User Needs Assessment – City Report City: Madrid

Project SOLUTIONS+

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This document complements the User Needs Assessment Guideline.
https://drive.google.com/file/d/12F3_C5g0doKrdDYdzgLQKFHj1c8VLbqV/view?usp=sharing

1 Approach

The User Needs aAssessment (UNA) has been carried out by Wuppertal Institute (Stefan Werland), UITP (Michele Tozzi) and VIRTUAL VEHICLE RESEARCH GMBH (Alois Steiner), as project partners members of the Madrid city teams, with the support of EMT (EMPRESA MUNICIPAL DE TRANSPORTES DE MADRID SA) as the leader of the S+ demo in Madrid. This task was kicked off in November 2020 with the identification of stakeholders active in the city/region of Madrid and relevant for the topic the city demo is addressing, i.e. smart charging for e-buses and promotion of e-mobility in the taxi, car-sharing and – potentially – last-mile delivery sector, by promoting easy access to new charging infrastructure. The full list of stakeholders identified is reported in Table 1, grouped by target group according to the approach defined by WP1 and in line with the user-definition in SOLUTIONS+. All selected stakeholders have been contacted and invited to contribute to the task according to their expertise and knowledge of the Madrid demo.

Table 1 – List of stakeholders identified as relevant for the Madrid UNA

Target group	**Stakeholder**
Public Transport Companies	EMPRESA MUNICIPAL DE TRANSPORTES DE MADRID SA – EMT
National / Regional / Local Authorities	Madrid City Council
	CONSORCIO REGIONAL DE TRANSPORTES DE MADRID - CRTM
E-Vehicle OEMs	BYD
	Irizar
Private Transport companies/ mobility providers	SHARE-NOW
	CityLogin
Electricity and charging infrastructure companies	ABB
	IBERDROLA

The majority of the stakeholders identified expressed their interest and availability in contributing to the User Needs Assessment activity and the findings are reported in this document. However, the UNA is an ongoing process and further interviews will be conducted as the demo project evolves and additional relevant stakeholders become visible and/or available. These might include car-sharing, taxi or logistic operator as well as passenger association and academia. Findings will continuously be integrated into this working document.

The UNA is to be performed via 2 activities: (i) an on-line survey and (ii) a set of stakeholder and expert interviews. Both are designed to grasp the perspective of local decision makers, operators and relevant stakeholders with respect to e-mobility and therefore investigate the suitability of the e-mobility solutions to be tested in Madrid vis-à-vis their needs and requirements as well as local barriers and opportunities.

I. The online survey has been considered suitable only for the stakeholders fully informed about the design and implementation of the Madrid demo. Overall, 3 responses have been totalised.
II. On the contrary, all the stakeholders listed in Table 1 have been invited to take part in the expert interviews. Overall, 7 interviews have been conducted, totalising 9 experts, as reported in Table 2.

Table 2 – Stakeholders interviewed for the Madrid UNA

Stakeholder Group	Stakeholder name	Stakeholder abbrev.	Method (Interview, Survey, KPI)	Date
Public Transport Companies	EMT	A1	Interview, KPI	19/11/2020
Regional / Local Authorities	CRTM	B1	Interview, KPI	2/12/2020
	Madrid City Council	B2	Interview, KPI	4/12/2020
E-Vehicle OEMs	BYD Europe	C1	Interview	6/01/2021
	Irizar e-mobility	C2	Interview, KPI	10/01/2021
Electricity and charging infrastructure companies	ABB	D1	KPI	12/01/2021
	Iberdrola	D2	Interview, KPI	9/12/2020

2 Results – Survey

The survey data was collected by using a self-completion online questionnaire consisting of twenty-four items measured using five-point Likert scale from -2 "*not at all important*" to 2 "very important", multiple-choice questions and open questions. The survey included five major sections: city identification (Question 1), city aims (Questions 4 to 11), implementation (Questions 12 to 18),

obstacles, limitations and barriers (Questions 19 to 21), and finally, background questions (Questions 22 to 26).

