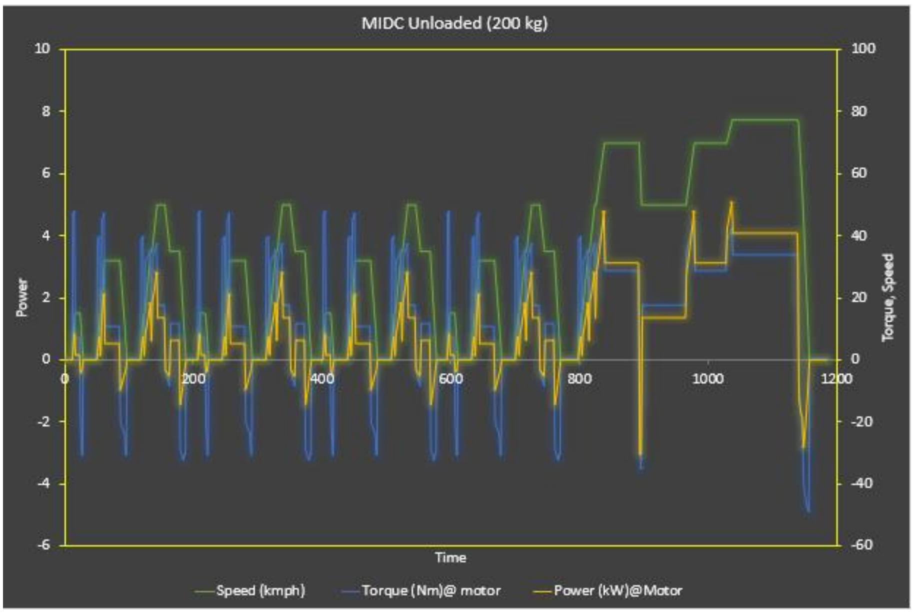


Figure 31 ***MIDC Unloaded Zero Gradient***

Figure 32 below shows the graph of values of power-torque-speed for MIDC driving cycle for loaded condition and combined gradient

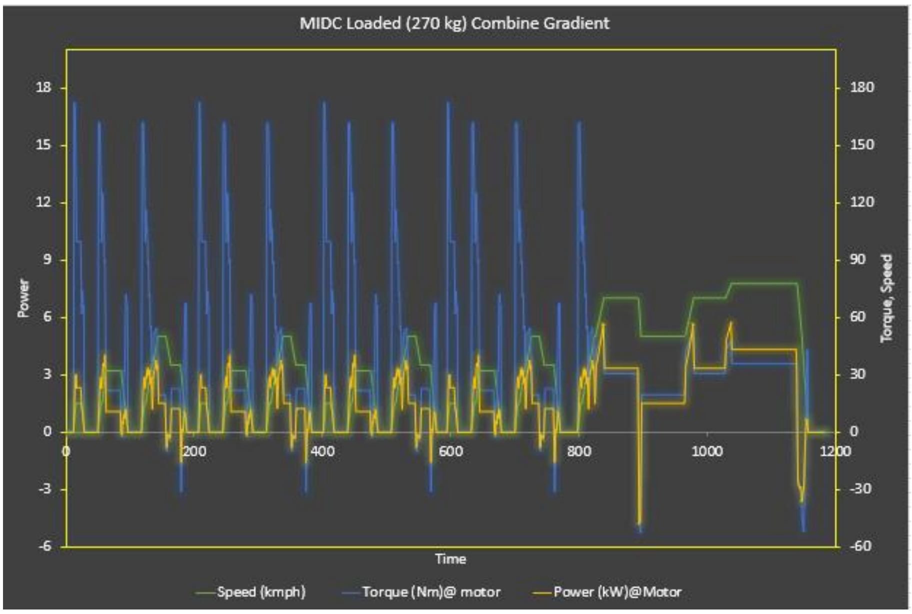


Figure 32 ***MIDC Loaded Combine Gradient***

Figure 33 below shows the graph of values of power-torque-speed for MIDC driving cycle for unloaded condition and combined gradient

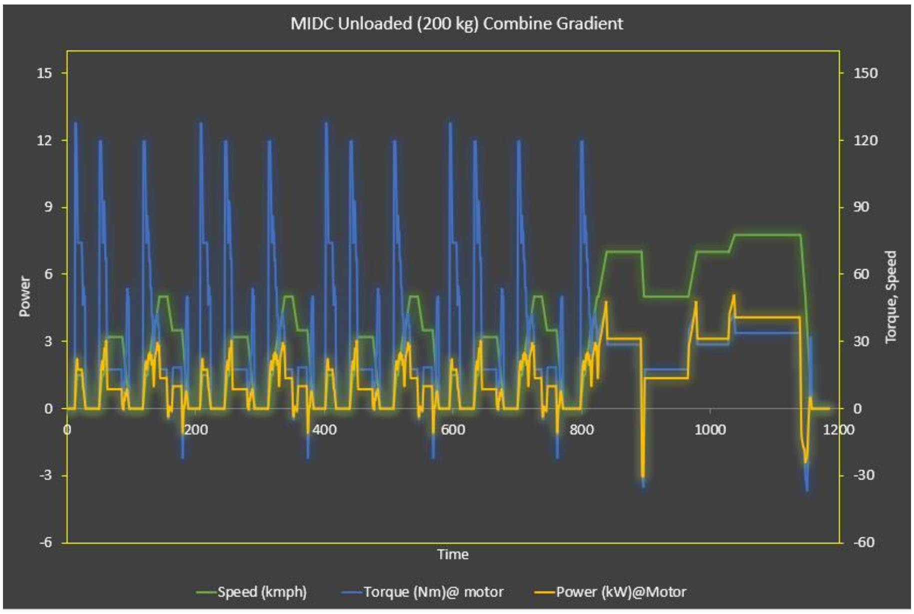


Figure 33 ***MIDC Unloaded Combine Gradient***

The ***Table 52*** below shows the summary of results obtained from the above graphs (Figure 20, 21, 22 & 23)

Scenario (MIDC Driving Cycle)	Gradient	Max Torque of Motor (Nm)	Power @ Max Torque (kW)	Max Power of Motor (kW)	Torque @Max Power (Nm)
Loaded Condition	Zero	63.89	1.13	5.68	47.39
Unloaded Condition	Zero	47.48	0.84	5.06	42.17
Loaded Condition	Combined	172	2.01	5.68	47.39
Unloaded Condition	Combined	127.47	1.49	5.06	42.17

Table 52 ***Results of Required Motor Sizing to drive the vehicle for MIDC***

Figure 34 below shows the graph of values of power-torque-speed for WLTP driving cycle for loaded condition and zero gradient.

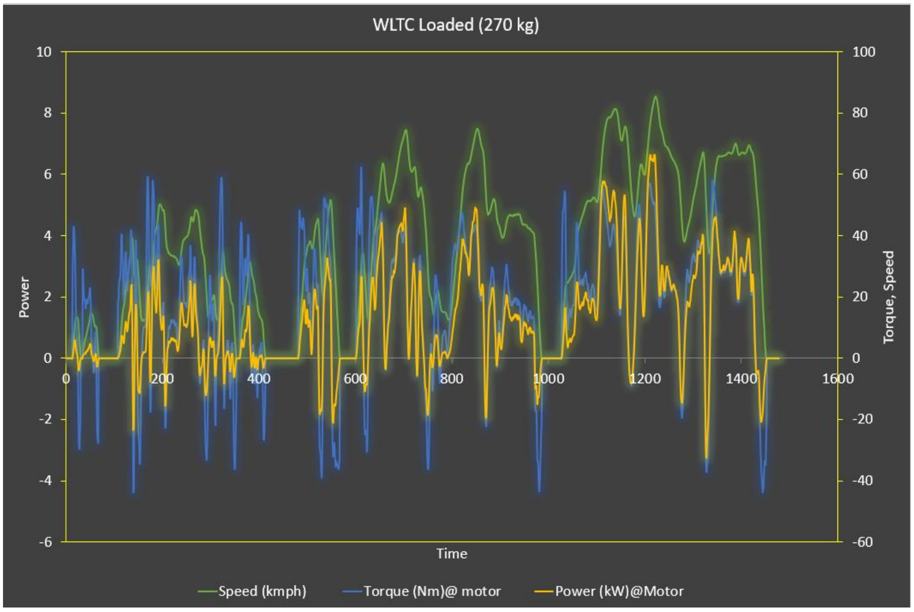


Figure 34 ***WLTP Loaded Zero Gradient***

Figure 35 below shows the graph of values of power-torque-speed for WLTP driving cycle for unloaded condition and zero gradient.

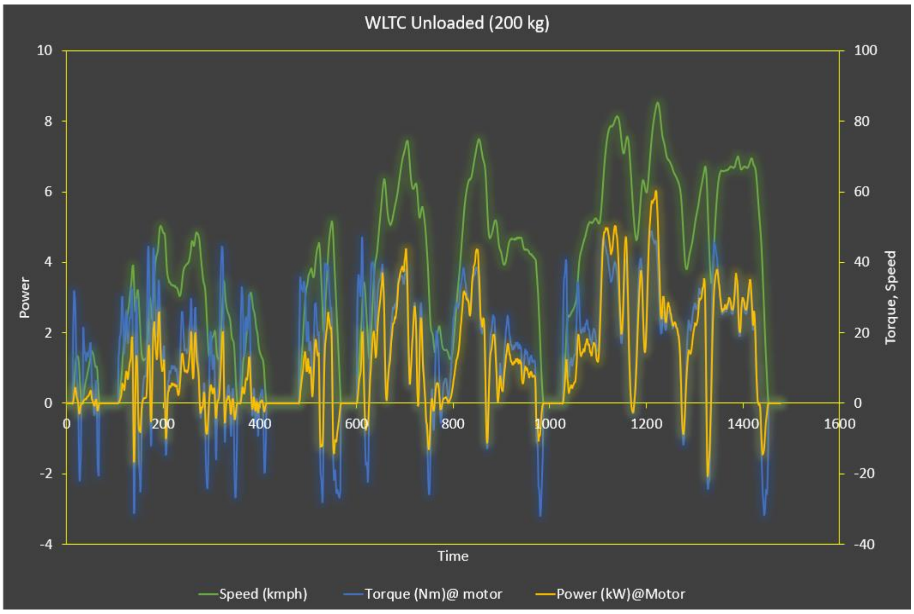


Figure 35 ***WLTP Unloaded Zero Gradient***

Figure 36 below shows the graph of values of power-torque-speed for WLTP driving cycle for loaded condition and combined gradient.

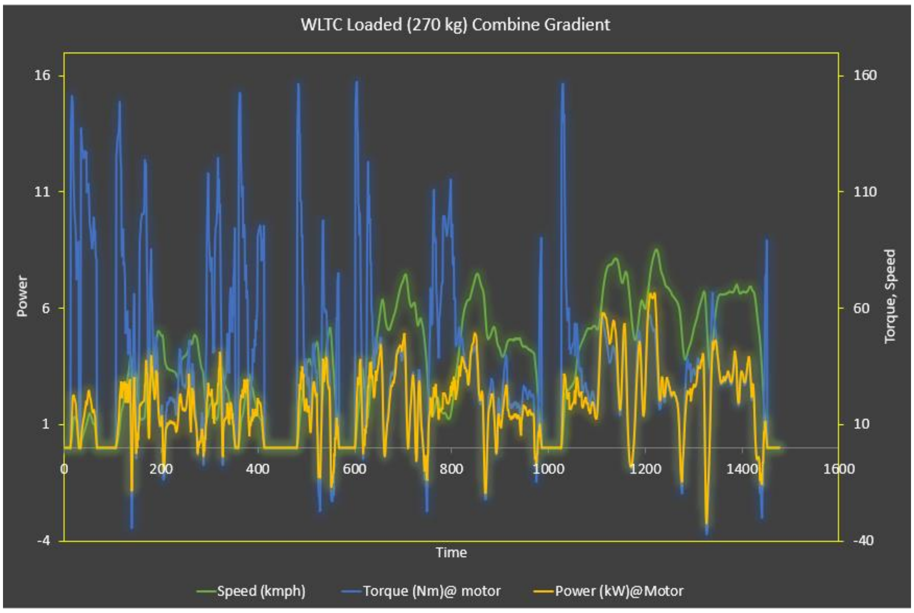


Figure 36 ***WLTP Loaded Combine Gradient***

Figure 37 below shows the graph of values of power-torque-speed for WLTP driving cycle for unloaded condition and combined gradient.

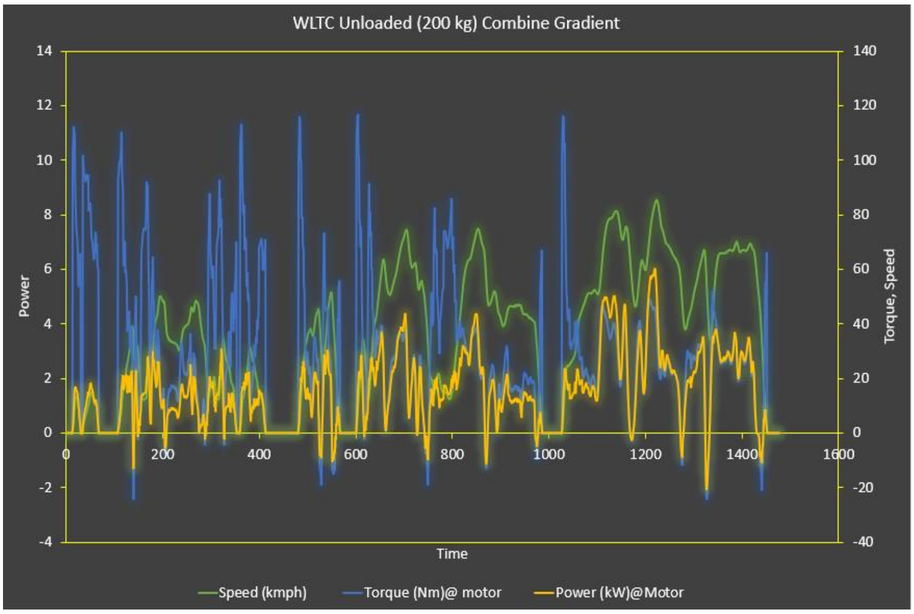


Figure 37 ***WLTP Unloaded Combine Gradient***

The ***Table 53*** below shows the summary of results obtained from the above graphs (Figure 24, 25, 26 & 27)

Scenario (WLTP Driving Cycle)	**Gradient**	**Max Torque of Motor (Nm)**	**Power @ Max Torque (kW)**	**Max Power of Motor (kW)**	**Torque @Max Power (Nm)**
Loaded Condition	Zero	62.22	2.62	6.63	50.65
Unloaded Condition	Zero	48.64	5.68	6.01	45.93
Loaded Condition	Combined	157.32	2.21	6.63	50.65
Unloaded Condition	Combined	116.63	1.64	6.01	45.93

Table 53 ***Results of Required Motor Sizing to drive the vehicle for WLTP***

2-Wheeler Motorcycle

Figure 38 below shows the graph of values of power-torque-speed for MIDC driving cycle for loaded condition and zero gradient.

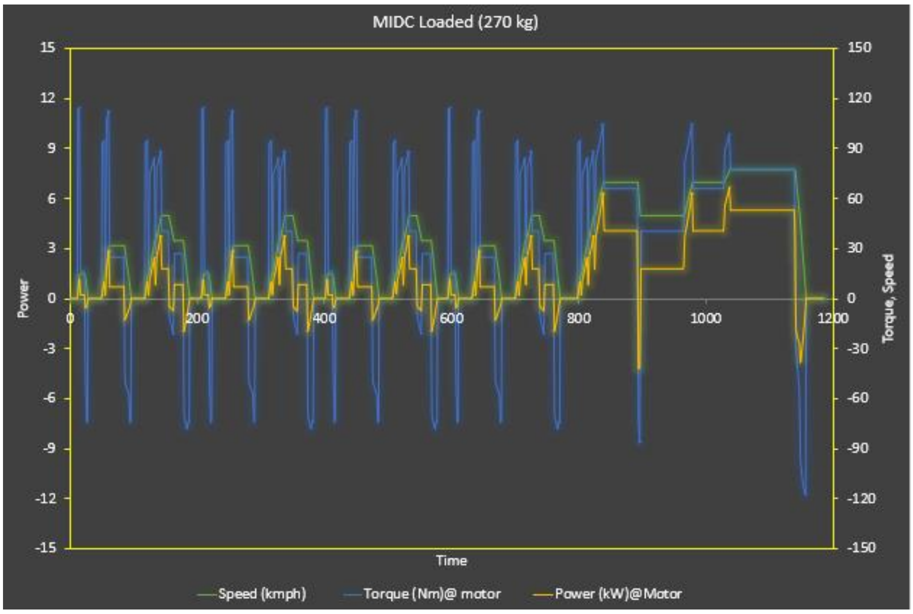


Figure 38 ***MIDC Loaded Zero Gradient***

Figure 39 below shows the graph of values of power-torque-speed for MIDC driving cycle for unloaded condition and zero gradient.

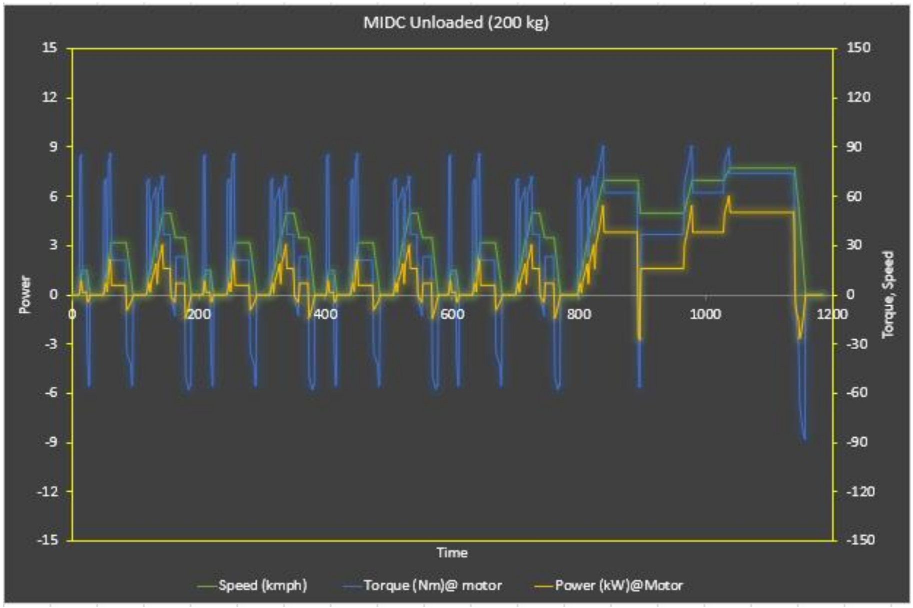


Figure 39 ***MIDC Unloaded Zero Gradient***

Figure 40 below shows the graph of values of power-torque-speed for MIDC driving cycle for loaded condition and combined gradient.

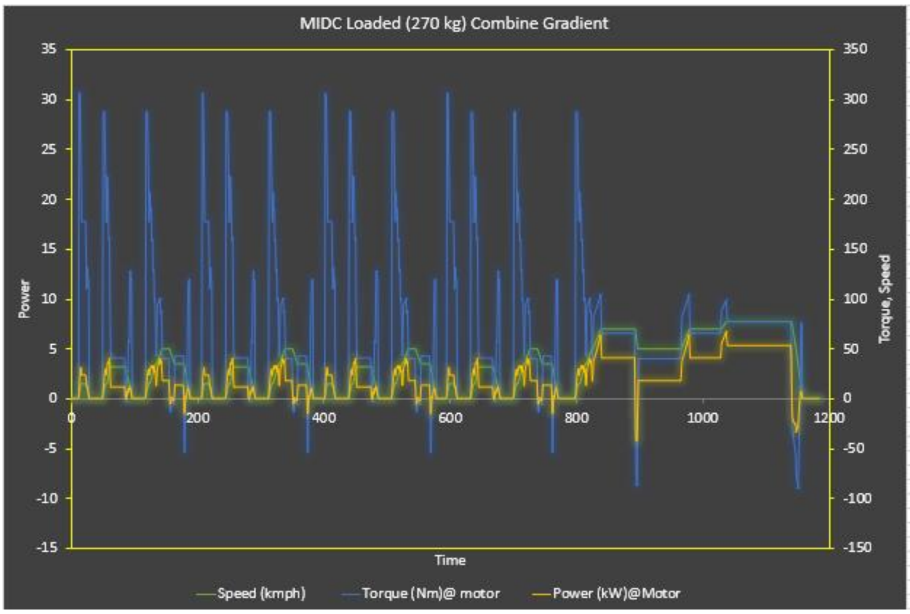


Figure 40 ***MIDC Loaded Combine Gradient***

Figure 41 below shows the graph of values of power-torque-speed for MIDC driving cycle for unloaded condition and combined gradient.

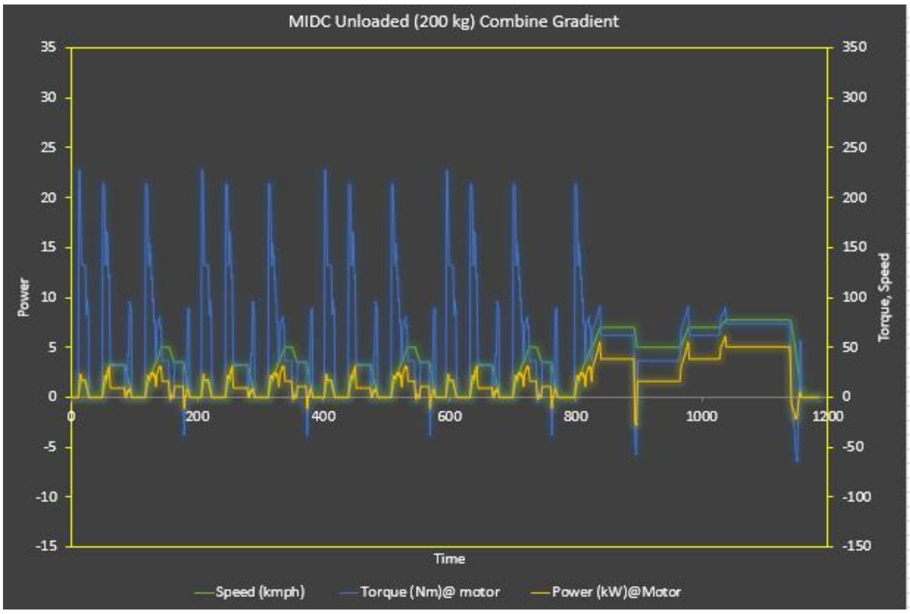


Figure 41 ***MIDC Unloaded Combine Gradient***

Table 54 below shows the summary of results obtained from the above graphs (Figure 28, 29, 30 & 31)

Scenario (MIDC Driving Cycle)	Gradient	Max Torque of Motor (Nm)	Power @ Max Torque (kW)	Max Power of Motor (kW)	Torque @Max Power (Nm)
Loaded Condition	Zero	114.05	1.13	6.62	98.23
Unloaded Condition	Zero	90.05	5.42	5.99	88.93
Loaded Condition	Combined	306.34	2.02	6.62	98.23
Unloaded Condition	Combined	227.07	1.49	5.99	88.93

Table 54 ***Results of Required Motor Sizing to drive the vehicle for MIDC***

Figure 42 below shows the graph of values of power-torque-speed for WLTP driving cycle for loaded condition and zero gradient.

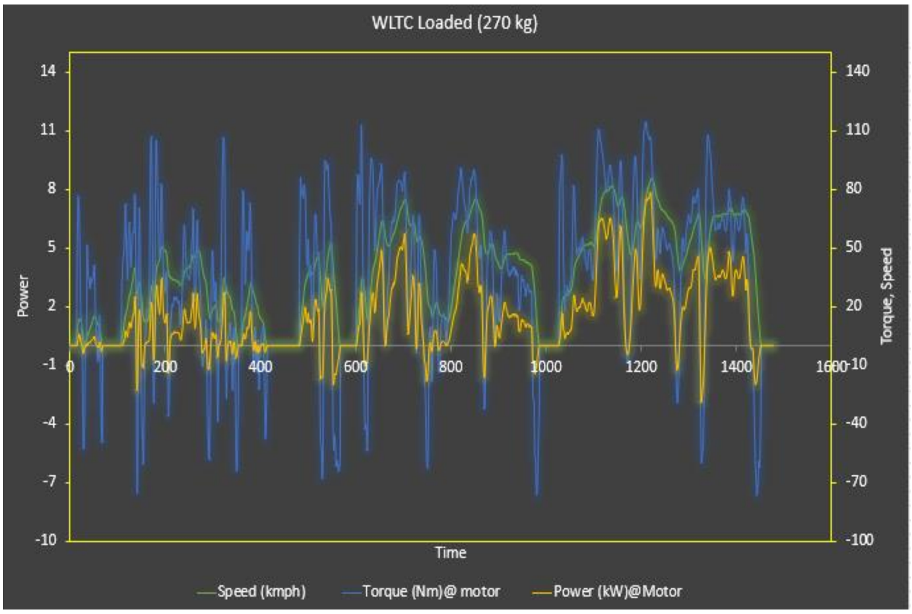


Figure 42 ***WLTP Loaded Zero Gradient***

Figure 43 below shows the graph of values of power-torque-speed for WLTP driving cycle for unloaded condition and zero gradient.

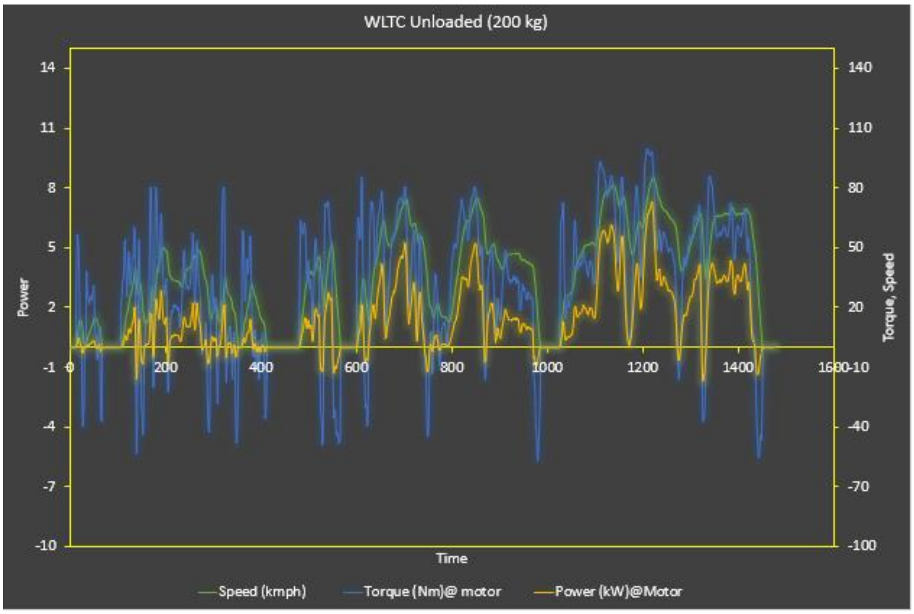


Figure 43 ***WLTP Unloaded Zero Gradient***

Figure 44 below shows the graph of values of power-torque-speed for WLTP driving cycle for loaded condition and combined gradient.

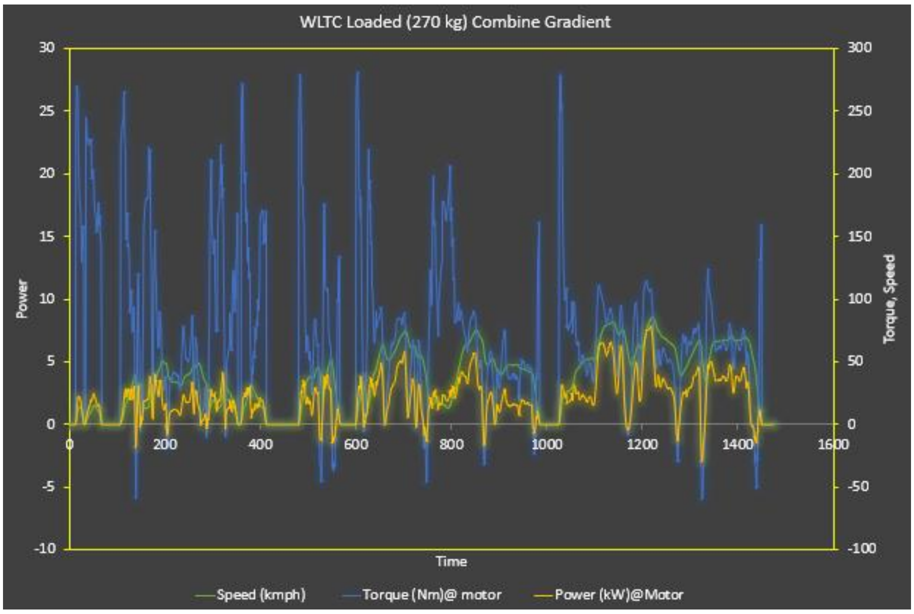


Figure 44 ***WLTP Loaded Combine Gradient***

Figure 45 below shows the graph of values of power-torque-speed for WLTP driving cycle for unloaded condition and combined gradient.

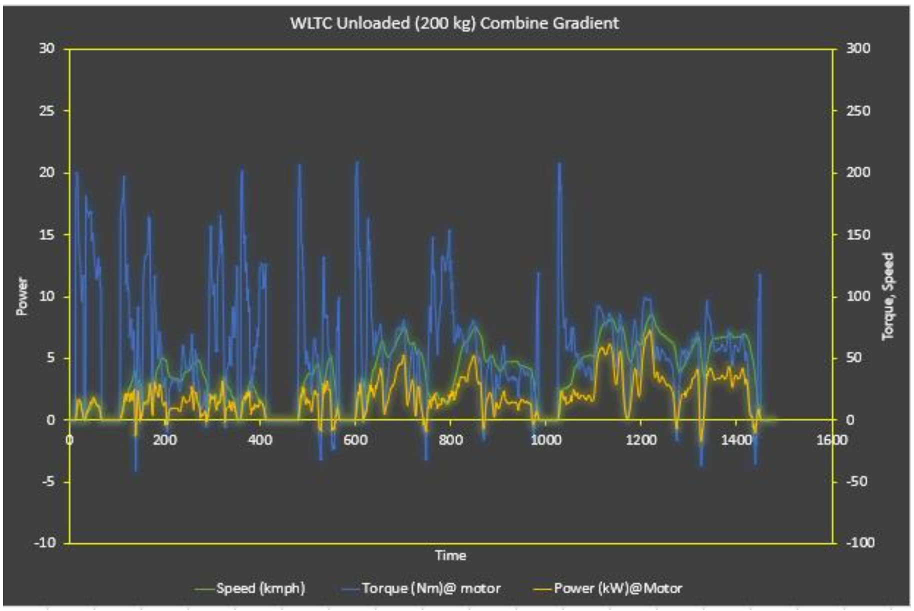


Figure 45 ***WLTP Unloaded Combine Gradient***

Table 55 below shows the summary of results obtained from the above graphs (Figure 32, 33, 34 & 35)

Scenario (WLTP Driving Cycle)	Gradient	Max Torque of Motor (Nm)	Power @ Max Torque (kW)	Max Power of Motor (kW)	Torque @Max Power (Nm)
Loaded Condition	Zero	114.07	7.33	7.85	106.68
Unloaded Condition	Zero	99.75	6.55	7.24	97.59
Loaded Condition	Combined	280.27	2.21	7.85	106.68
Unloaded Condition	Combined	207.93	1.64	7.24	97.59

Table 55 ***Results of Required Motor Sizing to drive the vehicle for WLTP***

These results provide a comprehensive understanding of the power and torque requirements under different driving conditions and cycles, ensuring the motor is appropriately sized for optimal vehicle performance.

SECTION 9

3-Wheeler (Passenger & Cargo)

Figure 46 below shows an overview of results obtained after performing a virtual simulation of motor sizing using MATLAB software for a 3-wheeler vehicle. It shows the output required (Motor power & Energy) for a vehicle to achieve certain required velocity against the given input parameters.

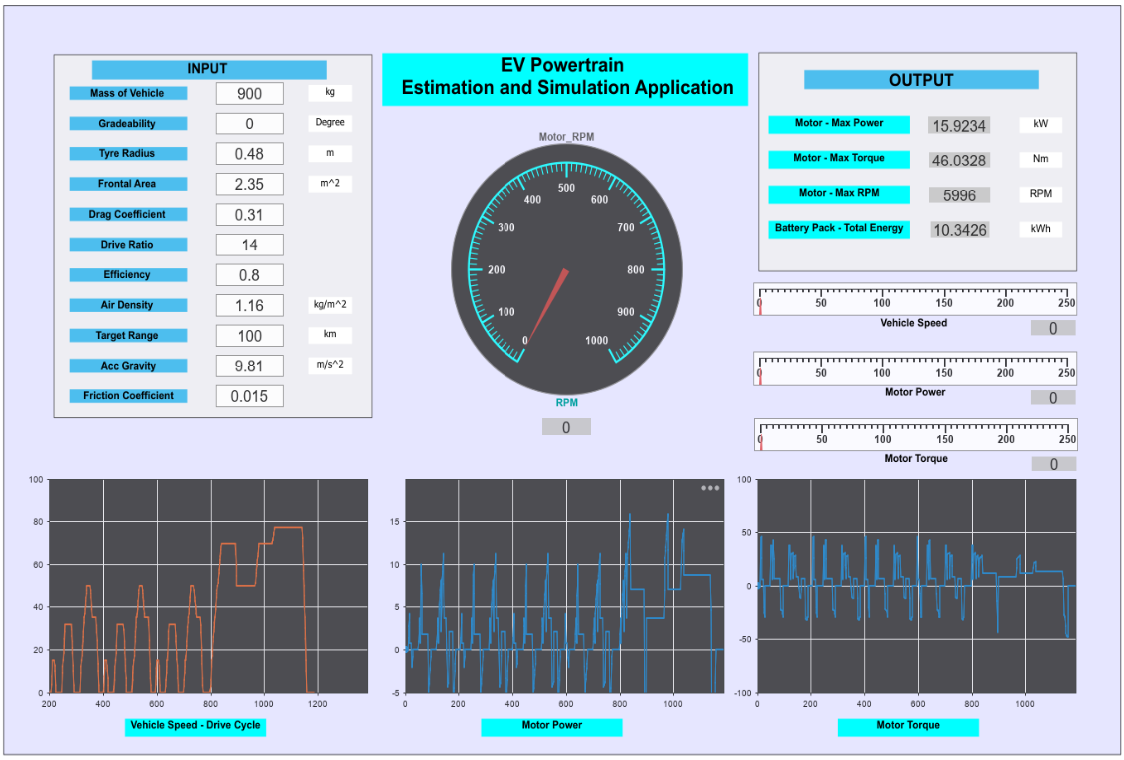


Figure 46 ***EV Powertrain Estimation and Simulation for 3-Wheeler***

8.3 Results: 3-Wheeler Motor Sizing

SECTION 10

Based on the mathematical expressions for motor sizing in 2.3 and the parameters provided in the ***Table 10*** and ***Table 11***. The calculated power and torque, under various conditions and drive cycles required to drive the vehicle are presented in the images below.

<u>3-Wheeler Passenger</u>

Figure 47 below shows the graph of values of power-torque-speed for MIDC driving cycle for loaded condition and zero gradient.

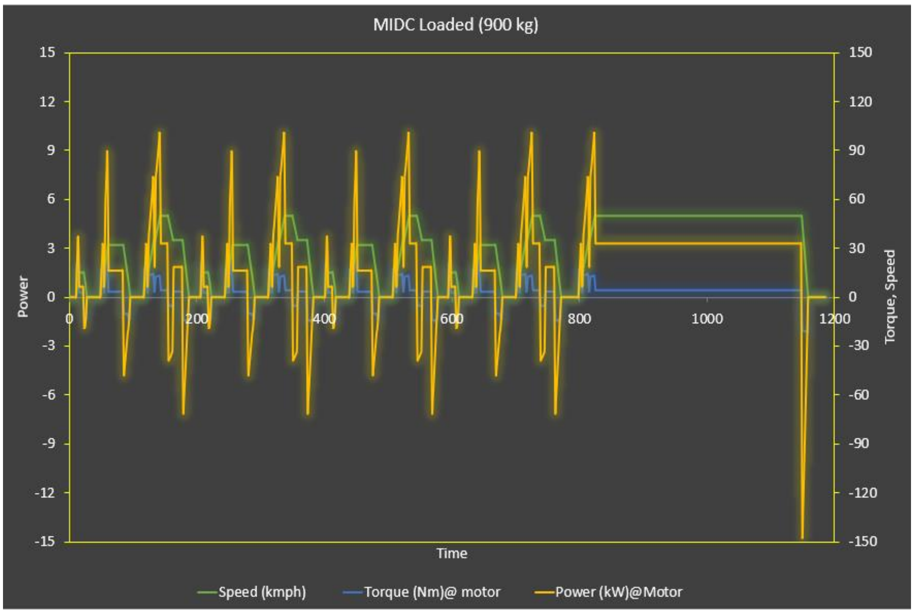


Figure 47 ***MIDC Loaded Zero Gradient***

Figure 48 below shows the graph of values of power-torque-speed for MIDC driving cycle for unloaded condition and zero gradient.

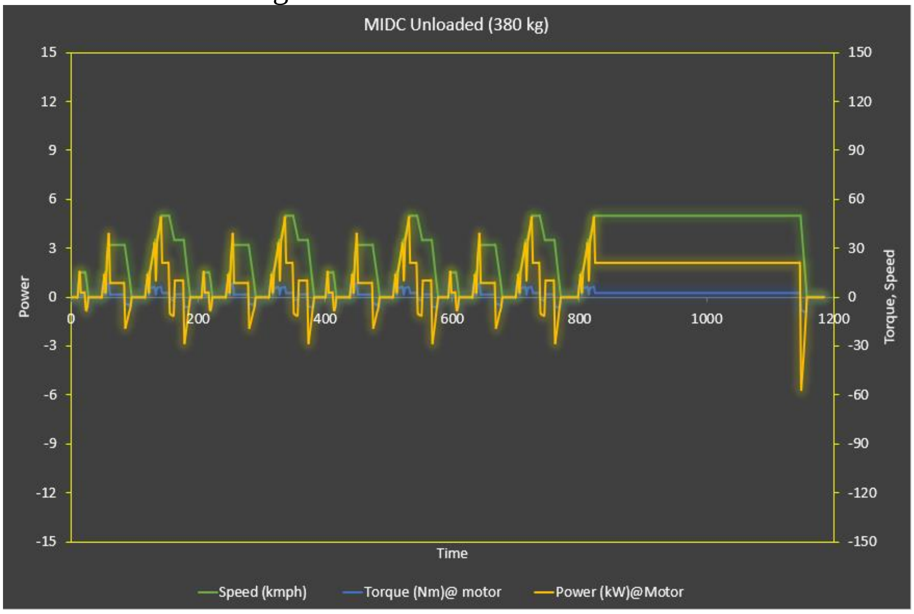


Figure 48 ***MIDC Unloaded Zero Gradient***

Figure 49 below shows the graph of values of power-torque-speed for MIDC driving cycle for loaded condition and combined gradient.

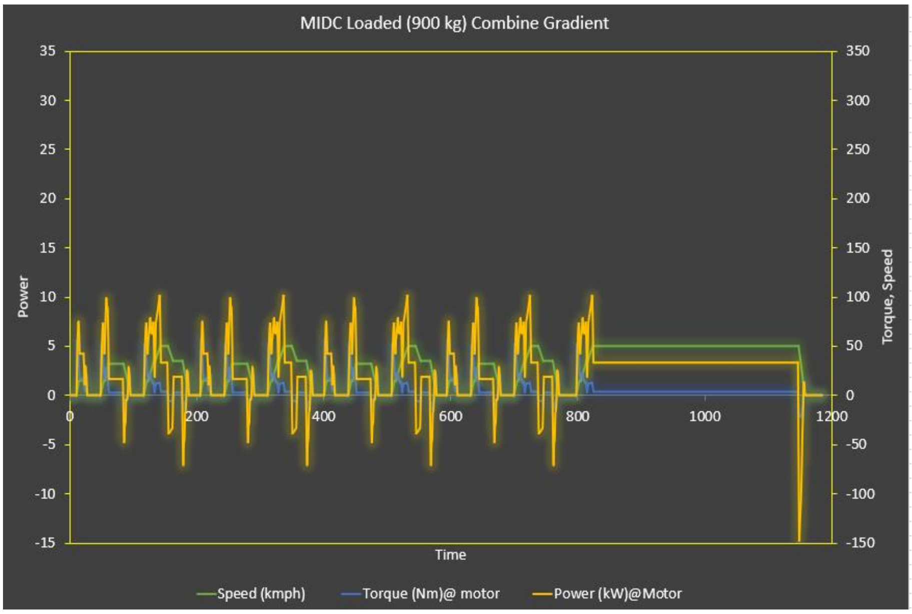


Figure 49 ***MIDC Loaded Combine Gradient***

Figure 50 below shows the graph of values of power-torque-speed for MIDC driving cycle for unloaded condition and zero gradient.

