D3.7 Technical Specifications for Demo Actions

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Contents

1. Introduction

This deliverable forms part of task 3.5 (Definition functional requirements for e-mobility innovations) which builds on the business models (3.3), needs assessments (3.1) activities in the partner cities that are implementing e-mobility vehicle fleet and infrastructure, including the electric vehicles, recharging equipment, electric energy supply, electric grid access and related infrastructure. Since the requirements and specifications will impact directly the performance, reliability and cost of the solutions to the cities, relatively precise and well described specifications will be key to identifying the most technically appropriate and economically viable offers. The responsible entities in the partner cities will prepare functional requirements as a basis for Work Package 4. Through this task, partners will advise partner cities in providing technical support using their expertise and know-how, based on previous experience with demonstration actions. Each partner city involved will clearly draft their needs, by considering and providing relevant information to the potential vehicle and equipment providers, as regards to the operational environment, duty cycles, projected lifetime, maintenance requirements, battery re-use/re-cycle, etc. The vehicle category and type (e.g. passenger, bus, freight, heavy-duty, light-duty, 2/3 wheelers), required powertrain characteristics and performance requirements (including, for example, maximum power, range, charging power, charging time etc.) will determine the selection of commercially available vehicles and their constituent sub-systems and components (battery system, power electronics, inverters, e-motors, etc.) and the corresponding charging equipment and infrastructure. Local climatic factors will also be carefully reviewed whilst suggesting suitable technical requirements for the city. For example, very warm or cold climate conditions, the heating and air conditioning systems have significant impact not only on the range of electric vehicles, but also on the operation, performance and expected lifetime of the batteries. The perspective of European and non-European Standards will be considered. Therefore, the task also carries out a review of the basis for system specifications as well as different standardisation bases applied in different countries and continents, their applicability and differences. Moreover, standards for using batteries for providing grid services, different contacting interfaces, as well as the communication technologies will be identified. The information will be provided to the demo partners for their purposes and later edited to be published as part of the toolbox (Task 1.1).

2. Vehicles to be developed in SOLUTIONSplus

SOLUTIONSplus is innovating on the application, adaptation and integration of different technologies; the development, testing and roll-out of e-mobility services and the initiation of new business opportunities and start-ups. The demonstration actions support the introduction and integration of electric buses, mini-buses, taxis, 2- and 3-wheelers in partner cities. The following are the vehicles to be developed:

Partner City	**Vehicles to be developed**
Hanoi	e-scooters
Pasig	e-multipurpose quadricycles
Kathmandu	e-bus (20-seater) e-3 wheelers (6-seater) e-3 shuttle (6-seater) e-microbus, 16-seater
Kigali	e-motorcycles e-bikes
Dar es Salaam	e-3 wheelers
Quito	e-cargo quadricycles e-delivery van e-bicycles e-buggy
Montevideo	e-buses e-3 wheelers e-cargo bikes
Madrid	e-taxi; e-bus e-carsharing
Hamburg	E-scooters e-taxi vehicle

3. Technical Specifications for each Urban Living Labs

3.1 Hanoi

3.1.1 Brief Description of Demo:

Hanoi e-mobility for last-mile connectivity: The demonstration project will focus on boosting the ridership and effectiveness of the currently running BRT and the forthcoming metro rail through the provision of shared e-scooter/moped services - tentatively referred to as "V-share" (short for Vietnam Sharing/Vehicle Sharing). It aims at deploying 100 e-scooters that will form the backbone of the sharing service. Aside from this, the demonstration will also include the integration of an e-bus charger in the City of Hanoi. Aside from these, Hanoi will also pursue the integration of a Mobility-as-a-service (MaaS) application in the city. The project will be a win-win for both public transport and e mobility. The demonstration project will have a high potential to not only make emobility attractive but also reduce the GHG emissions from transport and increase the share of public transport use.

3.1.2 Use case/s:

Shared E-scooter Services

The demonstration of the e-scooter sharing system will primarily be focused in a catchment area that features a commercial district and a bus rapid transit (BRT) line. During the demonstration period, the e-scooter sharing system is intended to be a station-based one (not free floating). This modality was purposely selected in order to ensure that the operations are manageable during the initial demonstration period. This also minimizes potential incidences of theft and vandalism during the non-operational hours.

3.1.3 Local regulations:

The table below shows the primary local regulations that are being considered in the design and implementation of the demonstration project in Hanoi. In particular these are primarily the ones which are directly related to the e-scooter sharing system.

Road Traffic Law (Law No. 23/2008)	This law stipulates the road traffic rules in Vietnam.
QCVN68:2013/BGTVT/SĐ1:2015 (2015)	National Technical Regulation on Electric Bicycles
QCVN 75:2014/BGTVT	National Technical Regulation of Motor used for Electric Bicycles
QCVN 76:2014/BGTVT	National Technical Regulation of Battery used for Electric Bicycles
QCVN 91:2019/BGTVT	National Technical Regulation on batteries of motorcycles and electric bikes
QCVN 52:2019/BGTVT	National Technical Regulation on fire safety structures of road vehicles
QCVN 47:2019/BGTVT	National Technical Regulation on

3.1.4 Technical requirements for Demo:

A. Vehicle Specifications

The discussions in Hanoi points towards the preference of making use of existing high-quality completely built up e-scooters. The sharing system will feature Honda e-PCX electric scooters. The use of the Honda vehicles enables the project to test the concept of a "shared system" while leveraging on the stability of existing (albeit quite new) products in the market. The vehicle characteristics are depicted in the following table.

Name	PCX Electric
Model	Honda ZAD-EF01
Lenght x Width x Height	1960 mm x 740 mm x 1095 mm
Wheelbase	1380 mm
Curb weight	144 kg
Max occupancy	2 persons
Max motor output	4.2 kw/ 5.7 horsepower
Power unit	EF01M/ AC motor
Max torque	18 Nm
Range	~41 kilometers(60km/h steady state; 1 passenger)
Charging time	6 hours (two mobile power packs)
Top speed	60 kilometres per hour
Battery type	Lithium ion
Battery voltage	50.4V
Battery capacity	20.8Ah x 2
Brakes	hydraulic disc (front) ; mechanical leading/trailing (rear)
Frame	double cradle
Battery charger	AC100V (single phase)

Honda e-PCX

Discussions with the local e-vehicle manufacturer Vinfast are also ongoing as the company has shown interest in infusing e-scooter units (and potentially charging stations) into the sharing system.

The e-motorcycles will be equipped with vehicle communication units (VCU) that will essentially enable IoT (Internet of things) technology integration that is needed for monitoring and control. The VCU is also capable of communicating with various battery management systems (BMS) of different vehicles that utilize different types of batteries.

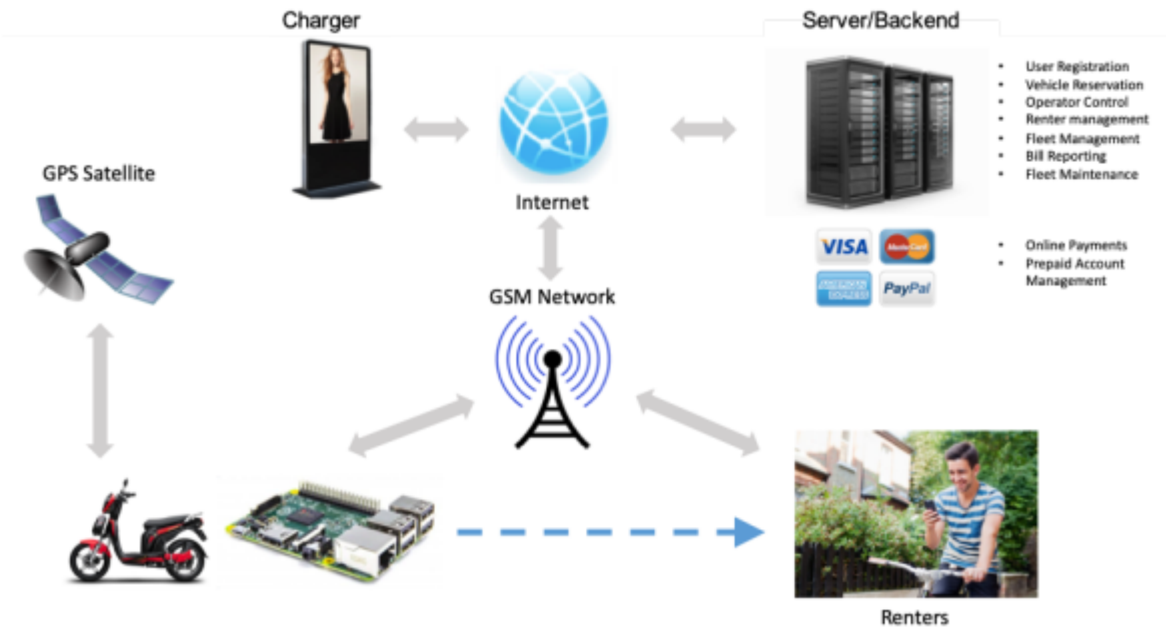
Aside from the e-motorcycles, the demonstration will also feature electric bikes to be provided by the local innovator QiQ. The e-bicycles complies with EN15194 e-bike safety standards. The said e-bike features a technology (ultra dense energy capacitor battery) that enables rapid charging of batteries and significantly higher battery life (50,000 cycles of charging).

E-bicycle to be Deployed

Dimensions	1600 mm x 560mm x 1060 mm
Frame	Aluminum
Weight	20 kg
Range	12 km
Battery	QIQ Ultracapacitor Battery
Charging time	7 minutes
Drive	250 watts
Communications VCU	3G Enabled, GPS Enabled, Accelerometer

B. Operational Specifications

V-Share will feature integrated elements that will enable smooth operations of the shared system. It will feature a cloud-based mobile phone app and cloud service that would allow customers to locate, book, and unlock the vehicles within the system. The application will provide a management backend system that can be tapped into by participating fleet operators later on for managing and controlling their fleets. The backend' functions can potentially be extended for use by the other cities within the SOL+ project that are also engaging in similar shared systems.



System Process Flow - VShare

The backend and frontend software, together with the VCUs that are to be integrated into the vehicles, will enable the following operational functions needed for such a scheme:

User registration	Users will be required to register with the system. Successful registrants will be provided with a user ID and password.
Booking	The VShare app will be the main user interface for finding, renting and unlocking units in the shared fleet
Unlocking of vehicle	The system will utilize a QR code-enabled locking mechanism that is tied up to the user app.
Vehicle condition reporting	The app can be used to record damages to the vehicles.
Parking and charging location identification	The system would be capable of integrating location identification features (e.g. for available parking, and charging points).

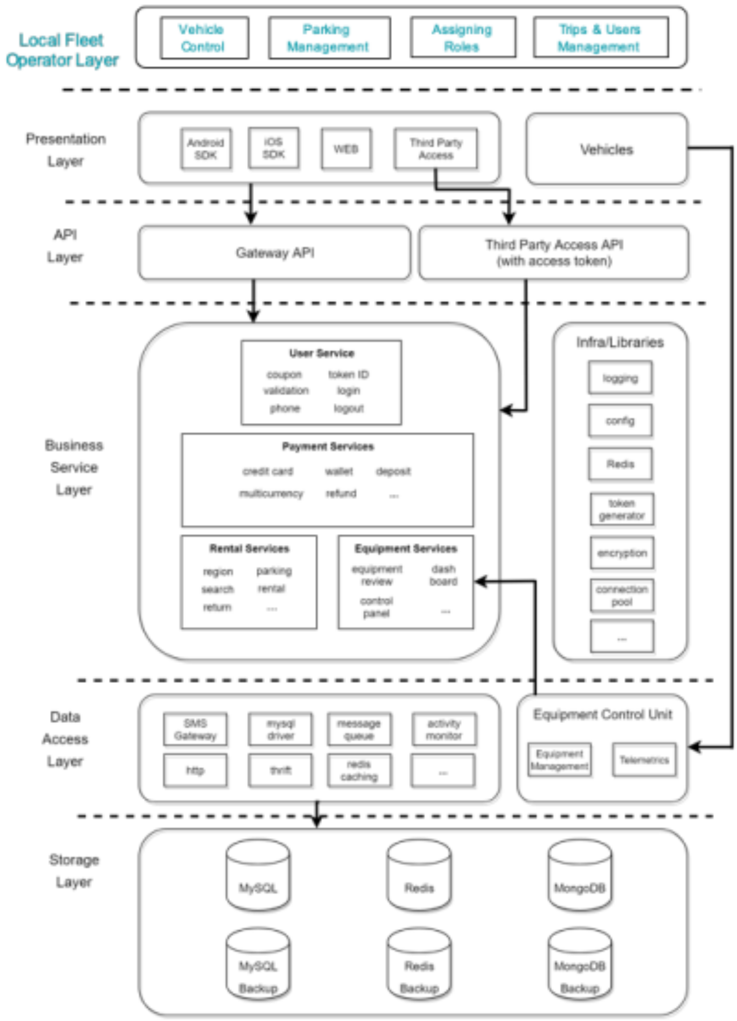
The VCU that will be integrated into the e-scooters will enable much needed monitoring of essential operational parameters that are related to the vehicle:

- Vehicle diagnostics
- GSM data connectivity
- GPS location reporting
- Accelerometer functions
- Power utilization monitoring
- Device activation and control
- Emergency help requests.