As already stressed, for the case of Madrid the online survey was considered suitable only for the stakeholders fully informed about the design and implementation of the SOLUTIONS+ demo. Overall, 3 responses have been gathered, all representing the stakeholder A1. Due to the low number of responses, only some qualitative conclusions are reported in the present document, while the full analysis is available in the project on-line repository.

Regarding the City Aims (Questions 4 to 11), according to stakeholder A1 the priority for the usage and acceptance of e-vehicles is "To decrease costs of the public transport provider", which got the maximum degree of importance (2.0), followed by "To increase the share of trips made with public transport". The latter is in line with the mobility patterns aims, where "To support multimodal travel chain", To study impacts of e-vehicle services on choice of travel mode" and "To improve quality of travelling" have been identified as the most relevant ones. Overall, e-mobility solutions seem to be conceived as a factor to improve the supply of public transport services in the city and eventually modify the modal shift towards more sustainable mobility behaviours.
Fleets renewal to support the decarbonization of transport is a key objective for the Region od Madrid (see 3.4) and the local public transport operators. This is confirmed in the question on the city environment where the "To reduce CO2 emissions" and "To reduce pollution (NOX, CO, PM10, PM2.5, VOC)" are rated as the top priorities (scored 2.0). Indeed, electric vehicles are also able "To reduce noise in road transport and living areas" which have been scored 1.67 out of 2.00.
The focus on the potential benefits of e-mobility for the citizens' wellbeing is again confirmed by the quality of life aims, being "To improve public health in general, esp. by reducing exposure of citizens to air pollution" (2.0) and "To improve livability of the city in general" (1.67) and "To enhance economic growth of transport service sector" (1.67), have received the higher scores. The physical wellbeing is therefore combined with the economic one.

Regarding the Implementation section (Questions 12 to 18), Madrid e-mobility solutions are primarily designed for the mobility of people across the city centre for all type of trips, from commuting to leisure and shopping. The stakeholders involved in providing and operating the services are the City together with public and private operators.

The main challenges to face for a successful implementation of the e-mobility solutions in Madrid (Questions 19 to 21), are respectively "Lack of money / financial resources" (3/3) and "Investments in the infrastructure needed" (3/3), followed by "Organizational issues" (2/3) and "Lack of service operators / people to operate the e-vehicle service" (1/3). Regulations are not seen as a main barrier, according to the comments of the respondents:

- "Existing legislation does not preclude the implementation and deployment of electric vehicles", and
- "In principle, current regulations are quite favourable to electric mobility. It is rather a matter of financial constraints, electricity supply, availability of charging infrastructure and the lack of vehicle models that can compete in terms of price with the current ICE ones (despite the financial support for their acquisition provided by different administrations)".

While the availability of financial resources is again confirmed as the main barrier:

- "The main barrier is economic. The transition to electric mobility won't be possible until the vehicles' prices become competitive with those of ICE vehicles", and
- "For private users, in addition to the above, there is also the perception that an electric vehicle cannot compare to an ICE in terms of range, which is still true, although there are more and more new models with higher ranges. But this means that outside the urban environment e-vehicles are still seen as a second car option, for example".

3 Results – Expert Interviews

3.1 Aims of the city and Expectations of Stakeholders

Questions related to the city's goals and the local stakeholders' expectations have been addressed to all the experts interviewed.

From a public transport operator's perspective, testing in real-life charging solutions for e-vehicles is key. Providing an efficient charging system and charging strategy to a continuously growing e-fleet is one of the main challenges stakeholder A1 is facing. Since the early 2000s, Madrid has been testing different types of electric and hybrid buses. Currently 83% of the stakeholder A1 bus fleet is clean or low-emitting. This is complemented by a fleet of over 2,500 pedelecs distributed across the 258 stations of BICIMAD, Madrid's bike sharing system. Beyond the services operated by stakeholder A1, the mobility ecosystem is quite active in Madrid, with taxi, ride-hailing and a wide number of shared mobility companies operating around 14,000 shared electric vehicles among cars, motorbikes, and e-scooters.
S+ demo is for stakeholder A1 an opportunity of testing new charging solutions and infrastructures, improve their expertise for the upscaling of the electric fleet from an operational perspective (e.g. upgrading their facilities) as well as for the definition of requirements for future tenders.