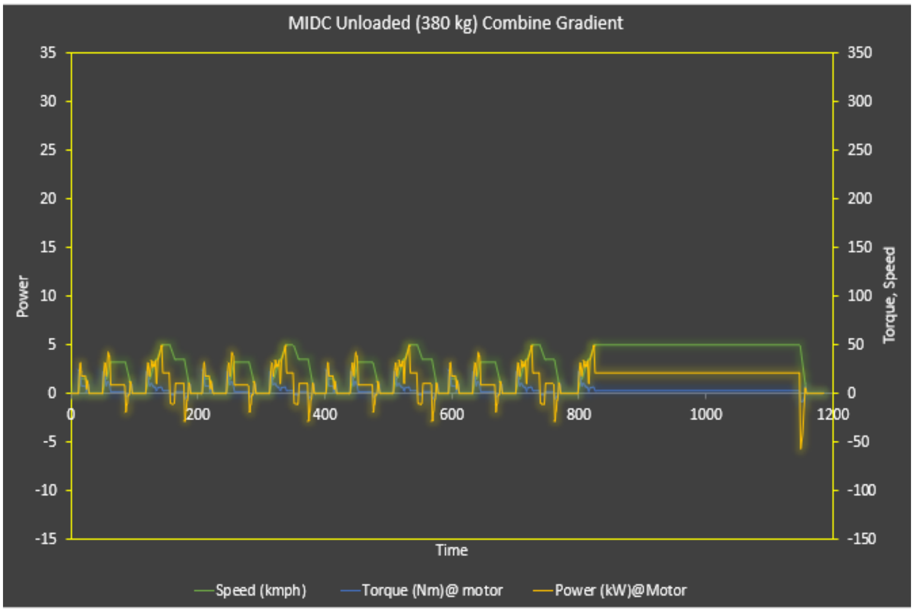


Figure 50 ***MIDC Unloaded Combine Gradient***

The ***Table 56*** below shows the summary of results obtained from the above graphs (Figure 36, 37, 38 & 39)

Scenario (MIDC Driving Cycle)	**Gradient**	**Max Torque of Motor (Nm)**	**Power @ Max Torque (kW)**	**Max Power of Motor (kW)**	**Torque @Max Power (Nm)**
Loaded Condition	Zero	20.45	3.74	10.05	12.88
Unloaded Condition	Zero	8.68	1.59	4.89	6.27
Loaded Condition	Combined	55.29	3.4	10.05	12.88
Unloaded Condition	Combined	23.35	1.43	4.89	6.27

Table 56 ***Results of Required Motor Sizing to drive the vehicle for MIDC***

Figure 51 below shows the graph of values of power-torque-speed for WLTP driving cycle for loaded condition and zero gradient.

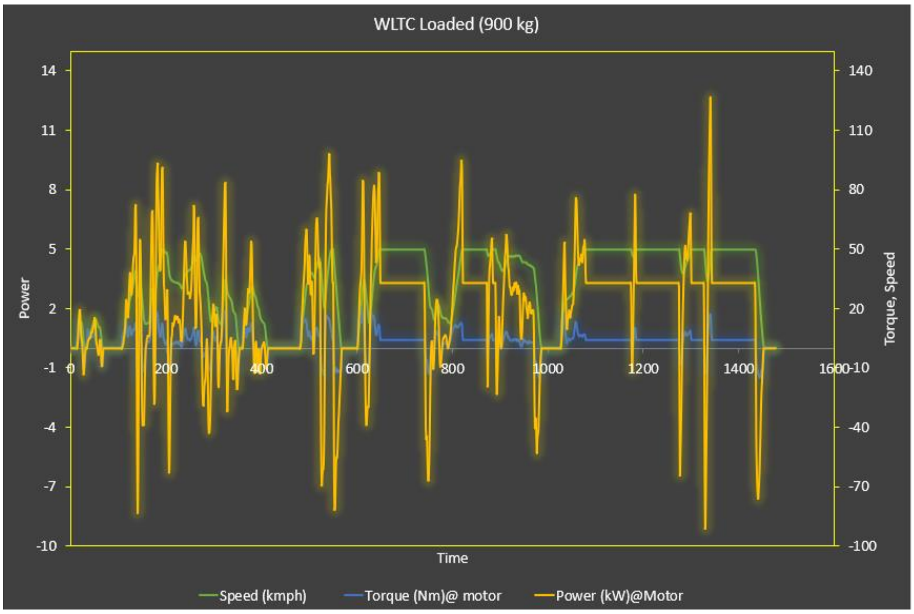


Figure 51 ***WLTP Loaded Zero Gradient***

Figure 52 below shows the graph of values of power-torque-speed for WLTP driving cycle for unloaded condition and zero gradient.

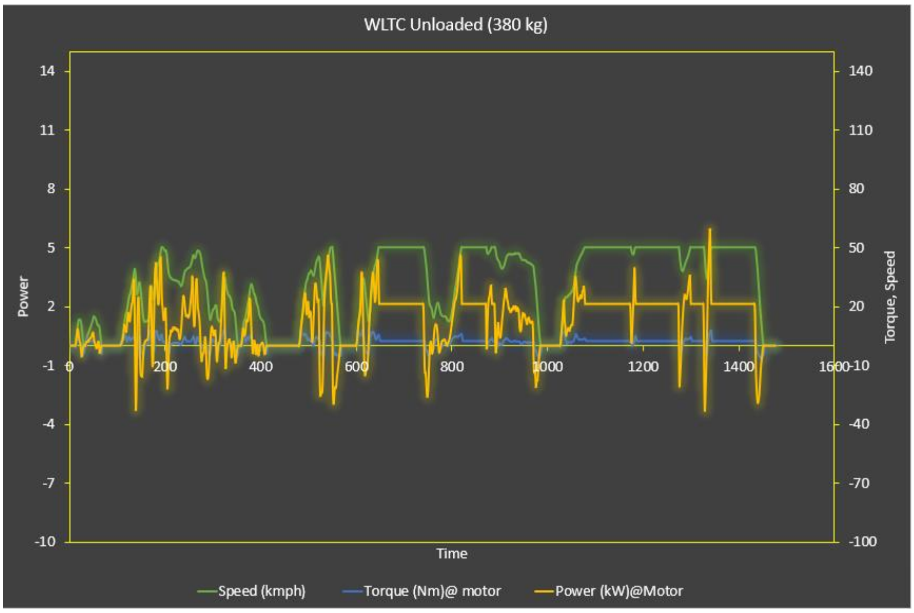


Figure 52 ***WLTP Unloaded Zero Gradient***

Figure 53 below shows the graph of values of power-torque-speed for WLTP driving cycle for loaded condition and combined gradient.

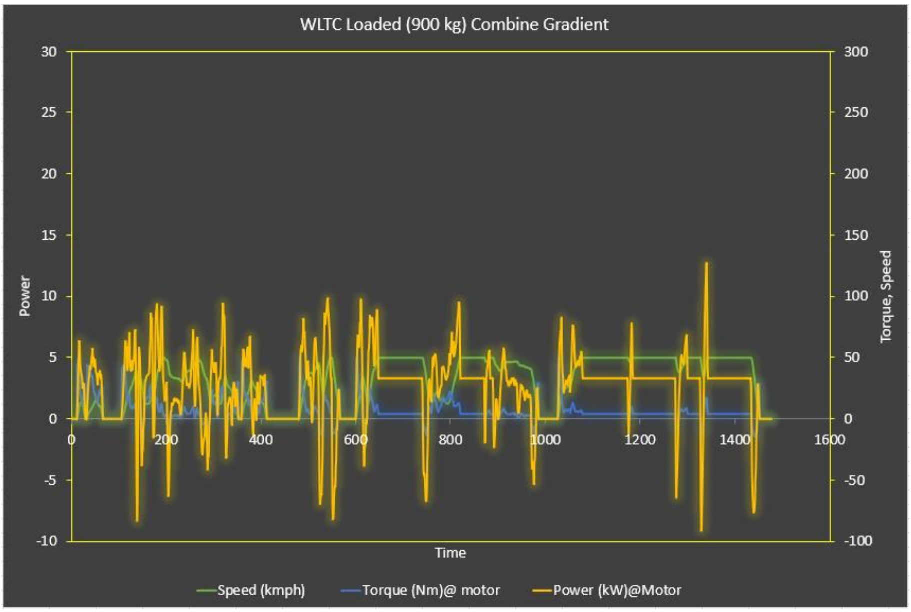


Figure 53 ***WLTP Loaded Combine Gradient***

Figure 54 below shows the graph of values of power-torque-speed for WLTP driving cycle for unloaded condition and combined gradient.

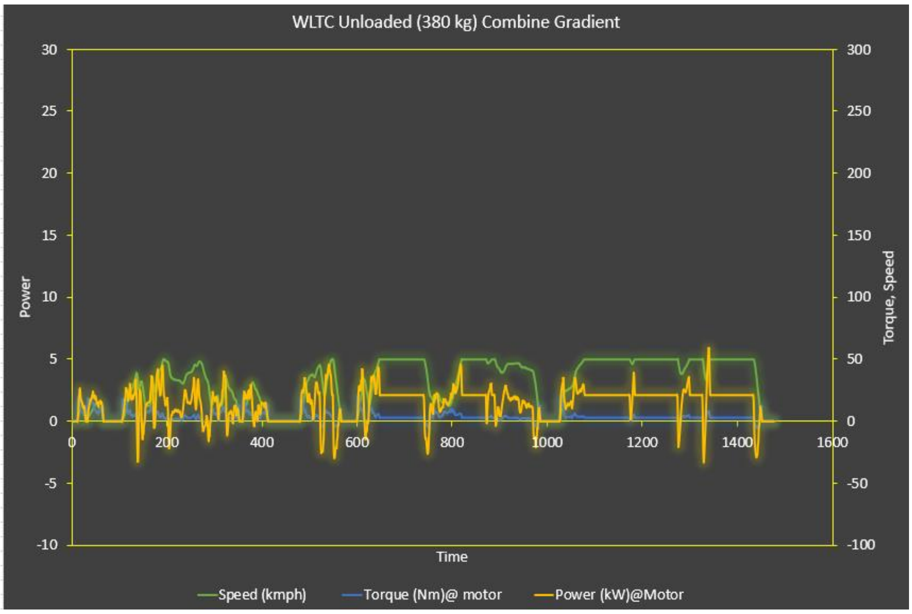


Figure 54 WLTP ***Unloaded Combine Gradient***

The ***Table 57*** below shows the summary of results obtained from the above graphs (Figure 40, 41, 42 & 43)

Scenario (WLTP Driving Cycle)	Gradient	Max Torque of Motor (Nm)	Power @ Max Torque (kW)	Max Power of Motor (kW)	Torque @Max Power (Nm)
Loaded Condition	Zero	19.4	8.45	12.6	16.72
Unloaded Condition	Zero	8.45	3.68	5.9	7.83
Loaded Condition	Combined	50.31	5.13	12.6	16.72
Unloaded Condition	Combined	21.25	2.17	5.9	7.83

Table 57 ***Results of Required Motor Sizing to drive the vehicle for WLTP***

3-Wheeler Cargo

Figure 55 below shows the graph of values of power-torque-speed for MIDC driving cycle for loaded condition and zero gradient.

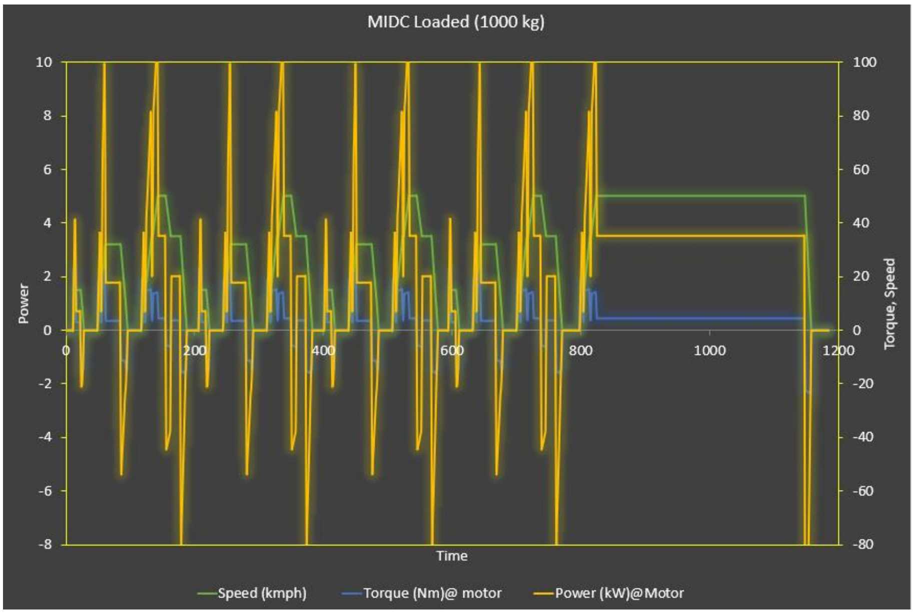


Figure 55 ***MIDC Loaded Zero Gradient***

Figure 56 below shows the graph of values of power-torque-speed for MIDC driving cycle for unloaded condition and zero gradient.

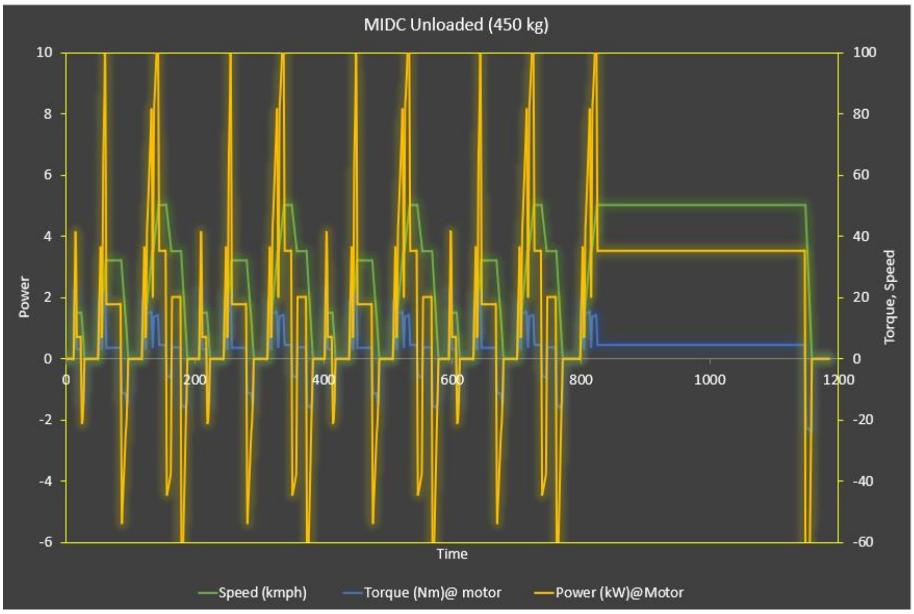


Figure 56 ***MIDC Unloaded Zero Gradient***

Figure 57 below shows the graph of values of power-torque-speed for MIDC driving cycle for loaded condition and combined gradient.

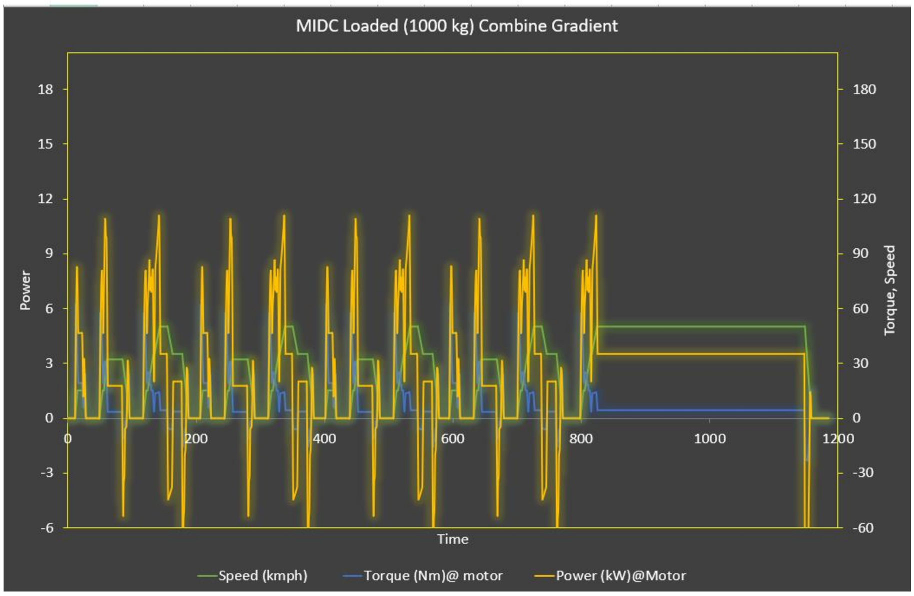


Figure 57 ***MIDC Loaded Combine Gradient***

Figure 58 below shows the graph of values of power-torque-speed for MIDC driving cycle for unloaded condition and zero gradient.

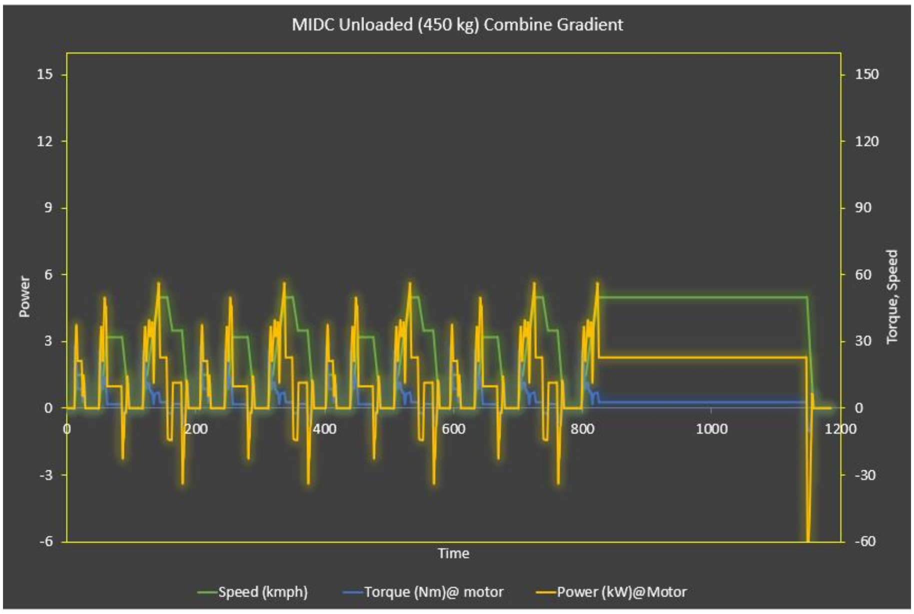


Figure 58 ***MIDC Unloaded Combine Gradient***

The ***Table 58*** below shows the summary of results obtained from the above graphs (Figure 44, 45, 46 & 47)

Scenario (MIDC Driving Cycle)	**Gradient**	**Max Torque of Motor (Nm)**	**Power @ Max Torque (kW)**	**Max Power of Motor (kW)**	**Torque @Max Power (Nm)**
Loaded Condition	Zero	22.73	4.16	11.04	14.16
Unloaded Condition	Zero	22.72	4.18	11.04	14.18
Loaded Condition	Combined	61.44	3.78	11.04	14.16
Unloaded Condition	Combined	27.65	1.7	5.58	7.16

Table 58 ***Results of Required Motor Sizing to drive the vehicle for MIDC***

Figure 59 below shows the graph of values of power-torque-speed for WLTP driving cycle for loaded condition and zero gradient.

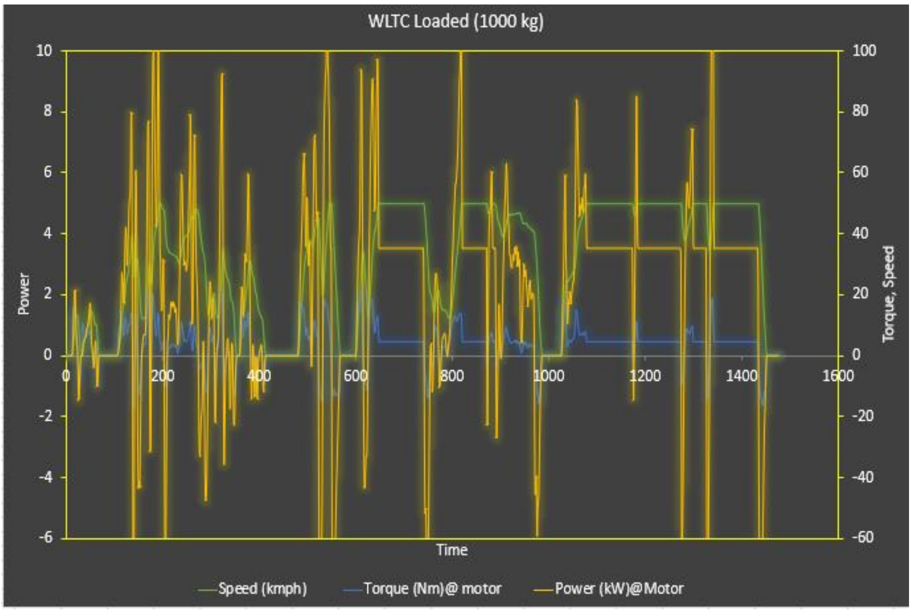


Figure 59 ***WLTP Loaded Zero Gradient***

Figure 60 below shows the graph of values of power-torque-speed for WLTP driving cycle for unloaded condition and zero gradient.

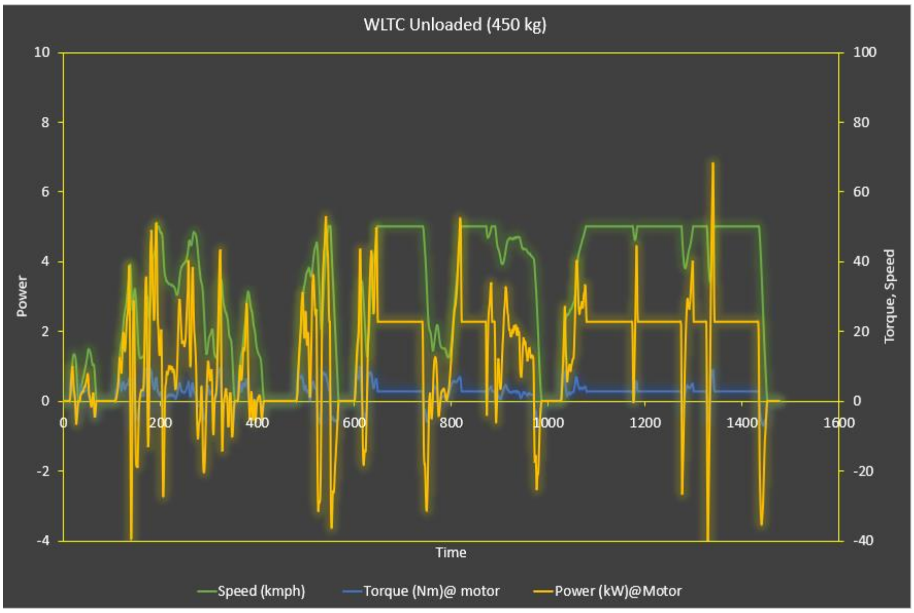


Figure 60 ***WLTP Unloaded Zero Gradient***

Figure 61 below shows the graph of values of power-torque-speed for WLTP driving cycle for loaded condition and combined gradient.

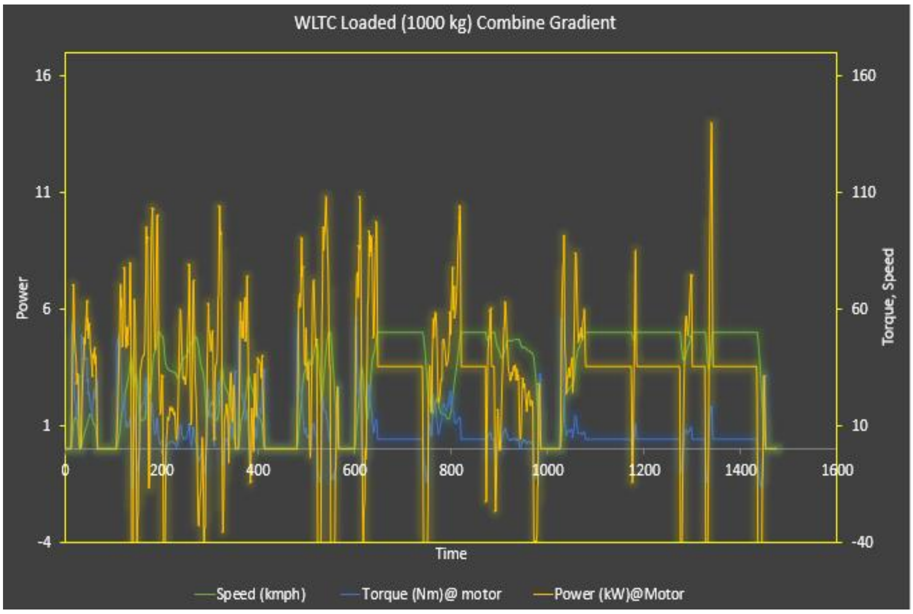


Figure 61 ***WLTP Loaded Combine Gradient***

Figure 62 below shows the graph of values of power-torque-speed for WLTP driving cycle for unloaded condition and combined gradient.

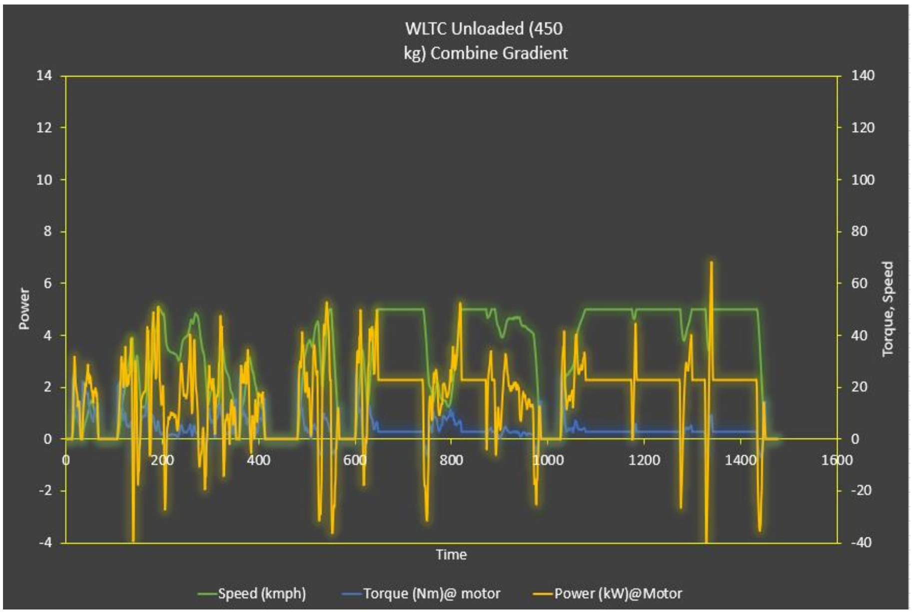


Figure 62 ***WLTP Unloaded Combine Gradient***

The ***Table 59*** below shows the summary of results obtained from the above graphs (Figure 48, 49, 50 & 51)

Scenario (WLTP Driving Cycle)	**Gradient**	**Max Torque of Motor (Nm)**	**Power @ Max Torque (kW)**	**Max Power of Motor (kW)**	**Torque @Max Power (Nm)**
Loaded Condition	Zero	21.5	9.37	13.89	18.43
Unloaded Condition	Zero	9..92	4.32	6.8	9.03
Loaded Condition	Combined	55.9	5.7	13.89	18.43
Unloaded Condition	Combined	25.16	2.57	6.88	9.03

Table 59 ***Results of Required Motor Sizing to drive the vehicle for WLTP***

These results provide a comprehensive understanding of the power and torque requirements under different driving conditions and cycles, ensuring the motor is appropriately sized for optimal vehicle performance.

8.4 Available kits survey as per proposed solution and procurement

SECTION 11

2-Wheeler Vehicle Retro-fitment Kits

The ***Table 60*** below shows the kit images for the different solutions opted along with their specification for 2-wheeler category.

Vehicle	**Retro-fit Kits**	**Details**
Retrofit Solution 1 (Splendor & Activa)	 	**Kit Specification** Splendor: Hub motor- 2kW Activa: Hub motor - 1.2kW Battery: 72V 40Ah
Retrofit Solution 2 (Splendor & Activa)	 	**Kit Specification** Splendor: Hub motor - 3kW Activa: Hub motor - 2kW Battery: 72V 35Ah

Retrofit Solution 3 (Splendor & Activa)	 	**Kit Specification** Splendor: Traction motor - 2kW Activa: Traction motor - 2kW Front to Rear Sprocket Ratio: 1:4.78 Battery: 60V 42Ah

Table 60 ***Procured Retro-fitment Kit for all category of 2-Wheeler Vehicles***

3-Wheeler Vehicle Retro-fitment Kits

The ***Table 61*** below shows the kit images for the different solutions opted along with their specification for 3-wheeler category.

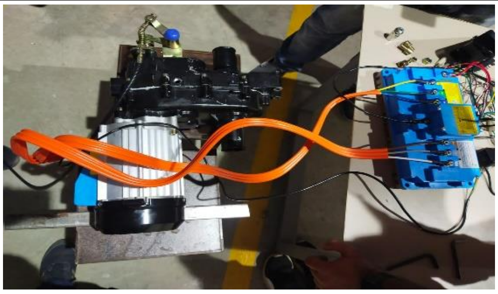
Solution	Retro-fit Kits	Details
Retrofit Solution 1 Bajaj RE Passenger & Piaggio Cargo		Kit Specification Power: 3kW Gearbox: 2-Speed Auto-clutch. Battery: 48V 100Ah (Passenger) Battery: 48V 200Ah (Cargo)
Retrofit Solution 2 Piaggio Ape Passenger & Bajaj Maxima Cargo		Kit Specification: Power: 4kW Gearbox: Single Speed gearbox (1:14 Ratio) Battery: 48 V 200Ah
Retrofit Solution 3 (Piaggio Ape City Passenger and Bajaj Maxima Cargo)		Kit Specifications: Power: 4.4kW (Passenger) Power: 7kW (Cargo) Gearbox: 2 Speed gear-box Battery: 48 V 200Ah

Table 61 ***Procured Retro-fitment Kit for all category of 3-Wheeler vehicle***

ANNEXURE 3

MILESTONE 3: FITMENT OF RETRO-FITMENT KIT, BATTERY PACK ON VEHICLE

9.1 3D Scanning and CAD Generation

SECTION 12

2-Wheeler Scooter

The ***Figure 63*** below shows the 3D scan generated CAD model for Activa Vehicle.

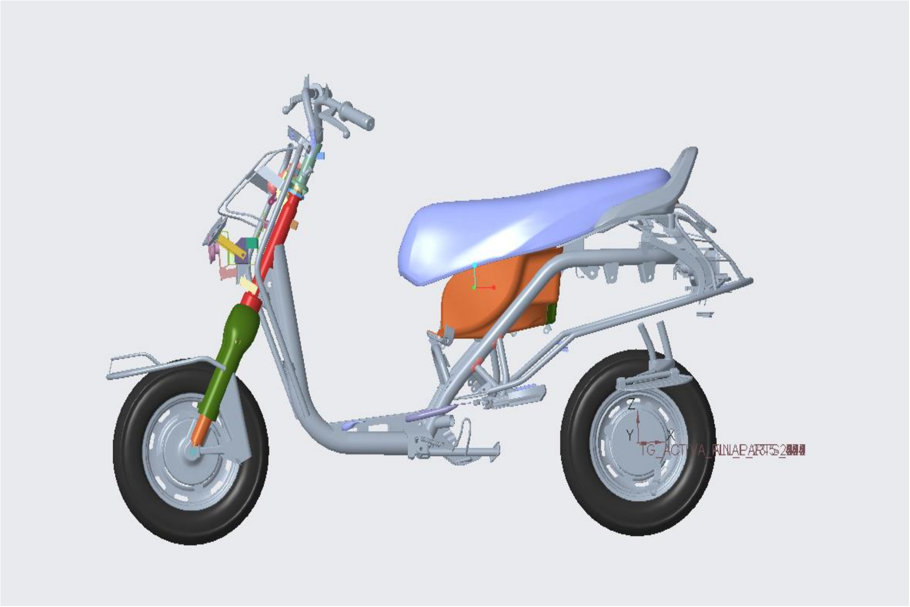


Figure 63 ***CAD Model of Activa 2-Wheeler (Without Body)***

The ***Figure 64*** below shows the CAD model of Activa vehicle with integrated retro-fitment solution.

Figure 64 ***CAD Model of Activa 2-Wheeler (With Body)***

2-Wheeler Motorcycle

The ***Figure 65*** & ***Figure 66*** below shows the 3D scanned CAD model of Splendor vehicle.

Figure 65 ***CAD Model of Splendor 2-Wheeler (Without Body)***

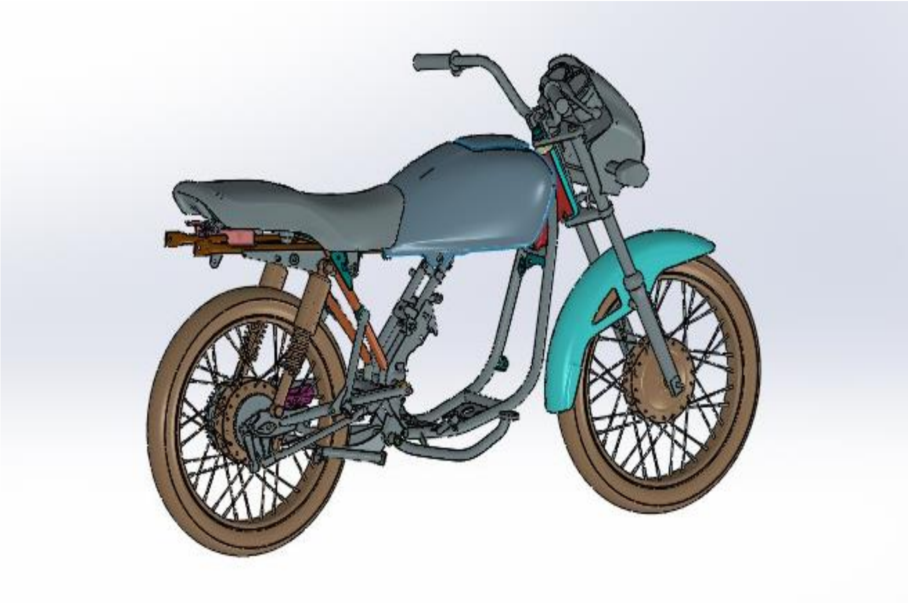


Figure 66 ***CAD Model of Splendor 2-Wheeler (Without Body)***

3-Wheeler Passenger Vehicle

Retro-fitment Solution 2

The ***Figure 67*** below shows the CAD model of solution 2 integrated into the passenger vehicle.

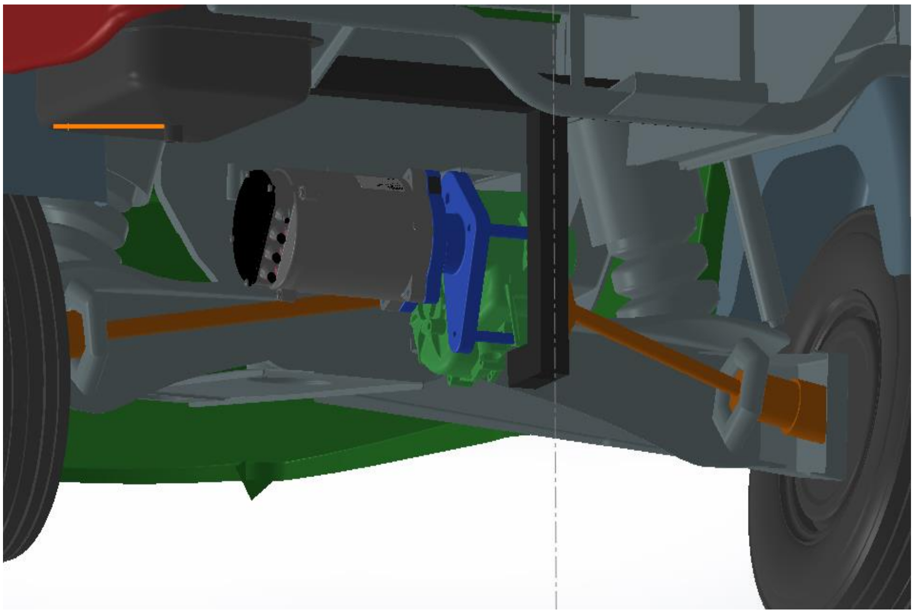


Figure 67 ***Piaggio Ape Xtra (Passenger Vehicle) CAD Model***

Retro-fitment Solution 3

The ***Figure 68*** below shows the CAD model of solution 3 integrated into the passenger vehicle.

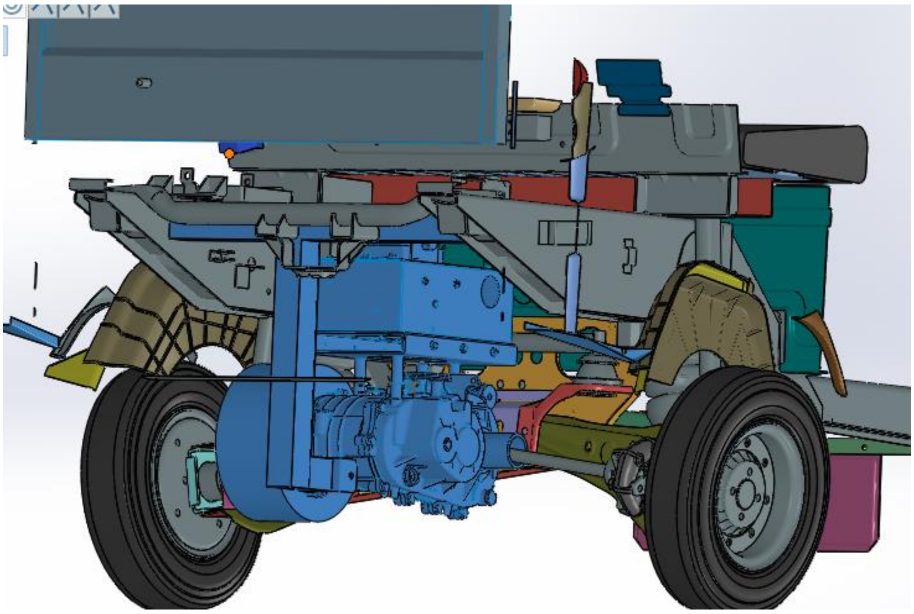


Figure 68 ***Piaggio Ape City (Passenger Vehicle) CAD Model***

3-Wheeler Cargo Vehicle

Retro-fitment Solution 2

The ***Figure 69*** below shows the CAD model of solution 2 integrated into the cargo vehicle.

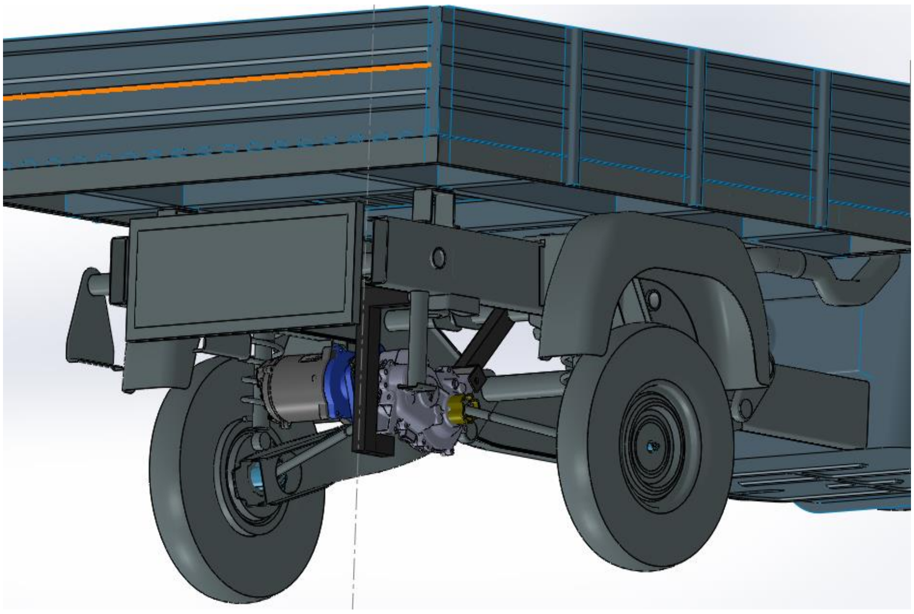


Figure 69 ***Bajaj Maxima (Cargo) CAD Model***

Retro-fitment Solution 3

The ***Figure 70*** below shows the CAD model of solution 3 integrated into the cargo vehicle.