The system will also be able to record information regarding the individual trips that are to be made by the users of the sharing scheme:

- Date/time of trip
- Duration of the trip
- Origin and destination
- Route taken and average speed

The detailed logic of the system is provided in the figure below:

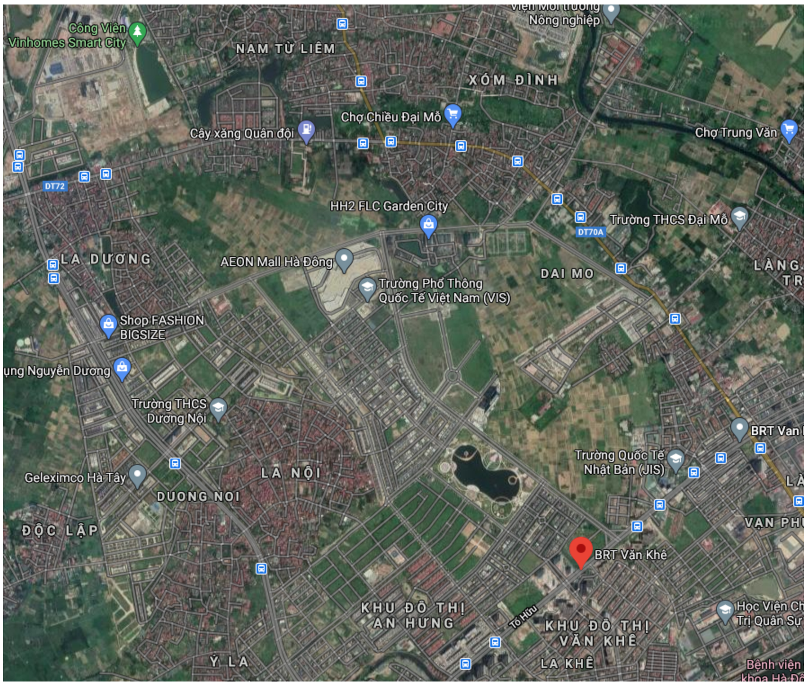


V-Share System Logic

In summary, the technologies to be utilized in the VShare demo will enable fleet monitoring; system operations management; management and monitoring of trips; as well as user reporting.

C. Integration Specifications

The e-scooter sharing system will be situated in a highly dense commercial area that connects to a major public transport station. E-scooter stations will be setup in relevant commercial sites (e.g. Aeon Mall) and BRT stations (e.g. BRT Van Khe). Close collaboration is being ensured between the project team, the relevant city authorities (e.g. Hanoi Department of Transport) and the management of the relevant private institutions in order to properly integrate the system, as well as the accompanying infrastructure (stations) within the area.



Map of the Pilot Area

Current discussions are ongoing in regards to the integration of the rapid e-bus charger in the intended e-bus testings that are supposed to happen in Hanoi. Further investigations towards the allocation of some shared e-scooter units into the e-bus routes will be done later on. The bus charger to be installed will be from ABB's Terra DC fast chargers which are designed for convenient charging of different EVs, including future models with high voltage battery systems. These are compact and flexible models which can be upgraded to have a charging power of up to 180 kW. The table below depicts the technical specifications of the Terra 184, which is at the highest end of the spectrum in the current Terra DC fast charger line-up of ABB (exact model to be installed will still be finalized).

ABB Terra 184 Technical Specifications

Parameter	Specifications (Terra 184)
Charging type	DC fast charging and AC type-2 charging
Outlet options	C:CCS cable; J:CHAdeMO cable, T: AC Type-2 socket
Input AC power rating	C,CC, CJ: 280A, 192 kVA @50Hz CCT/CJT: 310 A, 214 kVA @50Hz
Input voltage range	400 VAC +/- 10% (50 Hz or 60 Hz)- CE Version, 480 VAC or 270 VAC +/- 10% (50 Hz or 60 Hz) - UL Version
DC output power rating	180 kW
AC output power rating (optional)	22 kW
DC output voltage	150-920 Vdc
Number of EV served	Up to 3
Cable length	3.9 m Optional: 6.0 / 8.0 m
CCS cables maximum current	200 A, 300 A (optional)
CHAdeMO cables maximum current	200 A, 125 A (optional)
Connector types	3P + N +PE
Protection	overcurrent, overvoltage, undervoltage, ground fault including DC leakage protection, integrated sure protection
Overvoltage category	Type II
Power factor (full load)	>0.96
Efficiency	>95% (peak)
Standby power	80 W
Short circuit current	10 kA
Energy metering	Optional : MID metering for AC and DC outlets; Optional : Einchrecht/PTB compliant metering solution for AC and DC outlets
Cellular Communication	GSM/4G/LTE
Connectivity	Internet access via 4G/36/Ethernet (RJ45)
User authentication	App, ISO 15118 PlugnCharge, RFID, PIN code
User interface	7 inch LCD high contrast touchscreen
Communications protocol	OCPP 1.5/1.6/2.0/ OPC-UA
RFID reader	ISO 14442 A + B to part 4 and ISO/IEC 15693, Mifare, NFC, Calypso, Ultralight, Paypass, HID, and more
Emergency button	Yes

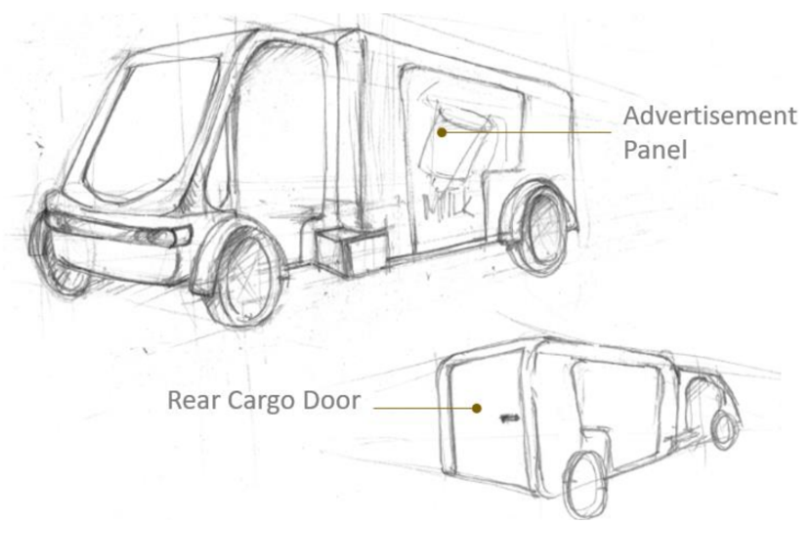
As of the date of writing of this document, discussions are being conducted regarding the potential integration of the Pluservier MaaS ecosystem in Hanoi. The intention is to explore how might such a MaaS app can be a means to consolidate information from the different public transport modes in the city into a single application that will provide commuters with better trip planning choices, and later on, access to a consolidated platform for booking and paying for trips.

3.2 Pasig

3.2.1 Brief Description of Demo:

The demonstration in Pasig will focus on integrated and shared urban logistics solutions, as well as investigate the potential for appropriate charging solutions. The activities on-the-ground will also include those that aim at improving the enabling conditions for e-mobility, and enhancing local capacities related to e-mobility.

Locally appropriate solutions addressing urban logistics are deemed to be quite important, as conventional vehicles that are currently being used are not particularly effective in conducting efficient movements considering the local conditions in the urban areas. The SOL+ demo will aim at producing and testing urban cargo quadricycles that are suited to the local conditions and can potentially transform how urban deliveries are done in the country. These quadricycles combine the nimbleness of smaller vehicles and the carrying capacity of larger vehicles that are currently being used in conducting urban deliveries in Pasig (e.g. motorcycles, cargo tricycles, and minivans). The quadricycle will also be designed to have a base that can carry different types of cargo, and will be designed in a way that it can easily be converted into a vehicle that can carry passengers. The design process will take into consideration the needs of the primary intended users, and will utilize a combination of European (e.g. Valeo motor), regional, and local components. The vehicles will also be equipped with appropriate sensors that can provide vital information needed for assessing the performance of the vehicles (e.g. for recording geo-spatial information, battery and motor performance, among others).



Potential Configuration of the SOL+ Vehicle in Pasig

3.2.2 Use case/s and Primary Functional Requirements:

Urban Delivery

The SOL+ vehicles will be tested as an urban delivery vehicle through the engagement with PHLPost, as well as other interested entities in Pasig City. PHLPost will primarily use the SOL+ units to bolster its current fleet that serves its operations in Pasig City.

Aside from PHLPost Pasig, the City of Pasig will also cooperate with other entities that are involved in the movement of goods. One particular use case that is being explored is to use the vehicle for delivering medical supplies within the city. This will be done through a partner pharmacy, as well as with the Pasig City Health Aid Office within the City Government. Discussions with locators at the public market are also to be conducted to explore the possibility of using the units for transferring the bulk goods from the large trucks to the final points of destinations during the early morning goods discharging operations.

On-demand Passenger Service

As the SOL+ quadricycles are to be designed as a multi-purpose quadricycle, it will be able to transport passengers as well. Some of the units that will be produced will be allotted towards testing an on-demand point-to-point passenger transport service that will complement existing public transport modes. One of the key target users would be senior citizens and differently-abled persons. It is also envisioned that the vehicles would be made available for late-evening/ early morning (wee-hours) services that would serve the public and would be made available through the app.

Support/ Utility Vehicle

The City of Pasig is currently evaluating potential uses for a unit (or two) to support their operations. Currently, discussions are ongoing on whether the/se unit/s can be tested as a utility vehicle for street cleaning or whether these will be used as a cargo vehicle for the delivery of medicine and/or relief goods during the pandemic.

The key functional requirements for the vehicles are listed below:

Vehicles

- Vehicles to comply with applicable local laws and regulations (operations, vehicle classification, safety, environmental)
- size must enable it to navigate through limited street widths with ease
- motor power must be sufficient to allow it operate in areas with high inclination angles
- customizable rear portion for accommodating both urban freight and passenger transport tasks
- passenger vehicle configuration must consider PWD accessibility
- maximum speed should be below 40 kmph (slow urban operations)
- load capacity should be able to handle operational requirements both as a passenger and urban freight vehicle (at least 300 kg payload)

- battery capacity should be able to accommodate intended daily routine and activities (i.e. ~70 kilometers per day as a passenger and an urban freight vehicle)
- appropriate vehicle performance monitoring system needs to be integrated in order to aid data collection and optimize vehicle performance
- similarly, a fleet maintenance decision support system that will aid preventive and corrective maintenance is also needed
- security features to be embedded into the vehicles

Charging

- An information management system and interface is needed in order to aid battery charging and swapping
- Charging system to comply with applicable local laws and regulations

Integration

- As a cargo delivery vehicle, the solution should incorporate appropriate decision support systems that would aid delivery planning and monitoring
- A ride hailing application (and associated services such as payment and routing) is needed in order to facilitate the booking of trips

3.2.3 Local regulations

The following are the relevant standards that have been adopted by the Philippine government in regards to electric vehicles. The development of the hardware for the SOL+ demo will take the applicable standards as guidance.

National Standard	Title
PNS ISO 6469-1:2012	Electrically propelled road vehicles – Safety specifications – Part 1: On-board rechargeable energy storage system
PNS ISO/PAS 19295:2018	Electrically propelled road vehicles – Specification of voltage sub-classes for voltage class B
PNS ISO 12405-3:2018	Electrically propelled road vehicles – Test specification for lithium-ion traction battery packs and systems – Part 3: Safety Requirements
PNS ISO/IEC PAS 16898:2018	Electrically propelled road vehicles – Dimensions and designation of secondary lithium-ion cells
PNS IEC 61851-21-1:2018	Electrically propelled road vehicles – Test specification for lithium-ion traction battery packs and systems – Part 2: Safety performance requirements
PNS IEC 61851-1:2012	Electric vehicle conductive charging system – Part 1: General requirements
PNS IEC 61851-21:2012	Electric vehicle conductive charging system – Part 21: Electric vehicle requirements for conductive connection to an AC/DC supply
PNS IEC 61851-22:2012	Electric vehicle conductive charging system – Part 22: AC electric vehicle charging station
PNS ISO 7637-1:2018	Road vehicles – Electrical disturbances from conduction and coupling – Part 1: Definitions and general considerations
PNS ISO 17409:2018	Electrically propelled road vehicles – Connection to an external electric power

	supply – Safety requirements
PNS IEC 62196-1:2019	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 1: General requirements
PNS IEC 62196-2:2019	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 2: Dimensional compatibility and interchangeability requirements for AC pin and contact-tube accessories
PNS IEC 62196-3:2019	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 3: Dimensional compatibility and interchangeability requirements for DC and AC/DC. pin and contact-tube vehicle couplers
PNS ISO 15118-1:2019	Road vehicles – Vehicle-to-grid communication interface – Part 1: General information and use-case definition
PNS ISO 15118-2: 2019	Road vehicles – Vehicle-to-grid communication interface – Part 2: Network and application protocol requirements
PNS ISO 15118-3:2019	Road vehicles – Vehicle-to-grid communication interface – Part 3: Physical and data link layer requirements
PNS ISO 15118-4:2019	Road vehicles – Vehicle-to-grid communication interface – Part 4: Network and application protocol conformance test
PNS ISO 15118-5:2019	Road vehicles – Vehicle-to-grid communication interface – Part 5: Physical and data link layer conformance tests
PNS ISO 15118-8:2019	Road vehicles – Vehicle-to-grid communication interface – Part 8: Physical layer and data link layer requirements for wireless communication
PNS ISO 11898-1:2019	Road vehicles – Controller area network (CAN) – Part 1: Data link layer and physical signaling

On the classification and registration of the SOL+ vehicle, the Land Transportation Office is currently in the process of drafting the "Consolidated Guidelines in the Recording and Registration of all Types of Electric Motor Vehicles." In the meantime, stipulations under the existing regulations will be taken into account, in particular, Administrative Order (AO) 2008-014 which provided guidelines on the registration of low speed vehicles (LSV) which covers 4-wheeled vehicles powered by alternative propulsion systems (including electricity) and has a maximum speed of 40 km/h.

