D1.4 Data Collection Plan

V2C2

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Executive summary

In order to be able to answer any critical question in a well-founded way, data needs to be collected methodically first and then analysed. This makes data collection an integral part of any successful impact assessment. The evaluation of the impact of the SOLUTIONplus demo projects is based on a sound collection and analysis of data generated during the implementation of the demo/pilot projects within the demonstration cities.

However, data collection in SOLUTIONplus is not simply about counting and describing the relevant data sources, because the impact questions to be answered and the data sources that enable them to be answered need to be connected. Therefore, first of all, creating a data collection strategy requires the generation of a comprehensive understanding of the demonstration project, including requirements and objectives, the operational strategies of the e-mobility solutions to implement and the stakeholders involved and affected by the new mobility offering.

Stakeholders pursue different goals and thus different impacts may be more or less relevant for them with respect to their business strategy or mission. In a second step, precise questions for impact analysis must be developed together with those partners that are responsible for the demo project implementation. Although a well-balanced impact assessment for the demo project seems to be appropriate, it is nevertheless important to give priority to evaluating those impacts that are of significant importance for the partners who are responsible for the operation of the e-mobility solutions. At the end of the day, the business models of the demo projects should above all be financially sustainable so as not to jeopardise the operation of the e-mobility solutions.

In a third step, to finally answer the jointly developed impact assessment questions, a definition of the required data sources must be made. In this process, some data (e.g. log files, transaction data or operation data) is already generated as a by-product of the implementation of the demo project and the operation of the e-mobility solution. However, these automatically generated data may not be sufficient to answer all the questions of the impact assessment and it may therefore also be necessary to collect further data (e.g. by conducting interviews or surveys with the beneficiaries of the solutions). Finally, data from additional sources not related to the demo project (e.g. reports, statistics) should also be included.

This deliverable D1.4 is a significant contribution to documenting the work conducted in WP1 “Toolbox and evaluation” and documents results of the task Task 1.3 “Impact assessment, data collection and evaluation” related to data collection. It first provides a methodological guide for the preparation of a data collection plan for the different city teams and then describes the city teams' data collection activities, including the specific impact assessment questions and the available data sources (that can be used to answer these questions) as well as additional data sources. The SOLUTIONplus data collection plan includes both a non-technical perspective (the development of specific impact analysis questions) and a more data-oriented perspective (the discussion of the data needed to answer these impact questions appropriately and as accurately as possible) to fully address data collection for impact assessment.

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1. Introduction

SOLUTIONSplus brings together highly committed cities, industry, research, implementing organisations and finance partners and establishes a global platform for shared, public and commercial e-mobility solutions to kick start the transition towards low-carbon urban mobility. Thereby, SOLUTIONSplus encompasses city level demonstrations (i.e. the implementation of projects) to test different types of innovative and integrated e-mobility solutions, complemented by a comprehensive toolbox, capacity development and replication activities.

City-level demonstrations actions in SOLUTIONSPlus will be launched in Hanoi (Vietnam), Pasig (Philippines), Lalitpur/Kathmandu (Nepal), Kigali (Rwanda), Dar es Salaam (Tanzania), Quito (Ecuador), Montevideo (Uruguay), Madrid (Spain) and Hamburg (Germany). In order to capture the achieved impacts of all demonstration activities at the city-level, it is necessary to define a well-thought set of different actions within the city teams responsible for all demonstration activities. This deliverable D1.4 “Data collection plan” documents part of the work performed within the task 1.3 “Impact Assessment, data collection and evaluation” within WP1.

In this context, a sound data collection strategy is a requirement for conducting any successful impact assessment. Although impact assessment is never about data collection at its core, data collection plays an integral role in the impact assessment process as data forms the base to answering questions in a well-founded way. However, data collection is not the beginning of this process. Any successful impact assessment always starts with defining the parameters to be assessed (on economic/ social/ environmental/ political levels) and then working out jointly the concrete questions to be answered and not the other way round by kicking-off a discussion on available datasets with a high level of technical details.

Impact-questions addressing the demonstrator activities’ impacts from the perspective of all relevant stakeholders need to be co-created with the experts from the city teams first and then prioritised together with the respective stakeholders and aligned with the SOLUTIONplus project and WP1 goals. Only after this prioritisation and fine-tuning of the impact-assessment questions has taken place, can it be ascertained which existing data sources can contribute to answering them or whether, for example, further data (e.g. from interviews or surveys) need to be collected. Such impact questions can be: What is the impact of the new e-mobility solution on the end users (social dimension), what is the impact on the revenue of the solution operator (economic dimension), or what is the impact on the carbon footprint (environmental dimension).

Any meaningful data collection plan is not primarily about describing available and further needed data sources (such as vehicle movement data, equipment operation data, interview data or survey data) at a high technical level of detail, but defining a very concrete plan (in terms of a strategy) for linking the developed impact-questions with available and unavailable data sources. Neither is the process of arriving at the questions to be developed trivial, nor is it assigning impact questions to potential data sources that can answer them. Figure 1 shows how data generated through city-level demonstration activities can answer impact assessment questions.

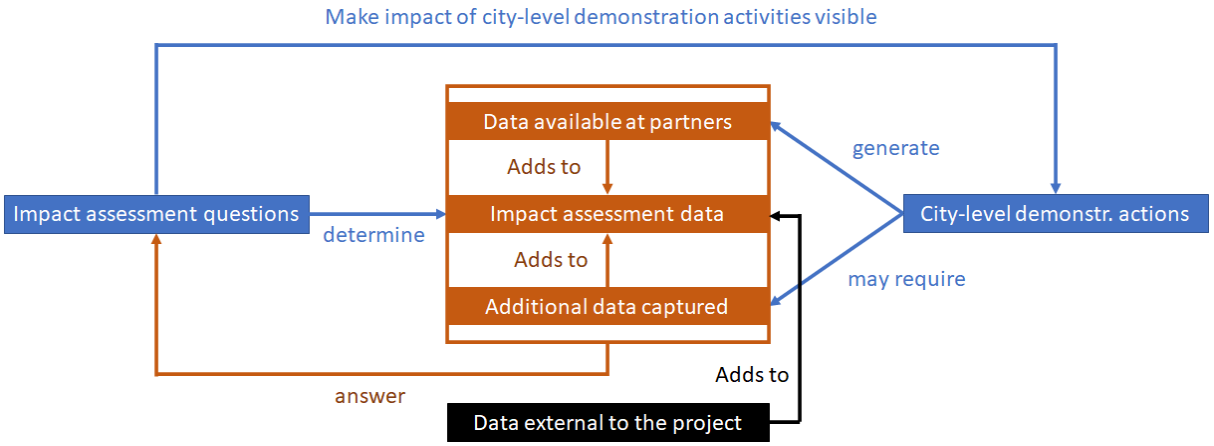

Figure 1: Impact assessment and data (high-level view)

A large part of the data relevant for the impact assessment will be automatically generated in the information systems of individual project partners or in the systems of other actors not directly participating in the project during the implementation of the city-level demonstration actions. However, this data represents the IP of the data owner and in most cases will not be shared with the SOLUTIONSplus consortium at all. It is much more likely that City teams will either have limited access to raw data via an application programming interface (API) for a specific purpose and to address specific impact questions (i.e. the raw data will remain in the data owners' information systems), or to individual reports be created by the data owners according to the requirements and impact-questions of the City teams (i.e. in textual form as tables or in visual for as an interactive dashboard). Thereby these reports transform raw data (data as it is collected by organisations during the demo project execution and made available in their information systems) to aggregated data (data as it is required by the city teams to answer impact-related questions). Transforming raw data to aggregated data is a very time-consuming process and requires different data analytics approaches. This limits the set of questions to be answered, as each question may require a different analysis procedure to be developed. In some cases, also a linkage (i.e. triangulation) of several data sources may be necessary to answer certain impact related questions sufficiently.

Further data relevant to impact analysis can be located in other sources including city administrations, reports from statistical offices, raw data from statistical portals (e.g., Eurostat), policy reports or scientific publications. While this data is not at all directly linked to the demonstration activities (i.e. it is not generated by them and it is not owned by the partners), it may help to better evaluate its impact.

Creating a sound data collection strategy requires comprehensive understanding of the demonstration project, including the project's requirements and objectives, the operational strategies of the e-mobility solutions to be implemented and the stakeholders involved and affected by the new mobility offering in a first step. Specific questions for impact analysis must be developed together with those partners that are responsible for the demo project

implementation. As stakeholders may pursue different goals, different impacts may be more or less relevant for them with respect to their organisational strategies. Priority can be given to evaluating those impacts that are of significant importance for the partners responsible for the operation of the e-mobility solutions as the business models of demo projects should above all be financially sustainable so as not to jeopardise the future operation of the e-mobility solutions. To finally answer impact assessment questions, a definition of the required data sources must be made. During the implementation of the demo projects some data (e.g. log files, transaction data or operation data) is already generated as a by-product. However, these automatically generated data may not be sufficient to answer all the questions of the impact assessment and it may therefore also be necessary to collect further data (e.g. by conducting interviews or surveys with the beneficiaries of the solutions to measure the benefit in a subjective way of different quality dimensions).

After this short introduction into data plans, D1.4 provides a methodology to develop the impact assessment questions within the SOLUTIONplus city teams, first. This methodological guide will support the city teams in their preparation of a sound data collection plan. Data collection plans will include a non-technical perspective (i.e. the development of specific impact analysis questions) and a more data-oriented perspective (i.e. the discussion of the data needed to answer these impact questions appropriately and as accurately as possible) to fully address data collection for impact assessment. Then, in section 3, the impact assessment questions and related data sources to answer them as well as the process of developing these questions within the city teams is presented.

2. Method

2.1 Data collection approach and background knowledge

A data collection plan is required to assess the impact of the SOLUTIONplus demonstration activities within the demonstration cities.

Background knowledge[1]: Technological interventions and developments (conducted within the demonstration cities under the SOLUTIONSplus umbrella) will generate impacts on economic, social, and environmental levels. This is usually known as the Triple Bottom Line Approach that focuses on the three dimensions of sustainability – the social, economic and environmental dimension. In this context, the technology acts as an enabler and is not an independent impact dimension. Within the SOLUTIONplus project, the environmental dimension has been split into two dimensions, environment and climate, and a political/institutional dimension is additionally added.

[1] A holistic framework for assessing support measuring the success of the demonstration projects is included in D1.2 Evaluation Framework.

Within the demo projects, different actors each pursue their own objectives and intend to achieve different impacts depending on their business models in the case of for-profit companies or in the case of public actors depending on political regulations, directives and laws. Therefore, it is important not to focus on the particular expected impacts of one or two stakeholders (e.g. the provider of a new mobility solution) only, but to allow for a well-balanced impact assessment according to the impact dimensions mentioned.

Impact assessment and impact-related data collection activities fall under the remits of the nine different city teams, as shown in Figure 2. Thereby, the official city team project partners may be complemented by additional partners (third parties) who are no project members but are important stakeholders within the demonstration activities as they provide, for example, the e-mobility solution to be implemented in the project phase. In this case, they pursue their own objectives, foresee impacts with different levels of importance and also own important data (generated by their solutions during operation) for impact assessment.

Figure 2: City-teams and their roles with respect to the data collection plan

For example, an e-mobility solution provider may want to focus on measuring the financial impact achieved, as this is most important for the business model, while a policy body may

focus on measuring the environmental impact of the e-mobility solution, as this is within the sphere of influence of policy and legislation. In the course of the data collection plan, despite the prioritisation of the questions, care must be taken to ensure that statements can be made about the impacts from all dimensions.