The Madrid demo seems to be fully in line with the goal of the City Council and the regional public transport authority. Different fleets (buses, scooters, taxis, bikes, trucks for last-mile delivery or waste collection) are currently experimenting or looking at e-mobility in the Madrid region. This is also the result of the ambitious goals set-up by the City Council in its Sustainability Strategy "Madrid360", among them reaching a network of 150 fast charging points by 2023 and reaching an electric bus fleet of 668 buses (out of 2003) by 2027. Recently, the City has also announced the goal to have a bus fleet diesel-free in 2023. A tender for more than 100 fully electric buses has been already published.
Local decision makers have expressed the need to gain knowledge from real-life tests on the technical and financial feasibility of smart charging solutions when applied to several fleets of different vehicles with different operational needs. This knowledge will guide, for instance, the future tenders for the renewal of the bus fleets in the whole Madrid region. By the end of 2024, new tenders will be published with higher requirement in terms of clean vehicles, being today 20% of fleet the target to meet.

For an OEM, a demo project is where their clients (e.g. public transport operators or logistic operators) want to verify the capabilities of the vehicles, their technological features, and their driving capacity. With the present electric vehicles and technology, stakeholder C1 is looking in the near future at how to implement these technologies especially into the 'last-mile' solutions. The flexibility of charging and

medium driving range allows the vehicles with the current technology to run for long hours in urban environment.

Continuous investments are expected in public transportation, and that means more electric buses will be in operation within cities, providing benefits to the passengers and residents, due to the reduction in sound and air pollution. Stakeholder C1, as a world leader in new energy vehicles, and the forerunner of battery technology, has the longest operational experience in electric buses in the world. They believe that a growth in e-mobility will be seen in other transport sectors, such as the logistic sector. Here the attention is mainly on electric trucks for the last-mile, being the technology already available to start operating, as the range of electric truck models recently launched seems to confirms.

Stakeholder C2 sees electromobility in urban areas as a trend “that came to stay”. Cities are aware of the importance of air quality and wants to grow in a sustainable way; to do so, it is necessary to implement “mobility policies that bet on the environment”. In addition to the shift of traditional public transport services to e-mobility (like buses), the last 5 years many solutions have appeared in cities, such as Madrid, which combine a clean propulsion technology with the sharing concept, like electric bikes, electric skates or electric scooter, since younger generations have not the purchasing power as their parents. New technologies and business models open the way to sustainable ways of travelling in cities.

Finally, the city’s goals and the local stakeholders’ expectations have been discussed with stakeholder D2, a global energy leader, the number one producer of wind power, and one of the world's biggest electricity utilities in terms of market capitalization. Even though D2 is not a partner of the S+ Madrid demo, they are in the process of collaborating with the City of Madrid to find good solutions to make the charging services of e-fleets more efficient and provide tailored services for different vehicles. Also, they are the energy provider of city public transport operator and an agreement has been recently signed to work together on the electrification of the urban bus network of Madrid, with the aim of consolidating sustainable mobility as an alternative to traditional transport. Therefore, stakeholder D2 shares the same objectives of the S+ Madrid demo and they are highly interests in its outcomes and the potential for the upscale of the project.

3.2 Regulation

The current national and regional regulation addresses several aspects related to the implementation of e-mobility in Madrid, however the expert interviews have pointed out, on one hand, the need to include in the regulations all the elements involved in e-mobility (from the funding instruments to the installation of charging infrastructure in public or private building, to the governance of e-micromobillity) and on the other hand, specific aspects that still need to be properly addressed.

Stakeholder A1, for instance, reported the need to adapt the existing regulations of low voltage applied to buildings.

For stakeholder B2 one key aspect is that new solutions, such as some fast-charging technologies, still lack appropriate regulations on safety and security which are normally addressed at national level. This seems to be due to the novelty of the solutions and the lack of information on the field: it is not yet clear what need to be covered by the regulations in such a multidisciplinary environment. There is the need to proof that new solutions and regulations comply with the national safety and security requirements, e.g. to ensure safety in relation to charging or the operation of clean vehicles. For

instance, gas-fuelled vehicles are not allowed in some in-door public transport interchange infrastructures in Madrid.