3.2.4 Technical requirements for Demo

A. Equipment Specifications

The following tables depict the basic technical features of the different hardware elements of the demonstration project in Pasig. It must be noted that these are subject to change, based on the findings of subsequent evaluations as guided by the pending user needs assessment activities.

Vehicle

Vehicle class	eL6 (electric quadcycle)
Drive system	full electric central drive
Peak speed	30 kilometres per hour
Vehicle dimensions	2,600 mm x 1,200 mm x 1,600 mm
Curb weight	130 kg
Load capacity	270 kg
Gross weight	400 kg
Load volume	max 1.5 cubic meter
Chassis built	steel ladder type
Body material	ABS/FRP composite
Climbing capacity	8- 12 degrees
Suspension	combination of coil-type suspension and leaf spring
Transmission	direct drive

Traction Motor

Make	Valeo
Model	e-Access
Rated power	2 kW
Peak torque	550-1100 Nm
Rated speed	3000 rpm
Weight	22 kg
Lifetime	>10000 hrs
Maintenance	3,500 hrs
Motor max efficiency	95.1%

Battery cells

Chemistry	Lithium ion
Battery cell type	Prismatic
Charger rate	3 kW or 6 kW
Energy storage capacity	6.5 kWh
Battery module voltage	48 V 70 Ah or 48V 140 Ah or 60V 70Ah
Cooling	Air cooled
Cell weight	1.55 kg
Impedance	≤0.7mΩ
Cell dimensions	36.2 mm x 115.2 mm x 200 mm

B. Operational Specifications

The SOL+ vehicle is intended to feature a base vehicle information management and control system which will provide information needed for condition monitoring and analytics, charging/swapping decision support, wheel load distribution advisory, vehicle security, GPS system and dynamic performance adjustment.

The vehicle will track real-time monitoring of the vital signs, key components and operational parameters which will be sent periodically to a Fleet Maintenance Decision Support System which is envisioned to integrate machine learning features to better understand its performance, specifically energy consumption and parts degradation, vis a vis various operational conditions including traffic conditions, vehicle load wheel distribution, climate conditions and driver behaviour. The information will also be processed continuously by the tool to prompt the driver for any urgent technical intervention to prevent further technical damage and operational disturbance. Wheel loads will be monitored by the system and prompts the driver whenever load distribution goes beyond acceptable ranges for good energy economy and vehicle stability. It shall also provide the driver intervention recommendations in including cargo stacking and/or wheel base adjustments. The system will also be responsible for sending the initial delivery route plan at the start of a working day and real-time location, battery SOC and estimated remaining range to the Battery Charging/Swapping Network Information Management System. The system will have the option to automatically make adjustments to vehicle performance as needed to extend battery range as needed. This module will automatically prepare a battery / charging swapping strategy at the start of the delivery day for each unit based on the forwarded initial delivery route plan and considering charging and swapping station locations and the battery module inventory. It will make further necessary changes on the strategies of the vehicles based on real-time operational status and technical considerations (e.g. SOC, remaining battery range, delivery status). The system therefore consolidates charging / swapping demand and supply capability and intelligently generates dynamic charging / swapping strategies for each unit.

The vehicle is also intended to feature an appropriate battery management system that will include the following features:

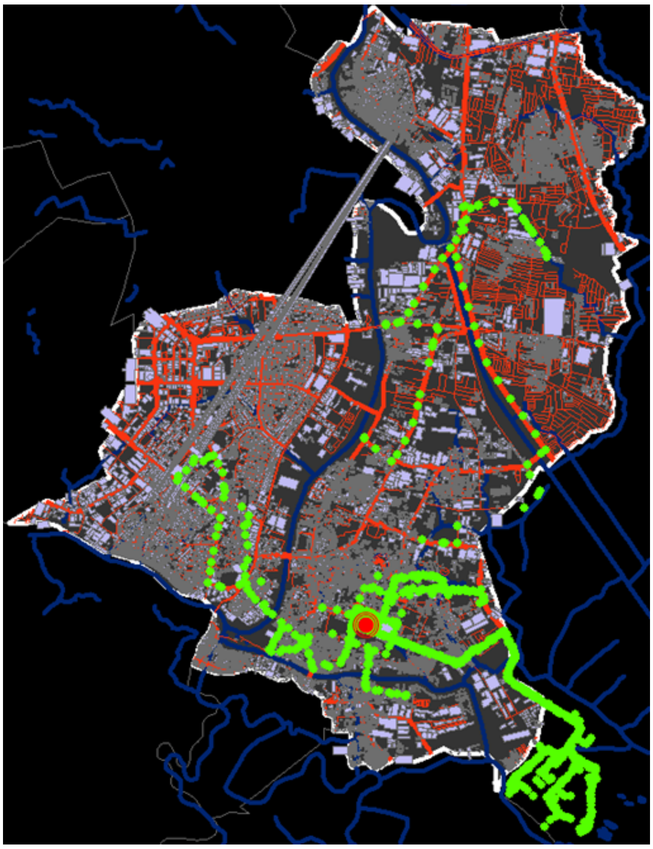
- Battery Location Tracking
- Remote real time state of charge (SOC) tracking
- Cell level condition monitoring
- Charging encryption
- Enhanced physical security and remote intrusion detection

Based on the initial information regarding the main use case (e.g. PHLPOst deliveries) the most appropriate model for charging during the demo is a battery swapping system. The basic technical specifications of the charging system are as follows:

Frequency	60 Hz
Number of phases	3-phase 240/48
Type of charging equipment	AC
Power source	Luzon power grid
Type of connector	AC

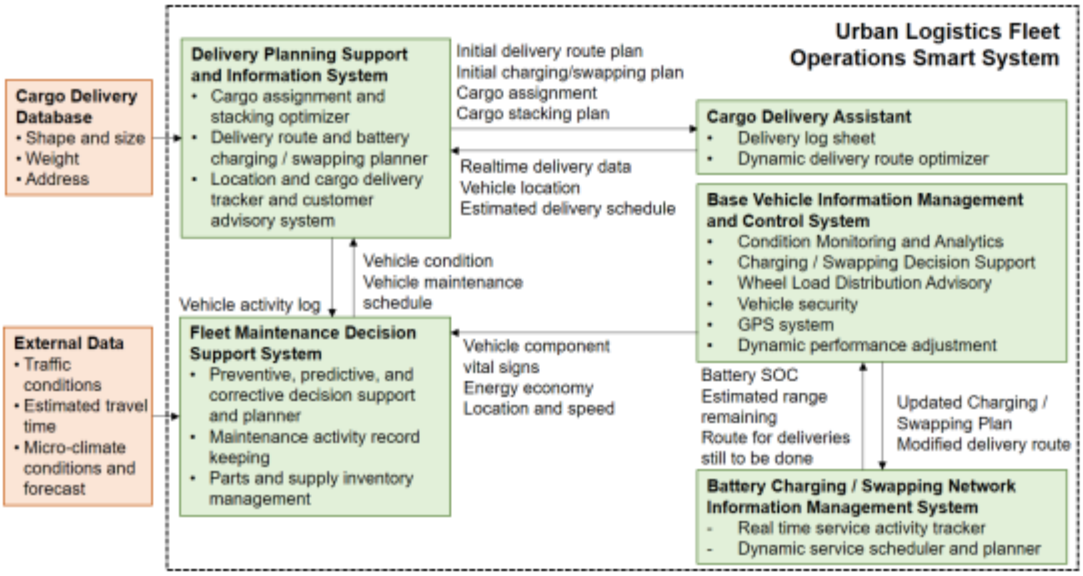
C. Integration Specifications

The vehicles will primarily be operating in Pasig City, which is approximately 31 square kilometers. In terms of the operations for the PHLPost Pasig branch, the vehicles might also be operated in nearby cities as the branch is serving other adjacent cities (as depicted in a daily sample of GPS tracks of the existing PHLPost e-trikes below).



Sample GPS Tracks for the Existing E-Tricycles of PHLPost

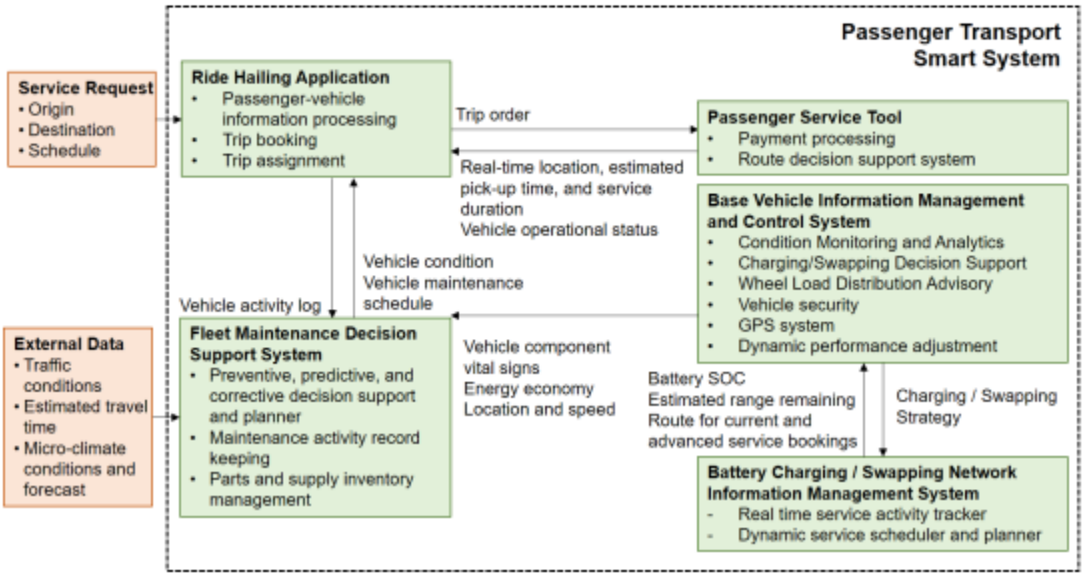
As mentioned in the previous section, the demo project will feature an urban logistics fleet operations system that will not only enable better operations management by the entity users, but will also enable the generation of evidence that can be used for wider integration in the user entity's (e.g. PHLPost) wider operations and strategic plans.



Urban Logistics Fleet Operations System

The passenger services will be limited within Pasig City. The exact priority areas are still to be discussed, but the selection will prioritize areas that are nearby the Pasig City hall (adjacent to the PHLPost Pasig facility that is reflected as the red dot in the map above).

The passenger transport fleet management system will enable holistic integration of the services to be provided by the shared passenger fleet into the existing services. An important thing to note in terms of acceptability is that the system should be introduced as a service that bolsters existing transport service capacities, and that it aims to fill in specific priority gaps in the system.



Passenger Transport Smart System

3.3 Kathmandu

3.3.1 Brief Description of Demo:

In Kathmandu, a demonstration action aims to contribute to creating an ecosystem for electric mobility in Kathmandu by demonstrating different Evs to enhance public transport, as well as suitable charging solutions and related services. The main demo activities include conversion of diesel bus to E-bus and production of modular e-3 wheelers, e- shuttle van and e-micro bus carried out by local manufacturers with the technical support from the consortium and equipment imported. The activities will initiate research based projects to proceed the development, which further strengthens the local manufacturing capability.

3.3.2 Use case/s and Primary Functional Requirements:

The SOL+ prototypes will be tested as an urban transportation vehicle for various purposes in the Kathmandu valley. The developed models will be tested and run through a local partner Sajha Yatayat. The discussions with local municipalities and local transportation organizations will be carried out to model the local required conditions and implementation in the project. The prototypes will be developed with a careful understanding of the functional needs of the vehicles as well as the topographical (road gradient of max 10°) and climatic conditions of Kathmandu, such as temperature avg. min 2˚C to avg. max 30˚C, 110 rainfall days, 1450mm). The prototypes runs around 130kms on full charge.

Conversion of diesel bus to E-bus

An old diesel bus will be converted to E-buses (1 unit), mainly replacing the drive system (motor, transmission and rear axle), as the chassis remains the same. The required components for the conversion will be imported and assembled locally. The converted e-bus will be operated in one of the current routes of Sajha Yatayat, once the permission to local operation is acquired.

Modular e-3 wheelers

The prototype of modular e-3 wheelers (6 seater), providing flexibility in the vehicle application, will be the remodeled version of existing Safa Tempos (10 seaters). It will use power trains from Valeo (eAccess technology) and other components either imported or locally manufactured. The three models of the modular e-3 wheelers will be developed, they are: passenger EV- mini Safa Tempo (2 units), municipal waste e-trike (2 units) and cargo e-trike (2 units). The mini Safa Tempo will provide public transport for inner-city residents and tourists and will also offer as a cab whenever required. It will serve as an eco-friendly mode for first/last mile connectivity and will help to replace gasoline vehicles of similar capacity in similar routes. It will run 8-10 trips per day with breaks for 2 mins max per stop and 1 hour break per day. The prototype of municipal waste e-trikes will aim to replace conventional diesel-powered mini pick up (or tricycle and tractors), which are open and unhygienic with leakage problems. It will run 4 trips per day with multiple stops depending on the sites. The cost-effective prototype of cargo e-trikes are for goods delivery in the inner market of the city replacing manual operating cycles, trikes, and quad cycles or rented petrol powered vehicles. It will also run 8-10 trips per day with breaks for 2 mins max per stop and 1 hour break per day.

