Electric mobility breakthrough in FVG

WP5

D5.3

NOEMIX Replication Package

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No754145

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

PROJECT DETAILS

PROJECT ACRONYM	Project title
NOEMIX	NOEMIX - New Mobility in Friuli Venezia Giulia
GRANT AGREEMENT NO:	TOPIC
754145	
START DATE	
01/06/2017	

WP DETAILS

WORK PACKAGE ID	WORK PACKAGE TITLE
WP5	Dissemination, exploitation and replication
WORK PACKAGE LEADER	
Area Science Park	

DELIVERABLE DETAILS

DELIVERABLE ID	DELIVERABLE TITLE
D5.2	NOEMIX Replication Package

DELIVERABLE DESCRIPTION

Replication package: a detailed operational handbook in Italian and in English, reporting for both versions a textual description of Noemix's methodology and process, the main steps leading to the launch of Noemix's tendering procedure – Two versions will be produce, one more extensive and detailed in Italian and one comprehensive, but synthetic in English for the international market.

EXPECTED DATE

M59 30/04/2022

PERSON RESPONSIBLE FOR THE DELIVERABLE

nature	Dissemination level
R-Report	P-Public

DOCUMENT DETAILS

VERSION	DATE
1	10/10/2022

Document author(S)

		Email
Laura Chessa (Area Science Park)	+39 040 375 5087	laura.chessa@areasciencepark.it
Fabio Tomasi (Area Science Park)		fabio.tomasi@areasciencepark.it
Marco Slavich (Area Science Park)		marco.slavich@areasciencepark.it
Barbara Monaco (Area Science Park)		barbara.monaco@areasciencepark.it

Status

Final (submitted to the EC)

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

SUMMARY

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Introduction

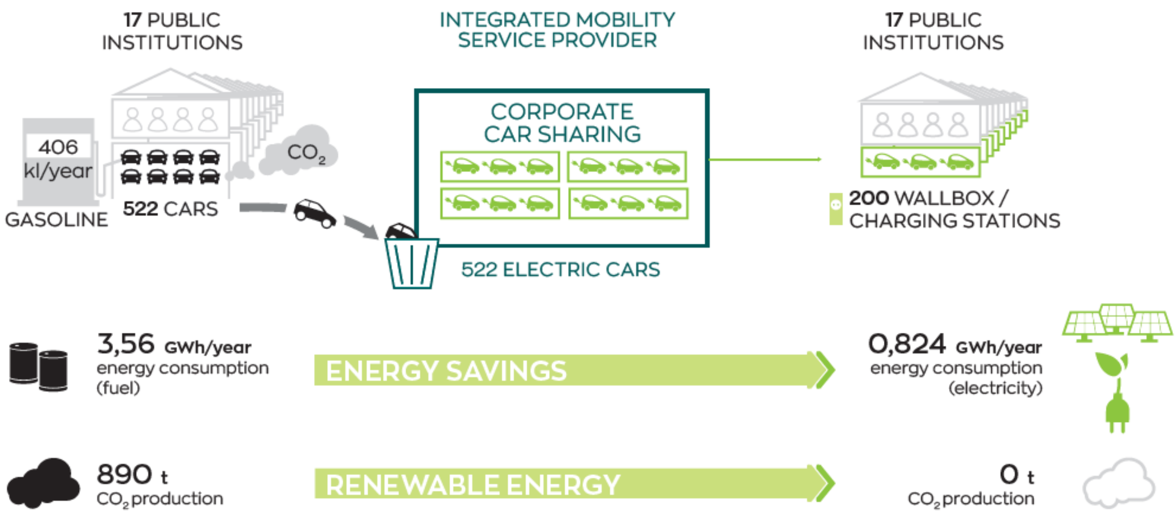
The project Noemix, financed by the European Union's Horizon 2020 research and innovation programme aims at making Friuli Venezia Giulia a forerunner region at the European level in the transition to a low-carbon economy by reducing urban pollution caused by motor vehicles. NOEMIX, started in June 2017, has a budget of **€ 900.000** granted by the European Commission that by 2023 will mobilize around **€ 21,5 million** of investments to give life to the NOEMIX service. Thanks to Noemix, Friuli Venezia Giulia is going to be the first region where a considerable share of company cars of municipalities, unions of municipalities (UTI), the healthcare authorities, the regional administration and other public institutions will be replaced by electric vehicles. By aggregating the mobility needs of several public authorities, the current model based on car ownership will be phased out and replaced by a centralized electric mobility service managed by private operators. In addition to the car-sharing service, the rental of electric vehicles including a software to manage and optimize the service, NOEMIX envisages to install charging stations as well as to produce electric energy from renewable energy sources.

Starting situation

From an initial analysis conducted in 2016, it appeared that the PA of Friuli Venezia Giulia (Friuli Venezia Giulia Autonomous Region, Healthcare Companies, Provincial Capital Municipalities, Port System Authority of the Eastern Adriatic Sea, Universities and research centres), had mobility needs managed with at least 1500 cars traveling 50-100 km per day, mainly in urban areas. Several critical issues were found in the management of the fleets of the Public Administrations. In particular: 70% were underused vehicles (mileage less than 10,000 km / year); a large proportion of vehicles were obsolete (530 were over 10 years old, of which 320 were over 15 years old); general lack of data (such as mileage) for over 380 vehicles.

Results and impact of the project

NOEMIX aims at reducing CO2 emissions, increasing the production of energy from renewable energy sources, reducing pollution – as a result of the reduction of the emissions deriving from internal combustion engines – as well as cutting down particulate matter and noise generated by congestion in urban areas. As shown in the chart, NOEMIX will introduce at least **522** electric vehicles in the fleet of regional public authorities, together with **200** charging stations and a photovoltaic plant that will satisfy the **100%** of the electric energy needs. The expected primary energy savings amount to about **2,736** GWh, with a reduction of around 1.000t of CO2 emissions. The model can be replicated in other regions in Italy and Europe.



NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Objectives and contents of the replication package

The replication package represents a key tool for the collection and dissemination of the NOEMIX experience. The package contains all the phases of the project as well as a description of the methodology and tested process, in order to indicate the path that the project has traced in the launching of the tender procedure for the mobility service.

In particular, this document includes:

a. A chapter dedicated to WP2: the methodology used for the context analysis and the mobility needs of Public Administrations in FVG Region will be illustrate and the lessons learned highlighted. It will also comprise the complete collection of the technical results of WP2 (context analysis - existing public fleet, usage habits, mobility needs, existing infrastructures, scenario analysis relating to the introduction of electric vehicles in the fleets of the Public Administration in the FVG Region);
b. A chapter dedicated to WP3: the methodology used will be highlighted and the lessons learned explained. The complete collection of the technical results of WP3 (feasibility study, financing scheme and business plan) will be provided attached;
c. A chapter dedicated to WP4: the focus will be on the methodology used for the administrative and legal choices undertaken by the project. It will include also the complete collection of the technical results of WP4 (Agreement between the FVG Region and entities belonging to the PA Panel, regulatory framework and tender procedure adopted with a complete set of documents and tender annexes). A final session will be dedicated to the lessons learned.

1. PARTICIPATED CONTEXT AND MOBILITY NEEDS ANALYSIS

Premise

The Noemix project proposes a centralized "turnkey" electric mobility service managed by private operators. It includes the rental of electric vehicles and the development of a digital software application for managing and optimizing the mobility of public administrations, but also the installed charging infrastructures and the production of energy from renewable sources.

In order to identify the potential interested public bodies and members of the project, the Friuli Venezia Giulia Region, coordinator of the activities, sent a formal request to participate in the NOEMIX project to all the public bodies of the regional territory. The entities that responded positively to this request therefore committed themselves to adhering to the future "NOEMIX turnkey service", after analysing the mobility needs of their company fleet and defining the mobility plan, carried out thanks to the support offered by the project.

To analyse the mobility needs of Public Administrations and identify, among the available endothermic motor vehicles, those potentially replaceable with electric vehicles or to be discarded, a collection of data on the vehicle fleets of the individual bodies involved was initially conducted, in order to ***depict the starting situation****.*

The contact persons appointed by each body were then called to collaborate (with the technical scientific partners of the project such as the University of Trieste and Area Science Park) to provide all the data necessary for the analysis of the body's mobility needs. Joining the project also entailed the commitment on the part of the Public Administrations to participate in the training sessions and in the two organized workshops: one dedicated to the employees of the Administration aimed at managing relationships with private entities providing the electric mobility service, and an optional one on the driving styles of electric cars open to all employees which will represent a fundamental moment to collect feedback from future users of the electric mobility service.

Data retrieval methodology

The contact persons appointed by each institution were contacted and the collection of data on the vehicle fleets took place through the preparation of specific questionnaires and interviews by project technical representatives from the University of Trieste and the Area Science Park. Information was requested to investigate the consistency, methods of use, management and costs of the vehicle fleet of each entity. In some cases, **criticalities were recorded in finding the necessary data**, which entailed delays in the information gathering phase. There are several reasons for this. The pressing bureaucracy of the Italian public administrations has certainly represented the first major obstacle. The request for a lot of data required specific authorizations even at different hierarchical levels and this led to evident delays. This proved to be particularly relevant when the research group requested additional information than that collected in the first phase, resulting in the need for the contact person interviewed to retrace the entire authorization process again. It should be emphasized, however, that the management of the vehicle fleet is not the core business of the entities interviewed. Also for this reason, only in very few cases is the management of the car fleet entrusted to officials assigned exclusively to this task. Very often, however, it occupies part of the time of the already few employees, whose main task is different and related to the large sector of infrastructure management. As a result, the collection and transmission of the requested data also suffered delays. Another important criticality encountered is represented by the fact that very often the Authorities collect data at an aggregate level on the entire vehicle fleet, without the detailed data on the individual vehicles available, which is instead necessary for the survey. And not all the information requested is registered by the Authorities, or maybe they exist but in formats that are not directly usable, such as the daily mileage of vehicles. In this case, in fact, each employee fills in a paper travel diary indicating, for each use of the vehicle, the date, the times of taking charge and delivery of the vehicle and the travelled kilometres, but the **lack of "computerization" or a digital organization of such data** makes them difficult to use. The lack of sufficient details to allow the research group to conduct the analysis in a timely and effective manner did not only concern simple travel information, but also the economic dimension of fleet management. In fact, various administrations (especially the Health Authorities) do not have an analytical accounting by type of vehicle or by single vehicle, but rather collect the various cost items at an aggregate level for the specific division to which the vehicles belong. Despite the appreciable effort of some appointees to try to separate the cost items for single vehicle or single vehicle type from the aggregate data, it was not possible to use the declared data directly, but it was necessary to estimate the detailed data necessary for the investigation.

Another data not always available concerned the number of parking spaces and the location of parked cars. There is a great heterogeneity between the Bodies on the number and availability of parking spaces, since some Public Administrations can rely on their exclusive parking within delimited areas, while others do not have this availability and are obliged to park wherever there is a free seat in a public place. This heterogeneity combined with the fact that practically no public administration is equipped with geolocated cars has required and requires even more time than expected to obtain precise data on where it will be possible to install the charging stations.

Finally critical was the finding of a lack of **knowledge and awareness of electric mobility**. Few organizations, among those interviewed, have had direct experience with electric cars so far. The common feeling in most bodies, at least initially, was one of reluctance and even opposition to the adoption of electric cars and this distrust certainly derives from a little or no knowledge of electric vehicles. This aspect has sometimes led to a delay in the collection of information because the scope of the project was often not fully understood or it was considered too ambitious for application in public administrations.

Despite the difficulties encountered in retrieving the data, all the information collected made it possible to have a clear picture of the vehicular situation of the entities interviewed. The data collected was then processed and the results are presented in this report at an aggregate level, and then, separately, for the Health Authorities, for the Municipal Administrations and for the other public Authorities

Vehicle classification

The vehicles in use by the interviewed public administrations include many types, from mopeds or small cars for urban use used for example by municipal messengers or health assistants, to vans used for example for the transport of medicines, to emergency ambulances.

In this analysis, the vehicles were classified into five categories based on their intended use:

- **cars for transporting people:** cars mainly intended for the transport of people, although in some cases they are also useful for transporting light work tools (sanitary appliances, measuring devices, etc.).
- **cars for people/things mixed use:** cars to be used both for the transport of people and goods. In this second case they are not too heavy work tools.
- **truck/van:** vehicle mainly used for the transport of goods or for a large number of people.
- **motorcycles and mopeds.**
- **other:** special purpose vehicles, such as for the specific transport of live animals, or rescue vehicles such as ambulances, or advanced rescue vehicles.

The Noemix project envisages the potential introduction of different types of electric vehicles, falling into the categories described. However, for the purposes of this project, the focus was mainly on cars used for passenger transport or for mixed use, as the offer available on the market of electric vehicles for the transport of goods or many people (vans, coaches, trucks) was still in the initial development phase, and therefore thinking of replacing these internal combustion vehicles was not an efficient choice.

Through the questionnaires submitted to the various Bodies, it was possible to photograph the characteristics of the vehicle fleet of the Public Administrations participating in the Project. In particular, it was possible to identify, for each entity interviewed and for each vehicle available, the type (among the five categories identified), the power supply, the make and model, the daily and annual mileage, the methods of use. (full day, half day, a few hours a day, ...), the location of the car park usually used, the amount of maintenance costs, the insurance premium and the management methods.

Looking at the age of vehicles for personal and mixed use available to Public Administrations, it emerges that the car fleet of the Bodies interviewed is made up of fairly dated cars: 59.1% of vehicles are over 10 years old, with 26.3 % are over 15 years old, and only 13.1% are under 4 years old.

Journeys

Overall, the vehicles supplied by the public administrations interviewed mostly travel (61.4%) up to 10,000 km per year, just over a fifth of the fleet considered covers distances between 10,000 and 15,000 km, and 16.9% distances greater than 15,000 km.