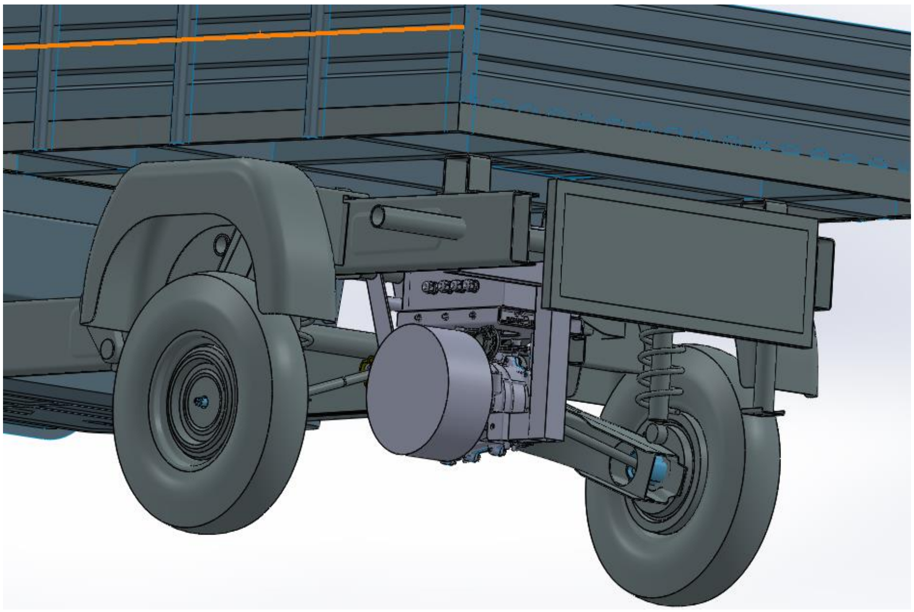


Figure 70 ***Bajaj Maxima (Cargo) CAD Model***

9.2 Wiring diagram

SECTION 13

The ***Figure 71*** below shows the detailed wiring architecture of a 2-wheeler (common for all retro-fitment solutions) across 2-wheeler category.

2-Wheeler Wiring Architecture (Without Aux. Battery)

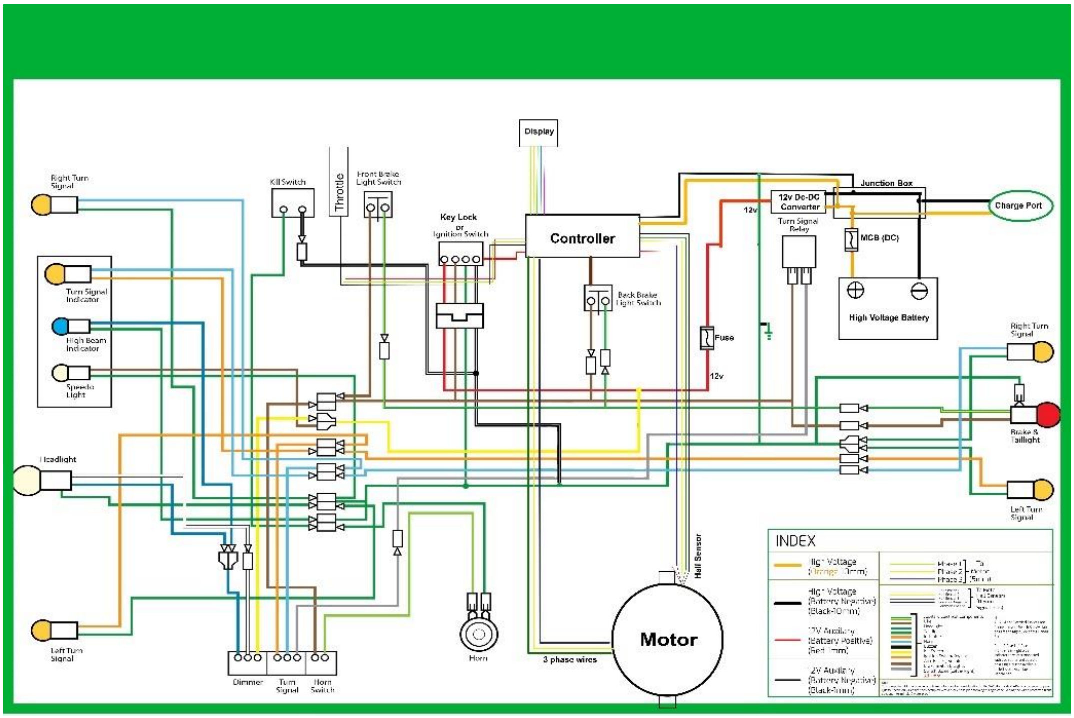


Figure 71 ***Detailed 2W Wiring Architecture***

The ***Figure 72*** below shows the detailed wiring architecture of a 3-wheeler (common for all retro-fitment solutions) across 3-wheeler category.

3-Wheeler Wiring Architecture (With Aux. Battery)

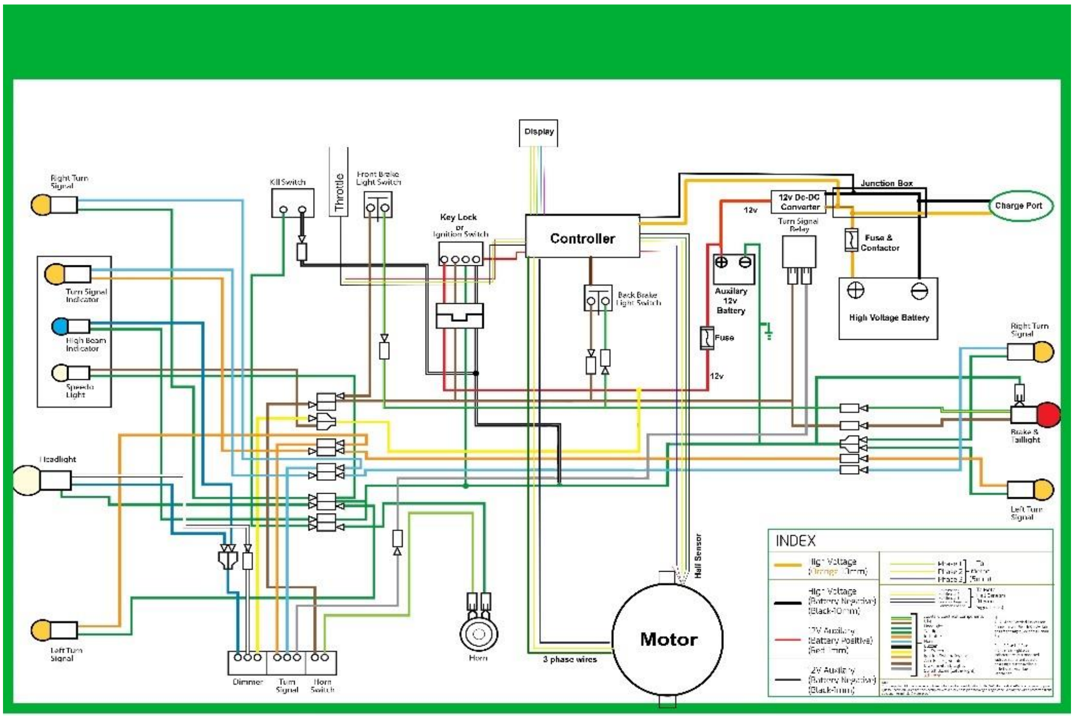


Figure 72 ***Detailed 3W Wiring Architecture***

Common Index for Wiring Harness

The ***Figure 73*** below shows the Index details of the wiring architecture common for 2-wheeler & 3-wheeler. It highlights the colour coding and diameter of the wiring harness used for different connections across the complete architecture.

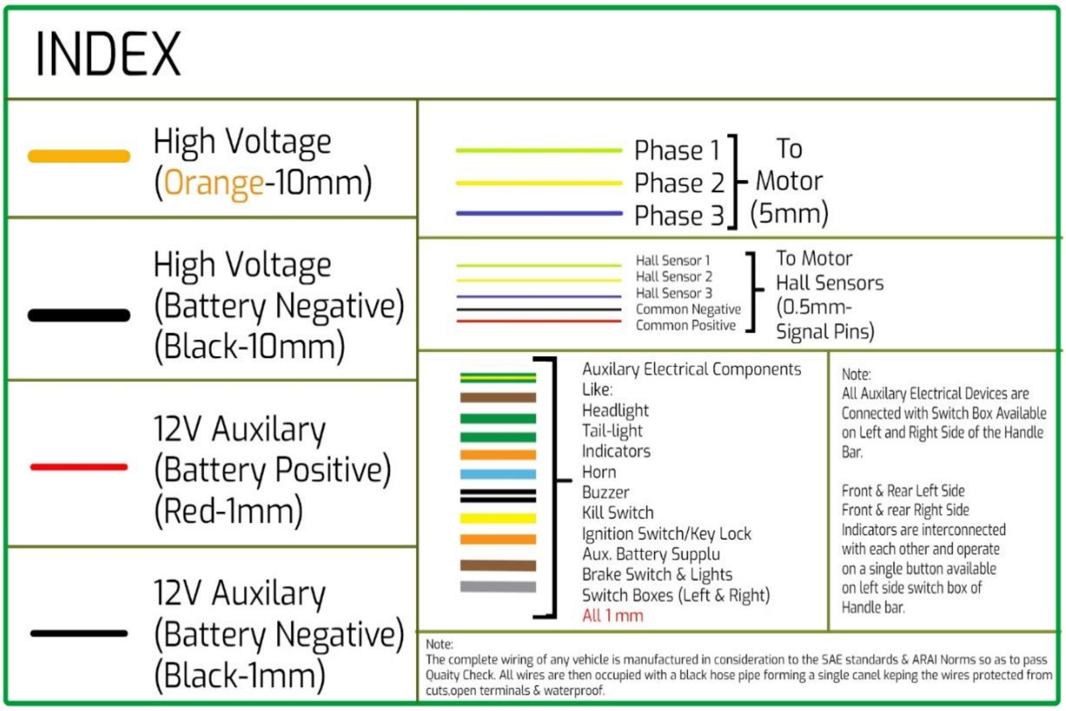


Figure 73 ***Index Details of Wiring Architecture***

9.3 Two-Wheeler Mountings/Alterations

SECTION 14

2-Wheeler Mountings/Alterations

Retro-fitment Solution 3 (Motorcycle)

For the integration of the retrofit solution 3 into the vehicle, modifications to the body frame (secondary members) have been performed. These alterations include:

- Removing the engine mounting bracket.
- Reshaping the connecting plates.
- Welding the base structure onto the frame for motor mounting.
- Reshaping the engine support member into a rectangular shape to create space for a safe and sturdy placement of the battery bracket.

The alterations performed on 2-wheeler motorcycle for solution 3 are illustrated in ***Figure 74, Figure 75*** and ***Figure 76.***

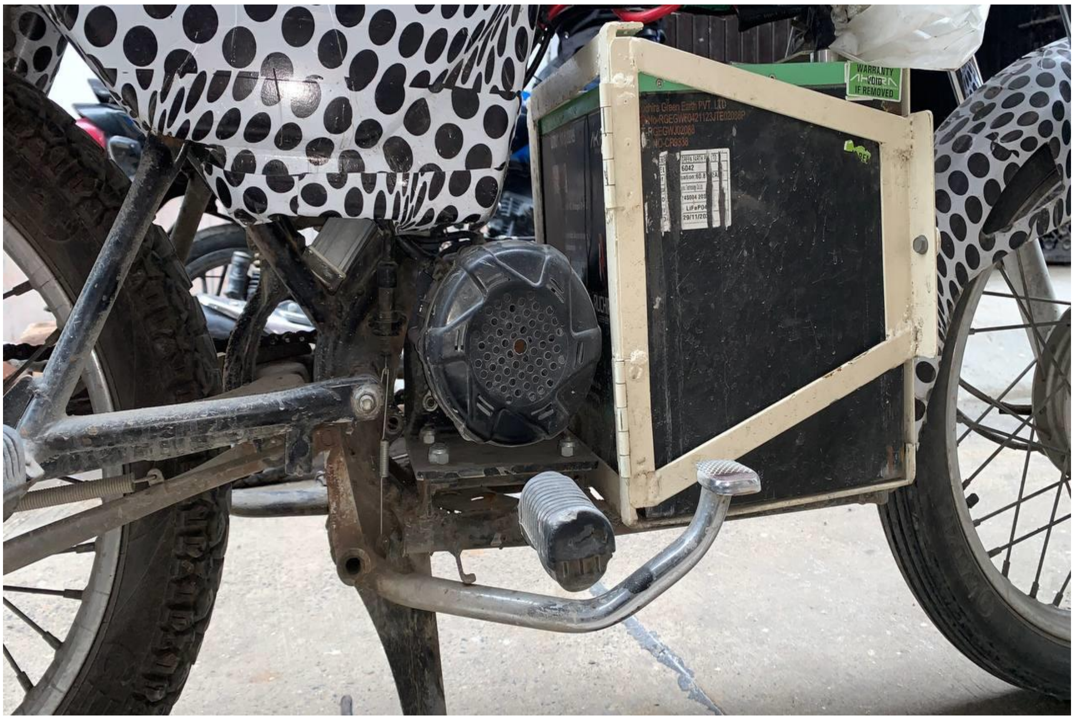


Figure 74 ***Alterations in Splendor for Retro-fit Solution 3***

Figure 75 ***Alterations in Splendor for Retro-fit Solution 3***

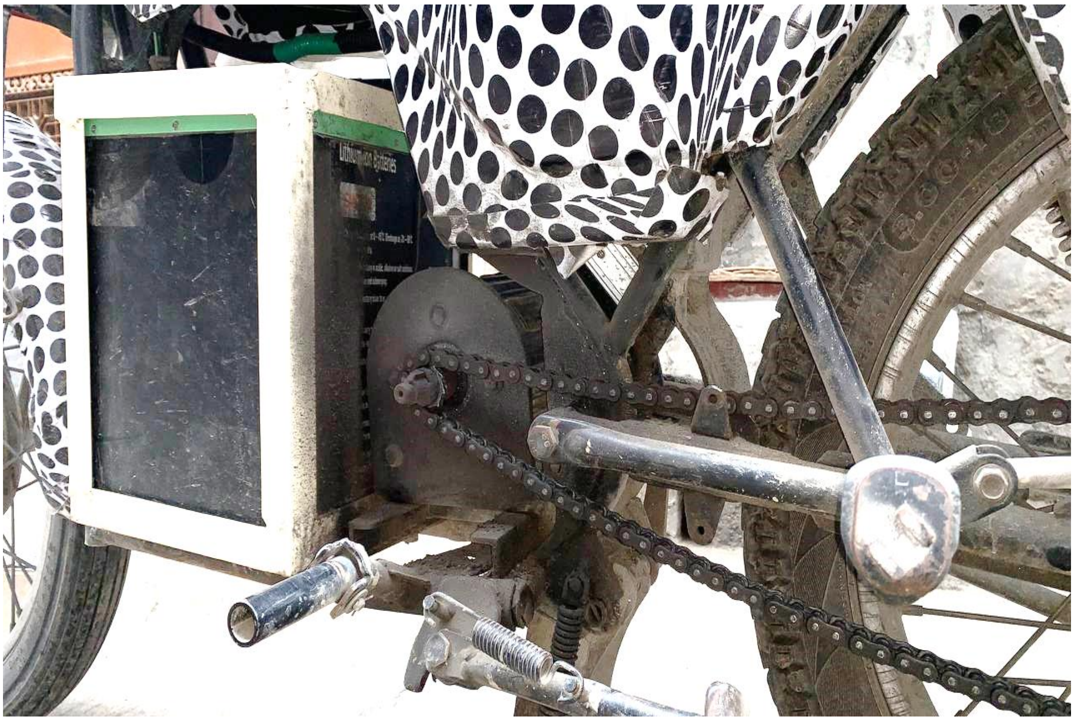


Figure 76 ***Alterations in Splendor for Retro-fit Solution 3***

SECTION 15

Retro-fitment Solution 3 (Scooter)

For the integration of retrofit solution 3 into the vehicle, modifications to the body frame (secondary members) have been performed. These alterations include:

- Removing the engine mounting bracket.
- Adding a shock absorber mounting to the frame through welding.
- Attaching an external swing arm reconstructed with a motor mounting plate.
- Using a front wheel rim attached with a plate and a hub to integrate the chain sprocket mechanism on the rear wheel side of the vehicle.
- Minor material removal from plastic case below the seat for comfortable fitment of battery pack and facilitating easily locking of the seat.

The alterations performed on 2-wheeler scooter for solution 3 are illustrated in ***Figure 77***, ***Figure 78*** and ***Figure 79.***

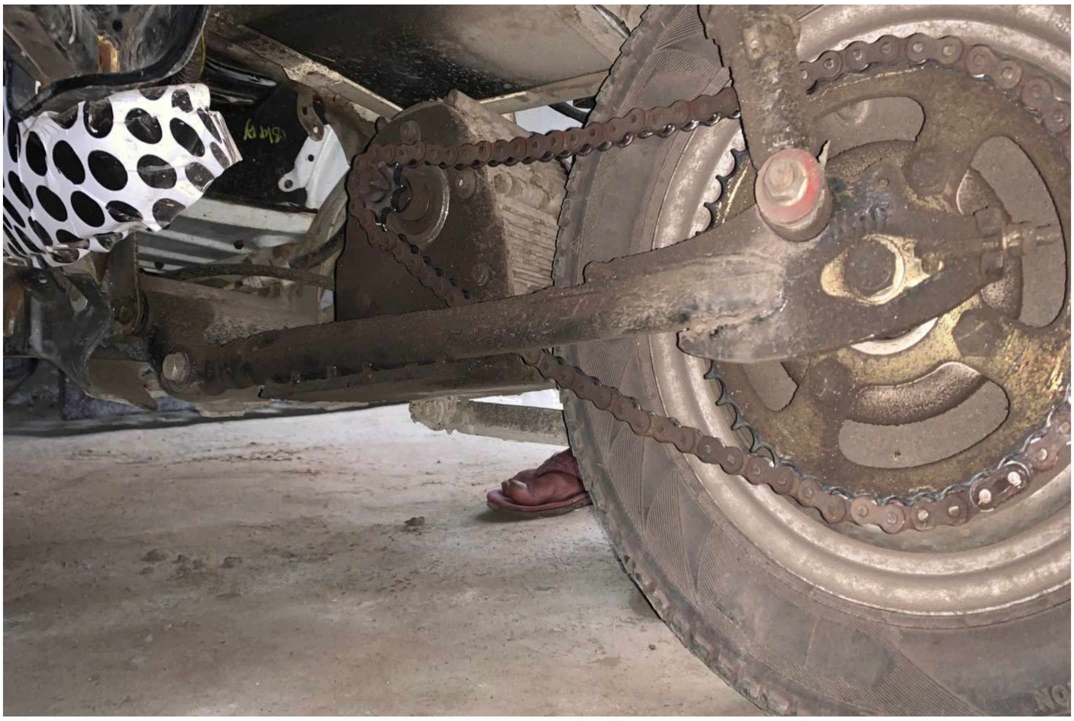


Figure 77 ***Alterations in Activa for Retro-fit Solution 3***

Figure 78 ***Alterations in Activa for Retro-fit Solution 3***

Figure 79 ***Alterations in Activa for Retro-fit Solution 3***

9.4 Three-Wheeler Mountings/Alterations

SECTION 16

Retro-fitment Solution 2 & 3 (Cargo Vehicle)

A series of similar alteration work is required for the 3-wheeler segment of cargo vehicles to facilitate the integration of EV components. Except for the retrofit kit mounting brackets, the common modifications needed include:

3.5.1 Increasing the Height of the Mounting Point of the Cargo Box:

- To accommodate the battery pack under the cargo box, the height of the mounting point needs to be increased.
- This can be achieved by welding a rectangular spacer made of metal, with dimensions of 3 inches (L) x 1.5 inches (b) x 20 mm (h).

3.5.2 Accessing the Battery Pack for Repairs:

- A cut in the base plate of the cargo box is required to create a cover for the battery pack, allowing easy access for repairs.

3.5.3 Modifying the Transmission System:

- Once the transmission system is integrated into the vehicle, the length of the transmission shafts needs to be adjusted to connect the wheels to the gearbox output.
- This is accomplished by changing the previous transmission shaft length using the sleeve integration method.

  These alterations ensure that the components of the EV are easily integrated into the cargo vehicle. Following images show the alterations made.

  The alterations performed on cargo vehicle to raise the height of cargo box for solution 2 & 3 are illustrated in ***Figure 80*** and ***Figure 81***.

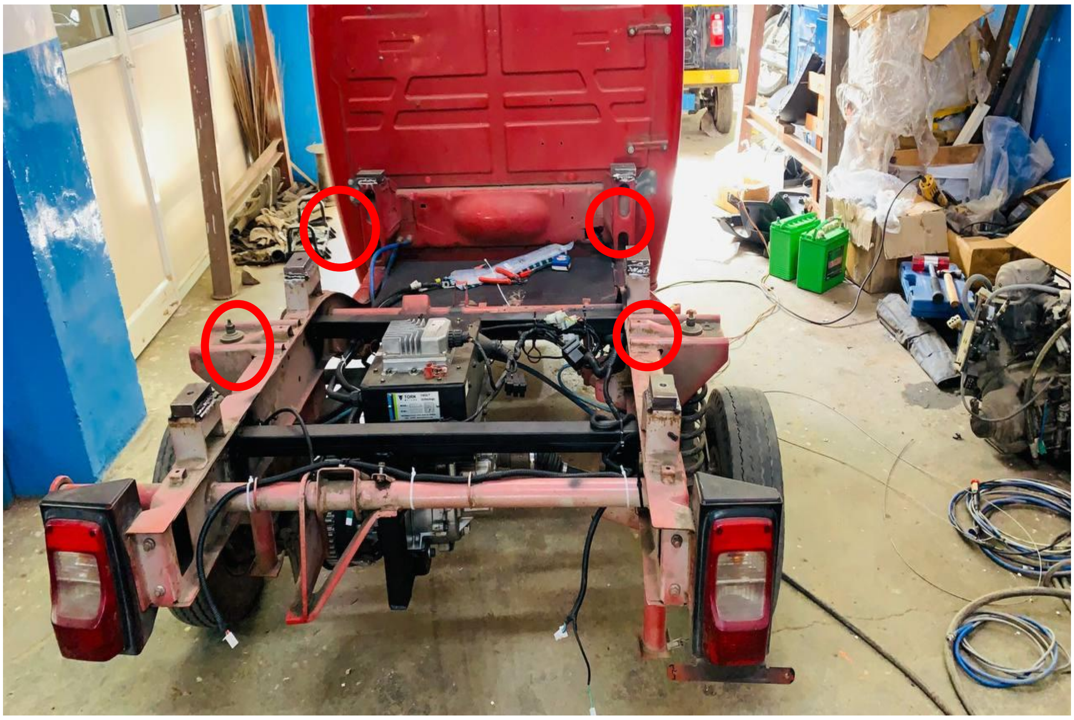


Figure 80 ***Alterations made for height increase of cargo box***

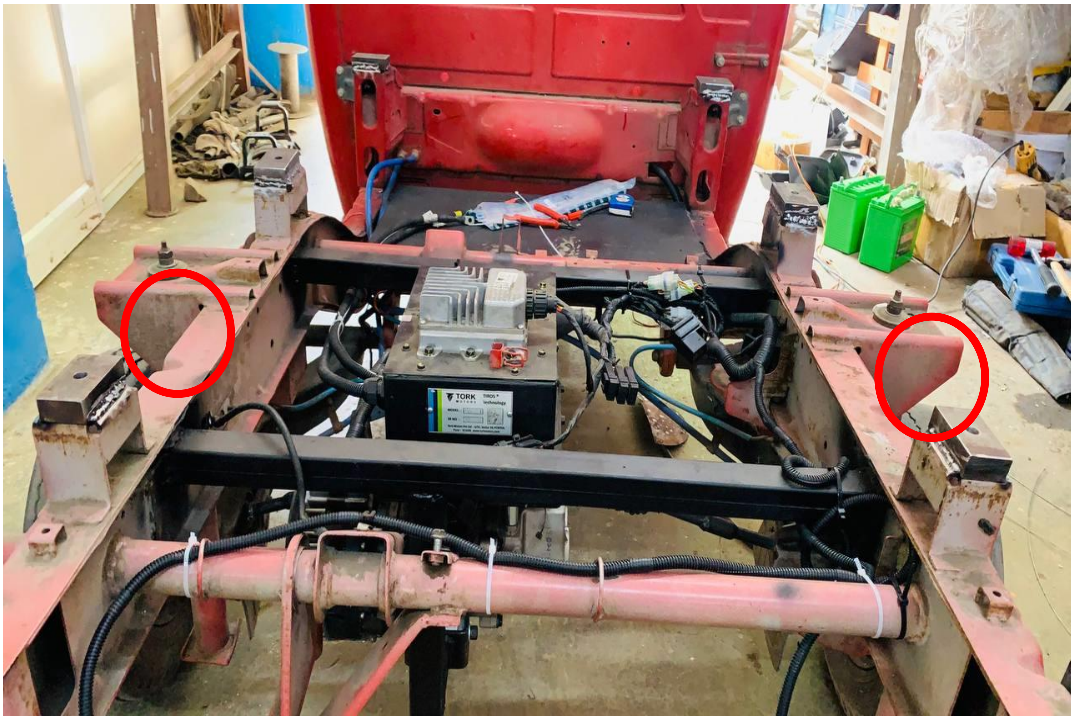


Figure 81 ***Alterations made for height increase of cargo box***

The ***Figure 82*** below illustrates the alteration made in shaft of all 3-wheelers for power transmission to wheels

Figure 82 ***Change of length of transmission shafts using sleeve method***

9.5 Results of Analysis for Motor Mounting Bracket (Rear)

SECTION 17

Total Deformation Analysis

Figure 83 below shows the total deformation that has occurred in the bracket after application of sudden jerking force on its mounting point. As the deformation value is less than its permissible value of 3 mm, the mounting will be considered safe.

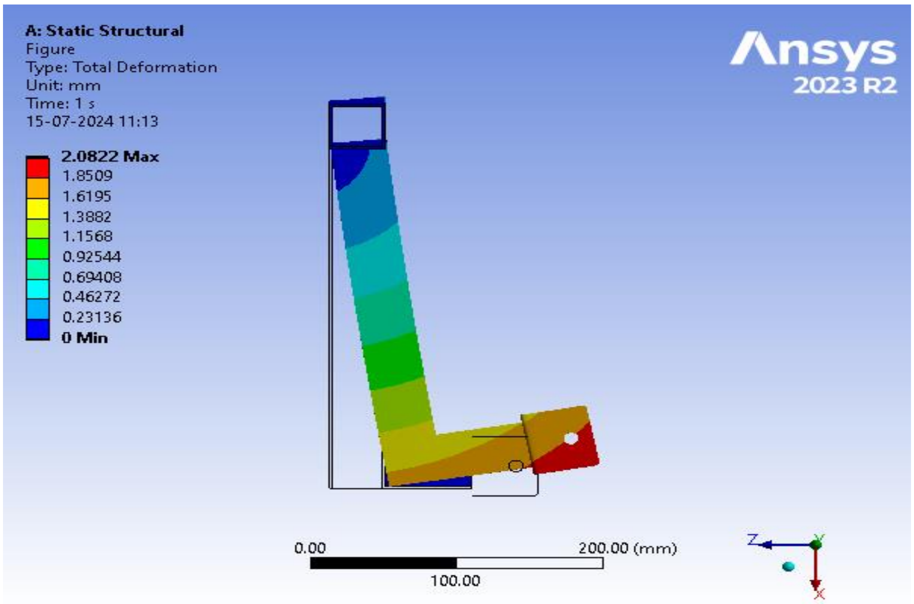


Figure 83 ***Total Deformation of Motor Mounting Rear Bracket***

Stress Analysis

Figure 84 and ***Figure 85*** below show the results of equivalent stress produced in the mounting bracket after applying jerking force on the motor bracket. The yield strength of Structural steel material is 365-400 MPa and the maximum stress induced in the bracket is 168.04 MPa which is less than the maximum yield strength. Thus, the bracket will be considered safe for mounting.

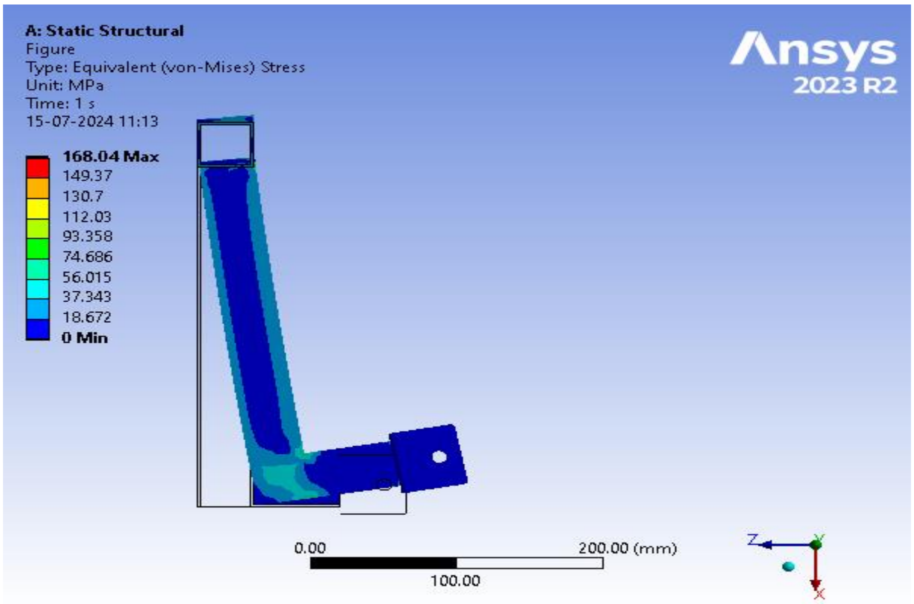


Figure 84 ***Equivalent Stress of Motor Mounting Rear Bracket***

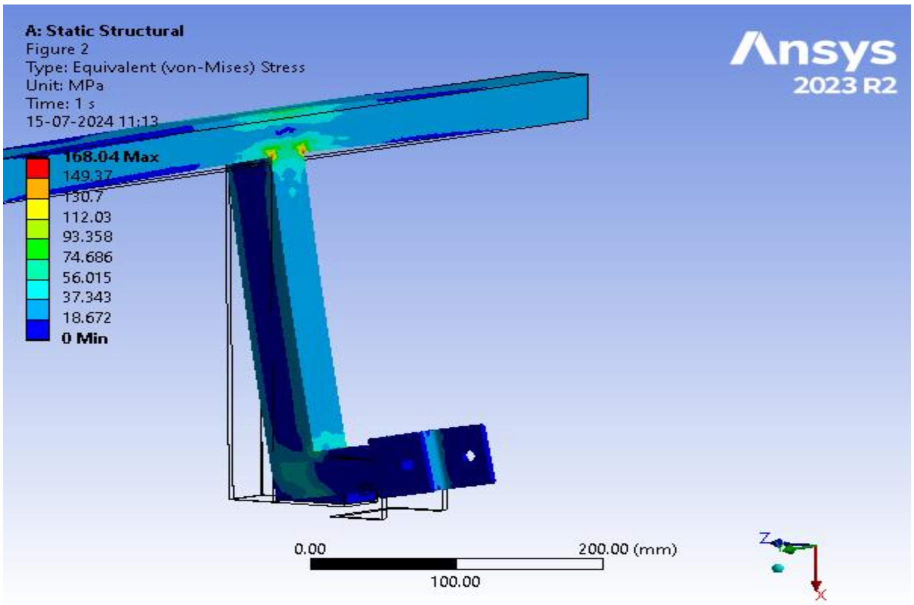


Figure 85 ***Equivalent Stress of Motor Mounting Rear Bracket***

Table 62 below mentions the results of deformation and stress analysis of motor mounting bracket.

Sr. No.	**Material**	**Permissible Value**	**Result**	**Remark**
1	Structural Steel	Deformation = 3mm	2 mm	Safe
		Yield stress = 365 MPa	168.04 MPa	Safe

Table 62 ***Summary of Rear Bracket Analysis***

9.6 Results of Analysis for Motor Mounting Bracket (Front)

SECTION 18

Total Deformation Analysis

Figure 86 and ***Figure 87*** show the total deformation that has occurred in the bracket after application of sudden jerking force on its mounting point. As the deformation value is less than its permissible value of 3 mm, it will be considered safe.

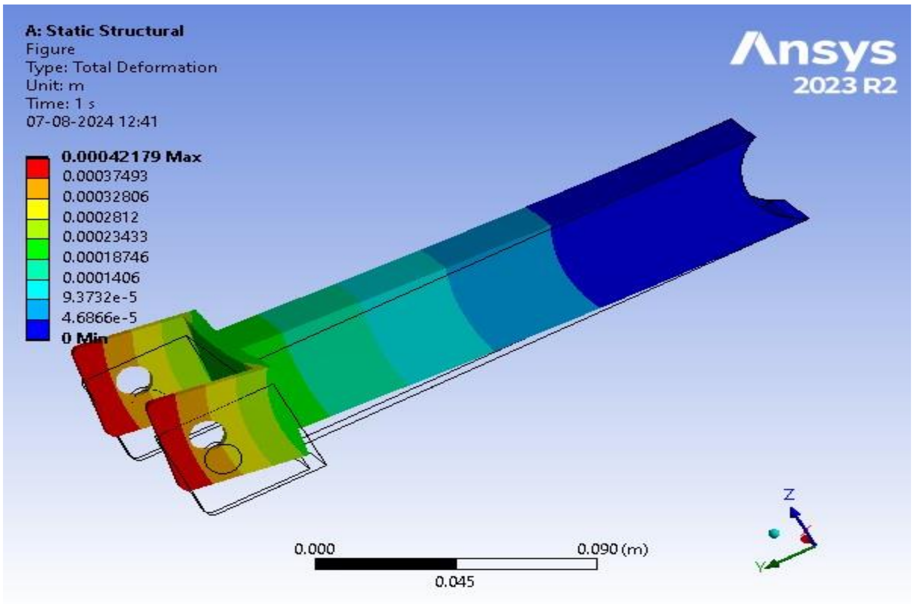


Figure 86 ***Total Deformation of Motor Mounting Front Bracket***

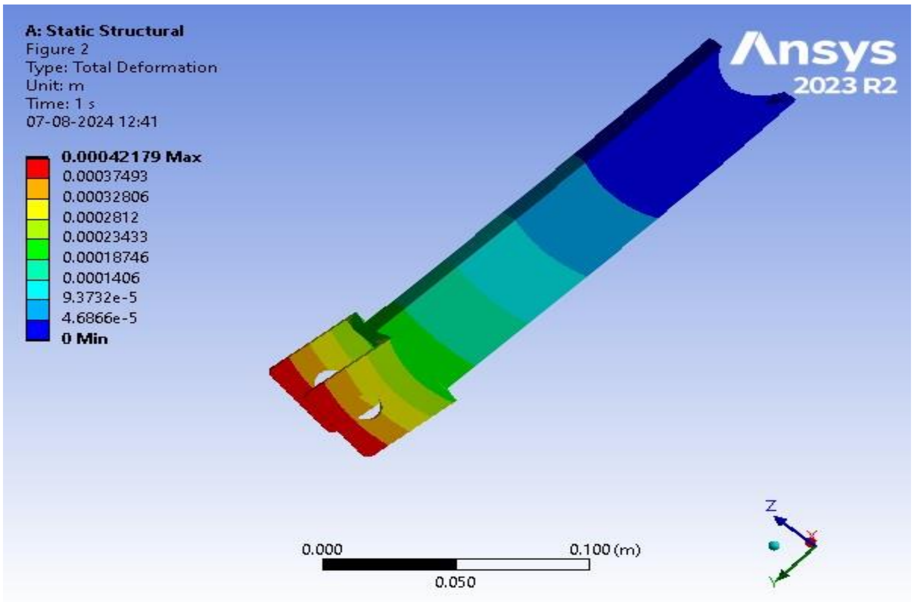


Figure 87 ***Total Deformation of Motor Mounting Front Bracket***

Stress Analysis

Figure 88 and ***Figure 89*** below show the results of equivalent stress produced in the mounting bracket after applying jerking force on the motor bracket. The yield strength of structural steel material is 365-400 MPa and the maximum stress induced in the bracket is 118.48 MPa which is less than the maximum yield strength. Thus, the bracket can be considered safe for mounting.

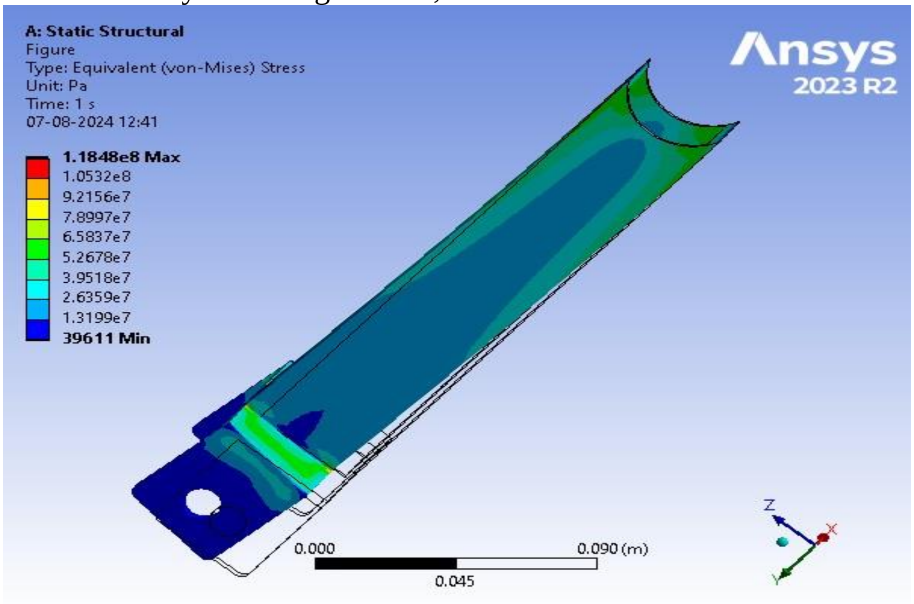


Figure 88 ***Equivalent Stress of Motor Mounting Front Bracket***

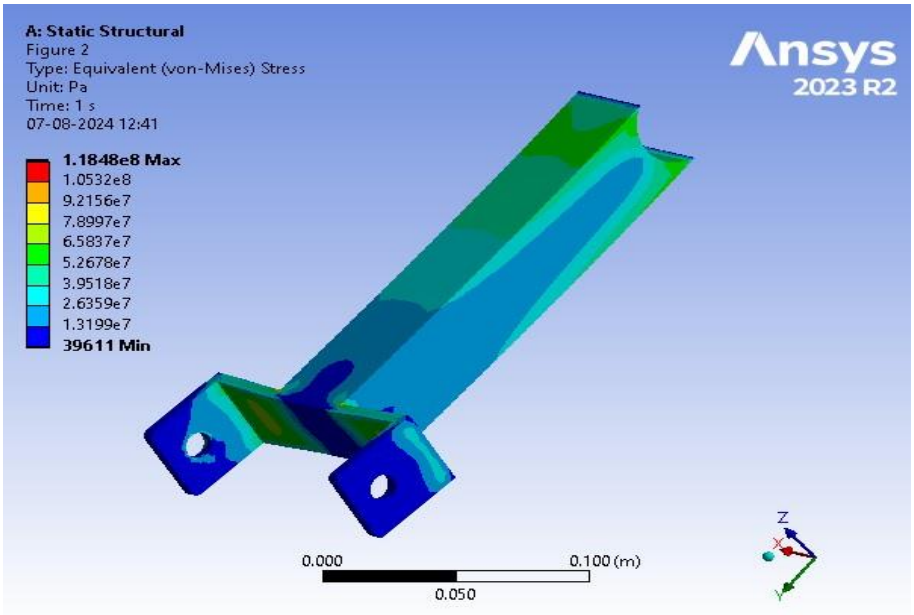


Figure 89 ***Equivalent Stress of Motor Mounting Front Bracket***

***Table 63* Summary of Front Bracket Analysis** below mentions the results of deformation and stress analysis of motor mounting bracket.

Sr. No.	Material	Permissible Value	Result	Remark
1	Structural Steel	Deformation = 3mm	0.42 mm	Safe
		Yield stress = 365 MPa	118.48 MPa	Safe

Table 63 ***Summary of Front Bracket Analysis***

9.7 Results of Analysis for Motor Sprocket

SECTION 19

Total Deformation Analysis

Figure 90 shows the total deformation that has occurred in the teeth of motor sprocket after application of chain force on its teeth peripheral exposed to the acting force. As the deformation value is less than its permissible value of 3 mm, the designed motor sprocket is considered to be safe.