In a first step, it makes sense to define a partner who is responsible for the impact assessment and moderates this process accordingly[2]. The development of relevant impact-questions according to the sustainability domains, the prioritisation of these questions and the mapping of these questions to possible data sources that are capable of answering them, will be answered in a series of workshops within the city teams. This is preferably done through several pre-impact assessment workshops conducted by the partner responsible for the impact assessment with the key partners in the city teams. It is particularly important that the partner responsible for the impact assessment generates a precise understanding of the demo project. This is best done by asking questions to partners responsible for the demonstration projects (who, what, why, how). As the understanding of the demo project and its objectives improves, the partners are gradually asked about the benefits they expect from the demo project, and the concrete impact questions slowly evolve from this. WP1 tasks such as the user needs assessment and the KPI weighting[3] with stakeholders relevant to the demonstration actions have provided further valuable input to the impact assessment process.

The following figure shows the three phases of a demonstration project at city level: (1) the planning phase, in which the scope of the demonstration project is defined and the expected impacts are elicited, (2) the implementation and operation phase, in which the data relevant for the impact assessment are generated by the operation of the e-mobility solutions, and (3) the impact analysis phase after completion of the demo project, in which a sound impact analysis examines whether the expected impacts could be transformed into actual impacts achieved using data directly generated during the demonstration project as well as contextual data that is somehow related to the demonstration project (see Figure 3).

[2] Further information on evaluation methods is included in D1.2 Evaluation Framework.
[3] More information on the Solutions+ KPI taxonomy can be found in Deliverable D1.2.

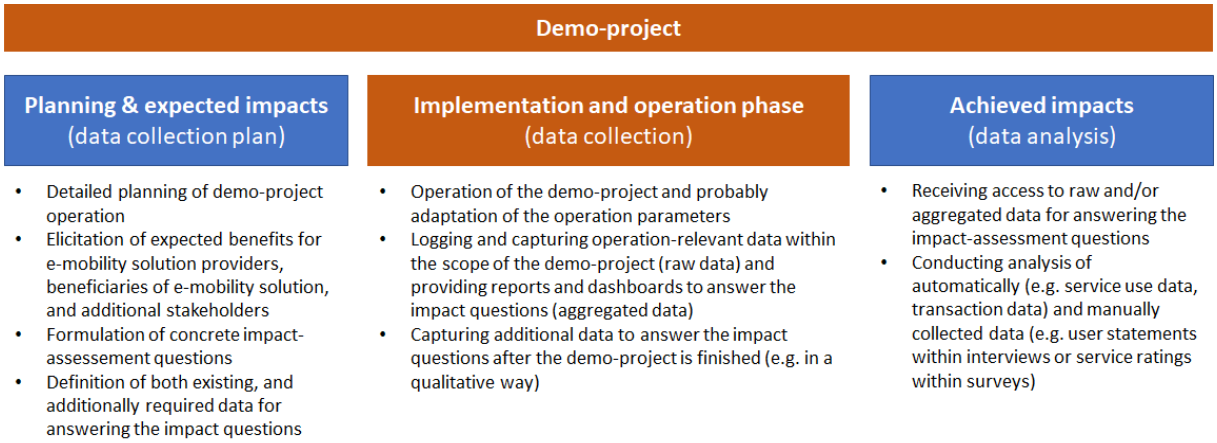

Figure 3: Impact-assessment questions and data collection strategies must be harmonized

In summary, the following steps are necessary for a data collection plan.

- In an initial step, a first set of impact questions for the demonstration project as well as general considerations on these impact questions is jointly developed. This catalogue is then further discussed in workshops, iterated, harmonised and prioritised.
- In a second step, this catalogue of impact-questions is extended with regard to the data, i.e. with which data (sources) can these questions be answered and which data quality is necessary for this?
- In a third step, it is considered which stakeholder would provide the necessary data under which conditions. Then the individual stakeholders are contacted and it is analysed what they can and really want to provide.
- All this information is finally compiled into one document, the data collection plan, in a fourth and final step.

The so-compiled city-specific data collection plans in the next section of this deliverable are composed of the following contents:

- A short summary of the demonstration actions
- A short description of the city teams and the responsible partners
- The collected impact assessment questions
- The data needed to answer the impact assessment questions
- The most relevant data sources and stakeholders than can provide this data
- The data collection and storage process

The Hamburg section was used as a blueprint for the other city chapters and is therefore more detailed.

It is extremely important that the collected impact data will not only facilitate measuring the direct impact of the Solutions+ demonstration projects, but also measuring certain impacts

of the Solutions+ project[4] such as saving 6,800t CO2e directly (i.e. in the short term in all 9 partner cities) and 7.5mt CO2e (indirectly, i.e. in the long-term by 2030).

2.2 Data storage in V2C2 cloud solution

For the centralized storage of data for the impact assessment V2C2 has set up a cloud-solution (Microsoft Sharepoint). There, both the subjective and objective data from the impact assessment teams can be stored and managed. For each city a separate data collection folder has been created (see Figure 4) and further available functions from the Sharepoint environment can be used if needed.

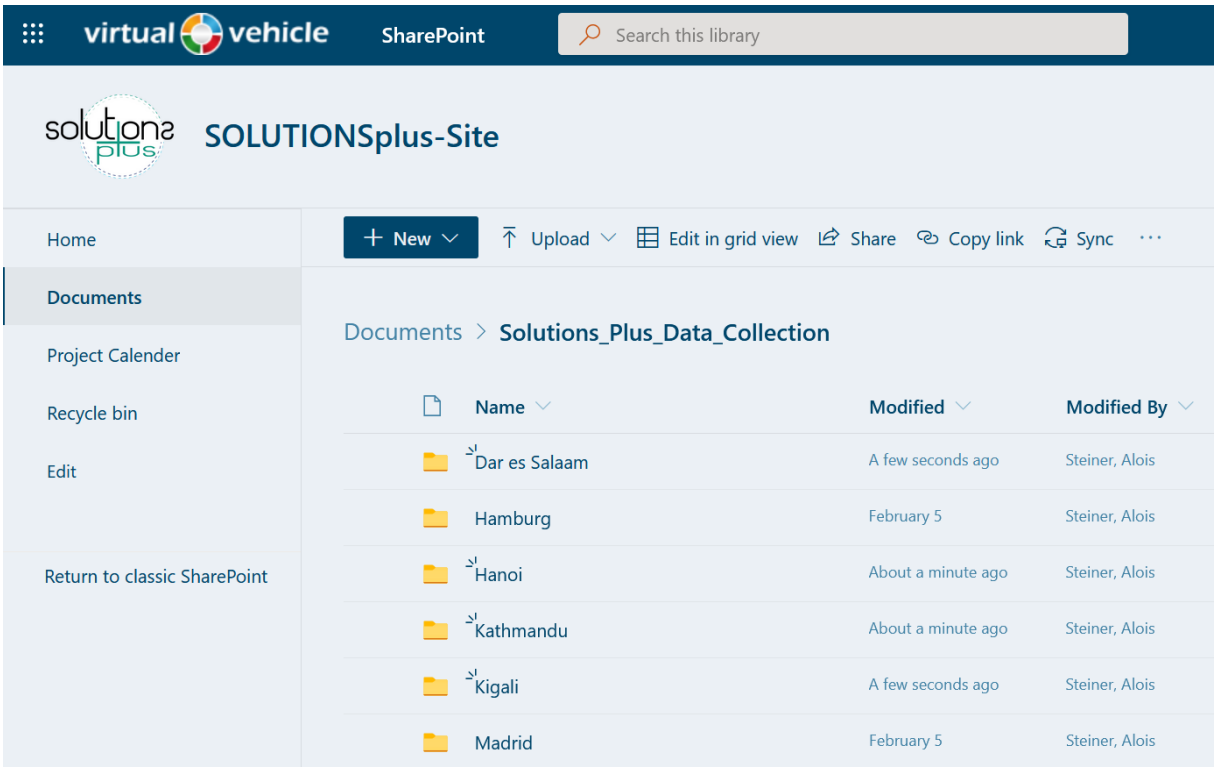

Figure 4: Microsoft Sharepoint data storage set up from V2C2

3. City-specific data collection plans

In the following subsections the respective data collection plans for each of the demonstration cities will be presented. The data management plan for the city of Hamburg is covered in more detail, followed by a shorter summary for each of the other cities.

3.1 Hamburg

Hamburg, officially the Free and Hanseatic City of Hamburg, is one of Germany's 16 federal states and, with a population of over 1.8 Mio, the second-largest city in Germany and 8th largest in the European Union. The city's metropolitan region is home to more than five million people. Hamburg's transport sector is responsible for 27% of the cities direct

[4] cf. Solutions+ Grant Agreement pg. 180ff.

emissions (BUE n.d.), and although the share of private motor vehicle trips is decreasing, the overall number of travelled passenger kilometres is expected to increase. In terms of air pollution Hamburg is ranked as one of the worst performing cities of Germany (Urbanista 2017). One major source for air pollution is the port of Hamburg, being one of the biggest in Europe and located in the city centre; around one third of nitrogen oxide pollution can be attributed to it (SZ 2019). Apart from measures targeting vessel and port management, Hamburg implemented measures to reduce noise and air pollution by enhancing the general (road) traffic situation, e.g. using emission free vehicles in public transport, improving the cycling infrastructure, or set-up of intermodal sharing systems. It has set a goal to reduce overall CO2-emissions by 40 per cent in 2020 and 55 per cent in 2030.

Short description of the city teams and the responsible partners

The impact assessment for the city of Hamburg is done by the following project partners:

- Virtual Vehicle Research GmbH (V2C2)
- Wuppertal Institut (WI)
- Hamburger Hochbahn AG (HOCHBAHN)

Short summary of the demonstration project

In a first step, a joint understanding of the demonstration project with its specific project goals between the impact assessment project partners V2C2, HOCHBAHN and WI has been generated. Among other things, this harmonised description of the demonstration project has emerged from this.

Actual situation: Hamburg is a city state in the north of the Federal Republic of Germany and is home to over 1.8 million inhabitants; together with the metropolitan region of Hamburg, it has over five million inhabitants. In order to improve the quality of life of the inhabitants, noise pollution is to be reduced and air quality improved, among other things. Besides the port of Hamburg, road traffic is one of the main sources of air pollution in Hamburg. Taking into account the development of the region (e.g. population growth and age distribution), it is also assumed that the number of private passenger kilometres travelled will increase.

Challenge to be solved: By mid-century at the latest, all sectors of the economy and ultimately all urban areas of life are to be decarbonised as far as possible, with transport-related CO2 emissions alone to be reduced by 30% between 2017 and 2030. To achieve this, the share of passenger kilometres travelled by private vehicles (with combustion engines) is to be reduced and the share of public transport is to be increased. In order to achieve this, the attractiveness of public transport should be increased and incentives should be created to avoid motorised private transport or private cars altogether.

Envisaged target situation: Under the global goal of reducing greenhouse gas emissions, the share of public transport is to be increased from 22% (2017) to 30% by 2030. Furthermore, every citizen should have access to an adequate public transport service within five minutes. The impact of a scooter sharing model linked to the public transport system and operated also in the decentralised areas of the city of Hamburg will be investigated.

Solution: Under these conditions, a pilot project is being carried out in the city of Hamburg, in the Solutions+Plus project. The aim of this exploratory pilot project is to find out how the attractiveness of public transport can be increased in a peripheral urban area by implementing an e-scooter rental system connected to the public transport. These e-scooters should improve the accessibility of the public transport system and thus increase the share of public transport to replace private individual transport. At the same time, individual transport with private cars should be reduced and the CO2 balance should be improved.

Impact assessment questions

In order to develop a city-specific data collection strategy for Hamburg, several workshops were conducted within the urban team responsible for the e-mobility project, the operation of an e-scooter sharing system at two different sites connected to public transport in the outskirts of Hamburg (still urban, but about 7.5 km from the city centre).

The e-scooter sharing system will be developed by the public transport operator (HOCHBAHN) with the support of an e-scooter sharing system provider (TIER) to facilitate the last mile connectivity to the public transport system, while V2C2 is responsible for the impact assessment supported by WI. Figure 5 visualises the overall goal of the demonstration project, providing last-mile access to the public transport system via shared e-scooters.