As for daily journeys, overall 40.3% of the vehicles involved in the Project travel less than 25 km per day and only 3.8% are used to cover distances of more than 100 km on a daily basis. Take into account the fact that the daily journeys have been estimated, given that only a few organizations have provided the detailed data based on the travel books of the individual vehicles. The estimate was obtained by dividing the annual mileage of each vehicle by the number of working days in a year.

The data on costs were provided in a different way by each Entity, on the basis of its own accounting organization. Very often the Bodies interviewed provided aggregate data, considering the entire vehicle fleet as a whole, and not individual vehicles or different types of vehicles. In this case, the management costs of the individual vehicles were estimated by dividing the total expenditure by the total number of vehicles (all types). Where the initial data allowed it, only the vehicles considered for the purposes of the project were counted. In any case, among the management costs, those relating to personnel have not been considered because they are difficult to separate and/or estimate.

Summarizing the analysis conducted so far, a series of considerations emerge from the data collected:

- the consistency of the car fleet must be photographed in a certain **reference year** but take into account the fact that there are <u>continuous variations</u> in the car fleet of the authorities (new purchases or divestments) even if limited;
- **the vehicles are in the majority of cases ownership**, and only rarely purchased with a leasing contract;
- **the car fleet is quite old**: in the case of the initial mapping of the Noemix project, <u>59.1% of the vehicles analysed are over 10 years old</u>, and only 13.1% are under 4 years old;
- **the renewal rate is very low**: both the acquisition of new vehicles and the disposal of old vehicles are very limited, and <u>this greatly affects maintenance costs</u>;

- **most of the vehicles considered cover limited distances**, less than 10,000 km in a year (61.4%) and 50 km per day (76.7%); the data on daily distances have been estimated, as they do not have the detailed data;
- **the vehicles are entrusted to different structures that manage them independently on the basis of their service needs**; health authorities are the most complex of the regional bodies contacted;
- the assigned structures are sometimes located in geographically distant places;
- the cars are parked at night in many places, sometimes owned by institutions and in reserved spaces, other times on public land;
- **vehicle management costs do not have the same degree of detail between the various entities contacted and are often provided at an aggregate level for the entire fleet**; the administrative costs for the management of the car fleet are difficult to estimate.

Scenario analysis relating to the introduction of electric vehicles in the FVG Region Public Administrations fleets

The potential requirement: from the current fleet to the future fleet

In the analysis of mobility needs in preparation for the sizing of the Noemix service, some strategies for sizing the vehicle fleet were proposed to improve the efficiency and productivity of the activities related to the transport sector of regional public companies. The management of a vehicle fleet includes:

- **financial activities:** purchase, rental, lease management, sale of second-hand items, insurance agreement;
- **logistic activities:** placement, transport, assignment, authorization of drivers;
- **vehicle maintenance activities:** tire replacement, overhauls, ordinary and extraordinary maintenance for both efficiency and safety reasons;
- **current management activities:** fuel cards, telepass, road tax, contacts with the insurance company, fines, claims;
- **mission planning activities:** delivery planning, intervention planning.

It is on these aspects that action must be taken to achieve greater management efficiency. This is possible, for example:

- appropriately choosing the combination of vehicle supply contract types *(purchase, leasing, long or short-term rental)* and within each category by making a selection of suppliers;
- limiting machine downtime through appropriate programming, both by limiting unladen movements and by anticipating maintenance and replacement activities through simulation models of the vehicle life cycle;
- defining and strengthening the company policies for the assignment of vehicles in order to accentuate the economic aspect;
- overseeing and monitoring the expenses related to vehicle management, to verify compliance with the expectations and settle any conflicts between suppliers and the company;
- implementing a company management system for road safety in compliance with the requirements of the international standard ISO 39001 ("*road traffic safety management systems*").

Recently, the availability of localization systems has added to the management activities the tracking of the position of the fleet and the advanced management of vehicle security by means of satellite anti-theft devices.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

*To analyse the potential needs of the organizations interviewed and understand the share of vehicles to be actively involved in the project (to replace/dismiss), reference was made to **4 evaluation dimensions**:*

- ✓ *the substitutability of endothermic motor vehicles with electric ones;*
- ✓ *re-organization actions based mainly on the transition from the assignee model to the vehicle sharing model;*
- ✓ *the potential downsizing of the fleet mainly following the proposed reorganization;*
- ✓ *the economic and social feasibility of replacing endothermic motor vehicles with electric vehicles.*

The 4 evaluation dimensions proposed, although specific, are not completely independent but strongly interact with each other. The replacement scenarios were discussed in relation to:

- technical constraints: use / autonomy;
- vehicle age;
- the point of view of the authority, how many of the managers interviewed declare the vehicles replaceable;
- infrastructural constraints: maximum number of electric vehicles that can be hosted by the institution, result of the direct survey.

Technical constraints

This criterion is based on the declared or estimated use of the vehicle in terms of km travelled per day in relation to the current range of electric vehicles. By way of example, consider that one of the main quantitative results of the survey carried out is that 96.2% of the vehicles travelled less than 100 km per day.

To comment on this analysis on the estimated average values, it is necessary to make two clarifications:

- it was not possible, except for small samples, to detect the daily distances actually travelled. Therefore, in the event that a vehicle has occasionally travelled more than 100 km, this is not visible in the estimates. To do this, it would have been necessary to monitor the actual daily journeys for a long period using IT tools (GPS locators) or to examine the travel sheets *(if they are filled in)*. It is therefore possible that the estimate that 96.2% of vehicles are replaceable from the point of view of range has been overestimated.
- the threshold of 100 km range of electric vehicles is to be considered as extremely prudent in relation to two developments underway: a) the increase in the range of electric vehicles (which often exceeds 300 km) also for vehicles of medium range; b) the increase in fast charging stations that make it possible to travel much longer than the range of vehicles by requiring an intermediate recharge of about 30-40 minutes, which could take place at the intermediate destination of the journey or during a work break. In this case, the 96.2% estimate is technically well founded.

Age

A further dimension to evaluate the substitutability of endothermic motor vehicles with electric vehicles concerns the age of the current fleet. This dimension gives us an indication not so much of the maximum possible substitutability as of the minimum recommended substitutability, in consideration of maintaining adequate levels of economy, comfort, environmental impact and safety. It is in fact evident that the greater the age of the vehicles, the worse the parameters listed above deteriorate.

The point of view of the institution

To complete the previous reasoning, it is useful to add the available information on the technical substitutability of endothermic motor vehicles with electric vehicles based on the declaration of the Authorities. Although it was not possible to collect these data from all the Bodies, in the case of the Municipalities there was an explicit question in the questionnaire as follows: "*Is the vehicle used only for journeys within 50 km? Or even for longer trips? In case of longer journeys, indicate the distance and frequency*". Since the question was formulated in an open way, the variety of answers provided did not allow for a statistical analysis of the same.

Infrastructural constraints

A further important problem relating to the replacement of endothermic motor vehicles with electric vehicles concerns the maximum number of electric vehicles that can be accommodated by the Authority, considering the need to have adequate space available for the installation of charging columns.

The reorganization scenarios were instead discussed in relation to:

- purchase vs rental,
- single management instead of assignment to services / offices,
- booking management.

Purchase vs rent

Buying a car has the advantage of allowing a choice between a higher number of specific models (not always available with rental) and involves lower costs associated with longer depreciation. Other non-negligible advantages are the absence of constraints (minimum and maximum) related to distances, on which the rental rate is based, and the possibility of direct negotiation of insurance coverage. On the other hand, however, the purchase involves financial immobilization and there are, for Public Administrations, regulatory constraints on the number and type of vehicles that can be purchased. In addition, purchased cars are subject to technical obsolescence, with depreciation entirely borne by the owner, and involve organizational rigidity.

On the other hand, the rental offers greater flexibility from a regulatory point of view, offering an "all inclusive" service involves lower administrative costs for the public body (for maintenance, accidents, ...), relieves the body from the risk depreciation (residual value charged to the renter) and guarantees the availability of replacement vehicles in the event of accidents or breakdowns. Among the disadvantages of renting the higher costs must certainly be mentioned and, thinking of electric vehicles, the limited availability of these vehicles by the hirers both in terms of number and variety.

Single management vs "assignee" model

In this analysis, the "assignee" model means that management mode in which vehicles are assigned to a specific service and are shared only within that service, or assigned to a single employee. In the case of single management, on the contrary, the vehicles are available to all employees of the Entity and can be used upon reservation.

The analysis carried out shows that the "assignee" model is far superior to the single management and this limits the possibilities of sharing and full-time use of the vehicles. An important part of the project, discussed during interviews with fleet managers, concerns not only the technical feasibility, but also the cultural constraints on shared use.

Booking management

From the interviews it emerged that the cases of use of vehicles according to a single management are limited. As regards the few experiences of car sharing found in limited cases from interviews with fleet managers, the following observations emerged:

- the booking system takes place via an e-mail service managed by two employees in charge of managing the car fleet;
- the company car is no longer "personal", but is used by all employees if necessary;
- using the public car instead of your own is to be preferred, as is the use of public transport;
- the cost for the administration is lower than the kilometer reimbursements that must be paid to employees who use private cars for work purposes;
- involvement of only some vehicles in the fleet, with the exception of those assigned and a car "reserved" to the technical office for emergencies;
- each vehicle travels more kilometres per year than in the previous management;
- need for a mindset change, to stop using one's own car in favour of an administration's one, perhaps even to be shared with colleagues if one takes common paths. Accepting sharing requires a noticeable change;
- economic savings and environmental protection are just some of the pillars of car sharing;
- idea of extending carpooling to users as well;
- installation of a black-box, which allows not only to locate the vehicle, but also to monitor its use, driving methods and any traffic violations.

More generally, from the interviews with the Bodies, it emerges that the main management method of the booking system is a management application developed internally or by specialized bodies (e.g., regional agency for information systems). Among the advantages of carpooling there are certainly a reduction in costs and in the number of vehicles, the possibility of rationalizing and making the use of cars more efficient, for example by distributing them on the basis of rental mileage ceilings or assigning them based on the type of journey. to go through. On the other hand, however, car sharing involves the need to book a car in advance and higher administrative costs precisely to cope with the management of this service.

A series of critical issues emerged from the interviews: the IT services currently used by public administrations are still insufficient and with a degree of sophistication that is not yet adequate, and often not integrated with company applications (in terms of holidays, timetables ...).

For the purpose of rationalizing the service, “computerized” vehicle access systems could be useful, e.g. with electronic keys or applications, but various problems have been encountered in this regard, including privacy problems or problems related to the availability, not always obvious, of personal smartphones by employees, for which there would be a need to equip them with company phones. We are therefore still far from an efficient management of the service.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Structure of the interview: mobility needs questionnaire

Data and functions of the respondent

Data about managing entity

- *Body*
- *Assignee structure*
- *Dislocation by geographical location*
- *Vehicle fleet purchasing manager*
- *Vehicle fleet managing responsible*
- *Vehicle fleet employees*

Data on the company fleet

- *Vehicle Type*
- *Brand*
- *Model*
- *Power*
- *Age*
- *Euro class*
- *Fuel type*

Company fleet usage data

- *Trips origin and destination*
- *Total distance measured (from odometer)*
- *Estimated annual mileage*
- *Daily mileage (estimated on 270 days)*
- *Recorded daily mileage*
- *Maximum recorded daily mileage*
- *Daily use time*
- *Time of use: morning, afternoon, evening (in %)*
- *Joint use: No. of people per trip, No. of people using the same vehicle*
- *No. of businesstrips made with vehicles owned by employees*

Company fleet costs data

- *Total management costs (recorded or estimated)*
- *Analitical management costs:*
  - Fuel consumption
  - Insurance
  - Car tax
  - Mantainance
  - Administrative costs
  - Reimbursement costs for cars owned by staff used for business trips due to the unavailability of company fleet vehicles

Preliminary survey for the design of infrastructures for electric vehicle recharging

- *Spaces for the installation of charging infrastructures (ground columns or wall boxes)*
- *Spaces for future parking bays for electric vehicles (closed / uncovered place, fenced, ...)*
- *Existing renewable energy production plants (photovoltaic panels) or available surfaces for installation*

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

2. FEASIBILITY STUDY AND FURTHER DESIGN LEVELS

Glossary

Units of measure

Kilowatt (kW): multiple of Watt (1000 W = 1 kW), the **electrical power unit of measurement** (i.e., the energy transferred per unit of time). Power could be defined as the electricity transfer 'speed': the greater the power, the greater the amount of energy that can be transferred in a given period of time.

Kilowatt-hour (kWh): multiple of Watt-hour (1000 Wh = 1 kWh), the **electricity unit of measurement**. It is defined as the total amount of energy provided by a one-kilowatt electrical power supplied for one hour continuously and constantly.

The terminology used is that defined by the 2014/94/UE directive.

Recharging point: an interface that is capable of charging one electric vehicle at a time.
To simplify this definition, we can say that it is an electrical socket (a bit more sophisticated as it is also equipped with a control system that manages the charging process) to which an electric vehicle can be connected.

Normal power recharging point: a recharging point that allows for a transfer of electricity to an electric vehicle with a power less than or equal to 22 kW, excluding devices with a power less than or equal to 3,7 kW, which are installed in private households or the primary purpose of which is not recharging electric vehicles, and which are not accessible to the public.
The transposition of the EU directive into the Italian legislation introduced further classification.
The normal power recharging point is detailed in the following types:
1) slow = equal to or less than 7,4 kW;
2) accelerated = greater than 7,4 kW and equal to or less than 22 kW.

High power recharging point: a recharging point that allows for a transfer of electricity to an electric vehicle with a power of more than 22 kW.
The transposition of the EU directive into the Italian legislation introduced further classification.
The high power recharging point is detailed in the following types:
1) fast = greater than 22 kW and equal to or less than 50 kW;
2) ultra-fast = greater than 50 kW.