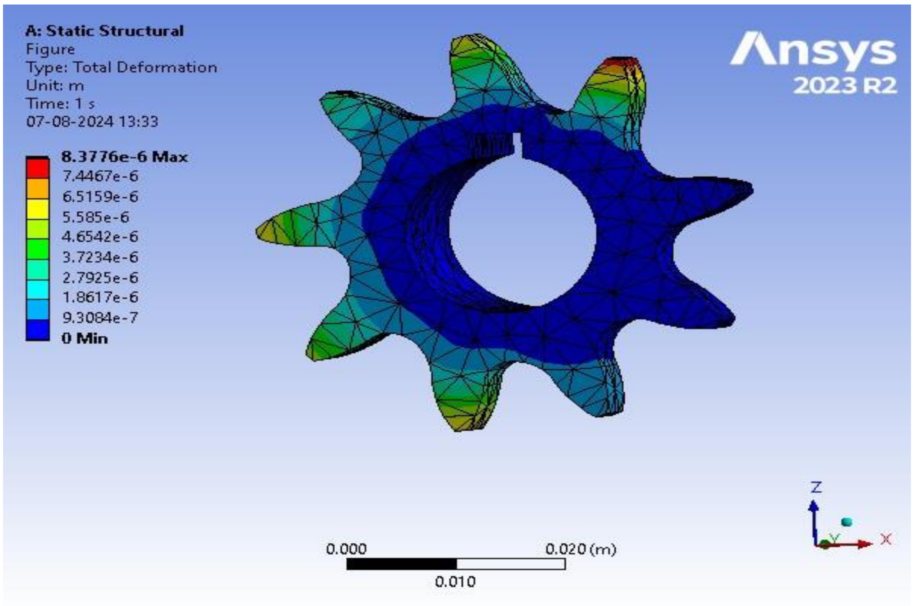


Figure 90 ***Total Deformation of Motor Sprocket for Retro-fitment Solution 3 (Motorcycle)***

Stress Analysis

Figure 91 below shows the equivalent stress analysis of motor sprocket. The maximum stress induced in the sprocket is 100.48 MPa which is less than the maximum yield strength. The yield strength of Structural steel material is 460-500 MPa. Thus, the bracket can be considered safe for mounting.

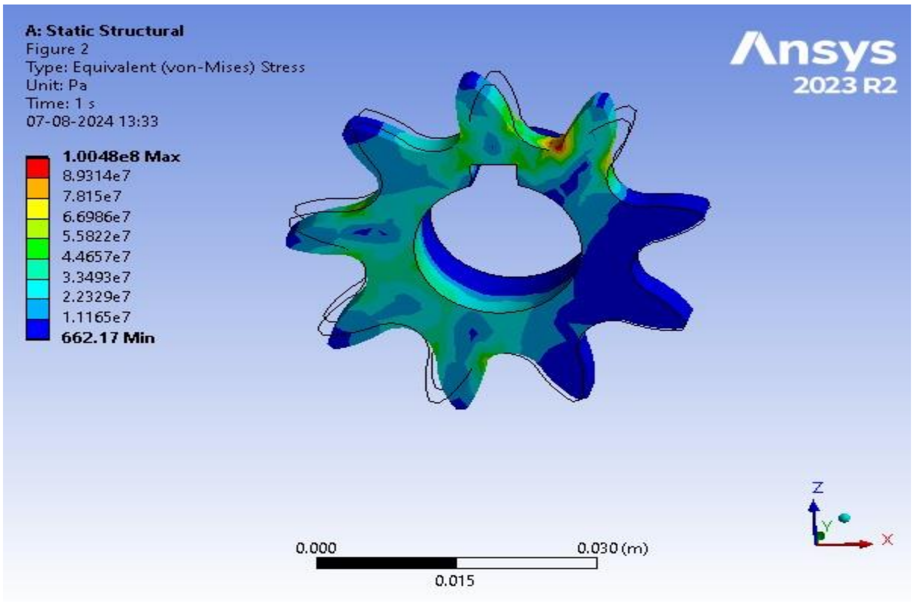


Figure 91 ***Equivalent Stress of Motor Sprocket for Retro-fitment Solution 3 (Motorcycle)***

Table 64 below mentions the results of deformation and stress analysis of motor mounting bracket.

Sr. No.	Material	Permissible Value	Result	Remark
1	Structural Steel	Deformation = 3mm	0.008 mm	Safe
		Yield stress = 460 MPa	100.48 MPa	Safe

Table 64 ***Summary of motor sprocket analysis***

9.8 DAQ Specification and Configuration

SECTION 20

PRODUCT SPECIFICATIONS

Module	
Name	Quectel EG91-EX, Quectel EG91-AUX
Technology	LTE (CaT1) / 3G (UMTS / HSPA) / 2G (GSM / GPRS) / GNSS
GNSS	
Protocol compatible	NMEA, GGA, GGL, GSA, GSV, RMC, VTG
Receiver	33/99 acquisition channels
Tracking sensitivity	-165 dBM
Position Accuracy	< 2.5 m CEP
Hot start	< 1 s
Warm start	< 25 s
Cold start	< 35 s
Cellular	
Technology	LTE Cat 1, UMTS, GSM
2G bands	EG91-EX: GSM: B3/B8 EG91-AUX: GSM: B2/B3/B5/B8
3G bands	EG91-EX: WCDMA: B1/B8 EG91-AUX: WCDMA: B1/B2/B5/B8
4G LTE bands	EG91-EX: LTE FDD: B1/B3/B7/B8/B20/B28 EG91-AUX: LTE-FDD: B1/B2/B3/B4/B5/B7/B8/B28/B66
Data transfer	LTE: LTE FDD: Max 10Mbps (DL)/Max 5Mbps (UL) UMTS: WCDMA: Max 384Kbps (DL)/Max 384Kbps (UL) GSM: GPRS: Max 107Kbps (DL)/Max 85.6Kbps (UL)
Data support	SMS (text/data)
Power	
Input voltage range	10–30 V DC with overvoltage and reverse polarity protection
Internal Back-up battery	550 mAh Ni-Mh, 8.4 V battery
Power consumption	At 12V < 4 mA (Deep Sleep) At 12V < 19 mA (Online Deep Sleep) At 12V < 24 mA (GPS Sleep) At 12V < 38 mA (nominal)

Physical specification

Dimensions	104,1 × 76,8 × 31,5 mm (L x W x H)
Weight	201 g

Operating environment

Operating temperature (without battery)	-40 °C to +85 °C	Storage temperature (with battery)	-20 °C to +45 °C
		Ingress Protection Rating	IP41
Storage temperature (without battery)	-40 °C to +85 °C	Battery storage temperature	-20 °C to +45°C

Bluetooth®

Specification	5.0 + LE
Supported peripherals	Temperature and Humidity sensor, Universal BLE sensors support

Interface

Digital Inputs	4	J1708	1
	SEE LESS	K-line	1
Analog Inputs	4	GNSS antenna	External High Gain
1-Wire	1	Cellular antenna	External LTE CAT 1 High Gain
RS232	2	USB	2.0 Mini-USB
RS485	1	Switchable CAN terminals	Not Supported
CAN J1939	2	LED indication	2 status LED lights

Features

Sensors	Accelerometer
Scenarios	Green/Eco Driving, Over Speeding detection, Jamming detection, Excessive Idl detection, Towing detection, Crash detection, Immobilizer, iButton Read Notification, Auto Geofencing, Manual Geofencing, Trip detection, Odometer, F counter, GNSS Unplug Detection, DDD download and Tacho online data, Offlin tracking
Supported peripherals	Garmin, RFID RS232, RFID 1-Wire, iButton 1-Wire, Temperature 1-Wire, LV-CAN200, ALL-CAN300, CAN-CONTROL, CAN FMS (J1939, J1708), K-line data, Continental tire pressure measurement sensor, Iridium SBD (Iridium Edge/TSM232), Carrier freezer, Log Mode, NMEA, TCP ASCII/Binary, Temperat and humidity sensor, Universal BLE sensors support
Sleep modes	GPS Sleep, Online Deep Sleep, Deep Sleep
Configuration and firmware update	FOTA Web, FOTA, Teltonika Configurator
SMS	Configuration, Events, DOUT control, Debug
GPRS commands	Configuration, DOUT control, Debug
Time Synchronization	GNSS, NITZ, NTP
Fuel monitoring	LLS (Analog), Digital LLS (RS232, RS485), LV-CAN200, ALL-CAN300, CAN-CONTROL, CAN FMS, Ultrasonic level sensor
Ignition detection	Digital Input, Accelerometer, External Power Voltage
RS232 Modes	Log Mode, NMEA, LLS, LCD, RFID HID/MF7, Garmin FMI, TCP ASCII/Binary, TCF ASCII/Binary (Buffered), Rec to LCD, Atol Tachograph, UL202-2 Fuel Sensor, Iridium Edge/TSM232 Satellite backup, Carrier Freezer
RS485 Modes	Silent, Log Mode, NMEA, LLS, TCP ASCII/Binary, TCP ASCII/Binary (Buffered)

Figure 92 ***DAQ Product Specifications***

Figure 92 shows DAQ product specifications.

9.9 DAQ Configuration

SECTION 21

A. System configuration

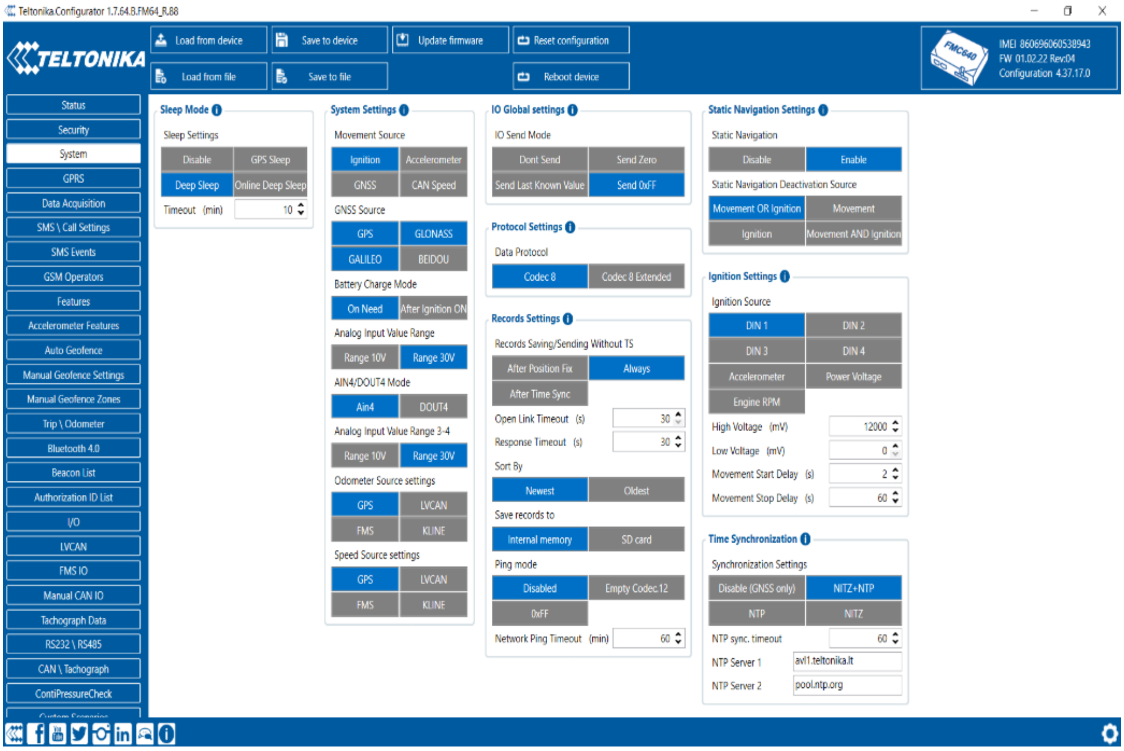


Figure 93 ***DAQ System Configuration***

Most parameters, as seen in ***Figure 93***, were maintained at the default value. The sleep timeout was set to 10 min.

B. GPRS configuration

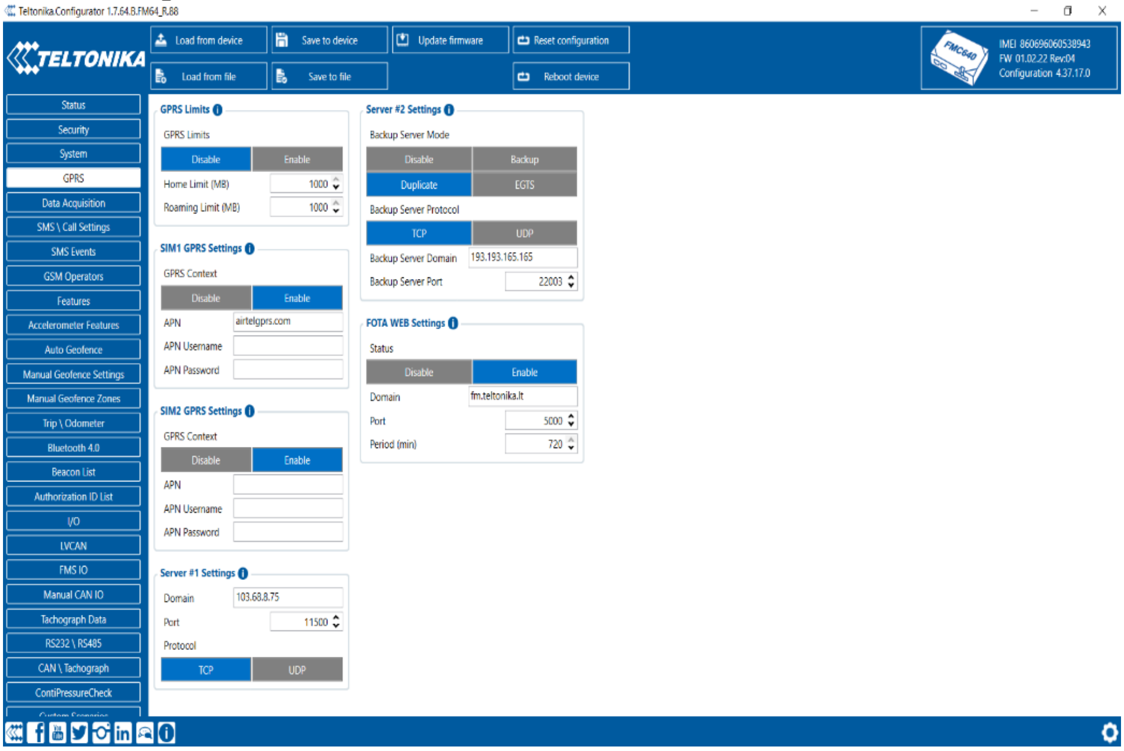


Figure 94 ***DAQ GPRS Configuration***

In this tab, as seen in ***Figure 94***, the sim card APN was added (sim card from Airtel was used). Also, the cloud storage server IP address was added so as to establish a connection between the device and the server and send the gathered data to the server (placed in ARAI premises).

C. Data Acquisition configuration

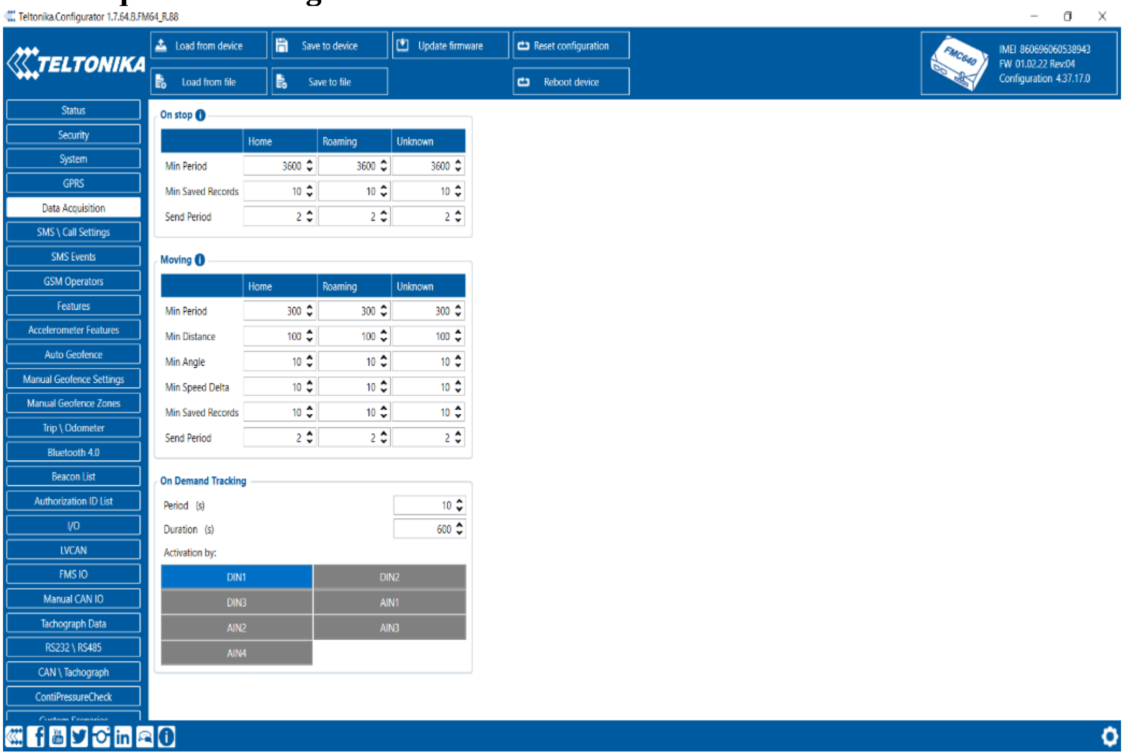


Figure 95 ***DAQ Data Acquisition Configuration***

The data collection frequency was set in this tab based on various vehicle movements. As seen in ***Figure 95***, there are provisions for setting the data acquisition frequency for the ‘stop’ and ‘moving’ state of the vehicle. During the stop state, we don’t require the data to be acquired at a higher frequency. However, during the moving state, we require the data to be collected at a higher frequency.

D. Input / Output (I/O) parameters configuration:

Figure 96 ***Input / Output (I/O) parameters configuration***

The number of data values of each parameter, to be collected per unit of time, was set in this tab. The considerations for setting these values were based on the priority of the parameters. As with ignition and geographic positions, the priority was set to low as the change in these parameters isn’t rapid. However, for the sensor values of current and voltage as also the speed, the priority was set to high as these values see instantaneous changes.

9.9.1 List of sensors

SECTION 22

9.9.1.1 Current sensor - LEM HASS 100-S

Table 65 below highlights the specifications of the Current sensor.

Specifications:

Series	HASS
Measurement	Current
Nominal Value	100A
Measuring Range	+- 300A
Secondary Nominal Signal	Voltage
Secondary Nominal Signal Value	Instantaneous 2.5 +/- 0.625V
Primary Signal	AC+DC
Supply Voltage	External DC Unipolar
Supply Voltage Range	5-5V
Accuracy	1%
Operating Temperature	-40˚C to 105˚C
Technology	Open loop Hall effect
Mounting	Panel

Table 65 ***Specifications of Current Sensor***

The LEM HASS 100-S, was selected as it provides a measuring range of +-300A, which was found to be the maximum operating current range of the kits procured. The current sensor was placed between the battery and the motor controller (with the arrow pointing towards the motor controller), to measure the current drawn from the battery against the input provided by the driver. The current sensor has a base value of 2.5V corresponding to 0A of current. For current being drawn from the battery, there is a change in the signal value by (300/2.5=0.00833 or 8.33mV) over the base value of 2.5 V. So, for 1A current flowing through the sensor, the signal value would be 2.508 V; and so on. Similarly, during regeneration the signal value would change by the same factor, albeit below the base value of 2.5V.

SECTION 23

9.9.1.2 Stepdown Voltage Regulator (12 to 5V)

The current sensor mentioned above operates at an input voltage of 5V. To provide this source, we used IC 7805 to stepdown the 12V input to 5V. The output of this circuit was provided to the current sensor as an input. The IC needs to be integrated with two capacitors of the specified ratings.

SECTION 24

9.9.1.3 Voltage Detection Module

This is a simple module which uses a potential divider to reduce an input voltage by a factor of 5. The module has two input ports for voltage source (VCC) and ground (GND). The signal to be measured is connected to these ports, whereas, the output is obtained at ‘S’ port.

9.9.1.4 Wiring Harness Layout & DAQ pinout

SECTION 25

The wiring harness connections of DAQ system as integrated on all vehicles are explained below:

- The throttle signal tapped from the vehicle wiring connection is connected to pin number 14 of the DAQ which is an analog input port, as shown in Figure 95 below.
- Ignition, also tapped from the vehicle wiring connection, is connected to pin number 15, a digital input port.
- The power source (12V) for the sensors and DAQ device is drawn from auxiliary battery in the case of 3-wheelers and from the DC-DC converter output in the case of 2-wheelers. One line drawn from the power source is connected to pin number 11 of the DAQ, with a 3A fuse connected across to safeguard the DAQ device.
- As mentioned in 3.8.3.2, the current sensor operates on an input power of 5V. To stepdown the 12V input to 5V, a line drawn from the power source is supplied to the input of stepdown voltage regulator. The output from this regulator, is provided as an input to the current sensor. The current sensor signal is connected to pin number 7 of the DAQ.
- For the voltage detection module, connections drawn from positive and negative terminals of the high voltage source are connected to the input ports (as discussed in 3.8.3.3). The signal line from 'S' port is connected to pin number 10 of the DAQ device.
- Ground lines from all the above discussed components are merged and connected to pin number 1 of the DAQ.

9.10 DAQ Placement Images

SECTION 26

2-Wheeler Motorcycle

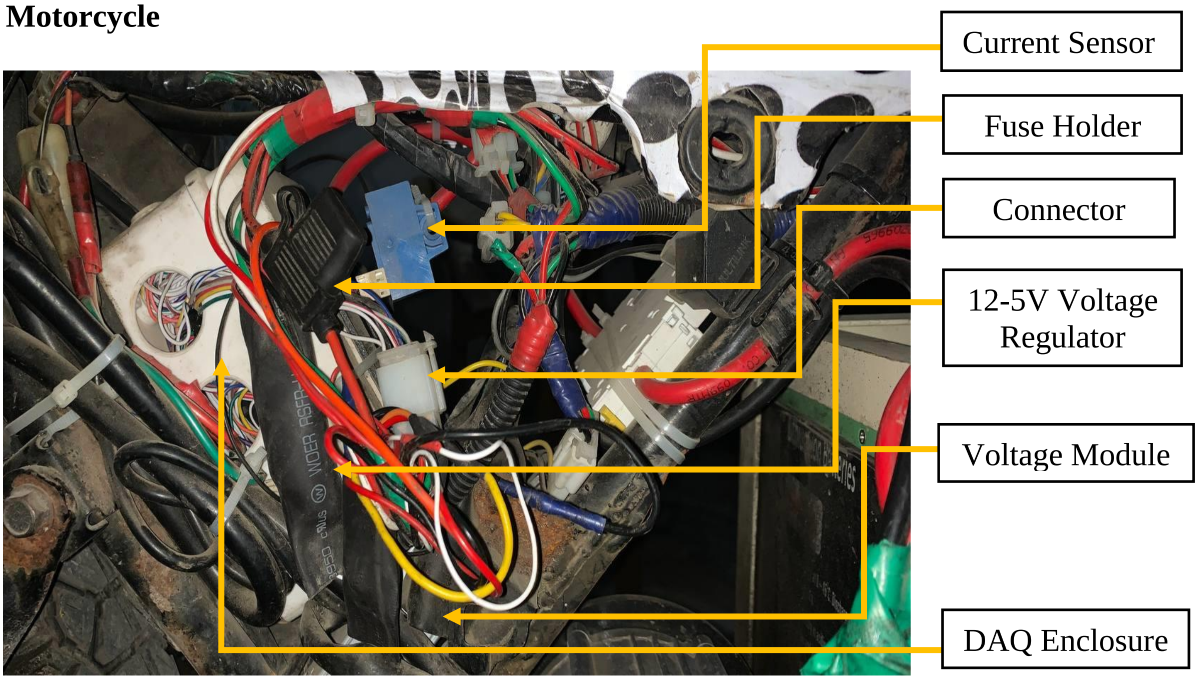


Figure 97 ***Sensor units of DAQ system in Motorcycle***

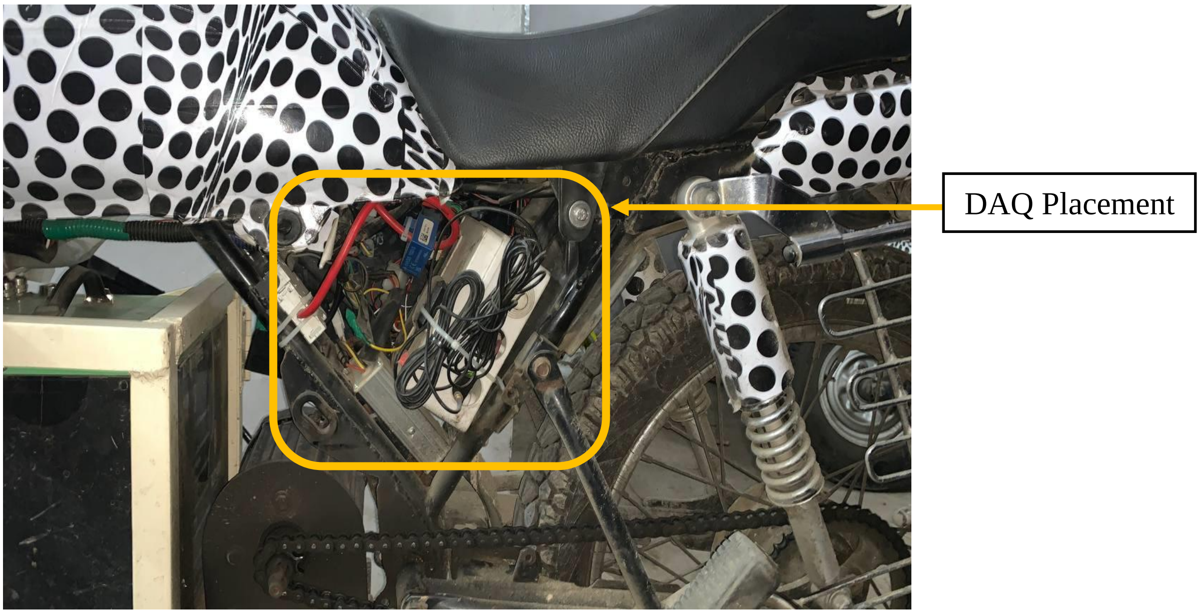


Figure 98 ***DAQ placement in Motorcycle***

In 2-wheeler motorcycles, the DAQ and sensors were placed in the space beneath the seat, where the auxiliary battery is placed in an IC engine vehicle.

2-Wheeler Scooter

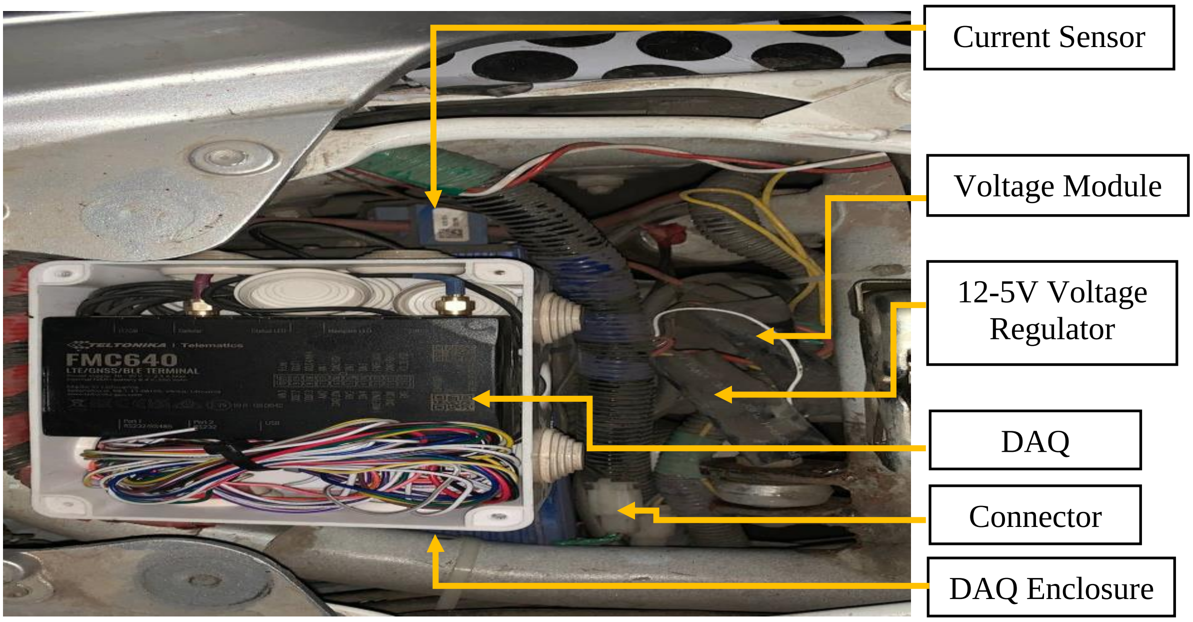


Figure 99 ***Sensor units of DAQ system in Scooter***

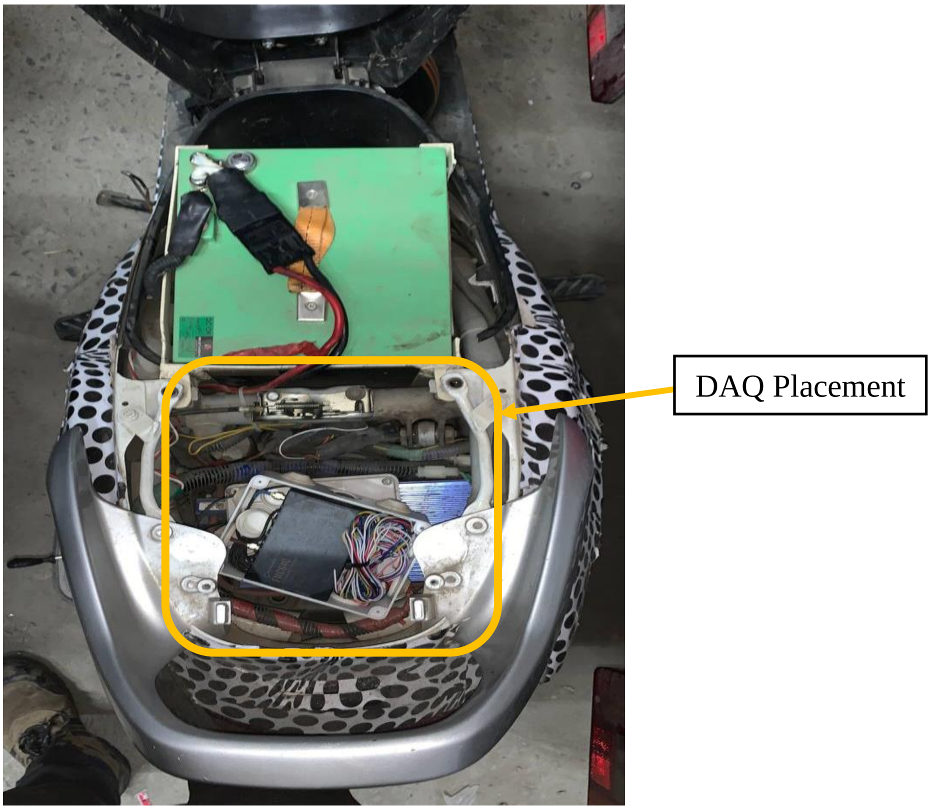


Figure 100 ***DAQ placement in Scooter***

In 2-wheeler scooters, the removal of fuel tank leaves an empty space for the motor controller and DAQ to be mounted. The sensors and DAQ's were placed in this compartment in all the 2-wheeler scooters.

3-Wheeler Passenger

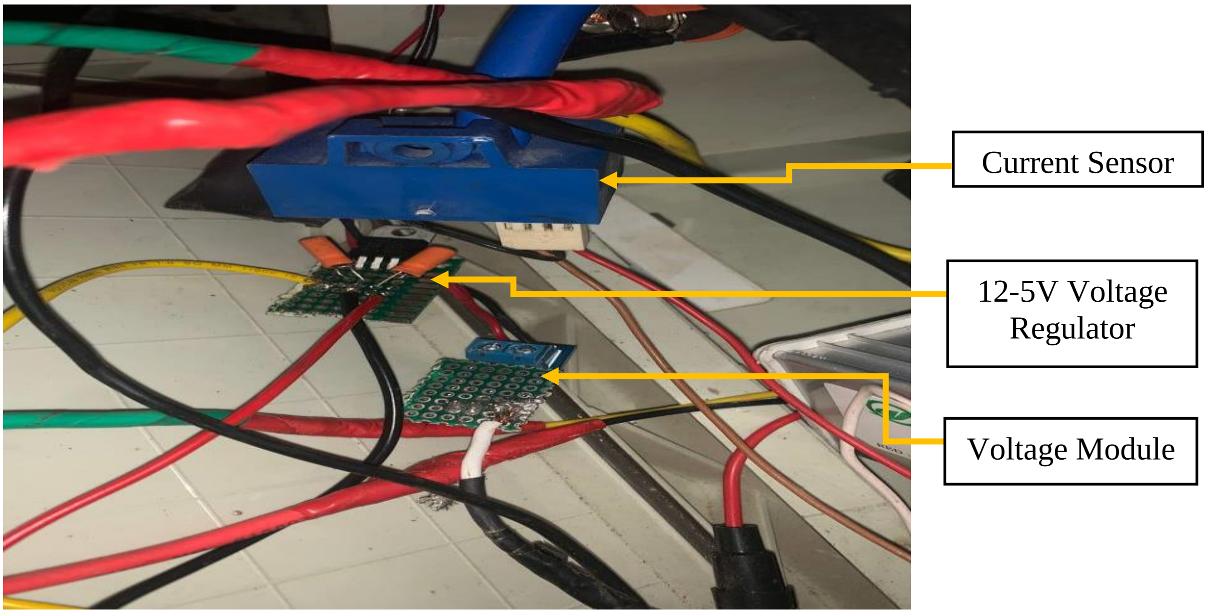


Figure 101 ***Sensor units of DAQ system in 3-wheeler passenger vehicle***

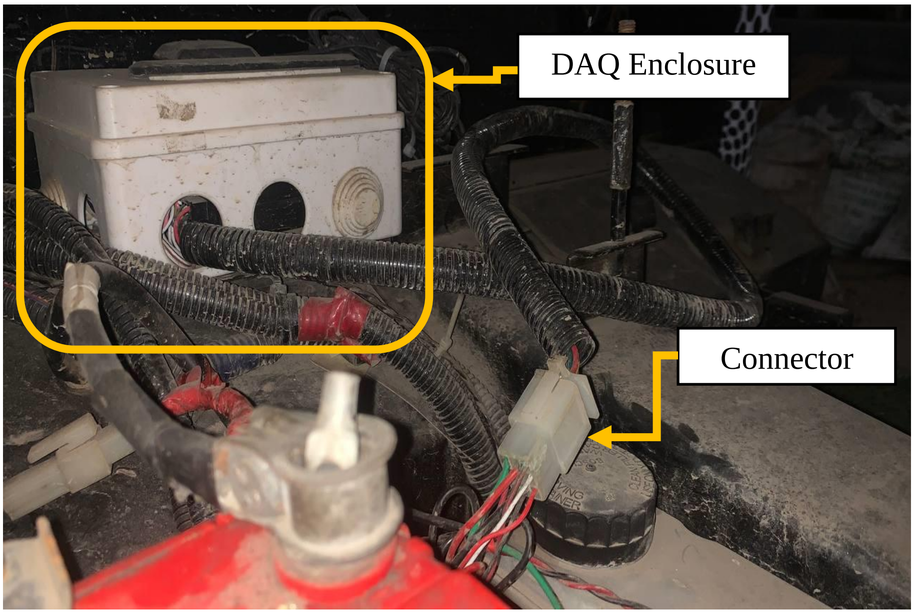


Figure 102 ***DAQ wiring in 3-wheeler passenger vehicle***

Figure 103 ***Sensor units enclosure in 3-wheeler passenger vehicle***

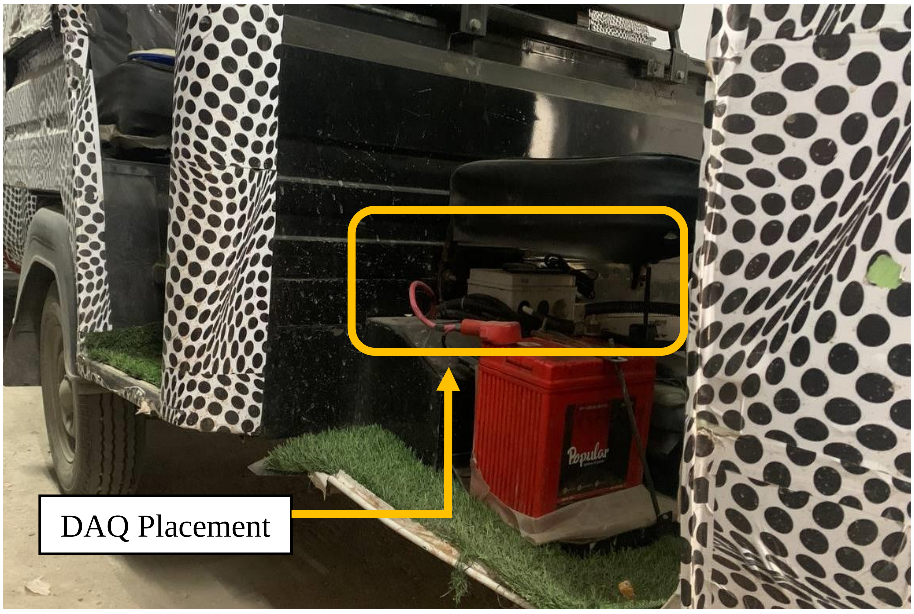


Figure 104 ***DAQ placement in 3-wheeler passenger vehicle***

In 3-wheeler passenger vehicles, the sensor units were placed in the junction box. The DAQ device was placed beneath the driver seat in the front compartment.

3-Wheeler Cargo

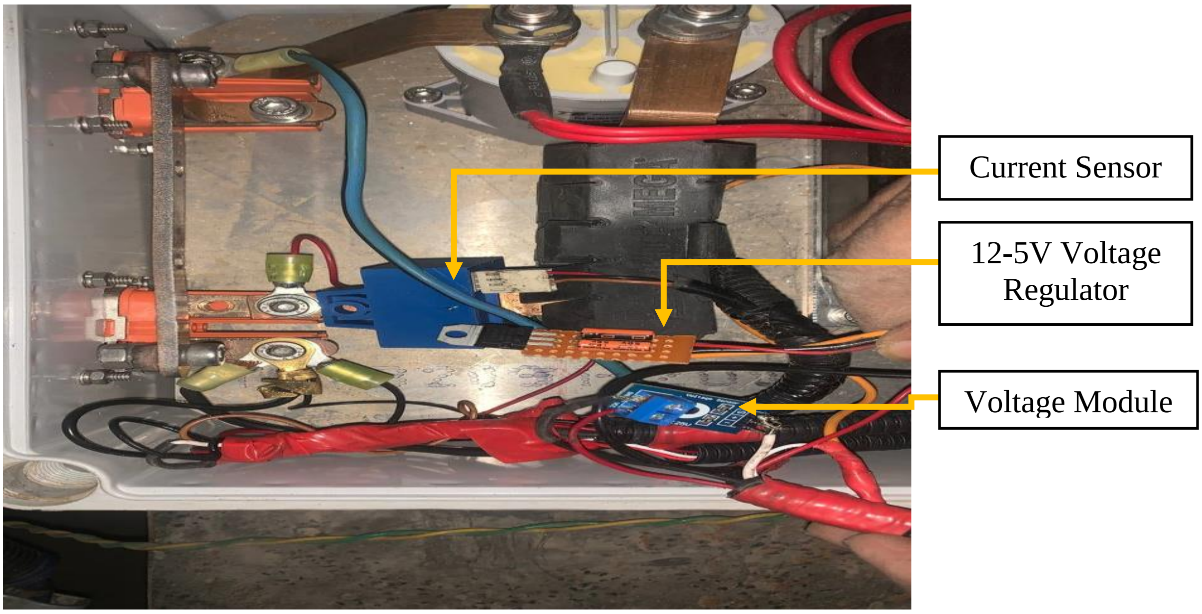


Figure 105 ***Sensor units of DAQ system in 3-wheeler cargo vehicle***

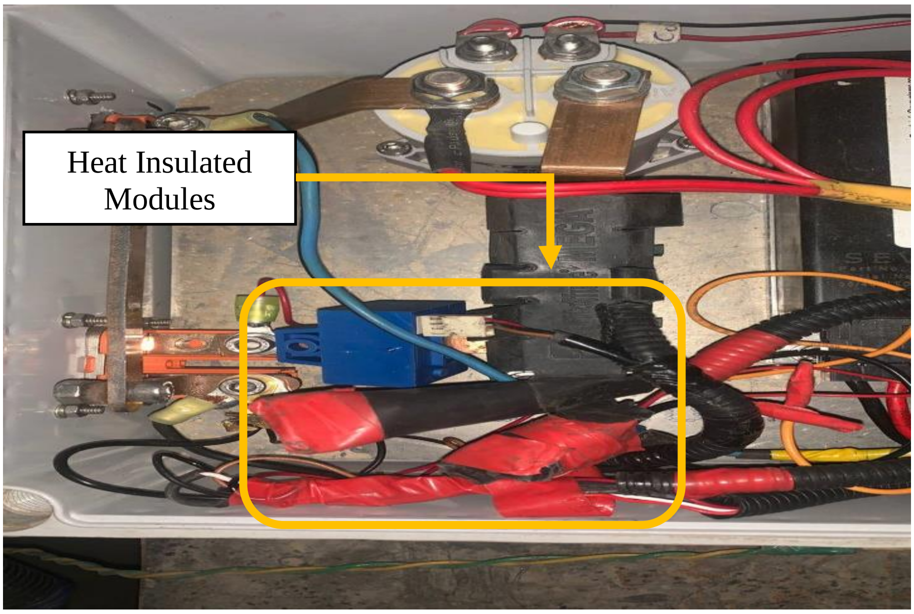


Figure 106 ***Heal insulated sensor units in 3-wheeler cargo vehicle***

Figure 107 ***Sensor units enclosure in 3-wheeler cargo vehicle***

Figure 108 ***DAQ placement in 3-wheeler cargo vehicle***

In 3-wheeler cargo vehicles, the sensor units were placed in the junction box beneath the cargo box. They were accessible from the cut-out in the cargo box. The DAQ device was placed beneath the driver seat in the front compartment.