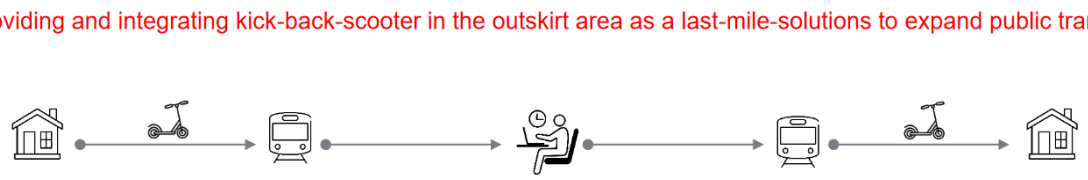

Figure 5: Hamburg demo-project: PT last mile connectivity with shared e-scooters

Project goals of the e-scooter sharing demonstration project are (1) to increase the overall attractiveness of the public transport offer (understand that the e-Scooter is adopted in the public transport offer and will thus be more widely used), (2) to allow entering and leaving the public transport network via the eScooter (first- and last-mile) and (3) to reduce private car use by shifting trips to combined e-scooter / public transport travel. The exploratory demo project aims at generating a better understanding on whether the provision of an e-kick-scooter sharing system as first- and last-mile solution for public transport can contribute to a shift in modal behaviour from private car use to public transport; and at understanding factors that influence the acceptance of such systems. The integration with

traditional public transport will be achieved via an app-integration (hvv switch) and incentives through subsidised parking zones at public transport stations will be tested.

A general impact-question for the impact assessment study can be formulated as follows: *How can the inhabitants of Hamburg who live within a certain radius around an underground station in the city periphery be motivated to avoid the private car for the journey into the city by using the e-scooter to connect to the public transport system and thus benefit from an ultimately increased overall attractiveness of the public transport offering?*

In the context of a previously implemented scooter sharing pilot in Hamburg, valuable experience was already gained, which will be incorporated into the SOLUTIONplus demo project, too. For example, it is known from the first pilot who the frequent users of shared e-scooter services are, i.e. between 24 and 35 years old, almost 75% male and 92% working or studying. In addition, the results of this first pilot project led to several changes for the implementation of the demonstration project: Changes in the new pilot include the selection of different peripheral areas for the e-scooter services, the selection of a different type of e-scooters with integrated safety concepts (e.g. the scooter is equipped with a helmet and indicators) which could also be more appealing to women, as well as the integration of the scooters into the HVV switch app, which did not exist in the first pilot either. In addition, the first project was accompanied by communication for a shorter period of time, namely only three weeks, whereas the communication support in the demonstration project is considerably extended to one year.

From HOCHBAHN's point of view, it is important to evaluate in the new demonstration project whether three main project goals are achieved. It is assumed that (1) e-scooters can have the potential of a first- and last-mile feeder to the public transport system and that the entire public transport system may benefit from this (i.e. it is to be analysed whether the scooter is actually used as a feeder to the public transport system thereby generating additional users of the public transport system). It should be (2) understood that the new e-scooter offer from HOCHBAHN is about facilitating transport intermodality in Hamburg (i.e. it is to assess the functionality of the overall transport system), and in this context (3) the overall attractiveness of public transport should be increased, because residents may then be more willing to travel in Hamburg without using a personal car as they do not perceive a big loss in their personal comfort (i.e. the attractiveness of the public transport system needs to be assessed).

It should be emphasised that different impacts will be relevant for the different partners, depending on their role and business/organisational model.

- While HOCHBAHN wants to increase its attractiveness as a public transport provider and get more users through the e-scooter offer, the e-scooter sharing provider TIER

will expect a profitable business model in the peripheral area of a city and sufficient revenues.

- The success depends on the exploration of a joint business model with the public transport provider. For instance, TIER might be paid a flat rate for providing the service independently of the profits for the public transport provider, or might earn a share of the profits (depending on the scooter use). Depending on the business models, the stakes will differ, while, still in the long run, understanding the profitability of the system as a future business option will be very interesting for TIER.
- In contrast, the city of Hamburg wants to promote a change in transport, reduce emissions in the urban area and ensure that in future every inhabitant of Hamburg can use a public transport service within five minutes (made possible, among other things, by various sharing solutions).
- Other relevant topics for the impact assessment for HOCHBAHN are the creation of a value-added multi-modal transport offer through e-scooters in the peripheral area, the increase of the overall attractiveness of public transport and the improvement of the service quality. The aim is to achieve frequent scooter use in the outskirts of cities (not by customers switching from public transport such as buses to scooters, but through car drivers becoming public transport customers). The use of e-scooters should be perceived as more comfortable and flexible than the previous journey by car because, for example, there is no need to search for a parking space. In addition, a possibility should be created for the scooter provider to continue its offer without any subsidies. Furthermore, positive environmental effects (reduction of emissions, contribution to CO2 neutrality) should be generated from the new offer.

In relation to the weighted KPI indicators from Task 1.3, exemplary impact assessment questions are:

- Impact on financial profitability
    - Will the demo project be financially viable (or remain dependent on public subsidies) in the mid- to long run?
    - How many e-scooter journeys are made daily as part of the pilot project? How many e-scooter journeys of these go to a public transport stop? How large is the core area of scooter use? How should the e-scooters be ideally distributed in the area?
    - What is the number of combined trips (scooter - public transport - scooter) towards the metro station/residential area and back? How will the number of passengers on public transport develop as a result of the e-scooter connection?
    - How many new customers will result from the pilot project for the e-scooter provider? How many new customers will result from the pilot project for the public transport provider?

    - Would customers also use the offer the new mobility service if it were not incentivised?
    - How many bookings come in via the public transport providers multimodal mobility booking, how many via the booking app of the escooter provider?
- Impact on alignment with city strategies
    - Will the demo project contribute to fulfill political objectives (i.e. to qualitative targets)?
    - How will the demo project contribute to quantified targets such as modal share, number of accidents, and transport related ghg emissions?
    - How will the demo project facilitate the implementation of city-level mobility strategies (e.g. climate strategy, urban development strategy, mobility plans, coalition agreements) in the mid and long term?
- Impact on climate/ environment
    - Will the demo project contribute to reducing greenhouse gas emissions, air and noise pollution, and the use of resources?
    - How many/what e-scooter journeys replace a journey previously made by private car? How many/which e-scooter journeys replace a journey previously made by public transport? Which other journey replaces the respective journey with the scooter?
- Impact on society
    - Will the demo project positively impact accessibility? How are booking numbers distributed over the course of the day?
    - How much has the attractiveness of public transport been increased?
    - How does the use of an e-scooter change the routes to the public transport station?
- Impact on wider economy
    - Will the demo project impact the wider economy?

<u>Data required to answer impact assessment questions</u>

During the definition of the demonstration project and the preparation of the tender for an e-scooter provider, the following impact assessment topics and their relation to concrete data sources were discussed:

- <u>E-scooter users and movement profiles</u> of e-scooters: Number of trips, average number of e-scooters used per day, average trips per e-scooter, users per day, trip duration (min.), target group and age of users, frequency of users (one-time users, frequent users, ...)
- <u>Sales and incentivisation</u> of the e-mobility service: Booking cancellations, comparison of user figures with and without incentivisation, customer satisfaction and recommendation rate, ratio of number of hvv switch bookings to direct bookings (download figures hvv switch app).

- Perception of public transport provider: Positioning of HOCHBAHN as an innovative service "provider", Passenger numbers on the bus (effects of interaction between e-scooters and bus transport), movement profile of e-scooter users with regard to enabling last-mile access to public transport (number of e-scooter trips are feeder trips to public transport).
- Operation of the e-scooter service: Comparison between demand and actual use, relevance of the selected business area (do we hit the right area, territorial expansion, are e-scooters increasingly on the edge of the business area), maintain quality and stability of the operation, availability of the offer (rebalancing, battery management).
- Sustainability of the e-mobility service: Calculate a CO2 indicator, attract more people to the public transport system by offering an attractive e-scooter service. Increase the understanding of what a future business model can look like, calculate the profitability of this business model, survey the possible need for further subsidies or integrate the IT systems of the service providers into the public transport provider's IT architecture.

Data sources and stakeholders than can provide this data

From public transport provider

- Public transport operation data (generated e.g. by hvv switch app[5], a mobile ticketing services for public transport and related mobility services operated by HOCHBAHN; e-scooter booking will be integrated in this app)
- Transaction/ ticketing data: bookings from multi-modal travel app (date/time/position, user)
- Public transport use: GPS data of the public transport stops, GPS data of the route network
- Public transport booking: Number of bookings via the booking platform, Reference values of public transport use, History of usage statistics
- Public transport operation and maintenance: Additional expenditure for the project area, number of employees for the project area
- Public transport users: User Id, enrolment statistics for the pilot project period, user profile

From E-scooter service provider:

- Operation data of demo project (date/time/position of e-scooter, battery information, userID), Number of e-scooters in operation (data/time/area), Data on service consumption (travel distance, vehicles use, energy consumption), Transaction and ticketing data such as bookings from Tier-app (date/time/position, revenues,

[5] https://www.hvv-switch.de/en/

user), data on additional staff (for the demo project), registration statistics, User ID, scooter experience of the user profile at registration, user profile

- Scooter use: GPS data during the journey with sufficient accuracy, GPS data of the user's parking locations, GPS data of the boundaries of the TIER area, GPS data of the scooter rides, GPS data of the incentivised parking locations, GPS data of the scooter parking location, GPS data of the start location of the ride, GPS position of the user at the time of booking, GPS position of the booked scooter, GPS positions of all parked scooters, GPS positions of the start and stop locations (sites) of the scooters, Use of the helmet during the ride, Scooter rides in the pilot project area, Start and stop times of the scooter rides, Start and stop locations of scooter rides, all rides that started in the project area, Incentivised parking location (yes/no)
- Scooter booking: Number of bookings via the hvv-swich booking platform, Number of bookings via the TIER booking platform, Booking times of a scooter ride, Comparison of user numbers (with/without incentives), Progression in the usage statistics, Incentives redeemed, Planned scooter usage times per booking
- Scooter operation and maintenance: Support costs for changing the batteries (additional support trips, personnel costs, ...), Operating hours of the battery, Number of employees for the project area, Number of kilometres driven per scooter / battery pack, Data sheet of the scooter, Savings through incentivised battery exchange (fewer care trips, credits, personnel costs, ...), Charging status of the scooters during the day, Strategies and efficiencies for managing the scooter fleet, Time of commissioning of the scooter, Time at which the scooter is taken out of service, Additional costs for the project area

City of Hamburg / Statistical offices:

- Inhabitants and population development in the demo area and the city area
- Share of trips by mode (Hamburg)
- Share of trips by distance and purpose (Hamburg)
- Data of e-mobility service provision (others than TIER)

Scientific studies:

- Data about e-scooters (average life span, embodied energy, etc.)
- Data about car fleet and average energy consumption / ghg emissions per km

Additionally needed and interesting data sources for the impact assessment are interviews and surveys among scooter and public transport users on the attractiveness of mobility services. Interviews and surveys allow answers to impact questions that are otherwise very complex to manage, such as the perception of the new mobility service offer or the impact of the service offering on people's mobility practices (such as whether e-scooters do lead to avoiding private car use and contribute to a positive carbon footprint). Ideally this qualitative

data gained through interviews and surveys can be linked to the factual e-scooter and public transport data use data (i.e. through a unique userID if the online survey link was accessed from the booking application).

Table 1 provides an overview on data needs, already extracted values, data sources and further assumptions as gained during the impact assessment process.