Looking at the smart charging to be tested in Madrid, one element to be considered for the upscale of the project is certainly developing clear guidelines and instructions for the installation of fast charging solutions, such as pantographs, in public spaces. This aspect was stressed by both stakeholder B1 the B2. In fact, the installation of charging infrastructure might require licenses released by different authorities at municipal, regional or national level. A simpler regulative framework is needed to integrate all different stakeholders and reduce the barriers for the implementation.

From an operational perspective, there is the need to adapt regulations dealing with taxi (existing regulation seems to not respond anymore to the changing urban mobility ecosystem) and micromobility as well as in a scenario of continuously growing e-fleets there is the need to investigate the access to charging infrastructure for fleets of private vehicles.

Stakeholder D2, as a member of the Spanish association for electro-mobility (AEDIVE, https://aedive.es/) is actively working to lobby on regulations that could help developing e-mobility in Spain. In their view, regulations on e-mobility in Spain have been improving significantly in the last years and overall they are on the good path. Aspects that need further deployment are:

- Administrative barriers for the legalisation of charging solutions. Current processes, often very long and time consuming, need to be reviewed and discussed with local, regional and central authorities.
- Role of private and public actors in e-mobility. Public administrations have a key active role in the promotion of e-mobility. EU regulations establishes that charging services are to be provided by private operators. Public Administrations should facilitate the access of private operators in the market and allow the private sector developing business models to facilitate efficiency and increase competitiveness.

3.3 Obstacles, limitations, barriers

Stakeholder A1 sees as the main challenge to face for the operation of e-buses in Madrid the power supply, since in the areas where the facilities are located (and the buses have to be charged) the power that can be supplied by the electricity company has been almost reached, as well as in other areas across the city centre. For an upscale of the SOL+ demonstration, beyond the project lifetime and scope, there is the need to investigate the quality and the capacity of the electricity distribution network and assure the possibility to supply enough energy in key locations across the city. The same point was also raised by stakeholder B2, who is aware that additional power infrastructure might be necessary for the deployment. The challenge, as stressed by stakeholder D2, is to provide the power needed when the whole bus fleet operated by the city operator will be electric and make it available at facilities (bus depots) located within a city like Madrid.

This is a multidisciplinary environment and requires the involvement of several expertise (e.g. energy provider, energy distribution company, public transport and mobility operator, OEMs, ITS providers) as well as multiple levels of public administrations. The commitment and the involvement from early stage of all the actors involved in the electrification of mobility in cities has been mentioned as critical by almost all the experts interviewed. This should lead to the definition of a roadmap, where potential

obstacles, like compliance of the e-components to existing regulations as well upfront costs, are timely addressed.

In addition to the collaboration between the private and public administrations, stakeholder C2 pointed out the need to further investments in R&D.

According to stakeholder C1, one of the biggest challenges to the deployment of electric vehicles is dealing with autonomy and mileage. Apart from improving charging power technology, if charging stations can be built as many as the gas stations, more and more customers would choose electric vehicles, also thanks to the support of big data and cloud service to provide smart charging management. Electric vehicles have the potential to realize more applications and support the shift to autonomous driving, thus electric vehicles will eventually replace gas-powered vehicles as smart phones replace traditional phones.

Additionally, as of today there is an absence of charging infrastructure dedicated to electric trucks in the EU. So far, the European Commission has set infrastructure deployment targets (Directive 2014/94/EU), but these only apply to filling stations / charging points for cars and vans – not those for heavy-duty vehicles. This sets a really big setback in rolling out trucks since customers will not want to invest in a transport solution without the right infrastructure.

Stakeholder C1 pointed out the need to adapt the market conditions in Europe to foster international green cooperation. Cooperation already exists between European countries and international stakeholders, however greater transparency and fairer market conditions in Europe – an environment where international businesses are encouraged to compete on a level playing field, are seen as key to boost the deployment for both demo and scale-up projects.
There is a clear need for greater policy support in Europe, especially for international companies wishing to export New Energy products and services. This support should come from governments and it includes funding, as financial help is essential for multiple industries; not only passenger cars, but also public transport and the logistic sector which seems to lack a detailed policy support strategy.