ANNEXURE 4

MILESTONE 4: RUNNING AND OPERATIONAL DATA ACQUISITION OF RETRO-FITTED VEHICLES IN REAL-LIFE FOR 5000 TO 6000 KM

10.1 On-Road Testing of Vehicles

SECTION 27

2-Wheeler Scooter

Retro-fitment Solution 1

Retro-fitment Solution 2

Retro-fitment Solution 3

2-Wheeler Motorcycle

Retro-fitment Solution 1

Retro-fitment Solution 2

Retro-fitment Solution 3

3-Wheeler Passenger

Retro-fitment Solution 1

Retro-fitment Solution 2

Retro-fitment Solution 3

3-Wheeler Cargo

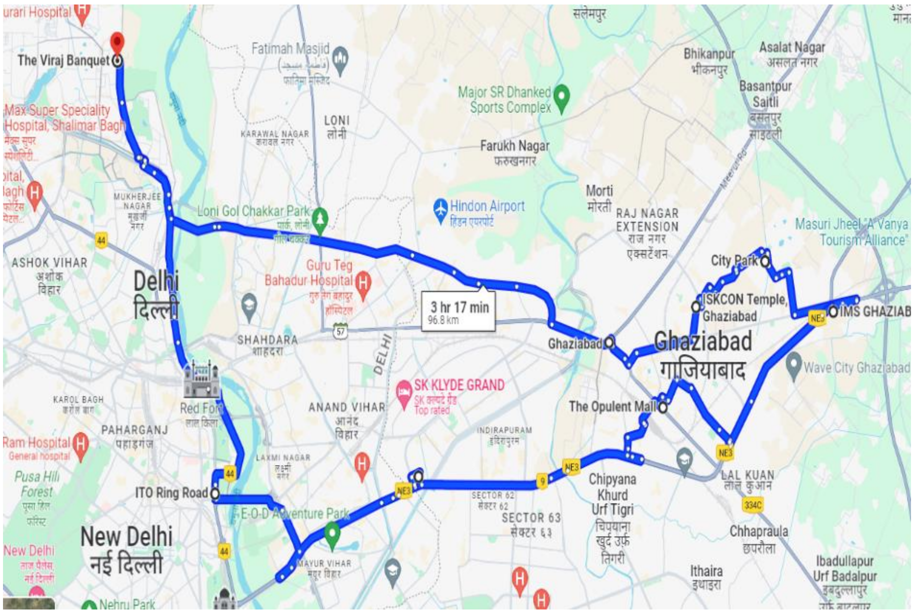
Retro-fitment Solution 1

Retro-fitment Solution 2

Retro-fitment Solution 3

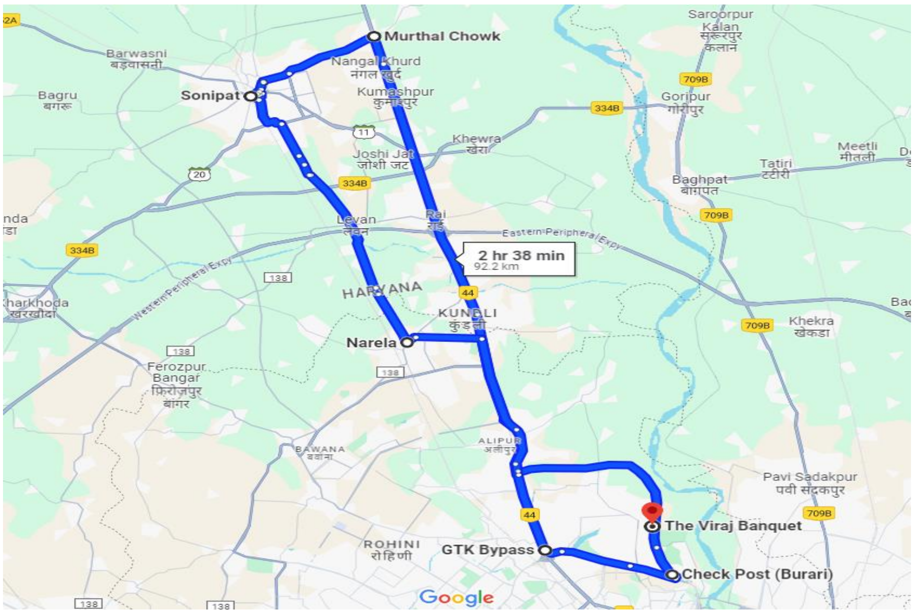
10.2 Major Routes for Testing in Delhi & NCR

SECTION 28



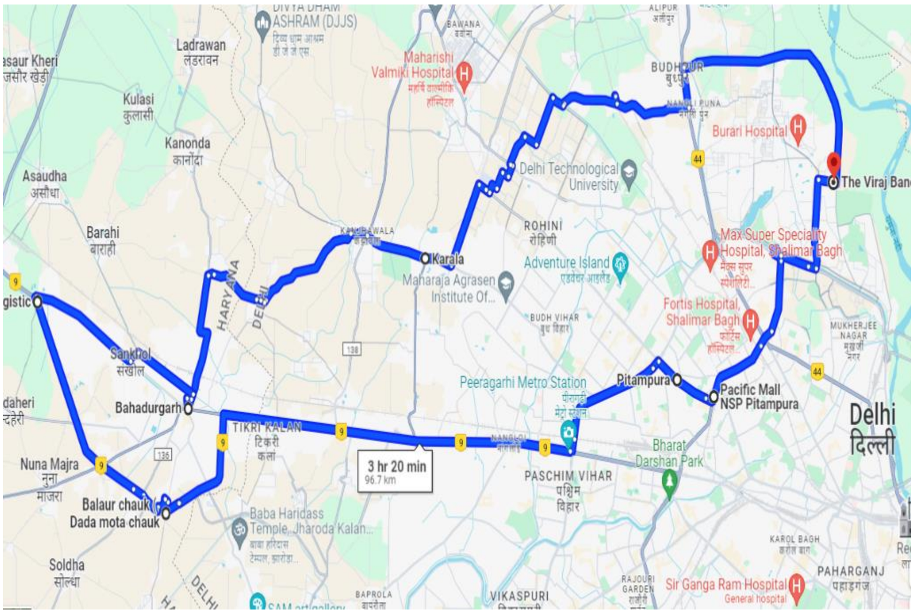
Route 1: Burari – Ghaziabad - New Delhi – Burari

Route 1 covers the Ghaziabad area of Uttar Pradesh which falls under Delhi-NCR region. Also, areas from Delhi namely Red Fort, ITO and Mayur Vihar are covered.



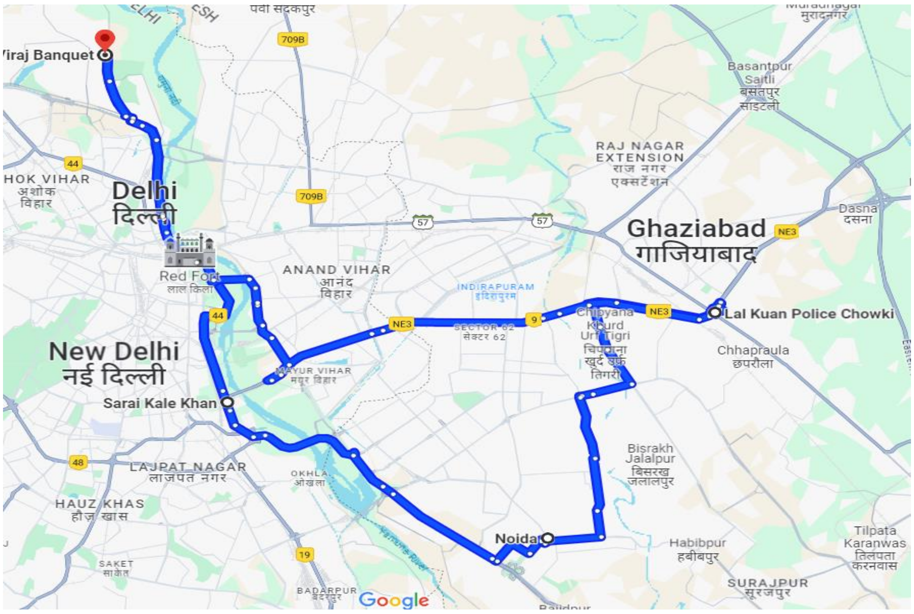
Route 2: Burari – Alipur – Murthal – Sonipat – Narela – Burari

Route 2 covers the Sonipat area of Haryana which falls under the Delhi-NCR region.



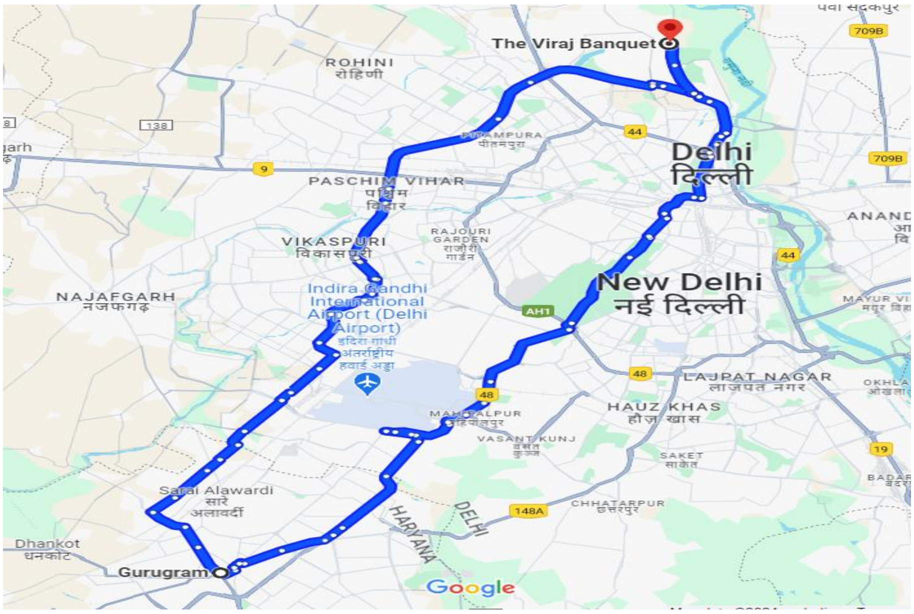
Route 3: Burari – Budhpur – Bahadurgarh – Paschim Vihar - Burari

Route 3 covers the Bahadurgarh area of Haryana which falls under the Delhi-NCR region. Also, areas from around Delhi namely Paschim Vihar, Pitampura, and Rohini are covered.



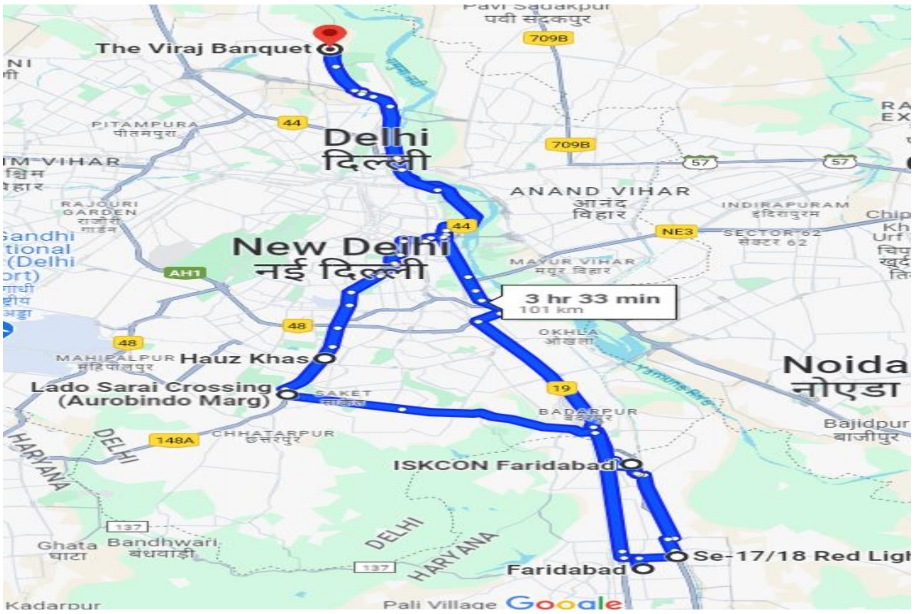
Route 4: Burari – RedFort – Noida – Ghaziabad – RedFort- Burari

Route 4 covers the Noida area of Uttar Pradesh which falls under Delhi-NCR region.



Route 5: Burari – Mangalpur – Gurugram – Vikaspuri – Burari

Route 5 covers the Gurugram area of Haryana which falls under the Delhi-NCR region. Also, areas from Delhi namely Vikaspuri and IGI airport are covered.



Route 6: Burari – RedFort – Faridabad – Chhatarpur – Burari

Route 6 covers the Faridabad area of Haryana which falls under the Delhi-NCR region.

ANNEXURE 5

MILESTONE 5: INTERPRETATION OF OPERATIONAL DATA COLLECTED DURING RUNNING

11.1 User Feedback
SECTION 29

<u>2-Wheeler Motorcycle</u>

2-Wheeler Motorcycle

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Anuj Dubey
Vehicle Driven: Splendor (Sol-1)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?
आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  Not Applicable

ए आर ए आई
ARAI

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?
ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?
आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	—	—	—	Range is ok for daily needs 100 km per charge	—

4. How convenient was the charging process?
चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional Charging Indication req. (except charger
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई
ARAI

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?
क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (4-5 hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?
ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?
आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?
क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

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User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?
क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  No
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?
क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?
आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ~~No~~ Throttle On-Off Switch should be provided.

12. Did you encounter any issues while driving the vehicle?
क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?
कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: ADubey

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2- Wheeler Motorcycle

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Krishan Singh

Vehicle Driven: Splendor (Sol. 1)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - o Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Comfort (आराम)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Range (रेंज)
  - o Comparatively Low
  - ✓ Sufficient
  - o Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - o Better than ICE vehicle
  - o Any other (please specify)

  Not Applicable

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - o Feels unsafe
   - ✓ Feels safe (Throttle on-off reg.)
   - o Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	Sufficient for daily travel of 80-90 Km	–	–	–	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - o Difficult
  - o Complicated
  - ✓ Easy
  - ✓ Any other Additional Charging Indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - o Any other

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - o Charging happens too slow
  - ✓ Normal Charging time (4-5 hrs)
  - o Need fast charging at home
  - o Any other
- 3-Wheeler (3-पहिया वाहन)
  - o Charging happens too slow
  - o Normal Charging time
  - o Need fast charging at home
  - o Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - o Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - o Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - o Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - o No
   - o Maybe
   - ✓ Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  NO, the vehicle was showing correct ~~fore~~ battery percentage and never faced sudden battery drop.
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    NO

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    NO

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    NO.

Place:

Signature: किशन.

2-wheeler Motorcycle

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Rishabh Singh

Vehicle Driven: Splendor (Sol. 7)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  Not Applicable.

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User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	Range of 100km is ok.	–	–	–	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional Charging Indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

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User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (4-5 hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

ए आर ए आई
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User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  No.
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    No.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: RSingh

ए आर ए आई
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2- Wheeler Motorcycle

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Anuj Dubey

Vehicle Driven: Splendor (Sol.2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle (motor jerk)
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  NA

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe (Motor starting torque is high)
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	Range of 100km is ok	–	–	–	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  Yes, battery was getting shutdown during trials. Repaired battery solved the problem to some extent

- 3-Wheeler (3-पहिया वाहन)

  N.A.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Throttle On-off switch should be provided.
    ② Charging plug should be properly mounted on vehicle.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① Battery shut down issue was continuous during initial trials

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: ADubey.

2-wheeler Motorcycle

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Krishan Singh

Vehicle Driven: Splendor (Sol. 2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - ✓ Not as good as ICE vehicle (Motor jerk during 0-10 kmph)
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  Not Applicable

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe (Throttle on-off req.)
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	Sufficient range of 90-100 km is ok	–	–	–	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indication required. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  Yes, the battery was getting shut down automatically during initial trials. After battery repairs the problem was reduced but not stopped.
- 3-Wheeler (3-पहिया वाहन)

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No,

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Throttle on-off switch should be provided.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: किशन.

ए आर ए आई ARAI

2-wheeler Motorcycle

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Rishabh Singh

Vehicle Driven: Splendor (Sol. 2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - ✓ Not as good as ICE vehicle (Motor jerk)
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  NA

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - ✓ Feels unsafe (Vehicle need more control at high speed. Above 50 kmph)
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	Range of 90-100 Km per charge is sufficient	–	–	–	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indicator req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  Yes, the battery was facing problem during initial trials and after repair of battery the problem was reduced
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ~~(1) lag while reverse mode was observed. will be good if removed~~

    NO.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    (1) Lag while switching to reverse mode.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    NO.

Place:

Signature: RSingh

ए आर ए आई ARAI

2- wheeler Motorcycle

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Anuj Dubey

Vehicle Driven: Splendor (Sol-3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

N.A.

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?

- Feels unsafe
- Feels safe (Throttle on- off req.)
- Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
Range of 50-55 Km per charge is very low.	—	—	—	—	—

4. How convenient was the charging process?

चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Addition charging Indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow (6-7 hrs)
  - Normal Charging time
  - Need fast charging at home (10 Amp. charger)
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?

- Confident to only solve minor mechanical issues
- Confident to solve minor electrical issues also
- Need training to solve minor electrical issues
- Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?

- Easy to find
- Need to search at multiple locations
- Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?

- No
- Maybe
- Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

No.

- 3-Wheeler (3-पहिया वाहन)

N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

① Reverse mode is not available. will be okay if provided.
② Throttle on/off switch

12. Did you encounter any issues while driving the vehicle?

क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

① Chain noise was coming.
② Chain tightening was also need to be done regularly.
③ MCB tripping was observed during initial trials.

13. Any additional comments or observations you would like to suggest?

कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

Range of vehicle should be atleast 80-90 km for daily req.

Place:

Signature: ADubey

ए आर ए आई ARAI

2-wheeler Motorcycle

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Krishan Singh
Vehicle Driven: Splendor (Sol.3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?
आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  Not Applicable

ए आर ए आई
ARAI

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?
ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe (Throttle on-off req.)
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?
आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
Low range of 50-55 Km per Charge is not sufficient	–	–	–	–	–

4. How convenient was the charging process?
चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except) charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई
ARAI

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?
क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow (6-7 hrs)
  - Normal Charging time
  - Need fast charging at home (10 Amp charger)
  - Any other Need fast charging at home
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?
ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?
आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?
क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

ए आर ए आई
ARAI

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?
क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  Yes, the battery faced sudden drop in SoC during initial trials. later on the battery was performing as per SoC and no sudden drop was observed.
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?
क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?
आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    1. Reverse mode
    2. Throttle on-off

12. Did you encounter any issues while driving the vehicle?
क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    1. chain noise
    2. chain slag.
    3. sprocket wear.

13. Any additional comments or observations you would like to suggest?
कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    Range of vehicle should be atleast 80-90 km.

Place:

Signature: किशन.

ए आर ए आई
ARAI

2 - wheeler Motorcycle

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Rishabh Singh

Vehicle Driven: Splendor (W1.3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  N. A

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe (Throttle on. off req.)
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional Indication req. for charging (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow (6-7 hrs)
  - Normal Charging time
  - Need fast charging at home (10 Amp charger)
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  No.
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Reverse mode
    ② Throttle on-off

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① chain Noise
    ② chain slag + lubrication.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    Range of vehicle should be atleast 80-90 Km for daily usage needs.

Place:

Signature: RSingh

2-Wheeler scooter

2-wheeler Scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Sonu Yadav

Vehicle Driven: Activa (S1.1)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?
   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  NA

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?
   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?
   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	Range of 80-90 km is Sufficient	—	—	—	—

4. How convenient was the charging process?
   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?
   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (4-5 hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?
   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?
   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?
   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe (Single person use only)
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?
   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  No
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?
    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No

11. What additional features do you think should be integrated with the vehicle for improved driving experience?
    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    No.

12. Did you encounter any issues while driving the vehicle?
    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?
    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: सोनु यादव.

2-wheeler scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Vivek Rai

Vehicle Driven: Activa (Sol.1)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - ✓ Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - ✓ Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - ✓ Not as good as ICE vehicle
  - ✓ Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  NA

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?

- Feels unsafe
- ✓ Feels safe
- Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	Range of 80-90Km per charge is sufficient	—	—	—	—

4. How convenient was the charging process?

चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional Charging Indicator req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (4-5hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?

- ✓ Confident to only solve minor mechanical issues
- Confident to solve minor electrical issues also
- ✓ Need training to solve minor electrical issues
- Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?

- Easy to find
- ✓ Need to search at multiple locations
- ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?

- ✓ No (speed and load issue)
- Maybe
- Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  No.

- 3-Wheeler (3-पहिया वाहन)

  N.A.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

No.

12. Did you encounter any issues while driving the vehicle?

क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

No.

13. Any additional comments or observations you would like to suggest?

कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

No.

Place:

Signature: Vivek

ए आर ए आई ARAI

2-wheeler Scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Ravi Kumar

Vehicle Driven: Activa (Sol.1)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - ✓ Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - ✓ Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - ✓ Not as good as ICE vehicle
  - ✓ Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  NA

ए आर ए आई
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User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बेटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	80-90 Km range is sufficient				

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indicator req (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई
ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (4-5 hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - ✓ No (unable to climb bridge.)
   - Maybe
   - Yes

ए आर ए आई
ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  No.
- 3-Wheeler (3-पहिया वाहन)

  N.A.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    NO.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ~~No~~ (1) Throttle kill switch

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    NO.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    NO.

Place:

Signature: कुमार रवि.

ए आर ए आई
ARAI

2-wheeler Scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Sonu Yadav

Vehicle Driven: Activa (Sol.2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - o Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Comfort (आराम)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Range (रेंज)
  - o Comparatively Low
  - ✓ Sufficient
  - o Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - o Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - o Better than ICE vehicle
  - o Any other (please specify)

  NA

एआरएआई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - o Feels unsafe
   - ✓ Feels safe
   - o Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	Range is Sufficient. 80-90 Km per charge, for daily use.	–	–	–	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - o Any other Additional Charging Indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - o Any other

एआरएआई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - o Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - o Need fast charging at home
  - o Any other
- 3-Wheeler (3-पहिया वाहन)
  - o Charging happens too slow
  - o Normal Charging time
  - o Need fast charging at home
  - o Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - o Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - o Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - o Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - o No
   - o Maybe
   - ✓ Yes

एआरएआई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  Yes, the battery was getting shutdown automatically during trials
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    NO

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Throttle on-off Switch

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ~~No~~ ① Battery cut-off issue was observed in initial trials

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: सोनु यादव.

एआरएआई ARAI

2-wheeler scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Vivek Rai

Vehicle Driven: Activa (801-2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  N/A.

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	Range of 100 km is sufficient for daily travel needs	–	–	–	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (exact charge)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  Yes, the battery shutdown issue was occurring during trials.

- 3-Wheeler (3-पहिया वाहन)

  N.A.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Throttle on-off switch

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① Battery cut-off issue was observed even after battery repair.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: Vivek

ए आर ए आई ARAI

ए आर ए आई ARAI Progress through Research

2-wheeler Scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Ravi Kumar

Vehicle Driven: Activa (50).2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

NA

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?

- Feels unsafe
- Feels safe
- Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
-	Sufficient Range is achieved. 90-100 Km	-	-	-	-

4. How convenient was the charging process?

चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except charger
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?

- Confident to only solve minor mechanical issues
- Confident to solve minor electrical issues also
- Need training to solve minor electrical issues
- Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?

- Easy to find
- Need to search at multiple locations
- Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?

- No
- Maybe
- Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

No.

- 3-Wheeler (3-पहिया वाहन)

N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

① Throttle on-off switch

12. Did you encounter any issues while driving the vehicle?

क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

No.

13. Any additional comments or observations you would like to suggest?

कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

No.

Place:

Signature: कुमार रवि.

ए आर ए आई ARAI

2-wheeler Scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Sonu Yadav

Vehicle Driven: Activa (Sol.3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Comfort (आराम)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Range (रेंज)
  - ✓ Comparatively Low
  - o Sufficient
  - o Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - ✓ Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - o Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - o Better than ICE vehicle
  - o Any other (please specify)

  NA.

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - o Feels unsafe
   - ✓ Feels safe
   - o Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
Range of 50-55 kmph is too low as per daily usage	–	–	–	–	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - o Any other Additional charging indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - o Any other

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - ✓ Charging happens too slow (6-7 hrs)
  - o Normal Charging time
  - ✓ Need fast charging at home (10 Amp. Charger)
  - o Any other
- 3-Wheeler (3-पहिया वाहन)
  - o Charging happens too slow
  - o Normal Charging time
  - o Need fast charging at home
  - o Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - o Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - o Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - o Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - o No
   - ✓ Maybe (If range & 80-90 kmpl)
   - o Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  NO
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    NO

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Throttle on/off Switch.
    ② Reverse mode.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① Chain Noise
    ② Chain Slag.
    ③ Chain was getting out of sprocket during initial trials

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    Range should be atleast 80-90 km for daily use.

Place:

Signature: सोनु यादव.

ए आर ए आई ARAI

2- wheeler scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: vivek Rai

Vehicle Driven: Activa (80.3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - ✓ Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - ✓ Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  NA.

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
Range is too low 50-55 km pc.					

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Addition charging Indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - ✓ Charging happens too slow
  - Normal Charging time (6-7 hrs)
  - ✓ Need fast charging at home (10-Amp charger req.)
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - ✓ Maybe (If range is 80-100 kmpc)
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  NO
- 3-Wheeler (3-पहिया वाहन)

  N.A.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Throttle on-off switch
    ② Reverse mode

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① chain noise.
    ② Sprocket wear burn

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    Range req. is 80-90 km for daily use.

Place:

Signature: VivekR

2-wheeler Scooter

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Ravi Kumar

Vehicle Driven: Athva (Sol.3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - ✓ Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - ✓ Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - ✓ Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  N.A.

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?

- Feels unsafe
- ✓ Feels safe
- Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
Range achieved is too low for daily need. 50-55 km					

4. How convenient was the charging process?

चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indication req. (except charger)
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - ✓ Charging happens too slow
  - Normal Charging time (6-7 hrs)
  - ✓ Need fast charging at home (10 Amp charger req.)
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?

- ✓ Confident to only solve minor mechanical issues
- Confident to solve minor electrical issues also
- ✓ Need training to solve minor electrical issues
- Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?

- Easy to find
- ✓ Need to search at multiple locations
- ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?

- ✓ No (range too low - 50kmpc)
- Maybe
- Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  No
- 3-Wheeler (3-पहिया वाहन)

  N.A

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

① Throttle on-off switch.
② Reverse mode.

12. Did you encounter any issues while driving the vehicle?

क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

① Chain noise + Sag.
② Chain lubrication need to be done regularly. (after 2 week)

13. Any additional comments or observations you would like to suggest?

कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

Range of vehicle is to be expected upto 80-90 km per charge

Place:

Signature: कुमार रवि

3-Wheeler Passenger

3-wheeler Passenger

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Prem Kumar
Vehicle Driven: Bajaj RE (Sol.1) - Passenger

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?
आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle (Gear changing is difficult)
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low (60 kmpc)
  - Sufficient
  - Need more for daily commute (100-150)
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

Gear changing (Needs to remove one hand from handlebar)

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?
ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?
आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
NA	NA	NA	60 kmpc is too low as per daily travel of an auto-rickshaw		upto 150 km per charge

4. How convenient was the charging process?
चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except charger)

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?
क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6hrs)
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?
ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?
आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?
क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe (Range 100-150 kmpc)
   - Yes

User/Driver Feedback Form
उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?
क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  —
- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?
क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?
आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    (1) Gear shifter on handle will make driving easy.
    (2) Battery charging Indication on display.
    (3) Battery percentage on display should be given.

12. Did you encounter any issues while driving the vehicle?
क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?
कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    Battery capacity should be increased for range upto 150 km per charge

Place:

Signature: प्रेम कुमार

3- wheeler Passenger

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Suhail Khan

Vehicle Driven: Bajaj RE (Sol-1) - Passenger

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle (Gear changing is difficult)
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low (60 Kmpl)
  - Sufficient
  - Need more for daily commute (130-140)
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  Gear changing (need to remove our hand from handle bar)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
NA	NA	NA	Range is too low as compared to daily needs (60 Kmpl)	-	upto 150 Km per charge

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication reqr (except charger)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time ~~(5-6 hrs)~~
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe Range (130 to 140 Kmpl)
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)
- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Km reading should be more accurate on display.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    Range of rickshaw should be upto 150 Km per charge and speed of 50-55 Kmph.

Place:

Signature: Suhail Khan

3-wheeler Passenger

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Gurmeet Singh

Vehicle Driven: Bajaj RE (80.1) - Passenger

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - ✓ Not as good as ICE vehicle (Gear changing is difficult).
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - ✓ Comparatively Low (60 Kmpc)
  - Sufficient
  - ✓ Need more for daily commute (150)
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - ✓ Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  Gear changing (need to remove one hand from handlebar).

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
			Range is 60 kmpc which is less as per daily req.		upto 150 km per charge

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other ______
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except charger)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time ~~(5-6 hrs)~~
  - Need fast charging at home
  - Any other ______
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other ______

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - ✓ Maybe (Range 150kmpc)
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  —
- 3-Wheeler (3-पहिया वाहन)

  NO.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    NO.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    Nothing.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    NO.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    Battery range should be increased to 150-160 Kmper charge.

Place:

Signature: G Singh

3- wheeler Passenger

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Prem Kumar

Vehicle Driven: Piaggio Passenger (Set 2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
  - ✓ Any other (please specify)

    feel good to drive gearless vehicle.

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - ✓ Will be better if additional safety is provided (please specify) Throttle on-off

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	—	—	—	Sufficient range of 100-120 km per charge	

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other ______
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging indication req. (except charger)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other ______
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other ______

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  NA
- 3-Wheeler (3-पहिया वाहन)

  No

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    1. Display should be provided showing ① Speed ② Battery% SoC ③ Battery temp. ④ Charging Status.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    Yes, ① Sometimes the vehicle takes delay in starting
    ② Sometimes delay is faces in reverse mode.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    ① Motor noise is okay but will be good if reduced.

Place:

Signature: प्रेम कुमार

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3- wheeler Passenger

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Suhail Khan

Vehicle Driven: ~~Bajaj RE~~ (Sol.2) Piaggio Passenger

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
  - ✓ Any other (please specify)

  No worries to change gear in different condition.

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User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?

- Feels unsafe
- ✓ Feels safe
- ✓ Will be better if additional safety is provided (please specify) Throttle on-off.

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
-	-	-	-	Sufficient range of 100-110 km per charge is achieved.	will be better if range of 150-160 km per charge is provided.

4. How convenient was the charging process?

चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional Charging Indication req. (except charger)

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User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?

- ✓ Confident to only solve minor mechanical issues
- Confident to solve minor electrical issues also
- ✓ Need training to solve minor electrical issues
- Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?

- Easy to find
- ✓ Need to search at multiple locations
- ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?

- No
- Maybe
- ✓ Yes

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User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A.

- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

① Display showing all battery & speed parameters.
② Throttle on-off switch.
③ F/R & Mode Switch buttons should be provided on dashboard.

12. Did you encounter any issues while driving the vehicle?

क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

Battery temp. rise during summers was leading to make battery unoperational till the temp. falls ~~below~~ below the set limit of 55°C.

13. Any additional comments or observations you would like to suggest?

कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

① Motor noise is okay but reduced noise will ~~be~~ give a smooth riding experience..

Place:

Signature: Suhail Khan

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Progress through Research

3- wheeler Passenger

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Gurmeet Singh

Vehicle Driven: Piaggio Passenger (Sol.2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  No need to change gear.

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify) Throttle on-off..

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	—	—	—	Range of 100 kmpc is good. Can be increased to 150-160 kmpc.	

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except charger)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A.
- 3-Wheeler (3-पहिया वाहन)

  NO.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    NO.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Display with all Parameters.
    ② Battery Charging Indicator.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    ① Motor noise should be reduced to offer smooth riding experience.

Place:

Signature: G Singh.

3- wheeler Passenger

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Prem Kumar

Vehicle Driven: Piaggio Passenger (Sol. 3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - ✓ Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - ✓ Not as good as ICE vehicle (Need more power for hilly areas)
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
  - Any other (please specify)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	–	–	–	Range of 80-90 km per charge is ok.	will be better if 120-150 km per charge range is provided.

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional Charging Indication req. on display (except charge)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A.
- 3-Wheeler (3-पहिया वाहन)

  No

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    N.A.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    Yes. Their are diff. codes which display shows like 1 or 4, 41, 49, 51. Also, the battery temp rises quickly during demmers which make battery Continously sound.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    ① Providing fans for battery cooling will be better.

Place:

Signature: प्रेम कुमार

ए आर ए आई ARAI

3- Wheeler Passenger

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Sthail Khan

Vehicle Driven: Piaggio Passenger (Sl. 3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle (Need more power for hilly areas)
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	–	–	–	90-100 Km range is sufficient. but more range of 120-150Km Should be provided.	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other additional charging Indication req. (except charger)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A.

- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Will be better if battery temp is displayed on Dashboard.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① Controller faulted due to over current issue.
    ② Recharge & DC- DC was also damaged.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    ① Speed of 50-55 Kmph. will be good if provided.
    ② More ventilation for battery is required.

Place:

Signature: Sthail Khan

3- wheeler Passenger

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Gurmeet Singh P-

Vehicle Driven: Piaggio Passenger ~~ETE~~ (801.3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - ✓ Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - ✓ Not as good as ICE vehicle (low pickup in hilly areas).
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
  - Any other (please specify)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	—	—	—	Sufficient range of 90-100 km is achieved which is good.	Range of 120-150 km per charge can be a good range as per requirement.

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging indication req. (except charger)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A

- 3-Wheeler (3-पहिया वाहन)

  NO.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    NO.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① Battery temp rise was creating issue but after repairs the problem was solved.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    ① Should provide a speed of 50-55 km ph & should easily ride on steep gradients.

Place:

Signature: ~~[illegible]~~ G Singh

3-wheeler cargo

3-wheeler Cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Vinay Marcus

Vehicle Driven: Piaggio Cargo (Sol.2)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?
   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - ✓ Need more for daily commute (150 Km/pr)
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  For changing gear one hand need to be removed from handle bar

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?
   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?
   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	–	–	–	Sufficient range is 90-100 Km per Charge.	Need range upto 150 Km per charge for daily commute.

4. How convenient was the charging process?
   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indication req. (except charger)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?
   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?
   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?
   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?
   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?
   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A
- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?
    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?
    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Gear lever should be available on handle bar.
    ② Battery temp & SoC should be displayed.

12. Did you encounter any issues while driving the vehicle?
    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① Transmission shafts of both side were damaged (eye of shaft inside muffcaps).

13. Any additional comments or observations you would like to suggest?
    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    ① Transmission shaft greese was getting used very quickly as compared to ICE gearbox transmission shaft.

Place:

Signature: Marcus.

ए आर ए आई ARAI

3-wheeler Cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Devendra Singh

Vehicle Driven: Piaggio Cargo (Sol:1)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Comfort (आराम)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Range (रेंज)
  - o Comparatively Low
  - o Sufficient
  - ✓ Need more for daily commute (120-150)
- Acceleration and Top speed (त्वरण और गति)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - ✓ Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - o Better than ICE vehicle
  - o Any other (please specify)

  for changing Gear one hand need to be removed from handle bar.

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - o Feels unsafe
   - ✓ Feels safe
   - o Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	–	–	–	Sufficient range of 90-100 km per charge is achieved.	Need more range. upto 120-150 km per charge for daily commute

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - o Any other
- 3-Wheeler (3-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - ✓ Any other Addition charging Indication req. (except charger)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - o Charging happens too slow
  - o Normal Charging time
  - o Need fast charging at home
  - o Any other
- 3-Wheeler (3-पहिया वाहन)
  - o Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - o Need fast charging at home
  - o Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - o Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - o Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - o Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - o No
   - o Maybe
   - ✓ Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A.
- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Gear shifter Should be on handle bar for easy access.
    ② Battery temp & SoC should be displayed.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: देवेंद्र सिंह

3-wheeler cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: ~~Ravi~~ Prem Kumar

Vehicle Driven: Piaggio Cargo (Sol-1)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - ✓ Need more for daily commute (120-130 Kmpc)
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

  For changing Gear our hand need to be removed from handle bar.

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	–	–	–	Sufficient range of 90-100 is achieved.	Range of 120-130 Kmpc. is required to meet daily needs

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indication req. (except charger)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A

- 3-Wheeler (3-पहिया वाहन)

  NO.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    NO.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Gear lever should be in hand.
    ② battery % + temp should be displayed on dashboard.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    NO.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    ① Transmission shaft eye on gearbox side was damaged & replaced.

Place:

Signature: प्रेम कुमार

ए आर ए आई ARAI

3- wheeler Cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Devendra Singh

Vehicle Driven: Bajaj Maxima (Sol-2)-Cargo

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - o Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Comfort (आराम)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Range (रेंज)
  - o Comparatively Low
  - ✓ Sufficient
  - o Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - o Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - o Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - o Not as good as ICE vehicle
  - o Similar to ICE vehicle
  - ✓ Better than ICE vehicle
  - ✓ Any other (please specify)

No need of gear changing gives comfort.

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?

- o Feels unsafe
- ✓ Feels safe
- o Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	–	–	–	Range is Sufficient 100-110 kmpc.	Range of 150-160 Km per Charge Should be provided

4. How convenient was the charging process?

चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - o Any other
- 3-Wheeler (3-पहिया वाहन)
  - o Difficult
  - o Complicated
  - o Easy
  - ✓ Any other Additional charging Indication req. (except charger)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - o Charging happens too slow
  - o Normal Charging time
  - o Need fast charging at home
  - o Any other
- 3-Wheeler (3-पहिया वाहन)
  - o Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - o Need fast charging at home
  - o Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?

- ✓ Confident to only solve minor mechanical issues
- o Confident to solve minor electrical issues also
- ✓ Need training to solve minor electrical issues
- o Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?

- o Easy to find
- ✓ Need to search at multiple locations
- ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?

- o No
- o Maybe
- ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

N.A

- 3-Wheeler (3-पहिया वाहन)

NO.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

Yes ~~No~~. Due to heat the battery temperature rise was an issue which was leading the battery to stop working.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

→ ① Display on dashboard should provide ⓐ Battery percentage, ⓑ Battery temperature ⓒ vehicle speed ⓓ vehicle mode of driving

→ ② Switch button should be provided above dashboard.

12. Did you encounter any issues while driving the vehicle?

क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

① Motor - GB coupling was damaged. (Internal teeths)

② Battery was ~~open~~ not operating when the battery temp. was above 55°C

13. Any additional comments or observations you would like to suggest?

कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

No.

Place:

Signature: देवेंद्र सिंह

ए आर ए आई ARAI

ए आर ए आई ARAI Progress through Research

3-wheeler Cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Vinay Marcus

Vehicle Driven: Bajaj Maxima (Sol-2) - Cargo

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
  - ✓ Any other (please specify)

   Easy to drive because of no gear changing.

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	–	–	–	Sufficient range of 100-110 Km per charge is ok.	Will be good if range of 150-160 Km per charge is provided

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indication req. (except charger)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A

- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    During summers, surrounding Temp was heating up the battery, which led to battery temp. rise rapidly and stop functioning.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    ① Standard Display

    ② Switch buttons should be above dashboard.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    ① Brakes were less active due to low brake fluid, later after repair brake were working properly.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: Marcus.

3-wheeler Cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Prem Kumar

Vehicle Driven: Bajaj Maxima (1.2) Cargo

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - ✓ Better than ICE vehicle
  - ✓ Any other (please specify)

  Easy to drive because of no gear changing.