Table 1: Key data, values and assumptions, and data sources

POPUL. & TARGET GROUP	VALUE	UNIT	DATA SOURCES & ASSUMPTIONS
Total population of demo area	78500	inhabitants	HOCHBAHN
Total Population of Hamburg	1.847.253	inhabitants	Statistik Nord
Target group: Typical user of shared e-scooters (defined by age)	18-65	years	HOCHBAHN, Portland
Share of target group in total number of inhabitants (for Hamburg)	64,96	Share of inhabitants between 18 and 65 y.	
MOBILITY DATA			
Total distance of car trips per day in Hamburg	25.600.000	vkm / day	MID2017 Hamburg
Car km and trips by purpose: Commute	8	vkm	MID2017 Hamburg, p.31 (for Hamburg)
Car km and trips by purpose: Leisure	4	vkm	MID2017 Hamburg, p.31 (for Hamburg)
share of e-scooter trips that replace car trips	30	%	Portland Study, (Hollingsworth et al., 2019; Moreau et al., 2020; Portland Bureau of Transportation, 2018; Smith & Schwieterman, 2018)
additional public transport trips (vkm)	0	vkm	Assumption: no new public transport vehicle km are induced by the demo project
PUBLIC TRANSPORT TRIPS			
CO2eq intensity of train- and bus vkm	--	g CO2 eq /km	HOCHBAHN
Average cost per additional train km	--	EUR	HOCHBAHN
COST & REVENUES			
Typical distance of scooter trips	***2***	vkm	Assumption, based on Statista.com: Average distance travelled on e-scooter in Germany in July and September 2019, by provider (in kilometers)
Typical duration of scooter trips (min)	***2***	min	*Assumption, not validated yet*
Cost of scooter trips per min	***0,19***	€/min	TIER app
Basic fee for scooter trips	***1***	€/trip	TIER app
Number of introduced scooter trips	***1***	*not validated*	*Assumption, not validated yet*

Public transport: share of additional passengers use single use tickets	40	%	*Assumption, based on MID 2017 Regionalbericht Hamburg*
Public transport: share of additional passengers already have a subscription ticket	20	%	*Assumption, not validated yet*
Cost of a single ticket	3,4	€ / trip	HOCHBAHN, switch app
Cost of monthly subscription	57,7	€/month	HOCHBAHN, switch app
Vehicle procurement (cost per unit * number of vehicles)	---	€ / vehicle	TIER
Servicing of vehicles (recharging, relocation) per day	---	€ / day	TIER
Service-km per scooter-km (incl. relocation, repair, charging)	0,2	vkm	*Assumption, not validated yet*
Hochbahn staff cost (over demo period)	---	€	HOCHBAHN
Cost for implementing parking zones, lanes, etc.	---	€	HOCHBAHN
Costs for app integration	---	€	HOCHBAHN
Costs from incentive measures; e.g. reduced fees for parking in parking zones	---	€	HOCHBAHN
Vehicle Data and emissions			
Emission factor vehicle-km	150	g CO2eq/km	Assumption, based on (infas, 2020)
Total number of e-scooters	100	number of vehicles	TIER
Typical lifetime of e-scooters	720	days	TIER
Energy use per scooter km	0,0146	kwh / vkm	(Weiss et al., 2020)
embedded ghg emission per e-scooter (raw material, production, transport, disposal)	123.000	g CO2 eq	(Hollingsworth et al., 2019)
Emission factor for service-km	250	g CO2eq / km	Assumption, based on
Environmental			
Avoidance cost per CO2 eq unit	100	€ / t CO2eq	The EU Handbook provides three values for avoidance costs of 1t CO2eq up to 2030: 60€ - 100€ -189€
Emission factor for energy mix (Germany)	401	g CO2eq/kwh	Umweltbundesamt, Federal Environmental Agency

<u>The data collection and storage process</u>

A series of key workshops was conducted within the city team of Hamburg to develop the data collection plan:

- 28.10.2020: Generate an understanding on the demo project goals and implementation strategies for impact assessment

- 18.11.2020: Elaborate the gained understanding on the demo project and clarification of HOCHBAHN's expected impacts
- 13.01.2020: Development of several concrete impact questions aligned to the triple bottom line dimension and description of required data to answering them
- 27.01.2020: Refinement and clarification of impact questions and required data sources
- 02.02.2021: Refinement and clarification of impact questions and required data sources

To complement the data collection process and to deepen the discussion on impact evaluation, several additional meetings were held between V2C2 and WI. The impact data received will be stored using Microsoft SharePoint as provided by V2C2.

3.2 Madrid

1) Short summary of the demonstration action:

The living lab in Madrid focuses on smart charging systems for the e-buses the city is currently testing and will be increasingly adopting in the upcoming years as part of a strategy aimed at raising the share of e-buses operated by the EMT – the Municipal Transport Company– with about 80 e-buses by 2020. Fast opportunity charging via new inverted pantographs will be tested and allow updating the fleet charging and operational strategy as well as investigating on charging interoperability for multi-brand bus fleets. The charging infrastructure will be installed in one of the EMT bus depots. Currently, the location is under definition. More specifically, the demonstration will focus on the following measures:

- Testing a software to monitor and control the power network for charging stations and e-buses, maximizing bus availability and operational efficiency.

- Installation of inverted pantographs for opportunity charging with a modular design offering charging power of 90kW, 180kW, 270kW and 360kW, enabling charging times of 3-6 minutes using a low-cost and low-weight interface on the roof of the bus. Besides increasing the power and thus the speed of each charge, the smart and wireless characteristics of this equipment, will increase the efficiency and safety of the charging process.

Overall it is expected to reduce the human-interfaced charging tasks and thus to significantly increase the share of e-buses to be charged in one depot.

2) Description of the city team:

The impact assessment for the city of Madrid is done by the following partners:

- Wuppertal Institut (WI)
- Union Internationale des Transports Publics (UITP)
- Virtual Vehicle Research GmbH (V2C2)
- Empresa Municipal de Transportes de Madrid S.A. (EMT)

3) Impact assessment questions (conceptual questions):

- What are the related costs and benefits of the inverted pantograph technology (compared to conductive charging)?
- How can the bus depot design be improved with this technology and what are the expected benefits? (operational capacity, safety etc.)
- What are possible scenarios to charge a certain number of buses during the night?
- Which features does the smart management software for overnight charging need to provide?

4)+5) Needed data for answering the impact assessment questions and data source or stakeholders/institutions that can provide the needed data (content of D1.6 section X.2.2):

In order to investigate the conceptual question the necessary data including the data source is summarized in Table 2.

Table 2: Data category, description and data source for the city of Madrid

Category	Description	Source
Vehicle data	Data about the e-Buses that will be charged with the inverted pantograph technology (e.g. battery capacity, driving range etc.) will be collected.	EMT
Data from the charging process	Details regarding the inverted pantograph technology (max. charging power etc.) has been obtained from the manufacturer ABB and will be obtained from the assessment of the charging process during the demonstration action. Further, also the feedback of the operators (bus drivers, maintenance personnel) shall be collected via surveys.	ABB, EMT
Data from the bus depot	In order to assess possible improvements in terms of the charging process for the bus depot the current situation has to be monitored and the boundary conditions in terms of the depot collected.	EMT
Grid data	Also boundary conditions from the power supply side (e.g. max. connection power) shall be collected.	EMT

6) How and when will the data be collected:

The following data has already been collected and is currently assessed:

- Collect datasheets from inverted pantograph from ABB
- Collect details from EMT regarding e-Buses from BYD

The following further data collection steps are foreseen, but the exact time schedule has partially not been defined yet:

- Collect details from EMT regarding the bus depot and the charging process (April 2021)
- Conduct measurements during the charging process of e-Buses in Madrid (tbd)
- Conduct a survey with the e-Bus drivers and/or operating personnel (tbd)

7) Where will the data be stored (default option: V2C2 sharepoint):

The data will be stored in the data storage provided by V2C2 (Microsoft sharepoint).

3.3 Dar es Salaam

1) Short summary of the demonstration action:

The demonstration in Dar Es Salaam focuses on e-mobility for last-mile connectivity and aims at integrating 60 electric 3-wheeler services with Dar es Salaam's BRT (DART) to support first/last mile connectivity. The deployment of e-3 wheelers is being planned around 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. The demonstration also involves the localisation and installation of charging infrastructure as well as the deployment of a Mobility-as-a-Service (MaaS) application to facilitate the integration of the BRT and the electric 3-wheeler services . The demonstration follows a systemic approach and includes the development of business models (vehicle ownership, rental schemes, and maintenance) and capacity building on electric mobility development to be offered to local stakeholders.

2) Description of the city team:

The impact assessment for Dar es Salaam is done by the following partners:

- DLR takes the lead in WP1 activities related to the demonstration in Dar es Salaam; supports the demo impact assessment and evaluation tasks, user needs and data requirements; and contributes to the WP4 regional implementation actions in Dar es Salaam. DLR also supports dissemination and communication activities under WP6.
- UEMI supports the implementation activities in Dar es Salaam and coordinates all interlinkages between project WP activities regarding the demonstration implementation in Dar es Salaam.
- ITDP supports local implementation activities in Dar es Salaam; provides technical assistance to local implementing partners and advises on policy dimensions necessary for the implementation of the demonstration in Dar es Salaam.
- DART is the main local implementing partner in the project. DART supports on-the-ground project activities and mobilizes the necessary local resources including data, staff and relevant stakeholders for the implementation of the demonstration actions in Dar es Salaam.
- UNEP and UNH provide policy support and facilitates exploitation and replication activities in relation to the demonstration in Dar es Salaam.

3) Impact assessment questions (conceptual questions):

- How many electric 3 wheelers do exist in the total fleet of 3 wheelers providing connectivity to the BRT system? What is their share in comparison to ICE 3 wheelers?
- How much greenhouse and local air quality emission reductions can be achieved with the introduction of electric 3 wheelers?
- What economic effects/impacts can be gained by drivers/business owners by adopting electric 3 wheelers?

- What is the impact on the accessibility of the introduction of integrated feeder services relying on electric 3 wheelers?
- What is the share of trips relying on the electric 3-wheelers as feeders that are completed through the MaaS application?

4)+5) Needed data for answering the impact assessment questions and data source or stakeholders/institutions that can provide the needed data (content of D1.6 section X.2.2):

In order to answer the impacts assessment questions outlined above, there is the need to collect the data/information shown in Table 3:

Table 3: Data category, description and data source for the city of Dar es Salaam

Category	**Description**	**Source of data**
Vehicles number / share	- Fleet of 3 wheelers - Engine share (ICE, electric) - OR number of ICE 3 wheelers, number of electric three wheelers	Vehicle Registration numbers from Tanzania Revenue Authority (TRA)
Emissions	- Emissions numbers for different drive train types for 3 wheelers - Daily kilometres driven, if appropriate distinct by engine types - Electric energy mix (carbon based, hydro, solar etc.) and resulting emissions	- Czeh (2019) - For ICE Goletz/Ehebrecht (2020), for electric t.b.d in the project - Ministry of Energy, TANESCO (official reports)
Economic effects/impacts	- Comparison of revenue figures such as daily average income of 3w-drivers, using a) ICE b) electric engine - Business models and market structure: institutional economic analysis and associated economic benefits	- a) Czeh (2019) & Ehebrecht (2018), b) internal analysis empirical study - project internal analysis, empirical study & field work

Impact on Accessibility	- Impact on SDG 11.2: Accessibility to PT - *optional: What is the impact on the accessibility for the population to reach certain locations (t.b.d)* Accessibility analysis using UrMoAc (provided by DLR in WP 1 toolbox), requiring data wise input information on: - Population information - Routable road network & information on modes - Locations	- Population: Census 2012 + projections, or DLR WSF 2015 or National Bureau of Statistics - Routable road network: OSM or similar - Public transport network (GTFS data for BRT) - *optional: Locations: OSM or similar*
Integration and MaaS App	- Information on overall number of trips using electric 3-wheelers - Information an overall trips with electric 3-wheelers using the MaaS App	- Internal Data from MaaS App, DART

6) How and when will the data be collected:

Depending on the type of data that is needed:

- Secondary data taken from previous studies will be collected using desk research.
- Data coming from institutions that are non-publicly available will be requested.
- Primary Data from the pilot service will be collected before and during the piloting phase and thereafter, if services continue to operate.

Timewise, data will be collected before they are needed to perform the working steps associated with them. Some data have already been collected. As using the most recent data as possible is usually suggested, we aim to collect data shortly before they are being processed.

