# D7.2: Amsterdam-Utrecht urban area UC-1 complete solution description

*June 2022 (M30)*

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## Technical References

| | |
|---|---|
| Project Acronym | INCIT-EV |
| Project Title | Large demonstration of user centric urban and long-range charging solutions to boost an engaging deployment of electric vehicles in Europe |
| Project Coordinator | CIRCE<br>Miguel Zarzuela - mzarzuela@fcirce.es |
| Project Duration | 01/2020 – 12/2023 |

| | |
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[1] PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

CO = Confidential, only for members of the consortium (including the Commission Services)

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| Document history | | | |
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| **V** | **Date** | **Partner(s)** | **Action** |
| V0.1 | 06/04/22 | CIRCE | Table of Content avaible for WP7 and WP8 deliverables |
| V0.2 | 13/06/22 | TotalEnergies, MRAe, WDS | First Draft. Contribution from all partners |
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| V0.4 | 06/07/22 | CIRCE | Final Quality Revision |
| V1.0 | 15/07/22 | TotalEnergies, MRAe, WDS, GFX | Final Consolidated version |
| | | | |

## Disclaimer of warranties

# 0 EXECUTIVE SUMMARY

This document is the deliverable "D7.2 – Amsterdam-Utrecht urban area UC-1 complete solution description" of the H2020 project INCIT-EV (project reference: 875683).

The main objective of this deliverable is to collects the main conclusions reached after finalizing the modelling, basic and detail engineering, and equipment development activities before the deployment of the WP7 UC-1

Use Case 1 of INCIT-EV contains three sub use cases, all of which are being demonstrated in The Netherlands. The common objective is to demonstrate the benefits of local, neighborhood and regional smart charging systems. The opportunities of managing the charging sessions and/or adjusting the power input/output by aggregating energy and load at different levels will be demonstrated.

Use Case 1a demonstrates public smart charging to prevent grid congestion. During the engineering phase, CPO TotalEnergies and platform provider GreenFlux set up an operational smart charging ecosystem where TotalEnergies is providing load forecasts and GreenFlux is dis-aggregating this load using an advanced algorithm over 120 charge points in the City of Haarlem. Extensive testing was part of the engineering phase, to see whether the algorithm was functioning well and EV drivers are not complaining on a lower-than-expected charging rate. The amount of complaints was negligible during the testing phase for the actual demonstration phase, the system is optimized and improved. At the end of the engineering phase, TotalEnergies, MRAE and grid operator Liander signed an agreement which includes the demonstration phase for this work package: aggregated smart charging in the public area, with DSO input for congestion management via the GOPACS platform.

Use Case 1b demonstrates bidirectional (Vehicle-to-Grid) Charging in an active community in Odijk, the Netherlands. Starting from EV car sharing initiatives in the Amsterdam/Utrecht region and technological demonstrations of bidirectional AC charging in the region, this use case is developing a user interface that guides and monitors bidirectional charging for shared e-cars, and improved interoperability by integrating new EV models into the V2G-EV system. Once testing of the Hyundai IONIQ5, the first AC-V2G production car worldwide, is completed, the demonstration will be fully functional and can be scaled up. The user app and development and interoperability of the underlying open protocols has been largely completed.

Use case 1c demonstrates the process and realization of charging infrastructure in collectively owned buildings. In the use case, both the technical and organizational innovations are central. Technical challenges relate to achieving the optimal solution of integrating charging infrastructure in a residential building. The organizational challenges are related to the decision-making process in the owners association of the apartment complex. The decision-making process at the pilot location is nearly finished. Lessons are bundled in a methodology, series of webinars and quick scan for these types of residential locations. This way UC1c approach offers lessons for owners associations of residential buildings all across the Netherlands.

The delivery of this deliverable is done in accordance with the description in the Grant Agreement Annex 1 Part A with minor time deviation (15 days) and no content deviation from the original planning.

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# ACRONYM LIST

*Table 1 - Acronym list*

| Acronym | Definition |
| --- | --- |
| AC | Alternating Current |
| API | Application Programming Interface |
| APP | Application |
| CDR | Charge Detail Record |
| CO2 | Carbon Dioxide |
| CPO | Charge Point Operator |
| DC | Direct Current |
| DSO | Distribution System Operator |
| EMSP | Electric Mobility Service Provider |
| EU | European Union |
| EV(s) | Electric Vehicle(s) |
| HMI | Human-Machine Interface |
| KPI | Key Performance Indicator |
| MAAS | Mobility as a Service |
| NL | Netherlands |
| OCPI | Open Charge Point Interface |
| OCPP | Open Charge Point Protocol |
| TSO | Transmission System Operator |
| UC | Use Case |
| V2G | Vehicle-to-Grid |
| VPP | Virtual Power Plant |
| WP | Work Package |

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# 1 INTRODUCTION

INCIT-EV aims to demonstrate an innovative set of charging infrastructures, technologies, and associated business models, ready to improve the EV users experience beyond early adopters, thus, fostering the EV market share in the EU. The project will seek the emergence of EV users' subjective expectations. 5 demo environments at urban, peri-urban, and extra-urban condition will be ready for the deployment of 7 use cases addressing:

- UC1: Smart and bi-directional charging optimized at different aggregation levels – Amsterdam – Utrecht Area. This Use Case has three sub-Use Cases:
    - UC1a: Regional aggregated smart charging (Coordinated by: PITPOINT and GREENFLUX)
    - UC1b: Community bidirectional charging (Coordinated by: WEDRIVESOLAR)
    - UC1c: Local private shared smart charging (Coordinated by: MRA-E)
- UC2: Dynamic wireless charging lane in urban areas - Paris
- UC3: Dynamic wireless charging for long distances -Versailles
- UC4: Charging Hub in a Park&Ride facility – Torino
- UC5: Superfast charging systems for EU corridors - Tallin
- UC6: Low power DC bidirectional charging infrastructure for EVs, including two-wheelers.
- UC7: Opportunity wireless charging

## 1.1 Contribution to INCIT-EV Objectives

WP7 and WP8 "Use Cases deployment and demonstration in urban and extra-urban areas" of the INCIT-EV project aims to model, design and develop the use cases to be demonstrated in all areas with aim of collecting real data from the field. The specific objectives are:

- To elaborate a plan for the successful deployment of the innovative use cases to be demonstrated (D7.1 and D8.1)
- To model, design and develop the different solutions addressing to be implemented in the project
- To commission all the developed equipment and prepare the field for the demonstration activities.
- To carry out the demonstration activities of the use cases, monitoring the defined KPIs for its ulterior contrast and analysis.
- To analyse the medium and long-term impacts of the use cases evaluating their techno-economic, environmental, regulatory and social aspects.

This deliverable collects the main conclusions reached after finalizing the modelling, basic and detail engineering, and equipment development activities before the deployment of the WP7 UC-1

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## 1.2 Contribution from partner table

*Table 2 - Contribution table*

| Partner | Contribution |
|---|---|
| TotalEnergies / PitPoint EV | Preparing the charging stations, creating operational smart charging architecture, contracting BRP for flexibility trading, execute smart charging on charge points, CPO role (charge point operator) |
| WDS | Installation of charging stations, preparation of shared e-cars, development smart charging software and user app. |
| MRA-E | Installation of charging stations at an apartment building of an owners association, and developing an approach for these kinds of locations. |
| GFX | Development of power management smart charging algorithm |

## 1.3 Relation to other project activities table

*Table 3 - Relation to other project activities table*

| Task | Relation to other project activities |
|---|---|
| T3.1 - Cost-effective low and medium Power DC-DC bidirectional chargers | Theorical modelling of the solution |
| T7.5 - Evaluation and impacts assessment | Short term impacts |

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# 2 OBJECTIVES UC-1

This chapter describes the objectives of UC-1, which is divided into three sub use-cases.

The main Objective of WP7 is to model, design and develop the use cases to be demonstrated at the urban areas. Furthermore, to deploy and monitor the previous use cases in the urban Demo-site areas (#1, #2, #5), of the project, with the aim of collecting real data from the field.

The main objectives for UC-1 are:

- To model, design and develop the different solutions addressing UC-1 in Amsterdam and Utrecht region
- To commission all the developed equipment and prepare the field for the demonstration activities
- To carry out the demonstration activities addressing the urban use cases while monitoring the defined demonstration KPIs.
- To analyze the medium and long-term impacts of the use cases performed at urban areas, evaluating their techno-economic, environmental, regulatory and social aspects.

In the following chapters, the objectives and complete solutions of each of the three sub-Use Cases are described.

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# 3 UC1A OBJECTIVES

The main objectives for UC-1 are translated into a main objective specifically for UC-1a:

**Reducing the impact of EV charging on the electricity grid, for example by smart or delayed charging by EV drivers during the traditional evening peak load**

To achieve this, the following sub objectives support UC-1a:

1. Develop a Smart Charging Algorithm for Aggregated smart charging on public charging stations
2. Setting up an Operational Smart Charging Platform/Ecosystem as a Charge Point Operator
3. Commissioning and operating a group of smart charging stations in a public urban area
4. Prevent grid congestion with public charging stations with use of a steering signal from a local Grid Operator
5. Monitor EV Driver behavior on public Smart Charging Stations; trouble-free smart charging for the EV Driver

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# 4 UC1A COMPLETE SOLUTION

UC1a focuses on Smart Charging to reduce peak load in the grid, also called Grid Congestion. The provided service consists of an operational platform and ecosystem of public charging stations that can reduce peak loads on demand by the local Grid Operator, without interfering with the EV drivers' needs. The results of modelling and engineering for UC1a consists of the following aspects:

### *Group of Public Smart Charging Stations*

In the city of Haarlem, Amsterdam Region, The Netherlands, TotalEnergies (PitPoint EV) is the Charge Point Operator of public AC charging infrastructure and MRA-Electric the Owner. A group of approximately 56 charging stations (110 charge points) has been selected based on general charging profiles and usage to be combined as an Aggregated Smart Charging group. The charging stations are equipped with a 3x25A grid connection and can supply 11 kW AC per socket. When two connectors are in use, the available 17 kW (3x25A x230V) is divided between the two sockets (smart load balancing). 5 stations have an increased grid connection (3x35A).