Recharging device: a device capable of providing the recharging service through one or more recharging points, commonly referred to as "charging pole" or "wallbox" in residential contexts.

Recharging infrastructure: a set of structural and building works and systems required for the construction of parking areas equipped with one or more recharging points for electric vehicles. In particular, the recharging infrastructure consists of one or more recharging devices and the electrical connections between them.

Recharging station: an area dedicated to the electric vehicles' recharging service which is composed of parking bays, recharging infrastructures and architectural and building elements functional to the recharging service. Non-discriminatory access to all users must be granted in case it is located in a public or publicly accessible area. A recharging station is connected to the electric grid via a point of delivery (POD) equipped with a smart meter to measure the energy both drawn, including energy for uses other than recharging, and fed.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Publicly accessible recharging or refueling point: a recharging or refueling point for the supply of alternative fuel granting non-discriminatory access to all the users. Non-discriminatory access can be provided according to several different authentication, use and payment terms and conditions. The following are considered recharging points open to the public:

1) a recharging point whose parking area is accessible to the public, also through authorization and payment of an access fee;
2) a recharging point connected to a system of shared vehicles and accessible to third parties, even following the payment of the recharging service.

Charging point not accessible to the public:

1) a recharging point installed in a private residential building or in an appurtenance of a private residential building, reserved exclusively for residents;
2) a recharging point exclusively intended for recharging vehicles in service within the same body, installed within an enclosed area owned by that body;
3) a recharging point installed in a maintenance or repair shop, not accessible to the public.

In addition the following terms will be used:

Slow charging: recharging process at a power up to 7.4 kW.

Accelerated charging: recharging process at a power greater than 7,4 kW and equal to or less than 22 kW.

Fast charging: recharging process at a power greater than 22 kW and equal to or less than 50 kW.

Ultra-fast charging: recharging process at a power greater than 50 kW.

Charging:

Slow		Accelerated		Fast	Ultra-fast
3,7 kW	**7,4 kW**	11 kW	**22 kW**	**50 kW**	→

Power

Battery capacity: the total amount of energy that can be stored, expressed in kilowatt-hour (kWh).

State of charge (SOC) ***(of the battery)*** or **level of charge:** the amount of energy stored in the battery in relation to its capacity. It is shown on the vehicle dashboard and is expressed as a percentage (%). Usually it is indicated with the acronym SOC.

Point of delivery (POD): it is the connection point between the electric grid and the private electric system *(generally corresponds to the energy meter)*. The POD acronym still derives from the old denomination "Point Of Delivery" which has been modified since, with the spread of distributed energy generation devices *(mainly photovoltaic plants)*, in many cases the flows are no longer one-way *(from the grid to the user)*, but bidirectional *(from the user to the grid too)*.

Light Electric Vehicle (LEV): a land vehicle propelled by an electric motor that uses an energy storage device (*e.g., a battery or fuel cell*), has two or three wheels and typically weighs less than 100kg. E-scooters and e-bikes are examples of light electric vehicles (LEV).

Battery Electric Vehicle (BEV): a type of electric vehicle (EV) exclusively powered by the chemical energy stored in rechargeable battery packs, with no secondary source of propulsion (*e.g., a hydrogen fuel cell, internal combustion engine, etc.*).

Preliminary size and charging infrastructure typology definition

The goal of the technical feasibility study is to assess and chose which sites are suitable for the installation of the recharging infrastructures needed to provide the electromobility service.

Once the PA mobility needs are clear and the number of EVs, their typology (2 or 5 seat, car or van, etc.) and their features (mainly the range needed, according to the daily mileage, and the battery capacity consequently) are defined, recharging infrastructure requirements can be outlined.

Vehicles' usage frequency and travelled distance are essential information to define the number of recharging points needed and the ratio between these and the vehicles' number. On the other hand, knowing vehicles' idle times according to working hours and routine activities is important in order to determine the recharging infrastructure power required (and therefore charging times).

If most of the fleet consists in vehicles with 400 km range which are used daily to travel 50 km on average, one charge a week (which will not even be a full charge) will suffice. Moreover, charging one vehicle a day in turns, 1 recharging point could be used to charge up to 5 different electric vehicles (considering 5 working days a week and no possibility of charging additional vehicles in the weekends due to staff unavailability). In addition, if the working hours are only daytime (e.g., between 8:00 a.m. and 7:00 p.m.), it will be possible to provide slow charging (e.g., 7,4 kW) at night (about 12 hours). Considering that a 400 km range vehicle is generally equipped with a battery of about 50 kWh, a full charge will take about 7 hours at a power of 7,4 kW.
In case of smaller vehicles (e.g., 2 seat cars) with a 22 kWh battery capacity and 100 km range, they must be charged every other day if they travel on average 50 km daily and the ratio between charging points and electric vehicles must be 1:2, i.e. one single charging point for 2 vehicles (the number of charging point is half the vehicles' one).

For each case (combination of vehicle usage level and available charging time) indicated in the table below the following charging point powers are suggested:

Charging power (P):	**3,7 kW ≤ P < 7,4 kW**	**7,4 kW o 11 kW**	**22 kW** (P ≤ 43 kW)	**P > 43 kW**
Electric current typology:	AC	AC	AC	DC
Vehicle usage:	Short journeys *(significantly lower than the vehicle range)* and/or occasional vehicle use	Daily vehicle use (one single use on a significant distance travelled or more than one use on a total distance not exceeding vehicle range)	More subsequent journeys during the day with a total milage longer than vehicle range	More subsequent journeys during the day with a total milage longer than the vehicle range
Available charging time:	Possible frequent short (partial) charging sessions or long idle times *(more than 12 hours)* e.g. night charging	Night charging or short partial charging sessions possible between subsequent journeys during the day	Idle times long enough to charge the vehicle *(even partially)*	Short idle times **Note: this kind of recharging infrastructures are very expensive!**
Preference: • = not recommended • • • = highly recommended	•	• • •	• •	•

Full charging time: *(approx.)*	**Battery size:**	**3,7 kW ≤ P < 7,4 kW**	**7,4 kW o 11 kW**	**22 kW** (P ≤ 43 kW)	**P > 43 kW**
	22 kWh	6 ÷ 3 hours	3 ÷ 2 hours	≈ 1 hour	< 1 hour
	50 kWh	14 ÷ 7 hours	7 ÷ 5 hours	> 2 hours	≈ 2 hours

It should be noted that nowadays most electric cars on the market accept a maximum charging power of 7,4 kW as a standard feature and, sometimes, 11 kW as an optional on request. Only some vehicles on the market accept charging powers equal to 22 kW or higher. The most common charging mode is Mode 3 which is the one that was also adopted in the Noemix project. The most used sockets and connectors are Type 2 (Mennekes) and we can say that currently they constitute the European standard for Mode 3 charging.

Charging mode	**Vehicle type**	**Location**	**Device**	**AC/DC**
Mode 1	LEV*	**on private properties only**	charging cable connected directly to a common electric socket	AC
Mode 2	LEV e BEV**	**on private properties only**	charging cable with a control box connected to a common electric socket	AC
Mode 3	**LEV e BEV**	**Both in public spaces and private premises**	**wallbox o charging pole**	**AC**
Mode 4	BEV	Both in public spaces and private premises	charging pole	**DC**

* Light Electric Vehicle

** Battery Electric Vehicle

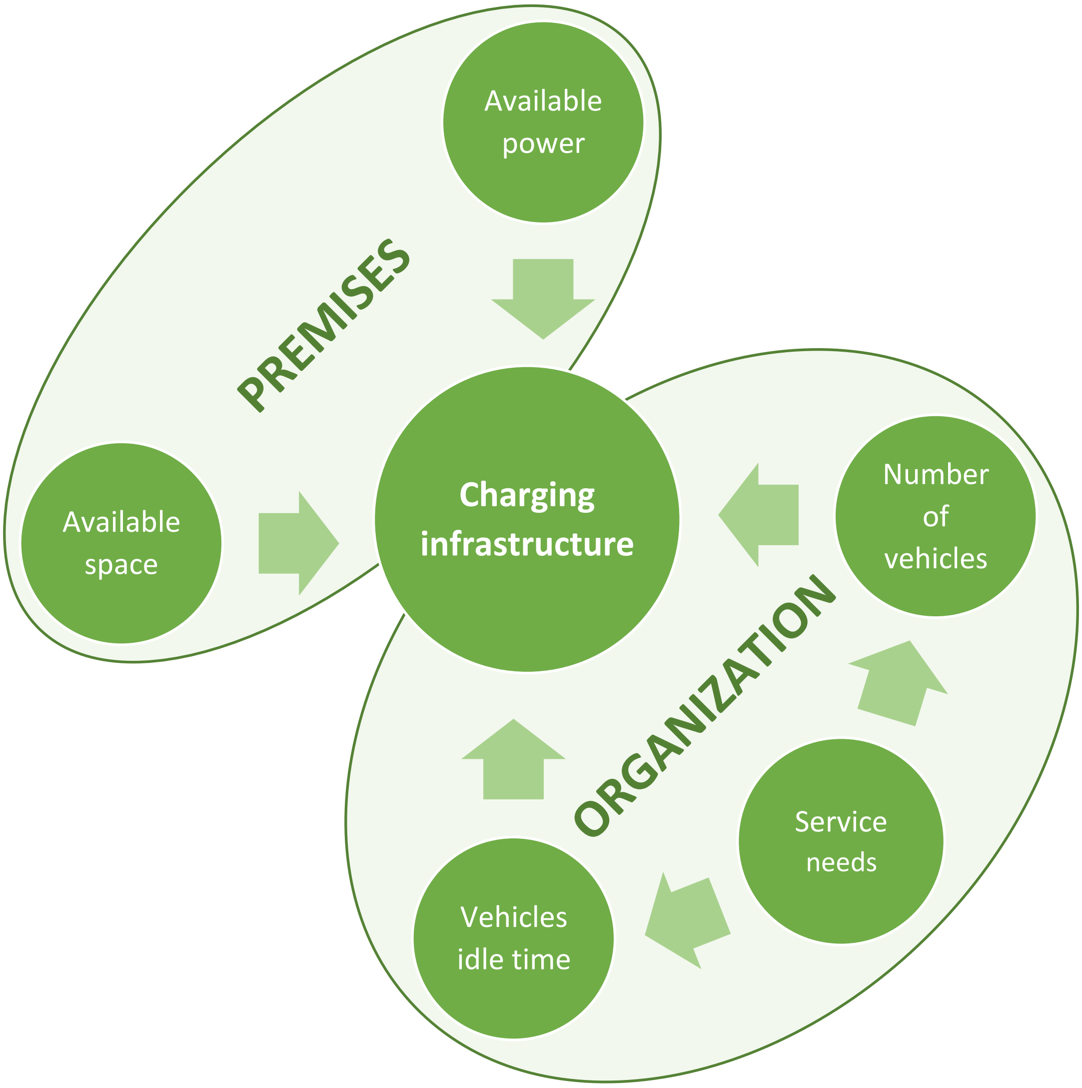
For power higher than 22 kW charging is mainly Mode 4 and direct current (DC) is provided by recharging infrastructures most of the times. Mode 4 standards are CHAdeMO and Combined Charging System (CCS) Combo2 usually, the latter is the most spread and is going to become the European standard.

In the light of the above, it would currently be sufficient to provide charging points of 7,4 kW or 11 kW, but considering the constant increase in the capacity of batteries of new cars on the market, infrastructure with charging points capable of delivering up to 22 kW (possibly limiting the power) can already be installed so that they can be used for a long time without having to replace them in the near future or they will be sufficient to recharge a larger fleet of vehicles. This is also one of the reasons why a low power charge is associated with a low degree of preference in the previous table on the recommended charging powers for each situation. On the other hand, charging with power greater than 22 kW is not recommended - except for special needs - because of the significant changes and adjustments necessary to the electrical system and the consequent high costs (both installation and use). Moreover, the management of charging operations should be taken into account: since charging takes only a couple of hours and so more than one vehicle could be recharged at a high power recharging point, except for the provision of a charging point for each vehicle, the presence of an operator is required to charge the vehicles sequentially. This is not possible outside working hours (for example in the case of night charging) and therefore it is necessary to provide such a type of charging point.

To optimize charging operations, it is also essential that vehicles are not assigned to certain people, offices or departments, but a corporate car sharing system managed by a software or a booking platform is put in place. In this way a vehicle with a level of charging enough to make the journey and be back without problems will always be assigned. Where the management system is sufficiently advanced, it could also request the destination and assign a vehicle capable of making the round-trip even if the battery is not fully charged and this would further optimize the sizing of the infrastructure and charging operations.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

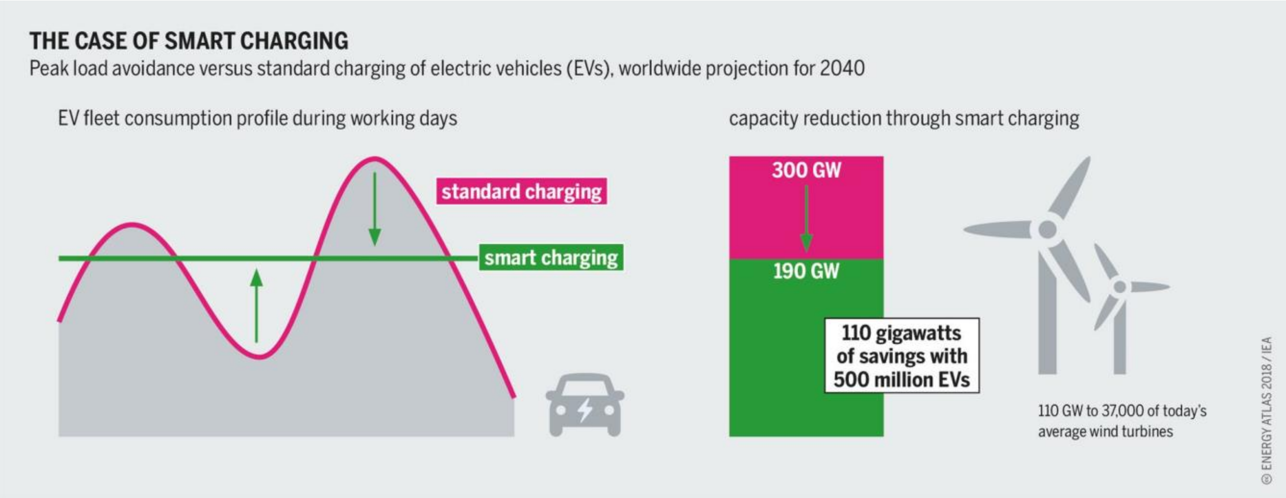
In the choice of the sites, in addition to assessing the compliance of the location of the vehicles with the service needs and the space available to build the stalls, it is essential to know both the contractual power of the user and the power already used in different time slots. It is necessary to determine when vehicles will be recharged (e.g., during or out of working hours, at night) and to analyse whether the power that is not used in that time slot is sufficient to carry out the charging operations.