7) Where will the data be stored (default option: V2C2 sharepoint):

Default option will be used as suggested by V2C2 (V2C2 Microsoft sharepoint).
Concerns (if any) by project partners related to specific data will be considered.

3.4 Hanoi

1) Short summary of the demonstration action:

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. The project will be a win-win for both public transport and e mobility. A technical support team will design and develop vehicles that are tailored for the local context and operated under the oversight of the local public transport operator and the city of Hanoi.

Smart services, fleet bundling, E-scooter GPS positioning that support eco-routing will also be part of the project (SOL+ MaaS App). 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.

The demonstration will be conducted in phases. For the first phase, there will be a trial with 50 shared e-scooter to test the sharing system to facilitate the traveling from BRT stop to a shopping mall and vice versa. There will be periodical assessment on the system to see what is good, what needs to be improved for the better pilot. After that the sharing system will be replicated to other locations in the city, probably connecting the Metro terminal with residential areas.

2) Description of the city team:

- **TNO** - Leads the WP1 activities including the assessment and evaluation, user needs assessment and definition of data requirements. Contributes to the demonstration implementation in Hanoi in WP4
- **University of Transport Technology (UTT)** - Local partner leading the demonstration implementation activities in Hanoi, coordinates contacts with local stakeholders for assessment in WP1.
- **Wuppertal Institute (WI) and Urban Electric Mobility Initiative (UEMI) -** Are primarily responsible for ensuring the interlinkages and consistency of the activities in Hanoi with the global developments in the SOLUTIONSplus project
- **Clean Air Asia (CAA) -** Supports the activities in Hanoi and is responsible for coordinating with relevant entities and initiatives at regional level

3) Impact assessment questions (conceptual questions):

For the demonstration project in Hanoi, the most relevant impact assessment questions are:

- How well do the e-scooters improve the connection between the shopping mall and the BRT station in terms of traveling time and people making use of the BRT?
- How much CO2 emission can be avoided by making use of e-scooters instead of conventional scooters?
- How well does the demonstration project contribute to creating public awareness of e-mobility solutions?

- Can the demonstration create conditions that accelerate the uptake of e-mobility solutions in Hanoi?
- Can the demonstration contribute to the enhancement of local capabilities relating to the deployment of e-mobility?

For the impact assessment on city level (for both baseline and the upscaled scenario), the list of KPI's as described in D1.2 will provide a guideline to the research questions and topics that will be adressed.

4)+5) Needed data for answering the impact assessment questions and data source or stakeholders/institutions that can provide the needed data (content of D1.6 section X.2.2):

To answer the research questions as stated under 3, the following data will be collected in the demonstration. The data categories listed in Table 4 are required for both the ex-ante assessment and the ex-post assessment.

Table 4: Data category, description and data source for the city of Hanoi

Category	Description	Source
Vehicle data	Data loggers will be installed on the e-scooters, logging the following vehicle data ● GPS: this will be used to visualize where the scooters will be used and what are frequent destinations. Will the scooters only be used in between the shopping mall and the BRT station or also in other places? ● Vehicle speed: This provides information about the typical use of the e-scooter, variations in vehicle speed due to traffic jams ● Drive torque/power: The required power/torque to drive the e-scooter can help to better understand the vehicle energy consumption	QiQ data loggers on vehicles
Charging	Data about charging can either be obtained on the vehicle based on the logged battery information or on the charger side. The charging information can be used to get insight in where, how often and for how long the e-scooters are being charged. Based on this insight, charger location and charger specifications can be optimised in later projects.	QiQ data loggers on vehicles Supplier of chargers
Energy consumption	Battery information will be logged on the vehicle, which gives insight in the energy consumption of the e-scooters. This is also required to see how much the load on the energy grid will be, especially for upscaled projects. Furthermore, The energy consumption can be used to calculate the WTW CO2 reduction that was achieved.	QiQ data loggers on vehicles
Maintenance	Scheduled and unscheduled repairs (and associated data - e.g. costs) would be documented to enable a more holistic approach towards conducting the financial analysis	OEM providing e-scooters (Honda) or local transport company

Safety	Safety incidents would be documented (e.g. major, minor crashes, charging incidences).	UTT as demonstration leader
User experience	The project team will strive to gather user experiences of the different user categories. Surveys with end users and interviews with local stakeholders will be part of this exercise	TNO, UTT, UEMI, local stakeholders
Use of BRT	Number of passengers making use of the BRT line to assess if the e-scooters contributed to an increase of the use of the BRT.	Transerco, local transport company
MaaS application	The MaaS application will be used to stimulate the last mile connectivity. Numbers of (unique) users can show how successful the deployment of the application is	

For the baseline and the upscaled assessment, data from existing sources describing the financial, political, environmental, social and economical trends in e-mobility in Hanoi will be used.

6) How and when will the data be collected:

Data concerning the use of the e-scooters will be collected during the demonstration phase. Data loggers will be installed on the vehicles to measure and collect the desired vehicle data. Other required data will be collected manually together with the stakeholders.

The collection of data required for the ex-ante assessment of the demonstration project and the baseline scenario for the scaled-up project has already been started and will continue in the first half of 2021). The ex-post assessment of the demonstration project and the impact assessment of the scaled-up project will follow the completion of the demo activities.

7) Where will the data be stored (default option: V2C2 sharepoint):

The data will be stored in the data storage provided by V2C2 (Microsoft sharepoint). Possible confidentiality of data needs to be considered and aligned with demonstration partners.

3.5 Kathmandu

1) Short summary of the demonstration action:

In Kathmandu, the demonstration action will contribute to developing an ecosystem for electric mobility by demonstrating different EVs to enhance public transport, as well as suitable charging solutions and related services (which will come at the later stage of the project). The main demo activities include conversion of a diesel bus to e-bus and production of remodelled e-3 wheelers, e- shuttle van and e-micro bus carried out by local manufacturers with imported equipment and the technical support of the consortium.

Conversion of diesel bus to e-bus
An old diesel bus will be converted to e-bus, mainly replacing the drive system (motor, transmission and rear axle). The required components for the conversion will be imported and assembled locally. For this research and development project, appropriate simulation software (e.g. Matlab and ANSYS) will be used for the design, optimisation and model development. Data loggers will be manufactured to measure and develop local drive cycles. Electro-mechanical systems will be developed to measure road gradeability, which is uncertain in Nepal.

Prototype of e-microbus
SOLUTIONSplus will collaborate with local manufacturers to develop/assemble an electric microbus (15 seater). The e-microbus 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.

Prototypes of e-3 wheelers
Through a multi-purpose concept, local manufactures selected under a SOLUTIONSplus local innovators call will redesign currently running e-3 wheelers (Safa Tempos) into: (i) modular e-3 wheelers (new design), and (ii) a remodelled Safa Tempo suitable for applications inspired by the current COVID pandemic:

- **Modular e-3 wheelers:** The local manufacturer will develop prototypes for a modular e-3 wheeler, providing deployment flexibility. With the same or minimal change in the technical specifications and main body, vehicle use can vary according to need. In addition to the powertrain provided by Valeo from the SOLUTIONSplus project (e.g. eAccess technology), other required components for the prototypes will be either imported or locally manufactured. The prototypes (in total six units) include passenger EV-mini Safa Tempo (6 seater), municipal waste e-trike, and cargo e-trike.
- **Remodelled Safa Tempo:** It includes design, development and deployment of improved Safa Tempo (three units) that are suitable for different purposes and will support entrepreneurs in modifying their Safa Tempos in order to improve their performance and sustainability.

Prototype of e-shuttle van
One prototype of e-shuttle van (4-wheeler, 6 seater) will be developed to replace conventional cars and vans used for tourist pick-up/drop-off and sightseeing in the inner city. Lalitpur Metropolitan City is planning to offer more such vehicles in Kathmandu mostly for heritage sightseeing.

2) Description of the city team:

The following partners participate in the impact assessment for the Kathmandu demo:

- **Denmark Technical University (DTU)** is leading the impact assessment of demonstration activities in Kathmandu
- **Sajha Yatayat** is the local partner that oversees the implementation of the demonstration activities and is responsible for mobilizing on-site activities and the direct coordination with stakeholders at the city level
- **Wuppertal Institute (WI) and Urban Electric Mobility Initiative (UEMI)** are primarily responsible for ensuring the interlinkages and consistency of the activities in Kathmandu with the global developments in the SOLUTIONSplus project
- **Clean Air Asia (CAA)** supports the activities in Kathmandu and is responsible for coordinating with relevant entities and initiatives at regional level

3) Impact assessment questions (conceptual questions):

The Kathmandu team will address the following impact assessment questions:

- What are the expected costs and benefits of the proposed e-mobility solutions in Kathmandu?
- Is vehicle conversion technically feasible and capable of meeting user needs?
- Is vehicle conversion a reasonable solution to the high capital requirements of EVs?
- How conducive is the regulatory framework in Nepal towards e-mobility and vehicle conversions? Can the project activities influence the legal framework?
- What is the GHG emission reduction potential of the proposed activities at the scaled-up level?
- How can the proposed (scaled-up) activities contribute in improving the environment in the Kathmandu valley?
- What are the expected impacts on societal aspects, such as accidents and quality of service?
- What are the wider economic impacts of the proposed solutions, such as on fuel imports and employment?

4) Needed data for answering the impact assessment questions (content of D1.6 section X.2.2):

Data requirements are determined by the Key Performance Indicators (KPIs) selected for the impact assessment in conjunction with the methods to be deployed in their estimation. The Table 5 and Table 6 briefly present the Level 2 KPIs[6][1] and the corresponding estimation

[6] The KPIs involved in the SOLUTIONSplus impact assessment have been categorized in four levels of detail. The Level 3 KPIs constitute the actual operational set of indicators. Levels 1 and 2 appearing in Table 1 define broader higher-level classifications, while Level 4 consists of lower-level indicators that enter the estimation of the Level 3 ones. More information on the KPI taxonomy can be found in Deliverable D1.2.

methods and data needs. Note that a distinction is provided for the estimation method, depending on whether the assessment concerns the demonstration project/component or the corresponding scaled up project. The absence of a demo entry in the estimation column signifies no expected effect at demonstration level.