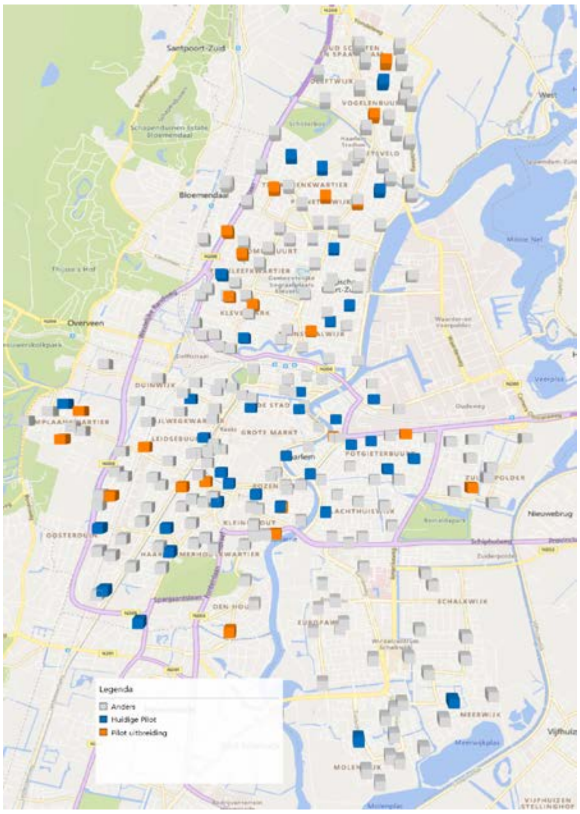


*Figure 1 - geographical overview of involved charging stations in Haarlem*

The stations can be recognized as Smart Charging stations by a sticker, referring to a specific website with information about this demo area (see Figure 2)

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*Figure 2 - Label for Smart Charging stations in Amsterdam region*

*Figure 3 - Smart Charging station operated by TotalEnergies*

### *Aggregated Smart Charging Algorithm*

A group of public smart charging stations has an aggregated load profile, the combined power this group will take from the grid at any moment in time. To perform congestion management, this load profile can be reduced. To dis-aggregate a new load profile in this group of charging stations (using the Open Charge Point Protocol – OCPP), GreenFlux developed a Smart Charging Algorithm focused on Power Management. An overview of the properties of this algorithm are presented in the table below.

*Table 4 - Properties of Smart Charging Algorithm*

| Topic | Solution |
|---|---|
| Commercial Purpose | Meant to combine large numbers (thousands or even hundreds of thousands) of charge stations into one so-called Virtual Power Plant (VPP) in order to adjust the charge rate of electric vehicles to the availability of electricity on the wholesale markets or the local/regional electricity grid |
| Technical purpose | Meant to keep the maximum power used by a group of charge stations as close as possible to a certain setpoint |
| Offline behaviour | In an offline situation, the customer service prevails over the financial optimum, meaning that in an offline scenario a charge station or a group of charge stations will not be curtailed, which may in some cases cause a deviation between the power setpoint and the power consumption of the VPP |
| Priority of a session | Users can request a high priority which will always be granted. Should all users in a group request high priority then this may cause a deviation between the power setpoint and the power consumption of the VPP (although with thousands of sessions this is a very unlikely scenario) |
| Unit | Control is done on power. Current per phase is not relevant, since energy markets deal in power, not current. |

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### Operational Smart Charging Ecosystem

The developed Operational Smart Charging ecosystem or platform consists of the following steps:

1. Load forecast: using historical data of the charge points, a forecast is created for the following 24 hours, resulting in a prediction of the charging needs within the group
2. Separately, the input of the DSO is collected (Congestion profile; required peak load reduction)
3. The amount of flexibility coming from the charging needs is calculated
4. An optimization is done based on the flexibility and the required peak load reduction, resulting in an optimized aggregated load forecast
5. This optimized load forecast is disaggregated using the developed algorithm

This operational flow has been developed, ensuring no human interaction is required for Smart Charging anymore.

### Connecting to a DSO via a flexibility trading market for congestion management

For congestion management, there needs to be 1) congestion and 2) a communication loop with the organization that needs this congestion to be solved (DSO or TSO). During the engineering phase, this feedback loop was not implemented. Testing was done based on fictional congestion situations. However, the goal for the commissioning and demo phase is to work with an actual connection with the local DSO and offer flexibility in an official standardized way via the GOPACS flexibility trading platform. The goal is to start with flex trading in July 2022.

## 4.1 UC1a Final modelling and engineering results

The result of the modelling and engineering phase for UC1a is an operational ecosystem including a group of public Smart Charging stations, being able to help reducing grid congestion via a flexibility trading platform, without interfering with the EV drivers' charging needs.

The conclusion of tests in this phase is that this is a viable model, which significantly helps reducing grid congestion.