Another reason why it is not recommended to install high power recharging points is that, having to charge at the same time a large number of vehicles when they are not used (and usually the idle times are the same for the entire fleet), the power required by the charging infrastructure will be very significant and the distribution system operator (DSO) may not even be able to meet the demand without upgrading the distribution network with, for example, the construction of a new secondary cabin (MV/LV). In fact, it is easy to calculate that if there are even just 5 charging points recharging 5 vehicles simultaneously – a not so unusual situation in company fleet car parks - at a power of 22 kW, 110 kW are needed. The distributors provide medium voltage supplies for power greater than 100 kW usually instead of low voltage as in most utilities, but getting a medium voltage supply could take time and is more expensive. Therefore, when an infrastructure with a very high overall power that requires an increase in the contractual power of the user is being planned to be built, the electricity distribution system operator should always be contacted to assess the feasibility of the project.

Smart charging

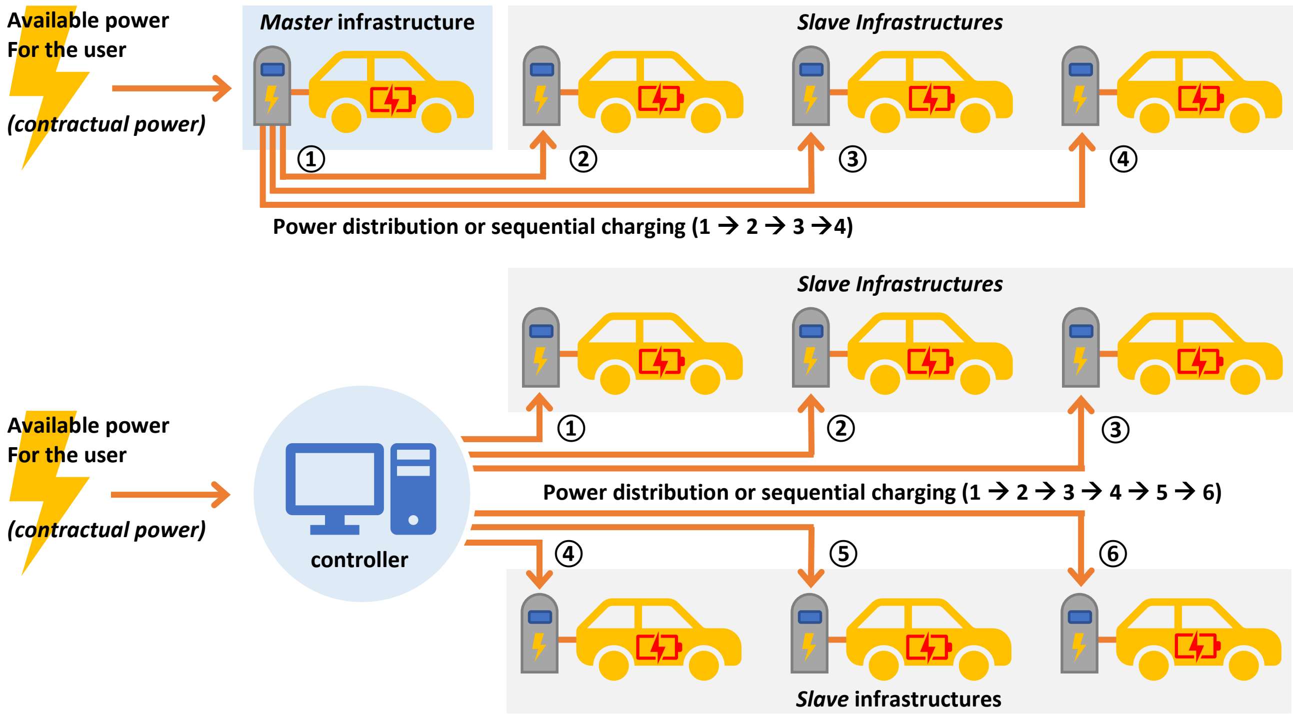
A solution to reduce the impact on the electricity grid and costs is smart charging, which consists of intelligent charging management. By coordinating the charging processes in order to reduce the demand for power generated by the simultaneous charging of a large number of vehicles, it is possible to dampen the peaks *(peak shaving)*, distributing the charging processes in sequence or performing them at lower power, using efficiently the whole available time to charge all the vehicles. In the absence of a charging management system, in fact, they would all start as soon as each vehicle is connected to the charging infrastructure: this would mean that, for example, at the end of the working day there would be a large number of vehicles simultaneously in charge at the maximum power available by the charging infrastructure (with the possibility also to exceed the contractual power of the user) that would finish the charging process after a few hours, while in the second part of the night there would be no more vehicles charging and the demand for power would be null.



Comparison between the impact of standard charging and smart charging (Source: Energy atlas 2018)

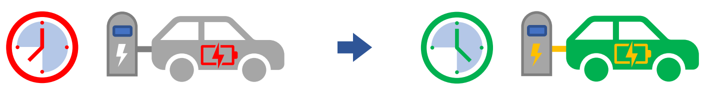
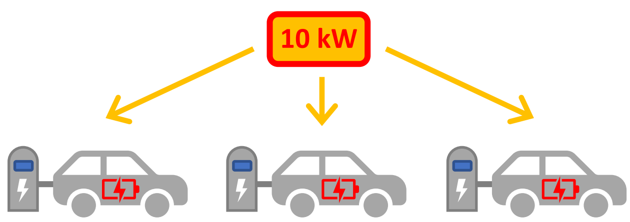
In order to implement *smart charging* it is necessary to provide for the exchange of information between the charging points and a *controller* that prioritizes and manages the charging processes based on the information received (*number of cars connected to the charging points of the station, power required and power available for charging*). This controller can be installed inside a charging pole that plays the role of "master" to which are connected all the other poles that make up the charging station ("slaves") according to a "master-slave" structure (there is a limit of slave charging points that can be controlled by the master column that varies according to the commercial product used, generally no more than 10 or 15) or you can install a control system upstream of the charging infrastructure (which will then all have a slave role).

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

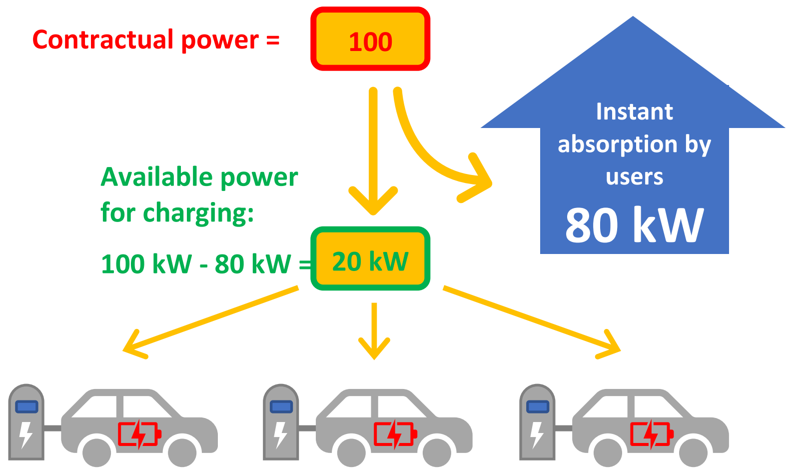


Possible smart charging architecture schemes

Smart charging infrastructures can be managed with different logics, more or less evolved.

Settings		**Description**
Static logic	**Time slots**	Charging takes place only within predetermined time slots (*timer*). *For example: night charging from 21:00 to 6:00* 
	Default maximum power available	A maximum power that can be absorbed for the recharging process of vehicles is preset and the station distributes it (*according to various logics that can be defined*) among all vehicles that must be recharged without ever exceeding this limit. *For example: 10 kW available for charging and 3 vehicles to recharge*  Possible applicable logics: - charging at maximum power (10 kw) of one vehicle at a time; - simultaneous charging of all 3 vehicles (≈ 3 kw/vehicle); - charging at 5 kw the vehicles 1 and 2 for one hour, vehicles 2 and 3 for the second hour, vehicles 3 and 1 for the third hour, vehicles 1 and 2 for the fourth hour, etc. (*this also prevents excessive overheating of the battery during charging that could damage it*).

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Dynamic logic	**Real-time maximum power available**	This dynamic setting provides a communication with a device that is installed in the main electrical panel and constantly measures the power consumption of the user so that, set the contractual power, it is possible to calculate the real-time maximum power that can be used for charging electric vehicles without exceeding the contractual power available to users. 

The solution adopted by the Noemix project is to provide a power regulation according to a dynamic logic. The adoption of such an advanced solution has become necessary because of the low power available to users and to avoid the request for power increases that would have led to an increase in current costs of the electricity supply for the agencies, putting economic sustainability at risk. The solution consists in the installation of a smart meter, an intelligent meter equipped with current clamps, in the general electrical panel. This device detects the instantaneous absorption due to the electrical loads of the user and communicates the data via a BUS cable to the controller that manages the charging infrastructure so that, knowing the contractual power and that absorbed instantly, it can adjust in real time the maximum power that can be absorbed by the charging station.

Site visits

Once the sites where the charging infrastructures are planned to be built have been defined, it is necessary to carry out on-site inspections to verify certain aspects.

Before going to the site it is advisable to ask the technicians of the body to collect data and technical documentation, so that they also arrive prepared and may be able to answer some questions that may arise during the inspection.

It is important to find beforehand:

Electricity supply data (→ *from bills*)	
POD number:	IT…………..
Customer number:	
Supply type:	MV/LV – V (single phase/three-phase)
Contractual power:	kW
Electricity consumption data (→ *from bills*)	
Yearly *(average)* consumption:	kWh/year
(Average) consumption in time slot F1*:	kWh/year
(Estimated) average power consumption in time slot F1:	kW
→ Available power for charging *EVs in time slot F1:*	kW
(Average) consumption in time slot F2**:	kWh/year
(Estimated) average power consumption in time slot F2:	kW
→ Available power for charging *EVs in time slot F2*	kW
(Average) consumption in time slot F3***:	kWh/year
(Estimated) average power consumption in time slot F3:	kW
→ Available power for charging *EVs in time slot F3*	kW
Project and/or as-built drawings *(if available)***:**	
General plan of the intervention area	
Land registry documentation	
Project (or better as-built drawing) of the electrical system - SINGLE/MULTI-LINE DIAGRAMS	
Architectural and structural project or as-built drawings of buildings affected by the intervention	
Project or survey/layout of the underground services of the external areas affected by the intervention	

* Time slot F1:
- *Monday to Friday from 8:00 to 19:00.*

** Time slot F2:
- *Monday to Friday from 7:00 to 8:00 and from 19:00 to 23:00;*
- *Saturday from 7:00 to 23:00.*

*** Time slot F3:
- *Monday to Saturday from 23:00 to 7:00;*
- *Sundays and holidays for the whole day.*

On site you can collect or verify other information, such as:

- parking type: outdoor/covered *(roof/porch/box/garage)*;
- type of charging infrastructure to be installed:
  - presence of an existing vertical support where the charging infrastructure can be fixed to or indoor installation → wallbox;
  - lack of an existing vertical support where the charging infrastructure can be fixed to →pole;

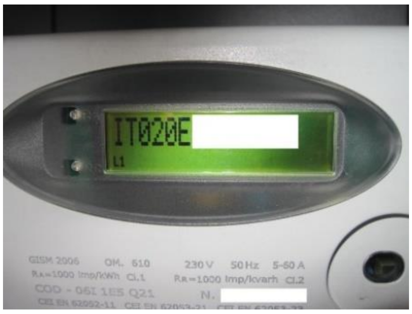
NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

- identification and localization of the electrical panel which the charging infrastructure will be connected to:
  - possibility of connection to an existing electrical panel or need for the installation of a new one;
  - hypothetical layout of the connection of the infrastructure to the electrical panel (*estimate of the linear meters to be realized*);
  - possibility of exploiting existing ducts or need for new ducts.

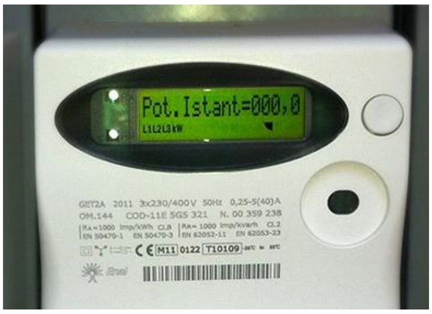
In addition, the possibility of interference with other underground services and the suitability of the chosen location for the charging stalls may also be assessed during the on-site survey, such as, for example, the accessibility of infrastructure to carry out the recharging of vehicles or, especially in the case of new stalls, the presence of adequate manoeuvring spaces.

If the meter is accessible and is digital, you can also take the opportunity to check, if possible, the correspondence of the POD number and to make a reading of the consumption data of both the current and the previous period.