Table 5: KPI estimation method and data needs

Key Performance Indicators		Estimation method	Data needs
Level 1	**Level 2**		
Effect on project finances	**Financial viability**	**Scaled-up:** The NPV, IRR and payback indices will be calculated via specialised financial assessment tools calibrated for the specific applications. The total cost of ownership (TCO) calculations of the UNEP eMob model can also be used. **Demo:** No need to go beyond TCO estimates, as the purpose is to collect the data required for assessing the financial viability of the scaled-up project. Possible economies and diseconomies of scale effects need to be considered in applying demo figures on the scaled-up project.	• Detailed capital, operating and maintenance costs on an annual basis for all project vehicles and for the duration of their expected lifespan • One-time project preparation (if applicable) and residual values • Cost structure of the corresponding baseline solutions (to be replaced by the proposed ones) • Expected revenues of the executing agency • Both costs and revenues are estimated on the basis of the corresponding volume figures and unit prices
	Availability of finance	**Scaled-up:** Direct rating (Likert scale)	• Available private, government and donor funds, credit lines, etc. to be used for the scaled-up project in case external funding is required
Effect on institu-tional frame-work	**Coherence with national plans/goals**	**Scaled up:** Direct rating (Likert scale)	• National plans and development goals in relation to SDGs, climate change, energy policies, transport policies, environmental protection policies, etc. • Similar plans and goals at regional/city level
	Alignment with legislation	**Scaled up:** Direct rating (Likert scale)	• National legislation concerning manufacturing, conversion, licensing, operation and decommissioning of urban transport vehicles with emphasis on EVs • Similar regulations at regional/city level • Technical standards for EV manufacturing and charging infrastructure
	Ease of implementation	**Scaled up:** Direct rating (Likert scale)	• Implementation of existing legislation • Enforcement mechanisms • Administrative barriers
Effect on climate	**Effect on GHG emissions**	**Scaled up:** Application of the UNEP eMob model **Demo:** Calculation of the GHG emissions abated by comparing the EV carbon emissions (if any) to those of the do-nothing practice	• Socio-economic data (population, regional GDP, expected GDP growth rate until target year) • Composition of relevant fleets (existing vehicle stock, projected sales until target year, composition of sales by technology) • Emission standards by year of introduction • Fuel quality standards by year of introduction • Existing and projected charging infrastructure • Fuel economy of vehicles involved • Operational characteristics (annual mileage, load factor, expected lifespan) • The default emission figures provided by the UNEP eMob model for the vehicles involved might be sufficient for the demo components
	Effect on air pollutants	**Scaled up:** Application of the UNEP eMob model **Demo:** Calculation of the NOx and PM2.5 emissions abated by comparing the EV corresponding emissions (if any) to those of the do-nothing practice	Ibid
	Effect on noise	**Scaled up:** Expected reduction in noise due to the electric drive as reported in literature **Demo:** Ibid	• Speed-noise diagram for diesel vehicles • Speed-noise diagram for EVs
	Effect on resource use	**Scaled up:** Quantification of mechanical parts and batteries recycled **Demo:** Ibid	• Weight of recycled parts (due to conversion) as a percentage of total weight • Battery recycling infrastructure • Volume of recycled batteries generated by project activities

Table 6: KPI estimation method and data needs (continued)

Key Performance Indicators		Estimation method	Data needs
Level 1	**Level 2**		
Effect on society	**Effect on accessibility**	**Scaled up:** No effect on accessibility is expected by the planned SOLUTIONSplus initiatives	N/A
	Effect on affordability	**Scaled up:** Effect is possible only in case of substantial cost savings due to the conversion of old diesel buses to e-buses	• Pricing policy of Sajha Yatayat
	Effect on travel time	**Scaled up:** Possible effect due to improved reliability of e-buses in comparison to diesel ones	• Delays due to malfunctions of diesel buses • Technical reliability of e-buses vs. diesel buses
	Effect on road safety	**Scaled up:** Comparison of EVs with traditional vehicles with respect to road accidents per vkm **Demo:** Monitoring and reporting of safety incidents during demo period	• Official annual national/regional/city statistics on road accidents by type (fatalities/major injuries, minor injuries/material damages, near misses) • Official annual statistics of road accidents by gender • Official annual statistics of road accidents involving vulnerable road users • Official statistics of road accidents involving EVs (in Nepal or abroad)
	Effect on charging safety	**Scaled up:** Comparison of EVs with traditional vehicles with respect to charging safety incidents per thousand recharging/refuelling operations **Demo:** Monitoring and reporting of charging safety incidents during demo period	• Official national/regional/city statistics on safety incidents during refuelling operations • Official statistics on safety incidents during recharging operations of EVs (in Nepal or abroad)
	Effect on security	**Scaled up:** Comparison of EVs with traditional vehicles with respect to security incidents per vkm **Demo:** Monitoring and reporting of security incidents during demo period	• Official national/regional/city statistics on security incidents of traditional vehicles • Official statistics on security incidents involving EVs (in Nepal or abroad)
	Effect on well-being	**Scaled up:** No effect on accessibility is expected by the planned SOLUTIONSplus initiatives	N/A
	Effect on service quality	**Scaled up:** Direct rating (Likert scale)	• User perceptions on suitability for climate changes, comfort, drivability (by professional drivers), chargeability, safety, personal security and transhipment quality
Effect on wider economy	**Effect on budget**	Scaled up: Comparison of required investment to the annual budget of the executing agency	• Annual budget of the executing agency
	Effect on external trade	**Scaled up:** Expected reduction in imported values due to lower fossil fuel quantities and the conversion activities	• Reduction of fossil fuel consumption due to the introduction of EVs • Reduction of import value due to converting existing buses
	Effect on employment	**Scaled up:** Expected effects on jobs and wages due to the introduced e-mobility activities on the basis of published information and input requirements observed during demo	• Effects on employment due to the introduction of e-mobility reported in Nepal and abroad • Human resources required for the conversion activity • Availability of necessary skills

5) Data source or stakeholders/institutions that can provide the needed data (content of D1.6 section X.2.2):

Stakeholders and other institutions expected to be involved in data provision and collection are listed in Table 7 by type of data needs. Additional data sources are provided in Table 8.

Table 7: Stakeholders/institutions involved in data provision and collection

Type of data	**Institution (source)**
Socio-economic data (GDP, population, external trade, employment)	IMF (Country data, Mar. 2020); Central Bureau of Statistics, Nepal
Vehicle fleet (stock, sales, technology shares)	Transport Management Office, Bagmati Province
Vehicle operations (mileage, load factors, fuel economy, maintenance)	Sajha Yatayat
Charging infrastructure	Sajha Yatayat
Vehicle emission standards	Ministry of Physical Infrastructure and Transport (MoPIT)
Fuel quality standards	MoPIT
Safety (accidents, security incidents)	Central Bureau of Statistics, Nepal
User perceptions (suitability for climate changes, comfort, drivability, chargeability, safety, personal security and transhipment quality)	DTU; Wuppertal Institute; UEMI; Clean Air Asia
Vehicle conversions (technical specifications, cost structures, productivity)	Sajha Yatayat; Local innovator/SME
General responsibility	DTU; Wuppertal Institute; UEMI

Table 8: Additional data sources

Journal articles	Sadavarte, P., Rupakheti, M., Bhave, P. V., Shakya, K., & Lawrence, M. G. (8. March 2019). Nepal Emission Inventory (NEEMI): a high resolution technology-based bottom-up emissions inventory for Nepal 2001-2016. *Atmospheric Chemistry and Physics Discussions*.
	Nepal, A. (March 2020). Mitigation of GHG Emission by Replacing Diesel Buses with Electric Buses in Kathmandu Valley "A Case Study of Sajha Yatayat". *Journal of Innovations in Engineering Education , 3* (1).
	Mool, E., Bhave, P. V., Khanal, N., Byanju, R. M., Adhikari, S., Das, B., et al. (March 2020). Traffic Condition and Emission Factor from Diesel Vehicles within the Kathmandu Valley. *Aerosol and Air Quality Research , 20* (3), S. 395-409.
	Bhattarai, K., Yousef, M., Greife, A., & Lama, S. (2019). Decision-Aiding Transit-Tracker Methodology for Bus Scheduling Using Real Time Information to Ameliorate Traffic Congestion in the Kathmandu Valley of Nepal. *Journal of Geographic Information System , 11*, S. 239-291.
	Shrestha, H. R. (2018). Existing Condition of Urban Mobility in Kathmandu Valley. *Invention Journal of Research Technology in Engineering & Management (IJRTEM) , 2* (6), S. 86-96.

	Das, B., Bhave, P. V., Puppala, S. P., & Byanju, R. M. (2018). *A Global Perspective of Vehicular Emission Control Policy and Practices: An Interface with Kathmandu Valley Case, Nepal.* Journal of Institute of Science and Technology. Tribhuvan University.
Donor reports	GGGI. (2018). *Investment Projects for Electric Mobility:Accelerating Implementation of Nepal's Nationally Determined Contribution.* Global Green Growth Institute. Kathmandu: Government of Nepal.
	GGGI. (2018a). *National Action Plan for Electric Mobility: Accelerating Implementation of Nepal's Nationally Determined Contribution.* Global Green Growth Institute. Kathmandu: Government of Nepal.
	GGGI. (2018b). *A Pre-feasibility Study: Deploying Electric Buses in the Kathmandu Valley.* Global Green Growth Institute. Kathmandu: Government of Nepal.
	The World Bank. (2019). *Nepal Infrastructure Sector Assessment: Private Sector Solutions for Sustainable Infrastructure Development.* Washington DC: International Bank for Reconstruction and Development/ The World Bank.
	The World Bank. (2020). *Delivering Road Safety in Nepal: Leadership Priorities and Initiatives to 2030.* International Bank for Reconstruction and Development/ The World Bank.
	ADB. (2020). *Nepal: Kathmandu Sustainable Urban Transport Project.* Asian Development Bank.
	The World Bank. (2013). *Gender and Public Transport.* The World Bank Group.
	JICA. (2017). *The Project on Urban Transport improvement for Kathmandu Valley in Federal Democratic Republic of Nepal.* Japan International Cooperation Agency. Federal Democratic Republic of Nepal,Department of Roads (DOR), Kathmandu Valley Development Authority (KVDA).
GoN reports	Government of Nepal. (2013). *Nepal Road Standard 2070.* Ministry of Physical Infrastructure & Transport, Department of Roads. Kathmandu: Government of Nepal.
	Giri, A. S. (2001). *Emission Regulations and Environmental Policies in Nepal.* Ministry of Industry, Commerce and Supplies.
NGO reports	CEN. (2020). *Fuel Economy Labelling of LDVs in Nepal.* Clean Energy Nepal.
Regulation	Government of Nepal. (1997). *Motor Vehicles and Transport Management Rules, 2054 (1997).* Nepal Law Commission.
	Government of Nepal. (2020). *Second Nationally Determined Contribution (NDC).* Kathmandu.
News Articles	Kumar, H. M. (21. January 2020). *Nepal's transition to Euro VI fuels not likely to significantly impact air pollution levels*. Abgerufen am 10. January 2021 von The Kathmandu Post: https://bit.ly/2Lie6hQ
	THT. (02. March 2018). *Imported vehicles to meet Euro IV norms*. Abgerufen am 16. December 2020 von The Himalayan Times: https://bit.ly/2MW1768

	Investopaper. (17. June 2020). *Government Announces New Electricity Tariff Rates in Nepal*. Abgerufen am 18. January 2021 von Investopaper: https://bit.ly/36GJ76C
Presentation (NGO)	Neupane, P. (n.d.). Developing Clean and Efficient Vehicle and Fuel Policy for Nepal. Clean Energy Nepal.
Presentation (GoN)	Shrestha, C. M. (n.d,). *Air Quality and Cleaner Used Vehicles: Case of Nepal.* Von https://bit.ly/3cHHcCH

6) How and when will the data be collected:

Data concerning vehicle conversion and remodelling activities will be collected during the actual demonstration phase and supplemented with simulation results on design optimisation. Data loggers will be used for developing local drive cycles and sensors will be installed on the converted vehicles to measure road gradeability. Manually collected data will supplement operational documentation.

The collection of data concerning the ex-ante assessment of the demonstration project and the baseline scenario that will be used for the assessment of the scaled-up project has already been initiated (early 2021). The ex-post assessment of the demonstration project and the impact assessment of the scaled-up project will follow the completion of the demo activities.

7) Where will the data be stored (default option: V2C2 sharepoint):

The raw data relating to the operations of the vehicles (i.e. vehicle activity, road gradeability) will be stored in an external server (details to be discussed with the local innovator), but the data is envisioned to be accessible to the SOLUTIONSplus project according to needs. Processed and summarized data will be uploaded to the V2C2 Microsoft sharepoint.

3.6 Kigali

1) Short summary of the demonstration action:

The demonstration action in SOLUTIONSplus focuses on e-mobility for last-mile connectivity in Kigali. It will have a systemic approach integrating the public transport system with electrified feeder-services provided by 30 e-moto taxis (new and/or remodelled) and 100 e-bikes that support first/last mile connectivity. With support from city authorities, transport operators and bus manufacturing companies, a suitable business model for e-buses for the city's buses will be explored. Expectedly, the project will create a good precursor to public transport electrification in Kigali. The business model for shared e-bikes (pedal bicycles) and e-moto taxi will also be developed in the demonstration project. The demonstration project will also test the establishment of an e-bike sharing 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. For the wider use of e-moto taxis and e-bikes, smart services applications will be explored that support Mobility-as-a-Service and eco-routing.