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	—	—	—	Range of 90-100 km per charge is Sufficient	—

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indication req. (except charger)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A.
- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    Yes. During summers battery temp. was rising too fast.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    (1) Display on dashboard will all imp parameters like. A) Speed B) Battery SoC C) Battery temp. D) mode of speed.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: प्रेम कुमार

ए आर ए आई ARAI

3-wheeler Cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Devendra Singh

Vehicle Driven: Bajaj Maxima (Sol-3) - cargo

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?
   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - ✓ Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - ✓ Not as good as ICE vehicle (Speed & pickup issue).
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - ✓ Not as good as ICE vehicle (pickup issue on gradients)(loading)
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - ✓ Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?
   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - ✓ Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?
   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	—	—	—	Range of 90-100 Km per charge is ok.	Need more range of 150-160 km per charge for daily needs

4. How convenient was the charging process?
   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - ✓ Any other Additional charging Indication req. (except charger)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?
   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - ✓ Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?
   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - ✓ Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - ✓ Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?
   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - ✓ Need to search at multiple locations
   - ✓ Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?
   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - ✓ Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?
   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)
  N.A
- 3-Wheeler (3-पहिया वाहन)
  NO.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?
    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?
    No

11. What additional features do you think should be integrated with the vehicle for improved driving experience?
    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?
    NO.

12. Did you encounter any issues while driving the vehicle?
    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?
    Pickup & speed issue on steep gradients. Display of codes such as IOC-49, 41, 04, 02.

13. Any additional comments or observations you would like to suggest?
    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?
    Vehicle should have more speed (50-55 kmph) & pickup power

Place:

Signature: देवेंद्र सिंह

ए आर ए आई ARAI

3- Wheeler Cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Vinay Marcus

Vehicle Driven: Bajaj Cargo (Sl. 3)

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle (Pickup issue on gradients)(loading)
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
—	—	—	—	Sufficient range of 90-100 Km per Charge is ok.	—

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except charger)

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A
- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    old kit was having pickup issue. New kit is performing good.
    No additional features req.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    Yes sometimes the battery was making sound due to temp. rise. (Normal Indication)

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    speed of 40-45 is not sufficient on highways. Atleast 50-55 should be given

Place:

Signature: Marcus

3-wheeler Cargo

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

User/Driver Name: Prem Kumar

Vehicle Driven: Bajaj Maxima (S1.3)-Cargo.

1. How would you rate the overall experience of driving a retrofitted electric vehicle (EV)?

   आप रेट्रो-फिटेड इलेक्ट्रिक वाहन (EV) चलाने के समग्र अनुभव को कैसे आंकेंगे?

- Riding experience as compared to ICE vehicle (ईंधन वाहन की तुलना में सवारी का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Comfort (आराम)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Range (रेंज)
  - Comparatively Low
  - Sufficient
  - Need more for daily commute
- Acceleration and Top speed (त्वरण और गति)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Driving experience on Gradient surface (ग्रेडिएंट सतह पर ड्राइविंग का अनुभव)
  - Not as good as ICE vehicle
  - Unable to sustain with pillion
  - Similar to ICE vehicle
  - Better than ICE vehicle
- Gear shifting in case of 3-wheelers (तिपहिया वाहनों के मामले में गियर शिफ्टिंग का अनुभव)
  - Not as good as ICE vehicle
  - Similar to ICE vehicle
  - Better than ICE vehicle
  - Any other (please specify)

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User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

2. How safe do you feel while driving an EV as compared to an ICE Vehicle?

   ICE वाहन की तुलना में ईवी चलाते समय आप कितना सुरक्षित महसूस करते हैं?
   - Feels unsafe
   - Feels safe
   - Will be better if additional safety is provided (please specify)

3. How would you rate the battery range of retro-fitted EV w.r.t daily travel needs in Delhi NCR?

   आप दिल्ली एनसीआर में दैनिक यात्रा आवश्यकताओं के संबंध में रेट्रो-फिटेड ईवी की बैटरी रेंज का मूल्यांकन कैसे करेंगे?

2- Wheeler 2-पहिया वाहन			3-Wheeler 3-पहिया वाहन		
Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए	Too Low बहुत कम	Sufficient पर्याप्त	Need more और चाहिए
–	–	–	–	Sufficient range of 100 km per charge is ok.	–

4. How convenient was the charging process?

   चार्जिंग प्रक्रिया/समय कितना सुविधाजनक था?

- 2-Wheeler (2-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Difficult
  - Complicated
  - Easy
  - Any other Additional charging Indication req. (except charger)

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

5. Did you experience any issues with the charging system in reference to the charging time taken?

   क्या आपने संदर्भ में चार्जिंग सिस्टम के साथ किसी समस्या का अनुभव किया है। चार्जिंग में लगने वाला समय?

- 2-Wheeler (2-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time
  - Need fast charging at home
  - Any other
- 3-Wheeler (3-पहिया वाहन)
  - Charging happens too slow
  - Normal Charging time (5-6 hrs)
  - Need fast charging at home
  - Any other

6. How confident do you feel to solve any minor issue that occurred in the vehicle while driving, as compared to that of ICE Vehicle?

   ICE वाहन की तुलना में वाहन चलाते समय वाहन में हुई किसी भी छोटी-मोटी समस्या को हल करने में आप कितना आश्वस्त महसूस करते हैं?
   - Confident to only solve minor mechanical issues
   - Confident to solve minor electrical issues also
   - Need training to solve minor electrical issues
   - Not confident

7. How would you compare finding the local mechanic for vehicle maintenance as compared to that of conventional ICE vehicle?

   आप पारंपरिक आईसीई वाहन की तुलना में वाहन रखरखाव के लिए स्थानीय मैकेनिक ढूंढने की तुलना कैसे करेंगे?
   - Easy to find
   - Need to search at multiple locations
   - Local mechanic avoids to handle Electric vehicle maintenance

8. Will you consider using retrofitted electric vehicle for your daily commute?

   क्या आप अपने दैनिक आवागमन के लिए रेट्रोफिटेड इलेक्ट्रिक वाहन का उपयोग करने पर विचार करेंगे?
   - No
   - Maybe
   - Yes

ए आर ए आई ARAI

User/Driver Feedback Form

उपयोगकर्ता/ड्राइवर फीडबैक फॉर्म

9. Did you notice any sudden drop in SoC after certain level of SoC drain?

   क्या आपने SoC के एक निश्चित स्तर के खत्म होने के बाद SoC में अचानक कोई गिरावट देखी?

- 2-Wheeler (2-पहिया वाहन)

  N.A

- 3-Wheeler (3-पहिया वाहन)

  No.

10. Did you notice any difference while starting & driving during different weather conditions (Cold, Summer & Rainy season)?

    क्या आपने विभिन्न मौसम स्थितियों (ठंड, गर्मी और बरसात के मौसम) के दौरान गाड़ी शुरू करते समय और गाड़ी चलाते समय कोई अंतर देखा?

    No.

11. What additional features do you think should be integrated with the vehicle for improved driving experience?

    आपके विचार से बेहतर ड्राइविंग अनुभव के लिए वाहन में कौन सी अतिरिक्त सुविधाएँ जोड़ी जानी चाहिए?

    No.

12. Did you encounter any issues while driving the vehicle?

    क्या आपको वाहन चलाते समय किसी समस्या का सामना करना पड़ा?

    No.

13. Any additional comments or observations you would like to suggest?

    कोई अतिरिक्त टिप्पणी या अवलोकन जो आप सुझाना चाहेंगे?

    No.

Place:

Signature: प्रेम कुमार

ए आर ए आई ARAI

11.2 Pollution Reduction Potential

SECTION 30

- 2W Solution 1 parameter

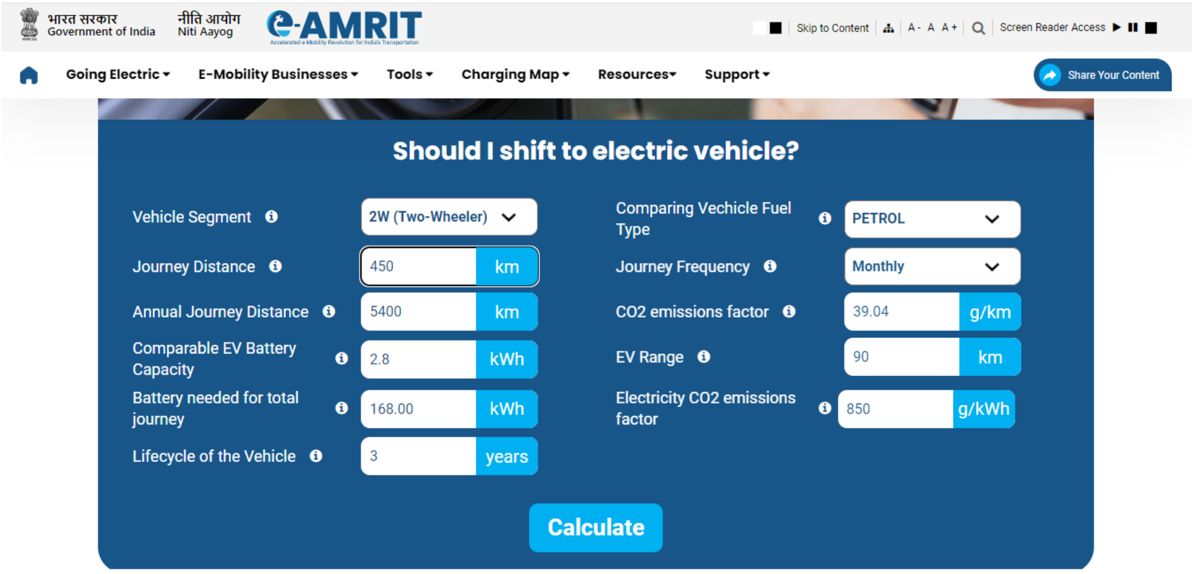

Figure 109 ***Input Parameter values to calculate PRP of 2-Wheeler (Sol. 1)***

- 2W Solution 1 Output

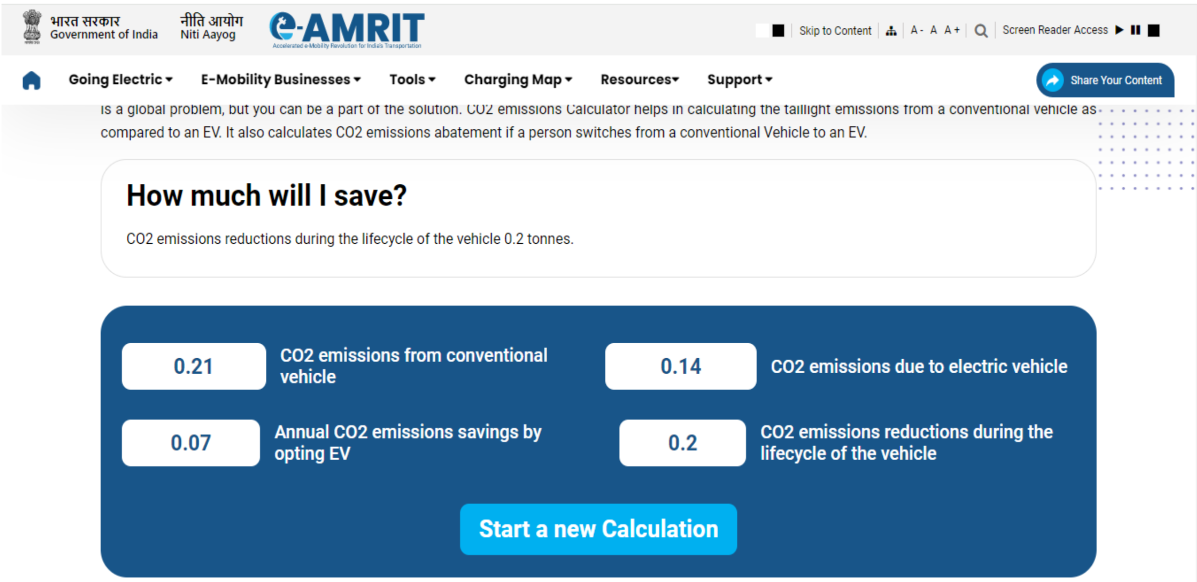

Figure 110 ***CO2 emission reduction of 2-Wheeler (Sol. 1)***

- 2W Solution 2 Parameter

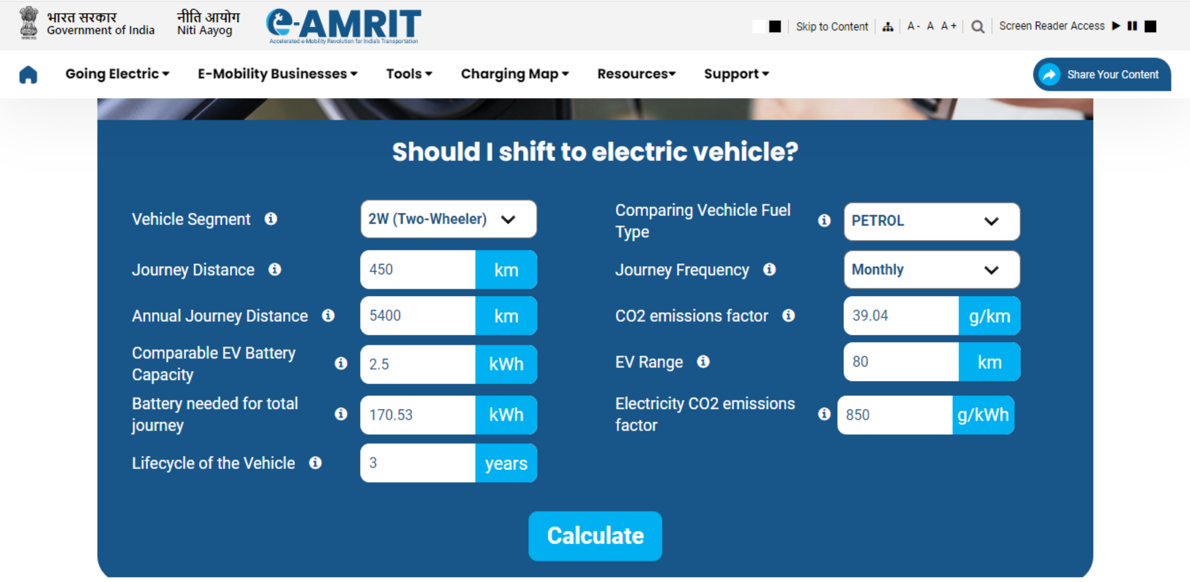

Figure 111 ***Input Parameter values to calculate PRP of 2-Wheeler (Sol. 2)***

- 2W Solution 2 output

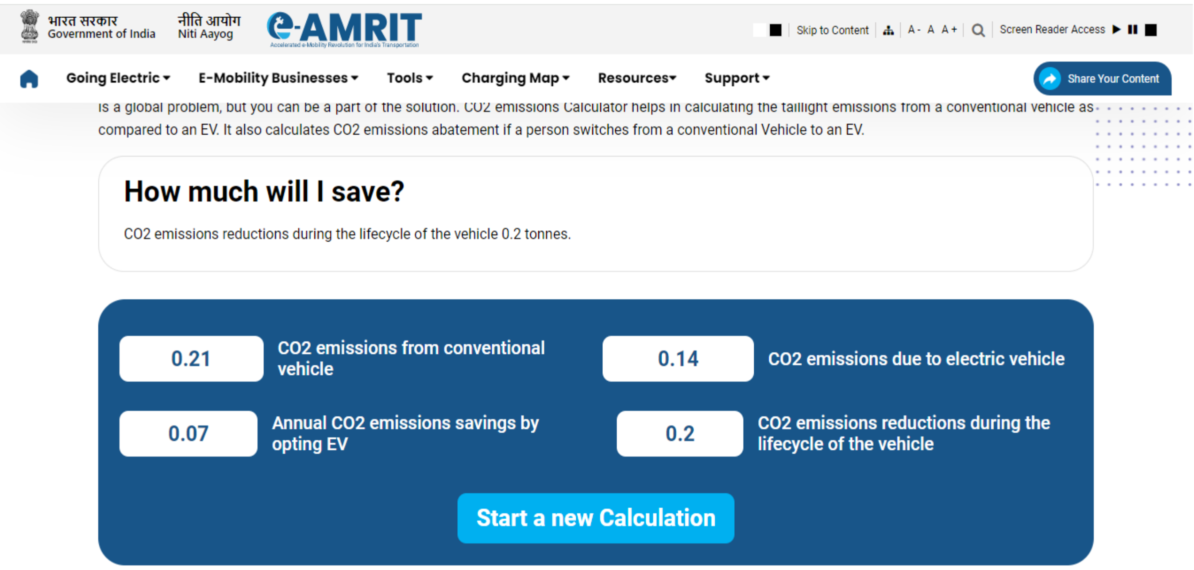

Figure 112 ***CO2 emission reduction of 2-Wheeler (Sol. 2)***

- 2W Solution 3 Parameter

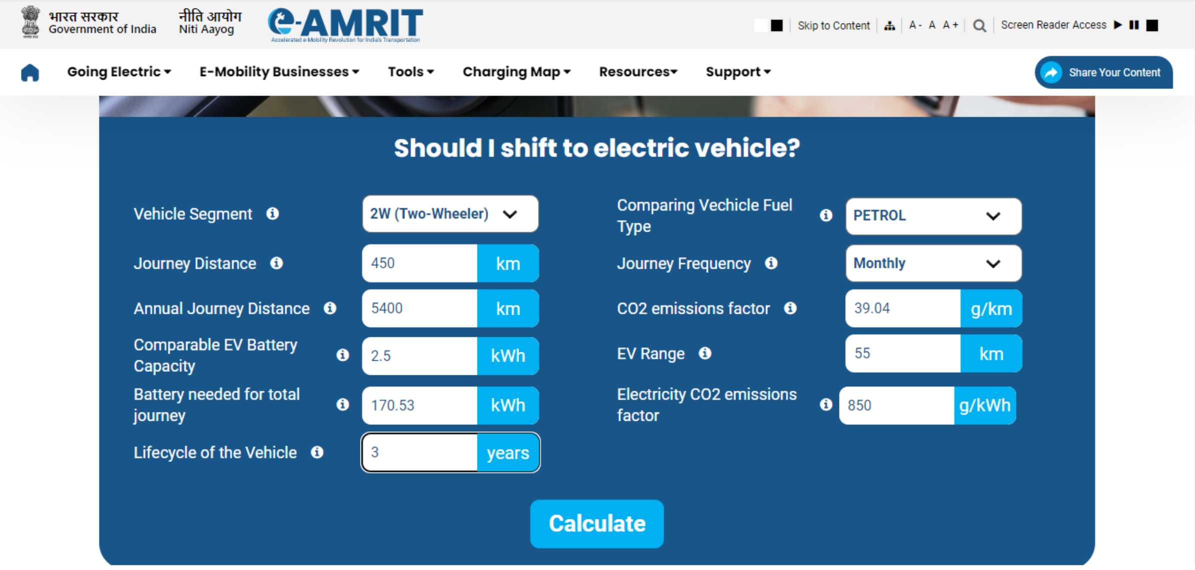

Figure 113 ***Input Parameter values to calculate PRP of 2-Wheeler (Sol. 3)***

- 2W Solution 3 output

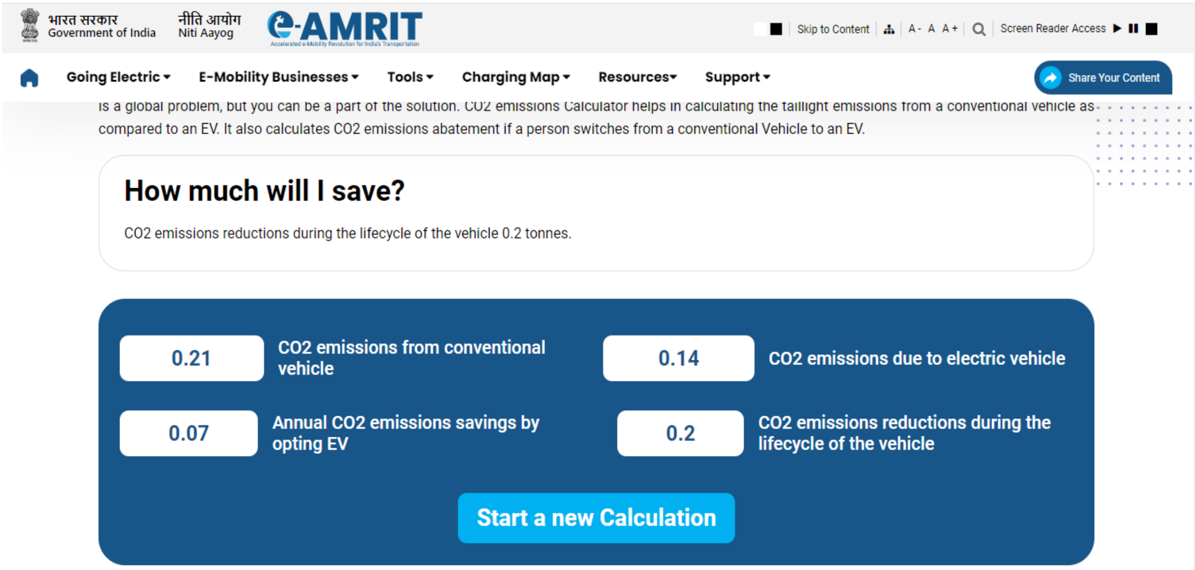

Figure 114 ***CO2 emission reduction of 2-Wheeler (Sol. 3)***

- 3W Passenger Solution 1 Parameter

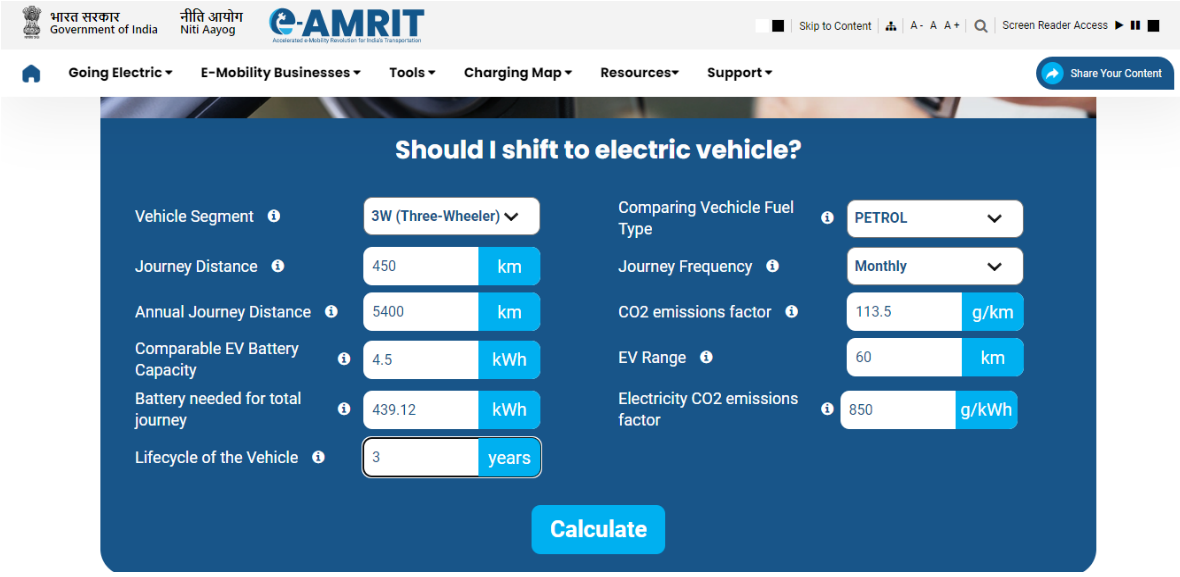

Figure 115 ***Input Parameter values to calculate PRP of 3-Wheeler (Sol. 1)***

- 3W Passenger Solution 1 output

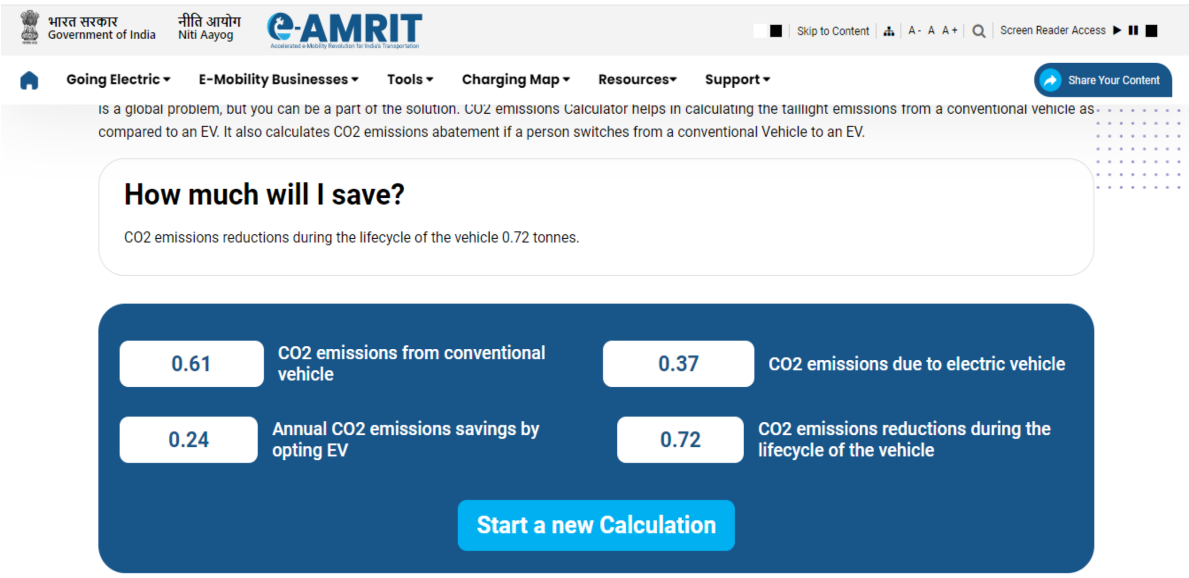

Figure 116 ***CO2 emission reduction of 3-Wheeler (Sol. 1)***

- 3W Petrol Parameter

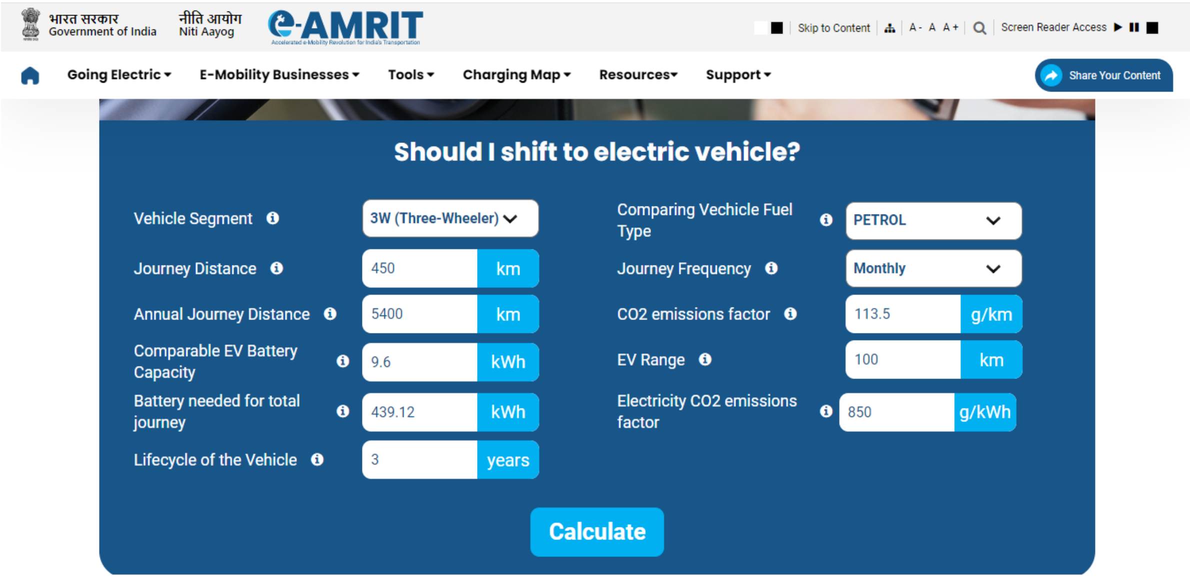

Figure 117 ***Input Parameter values to calculate PRP of 3-Wheeler (Sol. 2)***

- 3W Petrol output

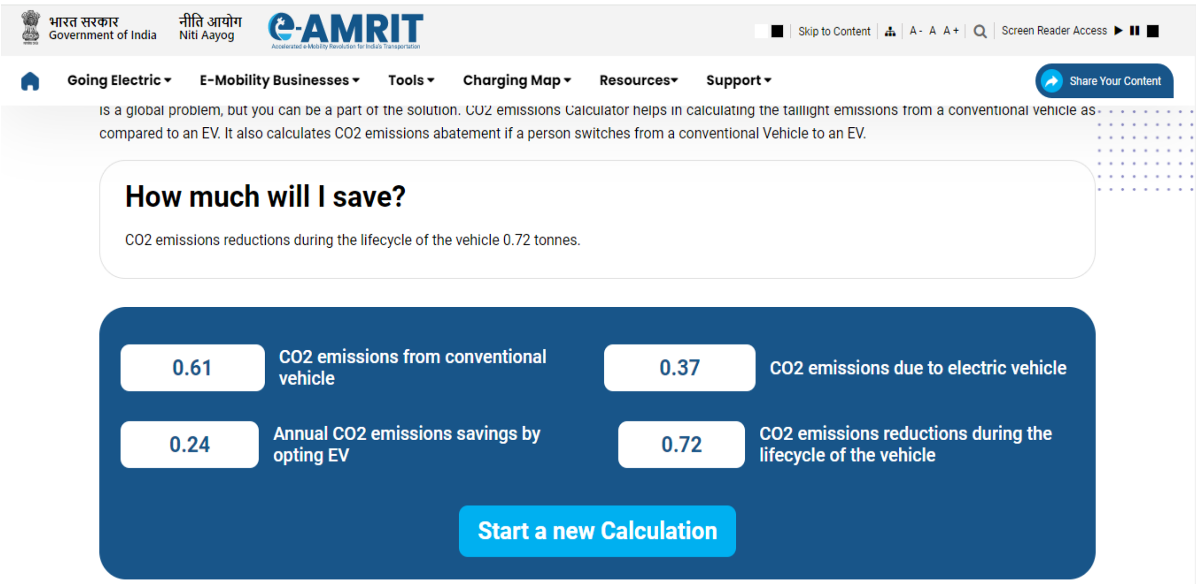

Figure 118 ***CO2 emission reduction of 3-Wheeler (Sol. 2)***

- 3W Diesel Parameter

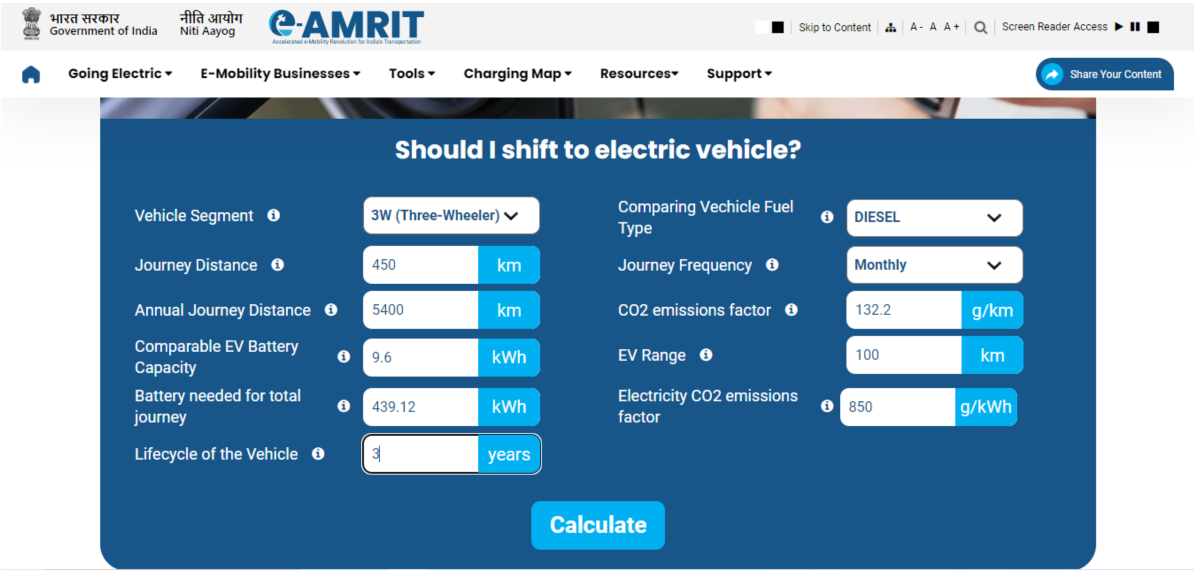

Figure 119 ***Input Parameter values to calculate PRP of 3-Wheeler (Sol. 3)***

- 3W Diesel output

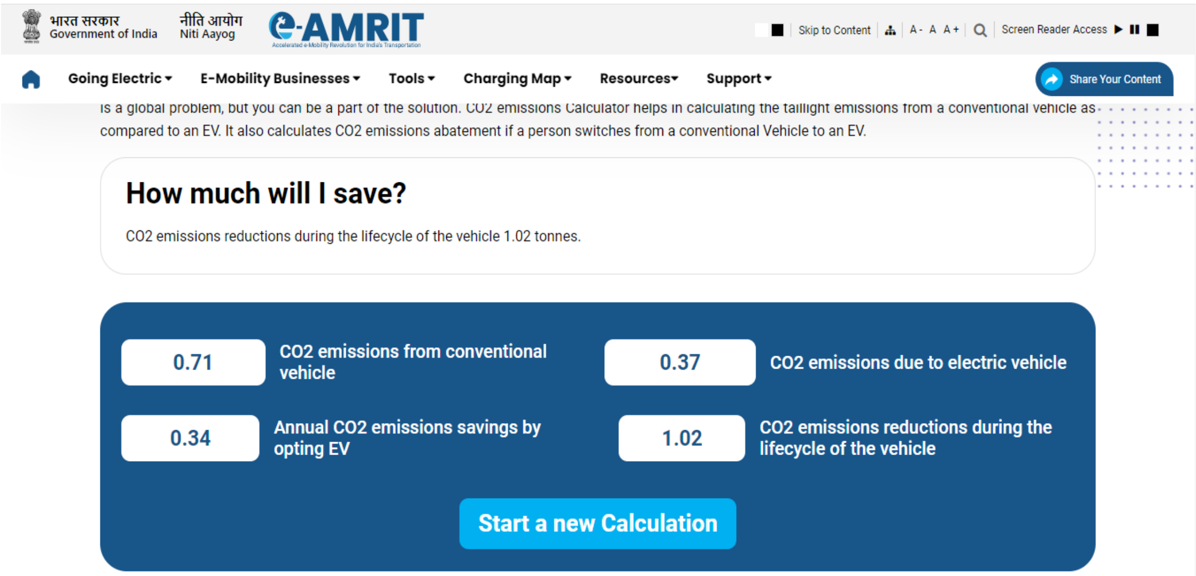

Figure 120 ***CO2 emission reduction of 3-Wheeler (Sol. 3)***

11.3 Vehicle Trials Test Data Result

SECTION 31

Test Objective:

- Run trials on retro-fitted 2-Wheelers and 3-Wheelers to assess performance of retro- fitment kits.
- Find suitability of retro-fitment kits for the category of vehicle intended, primarily with respect to power requirements.

Test Outcomes:

- Sizing requirements for 2W scooter, 2W motorcycle, 3W passenger and 3W cargo vehicle categories.
- Identification of key areas of concern with regards to functioning of retro-fitted vehicles.

11.4 Vehicle Category: 2-Wheeler Scooter

2-Wheeler Scooter Kit Specifications:

Battery Capacity				
		Solution 1	**Solution 2**	**Solution 3**
Manufacturer		GoGoA1	Nettoyer	Mechatronics
Motor Power	**Rated Power(kW)**	1.2	2.03	2.0
	Peak Power(kW)	2.3	3.51	3.0
Battery Capacity		72V 40Ah	72V 35Ah	60V 42Ah
Charger Capacity		72V 10A	72V 10A	60V 6A

Table 66 ***2-Wheeler Scooter Kit Specifications***

Table 66 summarises the specifications of kits for each solution of 2W scooter as specified by the manufacturer/provider.

Summary of 2-Wheeler Scooter Tests (Loaded Condition):

Duty Cycle for a Power Range: The term indicates instances of power that fall within the given power range as a percentage of total instances captured. Power utilization at most instances should lie below rated power for ideal sizing.

Loaded-With Pillion (70 kg)				
		Solution 1	Solution 2	Solution 3
Max Current(A)		53	85.8	79.6
#Duty Cycle (Rated Power to Peak Power, %)		22.71	5.36	2.57
Power	Avg Power(kW)	1.16	1.21	1.08
	Max Power(kW)	3.42	3.8	3.48
Speed	Avg Speed(km/h)	30.23	34.82	33.87
	Max Speed(km/h)	53	67	56
Range (kms, for SoC drain from 100 to 20%)		95-100	80-85	55-60

Table 67 ***Performance Summary of 2W Scooter for all 3 Solutions (Loaded Condition)***

Summary of 2-Wheeler Scooter Tests (Non-Loaded Condition):

Unloaded				
		Solution 1	Solution 2	Solution 3
Max Current(A)		48	79.6	69.9
#Duty Cycle (Rated Power to Peak Power, %)		19.49	5.00	1.27
Power	Avg Power(kW)	1.04	1.12	0.92
	Max Power(kW)	3.39	3.6	4.06
Speed	Avg Speed(km/h)	32.82	36.00	33.93
	Max Speed(km/h)	53	77	56
Range (kms, for SoC drain from 100 to 20%)		105-110	90-95	65-70

Table 68 ***Performance Summary of 2W Scooter for all 3 Solutions (Unloaded Condition)***

Observations:

- The peak power requirement, observed in ***Table 66***, during testing of all the vehicles in 2-wheeler scooter category was found to be close to 3.5kW.
- For rated power of 2kW in Solution 2 and Solution 3, as seen in ***Table 67***, duty cycle below rated power is 94.6 % and 97% respectively. Whereas, for solution 1 the duty cycle below rated power is less, indicating the motor is slightly undersized.

Recommendations:

Based on above observations, following recommendations for 2W scooter can be made:

- The recommended peak power range is 3.5-4.0kW.
- The recommended rated power range for this category is 2-2.5kW.

11.5 Vehicle Category: 2-Wheeler Motorcycle

2-Wheeler Motorcycle Kit Specifications:

Battery Capacity				
		Solution 1	**Solution 2**	**Solution 3**
Manufacturer		GoGoA1	Nettoyer	Mechatronics
Motor Power	**Rated Power(kW)**	2.0	2.65	2.0
	Peak Power(kW)	3.94	5.60	3.0
Battery Capacity		72V 40Ah	72V 35Ah	60V 42Ah
Charger Capacity		72V 10A	72V 10A	60V 6A

Table 69 ***2-Wheeler Motorcycle Kit Specifications***

Table 69 summarises the specifications of kits for each solution of 2W motorcycle as specified by the manufacturer/provider.

Summary of 2-Wheeler Motorcycle Tests (Loaded Condition):

Loaded-With Pillion (70 kg)				
		Solution 1	**Solution 2**	**Solution 3**
Max Current(A)		63.73	111.0	76.1
#Duty Cycle (Rated Power to Peak Power, %)		8.48	5.9	12.47
Power	**Avg Power(kW)**	1.05	1.39	1.32
	Max Power(kW)	4.15	6.52	4.10
Speed	**Avg Speed(km/h)**	26.40	36.74	36.59
	Max Speed(km/h)	69	79	73
Range (kms, for SoC drain from 100 to 20%)		80-85	75-80	50-55

Table 70 ***Performance Summary of 2W Motorcycle for all 3 Solutions (Loaded Condition)***

Summary of 2-Wheeler Motorcycle Tests (Non-Loaded Condition):

Unloaded				
		Solution 1	Solution 2	Solution 3
Max Current(A)		60.24	102.0	71.7
#Duty Cycle (Rated Power to Peak Power, %)		6.89	4.32	7.26
Power	Avg Power(kW)	0.93	1.29	1.16
	Max Power(kW)	4.14	6.12	3.83
Speed	Avg Speed(km/h)	30.27	38.97	38.07
	Max Speed(km/h)	73	84	70
Range (kms, for SoC drain from 100 to 20%)		95-100	85-90	60-65

Table 71 ***Performance Summary of 2W Motorcycle for all 3 Solutions (Unloaded Condition)***

Observations:

- Peak power for the category, observed in ***Table 69***, is close to 4kW for specified kit peak power at 3.9kW and 3kW in Solution 1 and 3 respectively.
- The observed peak power rises to 6.5kW for specified kit peak power at 5.6kW in solution 2.
- The maximum speed is also higher in Solution 2 as it has higher power rating (from ***Table 69*** and ***Table 70***).
- Duty cycle for region below rated power in all solutions, deduced from ***Table 69***, is significant; 92 % for Solution 1, 94% for Solution 2 and 88 % for Solution 3.

Recommendations:

Based on above observations following recommendations for 2W motorcycle can be made:

- The recommended peak power is use case specific in motorcycle category. In case of higher performance requirement, the recommended peak power is 6-6.5kW. For general requirements recommended peak power is 4-4.5kW.
- Recommended rated power range for this category is 2-2.5kW.