The test results below provide insight in the amount of power that has been reduced by 10%-25% during peak hours. An average peak reduction of 25 kW (0,8 kW per charging station[1]) was achieved. 0,8 kW will not or hardly affect the mobility needs of an EV Driver. It is possible to use a more aggressive algorithm to achieve more peak load reduction. It is more likely that this will affect users. During the demonstration phase,

[1] The smart charging group during the engineering phase consisted of 74 charge points; during the demo phase the group is extended to 110 charge points

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since the 100kW load reduction will now be obliged from the DSO, it could occur that the peak reduction per charging station will be higher.

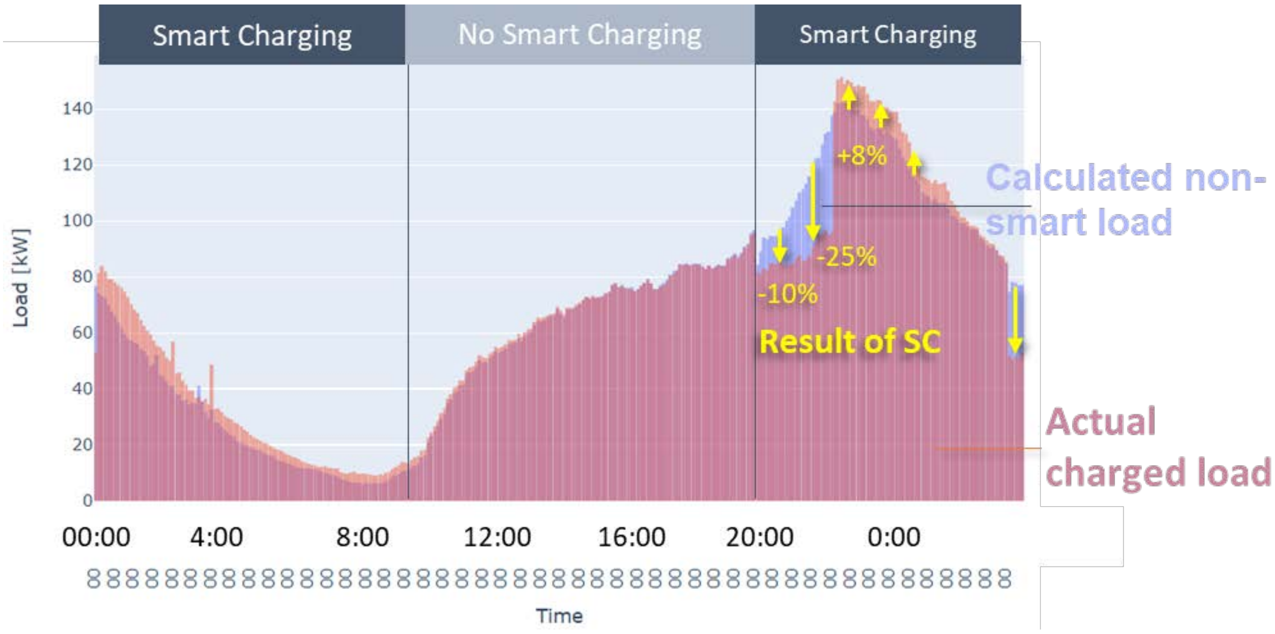


*Figure 4 - Smart Charging results during testing phase*

## 4.2 UC1a Expected data to be collected

The information and data to be collected is:

- Charging transaction data (Charge Detail Records, CDR's, data is formatted corresponding to the CDR protocol ANNEX I)
- Unsteered load profiles
- Optimized load profiles
- Reduced grid impact

## 4.3 UC1a Innovation

The real innovation in UC1a is that aggregated flexibility from a large group of public AC smart charging stations is able to reduce a peak load in the grid and therefore help to reduce grid congestion. Normally, only larger single loads connected to the Medium Voltage grid can act as such. An aggregated group of Low-Voltage connections is considered as very innovative. Also, the fact that there is no contract with an EV driver, can be considered innovative: the smart charging service is offered standard on the group of charging stations. EV Drivers have the possibility to 'opt-out' via an application (priority charging), however if they do not take any action, they are automatically part of the smart charging demonstrator.

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## 4.4 UC1a Risks

Risks for the success of UC1a are:

- Offline charging stations; due to various external reasons, a charging station can disconnect itself from the platform. Though it is still fully functional for the EV Driver, the Smart Charging Services will not be active anymore since a load profile cannot be dis-aggregated on an offline charger. Also, certain updates and configurations can cause a charging station to go offline. This is monitored daily, and a service team is ready to repair offline stations.
- EV Drivers opting-out; if EV drivers find that the smart/delayed charging impacts their mobility needs, they can opt-out of the pilot. The experience during the development phase is that the opt-out option is rarely used.
- Summer-impact; the operational phase starts with two summer months. In summer, EV driver behaviour is significantly different than in regular months. This means there is a higher chance that the load forecast is not as accurate as normal. However, since the steering profiles are not too aggressive, it is not likely that EV drivers will experience this.

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# 5 UC1B OBJECTIVES

Starting from EV car sharing initiatives in the Amsterdam/Utrecht region and technological demonstrations on bidirectional AC charging in the region, use case 1b has the goal to develop:

1. A user interface that guides and monitors bidirectional charging.

2. Improving interoperability by integrating two new EV models in the V2G-EV system.

In this Use Case, bidirectional charging points are demonstrated that are fully compatible with regular public charging, but on the other hand can provide smart AC bidirectional charging to compatible EV's. Also, the use of shared EV's for local communities is demonstrated with a civil initiative in Odijk.