2) Description of the city team:

- DTU leads the WP1 activities pertaining to user needs, assessment and evaluation in the Kigali demonstration.
- UEMI supports the demonstration implementation activities and coordinates all interlinkages between project WP activities in Kigali.
- ITDP supports local implementation activities in Kigali, provides technical assistance on planning, policy and connection to local stakeholders.
- The City of Kigali is the main local implementing partner, supporting on-the-ground project activities and mobilising the necessary local resources including data, staff and relevant stakeholders.
- UNEP and UNH provide policy support and facilitates exploitation and replication activities.
- CODATU supports communication and dissemination activities.

3) Impact assessment questions (conceptual questions):

- How well do electric motorcycles (taxis) and shared electric bicycles improve the last mile public transport connectivity?
- What is the financial feasibility of electric motorcycles (taxi use case) and shared electric bikes (pedal bicycles) as modes for last mile public transport connectivity?
- What is the feasibility of introducing electric buses?
- How much well to wheel greenhouse and local air quality emission reductions can be achieved with the introduction of electric motorcycles and electric bicycles?
- How much air quality emission reductions can be achieved with the introduction of electric motorcycles and electric bicycles?
- What economic effects/impacts can be gained by drivers/business owners by adopting electric motorcycles and electric bicycles?
- How many electric motorcycle and electric bike users for last mile connectivity rely on MaaS applications?

4)+5) Needed data for answering the impact assessment questions and stakeholders or institutions that can provide the needed data:

The impact assessment question, needed data and possible sources are summarized in Table 9 for the city of Kigali.

Table 9: Assessment questions, needed data and possible source for the city of Kigali

Assessment questions	Data needed	Possible source
How well do the electric two wheeler and electric bicycles improve the last mile public transport connectivity?	Travel time (before and after) Accessibility to jobs Modal choice of e-two-wheeler users	Public Transport data (BRTS study) Population census (2012) Kigali Master Plan (2020) WB Last Mile Connectivity Study (upcoming, end 2021) Small user survey (UEMI/ITDP staff)
What is the financial feasibility of electric motorbike and electric bicycle as modes for last mile public transport connectivity	Capital cost of emotos and ebikes Operating costs related to servicing and charging of emotos and ebikes Charging infrastructure costs Availability of emotos and ebikes (including charging time) Revenues per emoto and ebike Pricing levels for rental, leasing or purchase of vehicles	Data from service operators
How much greenhouse and local air quality emission reductions can be achieved with the introduction of electric motorcycles and electric bicycles?	Electricity consumed for each charge Kilometers travelled on each charge Mode shift Daily kilometres driven CO2 Intensity of electricity used for charging	Data from service operators, Sweco (2019)
What economic effects/impacts can be gained by drivers/business owners by adopting electric motorcycles and electric bicycles?	Number of jobs created by the demo actions Revenue figures and daily average income from demo actions Abated fossil fuel use Business models and market structure	Data from service operators Sweco (2019)

How many electric motorcycle and electric bike users for last mile connectivity rely on MaaS applications?	Number of users using MaaS app. Details of trips using MaaS app.	Data from MaaS app.
What is the feasibility of introducing electric buses?		Sweco (2019) GGGI (2021)

6) How and when will the data be collected:

- Secondary data taken from previous studies will be collected using desk research, some of the data is already with the research team
- Data coming from institutions that are non-publicly available will be requested.
- Primary data from the pilot service will be collected before and during the piloting phase and thereafter, if services continue to operate
- User survey (UEMI/ITDP staff).

Timewise, data will be collected before they are needed to perform the working steps associated with them. Some data have already been collected. As using the most recent data as possible is usually suggested, we aim to collect data shortly before they are being processed.

7) Where will the data be stored (default option: V2C2 sharepoint):

The data will be stored in the data storage provided by V2C2 (Microsoft sharepoint).

3.7 Montevideo

1) Short summary of the demonstration action:

The demonstration activities in Montevideo include two components:

- Component 1: E-bus charging station. The implementation of this e-mobility solution aims to: i) increase deployment of e-buses by replacing the buses equipped with an ICE, ii) improve the accessibility and comfort of buses by incorporating a flat floor without steps/stairs and iii) reduce air pollution and improve quality of life in the city center. This implementation will involve 10 e-buses and 10 e-taxis using the e-bus charging station.

- Component 2: Urban logistics. The implementation of this e-mobility solution aims to: i) promote low-carbon and efficient transport and reduce air pollution, ii) promote the introduction of new e-mobility solutions for freight delivery, iii) promote local manufacturing of e-vehicles and iv) improve road safety in the city centre. This implementation will involve the local assembly of cargo e-2- and 3-wheelers: 15 e-cargo bikes and four e-cargo tricycles which will be used for freight delivery and as part of a renting scheme.

2) Description of the city team:

Montevideo's city team involved in the assessment of these demonstration activities consists of the following partners: city representatives (such as Transport Division Mobility Department of Montevideo), WP1 representative VTT Technical Research Centre of Finland Ltd (VTT) and WP4 representatives: Wuppertal Institute (WI) and Urban Electric Mobility Initiative (UEMI). VTT‘s main responsibility is to coordinate the reporting of the relevant information in the corresponding SOLUTIONSplus project deliverables and to assist with the execution of research related tasks, such as assessment of the potential and realised impacts of demonstrations. WI and UEMI ensure that the planned activities in Montevideo are in line with the global developments in the SOLUTIONSplus project and facilitate the city stakeholders' engagement as well as assist with the practical implementation of demonstrations and data collection.

3) Impact assessment questions (conceptual questions):

The main conceptual questions for Montevideo‘s demonstrations are related to the city aims and the main aims of each demo component. These questions are summarised below.

- Do the implemented e-cargo bikes and tricycles contribute to promoting low-carbon and efficient transport services in Montevideo?
- Do these new solutions reduce air pollution in the city?
- Do the implemented e-cargo bikes and tricycles contribute to improving freight delivery services by access in the city centre for goods deliveries enabling better?
- Do the implemented e-mobility solutions improve road safety?

4)+5) Needed data for answering the impact assessment questions and stakeholders or institutions that can provide the needed data:

To investigate the conceptual questions and to assess the impacts of demonstrations several data types have been identified, such as objective data from existing data sources (e.g. GDP data, statistics, census), subjective data covering user and stakeholder views and perceptions of implemented e-mobility solutions, and technical data to be collected within the demo implementation (e.g. e-bus battery charging data). Relevant stakeholders will be involved in gathering and compiling the necessary data. Table 10 lists the required data and relevant sources to fulfill the data needs for the impact assessment for the city of Montevideo.

Table 10: Data type and recorded description to conduct the impact assessment for the city of Montevideo

Data type	Description
Estimates for e-mobility shift projections (e.g. population growth, GDP per capita, vehicle fleet information).	The input data required for the application of UNEP e-mobility calculator is gathered using international institutions' web pages (e.g. UN Population Division) and Uruguay‘s references (city level and national level).
Data to identify impacts of demonstrations and scaled up project on climate and environment, social aspects, economy as well as on demand, supply and use.	– Data required to evaluate the demonstration project´s impact across relevant KPIs. This data will be gathered through available sources (e.g. national statistics) and stakeholders (e.g. local innovators, service operators, Montevideo’s Municipality). – Two examples are provided: 1) To assess the impact of e-mobility solutions on noise, data related to noise will be accessible through city‘s local air monitoring stations with the collaboration of the Transport Division Mobility Department of Montevideo. 2) To assess the impact of e-mobility vehicles on road safety, data related to accidents and number of casualties involved will be explored through national statistics. When data is not available, literature references will be used to estimate the expected impacts.

Technical data on e-vehicle operations and charging infrastructure.	– Data related to e-cargo bikes and e-cargo tricycles in terms of number of trips, trip length (km), and operational hours. – Data from e-cargo bikes will be collect using an application built in by the manufactured and startup “cargoBike“. This data will used to analise the main variables of the last mile logistic trips made in those e-cargo bike. – The SME CargoBike could provide the gathered information that will be collected by the software and hardware that they will install in their e-cargo bikes. – Data related to the charging system (e.g. charging capability, charging time). – The Municipality of Montevideo will provide information from the chargers (although it depends on the operation scheme). – Public transport operators, such as the Company CUTCSA could provide information regarding the performance of their electric buses that will charge its batteries in the Ciudadela terminal.
Subjective data including online survey and interviews (involving stakeholders) prior to demonstration implementation, and surveys involving the local population, target users and stakeholders for the e-mobility solutions experience following demonstration implementation.	– Data for the user needs assessment before the implementation of project demonstrations. Data collection was coordinated by UEMI by identifying relevant online survey respondents and carrying out interviews for relevant Montevideo stakeholders.The collected data has been uploaded to the SharePoint and processed and analysed by VTT and UEMI. – Data required to evaluate the impact of project implementation will be gathered through additional surveys. These surveys will be designed to gather user and stakeholder perceptions on e-mobility solutions, accessibility, quality of services among other aspects. For example, survey among the users of the MOVÉS renting program can be considered to collect the user´s opinions and the main aspects of the program (e.g. benefits, pros and cons).

6) <u>How and when will the data be collected:</u>

Data for the user needs assessment was collected between November 2020 and January 2021 with an online survey and interviews involving relevant stakeholders. In addition, data collection on the required inputs for the UNEP e-mobility calculator has been started to enable making estimations on climate and environmental effects of shifting to e-vehicles in the long term. As an example of such required input data, the population of Uruguay growth projections from 2025 to 2030 and beyond were gathered. Furthermore, the process of collecting more specific data (e.g. technical data, operations, accessibility) for the impact assessment will start during the demonstration project implementation.

7) Where will the data be stored (default option: V2C2 sharepoint):

User needs assessment data and the results of their analysis were stored at the SOLUTIONSplus project SharePoint. The same applies to ongoing data collection, such as statistical data (times series data) and other relevant information contributing to the demonstration project impact assessment. More specific data, such as vehicle data and or data related to the operations of the e-mobility solutions might be stored in an external server accordingly to the requirements of the local innovator(s) involved. Besides agreed raw data, processed and analysed data will be stored via the V2C2 Microsoft SharePoint (as presented in Section 2.2).

3.8 Pasig

1) Short summary of the demonstration action:

The demonstration in Pasig will focus on integrated and shared urban e-mobility solutions, and locally-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. The Pasig demo will centre at the production and testing of multi-purpose urban electric quadricycles that are suited to the local conditions. 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 mini-vans). An example of a small L6 cargo quadricycle is provided on the picture on the right. The quadricycle will also be designed to easily be configurable to perform passenger, cargo, and utility-related transport tasks.[7]

A "shared vehicle use" concept will be investigated for feasibility in the Pasig pilot. This concept would center on the shared use system that would feature the use of the vehicles by PHLPost, the Pasig City Government, and by other private entities. The specific modalities by which the vehicles would be shared are being investigated as of the moment.

The SOL+ demonstration activities will also include collaboration with a parallel project spearheaded by the De Lasalle University and funded by the Department of Science and Technology to develop a "flexible electric van" (FLEV proposal) which features a chassis that can be used for multiple purposes (e.g. passenger/ cargo). The use of the FLEVs within the Pasig City Government, PHLPost, and other private entities are currently being investigated. In the case of Pasig City, the FLEVs can be suited for the operations of the General Services Office (GSO) and the medical depot. European components (i.e. electric motors) are to be tested in the FLEV, and use cases wherein the FLEV and the SOL+ quadricycles will be assessed.

2) Description of the city team:

The following SOL+ consortium members are involved in the activities in Pasig:

- The Pasig City Government - City Transportation and Development Management Office oversees the implementation of the activities, and is also responsible for mobilizing on-site activities and direct coordination with stakeholders at the city level.
- Clean Air Asia supports the activities in Pasig and is responsible for coordinating with relevant entities and initiatives at the national (as well as regional) level.
- Wuppertal Institute and UEMI are primarily responsible for ensuring the interlinkages and consistency of the activities in Pasig with the global developments in the SOL+ project. Wuppertal Institute is also providing advice and direct assistance to Pasig City in relation to Work Package 1.
- UNEP is providing strategic advice, and ensures that synergies with their own projects in Pasig are exploited.