E-shuttle van

The 6-seater e-shuttle van (1 unit) will be developed with local manufacturers, using Power train from Valeo (eAccess technology) and other components either imported or locally manufactured. This will be basically used for heritage site-seeing purposes.

E-microbus

The 16 seated e-microbus (1 unit) will be used as a public transportation (feeder) and has a high potential to replace thousands of diesel-powered micro buses running in different routes of the Kathmandu valley.

3.3.3 Local regulations:

Beside some supportive national policies for EVs in Nepal, there is no specific regulation in place describing the minimum performance requirements of EVs or setting guidelines for the operation of EVs and vehicle parts. The local manufacturers develop EVs based on the technical details provided by the respective component companies.

Nepal Electricity Authority plans to develop EV charging stations with 142 kW capacity, which is compatible to charge EV battery (Lithium ion integrated technology) with voltage range 200 V to 750 V with compatibility of combination of charging protocol, such as CCS 2.0, CHAdeMO, GB/T and AC Type 2 with CAN/PLC communication between Electric Vehicle Service Equipment (EVSE) and Electric Vehicle (EV). The operating system also has to be compatible for communication between EVSE and Central Monitoring System (CMS) with Open Charge Point Protocol (OCPP) 1.6 or latest version.[1]

[1] https://www.nea.org.np/admin/assets/uploads/supportive_docs/1579605070_Vol%20II.pdf

3.3.4 Technical requirements for Demo:

A. Vehicle Specifications

Converted E-bus and E-micro bus

Parameters	**Converted E-bus**	**E-micro bus**
L*W*H(mm)	9490*2460*3120	5100*1700*2180
Max. Passengers:	20+1	15+1
Max Speed	70Km/hr	55km/hr
Wheelbase(mm)	4765	2890
Curb weight(kg)	8000	3140
Max G.V.W(kg)	11600	4490
Motor (KW)	PMSM/AC Asyn 80 KW rated (may change during the project period)	15 rated
Battery (KWh)	LI-fepo4, 130 KWh Detailed information will be depending upon the battery packs that will be selected.	30KWh
Driving range	135 km	120 km
Climbing capacity	12 deg	12 deg
Steering position	RHD	RHD
Charging system	Overnight charging system	Overnight charging system
Rated Torque	800 Nm	
Chassis	Ladder chassis (in most of the cases)	
Transmission system		Direct drive on single speed

Modular e-3 wheelers and E-shuttle van

Parameters	Passenger EV- mini Safa Tempo	Municipal waste e-trike	Cargo e trike	E- shuttle van
L*W*H (mm)	3500*1330*1770	3500*1330*1770	3800*1600*2100	3500*1330*1770
Wheel Base(mm)	2600 mm	2600 mm	2600 mm	2600 mm
Motor (kW) (Valeo eAccess technology)	6	6	6	6
Max. Speed (km/hr)	60	45	45	60
Pay load (kg)	630	500	350	630
Battery (KWh) (Li-fe4)	10 kwh	10 kwh	10 kwh	10 Kwh
Driving range (km)	130	85	85	130
Charging time (hrs)	5	4	4	5
Climbing ability (%)	12	12	12	12
Ground clearance	175mm	175mm	175mm	175mm
Transmission	Single speed reducer	Single speed reducer	Single speed reducer	Single speed reducer
Brake	Front disc brake, rear oil brake	Front disc brake, rear oil brake	Front disc brake, rear oil brake	Front disc brake, rear oil brake
Front Suspension	Coil Spring and Shock Absorber	Coil Spring and Shock Absorber	Coil Spring and Shock Absorber	Coil Spring and Shock Absorber
Rear Suspension:	Coil Spring and Shock Absorber	Coil Spring and Shock Absorber	Coil Spring and Shock Absorber	Coil Spring and Shock Absorber

Tyre	Front 4.00-12/Rear 4.00-12	Front 4.00-12/Rear 4.00-12	Front 4.00-12/Rear 4.00-12	Front 4.00-12/Rear 4.00-12

B. Operational Specifications

Operational Aspect	**Charging**
Charging system	Overnight charging system (due to comparatively lower electricity rate at night as well as economically feasible at the current scenario of local requirement.
Battery management	Battery management system is available along with the battery pack. Consideration on battery reuse and/or recycling for the li-ion/li-fepo4 batteries
Communication devices / system / software (screen, interface, HMI, etc)	Smart management system that enables to tune the motor controller systems. Digital display system that provides the real time battery status
Safety aspects	Basic road safety and vehicle safety with the vehicle parts like braking system, strong chassis, and training to drivers and technicians.

C. Integration Specifications

Integration Aspect	**Technology**
Real time monitoring - controlled by app	GPS and smart dashboard screens in all demo prototypes
Application	Planned for an app with the services: booking, position of the vehicle (status of real-time drive position), and payment etc.

3.4 Kigali

3.4.1 Brief Description of Demo:

Electric mobility is at a nascent stage in Kigali, characterised by multiple pilot projects launched over the last two years, exploring the feasibility and scale-up of electric motorcycles (Ampersand, Safi Ride, Rwanda Electric Mobility), shared electric bikes (Gura Ride), shared e-cars and assembly plant (Volkswagen). Along these private initiatives, national policies are been reviewed to introduce mechanisms supporting electric mobility, to operationalize the target of 9% reduction of GHG emissions from the energy sector through EVs in 2030 enshrined in the updated NDC (Republic of Rwanda, 2020) and leaning on a general feasibility study finalised conducted in 2018 (Gustavsson et al., 2019).

The demonstration action in SOLUTIONSplus aims to support these developments and focus on e-mobility for last-mile connectivity in Kigali. It will have a systemic approach integrating the public bus system with electrified feeder services provided by 30 e-moto taxis (20 new and 10 remodelled) and 100 e-bikes that support first/last mile connectivity. Regarding this eBike sharing scheme, the demonstration project will also test the establishment of this scheme along the most widely used bus corridors with charging points fitted with solar power energy to provide seamless charging service to riders and patrons. With support from city authorities, transport operators and bus manufacturing companies, a suitable business model for e-buses for the city's current bus transport administration will be explored. Expectedly, the project will create a good precursor to public transport electrification in Kigali. Finally, for the wider use of E-Moto taxis and E-Bikes, smart services applications will be explored that support eco-routing.

3.4.2 Use case/s:

The SOL+ demonstration will foster the uptake of two types of innovative electric vehicles in order to promote passenger last-mile connectivity.
The introduction of shared electric vehicles, with dock stations strategically located next to bus stations, will improve seamless connections for passengers, facilitating first and last miles. These prototypes are a novelty in the Kigali urban landscape, providing a further mobility option for residents. Secondly, the demonstration will support the uptake of electric motorcycles, currently existing but at a very early stage. Passenger last-mile connectivity is promoted via components targeting physical integration (e.g. installation of fast charging infrastructure at public places and vantage points) and digital integration (MaaS application). This requires involving existing transport operators, service providers and associations including motorcycle taxi associations, bike rider groups and other relevant transport associations in Kigali.

3.4.3 Local regulations:

At the time of the feasibility study conducted in 2018 and mentioned above, no local regulations were addressing the category of EV. Consequently, the Study identified the need for following regulations and standards:

Vehicles	Incentives and regulations for new and second-hand imported vehicles (including motor vehicles)
Charging	Standardise connections to charging points via for example CHadeMo, follow the EU-regulation in this field or IEC 62196", charging design, safety and operational aspects; regulations for import of renewable energy generation components (e.g. solar panels)
Others	Gaps to be filled in current regulations e.g. safety laws, taxation laws, etc.

In its Work Plan for July-December 2020, the Rwanda Standards Board included ongoing work on a Rwanda standard (i.e. not regional) entitled "Electric vehicle charging stations – Requirements". This standard will be elaborated within the Technical Committee RSB/TC 50 Electrical Energy, Equipment and Accessories, under a preparatory stage by October 2020, coming into the committee stage by December 2020. The references for this standard are:

IEC 62196-1:2014	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 1: General requirements
IEC 62196-2:2016	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 2: Dimensional compatibility and interchangeability requirements for A.C. pin and contact-tube accessories
IEC 62196-3:2014	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 3: Dimensional compatibility and interchangeability requirements for D.C. and A.C./D.C. pin and contact-tube vehicle couplers

3.4.4 Technical requirements for Demo

Some topographic and climatic characteristics in Kigali may impact electric mobility:

- Hilly topography with steep slopes; variation between 1,300 and 1,600 metres average for the top of the ridges (Transport Plan. Kigali Master Plan 2050), evaluated between 1400 m and 1850 by Baffoe et al. (2020). Consequently, Ampersand integrates a starting torque of 200nm[2].
- Humidity ranging between 60% and 84% throughout the year; lowest temperatures between 14 and 16°, and highest temperatures between 26 and 28°[3]
- Episodes of significant floods[4].

The vehicle, operation and integration specifications below are suggestions based on the proposals received from Ampersand (motorcycle) and Gura Ride (electric bicycle).

A. Vehicle Specifications

Vehicle Type	**Electric motorcycle**
Drivetrain	5kW Nominal 8kWp brushless DC motor
Battery type	Swappable lithium-ion battery
Further battery details	IP67 battery enclosure, modular battery system with onboard safety and intelligence
Range	Indicative 65 km per swap; expected 90km through iterations in 2020
Starting torque	200nm
Brakes	Front and rear hydraulic disc brakes; 2kW onboard regenerative breaking
Others	Field orientation control custom controller Built in telematics recording up to 50 data points/sec 40W LED high-power front light

[2] Remeredzai, J. K. (2020). The Waiting List For Rwanda's Ampersand Electric Motorcycles Is Now At 7000! Clean Technica, 19.08.20.

[3] IAMAT (nd). Rwanda: Climate Information by City.

[4] World Bank (2020). *Making room for storm water: How floods in Kigali shed light on the need for integrated urban planning and upgrading*.

Vehicle Type	Electric bicycle
Model	Pedal System Electric Boost
Drivetrain	36V 500W; DC motor with 250watt and maximum capacity of 2100rpm
Battery	12.5ah, 36v
Fork	Steel
Frame	Alloy
Total weight	24 KG
Dimensions	1750 x 550 x 1150 mm
Connecting parts	Anti-theft of whole vehicle, providing special anti-theft disassembly and disassembly tools
Wheels	Wheelbase 1100mm; wheel of aluminum alloy spoke rim, front wheel uses a power-generating drum , with front and rear lights
Tyres	26inch non-inflatable foamed tire
Brake system	Front wheel Shimano roller brake, rear wheel strong drum brake
Other Accessories	Aluminum alloy pedal and crank, aluminum alloy handlebar, green tire cover, silver vegetable basket/carrier, seat tube with scale

B. Operational Specifications

Operational aspect	Technical specifications
Charging	**Motorcycle**: swappable battery system: state of the art fast charging / cashless network that enables battery swapping. 1 fully operational charging station+ 3-4 mini mobile swap stations
	E-bike: dock station with hybrid fast-charge solar panel + e-charging locker (battery charge bank).
Communication devices, system and software	**Motorcycle**: online and mobile platform Amper-Ops - Seamless management of battery packs with customisable parameters, e.g. state of health analysis and geofenced alarms - Customisable insights to intimately understand ROI of each station, driver and battery and respond in real-time - Smart maintenance systems automatically alerting on required battery or vehicle repairs before breakdowns

Safety aspects	See brakes systems above in vehicle specifications. **Motorcycle**: helmets, insurance and taxi registration, theoretical and practical training courses **E-bike**: safety helmets for riders, rider training course

C. Integration Specifications

The demonstration will foster integration at two levels. The e-Bike sharing scheme will be established along the most widely used bus corridors to facilitate last-mile connectivity. In addition, the demonstration will integrate a MaaS component. Doing so, it will consider recent efforts to integrate public transport systems in Kigali by the Rwanda Utilities Regulatory Authority (RURA) to deploy a mobile application intended to provide public transport users information on bus itineraries and schedules.

Integration aspect	Technical specifications
Physical integration	**Electric bike**: dock stations for the public bikeshare yet to launch as of July 2020. The location of 125 dock stations is identified, along bike lanes and bus routes
MaaS App	Building up on existing individual apps, currently not MaaS **Motorcycle:** own swap app with mobile payments integrated **E-bike**: single app for a fleet of smart bikes, e-(kick) scooters and e-bikes sharing

3.5 Dar es Salaam

3.5.1 Brief Description of Demo:

The demonstration project in Dar Es Salaam will focus on e-mobility for last-mile connectivity. The demonstration aims at integrating 60 electric feeder/e-3-wheeler and distribution services with Dar es Salaam's BRT (DART) to support first/last mile connectivity. The e-3-wheelers (newly built 50 imported/provided by DART and 10 newly built with Valeo components), will be an integral part of public transport. Under SOLUTIONSplus, the deployment of e-3 wheelers will happen at 5 DART stations considering urban locations: a) in the city centre, where fossil-fuelled 3-wheelers are currently banned for environmental reasons and where accessibility to/from the BRT stations can be limited due to longer distances; b) in peri-urban areas where combustion-fuelled 3-wheelers are currently very common as feeder-modes. Also, a feasibility study on the electrification with respect to vehicle specifications (range, speed), charging infrastructure (type and location) will be carried out. As part of this, state-of-the-art data collection methods using geo-localization devices will be applied for a detailed derivation of the systems specifications. Subsequently, an implementation plan for the introduction of e-3-wheelers will be developed. This will follow a systemic approach and include the development of business models (vehicle ownership, rental schemes, and maintenance), the charging infrastructure and localisation.