The communication required between the infrastructure, EV and the user-interface is prepared for further interoperability and will therefore be based on open protocols. The use case will lead up to the following expected results:

- Enabling the car-sharing platform by Goodmoovs to communicate with the charging infrastructure and back-office by preparing it for ISO15118 and OCPP 2.0. This will allow the app to share state of charge of specific vehicles with users and real-time monitoring of the bidirectional charging;
- By implementing the latest version of OCPI (expected to be 3.0) the charging station back-office is prepared for allowing optimisation of the direction of charging according to the energy market prices;
- The software and controller of the AC bidirectional charging stations will be upgraded to allow ISO15118 and OCPP 2.0 communication;
- The development of OCPP 2.0 is guided by WEDRIVESOLAR so as to allow the use case of AC bidirectional charging.

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# 6 UC1B COMPLETE SOLUTION

We Drive Solar (WDS) is the hub of a consortium of entrepreneurs, researchers, public bodies and stakeholders that develops and exploits bidirectional charging stations and shared EV's. Partners of the consortium include the research institute ElaadNL for standardization and embedding the correct protocols, DSO Stedin for the integration of bidirectional charging into the electricity grid, the local knowledge integrator Utrecht Sustainability Institute for the scientific validation of the ecosystem, and the city and region of Utrecht for upscaling. WDS has established a link based in open protocols (OCPI, OCPP and ISO15118) between the car-sharing platform (GoodMoovs mobile app) and the energy market. Hereby, the user is better informed on how bidirectional charging stabilizes the energy market, responds to energy prices and prevent CO2 emissions.

In this Use Case, bidirectional charging points are demonstrated that are fully compatible with regular public charging, but on the other hand can provide smart AC bidirectional charging to compatible EV's. Thus, the charging stations can make a significant contribution to electricity grid congestion management and balancing. Also, the use of shared EV's for local communities is demonstrated in cooperation with a civil initiative in a new housing district in the town of Odijk. The bidirectional charging technology has the goal to combine these goals with making a significant contribution to congestion management on the local electricity grid.

## 6.1 UC1b Final Modelling and engineering results

At the Odijk demonstration site, two public bidirectional e-car charging stations have been installed and at the time of writing, three WDS shared e-cars are in operation in the community. Following the growth of the neighborhood and actual demand, these numbers are expected to grow to 5 bidirectional charging stations and 5 e-cars.

UC1b features application of:

- 22 kW smart / V2G charging points that are ISO 15118 compatible and compatible with standard Type 2 charging, developed by WDS and its consortium of partners.
- Smart charged electric shared cars (Renault ZOE / Tesla Model 3 / Hyundai Kona, later also V2G Hyundai IONIQ5 cars), to grow to a total of 5, and a backoffice developed by Last Mile Solutions. A user interface app supporting V2G for shared car users.

The communication required between the infrastructure, EV and the user-interface is prepared for further interoperability and upscaling and is therefore based on open protocols. The following steps are in development:

- Enabling the car-sharing platform Goodmoovs to communicate with the charging infrastructure and back-office by preparing it for the open protocols of ISO15118 and OCPP 2.0. This will allow the app

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to share the state of charge of specific vehicles with users and real-time monitoring of the bidirectional charging.

- By implementing the latest version of OCPI (expected to be 3.0), the charging station back-office is prepared for allowing optimization of the direction of charging according to the energy market prices.
- The software and controller of the AC bidirectional charging stations will be upgraded to allow ISO15118 and OCPP 2.0 communication.
- The development of OCPP 2.0 is being guided by WDS so as to allow the use case of AC bidirectional charging.


*Figure 5 - WDS e-cars in Het Burgje, Odijk, the Netherlands*

Furthermore, TOMP-API (NL API for communication transport operators - MAAS providers) between car sharing data and aggregator, in order to be able to plan when cars can be charged, and test how much load shift will be possible. Also, a connection to the GOPACS network congestion trading platform between asset operators and TSO/DSO is being worked on. Benefits are optimized as real-time data from the vehicle and the energy market are combined to alter the most appropriate charging profile. Operating an AC bidirectional charging system that is suitable for multiple car models will be a ground-breaking innovation at European level.

In 2021, the pilot was started and the first e-cars and charging stations were taken in operation. At the same time, the interoperability between users and the system was extended. The coupling between the shared e-car reservation system and the energy markets makes it possible for the e-cars and reservation system to actually be smart charging and deliver energy services to the electricity system. The reservation system for the shared e-cars was extended to deliver more interoperability to these energy services. The payment structure for WDS customers and private car owners is given in the figure below.