[7] Supporting sub-systems: base vehicle information management and control; fleet maintenance decision support system; delivery planning; battery charging/swapping network information management system; cargo delivery assistance; passenger service tool.

- ZLC will be providing support in conducting analytical work related to determination of micro hubs and charge points.

The demonstration will also closely with partner institutions/divisions (to be finalized) such as the Philippine Postal Corporation, the Pasig City General Services Office and Medical Depot, which would be involved in testing the solutions and integrating them in their operations during the demo phase. The local innovator/SME will also play a key role, particularly in generating the activity data related to the solutions.

3) Impact assessment questions (conceptual questions):

The main guiding questions related to impact assessment are:

- Are there proposed solutions able to perform as well or better in conducting the intended tasks under the use cases against the alternative/s?
- How do proposed solutions compare financially against base case alternative/s within the context of the intended use cases?
- What are the expected economic costs and benefits of the proposed solutions in the demonstration?
- How can we describe a scale-up scenario wherein the diffusion of the proposed solutions is made feasible considering technological, financial, policy/regulation, market, and societal factors?

4) Needed data for answering the impact assessment questions (content of D1.6 section X.2.2):

The following categories of data are envisioned to be critical in determining the answers to the impact assessment questions:

Data to be Monitored: Project/Demonstration

The monitoring of the data on the actual performance of the solutions to be demonstrated is intended to be conducted, and will include data on the following (Table 11):

Table 11: Data category and description for the city of Pasig

Category	Description
Vehicle data	The system would enable automatic monitoring of the vehicle activity done by each SOL+ vehicle and would allow for the calculation of indicators that relate to the vehicle trips, vehicle-kilometers, operational hours, speeds, among others. Other data (to be discussed with the local innovator) are also envisioned to be collected as well, primarily for assessing the vehicle's performance against targets/standards, and not necessarily for impact assessment.
Loading activity	Aside from the vehicle activity, activity data relating to the loads (passengers/cargo) would also be collected. The system allows for automatic collection of passenger and cargo data, but manual methods for documenting the loads per trip would also be explored.
Energy consumption	The vehicles will also be equipped with components that will enable the monitoring of actual energy consumption. These data would then be combined

	with the activity and loading activity data to calculate related indicators such as average energy efficiencies.
Charging	Data relating to the charging cycles would be collected (particularly charging times)
Maintenance	Scheduled and unscheduled repairs (and associated data - e.g. costs) would be documented to enable a more holistic approach towards conducting the financial analysis
Safety	Safety incidents would be documented (e.g. major, minor crashes, charging incidences).
Users' sentiments	The project team will strive to gather sentiments of the different user categories (e.g. management, drivers, passengers) that would enrich the assessment.

Data to be Collected: Demo Base Scenario

The estimation of the impacts of the demonstration project will be based on the comparison with identified probable alternative/s. These "base case" scenarios will reflect a scenario wherein the tasks to be performed by the SOL+ vehicles (e.g. in terms of passenger-kilometers and ton-kilometers) are to be performed by viable alternatives. In the case of the Pasig demo, for example, these might be in the form of passengers taking the traditional tricycle, or cargo being transported using the existing light-duty vans or even tricycles. Whenever deemed appropriate, comparisons would be made, and data from existing records would be utilized. The team would gather data/existing indicators that would establish base case indicators (e.g. in terms of energy consumption, maintenance, safety).

Other Data: Impact Assessment - Scaled Up Scenario

Data that is needed for assessing the "scaled up" scenario would be gathered from existing sources. These would particularly be important in estimating the magnitude of economically valuated impacts in the scaled up scenario. These impacts are intended to be calculated using readily available tools such as the UNEP's eMob calculator which relies on input data that are feasible to collect/estimate in the context of developing countries/cities (e.g. GDP/capita; vehicle registration (total and new); emissions standards timeline; energy efficiency factors).

5) Stakeholders or institutions that can provide the needed data (content of D1.6 section X.2.2):

Table 12 depicts the main distribution of responsibilities in ensuring the collection of the priority data.

Table 12: Data category and institutions

Category	Institution/s
Data to be Monitored: Project/Demonstration	
Vehicle data	Local innovator/SME, partner entities
Loading activity	Local innovator/SME, partner entities
Energy consumption	Local innovator/SME
Charging	Local innovator/SME

Maintenance	Partner entities
Safety	partner entities
Users' sentiments	Local innovator/SME, Pasig CTDMO, Clean Air Asia
Data to be Collected: Demo Base Scenario	
General	Pasig CTDMO, Local innovator/SME
Other Data: Impact Assessment - Scaled Up Scenario	
General	Wuppertal Institute, Clean Air Asia, Pasig CTDMO (assistance from UNEP, ZLC when needed)

*Partner entities refer to those institutions/divisions which would take ownership of the vehicle during the demo phase.

6) <u>How and when will the data be collected:</u>

The data related to the solutions (e.g. vehicles and charging) will be monitored during the actual demonstration phase. These would primarily be generated through the sensors and backend systems that accompany the shared vehicles. Manual methods will also be used whenever feasible and appropriate to support the documentation.

The data for establishing the base scenario which the demo scenario will be compared to will be done prior, and during the demo implementation period. The process for gathering basic information and available values (e.g. fuel efficiencies of traditional vehicles) which can serve as "default" values had already begun (early 2021). More detailed information will be gathered as we further define the specific applications considering the intended use cases.

Similarly, the process for gathering the data needed for the wider impact assessment has been initiated, and will continue up leading up to the actual process of estimating the impacts of the scaled-up scenario.

7) <u>Where will the data be stored (default option: V2C2 sharepoint):</u>

The raw data relating to the operations of the equipment (i.e. vehicle activity, chagrin) will be stored in an external server (details to be discussed with the local innovator), but the data is envisioned to be accessible through APIs, in case needed by the SOL+ project. Processed and summarized data will be uploaded to the V2C2 Microsoft sharepoint.

3.9 Quito

1) Short summary of the demonstration action:

The demonstration activities in Quito include three components:

- Component 1: Low Emission Zone in the Historic Centre. The aim is to implement a multimodal e-mobility hub in the historical city centre to improve the mobility of passengers and enable last mile freight in a pedestrianised zone, as well as to promote introduction of new e-solutions for freight/cargo delivery. The goal of these implementations is to contribute towards the reduction of emissions in the historical city centre of Quito. The demonstration in Quito city centre includes the implementation of the following e-mobility solutions: 20 e-bikes and 2 e-buggies for the transport of people; 20 e-cargo bikes for last mile e-delivery services, 10 e-cargo quadricycles and 2 e-delivery vans for transport of goods in the city centre.

- Component 2: Charging equipment for E-BRT buses with the aim of renewal of bus fleets of all BRT lines. This demonstration will test and implement the charging equipment for 22 e-buses with high energy batteries (400kWh) to enable their operation all day without intermediate charging pauses.

- Component 3: Implementation of MaaS App in the Public Transport System with the aim to test whether this App would be useful to search and identify timetables, routes and available travel options by potential passengers as well as to enable automated paying process. This demonstration includes implementation of the Mock-up of App in integration with the BRT system.

2) Description of the city team:

Quito's city team involved in the assessment of these demonstration activities consists of the following partners: city representatives (such as Quito's Municipality), WP1 representative VTT Technical Research Centre of Finland Ltd (VTT) and WP4 representatives: Wuppertal Institute (WI) and Urban Electric Mobility Initiative (UEMI). VTT's main responsibility is to coordinate the reporting of the relevant information in the corresponding SOLUTIONSplus project deliverables and to assist with the execution of research related tasks, such as assessment of the potential and realised impacts of demonstrations. WI and UEMI ensure that the planned activities in Quito are in line with the global developments in the SOLUTIONSplus project and facilitate the city stakeholders' engagement as well as assist with the practical implementation of demonstrations and data collection.

3) Impact assessment questions (conceptual questions):

The main conceptual questions for Quito's demonstrations are related to the city aims and the main aims of each demo component. These questions are summarised below.

- Do the new e-mobility solutions enable easier access to the historical centre of Quito and improved mobility for passengers?

- Do the new e-mobility solutions for cargo delivery enable easier access to the historical centre of Quito for delivery vehicles and more efficient last mile cargo delivery?

- Does the implementation of a mobile MaaS App improve the travel experience of Quito's public transport users?

4)+5) Needed data for answering the impact assessment questions and stakeholders or institutions that can provide the needed data:

To investigate the conceptual questions and to assess the impacts of demonstrations several data types have been identified, such as objective data from existing data sources (e.g. GDP data, statistics, census), subjective data covering user and stakeholder views and perceptions of implemented e-mobility solutions, and technical data to be collected within the demo implementation (e.g. e-bus battery charging data). Relevant stakeholders will be involved in gathering and compiling the necessary data. Table 13 lists the required data and relevant sources to fulfill the data needs for the impact assessment for the city of Quito.

Table 13: Data type and recorded description to conduct the impact assessment for the city of Quito

Data type	Description
Estimates for e-mobility shift projections (e.g. population growth, GDP per capita, vehicle fleet information)	The input data required for the application of UNEP e-mobility calculator is gathered using international institutions' web pages (e.g. UN Population Division) and Ecuador's references (city level and national level).
Data to identify impacts of demonstrations and scale up project on climate and environment, social aspects, economy as well as on demand, supply and use.	– Data required to evaluate the demonstration project´s impact across relevant KPIs. This data will be gathered through available sources (e.g. national statistics) and stakeholders (e.g. local innovators, service operators, Quito's Municipality). – Two examples are provided: 1) To assess the impact of e-mobility solutions on noise, data related to noise will be accessible through the city's local air monitoring stations with the collaboration of Distrito Metropolitano de Quito. 2) To assess the impact of solutions on road safety, data related to accidents and number of casualties involved will be explored through national statistics. When data is not available, literature references will be used to estimate the expected impacts. – Data on the impact of e-cargo vehicles use by target user groupswill possibly be collected directly with the shops involved in the pilot.

Technical data on e-vehicle operations and charging infrastructure.	– Data related to vehicle trips, vehicle-kilometers, operational hours, speeds, energy consumption will be collected with the support of the SME and the selected operator for the last mail freight service. – Data related to the charging system (e.g.charging capability, charging time).
Subjective data including online survey and interviews (involving stakeholders) prior to demonstrations implementation, and surveys involving the local population, target users and stakeholders for the e-mobility solutions experience following demonstrations implementation.	– Data required for the user needs assessment before the implementation of project demonstrations. Data collection was conducted by UEMI by identifying relevant online survey respondents and conducting the interviews for relevant Quito stakeholders. Following, the collected data has been uploaded to the SharePoint and then, processed and analysed by VTT and UEMI. – Data required to evaluate the impact of project implementation will be gathered with additional surveys. These surveys will be designed to gather user and stakeholder perceptions on e-mobility solutions, accessibility, quality of services among other aspects.

6) How and when will the data be collected:

Data for the user needs assessment was collected between November 2020 and January 2021 with an online survey and interviews involving relevant stakeholders. In addition, data collection on the required inputs for the UNEP e-mobility calculator has started to enable estimating climate and environmental effects of shifting to e-vehicles in the long term. As an example of such required input data, the population of Ecuador growth projections from 2025 to 2030 and beyond were gathered. Furthermore, the process of collecting more specific data (e.g. technical data, operations, accessibility) for the impact assessment will start during the demonstration project implementation and continue during the scalling up.

7) Where will the data be stored (default option: V2C2 sharepoint):

User needs assessment data and the results of their analysis were stored at the SOLUTIONSplus project SharePoint. The same applies to ongoing data collection, such as statistical data (times series data) and other relevant information contributing to the demonstration project impact assessment. More specific data, such as vehicle data and or data related to the operations of the e-mobility solution might be stored in an external server accordingly to the requirements of the local innovator(s) involved. Besides agreed raw data, processed and analysed data will be stored via the V2C2 Microsoft SharePoint (as presented in Section 2.2).