① Button to make the reading (source);



② customer code/reference (source);



③ instantaneous power (source)

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Data collection questionnaire

In the preliminary phase of the site inspection activities, a questionnaire was developed be administered to entities wishing to participate in the project in order to collect systematically and in a unique and synoptic way all the information necessary for the feasibility study for the installation of charging stations at the indicated locations and their subsequent design. A possible structure of the survey is illustrated below.

- **INSTRUCTIONS sheet**
  This sheet provides all the information for the correct compilation of the file.
- **INSTITUTION sheet**
  This sheet is used for the collection of the addresses of the offices of the institution where the charging stations are to be installed and the details of the contact persons.
- **LOCATION sheet**
  This sheet collects data on each location of the institution where charging stations are to be installed. One sheet should be created for each location by duplicating the template structure and renamed with the location address.
- **ELECTRIC VEHICLES NEEDS sheet**
  This sheet is used to collect the number of new electric vehicles required by the institution, specifying the type of vehicle and the daily average mileage.
- **VEHICLES TO BE SCRAPPED sheet**
  In this sheet the list and details of the vehicles to be disposed are requested.
- **FLEET MANAGMENT SYSTEM sheet**
  This sheet is used to collect information about the current fleet management system.

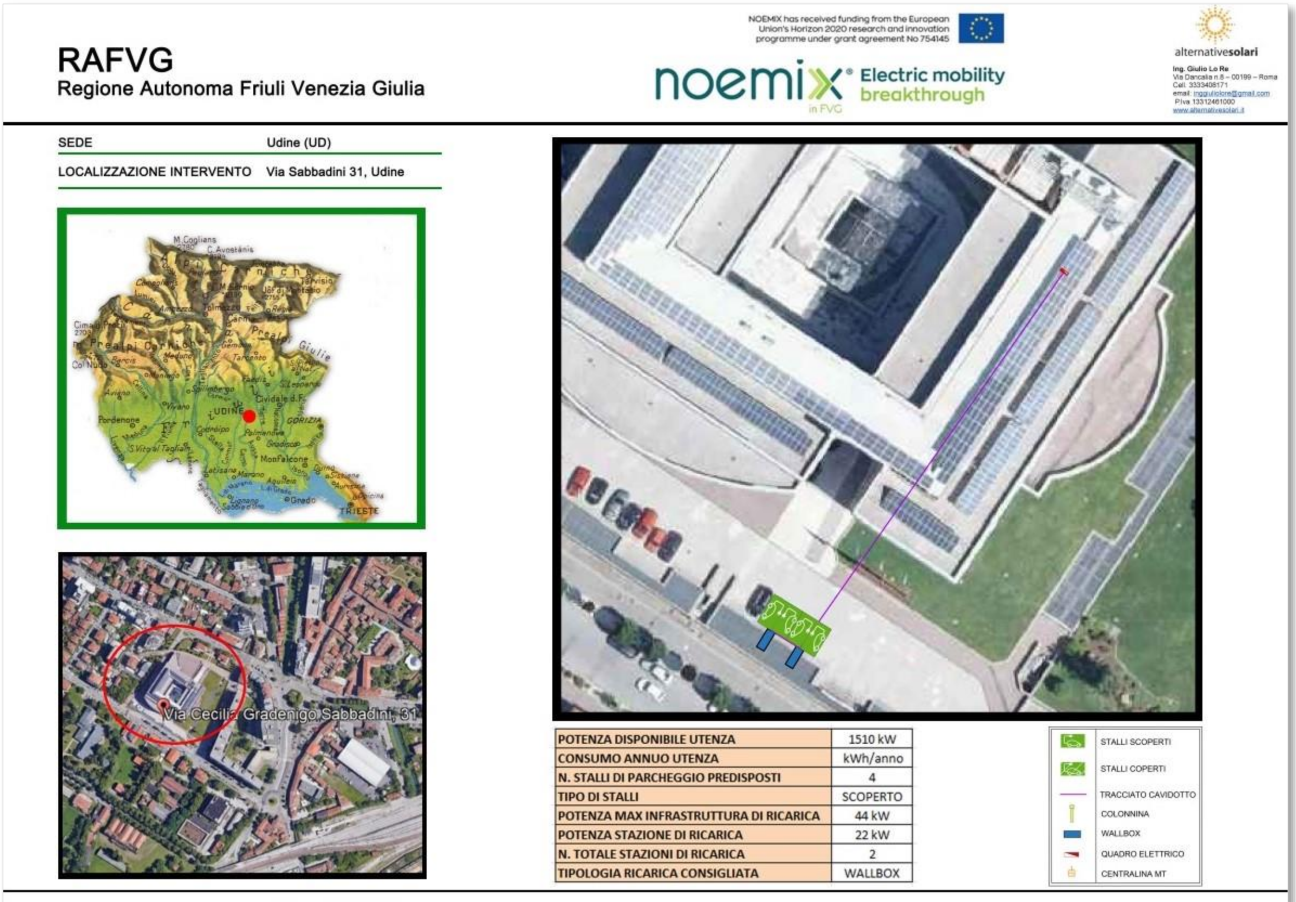
Summary data sheets on project sites

Following the inspection, all the information obtained can be collected in a summary sheet for each site visited.

The sheet can contain the following information and graphics and can be structured as in the example.

- *Name of the institution;*
- *Headquarter/operation offices addresses (it is also possible to insert a map at the appropriate scale or a general plan of the intervention area - if deemed useful - to facilitate the territorial framing);*
- *Layout draft: outline of the location of the infrastructures with the indication of the position of the general electric panel and of the electrical connection;*
- *User data:*
  - *contractual power (kW);*
  - *annual consumption (kWh);*
  - *average power consumption in the different time slots (kW);*
- *Details of the planned infrastructure:*
  - *number and type of parking stalls (outdoor/covered);*
  - *type of charging infrastructure: recharging pole/wallbox;*
  - *maximum output from each infrastructure (e.g., 44 kW - 2x22 kW);*
  - *maximum output from the charging station (kW).*

A textual section dedicated to annotations and comments can be included.


RAFVG
Regione Autonoma Friuli Venezia Giulia

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

noemix® Electric mobility breakthrough in FVG

alternativesolari
Ing. Giulio Lo Re

SEDE: Udine (UD)
LOCALIZZAZIONE INTERVENTO: Via Sabbadini 31, Udine

POTENZA DISPONIBILE UTENZA	1510 kW
CONSUMO ANNUO UTENZA	kWh/anno
N. STALLI DI PARCHEGGIO PREDISPOSTI	4
TIPO DI STALLI	SCOPERTO
POTENZA MAX INFRASTRUTTURA DI RICARICA	44 kW
POTENZA STAZIONE DI RICARICA	22 kW
N. TOTALE STAZIONI DI RICARICA	2
TIPOLOGIA RICARICA CONSIGLIATA	WALLBOX

Example of a summary data sheet

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

More detailed design levels

In the Noemix project that brings together 17 different bodies, it was necessary to conduct a feasibility study that was subsequently put to tender for the final and executive design. Nonetheless the drafting of a feasibility study can be avoided by requiring it directly as the first phase of the final design or defining in advance the sites' requirements for eligibility (especially related to the available power).

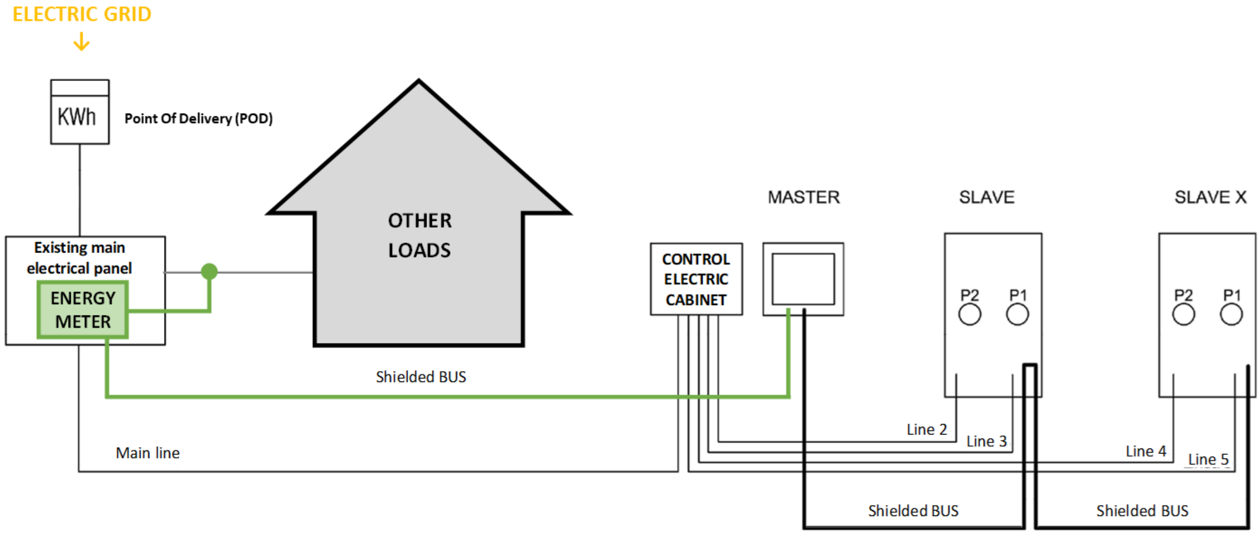
Requirement:	Reason:
Electrical system: **electrical system meeting all legal requirements or certified**	*faster installation of infrastructure and higher confidence that the existing installation is adequate and safe to use*
Power: **≥ 3,7 kW available at the utility for each planned recharging point** *(at least overnight and compatible with service requirements)*	• *night-time is vehicles' idle period usually* • *considering the time slot between 19:00 and 7:00 as night-time idle (also keeping one more hour as a buffer between 7:00 and 8:00),* ***12 hours can be considered the minimum time available for charging*** • *assuming 3,7 kW as the minimum charging power,* ***it can be assumed that about 40 kWh of energy can be accumulated in the battery of a vehicle in a 12-hour period***
Space suitability: **accessibility of charging infrastructure**	*easy access to the place where the charging infrastructures are installed due to the presence of sufficient space*
Space suitability: **easy vehicle accessibility to the parking stalls**	*check the presence of adequate space to create new parking stalls, for the circulation lanes to reach them and for manoeuvring*
Fire safety: **recharging infrastructures in garages**	*especially in the case of garages subject to Fire Prevention Certificate attention must be paid to current legislation requirements (in particular the obligation to notify the presence of charging infrastructure for electric vehicles at the time of the certificate renewal)*

The further levels of design required by the legislation *(final and executive design)* must be drawn up in order to install the charging infrastructures. In particular, the final project serves to define the characteristics of the infrastructures and the works to be carried out and to obtain any permits.

Drafting the executive project could be avoided, but it was chosen to launch a tender for the executive design as well to reduce any possible controversy. In addition, it is always necessary to check which level of design is required by the legislation for each type of contract.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Architecture of the charging infrastructure



The Noemix project establishes that, in the presence of a charging station consisting of several infrastructures and a low power availability, an energy meter control unit will be installed in the existing main electric panel, immediately downstream of the general switch. This device measures instantaneously the power absorbed by the utility and is able to communicate with the master unit of the system via a shielded BUS cable, indicating the overall maximum power the charging station can deliver without exceeding the contractual power. The master unit, which in turn is connected via a shielded BUS cable to the slave units (recharging poles/wallboxes) that make up the charging station, determines instantaneously how much power each charging point can deliver according to the power available at the moment and thus also allows each infrastructure to show to the operator the estimated charging times.

The items of the system components indicated in the unit price list of the project are reported below:

Energy meter control unit
Supply and installation of a modular AC energy meter control unit, auxiliary supply voltage 110-230-400 Vac, f = 50/60 Hz, nominal input voltage from 20 to 500 V, nominal input current 5 A via openable TA, in compliance with CEI-EN 61010-1 standards, including snap-on mounting on DIN or OMEGA rail within distribution cabinets of any type, including connections, wiring, marking. For current, voltage, power and cosfi measurements and equipped with RS485/BUS output

Control unit for multi-plug recharging poles/wallboxes
Supply and installation of multi-plug station management unit with master-slave architecture for cost optimization, by programming the maximum power output based on the instantaneous need, including installation, programming, connection and any other obligation required to deliver the work finished, functioning and in a workmanlike manner.

Wallbox equipped with two T2 sockets (22+22 kW)
Supply and installation of double-point wallbox 22+22 kW equipped with Type 2 sockets, three-phase power supply + N, 400/230 V AC for power circuit and single-phase 230 V AC for control circuit, for TT - TN - IT systems. The terminal must have two Mode 3 recharging points allowing slow charging (6-8 h) at 16 A or averagely rapid charging (30 min - 1 h) at 32 A, 400V (PWM safety system mode), allowed both in domestic and public spaces. Charging must take place through a special power supply system equipped with specific connectors. Each unit must be equipped with a screen and a RFID card reader.

Features:
- mode 3 charging wallbox;
- display;
- standard or custom silk-screen printing;
- simultaneous charging of 2 vehicles, max. power 22 + 22 kW;
- RFID badge recharge activation;
- real-time power absorption modulation function according to other loads of the utility;
- integrated residual direct current detection device (RDC-DD);
- compatibility for type a line protection devices.

Including testing and any other obligation required to deliver the work finished, functioning and in a workmanlike manner.

Recharging pole equipped with two T2 sockets (22+22 kW)

Supply and installation of double-point recharging pole 22+22 kW equipped with Type 2 sockets, three-phase power supply + N, 400/230 V AC for power circuit and single-phase 230 V AC for control circuit, for TT - TN - IT systems. The terminal must have two Mode 3 recharging points allowing slow charging (6-8 h) at 16 A or averagely rapid charging (30 min - 1 h) at 32 A, 400V (PWM safety system mode), allowed both in domestic and public spaces. Charging must take place through a special power supply system equipped with specific connectors. Each unit must be equipped with a screen and a RFID card reader.