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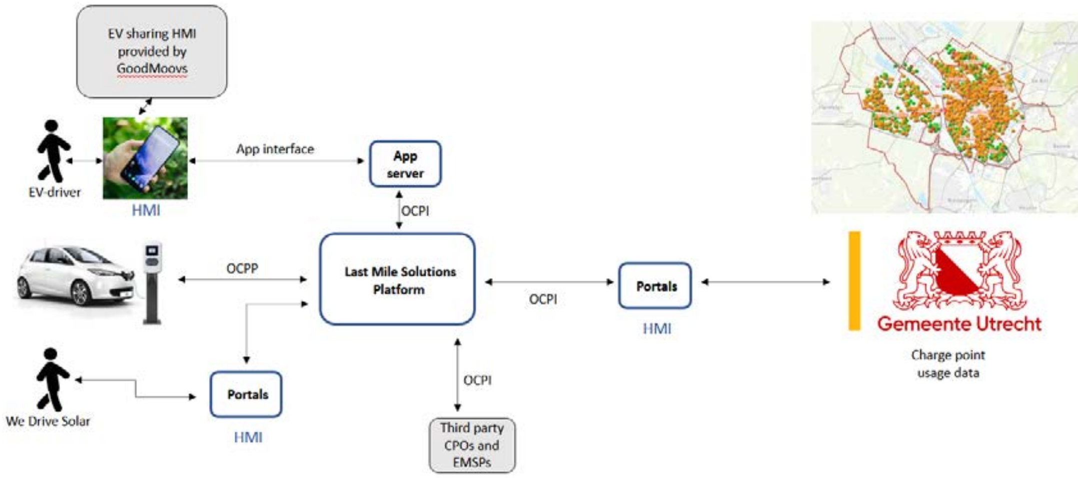


*Figure 6 - Payment structure for UC1b*

In Spring 2022, car manufacturer Hyundai and We Drive Solar announced the introduction of the world's first series produced V2G car, the model IONIQ5, on the market in Utrecht. These cars will be connected to INCIT-EV demonstrator using the new international ISO 15118 standard. From that moment, the bidirectional ecosystem will be in full operation and will fulfil its ambitions on the energy field (use the EV batteries as a virtual battery to reduce electricity network congestion and maximize renewable electricity use) as well as on the mobility field (reduce air pollution, increase healthy mobility, reduce the claim of cars on urban (parking) space).

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*Figure 7 - Launch of the Hyundai IONIQ5 in the WDS V2G ecosystem*
*From left to right: Robin Berg, Director of We Drive Solar; Vivianne Heijnen, Minister of Infrastructure and Watermanagement; Sharon Dijksma, Mayor of Utrecht; Anneke de Vries, Dutch Railroad NS; Michael Cole, President & CEO Hyundai Motor Europe; Onno Dwars, Ballast Nedam Development; Bart Meijer, CEO of MRP (source: Hyundai)*

When the system is fully operational, the focus will be on monitoring and evaluation of user aspects. During the operation, relevant actions will be logged while the correct performance of the monitoring system will be periodically checked. Corrective measures required to amend any low performance will be applied.

Already, the use of the shared e-cars and various technical and non-technical aspects are being monitored. This Use Case is expected to have high replication potential especially in the large segment of sustainable new housing districts.

## 6.2 UC1b Expected data to be collected

The data to be collected for UC1b is:

- Charging transaction data (Charge Detail Records, CDR's, data is formatted corresponding to the CDR protocol ANNEX I)
- Optimized load profiles
- Data on shared e-car use
- Aggregated data on usage aspects.

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## 6.3 UC1b Innovation

In Spring 2022, car manufacturer Hyundai and We Drive Solar announced the introduction of the world's first series produced V2G car, the model IONIQ5, on the market in Utrecht. These cars will be connected to INCIT-EV demonstrator using the new international ISO 15118 standard. From that moment, the Bidirectional Ecosystem will be in full operation and will fulfil its ambitions on the energy field (use the EV batteries as a virtual battery to reduce electricity network congestion and maximize renewable electricity use) as well as on the mobility field (reduce air pollution, increase healthy mobility, reduce the claim of cars on urban (parking) space). This will establish the first V2G operation using production cars using scalable AC technology.

## 6.4 UC1b Risks

By mid-June 2022, the V2G operation of the Hyundai IONIQ5 with the charging infrastructure of WDS is being tested and debugged. Before end 2022, software updates are expected to enable full V2G operation of the IONIQ5. As always with complex technology, there is a certain risk that testing and debugging might take more time than expected at the time of writing.

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# 7 UC1C OBJECTIVES

UC-1c focuses on private charging in apartment blocks with owner associations. The use case aims to achieve goals both on the local level in helping an apartment block to realize cost-effective and user-friendly charging infrastructure and combine the lessons learned in an approach that benefits other apartment blocks in the region.

The main objectives for UC1c are:

1. Commissioning of intelligent charging infrastructure integrated in the grid connection in a privately owned apartment building
2. Monitoring technical and non-technical aspects, to develop in depth knowledge of optimal charging within apartment blocks
3. Disseminate lessons to benefit for residents of apartment blocks in the MRA-E region, as well as DSOs, CPOs and municipalities.

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# 8 UC1C COMPLETE SOLUTION

## Commissioning and monitoring

As part of the goals of the UC1c we are working on the commissioning of intelligent charging infrastructure integrated in the grid connection in an apartment building. After selection of the apartment block in Purmerend, the UC1c partners started with process guidance for the owners association of the building. Contact with the buildings board resulted in an advice on the realisation of twelve 11 kW chargers, more or less. Furthermore, the board is assisted in technological, legal, organisational, and financial aspects, to select the best solution for the apartment building.