11.6 Vehicle Category: 3-Wheeler Passenger

3-Wheeler Passenger Kit Specifications:

Battery Capacity				
		Solution 1	Solution 2	Solution 3
Manufacturer		3eVI	Mahle	Tork
Motor Power	Rated Power(kW)	3.0	4.0	4.4
	Peak Power(kW)	6.5	7.0	10.0
Battery Capacity (Ah)		48V 100Ah	48V 200Ah	48V 200Ah
Charger Capacity		48V 25A	48V 40A	48V 40A

Table 72 ***3-Wheeler Passenger Kit Specifications***

Table 72 summarises the specifications of kits for each solution of 3W passenger vehicle as specified by the manufacturer/provider.

Summary of 3-Wheeler Passenger Tests (Loaded Condition):

Loaded- With Dead Weight (210-240 kg)				
		Solution 1	Solution 2	Solution 3
Max Current(A)		146.75	135.2	143.0
#Duty Cycle (Rated Power to Peak Power, %)		12.33	6.34	4.53
Power	Avg Power(kW)	1.65	2.26	2.77
	Max Power(kW)	6.44	7.08	7.10
Speed	Avg Speed(km/h)	27.53	32.74	32.10
	Max Speed(km/h)	52.00	56.00	50.00
Range (kms, for SoC drain from 100 to 20%)		60-65	95-100	85-90

Table 73 ***Performance Summary of 3W Passenger for all 3 Solutions (Loaded Condition)***

Summary of 3-Wheeler Passenger Tests (Unloaded Condition):

Unloaded				
		Solution 1	Solution 2	Solution 3
Max Current(A)		147.59	147.01	134.05
#Duty Cycle (Rated Power to Peak Power, %)		3.68	4.53	4.47
Power	Avg Power(kW)	1.05	1.86	2.13
	Max Power(kW)	6.91	6.354	6.74
Speed	Avg Speed(km/h)	26.88	25.71	27.5
	Max Speed(km/h)	49.00	60	53
Range (kms, for SoC drain from 100 to 20%)		75-80	105-110	95-100

Table 74 ***Performance Summary of 3W Passenger for all 3 Solutions (Unloaded Condition)***

Observations:

- The highest peak power, as seen in ***Table 72***, is obtained in Solution 3 at 7.10kW; with sufficiently higher kit specified peak power at 10kW.
- The duty cycle for the region below peak for Solutions 1, 2 and 3 are 88%, 94% and 96 % respectively (from ***Table 73***), indicating ideal sizing for nominal ratings of Solution 2 and 3.

Recommendations:

Based on above observations following recommendations for 3W passenger vehicle can be made:

- The recommended peak power range for this category is 7-7.5kW.
- The recommended rated power range for this category is 4-4.5kW.

11.7 Vehicle Category: 3-Wheeler Cargo

3-Wheeler Cargo Kit Specifications:

Battery Capacity				
		Solution 1	Solution 2	Solution 3
Manufacturer		3eVI	Mahle	Tork
Motor Power	Rated Power(kW)	3.0	4.0	7.5
	Peak Power(kW)	6.5	7.0	12.0
Battery Capacity		48V 200Ah	48V 200Ah	48V 200Ah
Charger Capacity		48V 40A	48V 40A	48V 40A

Table 75 ***3-Wheeler Cargo Kit Specifications***

Table 75 summarises the specifications of kits for each solution of 3W cargo vehicle as specified by the manufacturer/provider.

Summary of 3-Wheeler Cargo Tests (Loaded Condition):

Loaded- With Dead Weights (400-425 kg)				
		Solution 1	Solution 2	Solution 3
Max Current(A)		138.79	146.75	160.3
#Duty Cycle (Rated Power to Peak Power, %)		43.44	8.58	0
Power	Avg Power(kW)	2.76	2.65	2.72
	Max Power(kW)	6.23	7.56	7.17
Speed	Avg Speed(km/h)	30.46	33.15	34.17
	Max Speed(km/h)	53.00	57.00	51
Range (kms, for SoC drain from 100 to 20%)		75-80	95-100	80-85

Table 76 ***Performance Summary of 3W Cargo for all 3 Solutions (Loaded Condition)***

Summary of 3-Wheeler Cargo Tests (Unloaded Condition):

Unloaded				
		Solution 1	**Solution 2**	**Solution 3**
Max Current(A)		150.2	130.60	149.4
#Duty Cycle (Rated Power to Peak Power, %)		23.81	5.83	0
Power	**Avg Power(kW)**	2.02	1.97	1.9
	Max Power(kW)	6.87	6.24	6.65
Speed	**Avg Speed(km/h)**	30.63	34.05	31.17
	Max Speed(km/h)	50	56	51
Range (kms, for SoC drain from 100 to 20%)		90-95	100-105	95-100

Table 77 ***Performance Summary of 3W Cargo for all 3 Solutions (Unloaded Condition)***

Observations:

- The highest peak power for all solutions in this category, observed in ***Table 75***, is 7.56kW.
- The rated power for Solution 3 specified in ***Table 76*** is 7kW, which is close to the peak power observed and way above observed average power of 2.72kW, indicating oversizing.
- The duty cycle for region below rated power for Solution 1 (from ***Table 76***) is 56% indicating under-sizing or inadequate rated power.
- The duty cycle for region below rated power for Solution 2 as seen in ***Table 76*** is 92 %, indicating maximum utilization in this region.

Recommendations:

- The recommended peak power range is 7-7.5kW.
- The recommended rated power range is 4-4.5kW.

11.8 Test Data Plots

As discussed in 3.8 above, the test vehicles were equipped with DAQ devices for data monitoring collecting data for the following parameters: vehicle speed, throttle input, current drawn, voltage and altitude. The data plots for each vehicle for the mentioned parameters over a patch time interval from the test trials have been displayed in ***Figure 121*** to ***Figure 132***. The monitored parameters were found to follow predicted trend. Expected trends were observed with altitude variation. In all vehicles, the current and speed were observed to be following the same trend as the throttle input; ascertaining the fact that the motor controller and battery response were in-line with driver inputs.

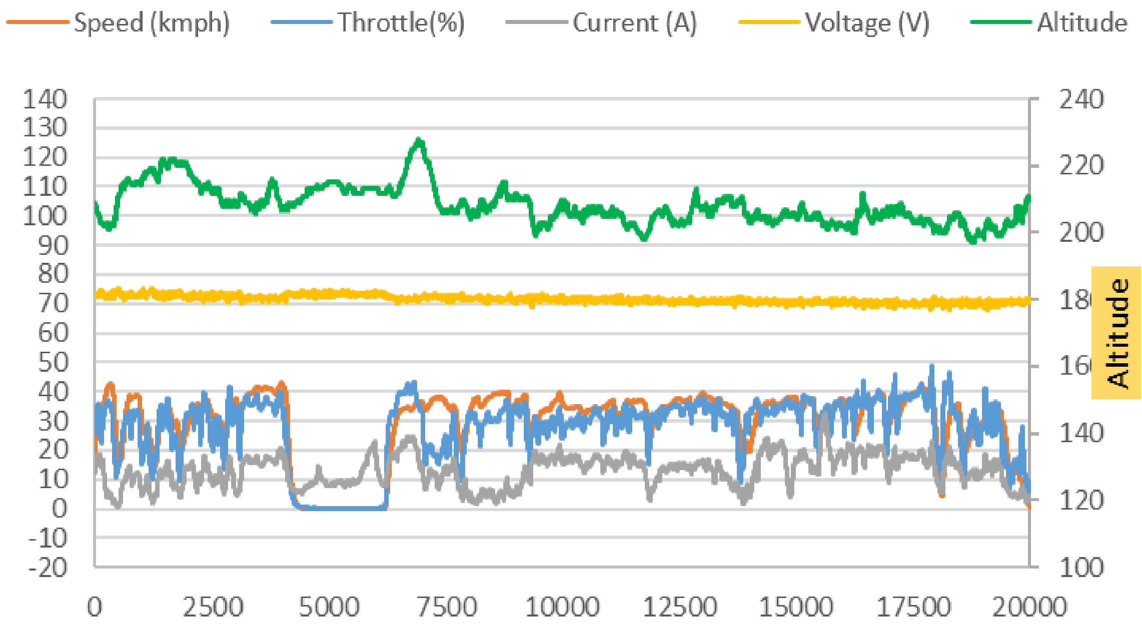

Figure 121 ***Testing Plot for 2-Wheeler Scooter (Solution 1)***

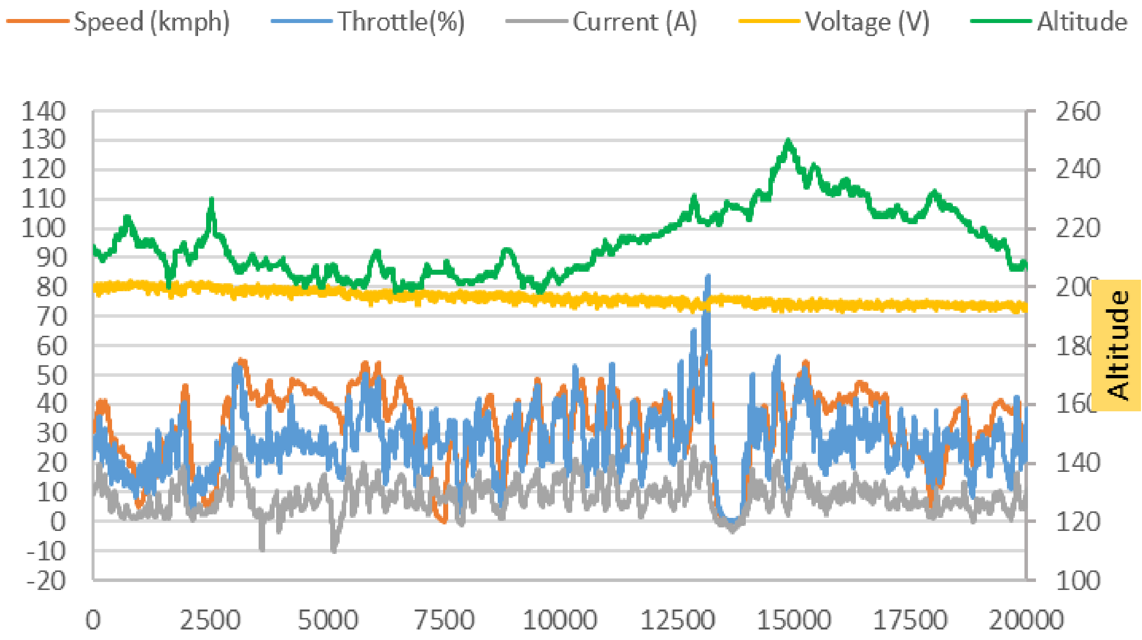

Figure 122 ***Testing Plot for 2-Wheeler Scooter (Solution 2)***

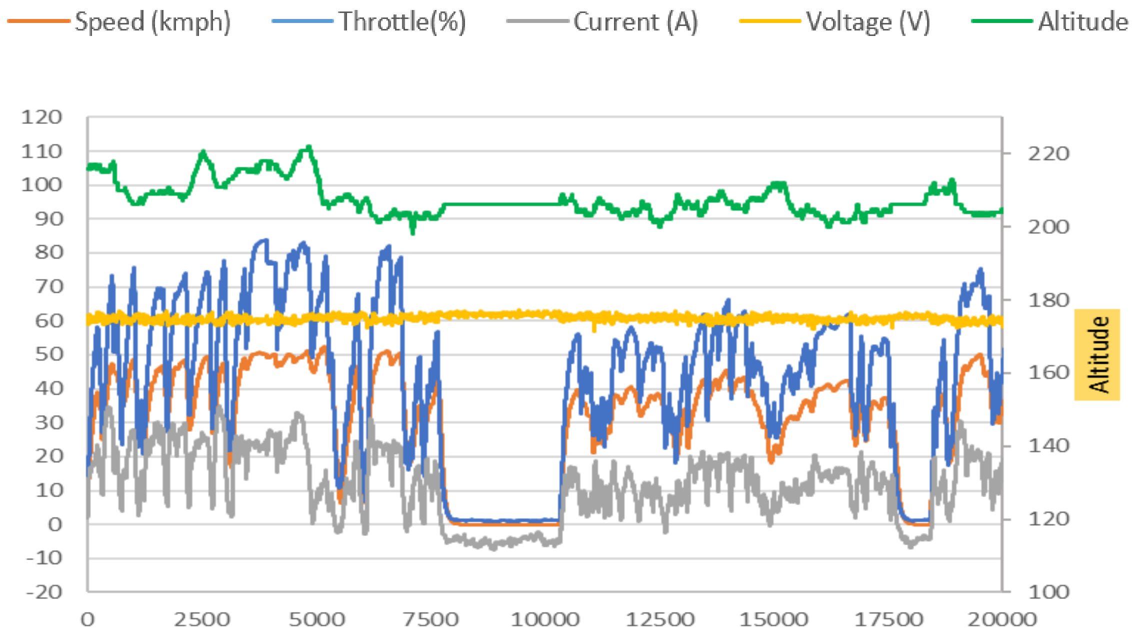

Figure 123 ***Testing Plot for 2-Wheeler Scooter (Solution 3)***

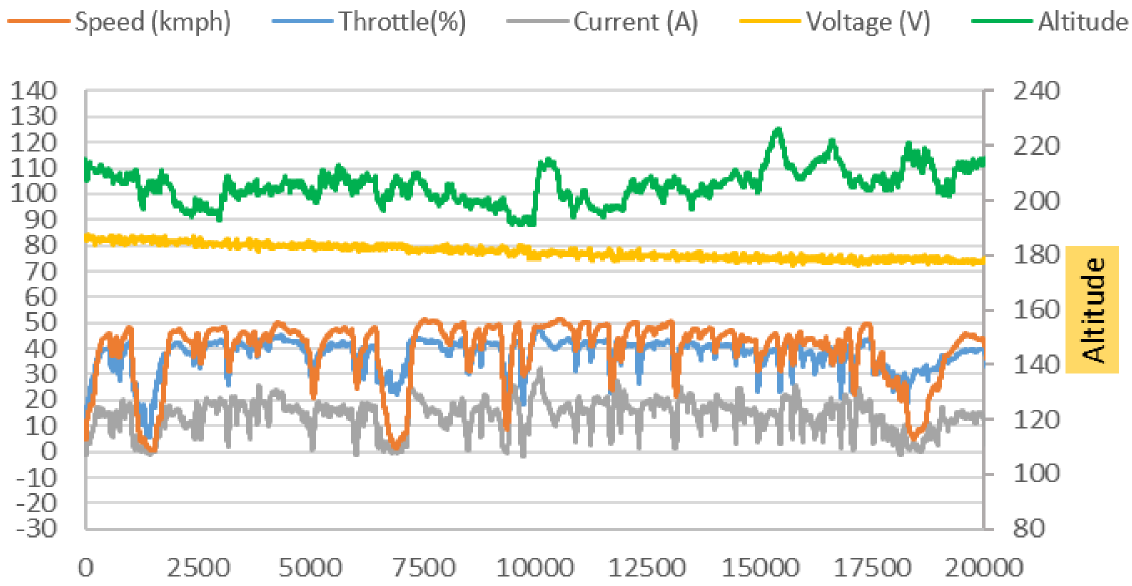

Figure 124 ***Testing Plot for 2-Wheeler Motorcycle (Solution 1)***

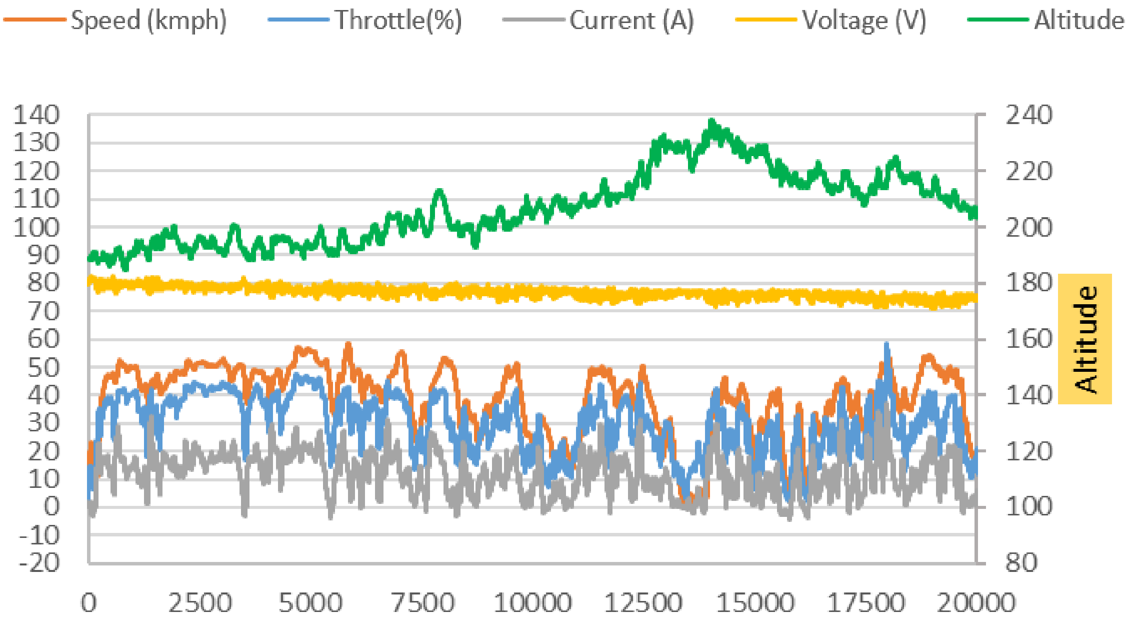

Figure 125 ***Testing Plot for 2-Wheeler Motorcycle (Solution 2)***

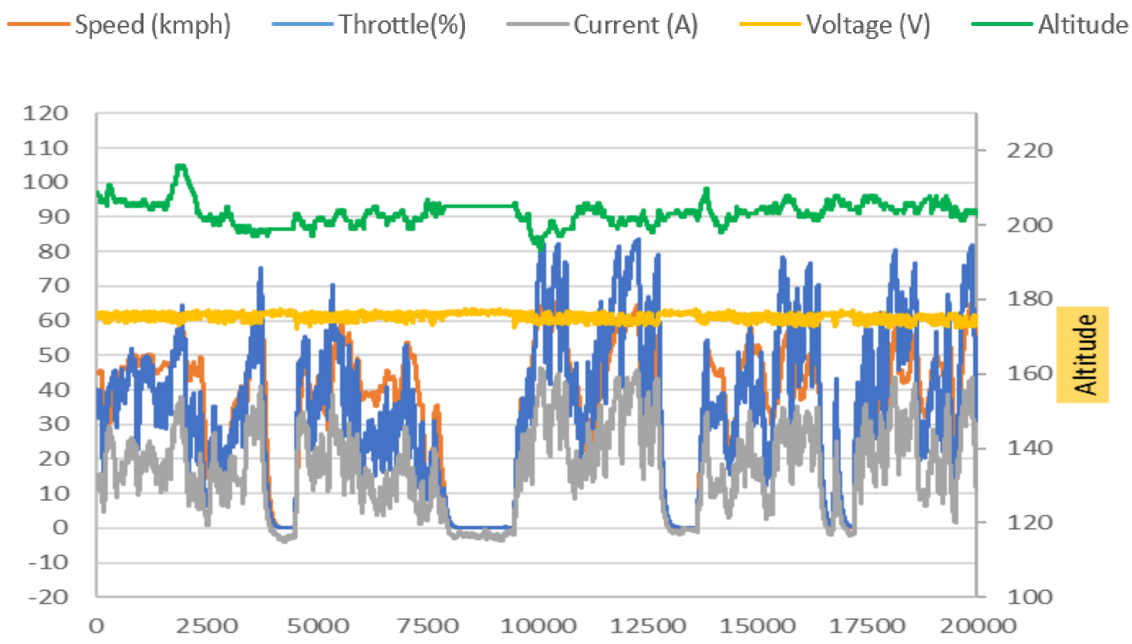

Figure 126 ***Testing Plot for 2-Wheeler Motorcycle (Solution 3)***

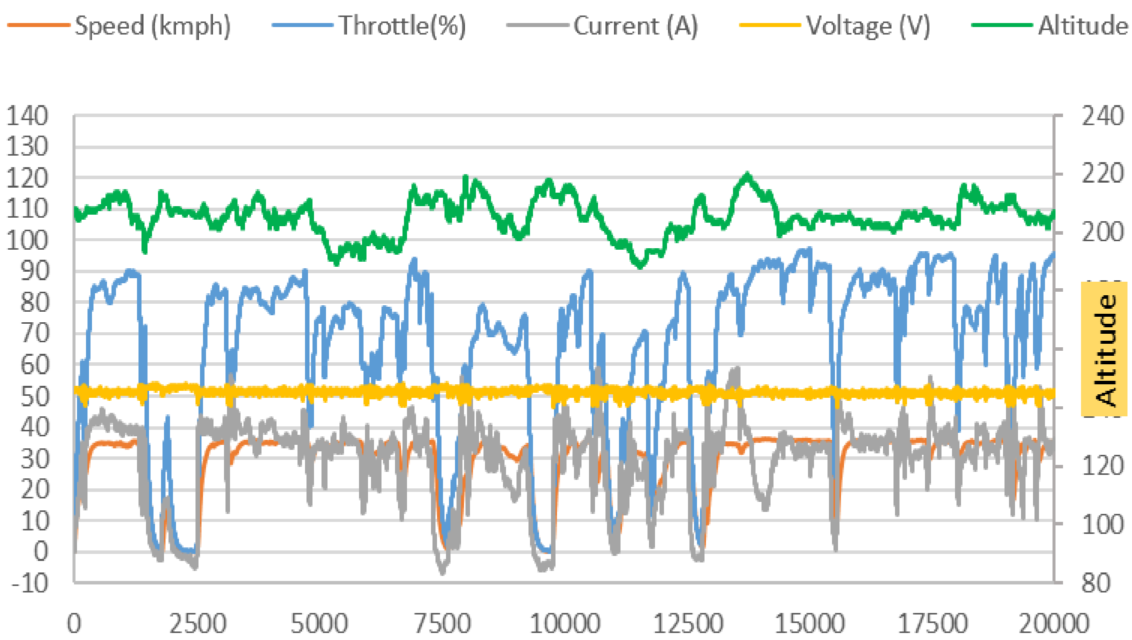

Figure 127 ***Testing Plot for 3-Wheeler Passenger (Solution 1)***

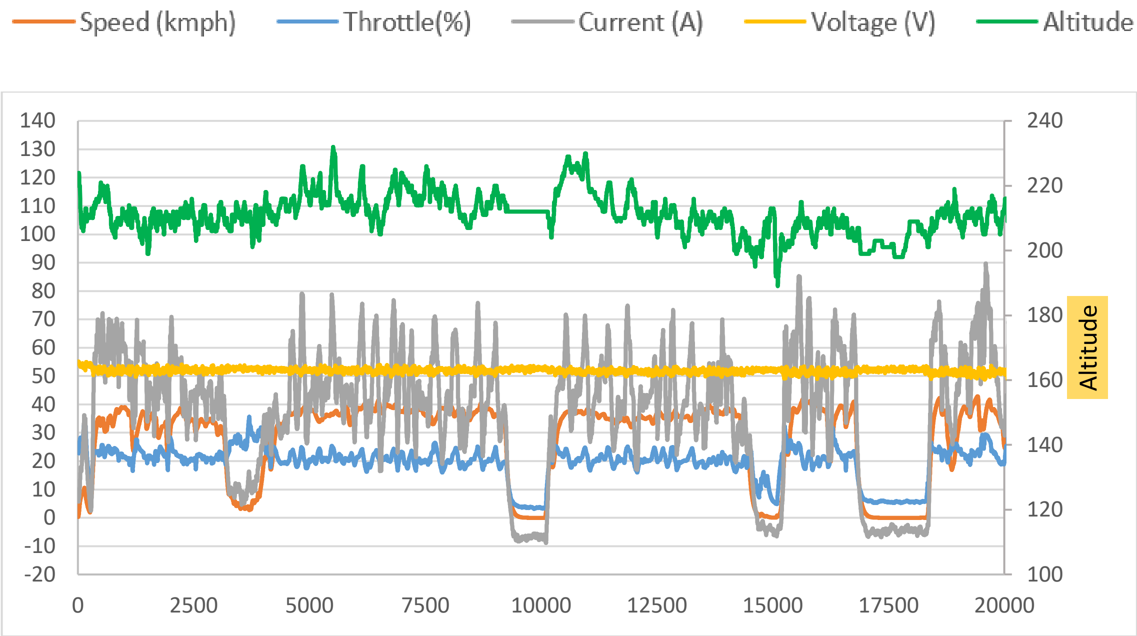

Figure 128 ***Testing Plot for 3-Wheeler Passenger (Solution 2)***

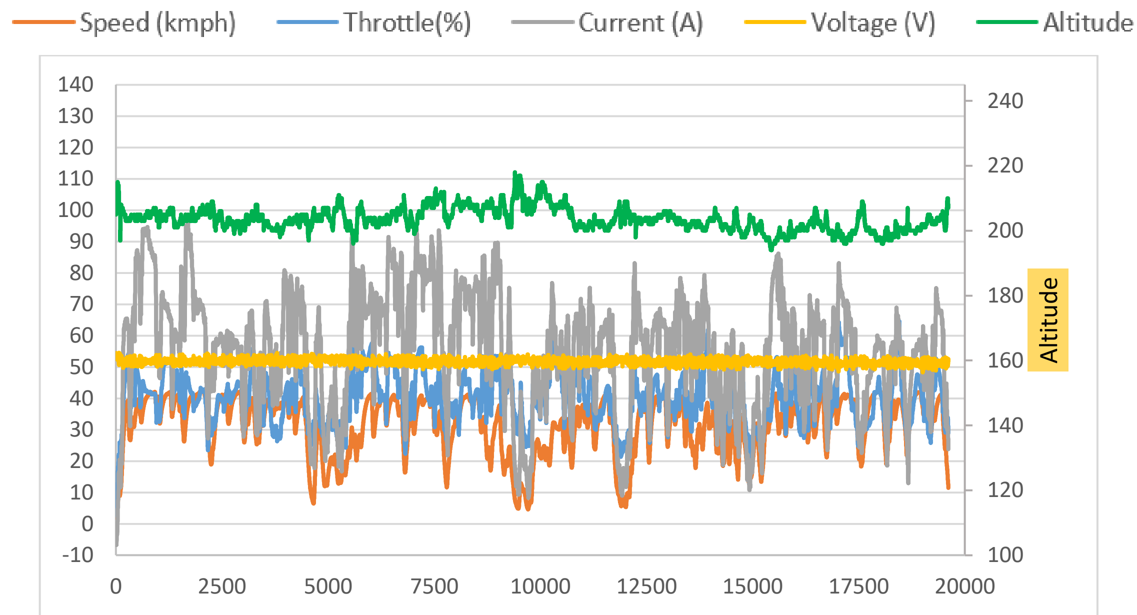

Figure 129 ***Testing Plot for 3-Wheeler Passenger (Solution 3)***

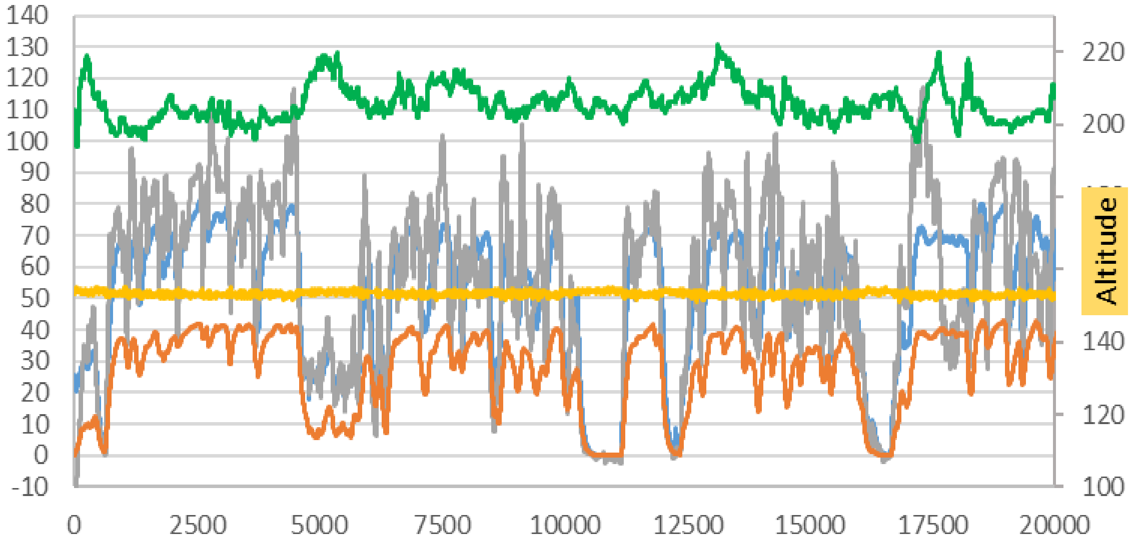

Figure 130 ***Testing Plot for 3-Wheeler Cargo (Solution 1)***

Speed (kmph) Throttle(%) Current (A) Voltage (V) Altitude

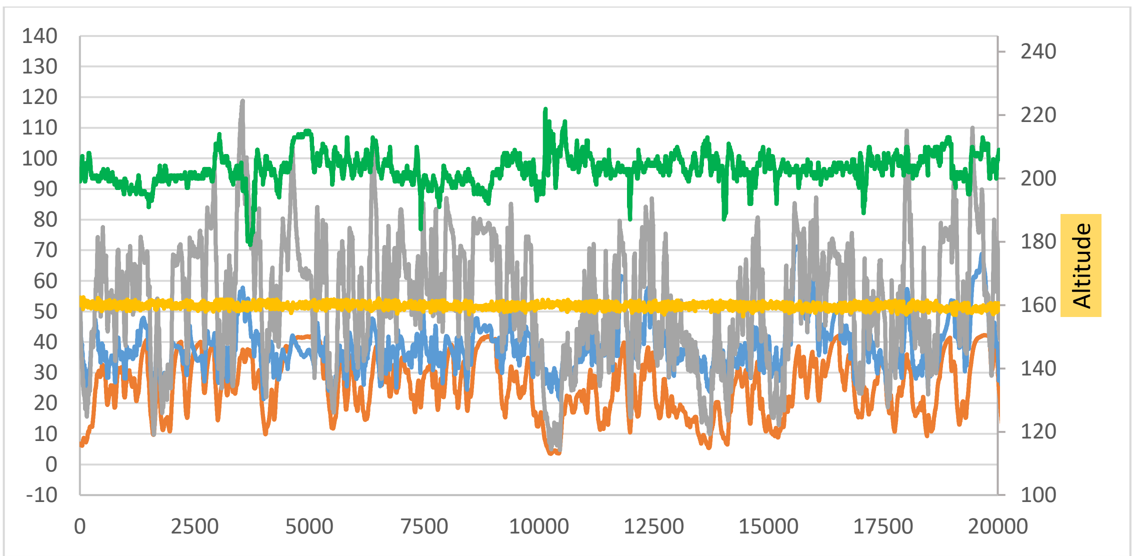

Figure 131 ***Testing Plot for 3-Wheeler Cargo (Solution 2)***

Speed (kmph) Throttle(%) Current (A) Voltage (V) Altitude

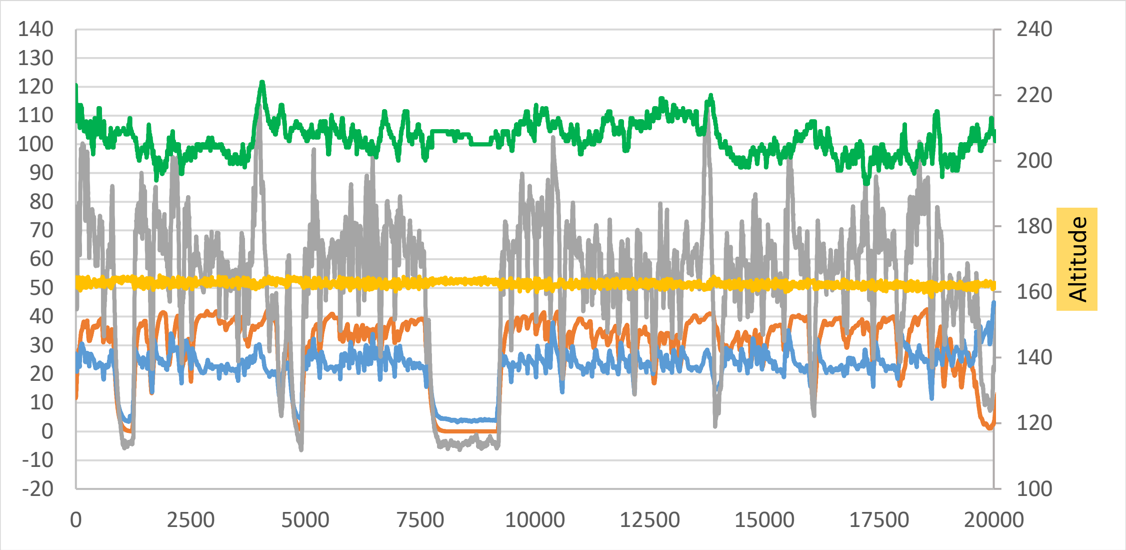

Figure 132 ***Testing Plot for 3-Wheeler Cargo (Solution 3)***

ANNEXURE 6

MILESTONE 6: EVALUATION AND RECOMMENDATION OF RETRO-FITMENT SOLUTIONS

12.1 Total Cost of Ownership (TCO)

SECTION 32

- **Total Cost of Ownership (ICE vehicle)**

2-Wheeler

Table 78 below shows the total cost of ownership if a consumer procures new 2-wheeler for his/her daily city commute. The TCO is calculated based on the current market prices and for operation of 80,000km.

Fuel Type	Category	2-Wheeler	
	Details	Splendor Motorcycle	Activa Scooter
IC-Engine Operated 2-Wheeler (Petrol)	Vehicle Initial Price	1,25,000	1,10,000
	Mileage (km)	50	35
	Petrol Price	95	95
	Vehicle Run	80000	80000
	Price (per km) = (Petrol Price/Mileage)	1.9	2.7
	Running Cost =((Price/Km) * Vehicle Run)	152000	217143
	Maintenance / Service Cost (Every 5000Km)	4200	4200
	Tyre Cost (Cost of Tyre * No. of times changed)	7600	7600
	Maintenance Cost for 80000 Km ((80000 * Maint. For 5000)/5000) (Refer Table 57 & 58)	67200	67200
	Total Cost = (Initial + Running)	**3,51,800**	**4,01,943**

Table 78 ***TCO for ICE 2-Wheeler***

3-Wheeler

Table 79 below shows the total cost of ownership if a consumer procures new 3-wheeler for his/her daily city commute. The TCO is calculated based on the current market prices and for operation of 80,000km.

Fuel Type	**Category**	**3-Wheeler**			
	Details	**Passenger (Petrol)**	**Passenger (CNG)**	**Cargo (Diesel)**	**Cargo (CNG)**
3-Wheeler (Petrol, Diesel, CNG)	Vehicle Initial Price	1,50,000	1,80,000	2,50,000	2,80,000
	Mileage (km)	30	30	25	25
	Petrol Price	95	76	89	76
	Vehicle Run	80000	80000	80000	80000
	Price (per km) = (Petrol Price/Mileage)	3.2	2.5	3.6	3.0
	Running Cost =((Price/Km) * Vehicle Run)	253333	202667	284800	243200
	Maintenance / Service Cost (Every 5000Km)	4000	4000	4000	4000
	Tyre Cost (Cost of Tyre * No. of times changed)	4800	4800	4800	4800
	Maintenance Cost for 80000 Km ((80000 * Maint. For 5000)/5000) (Refer Table 57 & 58)	64000	64000	64000	64000
	Total Cost = (Initial + Running)	**4,72,133**	**4,51,467**	**6,03,600**	**5,92,000**

Table 79 ***TCO for ICE 3-Wheeler***

- **Total Cost of Ownership (Retro-fitted vehicle)**

2-Wheeler

Table 80 below shows the total cost of ownership if a consumer retro-fits his/her old 2-wheeler with pure electric drive for his/her daily city commute. The TCO is calculated based on the current market prices and for operation of 80,000km.

Fuel Type	**Category**	**2-Wheeler**	
	Details	**Splendor Motorcycle**	**Activa Scooter**
Retro-fitted Electric Vehicle 2-Wheeler	Motor Power	2kW	2 kW
	Battery Capacity	60V 42Ah	72V 40Ah
	Battery Power (kWh)	2.52	2.88
	Charger Specs	60V 10Ah	72V 10Ah
	Kit Price	25000	27000
	Charger Price	7000	8000
	Battery Price	35000	70000
	Range (Km/charge)	60	80
	Electricity Price (per kW)	8	8
	Battery Life (KM's)	80000	80000
	Electricity Cost (per Km) =(Battery(kWh) * Electricity Price (per kW))/Range	0.34	0.29
	Total Running Cost = (Electricity Cost (per Km) * Battery Life(km))	26880	23040
	Maintenance / Service Cost (Every 5000Km)	1800	3000
	Tyre Cost (Cost of Tyre * No. of times changed)	7600	4800
	Maintenance Cost for 80000 Km ((80000 * Maint. For 5000Km)/5000) (Refer Table 57 & 58)	28800	48000
	Ownership Cost = (Running + Initial)	**1,30,280**	**1,80,840**

Table 80 ***TCO for Retro-fitted 2-Wheeler***

3-Wheeler

Table 81 below shows the total cost of ownership if a consumer retro-fits his/her old 3-wheeler with pure electric drive for his/her daily city commute/business work. The TCO is calculated based on the current market prices and for operation of 80,000km.

Fuel Type	**Category**	**3-Wheeler**		
	Details	**Passenger**	**Passenger**	**Cargo**
Retro-fitted Electric Vehicle 3-Wheeler	Motor Power	4.5kW	4.5kW	7.5kW
	Battery Capacity	48V 100Ah	48V 200Ah	48V 200Ah
	Battery Power (kWh)	4.8	9.6	9.6
	Charger Specs	48V 25Ah	48V 40Ah	48V 40Ah
	Kit Price	97000	97000	97000
	Charger Price	14000	17500	17500
	Battery Price	90000	150000	150000
	Range (Km/charge)	60	90	90
	Electricity Price (per kW)	8	8	8
	Battery Life (KM's)	80000	80000	80000
	Electricity Cost (per Km) =(Battery(kWh)*Electricity Price (per kW))/Range	0.64	0.85	0.85
	Total Running Cost = (Electricity Cost (per km) * Battery Life(km))	51200	68267	68267
	Maintenance / Service Cost (Every 5000Km)	3000	3000	3000
	Tyre Cost (Cost of Tyre * No. of times changed)	4800	4800	4800
	Maintenance Cost for 80000 Km ((80000 * Maint. For 5000Km)/5000) (Refer Table 57 & 58)	48000	48000	48000
	Ownership Cost = (Running + Initial)	**3,05,000**	**3,85,567**	**3,85,567**

Table 81 ***TCO for Retro-fitted 3-Wheeler***

- **Total Cost of Ownership (New Electric Vehicle)**

2-Wheeler

Table 82 below shows the total cost of ownership if a consumer procures a new purely electric operated 2-wheeler for his/her daily city commute. The TCO is calculated based on the current market prices and for operation of 80,000km.

Fuel Type	Category	2-Wheeler	
	Details	**Revolt Motorcycle**	**Ola Scooter**
New Electric Procured 2-Wheeler	Motor Power	3 kW	2kW
	Vehicle Initial Price	1,50,000	90,000
	Battery Power (kWh)	3.24	2
	Range (Km/charge)	80	85
	Electricity Price (per kW)	8	8
	Battery Life (KM's)	80000	80000
	Electricity Cost (per Km) =(Battery(kWh)*Electricity Price (per kW))/Range	0.32	0.19
	Total Running Cost = (Electricity Cost (per Km) * Battery Life(km))	25920	15059
	Maintenance / Service Cost (Every 5000Km)	1800	1800
	Tyre Cost (Cost of Tyre * No. of times changed)	7600	7600
	Maintenance Cost for 80000 Km ((80000 * Maint. For 5000Km)/5000) (Refer Table 57 & 58)	28800	28800
	Ownership Cost = (Running + Initial)	**2,12,320**	**1,41,459**

Table 82 ***TCO for New Electric 2-Wheeler***

3-Wheeler

Table 83 below shows the total cost of ownership if a consumer procures a new purely electric operated 3-wheeler for his/her daily city/business commute. The TCO is calculated based on the current market prices and for operation of 80,000km.