Further aspects to be assessed under the demonstration relate to the battery type (fixed vs. battery swapping), ownership models (leasing/pay-per-use model), the use of existing telecom and power distribution boxes to accommodate vehicle charging, fleet bundling, and eco-routing. Interaction with the passengers and the system will be fostered through the SOLUTIONSplus-MaaS-smartphone application that will consider the growing smartphone ownership of Dar es Salaam's population, to allow a maximum spread of the use and increase smart metering services. An open Application Program Interface (API) will be made available to allow 3rd-parties/software programmers to develop further services.

3.5.2 Use case/s:

The demonstration action will address two highly important challenges of urban mobility: Firstly, how to overcome the last-mile connectivity issue of mass-transit services such as BRT, secondly the issue of sustainability for combustion fuelled small-scale vehicles. Innovative aspects of the project are as follows: it will make electric 3-wheelers appear on the streets of Dar es Salaam for the first time, showcasing the suitability and advantages of electric vehicles; and also it will be placed in different locations in the city (central/down-town, commercial, residential and sub-urban) to test various types of locations and environments with respect to the usability of electric three-wheelers. This includes BRT stations and terminals that are served by 3-wheeler-taxis already and where e-mobility can easily adapt to the micro-local context and integrate into the existing system.

3.5.3 Local regulations:

There is a regulation by the Dar es Salaam City that restricts the use of 3-wheelers in the city centre unless under special registration and permits that need to be paid for. The aim of this regulation is to regulate the amount of traffic in the city centre. The restrictions made by the Dar es salaam city by laws also apply to trucks, two wheelers, and carts. There are also standards released by the Tanzania Bureau of Standards (TBS) on electric three wheelers. The standards have some specifications on safety issues in relation to the cabin of three wheelers, position of batteries in relation to sitting position of passengers and specifications on requirements of three wheelers on slopes (areas of inclination). There are other regulations that relate to tax imposed on SMEs, import tax, etc.

3.5.4 Technical requirements for Demo:

The technical specifications below are suggestions based on the proposals received from the following Start-Ups: Elico, Solar E Cycles Kenya (SECK) and FabLab Rwanda.

A. Vehicle Specifications and Operational aspects

Vehicle Type	Technical Specifications
Electric two and three wheelers by Elico	**Vehicle Aspect** • Conversion of three-wheeler 395 Cc fossil-fuel IC engines and two wheelers with 185Cc IC engines to electric. • Vehicle aspects to be monitored include mileage, charge-times, reliability, horsepower **Operational Aspect** • Multi-purpose charging and e-mobility station • Charging stations will be solar-powered • Capacity to offer changeover batteries with complimentary services at the station such as technology display, and general information sharing on transition to electric mobility • Battery module of 2,3 kWh usable capacity, 4 kWh nominal capacity. • Batteries will be leased-to-use

Light electric solar-powered Tricycle by Solar E Cycles Kenya (SECK) and FabLab Rwanda	**Vehicle Aspect**

TECHNICAL DETAIL	**TRY.KE**
Legal homologation	Pedelec, electric-assist when pedalling, no throttle
Motor Power-Continuous	2 x 350W
Max Speed (Motor Support)	35kph - limited to 25kph
Walk assistance (Start-up help)	6 kph
Vehicle Width	1000mm
Vehicle Length	2050mm
Vehicle Height	1560mm
Cargo Box (bottom section)	600mm x 700mm x 500mm (210l)
Cargo box (top section)	800mm x 750mm x 1000mm (600l)
Cargo volume (Behind driver)	1 m3
Motors (2, optional 3)	BAFANG RM G020.350.D
Controller	CR S207.1000.SN. Dual drive, front/rear light
Tires	KENDA K1167 20*4.0
Rims	P73D 20"*14G*36H A/V
Display	C01DP
Torque sensor	SR PA211.32.ST
Gear hub	2-speed automatic gear hub IG-2S20
Front brake	EB4D T6 Hydraulic Disc Brake Assy 203mm disc
Rear brake	One brake lever with two callipers 203mm disc
MPPT	Victron 100-20 48V
PV & Inverter	300 W, 48V DC - 240V AC 50hz - 12V - USB 1000W
Battery	Lithium-ion 20Ah to 50Ah 48V 1000Wh - 2500Wh
BMS	TBD
Passenger	1 - seated.
Ground clearance	200mm
Driving position	Upright.
Saddle	Adjustable
GVW	300

	Operational Aspect • Solar-powered charging • On-board data/power management system for dedicated customer support, fleet, and real-time maintenance tracking

B. Integration Aspects

Integration Aspect	**Technical Specifications**
Physical Integration	The deployment of e-3 wheelers will happen at 5 DART stations considering urban locations: a) in the city centre, where fossil-fuelled 3-wheelers are currently banned for environmental reasons and where accessibility to/from the BRT stations can be limited due to longer distances; b) in peri-urban areas where combustion-fuelled 3-wheelers are currently very common as feeder-modes.
MaaS App	Interaction with the passengers and the system will be fostered through the SOLUTIONSplus-MaaS-smartphone application. An open Application Program Interface (API) will be made available to allow 3rd-parties/software programmers to develop further services.

3.6 Quito

3.6.1 Brief Description of Demo:

The Historic Center of Quito (HCQ) comprises an urban area of 376 hectares, with a (shrinking) population of approximately 40,000 inhabitants. Declared by UNESCO as the first World Heritage Site in 1978, it is considered one of the most important historical sites of Latin America. Even though the HCQ has been losing residents for the past 3 decades, during daytime it still attracts important influxes of locals and foreigners and concentrates a high amount of business density. Due to its location in the center of a long and narrow city as Quito, the HCQ is an obligatory crossing point for all the commuters from the southern area of the city that go to the Central Business District (CBD) to work and study. However, the colonial urban structure, which remains unchanged, has no capacity to assume the current flow of vehicles, generating high levels of congestion, as well as air and noise pollution.

In such context, the demo project in Quito aligns with the city's aim of converting the HCQ in a Low Emission Zone and will contribute to the establishment of the multi-modal e-mobility hub and to the integration of the existing mass transit lines. The hub in the HCQ's LEZ will take advantage of the existing electric infrastructure of the trolleybus and the subway systems in the area to create multimodal charging points.

The demonstration activities focus on creating connectivity between transport lines and subway stations and on improving supply activities of commercial establishments through various e-mobility solutions in order to contribute to the consolidation of the LEZ in the HCQ.

Good provision is currently complex due to the population density, touristic character, and narrowness of the HCQ streets, which impairs the enjoyment of public space of pedestrians. Moreover, existing regulation on night loading and unloading schedules are not compatible with the business dynamics of the territory, and the infrastructure to support the load demand and download of commercial establishments in the HCQ is deficient. Therefore the demo project also includes the development of a Logistic Plan for the LEZ, specifically designed to cater these particular needs.

In order to comply with the charging requirements of the EVs circulating in the area, the action will take advantage of the DC (Direct Current)-Grid to which the trolleybus catenaries and the subway are connected.

3.6.2 Use case/s:

In order to contribute to the consolidation of the planned LEZ in the HCQ and the integration of the existing mass transit lines, the following use cases are considered:

SOL	Modes	Vehicles	Operation	Integration
Passenger connectivity		**20** E-bikes for the bike sharing system	Charging depot for e-bike sharing vehicles	Physical and tariff integration to the BRT and subway system SOL+ MaaS App
		2 E-buggy	Integrated ticketing, TSY charging system	
		30 E-BRT buses (Procured by the MDMQ)	ABB charging equipment for the BRT system (3 lines) (tbc)	
Last mile logistics		**20** E-cargo bikes for the bike sharing system	Charging depot for e-bike sharing vehicles	Integration of passenger and freight transport in the bike sharing system
		10 E-cargo quadricycles	Distribution Centre and charging points for e-cargo vehicles	GPS and control centre Smart services (apps) Integration of last-mile services
		2 E-delivery van		

3.6.3 Local regulations:

E-mobility is promoted by the national government through various policies and initiatives to promote e-mobility and with a full import tariff exemption for EVs and parts. However, the more relevant local regulations for the assembly and operation of EVs as part of the demo project are listed below:

STANDARD NUMBER	TITLE	SCOPE
	Organic Law of Land Transportation, Traffic and Road Safety - Art (s). 205	Homologation requirement for both mporters of vehicles, spare parts, equipment, parts and pieces; and assemblers
NTE INEN 2656:2012	Vehicle classification standard	This standard applies to all vehicles designed for land circulation (motor vehicles and cargo units)
RTE INEN 034	Minimum safety elements in motor vehicles	This Ecuadorian technical regulation applies to all vehicles that will enter the park Ecuadorian automotive, whether imported, assembled or manufactured in the country.
RTE INEN 136 (1R)	Technical Requirements for Motorcycles	This technical regulation applies to all motorcycles and tricycles that are imported or assembled and commercialized in Ecuador.
NTE INEN 2558	Braking System	Product requirement
RTE INEN 011	Tires (including emergency tires, if any)	
NTE INEN 2556	Mirrors	
NTE INEN 2559	Suspension system	
NTE INEN 2557	Direction system	
NTE INEN 2560	Lighting	
RTE INEN 048	Three-wheeled motor vehicle for passenger transport and freight transport	This Ecuadorian technical regulation applies to allthree-wheeled vehicles for passenger and freight transport, whether imported, assembled or manufactured and commercialized in the country.
RTE INEN 017	Control of Pollution Emissions of Road Movable Sources	This Ecuadorian Technical Regulation applies to both imported and motorized vehicles locally manufactured.
PRTE INEN 162	Charging accessories for electric vehicles	Draft regulation that establishes the technical and safety characteristics that connectors, chargers, wiring and batteries must meet for charging electric vehicles.

3.6.4 Technical requirements for Demo:

A. Vehicle Specifications

E-quadricycle

Parameters	**Specifications**
Dimension (mm)	L2500 * W840 * H1620
Empty weight	180 kg
Payload weight (including driver)	400 kg
Maximum speed	32-40 km/h (can be set in the converter)
Climbing capacity	20%
Maximum range (on flat road)	60 km approx
Modes	3 speed preselectable, reverse mode
Turn radius	3 m
Tyres size	80/90-17 antipuncture
E-motor power	1200 W (to be finally defined with Valeo)
Battery	type: Lead Acid or LiPo - 60-72-96 V, 80-60-40 Ah life: 500 charges to 100%
Charger	can be integrated or external
Motor	directly connected to the gearbox (1:15) and to the differential to the rear wheels
Suspension system	front: independent, 150 mm stroke rear: monoshock type, 150 mm stroke
Further equipment	front lights, rear light, directional light horn Rear camera on behalf of rear mirror USB charging port

Eride 3.0 "Phoenix" prototype

e-cargo bike: two-wheeler (Long Jhon) and tricycle

Parameters	**Specifications**
Frame material	A36 steel frame
Modes	16 speeds
Motor	600 - 1000 W Model: central box
Battery	lithium battery

Reference picture:

E-buggy

Parameters	Specifications
Dimensions (mm)	L3070 * W1360 *H1800
Seats	4
Load capacity	400 kg
Weight equipped	600 kg
Wheels	155/60/13 wheel base: 2040 mm
Ground clearance	130 mm
Radius of turn	2,5 m
Track	1000 mm
Range	200 km
Speed	max. 40 km/h
Engine type	Synchronous engine with constant magnets
Peak power	3,5 kW
Battery	type of traction: Li-ion capacity: 11,8 kWh nominal voltage: 51 V auxiliary battery: 12 V / 60 Ah
Charging time	6 h
Operating hours	5-6 h
Motor	on the rear axle
Modes	remote or autonomous
Features	all mechanisms (steering system, brakes, electric motor) are driven by drives electrical

Reference picture:

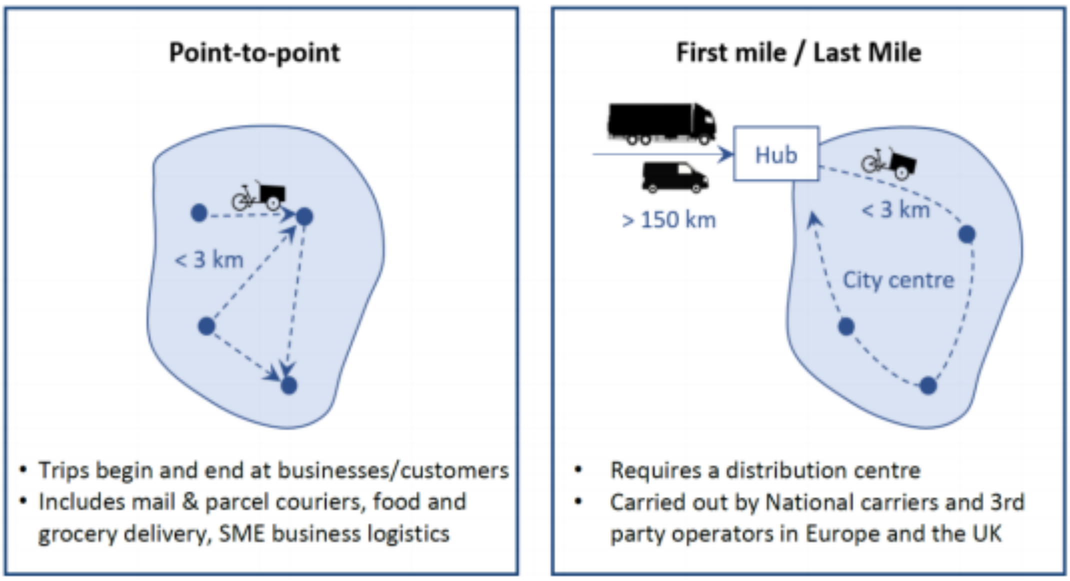
E-delivery van

Dimensions (mm)	L 3530*W 1.500*H 1.980
Seats	2
Load capacity	
Maximum autonomy	72 km
Maximum negotiable slope (with high-performance batteries)	30%
Top speed	44 km/h
Unloaded vehicle weight	900 kg
GVW | gross vehicle weight	1510 kg
Maximum motor power	14 kW
Maximum motor torque	113 Nm
Minimum turning radius	2600 mm

Reference picture:

B. Operational Specifications

Regarding freight activities in the Quito central area, key issues that hinder the efficiency and sustainability of last mile/first mile/point to point deliveries are being assessed and two freight services are being considered: P2P services collect items from one party and deliver them to another party at a different location whereas first/last mile services carry deliveries from a local distribution center to a customer.