The charging infrastructure will be installed and managed by one CPO for the entire building, to ensure optimal safety, smart charging, and a suitable solution for all the inhabitants. The level of smart charging of the system will be Dynamic Load Balancing, that continuously monitors the current capacity available in the building and distributes that between the charge points.

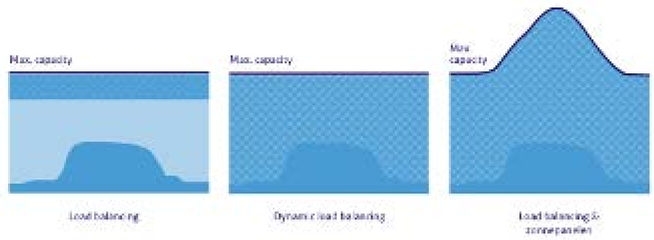


*Figure 8 - Different types of Smart Charging, dynamic load balancing is implemented in the building*

The end-users in a shared system will have different preferences and in a shared system an acceptable solution will need to be found for all, preferences/priorities can include:

- AC/DC -high/low power
- cost-efficiency in operation
- cost-efficiency when investing
- reliability, flexibility and safety
- CO2 emissions reduction
- optimize utilization of locally produced energy

Current solutions remain technologically driven and do not put the user at the center. Working together with the end-users, a technical, organizational and financial solution is developed that best meets user requirements and the available resources. The charging solutions will provide up to date insight (i.e., app, web-dashboard) for users on the benefits of smart charging.

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### Methodology and dissemination of results

Private parking space in inner cities is often shared amongst users, such as in apartment blocks and in shared office space complexes. Having private charging infrastructure installed at these locations poses users with several challenges. Known issues are the lack of support in apartment blocks from other inhabitants, concerns about fire safety, unwillingness of building owners to invest in charging infrastructure and the lack of technical knowledge or organizational capacity from inhabitants or tenants to have charging infrastructure installed. These issues result in many apartment blocks, charging infrastructure realization being delayed or not implemented. This is unfortunate, as the apartment owners usually don't have access to public parking, and therefore have no charging option at home.


*Figure 9 - Parking situation for appartment blocks, part of the methodology developed*

With regards to the dissemination of lessons learned from the demonstration project, a method is developed for end-users that guides the realization of charging infrastructure that meets the specific needs of their situation. Additionally, this method can significantly reduce the effort of CPOs to come up with a suitable offer. The demonstrations, including the decision-making process and the technical, organizational, and financial model, are made available as best practices online and spread out through a video and series of webinars.

*Figure 10 – video still from webinar 'charging at the apartment block'*

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Lastly, based on our experiences an online tool is developed which generates a quick scan to future users that are dependent on shared private parking. The quick scan advises on the suitable financial, technical, organizational model and the opportunities for a system that integrates local power production, storage and V2G.

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## 8.1 UC1c Expected data to be collected

The data to be collected for UC1b is:

- Charging transaction data (Charge Detail Records, CDR's, data is formatted corresponding to the CDR protocol ANNEX I)
- Optimized load profiles
- Aggregated data on usage aspects

## 8.2 UC1c Innovation

In Use Case 1c the innovations are both organisational and technical. Charging electric vehicles at residential apartment blocks in The Netherlands is a subject that is hard to reach progress, since owner associations have to decide with the collective to install charging infrastructure. This has been complicated by more recent questions and media attention about fire hazards in underground parking's.

The innovations in *organisational* terms therefor comprise of the help with gaining a majority in favor of installing charging infrastructure, by informing the inhabitants. Secondly, the development of an approach for owner associations to be able to reach a support base and work out the technical issues on their own, is a major organisational innovation of its own. Already there are dozens of owner associations that are using this approach that is distributed by MRA-E and its partners all over The Netherlands.

In terms of the more *technical* innovations three novities are integrated into the project location or the approach. First of all, dynamic load balancing is used to balance the buildings grid connections with the charging infrastructure system, to enable an optimal use of the grid connections. Secondly, previously installed chargers (2) are integrated into the system, including the dynamic load balancing. Thirdly, the technical solutions that are available to owners associations – both in terms of cabling and charging points – are described and explained in the approach that we developed.

## 8.3 UC1c Risks

Decisions on commissioning must be made by owners associations. Presumed fire safety risks are an issue that could impact positive decision making. To mitigate this risk, a lot of attention is paid to informing the building owners and safety measures that are taken in order to ensure optimal safety.

There is an issue with the current charging infrastructure installed, that should be changed or altered in order to work well with the Dynamic Load Balancing of the new charging infrastructure. Together with the selected CPO the optimal solution for this system is being developed.

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# 9 CONCLUSIONS

Use Case 1 of INCIT-EV contains three sub use cases, all of which are being demonstrated in The Netherlands. The common objective is to demonstrate the benefits of local, neighbourhood and regional smart charging systems. The opportunities of managing the charging sessions and/or adjusting the power input/output by aggregating energy and load at different levels will be demonstrated.