3.4 Sustainability of the e-Mobility solutions to be implemented

Investigating and testing in real-life the feasibility of smart charging solutions for electric vehicles is considered key by all the local stakeholders interviewed in the process of making urban mobility more sustainable in Madrid. In fact, electric mobility is a pillar of several strategic plans at national, regional and municipal level which set ambitious sustainable goals for the coming years. Among them:

- the first Climate Change and Energy Transition Law to achieve emissions neutrality by 2050, aligned with the EU Green Deal, recently drafted (May 2020) by the Spanish Government.
- the Air Quality and Climate Change Strategy of Madrid Region, so-called “Plan Azul +”, in line with the Sustainable Development Goals set by the European Union, provides funding for fleet renewal, among others, with the goal to help the decarbonization of transport.
- the new sustainability strategy “Madrid360” of Madrid City, launched in September 2019, which sets specific target for electric mobility (see 3.1) and air quality (e.g. reducing the nitrogen oxide emissions by 20% until 2023).

Stakeholder B1 sees the opportunity to capitalize on the findings of the S+ demo to guide the renewal of the bus fleets in operation not only in the city of Madrid but also in the suburbs and the surroundings, where a significant mobility demand can be met within a relatively small distance, with a potential target of 1M people living in an area up to 10km far from the city. To achieve environmental goals, it is important to have electric vehicles implemented in the whole Madrid region and - at the same time - focus on green energy and therefore work on the energy sources used to meet the energy needs. The less noise associated to e-buses in comparison with traditional buses is seen as a positive factor not only as a benefit for the city, due to its impact on the noise pollution, but also to improve the working conditions of bus drivers. In a social sense, the shift to e-buses is not expected to produce any relevant impact, as for the goal of the regional transport authority is actually to provide at least he same service which is today provide with traditionally fuelled buses so that the users will not perceive a discontinuity.

From a wider perspective, supporting to deployment of electric technology and e-mobility services is seen as an opportunity to boost the economy, by developing new business opportunities based on emerging technologies. Sharing services, that are taking advantage of the electric revolution, are also associated to accessibility and social inclusiveness concerns.

For stakeholder C1, COVID-19 has led to de-globalisation and businesses have suffered as a result. The climate challenge, however, is ever-present, and it affects us all. We must re-engage with one another – internationally – to underline the urgent need to reduce our carbon footprint. We must all adopt a sustainable 'mindset', where all parties work in harmony to create a total solution to efficient transportation with continuous technological innovation.

3.5 Impact on existing business models

From the perspective of the bus operator, the business model is not significantly impacted by the shift to electricity, as operations with e-buses and with diesel-fuelled busses are carried out in a similar way, taking into account the difference in terms of performances.

It is expected that the multiple business sectors related to fossil fuels will progressively adapt to the new scenario, where the request for new propulsion technologies will increase at the expenses of fossil fuels. This process is already on-going.

According to stakeholder D2, the development of successful business models and opportunities is possible only if public administrations recognize the role of the private sector in the process of electrifying mobility in cities and allow private partners to step in.

Technology is advancing very fast and electro-mobility is a sector of future growth, therefore the OEMs that are betting and investing in electro-mobility solutions are already adapting their business model to this new scenario.
There is need for vehicle manufacturers to control and understand the entire electric motor and technology, from the drive aisle, the electric motor, the design of the electric systems to the power supply. Stakeholder C1 is an example of an OEM who has a unified technology development for passenger cars and commercial vehicles which gives the company a complete understanding of how

the electric vehicles work, from the raw materials to the final product. This approach simplifies the life of the customers, as the OEM serves as a one-stop shop.
This shift in the business model is already being implemented by OEMs worldwide.

Partnerships is also identified as a strategic factor for OEMS to face the transition to electric vehicles. As an international player, stakeholder C1 recognizes partnership as a key value. One of the first examples includes the partnership with Daimler AG to develop electric vehicles since 2010 and partnering with Alexander Dennis Limited (ADL), the largest bus producer in the UK since 2015.
In Europe, stakeholder C1 is committed to "Made in Europe for Europe" development concept. With their local R&D center based in the Netherlands and two factories in France and Hungary, they aim to cooperate locally, nurture local businesses, engage with universities and start-ups and create job opportunities. In this sense, partnership to promote e-mobility ensure benefits for multiple stakeholders.