Regarding micro hub location, it may be on the edge of the Low Emission Zone. One of the main determinants of location for transhipment point is a requirement for a short distance from the distribution center to the commercial establishments because of the range of vehicles and also the topography of the HCQ.

Location of logistics hubs will be determined based on supply chain perspective (reduction in transportation costs and lead time) and represents an output of the “software” stage and it is considered as a strategic and long term decision due to the large amount of capital invested and the length of time that facilities will be available.

Sizing of micro hubs will depend on their number and the demand for delivery generated by commercial activities in the gravitating area as well as the delivery times. The demand can be subject to variability in terms of magnitude (number of deliveries per day) and time (from one day to another).

On the connectivity with public transport side, at the moment, there are still ongoing discussions about the ABB charging, which depends on the local definitions on the number of buses and operations, as well as on the electricity grid. Two types of chargers are being considered, the technical specifications can be found in the tables below. The first option (Terra CE 184 CC 0-7M-0-0) includes 2 connections, simultaneous charging is possible. The second one (HVC CE 150 C-M-0) includes 3 connections but allows only sequential charging.

DC Fast Charging Terra UL: CE 184 CC 0-7M-0-0

Characteristics	**Specifications**
Extended product type	Terra CE 184 CC 0-7M-0-0
Descriptions	Terra 180 kW charger, CCS and CCS; Terra 184 EV charger, 90 kW, with 2 connectors, CCS and CCS, CE
Product ID	6AGC080811
Output power	DC 180 kW
Nr. of EV connectors	(CSS 2) 2 pieces
Nr. of socket outlets	No socket outlet
Connection power	Nominal 192 kW
Nr. of phases	3
Nr. of RCDs electric vehicle supply equipment	Type A 2 piece
Nr. of miniature circuit breakers (MCBs)	3

Communication Interface	3G; 4G; Ethernet
Authentication Method	RFID NFC Pincode App
Energy meter type	DC
Screen size	7 in
Mounting type	Floor fastening
Degree of protection	acc. to IEC 60529 IP54
Impact Resistance Rating	Housing IK10 Display IK08
Housing Material	Steel
Load management method	OCPP-based

Reference picture:

HEV-charger

Characteristic	**Specification**
Dimensions (W,D,H)	Power cabinet: 1170 x 770 x 2030 mm Depot eh arge box: 600 x 220 x 800 mm
Connection method between charger and bus	CSS 1 or CSS 2

Power	100 kW, 150 kW
Input AC connection	3P + PE
Rated input current & power (per 150 kW module)	100 kW: 3 x 170 A, 117 kVA 150 kW: 3 x 250 A, 173 kVA
Input voltage range	400 V AC +/-10% (50 Hz or 60 Hz)
Maximum output current (per 150 kW power cabinet)	100 kW: 166 A 150 kW: 200 A (limited by CCS cable)
Output voltage range	150 - 850 V DC
DC connection standard	IEC 61851-23 / DIN 70121/ ISO 15118
Environment	Indoor / Outdoor
Operating temperature	Standard: -10 °C to +SO °C Optional: -35 °C to + 50 °C
Network connection	GSM / 3G modern 10/100 base-T Ethernet
Protection	Charge cabinet: IP54- IK10 Depot charge box: IP65- IK10
Sequential charging	Up to 3 outlets per charger
Cable length between depot charge box and cabinet	Up to 150 m
Cable length between 2 depot charge boxes	Up to 30 m
Cable length connector	Standard: 3.5 m Optional: 7 m

Reference picture:

Heavy Vehicle Charging Connector CE: HVC CE 150 C-M-0

Characteristic	**Specification**
Extended product type	HVC CE 150 C-M-0
Descriptions	HVC-C 150 kW Master power cabinet, CE; HVC power cabinet 150 kW, master configuration, CE, to be used in combination with Depot Charge Box
Product ID	6AGC073512
Screen size	7 in

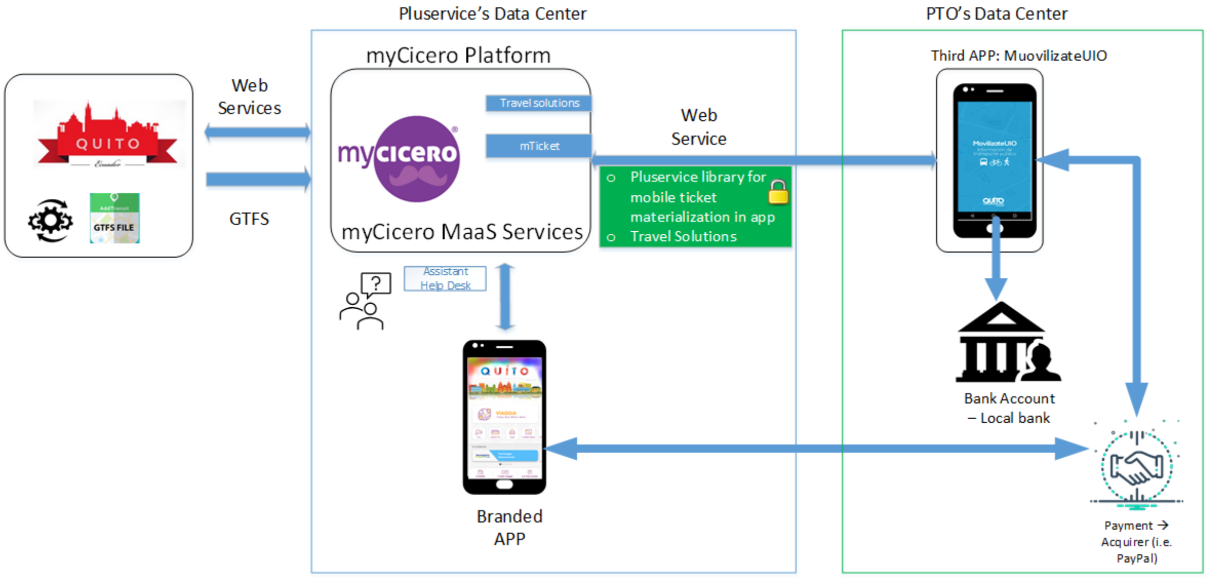
Source: ABB catalogue

C. Integration Specifications

The HCQ is very centrally located in Quito, many shops and governmental institutions are located in this area. That's why it is an important hub for many people from different parts of Quito. Different public transport infrastructure is available, like three BRT bus lines (operated by EPMTPQ 'Empresa Pública Metropolitana de Transport de Pasajeros de Quito'), and from 2021, a metro line will also run through it (operated by EPMMDQ 'Empresa Pública Metropolitana Metro de Quito'). Walking and cycling infrastructure is sometimes available, but often in bad condition.

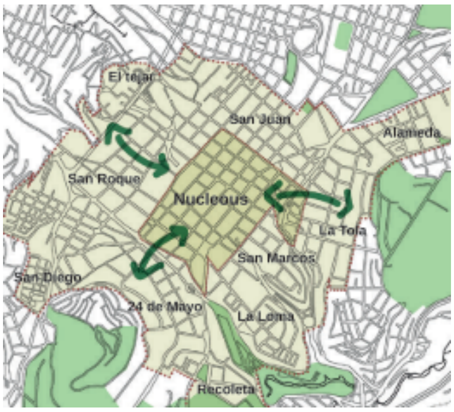
As one aspect of 'mobility as a service', an app shall be implemented, which combines different services for the customers and though facilitates the use of public transport. Important actors are the city of Quito, Pluservice, and the public transport operators (PTO) EPMMDQ and EPMTPQ. The app shall enable the users to combine every service needed to use public transport, from planning a route, checking the timetable, buying a ticket, and paying for it. Until now, the paying mechanisms vary between the PTOs: while for BRT you have to buy a physical ticket, for the metro a mTicket is planned which works with QR-codes.

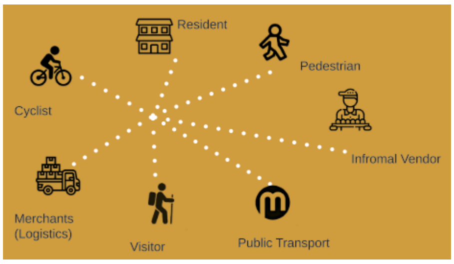
While the BRT and metro lines provide good connections from north to south, transversal connectivity between east and west do not exist so far. The implementation of an intermodal corridor in the HCQ shall fulfill this, while at the same time promoting micro-mobility, and supporting intermodal transport. (Charging-) infrastructure for electric two- and three-wheelers as well as cargo bikes shall be created. The intermodal corridor will extend from the BRT station 'San Roque' in the western part to the station 'La Marin' in the eastern part of the HCQ. Other BRT and metro stations as well as logistic centers lie within or near the intermodal corridor. The streets within the intermodal corridor are old colonial streets with a width of 6-7 meters.



By making the transport in the HCQ more diverse, a bigger spectrum of actors and stakeholders that has to be included.

A general challenge for the city of Quito is the social disruption between richer and poorer areas, in which the HCQ functions pretty much as the border between these. The implementation of the intermodal corridor can also be seen as a chance of connecting these regions better with each other, improving the connection and accessibility to the city, and by that contributing to social and cultural integration.





3.7 Montevideo

3.7.1 Brief Description of Demo:

The Demo for Montevideo has two components: the first one is the promotion of local manufacturing of electric vehicles for last mile logistics, and the second one is the installation of charging infrastructure for e-buses in the Old City (city center) of Montevideo. The modes, quantity, operation and integration of each component is indicated in the following table:

Modes	Vehicles	Operation	Integration
	10 E-taxis (Procured by private operators)	Multi-standard 50 kw fast charging for E-taxi	Bus and taxi service integration
	30 E-BRT buses (Procured by the IM)	Charging infrastructure for PT integration (3 lines)	PT integration Interoperability
	15 E-cargo bikes	Charging points for e-cargo bikes	Integration to the MOVÉS renting scheme and green fleet program
	3 E-cargo tricycles	Charging points for E-3-wheelers	

Regarding the first component -last mile logistics- , SOLUTIONSplus is cooperating with the MOVÉS project, a GEF financed project that is being carried out in Uruguay, for a joint program that will integrate: 1) local assembly of e-cargo bikes and electric 3/4-wheelers, 2) a renting scheme for the produced vehicles that will ensure producers a renting fee for each vehicle during a year, and 3) identification of potential long term users of the produced vehicles. The estimated quantity of vehicles that will be financed by this call and program is 15 e-cargo bikes and 3 electric tri/quadri-cycles.

In collaboration with MOVÉS, a call was already launched in order to support the manufacturing of these tricycles (3/4-wheelers) and e-cargo bikes. Within the options managed, there is the possibility of building a tricycle with considerable load capacity and adequate performance for various types of goods, including heavy ones. As it is shown in the tables below, some specifications were already defined but there will be other technical specifications and design criteria that will be presented by every candidate and will be defined after being awarded.

3.7.2 Use case/s:

For tricycles and/or quadricycles the possible use cases are:

- o Last mile deliveries.
- o Freight transport (eg: gas cylinders, bulky waste, etc.)
- o Other uses proposed by the Local Manufacturer

For e-cargo bikes the possible use cases are:

- o Deliveries of fast food, restaurants and cafeterias
- o Products of supermarket, pharmacy and other items
- o Solid waste collection
- o Other uses proposed by the local manufacturer

3.7.3 Local regulations:

The local standard UNIT 1234-2016 covers the requirements of the connectors for tri/quadri-cycles. At the present, no additional local regulations are formally required for this type of vehicle but it is expected to ask for the UN regulations compliment in the shirt time. Besides standards and requirements for homologation (not mandatory at the present), every tri/quadri-cycle must comply with a licence issued by the Municipality of the city as well as a binding insurance for that kind of vehicle.

Currently, a revision of the UNIT 1234-2016 is being carried out in order to integrate the charging requirements for direct current (DC). The draft of that revision indicates that the normalized connector for DC charging infrastructure is CCS combo 2 in correspondence with IEC 62196.