Features:
- mode 3 charging station;
- display;
- simultaneous charging of 2 vehicles, max. power 22 + 22 kW;
- metal shell painted with weatherproof and anti-corrosion treatment;
- RFID badge recharge activation;
- real-time power absorption modulation function according to other loads of the utility;
- integrated residual direct current detection device (RDC-DD);
- compatibility for type a line protection devices;
- graphic customization with logos and graphics on the entire surface of the outside of the column.

Including testing and any other obligation and accessory (including anchoring masks) required to deliver the work finished, functioning and in a workmanlike manner.

The activation and management of the charging processes, as well as the procedures of booking and access to vehicles, can be carried out via app or web portal using a smartphone. However, since not all employees of the member organizations have a company smartphone, privacy issues and trade union agreements do not allow this innovative solution to be adopted. However, it is possible to sign an ad hoc agreement with workers' trade unions for the use of private smartphones or users may be allowed to use it on a voluntary basis.

In the Noemix project, therefore, a compromise solution had to be adopted: 2 smart cards were required for each vehicle to allow its opening and use (like traditional keys) and inside each vehicle there will be an RFID badge that will allow authentication at the infrastructures to perform charging operations.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Alternative hypotheses for the realization of the charging stations

During the development of the feasibility study, when a wide variety of different situations emerged at the premises of the institutions and some critical issues too, the cost and the time necessary for the realization of the recharging stations have been assessed and also alternative options considered.

In order to simplify the tender for the provision of the mobility service, which also includes the installation of the recharging infrastructures, it was assumed that the contractor would only be required to install the infrastructures or, at most, lay down the cables to connect the charging infrastructures to the existing framework.

The construction works could have been carried out by each institution (some even indicated their availability) or by a separate tender prior to the tender for the provision of the e-mobility service.

These hypotheses, however, were all discarded due of the tight timetables dictated by the deadlines imposed by the European project and the complexity that would have been generated to coordinate the different construction sites. Furthermore, since the service provider must guarantee the continuity of the provision of the mobility service (and consequently also of the charging operations), the likelihood of litigation in the event of malfunctions could have been increased, an eventuality that is countered by requiring the provision of a "turnkey" service to a single entity that will then have control and complete responsibility over all service components.

Monitoring of charging infrastructure and processes

A recharging infrastructure management platform will be available and it will be accessible to both the mobility service provider and the institutions fleet managers. It will allow the monitoring of the recharging infrastructure state (free, charging, charge finished, out of order) and to perform remote operations (e.g., update firmware, unlock a specific socket to release the connector or reboot the infrastructure in case of malfunctions).

Maintenance

The Noemix project requires the contractor to provide a "turnkey" mobility service and it is therefore obliged to carry out all maintenance operations, both ordinary and extraordinary, on charging stations in order to ensure the smooth delivery of the service.
The maintenance consists of:

- ordinary:
  - the setting of the devices;
  - the updating or complete reinstallation and configuration of the software;
- extraordinary:
  - the repairs;
  - the replacement (consisting in the withdrawal of defective products, delivery and installation of the substitute);
  - the assistance provided by a call centre.

In addition to routine maintenance, which is generally easy to plan, the infrastructure monitoring system allows for timely intervention, even remotely in some cases and without the need of a report from users, which would otherwise be difficult to guarantee given the territorial spread of the infrastructures.
If a particularly advanced system is provided, the presence of predictive maintenance functionalities could also be possible.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Alternative business model assumptions

Innovative business models can be envisaged to make the introduction of an e-mobility system in public administrations more economically sustainable.

Since in many cases the vehicles are scarcely used, usually for short trips, and therefore they do not require long and/or frequent charge, it could be envisaged to allow public charging at the infrastructure of the institution at certain times that do not interfere with service needs. It is essential that charging points are installed in areas that are freely accessible to the public, the vehicles of the company fleet must be moved when charging is complete (the presence of an employee in charge of this operation is therefore necessary) and recharging infrastructures must be managed by a Charging Point Operator (CPO) that can carry out the commercial activity of selling the charging service.

The provision of the company charging infrastructures also for public charging makes the installation and management of charging points very attractive for CPOs which could offer considerable discounts in the tender phase, since their remuneration would not only derive from offering the service exclusively to a public body that usually has very limited mobility needs.

Another option to increase the use of charging infrastructures and their economic sustainability without generating too many complications could be to allow employees to recharge their private vehicles upon payment at certain times.

Alternatively, it could be the public administration that does not have charging infrastructure and make arrangements with a CPO to install charging infrastructure on public land near its premises and reserve charging points in certain time slots agreed contractually. Also in this case it is necessary the presence of an employee who moves the vehicles when charging is complete to free the stalls or to charge the vehicles only during the agreed time slots, since the charging points are not always usable by the administration and therefore not necessarily this can be done directly by each employee at the end of the use of the vehicle.

Such innovative operating models can reduce the costs of the e-mobility service for the administration as the service provider can be remunerated by selling a service to private individuals, but they require more fleet management and dedicated staff.

To avoid having to move vehicles, design solutions could be adopted, such as providing two parking spaces at a recharging point *(i.e., one reserved for company cars and the other for private vehicles)* and providing for the automatic unblocking of the socket at the end of charging to allow anyone to pull out the plug and charge another vehicle.

In addition to the charging infrastructures, vehicles could also be used for purposes other than those of service outside working hours.

It can be envisaged that the fleet of company vehicles outside working hours could be available to employees only (the simplest option) for off-work journeys or to everyone, becoming a real car sharing service. Again, while there are some advantages in terms of economic sustainability, there are also criticalities, some of which may even make it economically unsustainable or impact negatively on operations for service purposes. An increased use of vehicles in fact suffers the same problems of car sharing fleets, such as the cleaning and hygiene of the passenger compartment of vehicles and possible damage and vandalism; the greater the number of users and the greater the extent of these problems that will have to be addressed and resolved with an increase in operating costs to ensure the quality of all services operated with the vehicles and the regular provision of the main service (i.e., corporate car sharing). In addition, if extra-work use is intense, there may not be enough time to recharge the vehicles and therefore this could impact service activities.

Given the low utilisation of vehicles, another option that was considered at the beginning of the project and that would have significantly optimized the mobility of public administrations is corporate car sharing between several entities, whereby a single fleet could be used by all participating entities upon reservation. In order to implement this possibility, institutions must necessarily have offices located close to each other. Since the project and the Noemix mobility service are managed by the Friuli Venezia Giulia Region, this hypothesis would have been feasible in some cases, but it met with cultural resistance and several potential administrative problems (allocation of costs according to actual use). Not knowing the actual use of the fleets of all members would have made impossible to adequately size the shared fleet and ensure that there was always a high probability of finding a vehicle available when needed. This fear, which cannot be proved nor denied with data, led to the abandonment of this option.

A similar solution is already in use in some public administrations based in large cities and involves concluding agreements with an urban carsharing company to reserve certain vehicles (which must be located and available in defined areas near the institution's premises) during working hours. In this way, mobility is completely outsourced and its management is no longer a task for any employee of the authority.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

<table>
<tr><th colspan="3">Business model</th><th>Requirements</th><th>Critical issues</th></tr>
<tr><td rowspan="3">Infrastructures</td><td rowspan="2">owned by the PA itself</td><td>Public charging out of working hours</td><td rowspan="2">- Free access to the charging infrastructures
- More fleet management tasks (need for operators managing charging processes)
- Infrastructures managed by a CPO</td><td rowspan="3">- Possible interferences with working activities
(e.g., parking lots for charging occupied by private vehicles during working hours that prevent charging of company vehicles)</td></tr>
<tr><td>Charging limited to employees' private vehicles</td></tr>
<tr><td>third parties' ownership</td><td>Public charging points reserved in specific time slots</td><td>- More fleet management tasks (need for operators managing charging processes)</td></tr>
<tr><td rowspan="4">Vehicles</td><td colspan="2">Corporate car sharing with a fleet shared by several entities</td><td>- Need for a coordinating body or a coordinating board that manages the service and the relations both with the supplier and between the entities using the service (e.g., cost breakdown based on use)
- Geographic position: users' facilities located in close proximity
- Accurate knowledge of users' mobility needs for the correct sizing of the fleet needed</td><td>- Difficulties in coordinating several entities
- Administrative difficulties (cost breakdown among involved public administrations)</td></tr>
<tr><td rowspan="2">owned/rented by the PA itself</td><td>Used by employees out of working hours</td><td>Easier management of the service
↓
- Fleet managed by a car sharing operator (who can sell the mobility service)</td><td rowspan="3">- Increased risk of damage or vandalism (possibility of downtime due to unserviceable vehicles)
- Hygiene and cleaning of vehicle interiors (more frequent cleaning operations required)
↓
Increase in operating costs
- Insufficient time for charging (if use out of working hours is extensive)</td></tr>
<tr><td>Public use out of working hours</td><td>More complex management of the service
↓
- Fleet managed by a car sharing operator (who can sell the mobility service)</td></tr>
<tr><td>third parties' ownership</td><td>Public car sharing service</td><td>- Fully outsourced management
↓
public administrations don't manage the service any more</td></tr>
</table>

Summary table of the main business models that can be implemented to increase the economic sustainability of an electric mobility service with an indication of the organisational requirements and possible critical issues.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

PHOTOVOLTAIC ENERGY PRODUCTION

In order to ensure the environmental sustainability of the electric mobility service, the vehicles are to be powered exclusively with energy produced from renewable sources that do not produce greenhouse gas emissions. The original version of the project envisaged that 50% of the energy used would be certified green energy and only 50% would be produced through the installation of new photovoltaic systems on the premises of the participating entities. However, discussions with the institutions during the mobility need analysis and on-site visits revealed several critical issues concerning the supply of certified green energy. While some entities already had certified green energy supplies (or part of them), others had Energy Performance Contracts (EPC) in place whose conditions were difficult to modify during the contract period. Moreover, certified green energy is more expensive and there are not always quotas available for purchase.

To overcome this problem, it was decided to power the vehicles completely with energy produced by new photovoltaic systems and to reduce time and cost it was decided to build a single large plant, exploiting the availability of already urbanized spaces at the intermodal hub of Ronchi dei Legionari.

Since the photovoltaic system is built at a single site, the energy produced will not directly feed the charging infrastructure of electric vehicles, but it will allow the compensation of consumption on the global budget. In addition to localization, another critical issue that would have been encountered in directly charging vehicles with the energy produced by photovoltaics would have been due to the time lag between the production and use of energy that generally characterises photovoltaics: in case of overnight recharging, it would have been necessary to provide also the storage systems for the energy produced that would have complicated the realization of the project and further increased costs.

In the current situation, which has seen a significant increase in energy costs and a greater offer on the market of storage systems and at lower costs, the implementation of such systems could be more economically viable or even cost-effective. To assess this possibility, a case-by-case analysis should be carried out in order to calculate the payback period of the investment for the implementation of the system. In addition, it is also possible to consider other operating models, made possible by regulatory developments after the writing of the Noemix project. Storage systems could become part of a **"Mixed Enabled Virtual Unit" (UVAM *or MEVU in English*)**[1] managed by a third-party aggregator (Balancing Service Provider - BSP) to also provide dispatching services to the electricity grid (obtaining a remuneration that contribute to reducing the payback period). In case of lack of areas on which to install photovoltaic systems in the appurtenances of the user or on one or more properties of the same public body (*the only type of entity that so far could require to implement an exchange mechanism*[2] *allowing, under certain conditions, to input into the grid the energy produced and use it at another location),* the development of the legislation allows all types of subjects (both public and private, even aggregated together in a mixed form) to apply also the model of the **renewable energy community**[3]. According to this model several different entities can aggregate and constitute a single legal entity that can exchange the energy produced by renewable sources plants owned by it (or one or more entities that constitute it)

[1] Things you need to know about UVAM | Lightbox (terna.it)
L'apertura delle risorse distribuite al mercato dei servizi: quale bilancio?
[2] The so called "Scambio sul posto altrove"
[3] GRUPPI DI AUTOCONSUMATORI E DI COMUNITÀ DI ENERGIA RINNOVABILE (gse.it)

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

on a non-profit basis and provided that all utilities are connected to the same secondary distribution booth[4].

For communication purposes, initially it was also considered the idea of building solar carports at some member organizations' very visible locations (for example in the square in front of the town hall) but this option was rejected because of the high cost of such interventions.

Example of a solar carport in Udine (source: diariofvg.it)

Methodology for estimating the size of the photovoltaic system

To estimate the size of the photovoltaic system needed to power the entire fleet, and consequently also determine the area needed for the installation, the starting point was the number and characteristics of the vehicles required and the mobility needs of the participating entities.

As regards the mobility needs of the administrations, following the analysis previously carried out, to simplify the calculation, an annual distance of 10,500 km per vehicle is considered (average daily journey of approximately 53 km, taking into account 200 working days per year) so consequently 52,500 km covered over the five years of the mobility service.

In the presence of a system for monitoring the use of fleets, the actual annual journeys can also be used. In this case, if data are available for several years, it is advisable to compare them to verify the presence of significant differences between different years and therefore define which choice to make (for example, oversizing of the plant or calculating the multi-year average yearly mileage) also considering other factors such as economic resources or available space.

[4] Soon this possibility should be extended to all users connected to the same primary distribution booth: this is allowed by D.Lgs. 199/2021 *(transposition of the European directive RED II)*, but its implementing decrees are still missing.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

The average consumption of electric vehicles was considered to be 0.1775 kWh/km. The average range of the vehicles is at least 200 km, so that, covering an average of 53 km/day, the daily consumption is 26% of the battery capacity.