Finally, it was pointed out that the deployment of e-mobility on a large scale asks for employees with the needed expertise for both operators and industries. Trainings and new curricula are needed to re-train the current employees and form the future workforce. This can certainly have an impact on academia and research business.

3.6 Implications for Planning and Urban Development

In the deployment of the Madrid e-mobility solutions urban planning goes hand-in-hand with the planning of the transport and the energy network. It is well-know, for instance, that the deployment of e-buses requires adaptions to the urban spatial planning. Key factors are, among others, the location and distribution of bus hubs, availability of space at bus stops for opportunity charging facilities, bus stop and bus bays design (position of the bus vs the charging technology), re-design of the bus depot to house the necessary charging infrastructure.

Stakeholder B2 sees e-mobility as one of the tools to reduce the use of private cars in the coming years by offering a wider offer of mobility services. Madrid is already a demo city for e-sharing services, such as electric car and motorbike sharing, and the local authorities are willing to further support the deployment of such services as a complement to traditional public transport. This implies policies to supply parking and charging facilities both in dedicated areas (e.g. public transport operator parking facilities) and on-street. For the time being the charging points are not enough and are mainly located in the city centre. Actions are needed to supply specific charging points for sharing services and deploy them in a bigger area to extend the services outside the city centre. Plans exist to offer electric solutions and infrastructure also for the logistic and last-mile delivery sector. These initiatives are already part of the overall urban transformation and are complementary to solutions to further support sustainable mobility behaviours such as increasing pedestrian areas and bike lanes. Also they are key element of new urban development patterns to reduce the use of private cars.

Fleets of electric buses in operation in the city require dedicated charging infrastructure as well. Stakeholder B1 commented on the difficulty to build such infrastructure which are very often not seen positively by local administrations. Charging solutions and strategies might need to adapt accordingly. Also, bigger bus depots equipped with powerful electric supply are needed. The lack of such infrastructure within cites might slow down the shift to e-mobility.

Planning implications for the transport system include the design of the routes and the operation of the fleets to be adapted to the electricity scenario. For instance, regional bus routes are very dynamic with routes and schedule changing very frequently. Opportunity charging would not be an option in this case. Potentially a different design of the network might come up with a backbone of main routes (no change in the route nor schedule) and feeder flexible routes.

According to stakeholder A1, the city of Madrid is already actively adapting its urban planning to a scenario where e-mobility will have a bigger role. For instance, by deploying charging infrastructure with public access across the city, forcing to install charging facilities at public underground parkings, setting incentives for electric vehicles and restrictions for those more pollutant in terms of dedicated infrastructure and accessibility. As already stressed by stakeholder B2, the implications of e-mobility on urban planning and development are complementary to the overall plan to make the urban environment more livable by promoting sustainable mobility behaviors, like walking and cycling, and offering a diverse and integrated offer of mobility services.
As an operator, stakeholder A1 is aware that working with electric vehicles requires a change in the way of operating the fleets, as a new technology perform well only if deployed in its best operational conditions. The designing of the whole transport system is affected, from the vehicle to the infrastructure (bus stops, bus depots, dedicated lanes, charging facilities) to the operational dimension (network and route design, fleet management, maintenance and depot operations, workforce skills and training, investment and tendering). In fact, any change derived from the introduction of e-buses must be able to ensure safe and reliable operation, offering service excellence without compromising the versatility and flexibility of bus operations. Finally, the adaptation of the energy network (grid supply) requires investment and timely planning, also considering the impact that this might have in terms of public works.

According to the stakeholder D2, the challenge to face is to meet the power needs of a growing and diversified electric fleet. Buses, taxi, last-mile delivery trucks, motorbikes, bikes, private cars, car sharing, etc. All of them need to be charged and this requires an accurate planning of the needed electricity power in order to optimize the power availability. Optimization might include a strategy time-based, where some vehicles are charged over-night (e.g; buses at the depots) and others are charged at daytime.