3.7.4 Technical requirements for Demo:

First Component

The vehicle specifications for tricycles and quadricycles are the following (each applicant will present their own design. The requirements established in this table are a minimum that the applicant must comply with no other minimum design specifications, except those arising from compliance with local licensing and regulations):

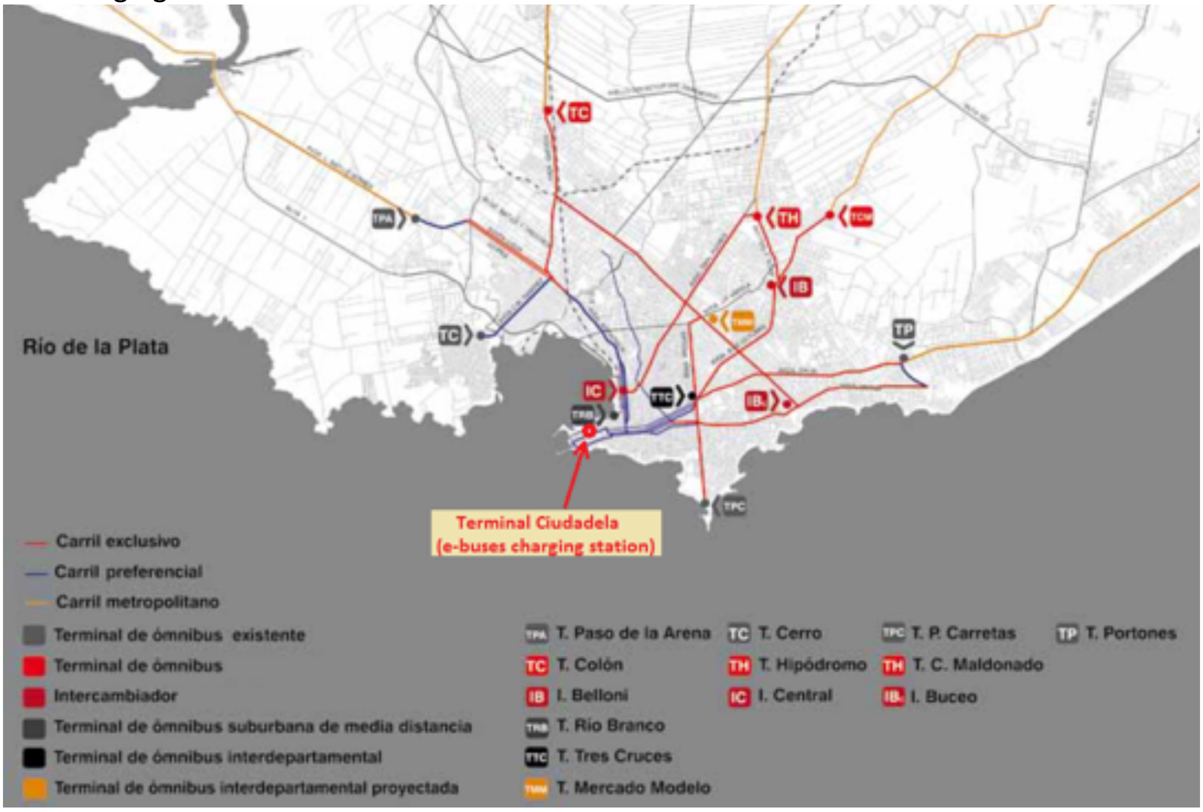
Characteristic	**Specification**
Accelerator:	They may have an accelerator, and be self-propelled.
Number of wheels:	Three or four wheels.
Minimum load capacity (min. payload):	200 kg
Maximum load capacity (max. payload):	600 kg
Maximum speed:	45 km/h
Minimum autonomy (range):	80 km
Minimum slope:	10%
Type of connector:	Type A connector according to the local Standard UNIT 1234

The vehicle specifications for e-cargo bikes are the following:

Characteristic	Specification
Electric assistance:	Pedal assistance (without accelerator / without self-propelled).
Number of wheels:	two or three wheels (vehicles with more than 3 wheels could be evaluated)
Minimum load capacity (payload):	80 kg
Minimum volume capacity:	0.10 m3 (100 liters)
Maximum pedaling assistance speed:	25 km/h
Frame dimensions:	To be developed by the designer.
Suggested Frame Material	Aluminum / carbon fiber / iron / steel / bamboo / others
Electric Motor:	Selected by the designer / Max. Power 250W
Battery chemistry:	Lithium-ion
Tyre:	Depending on the design.
Display:	Not mandatory
Charger:	230V / 50Hz / 2ph
Charging time:	6-8 hours
Max assisted speed:	25km/h
Range:	Depending on battery sizing
Brakes:	Disc brake / Mechanical brake / sensor based (not mandatory)
Battery life:	>1000 cycle
Climbing capacity:	>10%

Second Component

The second component for Montevideo city consists of the installation of e-bus charging infrastructure. Currently, there are 140 bus lines that have 107 destinations and 4721 stops covered by 1528 buses, 31 of which are electric. In the image below, it is possible to see the main corridors, terminals and the main structure of the Metropolitan Transport System (STM). In the picture it is indicated the localization of the Ciudadela Terminal, the place where the e-bus charging infrastructure would be installed.



Source: mobility plan report "towards an accessible, democratic and efficient mobility system 2010-2020", Municipality of Montevideo.

As regards the terminal and its surroundings, it was signed an agreement between UTE (the public utility company of Uruguay) and UDELAR (Public University) in order to design public spaces for electric vehicles charging stations. In that context, some specific work would be carried out on the Ciudadela Terminal that could be further implemented on site.

The e-bus public transport fleet currently has 21 BYD electric buses equipped with connectors CCS type 2, and 10 Yutong electric buses equipped with the Chinese standard GB/T. After an exhaustive analysis of the situation it was concluded that the charging infrastructure must comply with the standard that will apply for the new buses - not for the existing ones.

The Uruguayan Institute of Technical Standards (UNIT, a non gubernamental independent organization) has started the process for the standardization of connectors for DC charging infrastructure. The first draft (currently in stage of public consultation) was issued being the proposed connector the CCS combo 2 in concordance with IEC 62196.

The existing BYD electric buses would require the following technical specifications: 2x40 kW AC, Type 2, for charging in Mode 3 - Case C. It is expected that the future requirement for electric buses is CCS combo 2 (according to the new local normative and new requirements from the side of the government). The maximum current for this connector is 200 A (DC) and the maximum voltage is 1000 V (DC). At the present, it is not defined the requirement of maximum power (kW) for the future electric buses. The table below summarize the local normative that is related to the electric mobility in Uruguay:

Std. Number	Title	Scope
UNIT IEC 61851-1: 2017	"Conductive charging system for electric vehicles – Part 1: General requirements".	This standard is the first part of the IEC 61851-1 series that specifies the general requirements for the supply of electrical energy for electric road vehicles. It should be noted that the vehicle and the electric vehicle power system are a complete system that is covered by a series of IEC and ISO standards. IEC 61851 covers the mechanical, electrical, communication, EMC, and performance requirements for the VE power system used to charge electric vehicles, including light electric vehicles.
UNIT 1234:2016	"Conductive Charging System for Electric Vehicles – Vehicle Tabs, Sockets, Vehicle Connectors and Vehicle Input Connections – Standard Formats".	This standard establishes a system of standardized formats for tokens, outlets, vehicle connectors and vehicle entrances for conductive vehicle charging AC. This standard is under revision in order to regulate the DC charging connectors.
Decree 373/003	"Regulation on the handling and disposal of electric lead-acid batteries or accumulators for starting engines."	This Decree regulates the handling and disposal of electric lead-acid batteries or accumulators for starting engines. This decree is being updated to adapt it to the new battery technologies that electric vehicles incorporate. It is expected to be issued the new regulation during the first semester of 2021.
UNIT 1130: 2013	"Energy Efficiency – Light Automotive Vehicles – Labeling."	This standard establishes the criteria for defining the performance of light vehicles and the characteristics of the energy efficiency label. A UNIT technical committee is currently active to update the standard, which will include vehicle efficiency labeling for electric and hybrid vehicles.

Operational Specifications

At the moment, there are still ongoing discussions about the ABB charging, which depends on the local definitions on the number of buses and operations, as well as on the electricity grid. Two types of chargers are being considered, the technical specifications can be found in the tables below. The first option (Terra CE 184 CC 0-7M-0-0) includes 2 connections, simultaneous charging is possible. The second one (HVC CE 150 C-M-0) includes 3 connections but allows only sequential charging.

DC Fast Charging Terra UL: CE 184 CC 0-7M-0-0

Characteristic	**Specification**
Extended product type	Terra CE 184 CC 0-7M-0-0
Descriptions	Terra 180 kW charger, CCS and CCS; Terra 184 EV charger, 90 kW, with 2 connectors, CCS and CCS, CE
Product ID	6AGC080811
Output power	DC 180 kW
Nr. of EV connectors	(CSS 2) 2 pieces
Nr. of socket outlets	No socket outlet
Connection power	Nominal 192 kW
Nr. of phases	3
Nr. of RCDs electric vehicle supply equipment	Type A 2 piece
Nr. of miniature circuit breakers (MCBs)	3
Communication Interface	3G; 4G; Ethernet
Authentication Method	RFID NFC Pincode App
Energy meter type	DC
Screen size	7 in
Mounting type	Floor fastening
Degree of protection	acc. to IEC 60529 IP54

Impact Resistance Rating	Housing IK10 Display IK08
Housing Material	Steel
Load management method	OCPP-based

Reference picture:

HEV-charger

Characteristic	**Specification**
Dimensions (W,D,H)	Power cabinet: 1170 x 770 x 2030 mm Depot eh arge box: 600 x 220 x 800 mm
Connection method between charger and bus	CSS 1 or CSS 2
Power	100 kW, 150 kW
Input AC connection	3P + PE
Rated input current & power (per 150 kW module)	100 kW: 3 x 170 A, 117 kVA 150 kW: 3 x 250 A, 173 kVA
Input voltage range	400 V AC +/-10% (50 Hz or 60 Hz)
Maximum output current (per 150 kW power cabinet)	100 kW: 166 A 150 kW: 200 A (limited by CCS cable)
Output voltage range	150 - 850 V DC
DC connection standard	IEC 61851-23 / DIN 70121/ ISO 15118
Environment	Indoor / Outdoor

Operating temperature	Standard: -10 °C to +SO °C Optional: -35 °C to + 50 °C
Network connection	GSM / 3G modern 10/100 base-T Ethernet
Protection	Charge cabinet: IP54- IK10 Depot charge box: IP65- IK10
Sequential charging	Up to 3 outlets per charger
Cable length between depot charge box and cabinet	Up to 150 m
Cable length between 2 depot charge boxes	Up to 30 m
Cable length connector	Standard: 3.5 m Optional: 7 m

Reference picture:

Heavy Vehicle Charging Connector CE: HVC CE 150 C-M-0

Characteristic	**Specification**
Extended product type	HVC CE 150 C-M-0
Descriptions	HVC-C 150 kW Master power cabinet, CE; HVC power cabinet 150 kW, master configuration, CE, to be used in combination with Depot Charge Box
Product ID	6AGC073512
Screen size	7 in

Source: ABB catalogue

3.8 Madrid

3.8.1 Brief Description of Demo:

The demo in Madrid focuses on implementing electric charging solutions for the e-bus fleet of the local public transport operator EMT, as well as its management. For this purpose, 3 inverted pantographs and 1 charging cable will be installed at the bus depot Carabanchel located in the southern part of Madrid. A virtual monitoring system will enable secure and smart charging solutions. Additionally, the integration of e-taxis and shared electric vehicles into the e-charging infrastructure is planned.

3.8.2 Use case/s:

The demo will contribute to the testing of new and innovative charging technologies, such as inverted pantographs, to the ones that are already existing in Madrid in order to accelerate the electrification of the bus-fleet in Madrid by providing safer and more efficient charging solutions. By that, the demo contributes to making Madrid's public transport more environmentally and economically sustainable: Electric vehicles do not only save emissions like NOx and CO2, the costs per 100 kilometers are also cheaper in comparison to other drives like combustion engines.

3.8.3 Local regulations:

Madrid has made a huge progress in terms of the electrification of its bus fleet, which will continue in the next years. Yet, the regulations related to charging infrastructure are still inexistent, making the interoperability of their existing e-bus fleet a challenge. The technical specifications for charging equipment are stipulated only in the individual tenders. However, it is worth mentioning that in order to advance to standardisation and interoperability of its e-bus fleet, the EMT assigns extra points to manufacturers that provide electric buses that comply with international charging standards. The following table summarizes the Directives, regulations, standards and plans that have an influence on the implementation of this demo.