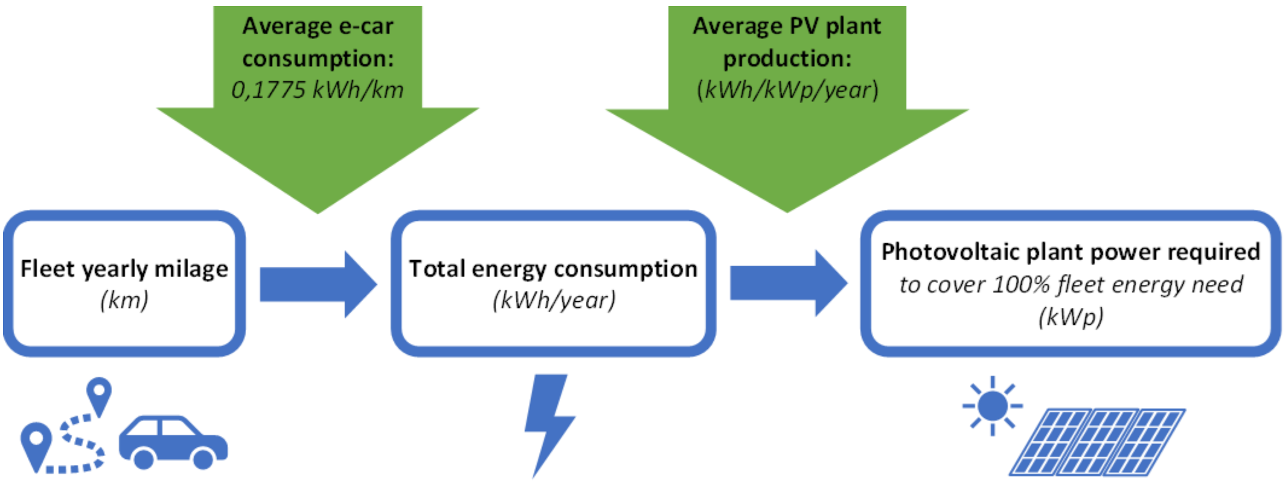
Considering the annual mileage of the entire electric vehicle fleet (522 x 10,500 km = 5,481,000 km) and an average consumption of 0.1775 kWh/km, an annual energy requirement of 972,878 kWh is defined.

The average productivity of a photovoltaic system in the place where it is expected to be built can be defined through tables or calculated using software available online as PVGIS developed by the European Solar Test Installation (ESTI) of the Joint Research Centre (JRC) of the European Commission.

Geographic area	Average yearly production
Northern Italy	1.100 kWh/kWp/year
Central Italy	1.300 kWh/kWp/year
Southern Italy	1.500 kWh/kWp/year

Average annual photovoltaic production in Italy expressed in kilowatt-hour per kilowatt-peak

When the average productivity of a photovoltaic system, expressed in kWh/kWp, is defined and knowing the annual energy requirement for charging electric vehicles, it is easy to determine the necessary power (kWp) of the photovoltaic system.



Logical process for the preliminary definition of the photovoltaic system size

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Summary table of data used for the preliminary definition of the photovoltaic plant size	
Number of participating public administrations:	17
Vehicles in the fleet:	2.000
Vehicles replaced by the Noemix project:	**522**
Percentage in relation to the total number of vehicles:	26%
Average annual mileage of each vehicle (km):	**10.500**
Number of working days considered *(dd/year)*:	200
Average daily journey of each vehicle *(km)*:	53
Average mileage of 1 vehicle in 5 years *(km)*:	52.500
Average consumption of an electric car *(kWh/km)*:	**0,1775**
Mileage of the whole 522 vehicle fleet *(km/year)*:	5.481.000
Total energy consumption *(kWh/year)*:	**972.878**
Average photovoltaic plant productivity* *(kWh/kWp)*:	1.180
Plant power needed to cover 100% of the needs *(kWp)*:	**824**

* **referred to the area of Ronchi dei Legionari**

3. ADMINISTRATIVE AND LEGAL FRAMEWORK

Introduction

As part of the activities of work package 4, Area Science Park had the task of selecting an external legal consultant in order to support the project and in particular the regional Purchasing Unit (CUC) in preparing the tender documents, identifying the most suited legal instruments and procedures for acquiring NOEMIX the service, in line with what emerged from the analysis of the mobility needs of the regional Public Administrations participating in the project, from the economic-financial plan that Area Science Park developed with the contribution of the University of Trieste and the BIT company and the feasibility project for the charging infrastructures.

Therefore Area Science Park, as project coordinator, selected and appointed a legal advisor (ATI composed of Studio Gianni & Origoni and SINLOC) who had the following tasks:

a) preparation of the collaboration agreement between the bodies participating in the mobility service of Noemix (PA Panel), which regulates the relationship between the parties, the management of payments and sanctions, the delegation of the pa panel to the CUC of the Autonomous Region of Friuli Venezia Giulia to announce the tender, stipulate and manage the contract in the name and on behalf of all participating entities;
b) support and technical assistance in the drafting and preparation of tender documentation based on the provisions of Legislative Decree 18 April 2016, n. 50, with particular regard to the identification of the technical elements and principles of the tender specifications and the contract scheme, of the forms, of the verification and monitoring plans;
c) support and assistance in drafting the economic prospectus of the tender;
d) support to the offices of the Contracting Authority in answering the questions posed by the parties participating in the tender procedures published by the Contracting Authority as part of the Noemix project;
e) possible proposal of experts for the commission of selection appointed for the evaluation of the offers received in response to the announcement;
f) drafting of opinions on matters and documents, including preliminary ones, if requested by the regional administration in relation to the tender procedure;
g) support in the drafting of an agreement between the Autonomous Region of Friuli Venezia Giulia and the association of car wreckers for the scrapping of old vehicles owned by the entities adhering to the agreement referred to in point a).

PA Panel constitution and the agreement with the Friuli Venezia Giulia Region

The NOEMIX project envisaged the establishment of a PA Panel, which is a Panel made up of Public Administrations that have expressed an interest in participating in the project. The FVG Region has assumed the role of coordinator of the PA Panel for the organization of the planned activities.

The scope of the PA Panel was to:

- schedule periodical meetings;
- facilitate data-collection;

- share information;
- discuss mobility needs of the PA.

During the first phase of the Project, the meetings of the PA Panel have been undoubtedly a useful tool to define the scope of the Project. However, the interactions among the PA involved in the Project highlighted as well some critical issues. The main issue concerned the adequate coordination of the different needs of the PA and the collecting of the formal participations of the PA to the Project. In addition, the data collection proved complex and very time-consuming.

In order to overcome the aforementioned critical issues, a *vademecum* summarizing the object of the "centralized mobility service" was shared with the PA. One of the most controversial points and for which a longer negotiation was necessary was undoubtedly the issue of the division of costs between the Friuli Venezia Giulia Region and the bodies participating in the project.

Thanks to the support of the legal advisor, a formal agreement has been signed between Public administrations of the PA Panel and the FVG Region, in order to define and regulate their respective commitments and obligations in relation to the Project.

The main topics to be regulated by the Agreement were the following:

- ratify the activities already carried out for the implementation of the Project;
- collect the data and information needed to implement the Project;
- define the costs to be borne by FVG Region;
- define the costs to be borne by the PA;
- establish the mutual obligations of the parties;
- ensure the regular execution of the public tender for the awarding of a fully integrated car sharing service.

In this regard, the following is a brief list of key findings that affected the drafting and negotiation of the Agreement between PA and FVG Region.

The analysis carried out by the legal advisor and the internal discussions within the working group dedicated to the Project first led to exclude the solution of drafting a single contract to be sign by all PA. In order to avoid the loss of time related to possible delays of individual PA, it was decided that each PA would have signed its own contract with FVG Region, on the basis of the same contractual framework. This solution resulted to be also functional to simplify the attachments. Each contract, in fact, has only the annexes that pertain to the individual PA involved.

Each PA were required to provide certain data necessary for the Project development. For example - among others - the vehicle technical requirements envisaged, the location of the infrastructures to be placed for the installation of charging stations.

The several difficulties encountered in data collection have highlighted the need to provide that these data should have been included in attachments to the Agreement, in order to simplify possible amendments without the need of amending the same Agreement.

Under Project NOEMIX the historical cost related to the use of traditional cars to be replaced with electric vehicles is borne by each PA. Any cost exceeding the historical costs is borne by the FVG Region. However, since the cost of electricity is borne individually by each PA, it was necessary to draw up appropriate contractual clauses at this regard with the support of an economical advisor (*i.e*. Sinloc).

In order to guarantee the implementation of Project NOEMIX throughout its duration it was necessary to draw up contractual clauses to ensure the collaboration between PA and FVG Region to be included in the Agreement. Nevertheless, the Agreement has a concise structure so that it is adaptable to the Project development. A detailed regulation could have discouraged administrations from signing the Agreement and could have not been compatible with the evolution of the Project.

As far as the tender for the Mobility Service is concerned, the contract shall ensure that the PA promptly perform the activities they are responsible for.

The contractual form of the Agreement

In the light of the above, the chosen contractual form of the Agreement is intended to mitigate the identified critical issues and to balance the interests of the parties. The chosen contractual form is a "Convenzione Quadro" having the contractual structure summarized below, by following the order of the main articles.

Introduction
The introduction summarizes the purpose and status of the Project NOEMIX implementation. In particular, all participating PA are listed.

Article 1
Article 1 states that the Preamble and Annexes constitute an integral and substantive part of the Agreement and provides the list of the annexes.

- annex a is the pa resolution to enter into the agreement.
- annex b called "addendum" lists vehicle requirements and input data.
- annex c contains land registry searches concerning charging infrastructure.
- annex d concerns the calculation of the contribution and of the conventional electricity cost. a simplified procedure of amending annexes b and d is regulated (also at article 8).

Article 2
The purpose of the article is regulating the mutual relations between the FVG Region and the PA and their respective commitments for the implementation of Project NOEMIX.

Article 3
The Parties undertake to cooperate to put in place every act, measure and initiative necessary and useful in order to achieve the development of the Project, in compliance with the timelines and obligations imposed by the Project's financing program. Each PA declares that it has full availability of the areas where the charging infrastructure and related sub-services will be placed.

Article 4
according to the agreement, the object of the tender for the awarding of the mobility service includes:
- provision of electric vehicles, including the related ordinary insurance coverage and payment of car tax;
- maintenance service of the mentioned vehicles;
- management and optimization service of the fleet utilization to be realized through an integrated telematics system on a web platform;
- supply with installation, management and maintenance of charging stations for electric vehicles;

and does not include:
- supply of electricity;
- possible customization of electric vehicles by affixing the entity's logo.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Article 5
The Parties agree that the Project is aimed at assuring PA the invariance of the historical operating costs. Therefore, the expense related to the Mobility Service, including insurance expenses, car tax and ordinary maintenance costs (and extraordinary, for causes attributable to the Mobility Service operator), added to the expense for the supply of electricity incurred by the PA, shall not exceed the cost currently incurred by the PA for fuel costs, insurance costs, car tax, and routine and extraordinary maintenance costs referred to motor company cars.
The expense for the supply of electricity incurred by the PA is calculated in accordance with a conventional calculation method set out in the Annex D.

Article 6
FVG Region is the delegated body for the launch and management of public tenders for the implementation of the Project.
Each PA undertakes to cooperate in the preliminary activities, preparation, execution and implementation of the public tenders, and for inspections, and to sign promptly the relevant contracts and to fulfill exactly the obligations arising therefrom, including the performance of administrative activities within its competence for the implementation of the works and the provision of the agreed services.

Article 7
The duration of Agreement starts from the date of its signing until the completion of the provision of the Mobility Service, subject to any extensions agreed in writing between the Parties.

THE POSSIBLE TENDER PROCEDURES' OPTIONS

Different administrative procedures have been taken into account and analysed for the NOEMIX service tender. A detailed analysis is included in Deliverable 4.1

The procedures taken into account have been:

a) **a single tender procedure for the assignment of a concession or a contract**, aiming at the creation of a "turnkey" service including the supply, installation and maintenance of (i) rental electric vehicles (ii) charging infrastructures and (iii) online platform for booking, monitoring and fleet management;

b) **a single tender procedure divided into two distinct lots**, one for the supply and management of the vehicle rental service; the second for the design and execution of the work for the installation of the charging infrastructure;

c) **two separate tender procedures**, with simultaneous or deferred timing, for the award of (i) a concession or contract for the supply and management of the rental service and (ii) a contract for the design and execution of charging infrastructure work;

d) **a single tender procedure divided into two distinct homogeneous lots**, which include both the supply of the charging stations and the rental service; the division into two functional lots is based on the type of the recipient of the service user and the relative use of the vehicle.

Pros and Cons of different procedures have been listed and analysed to select the most suitable procedure to be adopted for Noemix service. An evaluation sheet has been created to choose the most suitable service contract to be adopted for Noemix service.

In the end, the contracting authority, supported by the legal consultants, decided to choose a single tender. In particular, it has been considered more convenient, and also more efficient for the time schedule of the

Project deriving also from the European funds of the programme "*Horizon 2020*", to proceed with a unique tender for the awarding of the overall E-Mobility Service based on the following aspects:

- the carrying out of one tender procedure takes reasonably less time whether compared with the carrying out of two autonomous procedures, considering the duplication of the activities linked to the preparation of the tender documents (including the drafting of separate contracts), the launching of the two tenders and the actual carrying out of the same separate tenders (in fact, said activities would be again inevitably duplicated);
- the carrying out of one tender procedure significantly limits the level of the risks related to potential interferences and technical incompatibilities between the two segments of the e-mobility service (*i.e.*, on the one hand, the lease of electric vehicles and, on the other hand, the supply and installation of charging station, including the execution of the relevant related works).