Fuel Type	Category	3-Wheeler	
	Details	**Passenger**	**Cargo**
New Electric Procured 3-Wheeler	Motor Power	4.5 kW	8.2 kW
	Vehicle Initial Price	2,20,000	4,50,000
	Battery Power (kWh)	4.5	11
	Range (Km/charge)	90	130
	Electricity Price (per kW)	8	8
	Battery Life (KM's)	80000	80000
	Electricity Cost (per Km) =(Battery(kWh)*Electricity Price (per kW))/Range	0.40	0.68
	Total Running Cost = (Electricity Cost (per Km) * Battery Life(km))	32000	54154
	Maintenance / Service Cost (Every 5000Km)	3000	3000
	Tyre Cost (Cost of Tyre * No. of times changed)	4800	4800
	Maintenance Cost for 80000 Km ((80000 * Maint. For 5000Km)/5000) (Refer Table 57 & 58)	48000	48000
	Ownership Cost = (Running + Initial)	**3,04,800**	**5,56,954**

Table 83 ***TCO for New Electric 3-Wheeler***

- **Maintenance / Service Cost Details**

Table 84 below mentions the Maintenance / Service cost incurred in all types of 2-wheeler and 3-wheeler over a period of 5000 km. The costs are considered based on current market charges and may vary in future.

	Petrol	**Petrol / CNG**	**Electric**	
Maintenance Cost	**2-Wheeler**	**3-Wheeler**	**2-wheeler**	**3-wheeler**
Brake Service	400	750	400	750
Engine Oil	400	450	0	0
Greasing/Lubrication	200	400	0	400
Total Cost	1,000	1,600	400	1,150
Service due Km	1200	2000	1200	2000
Service Cost for 5000 Km	4166.66	4000	1666.66	2875

Table 84 ***Service cost of All types of 2-Wheeler & 3-Wheeler***

Table 85 below mentions the cost incurred for change of tyres for All types of 2-wheeler & 3-wheeler over a period of 80000 km drive

Tyre Life (Km)	**Vehicle**	**Tyre Cost**	**Total KM's**	**No. of times Changed**	**Final Cost**
20000	2-Wheeler	1900	80000	4	7600
40000	3-Wheeler	2400	80000	2	4800

Table 85 ***Service cost related to Tyres of All Types of 2-Wheeler & 3-Wheeler***

- **Summary**

Table 86 and ***Table 87*** below mentions the summary of TCO comparison.

The resale value of a 2W and 3W are considered on current market survey and same costs are included in total cost of ownership for retro-fitted vehicle's total cost of ownership over a period of 80000kms.

Category	**Resale Value (10 yrs. old Good Condition)**	**I.C Engine Vehicle**	**Retro-fitted Vehicle (Including Resale Value)**	**New Electric**
Splendor	30,000	3,51,800	1,30,280	2,12,320
Activa	25,000	4,01,943	1,80,840	1,41,459

Table 86 ***TCO Comparison for 2-Wheeler Category***

Category	**Resale Value (10 yrs. old Good Condition)**	**Fuel Types**			**Retro-fitted Vehicle (Including Resale Value)**	**New Electric**
		Petrol	**Diesel**	**CNG**		
Passenger	90,000	4,72,133	NA	4,51,467	3,05,000 (100Ah) 3,85,567 (200 Ah)	3,04,800
Cargo	1,20,000	NA	6,03,600	5,92,000	3,85,567	5,56,954

Table 87 ***TCO Comparison for 3-Wheeler Category***

ANNEXURE 7

The procedure to calculate various parameter values of power, speed, range, etc. from the raw data collected during run trials, as covered in 5.1 to 5.4, is discussed in ANNEXURE 1.

Procedure:

A. Data for 2W scooter solution 1 is taken as reference to demonstrate the procedure. The format (Message_Report) in which raw data was logged during running of the vehicle is shown in Figure 133.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Q	R	S	
1		Time	Coordinates	Location	Speed, kn	Igniti	Altitud	Throt	Curre	Amp	Voltag	Pow	Op pow	1.2 to				
11931	11930	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0				
11932	11931	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Parameter	Speed	Pov
11933	11932	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Max	47	
11934	11933	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0		Average	25.13	
11935	11934	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11936	11935	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11937	11936	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11938	11937	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11939	11938	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11943	11942	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	798.0	2519.0	1.08	16347.0	0.09	0.08	0.0				
11944	11943	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	798.0	2519.0	1.08	16347.0	0.09	0.08	0.0				
11945	11944	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	856.0	2512.0	0.24	16259.0	0.02	0.02	0.0				
11946	11945	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	827.0	2468.0	-5.06	16303.0	-0.43	-0.39	0.0				
11947	11946	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	856.0	2512.0	0.24	16259.0	0.02	0.02	0.0				
11948	11947	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	827.0	2468.0	-5.06	16303.0	-0.43	-0.39	0.0				
11949	11948	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	856.0	2512.0	0.24	16259.0	0.02	0.02	0.0				
11950	11949	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0				
11951	11950	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	827.0	2468.0	-5.06	16303.0	-0.43	-0.39	0.0				
11952	11951	2024-02-14 09:23:06	28.751760, 77.205	Radhe Sham Tyag	6	1.0	95.0	798.0	2519.0	1.08	16347.0	0.09	0.08	0.0				
11953	11952	2024-02-14 09:23:06	28.751760, 77.205	Radhe Sham Tyag	3	1.0	95.0	805.0	2512.0	0.24	16289.0	0.02	0.02	0.0				
11954	11953	2024-02-14 09:23:06	28.751760, 77.205	Radhe Sham Tyag	3	1.0	95.0	849.0	2512.0	0.24	16296.0	0.02	0.02	0.0				
11955	11954	2024-02-14 09:23:07	28.751761, 77.205	Radhe Sham Tyag	3	1.0	96.0	886.0	2365.0	-17.47	16289.0	-1.49	-1.34	0.0				
11956	11955	2024-02-14 09:23:07	28.751761, 77.205	Radhe Sham Tyag	3	1.0	96.0	886.0	2365.0	-17.47	16289.0	-1.49	-1.34	0.0				
11957	11956	2024-02-14 09:23:07	28.751761, 77.205	Radhe Sham Tyag	3	1.0	96.0	842.0	2512.0	0.24	16179.0	0.02	0.02	0.0				
11958	11957	2024-02-14 09:23:07	28.751761, 77.205	Radhe Sham Tyag	3	1.0	96.0	842.0	2512.0	0.24	16179.0	0.02	0.02	0.0				
11959	11958	2024-02-14 09:23:07	28.751761, 77.205	Radhe Sham Tyag	3	1.0	96.0	739.0	2512.0	0.24	16442.0	0.02	0.02	0.0				
11960	11959	2024-02-14 09:23:07	28.751761, 77.205	Radhe Sham Tyag	3	1.0	96.0	739.0	2512.0	0.24	16442.0	0.02	0.02	0.0				
11961	11960	2024-02-14 09:23:07	28.751761, 77.205	Radhe Sham Tyag	3	1.0	96.0	856.0	2534.0	2.89	16245.0	0.25	0.22	0.0				

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Figure 133 ***Format of data logging***

- Starting from the left of Figure, second column contains the date and time values.
- Third column contains the geographic coordinates traced at a particular instance of time.
- Fourth column has the location name corresponding to geographic coordinate.
- The speed values are stored in column number 5. These values are in kmph.
- The vehicle ignition status is recorded in column number 6. Here, 1 stands for 'ON' while 0 corresponds to 'OFF' state of the vehicle.
- The altitude at a specific location is stored in column number 7. These values show the height of a particular point above mean sea level in meters (m).
- The throttle value recorded from the vehicle is stored in column number 8. These values are in mV. Throttle values range from 0.85 to 4.25V with the lower value corresponding to 0% throttle, whereas, 4.25V corresponds to 100%.
- The current values obtained from the current sensor are stored in column 9 in mV. Current values are as discussed in 3.8.3.1.
- Column number 10 stores the voltage values in mV. These values are stored at 1/5th of the actual value, as discussed in 3.8.3.3

B. Based on these raw values the various parameter values are calculated as:

1. Current

J11931 =IF((I11931/1000)<1.5,0,((I11931/1000)-2.5)/0.0083)

1	A	Time	Coordinates	Location	Speed, kn	Igniti	Altitud	Throt	Curre	Amp	Voltag	Pow	Op pow	1.2 to	Q	R	S	Po
11931	11930	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	[illegible]	15.54	16208.0	1.26	1.13	0.0				
11932	11931	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Parameter	Speed	Po
11933	11932	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Max	47	
11934	11933	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0		Average	25.13	
11935	11934	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11936	11935	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11937	11936	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11938	11937	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				

Figure 134 ***Calculation of current values***

The current values are recorded in mV, as discussed in 3.8.3.1. To convert these values to Amperes, we apply the formula as shown in Figure 134. The 'IF' condition is applied to negate any fluctuations of the current sensor. The raw value obtained in mV is divided by 1000 to convert it to V. Then this value is subtracted from 2.5 which is the base value of the current sensor. This gives us the change in current or delta in terms of voltage. This *delta* is then divided by 0.0083, which is the voltage value corresponding to per Ampere of current. The final value obtained is the current value through the sensor in Ampere.

2. Power

L11931 =IF(E11931=0,0,IF((I11931/1000)<1.5,0,((((I11931/1000)-2.5)/0.0083)*(K11931/1000)*5)/1000))

1	A	Time	Coordinates	Location	Speed, kn	Igniti	Altitud	Throt	Curre	Amp	Voltag	Pow	Op pow	1.2 to	Q	R	S	Pov
11931	11930	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0				
11932	11931	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Parameter	Speed	Pov
11933	11932	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Max	47	
11934	11933	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0		Average	25.13	
11935	11934	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11936	11935	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11937	11936	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11938	11937	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11939	11938	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11943	11942	2024-02-14 09:23:05	28.751759, 77.205	Radhe Sham Tyag	6	1.0	93.0	798.0	2519.0	1.08	16347.0	0.09	0.08	0.0				

Figure 135 ***Calculation of Electrical Power Consumed by Motor***

The power here refers to the electrical power consumed by the motor against that demand by the driver. Power, in electrical terms, is the product of voltage and current. As seen in Figure 135, the power is calculated for speed values greater than 0. The raw voltage value obtained is a reduction by a factor of 5 of the actual value, as discussed in 3.8.3.3. Power is obtained as a product of the current and voltage values. To convert the power to kW, it is divided by 1000.

3. Output Power

M11931 =0.9*L11931

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Q	R	S	
1		Time	Coordinates	Location	Speed, kn	Igniti	Altitud	Throt	Curre	Amp	Voltag	Pow	Op pow	1.2 to				
11931	11930	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0				
11932	11931	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Parameter	Speed	Pov
11933	11932	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Max	47	
11934	11933	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0		Average	25.13	
11935	11934	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11936	11935	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11937	11936	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				

Figure 136 ***Estimation of Output Power***

The output power is estimated from the input power by considering an efficiency of 90%, which is practical in electric drives used in traction applications.

4. Duty cycle

N11931 =IF(AND(M11931>1.2,M11931<2.3),1,0)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Q	R	S	
1		Time	Coordinates	Location	Speed, kn	Igniti	Altitud	Throt	Curre	Amp	Voltag	Pow	Op pow	1.2 to				
11931	11930	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0				
11932	11931	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Parameter	Speed	Po
11933	11932	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0		Max	47	
11934	11933	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0		Average	25.13	
11935	11934	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11936	11935	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0				
11937	11936	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11938	11937	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				
11939	11938	2024-02-14 09:23:04	28.751747, 77.204	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0				

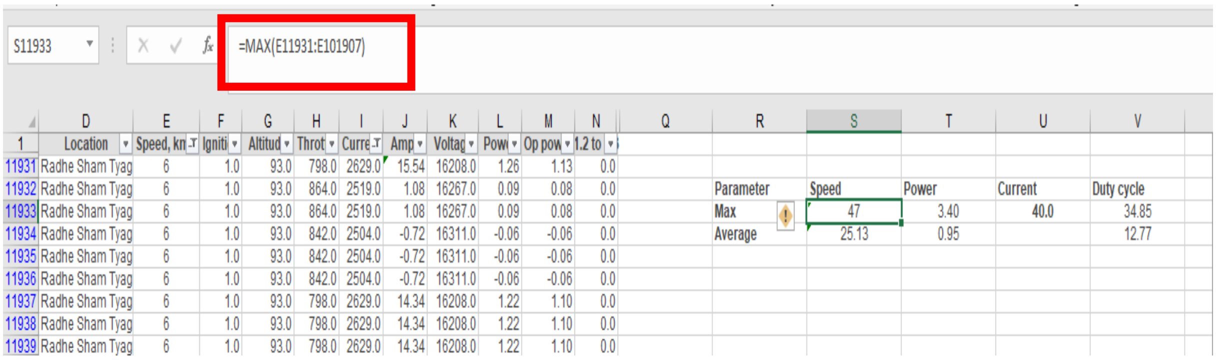
Figure 137 ***Calculation of Duty Cycle of Rated Power***

In the last column, an ‘IF’ condition is implemented to factor in the values above *rated power* for calculation of duty cycle. Value 1 would be returned for a true condition, i.e. for power values above the rated power, while 0 would be returned otherwise.

5. Deduced values

After calculating the instantaneous values for current and power, the peak and average values were deduced for each trial run. For trial runs of vehicle, more than once a day, the values were noted separately for each run. Each run is defined as a round trip from the starting location (where vehicles were parked) to the landmarked location and back.

- For speed, the Maximum and Average values were deduced for the data range of trial as shown in Figure 138Figure 139resp. Basic Microsoft Excel formulae were used for these calculations.

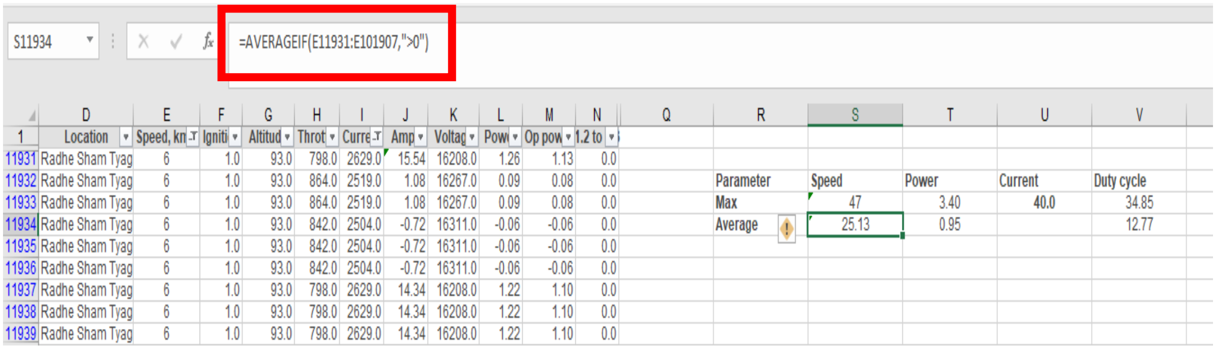


S11933 | =MAX(E11931:E101907)

1	Location	Speed, km	Igniti	Altitud	Throt	Curre	Amp	Voltag	Pow	Op pow	1.2 to
11931	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0
11932	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11933	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11934	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11935	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11936	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11937	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11938	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11939	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0

Parameter	Speed	Power	Current	Duty cycle
Max	47	3.40	40.0	34.85
Average	25.13	0.95		12.77

Figure 138 ***Deduced Maximum Speed for Trial Run***



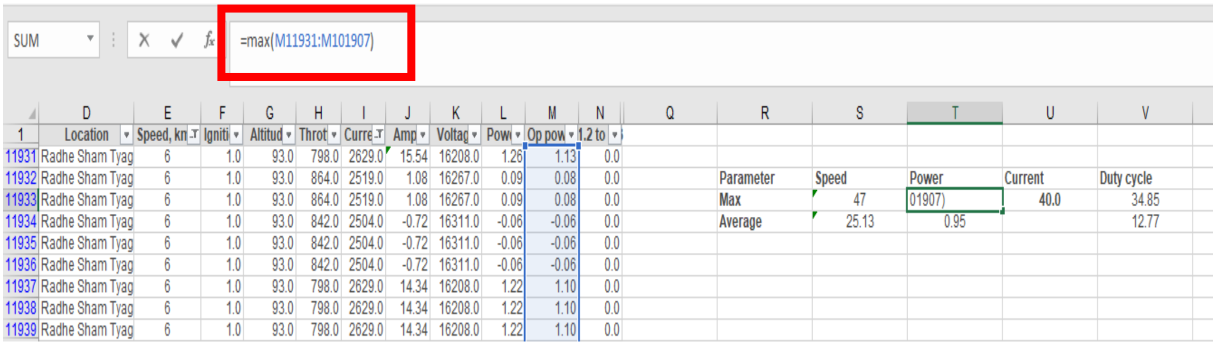
S11934 | =AVERAGEIF(E11931:E101907,">0")

1	Location	Speed, km	Igniti	Altitud	Throt	Curre	Amp	Voltag	Pow	Op pow	1.2 to
11931	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0
11932	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11933	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11934	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11935	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11936	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11937	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11938	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11939	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0

Parameter	Speed	Power	Current	Duty cycle
Max	47	3.40	40.0	34.85
Average	25.13	0.95		12.77

Figure 139 ***Deduced Average Speed for Trial Run***

- Similarly, both the values for power were deduced as shown in Figure 140Figure 141.

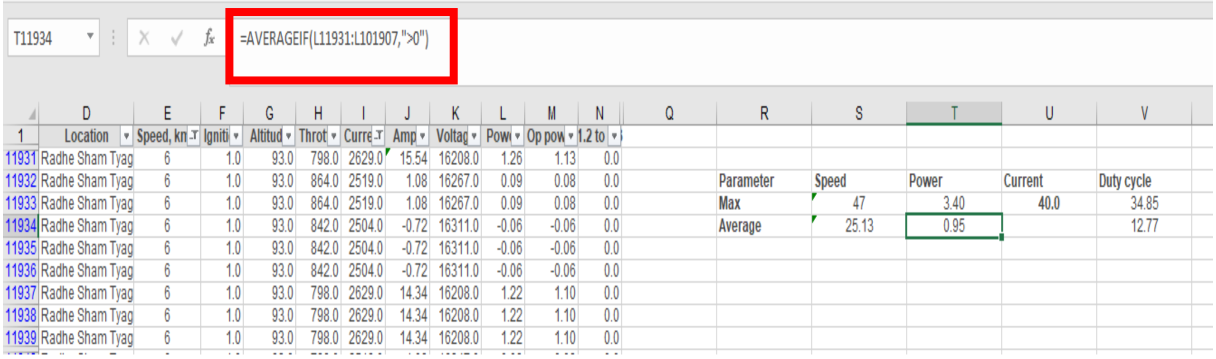


SUM | =max(M11931:M101907)

1	Location	Speed, km	Igniti	Altitud	Throt	Curre	Amp	Voltag	Pow	Op pow	1.2 to
11931	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0
11932	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11933	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11934	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11935	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11936	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11937	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11938	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11939	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0

Parameter	Speed	Power	Current	Duty cycle
Max	47	01907)	40.0	34.85
Average	25.13	0.95		12.77

Figure 140 ***Deduced Maximum Power for Trial Run***



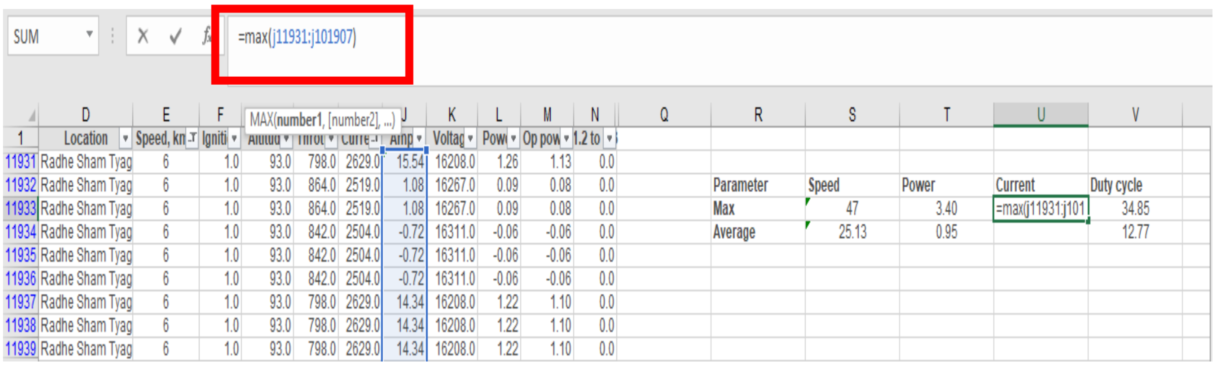
T11934 | =AVERAGEIF(L11931:L101907,">0")

	D Location	E Speed, km	F Igniti	G Altitud	H Throt	I Curre	J Amp	K Voltag	L Pow	M Op pow	N 1.2 to
11931	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0
11932	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11933	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11934	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11935	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11936	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11937	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11938	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11939	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0

Parameter	Speed	Power	Current	Duty cycle
Max	47	3.40	40.0	34.85
Average	25.13	0.95		12.77

Figure 141 ***Deduced Average Power for Trial Run***

- Maximum value of current was deduced for the data range as shown in Figure 142.



SUM | =max(j11931:j101907)

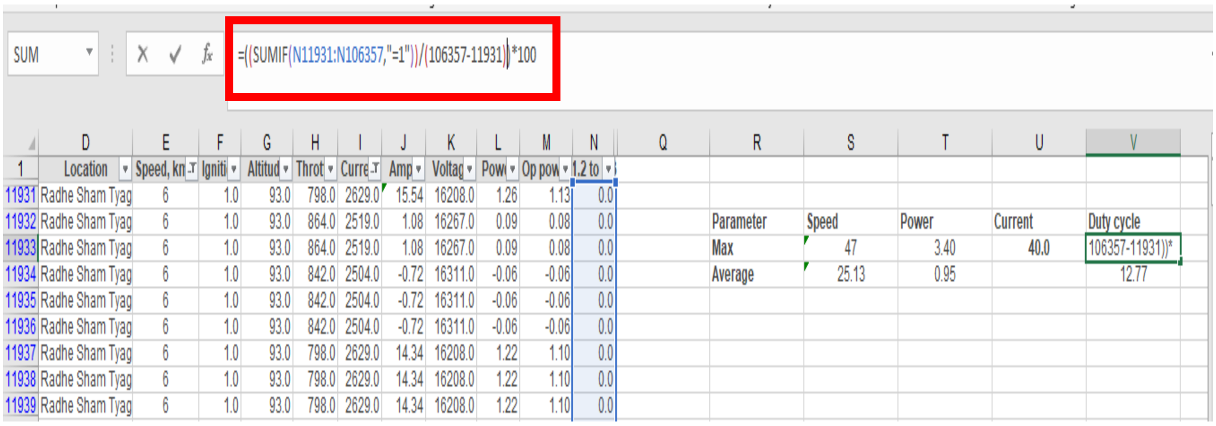
MAX(number1, [number2], ...)

	D Location	E Speed, km	F Igniti	G Altitud	H Throt	I Curre	J Amp	K Voltag	L Pow	M Op pow	N 1.2 to
11931	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0
11932	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11933	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11934	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11935	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11936	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11937	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11938	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11939	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0

Parameter	Speed	Power	Current	Duty cycle
Max	47	3.40	=max(j11931:j101	34.85
Average	25.13	0.95		12.77

Figure 142 ***Deduced Maximum Current for Trial Run***

- The duty cycle of peak power as a percentage of total values captured is calculated as shown in Figure 143. The values corresponding to the value 1 in the last column of the table, discussed in point number 4 above, are summed and divided by the total number of instances of the trial run. This gives us the duty cycle as a percentage.



SUM | =((SUMIF(N11931:N106357,"=1"))/(106357-11931))*100

	D Location	E Speed, km	F Igniti	G Altitud	H Throt	I Curre	J Amp	K Voltag	L Pow	M Op pow	N 1.2 to
11931	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	15.54	16208.0	1.26	1.13	0.0
11932	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11933	Radhe Sham Tyag	6	1.0	93.0	864.0	2519.0	1.08	16267.0	0.09	0.08	0.0
11934	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11935	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11936	Radhe Sham Tyag	6	1.0	93.0	842.0	2504.0	-0.72	16311.0	-0.06	-0.06	0.0
11937	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11938	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0
11939	Radhe Sham Tyag	6	1.0	93.0	798.0	2629.0	14.34	16208.0	1.22	1.10	0.0

Parameter	Speed	Power	Current	Duty cycle
Max	47	3.40	40.0	106357-11931))*
Average	25.13	0.95		12.77

Figure 143 ***Deduced Duty Cycle for Trial Run***

C. Summary of records for entire test duration

1. Above deduced parameters for each day are summarized in a sheet as shown in Figure 144

	Data Summary for 2W Scooter Solution 1(Activa GoGoA1)													
	Vehicle	Date	Loading Condition	Speed(kmph)		Power(kW)		Output Power (kW)	Max Current	Duty Cycle of Max Power (%)	Distance Covered	Change in SoC		Estimated Range
				Max	Averag	Max	Average	90% ef	A	1.2 to 2	(km)	Start	End	(100 - 20
	Activa GoGoA1	12.02.24	L	43	33	3.35	1.09	3.02		14.32	90	99	34	110.77
	Rated - 1.2 kW	13.02.24	NL	44	28	3.32	1.13	2.99		20.72	93	98	32	112.73
	Peak - 2 kW	14.02.24	NL								99	98	0	80.82
		15.02.24	NL	46	30	3.23	0.85	2.91		12.67	85	100	40	113.33
		16.02.24	NL	44	31	3.37	0.98	3.03		17.47	80	100	41	108.47
		17.02.24	NL	47	32	3.31	0.9	2.98		13.89	86	100	39	112.79

Figure 144 ***Data Summary of Parameter Values***

2. Besides the parameters discussed above, range is estimated in the summary sheet from the logged values of distance and SoC. The range is estimated considering 80% depth of discharge (DoD) of the battery.

P5 | =(M5*80)/(N5-O5)

	A	B	C	D	E	F	G	H	I	J	K	M	N	O	P
1															
2		Data Summary for 2W Scooter Solution 1(Activa GoGoA1)													
3		Vehicle	Date	Loading Condition	Speed(kmph)		Power(kW)		Output Power (kW)	Max Current	Duty Cycle of Max Power (%)	Distance Covered	Change in SoC		Estimated Range
4					Max	Averag	Max	Average	90% ef	A	1.2 to 2	(km)	Start	End	(100 - 20
5		Activa GoGoA1	12.02.24	L	43	33	3.35	1.09	3.02		14.32	90	99	34	110.77
6		Rated - 1.2 kW	13.02.24	NL	44	28	3.32	1.13	2.99		20.72	93	98	32	112.73
7		Peak - 2 kW	14.02.24	NL								99	98	0	80.82
8			15.02.24	NL	46	30	3.23	0.85	2.91		12.67	85	100	40	113.33

Figure 145 ***Range Estimation for Trial Run***

The formula for range estimation is implemented as shown in Figure 145. Basic *interpolation* formula was used in this regard. The loading condition for the test run is also mentioned in the summary.

After summarizing values for entire test duration of a vehicle, the final deductions for the solution are drawn for both the loading conditions of the vehicle. The final summarized values are as discussed in section 5.

ANNEXURE 8

The procedure to generate data plots as covered in 5.5, is discussed in ANNEXURE 2.

Procedure:

The data plots were obtained from the raw data logged in Message_Report as discussed in ANNEXURE 1. The current and voltage values were calculated as discussed in ANNEXURE 1. Additionally, just the throttle values had to be calculated as a percentage. The same is shown in Figure 146.

I4 `=MIN(100,IF((((H4/1000)-0.85)/(4.25-0.85)*100)>0,((H4/1000)-0.85)/(4.25-0.85)*100,0))`

	A	B	C	D	E	F	G	H	I	J	K	L	M	T	U	V	W	X
1							227.0				82.00							
2	№	Time	Coordinates	Location	Speed, km/	io_1	Altitude	io_9	Throttle(%)	io_10	Current(A)	io_11	Voltage (V)		Speed	Throttle	Current	
3															#N/A	#N/A	#N/A	
4		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1289	12.91	2468	-3.86	12150	60.75		5	12.91	-3.86	
5		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1384	15.71	2504	0.48	12106	60.53		5	12.95368	-3.79036	
6		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1384	15.71	2504	0.48	12106	60.53		5	12.99496	-3.72628	
7		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1384	15.71	2504	0.48	12106	60.53		5	13.03562	-3.66315	
8		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1311	13.56	2490	-1.20	12150	60.75		5	13.04347	-3.62628	
9		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1311	13.56	2490	-1.20	12150	60.75		5	13.0512	-3.58996	
10		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1076	6.65	2468	-3.86	12333	61.67		5	12.95514	-3.59394	
11		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1311	13.56	2490	-1.20	12150	60.75		5	12.96419	-3.5581	
12		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	0.0	1.0	217	1032	5.35	2475	-3.01	12099	60.50		4.925	12.85003	-3.54991	
13		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1076	6.65	2468	-3.86	12333	61.67		4.926125	12.75698	-3.55449	
14		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1076	6.65	2468	-3.86	12333	61.67		4.92723313	12.66533	-3.55901	
15		2024-06-14 16:09:14	28.751749	Radhe Sham Tya	5.0	1.0	217	1076	6.65	2468	-3.86	12333	61.67		4.92832463	12.57506	-3.56345	
16		2024-06-14 16:09:15	28.751753	Radhe Sham Tya	5.0	1.0	217	1289	12.91	2468	-3.86	12150	60.75		4.92939976	12.58011	-3.56783	
17		2024-06-14 16:09:15	28.751753	Radhe Sham Tya	3.0	1.0	217	1318	13.76	2468	-3.86	12165	60.83		4.90045876	12.59788	-3.57215	
18		2024-06-14 16:09:15	28.751753	Radhe Sham Tya	3.0	1.0	217	1318	13.76	2468	-3.86	12165	60.83		4.87195188	12.61538	-3.5764	
19		2024-06-14 16:09:15	28.751753	Radhe Sham Tya	3.0	1.0	217	1318	13.76	2468	-3.86	12165	60.83		4.8438726	12.63262	-3.58058	
20		2024-06-14 16:09:15	28.751753	Radhe Sham Tya	3.0	1.0	217	1311	13.56	2585	10.24	12114	60.57		4.81621451	12.64651	-3.37326	
21		2024-06-14 16:09:15	28.751753	Radhe Sham Tya	3.0	1.0	217	1311	13.56	2585	10.24	12114	60.57		4.7889713	12.6602	-3.16905	

Figure 146 ***Calculation of Parameter Values for Data Plots***

As discussed in ANNEXURE 1, the throttle values range from 0.85 to 4.25 V. So, using percentage formula the percentage of throttle is calculated as:

$$\% = \frac{x - x_1}{x_2 - x_1} * 100$$

where,
x = instantaneous value
x_1 = lower value of range, i.e. 0.85
x_2 = higher value of range, i.e. 4.25

The 'MIN' function is used to negate voltage fluctuations above the higher value of the range, while the 'IF' condition is used against the values below the lower range.

Having calculated the values for throttle, current and voltage, their respective values are smoothened using exponential smoothening from the data analysis section of *Data* tab. This is done to smoothen the data plots as the plots without being smoothened look haphazard because the data values are subject to change at each instance of time. The smoothening procedure is displayed in Figure 147

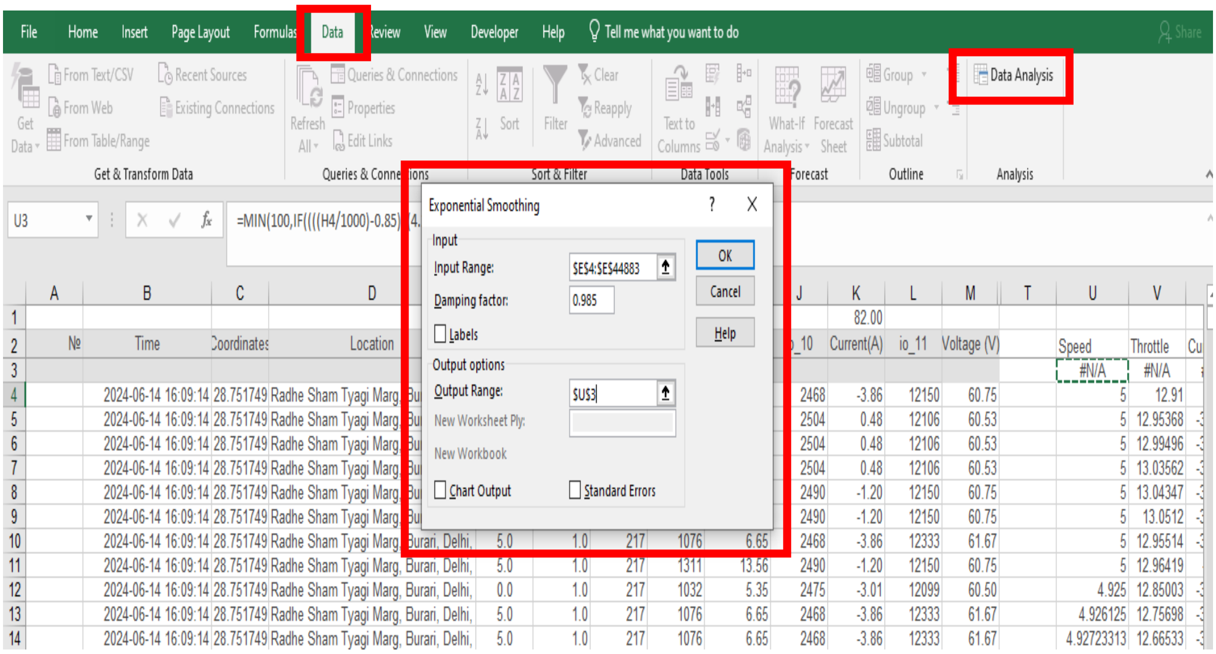


Figure 147 ***Data Smoothening Procedure***

The smoothened values are then plotted using the line/area charts. The details of the plots are as displayed in Figure 148:

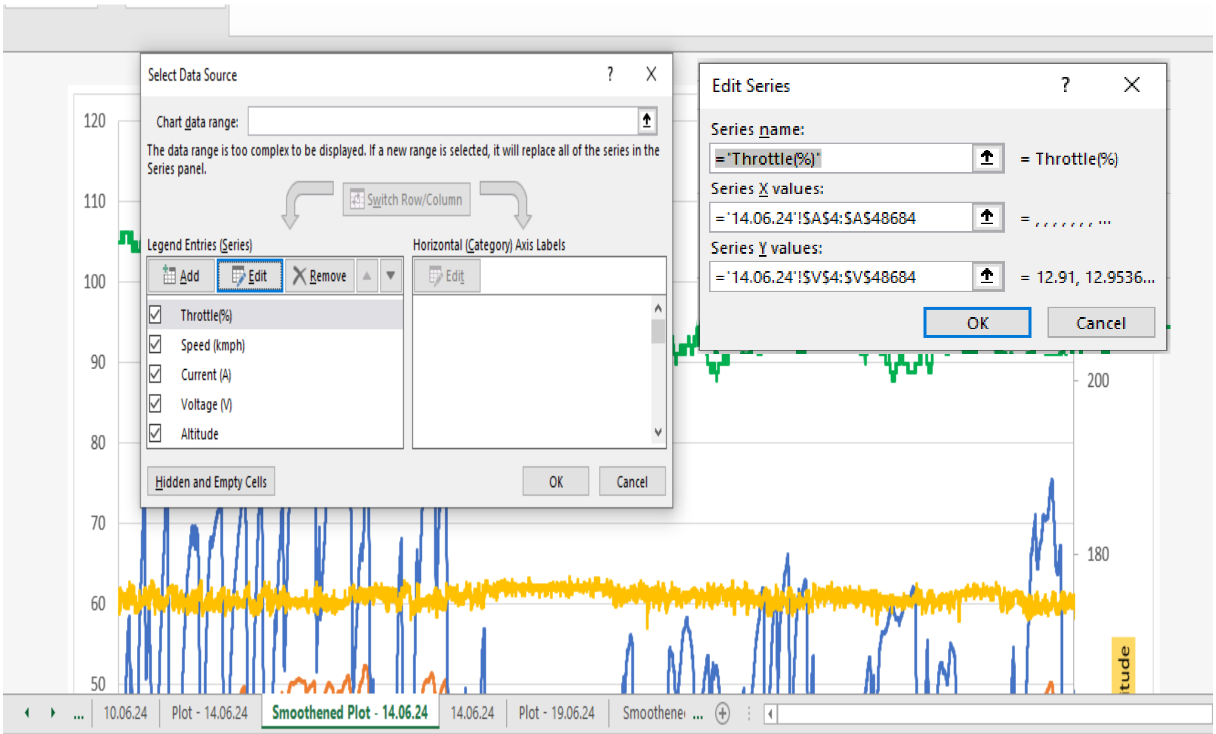


Figure 148 ***Plotting Data Charts***

The series X values contain number of instances to be plot while the series Y values contain the smoothened values. Of the five parameters, altitude is plotted on the secondary vertical axis. The smoothened plot is displayed in *Figure 148*.

ANNEXURE 9

KIT DETERIORATION:

The kit performance for each vehicle was compared over the initial and final phase of testing to find out change in performance. The parameters used for comparison of performance included peak power (loaded condition), range (loaded condition), change in battery temperature over a test trial and charging duration.

2-Wheeler Scooter:

	Test Phase	Test Data - Initial Phase	Test Data - End Phase
2-Wheeler Scooter Solution 1	Peak Power (kW)	3.37	3.42
	Range (km)	98.44	97.61
	Change in Temperature (°C)	5.76	6.02
	Charging Time	4H 24 Min	4 H 27 Min

Table 88 ***Performance Data over time for 2-Wheeler Scooter Solution-1***

	Test Phase	Test Data - Initial Phase	Test Data - End Phase
2-Wheeler Scooter Solution 2	Peak Power (kW)	3.71	3.63
	Range (km)	82.7	81.01
	Change in Temperature (°C)	7.94	8.62
	Charging Time	4 H 25 Min	4 H 28 Min

Table 89 ***Performance Data over time for 2-Wheeler Scooter Solution-2***

	Test Phase	Test Data - Initial Phase	Test Data - End Phase
2-Wheeler Scooter Solution 3	Peak Power (kW)	3.42	3.2
	Range (km)	57.32	56.21
	Change in Temperature (°C)	9.2	10.3
	Charging Time	6H 37 Min	6 H 39 Min

Table 90 ***Performance Data over time for 2-Wheeler Scooter Solution-3***

2-Wheeler Motorcycle:

2-Wheeler Motor-cycle Solution 1	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	4.01	3.89
	Range (km)	83.75	83.26
	Change in Temperature (°C)	5.2	6.1
	Charging Time	4.01	3.89

Table 91 ***Performance Data over time for 2-Wheeler Motorcycle Solution-1***

2-Wheeler Motor-cycle Solution 2	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	6.17	6.05
	Range (km)	79	77
	Change in Temperature (°C)	7.6	8.1
	Charging Time	4H 22 Min	4 H 26 Min

Table 92 ***Performance Data over time for 2-Wheeler Motorcycle Solution-2***

2-Wheeler Motor-cycle Solution 3	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	3.92	3.85
	Range (km)	54.9	53.7
	Change in Temperature (°C)	9.3	10.2
	Charging Time	6H 35 Min	6 H 38 Min

Table 93 ***Performance Data over time for 2-Wheeler Motorcycle Solution-3***

3-Wheeler Passenger:

3-Wheeler Passenger Solution 1	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	6.35	6.27
	Range (km)	63.8	63.4
	Change in Temperature (°C)	8.7	9.2
	Charging Time	4H 22 Min	4 H 33 Min

Table 94 ***Performance Data over time for 3-Wheeler Passenger Solution-1***

3-Wheeler Passenger Solution 2	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	7.08	6.86
	Range (km)	99.78	98.03
	Change in Temperature (°C)	7.6	8.1
	Charging Time	4 H 51 Min	4 H 52 Min

Table 95 ***Performance Data over time for 3-Wheeler Passenger Solution-2***

3-Wheeler Passenger Solution 3	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	7.02	6.82
	Range (km)	89.7	86.2
	Change in Temperature (°C)	9.3	9.8
	Charging Time	4H 50 Min	4 H 53 Min

Table 96 ***Performance Data over time for 3-Wheeler Passenger Solution-3***

3-Wheeler Cargo:

3-Wheeler Cargo Solution 1	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	5.97	6.09
	Range (km)	79.07	78.50
	Change in Temperature (°C)	8.04	9.22
	Charging Time	4 H 38 Min	4 H 43 Min

Table 97 ***Performance Data over time for 3-Wheeler Cargo Solution-1***

3-Wheeler Cargo Solution 2	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	6.47	6.39
	Range (km)	97.89	95.91
	Change in Temperature (°C)	8.74	9.24
	Charging Time	4 H 42 Min	4 H 45 Min

Table 98 ***Performance Data over time for 3-Wheeler Cargo Solution-2***

3-Wheeler Cargo Solution 3	Test Phase	Test Data - Initial Phase	Test Data - End Phase
	Peak Power (kW)	6.97	6.77
	Range (km)	84.29	83.16
	Change in Temperature (^oC)	9.2	10.3
	Charging Time	4H 42 Min	4 H 45 Min

Table 99 ***Performance Data over time for 3-Wheeler Cargo Solution-3***

The deterioration in kit performance of all the solutions, as seen in ***Table 88*** to ***Table 99***, is marginal over the duration of test cycle.