Title (Number)	Scope
EU Directive on Promotion of Clean and Efficient road transport vehicles (2009/33/EC)	EU member states are required to develop national policy frameworks for the market development of alternative fuels & infrastructure (Directive on Alternative Fuel Infrastructure of 2016) and to consider energy consumption and environmental impacts when purchasing and leasing road vehicles (Directive on Promotion of Clean and Efficient road transport vehicles; 2009/33/EC). A revision of this Directive entered into force in August 2019 (Clean Vehicle Directive; 2019/1161/EU), setting out mandatory minimum procurement targets in each Member State for clean light-duty vehicles, trucks and buses for 2025 and 2030.
Madrid 360	Madrid 360 is a plan developed by Madrid's Municipality

	to improve the air quality in the city. One of its targets is the electrification of the EMT fleet by increasing the number of e-buses to 667 by 2027.
Strategic Plan EMT	The Strategic Plan summarizes the EMT's objectives for the next years and the pathways to achieve them. One target is to increase the number of state-of-the-art ecological vehicles such as e- and hybrid-vehicles.
Reglamento Electrónico Baja Tensión	The REBT regulates low voltage electrical installations in Spain. They have to be compliant with the REBT to ensure certain safety standards.
Electric vehicle conductive charging system. Part 1: General requirements (UNE-EN IEC 61851-1: 2020)	This part of IEC 61851 applies to EV supply equipment for charging electric road vehicles, with a rated supply voltage up to 1 000 V AC or up to 1 500 V DC. and a rated output voltage up to 1 000 V AC. or up to 1 500 V DC. Electric road vehicles (EV) cover all road vehicles, including plug-in hybrid road vehicles (PHEV), that derive all or part of their energy from on-board rechargeable energy storage systems (RESS).

3.8.4 Technical requirements for Demo:

A. Vehicles and charging equipment

Vehicles

The buses used for the demo will be standard buses of a length of 12 meters. Batteries on board will provide them with energy during their daily performance. The minimum range shall be sufficient to provide service for 16 hours at an average commercial speed of 14 km/h. The charging will only take place during the night, with a maximum of 5 hours to fully charge them.

The demo in Madrid focuses on the installation of charging infrastructure to charge the existing and future e-bus fleet. However, the e-buses will have to fulfill certain characteristics to be able to charge using the proposed inverted pantographs. Thus, the existing e-buses will have to undergo some modifications and the new ones will have to include additional specifications in the tenders. The following table indicates the characteristics that the buses should have.

Roof bars

Equipment designation	contact rail
Rated voltage	750 V DC
Permanent charging current	600 A
Short-circuit current (individual error)	3,000 A for 100 ms
Built-in electrical heating	
Rated voltage	24 V/DC
Power rating	85 W
Connection plug for the heating unit	pin housing 2 pin contacts

Reference picture of pantograph and roof bars

Source: Technical Documentation Stemmann-Technik

Inverted Pantographs

Two different types of inverted pantographs will be installed: OppCharge Overnight Pantograph (400 A at 200-900 VDC), and OppCharge Pantograph (400++ A at 200-900 VDC). Matrix load will be possible, meaning that the pantographs share the load between them depending on the amount of buses that are connected at the moment. The following power configurations are needed for the interfaces: 4*90 kW, 1*90 kW + 1*270 kW, 2*180 kW, 1*360 kW. Sound emissions are limited to 75 dB at 1 meter front facing at a height of 180 cm.

Characteristic	**Specification**
Dimensions (W,D,H)	Power cabinet : 1170 x 770 x 2030 mm Pole: 4850 x 1060 x 5820 mm
Power range	150 - 300 - 450 - 600 kW
Input voltage range	400 V AC +/- 10% (50 Hz or 60 Hz)
Output voltage range	150-850 V DC
Input AC connection	3P + PE
Rated input current & power (per 150 kW power cabinet)	3*250 A, 173 kVA
DC connection standard	IEC 61851-23 / OppCharge
Connection method between charger and bus	4-pole automatic connection system
Environment	Indoor / Outdoor
Operating temperature	Standard:-10 °C to +50 °C Optional: -35 °C to + 50 °C
Network connection	GSM / 3G modern 10/100 base-T Ethernet
Protection	IP54- IK10
Lowering time	approx. 5-10 sec.
Raising time	approx. 3-7 sec.

Source: ABB catalogue

Collector head	
Rated voltage	750 V DC
Permanent charging current	600 A
Short-circuit current (individual error)	3,000 A for 100 ms
Ambient temperature	-40°C / +75°C
Contact strip length per Pol	approx. 570 mm
Protection type 750 V DC	IP 00 acc. IEC 529, EN 60529
Sensor-detection highest/ lower position	
Sensor type	Inductive sensor
Electrical design	DC PNP
Operating voltage	10 up to 30 VDC
Current consumption	<20 mA
Current rating	200 mA
Ambient temperature	-25°C up to 70°C

Protection	IP 67
Contact rails for electrical heating	
Rated voltage	230 V/AC
Power Rating	60W
Protection type for heater	IP 65

Source: Technical Documentation Stemmann-Technik

B. Operational Specifications

EMT will equip the portal with a high power grid. The electricity supply shall be extended by 5 MW to provide the necessary energy for charging and the assembly of two transformer centers to integrate all the new electrical equipment. The buses will be equipped with roof bars. The charging communication protocols of the buses will be changed to enable charging by inverted pantographs. The connection with the overhead pantograph will be fully automated, in contrast to the current charging with cables which is done manually. The interfaces are interoperable with different brands, in the Madrid case with Irizar and ByD. A software for monitoring the charging efficiency and reporting problems will also be provided by ABB, enabling smart charging. Together, the inverted pantographs and the software will increase the efficiency and safety of the charging process.

Apart from buses, EMT also plans to facilitate access of e-taxis and e-car sharing-vehicles to the charging infrastructure. For that, the creation of an electric mobility hub in the city centre of Madrid is planned.

C. Integration Specifications

The pilot will be carried out in the Carabanchel bus depot in the southern part of Madrid. It's area is 65,000 km². At the moment, 420 buses are stationed there, providing service to 48 bus lines. In 2021, 50 electric buses will be stationed there. By that the e-bus fleet will be well integrated into the public transport system of Madrid, making it more sustainable.


Centro de Operaciones Carabanchel

A high amount of electricity will be needed to meet the demand, but as the buses will charge primarily during the night, when the electricity demand is low, this should not cause shortages. Apart from the pantographs that are planned to be installed with the contribution from SOLUTIONSplus, the city of Madrid plans to further extend its e-bus charging infrastructure. By the end of this year 2020, Madrid will have 105 e-buses running in the city, and until 2027, the size of the e-bus fleet shall grow to 667.

3.9 Hamburg

3.9.1 Brief Description of Demo:

The demonstration action in Hamburg is on e-mobility for last mile connectivity, especially in the city periphery. The public transport operator (Hochbahn) will develop an e-kick-scooter sharing system with support of the project, which will aim to test an incentive and pricing scheme that complements the public transport system and coverage rather than competing with it. The introduction of smart last-mile services in the peri-urban area will be part of demonstration activities. The vehicles (e-kick scooters) will be provided and the system will be operated by an external provider.

Another important project is the implementation of the mobility platform *switchh (https://www.switchh.de)*. The platform is coordinated and managed by Hamburger Hochbahn AG (see below), private car-sharing providers Share Now and Cambio and the bike-sharing provider StadtRad. The platform provides an app with which all forms of mobility can be booked easily and from a single source. This makes it easier for users to switch from one mode to the other (BMVI 2018). Next to the app there are so-called *switchh*-stations, installed by HOCHBAHN, which are parking spaces integrating the different car-sharing operators acting as real intermodal connection points. 150 of these are to be equipped with e-charging stations for e-sharing vehicles.

One recent trend is, like in many other cities, use of e-scooters for micro-mobility. E-scooters were introduced to Hamburg in summer 2019 and as of October 2019 there are almost 7.500 of these vehicles stationed from four different companies, mostly in the inner city.

3.9.2 Use case/s:

The demonstration of the e-scooter sharing system as a first and last mile solution will focus on a suburban area of the city of Hamburg. The demonstration action in Hamburg is about providing and implementing an e-scooter-sharing-service for last mile connectivity, especially in the outskirt area. The overall objective is to expand and enhance the attraction of public transport.

The chosen business area in the outskirts will not be profitable in the short run. Therefore, it will be necessary to pay potential service providers an operation fee to balance operating cost due to higher relocalisation activities in these areas. In the long run, there might be the opportunity of revenue enhancement by increasing the attractiveness of public transport, expanding existing mobility offers and attracting new customers to public transport.

Approach:
E-scooter are collected and charged overnight. In the morning the provider will place e-scooters in residential areas, so that the customer can use the e-scooter to get to the nearest public transport station. On the way back, the e-scooters should be positioned at the public transport station (on specially provided park and ride areas), so that the customer can take the e-scooter for the last mile. To increase the added value for the customers, the e-scooter sharing system will be integrated into Hamburg's mobility as a service (MaaS) app.

3.9.3 Local regulations:
As a reaction to persistently high levels of nitrogen dioxide concentrations in many German cities (exceeding EU limits), the German government decided to authorise small electric mobility vehicles on public roads in Germany, in order to relieve traffic and to make urban transportation more environmentally-friendly. The German Ministry for transport acknowledges micromobility vehicles as a valuable option to covering short distances, in particular so-called last mile mobility[5]. In 2019, the national *personal light electric vehicles Ordinance (PLEV)* came into force, which allows the use of Personal Light Electric Vehicles with a handlebar or a stanchion on public roads. Moreover, the Federal Motor Transport Authority (Kraftfahrtbundesamt, KBA) issued a list of the general type approvals for Personal Light Electric Vehicles.
The City of Hamburg has been quite successful in implementing activities to transform urban mobility towards a more sustainable one. The activities are embedded in different programs and plans, outlining respective measures (see BMVI 2018), e.g.:

- The Mobility Program of 2013 (Mobilitätsprogramm) in the context of continuous mobility planning,
- The Second Clean Air Plan (Fortschreibung Luftreinhalteplan, LRP) of 2017, containing different measure to comply with the NOx emissions,
- The concept for further developing electro-mobility (Konzept zur Weiterentwicklung der Elektromobilität 2017) in 2017 and the Masterplan charging infrastructure (Masterplan Ladeinfrastruktur) of 2014 to accelerate the electrification of vehicles in commercial fleets and private use,
- ITS (Intelligent Transport Systems) Strategy for Hamburg of 2016 and its continuation in 2018 for the continuous digitization of the transport system,
- Hamburg Noise Action Plan of 2013 and its continuation (2018) to reduce the impact of noise on the population,
- Hamburg Climate Plan 2015 for the reduction of CO_2 emissions,
- The SmartPORT Initiative of the Hamburg Port Authority with the partial aspects "logistics" to improve the traffic and goods flows,

[5] https://www.bmvi.de/SharedDocs/EN/Articles/StV/Roadtraffic/light-electric-vehicles-faq.html (assessed 27.10.2020)

- The "Hamburg Green City Plan", focusing on electrification, digitalisation, urban mobility and logistics[6] (BMVI 2018).
- In December 2019 it adopted the continuation of Hamburg's Climate Plan, with a CO_2 emission reduction target of 55% by 2030 (and climate neutrality in 2050).
- climate protection law, creating a binding legal framework for reduction targets (December 2019).

3.9.4 Technical requirements for Demo:

A. Vehicle Specifications

Vehicle Type	**Technical Specifications**	**Local and National Regulations**
E-scooter	In order to be legally used on public roads in Germany, PLEVs must meet the following conditions: • handlebar or stanchion (at least 500mm) • maximum design speed of at least 6 km/h up to a maximum of 20 km/h, • two independent brake systems with deceleration value of at least 3.5 m/s^2 (and an individual minimum deceleration of 44 per cent of the brake force in the event of failure of the other brake) **Drivetrain** power restricted to 500 watt (1400 watt for self-balancing vehicles) **Battery** Batteries must meet the safety requirements of chapter 4.2.3 of DIN EN 15194:2018-11 **Total weight** maximum vehicle mass without driver not exceeding 55 kg	Road Traffic Ordinance (StVO), Road Traffic Licensing Ordinance (StVZO), Vehicle Registration Ordinance (FZV)

[6] Under the National Government´s initiative on Clean Air 2017 - 2020 Immediate Programme ("Sofortprogramm Saubere Luft") all cities with air quality standards not complying with EU limits, had to formulate such a plan as prerequisite for the use of federal funding.

	Dimensions (length, width, height) overall width not exceeding 700 mm, overall height not exceeding 1400 mm overall length of not more than 2000 mm **Passengers** Max. 1 Passenger, no additional passengers allowed	

B. Operational Specifications

Operational Aspect	**Technical Specifications**	**Local and National Regulations**	**Related local considerations**
Charging	- Voltage - Frequency (hz) - Number phases - Type of charging equipment - Electric infrastructure - Power source - charging time - Type of connector	- fire protection	- local infrastructure - available parking spaces (nearby the stations) - power network
Battery manageme nt	- Battery swapping - Battery reuse and / or recycling		Battery swapping by: - provider - user
Communica tion devices / system / software (screen, interface, HMI, etc)	- GPS tracking - charging modules - App (booking process)	- data protection - anonymised motion profile	- HVV switch app
Safety aspects	Vehicles must have effective protection against direct contact with all electrically live components.	Driving Licence Ordinance, Personal light electric vehicles Ordinance	- (online) driving school if requested - safety trainings

	The engine power control must automatically reset to zero within one second when released. PLEV with maximum design speed of over 12 km/h must be driven in bicycle lanes and may be driven by persons aged 14 and over. No driving licence is required, but the vehicle must be insured. Helmet Indicator Power box		

C. Integration Specifications

Integration Aspect	**Technical Specifications**	**Local and National Regulations**	**Related local considerations**
Physical Integration	- location - infrastructure - parking spaces/zones - racks	- building regulations - escape and emergency routes - regulations for passenger transport	- park and ride stations - switch stations
MaaS App	- combination of different transport modes - deep integration	- existing travel tariff of Hamburg	- incentive schemes for intermodal transport