Save for the above, according to the typical contractual scheme based on the prior awarding of a framework agreement ("*contratto quadro*") and the subsequent entering into of executive contracts ("*contratti attuativi*"), even if it has been carried out a unique tender procedure, following the awarding and the entering into of the framework agreement, each Public Administration involved will be entitle to enter into autonomous executive contracts with the selected private partner(s) in relation to the supply of the integrated E-Mobility Services. Therefore, each executive contract will be limited to the specific needs of the relevant Public Administration.

Under a different perspective, even if it has been preferred to proceed with a unique tender procedure for the awarding of the overall E-Mobility Service, the contracts underlying the same tender has been divided into no. 2 lots, on the basis of the previous identification of two different main groups of contracting Public Administrations involved in the Project Noemix:

- one lot regards the e-mobility service to be provided to the participating municipalities and other public administrations of the FVG Region involved in the project;

- the other lot regards the e-mobility service to be provided to the participating public hospital organizations of the FVG Region.

The aforementioned scheme of no. 2 lot has been identified (*a*) based on a specific technical and financial assessment carried out by an appointed technical advisor which identified and validate the structure of no. 2 lots, and (*b*) in order to cope with the general principle set under the Procurement Code, according to which public administrations should facilitate the participation to tender procedure of potentially interested private partners (including small and medium-sized enterprises), reducing accordingly the size of the contracts to be awarded, as well as taking into account the differences among the participating Public Administrations.

Save for the main features highlighted above, it should be noted that it has been decided to proceed with a standard open tender procedure according to Article 60 of the Procurement Code, which has been identified as the most suitable tender procedure for the Project, in order to guarantee the broader participation of interested private parties in compliance with the applicable regulation, based also on the general practice of central purchasing body of the FVG Region.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Tender documents' structure and implementation of the tender procedure

According to the identified tender procedure scheme, the awarding procedure managed by FVG Region, acting as the delegated purchasing body of all the participating Public Administrations, is characterized by the following implementation structure:

- firstly, FVG Region, by means of its central purchasing body, is entitled to call the unique tender procedure for the awarding of the aggregate e-mobility service (simultaneously for the no. 2 lots identified in the previous paragraph);
- following the awarding, the FVG Region shall enter into a framework agreement with the selected private partner(s);
- on the basis of the legally binding terms of said framework agreement, each participating Public Administration shall enter into an executive contract with the selected private partner(s), for the supply of the aggregate e-mobility service limited to the specific needs of each participating Public Administration as preliminarily identified in the agreements;
- on the basis of the relevant executive contract, the selected private partner(s) shall start the activities related to the e-mobility service, starting from the carrying out of the relevant works and the subsequent installation of the necessary charging stations, together with the lease of the electric vehicles.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

The contract with the supplier: Single contract or a Framework agreement?

Advantages and disadvantages for the stipulation of a single contract or a framework agreement and implementing contracts have been analysed.

SINGLE CONTRACT	FRAMEWORK AGREEMENT AND IMPLEMENTING CONTRACTS
A single contract simultaneously signed by (i) the FVG Region, (ii) each of the Entities involved in the Project and (iii) the contractor of the Mobility Service (the "**Single Contract**"). Pros: (i) uniqueness of the contractual relationship; (ii) simplification and maximum efficiency for the contractor; (iii) reduction of administrative costs for the supplier. Criticalities: (i) despite the formal uniqueness of the contractual relationship, it would be necessary to manage the existence of multiple contractual positions, which would lead to greater exposure of the FVG Region in disputes that may possibly arise and difficulties in managing them in a single contractual context; (ii) higher charges relating to the aforementioned management; (iii) downsizing of the management and monitoring powers of the individual Bodies; (iv) in principle, the FVG Region, following a notification from the Entity, should take action to verify and manage any contractual problems that may arise, both ordinary and extraordinary (e.g. malfunctioning of the columns or vehicles); (v) in the event of non-fulfilment, even relating to a single Entity (or a few Entities), the critical issues would be complex to manage, as they would automatically affect the overall contractual performance; (vi) the provision of any additional services would be objectively difficult to manage without an agreement with the individual body, especially in the event of improper use by the body itself.	The FVG Region, as CUC, enters into a Framework Agreement with the contractor, to which the Bodies adhere by signing individual implementation contracts ("**Supply Orders**" or "**Implementation Contracts**"). Each Implementation Contract incorporates the core of general conditions contained in the Framework Contract between the FVG Region and the contractor, also providing for specific and autonomous obligations for the individual Entity to which it refers. Pros: (i) greater flexibility on the methods and times for subscribing and activating the Service; (ii) possibility for the contractor and the Bodies to agree on the details (both temporal and qualitative) of the supply, agreeing more effectively on the concrete activation of the Service; (iii) greater flexibility and effectiveness, deriving from the establishment of a single relationship with each Entity, with regard to the methods of managing the Contract in its validity; (vi) FVG Region holds the supervisory function, with the power to intervene, in the face of greater involvement and accountability of each Body in verifying the correctness of the execution of the Service; (v) any contractual problems could be easier to resolve, without impacting on a single contract, with repercussions for all other Bodies not directly concerned (e.g. in the event of early termination of the same, the criticalities may not automatically affect the others relationships); (vi) any activation of additional services would be managed and negotiated (within the established limits), as well as paid for independently by the Entity towards the service provider; Criticalities: (i) the onset of as many relationships as there are signed contracts. (ii) many relationships to be managed at administrative and accounting level by the contractor; (iii) higher administrative costs for the Service supplier.

In light of the above, the tender documentation at the basis of the tender procedure for the implementation of Project Noemix includes the following main documents:

- the tender documentation regulating the tender procedure;
- the scheme of the framework agreement, limited to the provisions regarding mainly the general obligations of the selected private partner(s), as well as the specific obligations related to the entering into the executive contracts with each participating Public Administration;
- the scheme of the executive contract and the attached technical specifications, providing for the detailed regulation of the activities to be carried out by the selected private partner(s) in order to implement and provide all the services underlying the awarded e-mobility service;
- the technical projects of each site identified for the installation of the charging stations and the execution of the relevant related works;
- all the additional technical and contractual annexes providing for detailed information on the main characteristics of the e-mobility service and the needs of the participating Public Administration.

Regarding the technical specifications under point (*iii*), a thorough work was made as to define the contractual obligations of the supplier from the technical point of view.

The final version of the document, consisting of about 40 pages, is structured in sections as follows:

i. General aspects: definitions, object, lots, values and duration;
ii. Charging stations: technical specifications and general regulation of the supply and installation;
iii. Vehicles: technical specification, conditions of supply and services included (maintenance, repair, tires, service centres, assistance, insurance etc.);
iv. Fleet management services: minimum features of the management and control system (data analyzed, interface, access, security, etc.), additional services and optionals;
v. Other contractual obligations: end of contract, technology progress and out-of-stock, penalties and other charges on the service provider.

Having regard to the documents under points (*iv*), it is worth noticing that prior to the tender procedure for the awarding of the E-Mobility Service, it has been necessary to call a separate tender for selecting professional designers in order to draw said technical projects for each site identified as suitable for the installation of charging stations. These documents were required according to the applicable regulation in the field of public procurement in Italy, as a consequence of the works to be awarded for the purpose of the implementation of the aggregate E-Mobility Service.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

Risks in awarding and signing the contract

Under a legal perspective, the Project had to consider the typical risks related to the carrying out of a public tender procedure as set forth according to the rules of the Procurement Code. On this regard, one major risk of potential failure of the Project is strictly related to the outcome of the public tender launched for the awarding of the E-Mobility Service. In particular, save for the theoretical risk of objection and challenge by third parties, it is typical of a public tender procedure the possible event of having also no participants, resulting in the impossibility to award and subsequently sign the public contract at hands. The risk of having no participant (*deserted tender*) shall be particularly taken into account prior to the launch of the tender procedure. In light of said risk, it is essential to fully investigate the relevant market of the concerned contract to be awarded, in order to assess the existence of interested private partners which might participate to the tender. To this purpose, in the context of the Project Noemix, many assessments of the *e*-vehicle market have been made, especially by AREA Science Park, in order to assess the presence of adequate partners and to identify the technical features to be requested in the context of the awarding of the E-Mobility Service.

The risk of deserted tender: an important lesson learned

The first launch of the tender procedure for the awarding of the E-Mobility Service, the lot n.2 received no offer, resulting in the impossibility to award the contract in relation to the concerned lot. This was probably due to the exceptional circumstances of the present economic context, i.e. the war in Ukraine and the highly raising costs for the supply of energy and materials, which is making extremely difficult to produce electric vehicles, resulting in higher production costs and long delay in the delivery of the products.

The current raising of all costs made no profitable for private operators to present an offer for the lot n.2. therefore, the FVG Region had to increase the total budget for the tender.
The launch a new tender procedure for the awarding of the failed lot resulted inevitably in a significant delay of the schedule timeline of the Project.

Lessons Learned

Project Noemix was very innovative in the Italian context, being probably the first in the field of integrated *e*-mobility services in the public sector. As a consequence, all the activities carried out from the legal, procedural, technical and economic perspective faced the lack of previous examples and experiences that could have helped identify and avoid issues.

In fact, during the development and implementation of the Project Noemix, the partners have encountered hurdles and barriers that required quite some effort to be overcome. However, this experience allowed to learn some lessons that will be highly valuable for the replication of the project in other context and that could inspire and support other Public Administrations willing to follow the example.

The following are the main lessons learnt from the Project Noemix:

- **bundling of vehicles and charging infrastructure:** one of the main themes of discussion among the project partners was about the convenience of bundling the leasing of the vehicle and the supply, installation and operation of the charging infrastructure. On one side, it is true that the two objects are quite different, require different technical skills and expertise by the suppliers and may thus force suppliers to join forces to participate to the tender. On the other side, the two object are too linked and synergistic for several reasons to be tendered separately. As explained, the final decision was to structure the tender in order to award the service as a whole, including both the leasing service and the charging infrastructure.
- **timing and level of the design:** according to the Italian procurement code, in order to launch a tender for the execution of public works an executive project design is needed. This is the highest and most complex level of design that contains all the information and data for the contractor to directly start the construction works. Very often, drafting an executive design for a project takes longer than expected for several reasons: need to directly inspect the sites; need to collect data and information that are not always available or ready *(in this case, from several public administrations)*; need to consult third parties and database to ensure the feasibility of the works; etc. In addition, according to the Italian procurement code, if the expected cost to draft the executive design is higher than the threshold set by law for the lawful direct awarding, which has been the case of project Noemix, a public tender is needed to select the designer. Finally, the output produced by the designer needs to be validated before it can be used as a basis for the tendering. Reviews, adjustments and fine-tunings may be needed to ensure its compliance. Therefore, all this process requires time and the risk of delays, which exists and is relevant, is a key variable that must be taken into consideration in the organization and management of the tender.
- **agreements between the participants:** one of the main issues faced during the structuring of the process was related to the signature of the agreements between the participating Public Authorities and the FVG Region. While, on one side, aggregating several participants and creating critical mass is key for the success of the project, on the other side involving, organizing and binding several Public Administration may be very complicated and troublesome. Each Public Administration is autonomous and every decision must be taken within its own organization according to its internal regulation. So, the agreements, once drafted by the project partners, had to be negotiated and eventually approved by all the participants partners before the tendering. This process requires time and effort, and this may cause delays in the implementation of the project. One key factor to overcome this issue is to start negotiating the agreement in advance, fixing the general principles,

obligations and economic values in the contract, while delegating the development of the operational activities and the tendering to the aggregating body. Otherwise, it would be necessary to go back to each participant to ask for the approval of every step of the procedure, dramatically increasing the risk of delays or even not to find an agreement with all of them.

- **financial aspects:** the overall expected cost of the new *e*-mobility service is higher than the average historical expenditure for the fleet management. This is mainly because the cars that need to be replaced are old and their initial purchase cost has already been depreciated. This means that entering the leasing contract implies an increase in the current expenditure for the Public Administration, that need to find the right financial coverage. Very often in the public sector, this is a barrier that is difficult to overcome due to the strict regulation, constraints and spending review policies for the Public Administrations. In the case of the project Noemix, the FVG Region provided all the financial resources needed to fill the gap between the historical average cost and the future expected cost of the leasing. Other Public Administrations willing to replicate this project must take this aspect into consideration in their financial planning.
- **external costs:** Public Administrations should consider the non-financial benefits that can be generated by the electric transition of their fleet such as: reduction of polluting gas emissions; greater comfort for users; improved fleet management with comprehensive services included. A study conducted by the University of Trieste evaluated and compared the external costs *(air pollution, climate change, noise, accidents)* without Noemix and the aforementioned external costs with Noemix. The results indicate annual cost savings of € 283,345. In the 5 years of the Noemix project, we therefore arrive at a total saving on external costs of € 1,416,725, therefore € 2,714 for each car.

In line with the objectives of the European green deal, the public sector has a responsibility to lead the electric transition in the mobility sector, setting a good example and good practice for citizens.

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

ANNEXES

1. Survey on mobility needs
2. Technical feasibility study
3. Financing scheme
4. Business plan
5. Framework agreement (it)
6. Noemix set of tender documents
7. External costs evaluation
8. Noemix video tutorials

   VIDEO 1 - INTRODUCTION TO ELECTRIC VEHICLES

   VIDEO 2 - HOW TO CHARGE AN ELECTRIC VEHICLE

   VIDEO 3 - HOW TO DRIVE AN ELECTRIC VEHICLE

NOEMIX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 754145

ABBREVIATIONS

AC: Alternating Current

BEV: Battery Electric Vehicle

CPO: Charging Point Operator

DC: Direct Current

DSO: Distribution System Operator

EPC: Energy Performance Contract

EV: Electric Vehicle

FVG: Friuli Venezia Giulia (region)

kW: Kilowatt

kWh: Kilowatt-hour

kWp: Kilowatt-peak

LEV: Light Electric Vehicle

PA(s): Public Administration(s)

SOC: *(battery)* State of Charging

UVAM: Unità Virtuali Abilitate Miste *(MEVU – Mixed Enabled Virtual Units)*