For Use Case 1a the engineering and modelling phase resulted in an already achieved peak reduction of 10% - 25%, which is promising for the demonstration phase. The CPO, client and platform provider have delivered a unique smart charging ecosystem on public charge points, without influencing the EV Drivers' mobility needs. Greater peak reduction is achievable by the use of more aggressive smart charging algorithms with higher impact in the charging times.

Use Case 1b demonstrates bidirectional (Vehicle-to-Grid) Charging in an active community in Odijk, the Netherlands. Starting from EV car sharing initiatives in the Amsterdam/Utrecht region and technological demonstrations of bidirectional AC charging in the region, this use case is developing a user interface that guides and monitors bidirectional charging for shared e-cars, and improved interoperability by integrating new EV models into the V2G-EV system. Once testing of the Hyundai IONIQ5, the first AC-V2G production car worldwide, is completed, the demonstration will be fully functional and can be scaled up. The user app and development and interoperability of the underlying open protocols has been largely completed.

Use Case 1c demonstrates the road to installation of charging infrastructure in apartment buildings with owners associations in The Netherlands. With Use Case 1c the most exciting innovation and development is in the preparation before selecting a charge point operator. Building a support base within the owners associations, working on the technical solutions best suited for the apartment complex and developing an approach that is useful for hundreds of apartment buildings in The Netherlands.

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# ANNEX 1 – CHARGE DETAIL RECORDS

| Field | Format | Required | Description |
|---|---|---|---|
| *CDR_ID* | AN25 | Y | Charge Data Record number. Unique per Infra_Provider_ID. |
| *Start_datetime* | [YYYY]-[MM]-[DD] T[hh]:[mm]:[ss] ±[hh]:[mm] | Y | Start date and time of the charge session (logon with the RFID badge). Local time is used. Format is according to ISO8601 UTC+Offset |
| *End_datetime* | [YYYY]-[MM]-[DD] T[hh]:[mm]:[ss] ±[hh]:[mm] | Y | End date and time of the charge session (usually logoff with the RFID badge). Local time is used. Format is according to ISO8601 UTC+Offset |
| *Duration* | [hh]:[mm]:[ss] | N | Duration of the charge session |
| *Volume* | N4,N4 | N | The volume delivered during the charge session in kWh. Supply of this field is advised. Four digits decimal precision. Decimal comma. |
| *Charge_Point_Address* | AN50 | Y | Address (street and possibly housenumber) of the location of the chargepoint. Supply of this field is advised to cope with changes in the charge infrastructure over time. |
| *Charge_Point_ZIP* | AN10 | Y | Where available the ZIP code of the location of the chargepoint, conforming to country standard |
| *Charge_Point_City* | AN50 | Y | City of the location of the chargepoint. Supply of this field is advised to cope with changes in the charge infrastructure over time. |
| *Charge_Point_Country* | AN3 | Y | Country of the location of the chargepoint. Format is according to the three-character ISO-3166 code. Supply of this field is advised to cope with changes in the charge infrastructure over time. |
| *Charge_Point_Type* | AN2 | N | Charge Point Type. Allowed values: See worksheet "Field domainvalues" (values allowed can be extended over time) |
| *Product_Type* | AN2 | N | Identifies the type of the product that is delivered on the chargepoint. Allowed values: See worksheet "Field domainvalues". Default value = Unspecified |
| *Tariff_Type* | AN2 | N | Identifies the type of tariff the Infra Provider will use for this charge session. The values are determined per Infra Provider and it is the responsibility of the Infra Provider to cover all possible values in the mutual contracts with Service Providers. Allowed values: See worksheet "Field domainvalues" (values allowed can be extended over time) |
| *Authentication_ID* | AN20 | Y | Customer identification, RFID decoded as stored in the central register. |
| *Contract_ID* | AN20 | N | Customer contract identification or ExternalID of the ChargeBadge as stored in the central register (as ExternalID). The Contract_ID is preferred to be supplied. |

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| | | | |
|---|---|---|---|
| *Meter_ID* | AN20 | N | Meter identification. Supply of this field is advised in order to have a fully demonstrable registration of the chargesession data. |
| *OBIS_Code* | AN9 | N | OBIS object identification of the register in the meter. Format is according to the OBIS if the COSEM application layer (defined in IEC 62056-61) and as such aligned with the Dutch Smart Meter Requirements. Supply of this field is advised in order to have a fully demonstrable registration of the chargesession data. |
| *Charge_Point_ID* | AN50 | Y | Charge Point Identification. The Charge Point ID identifies the physical socket (within the Chargepoint Operator) that was used for charging in for the particular CDR. |
| *Service_Provider_ID* | AN20 | Y | Service Provider Identification (i.e. the recipient of the CDR), as stored in the central register |
| *Infra_Provider_ID* | AN20 | Y | Infra provider Identification (i.e. the sender of the CDR), as stored in the central register |
| *Calculated_Cost* | N3,N2 | N | Cost of the charge session in Euro excluding VAT, the Infra Provider will charge the Service provider according to their mutual agreement. Supply of this field is advised. Decimal comma. |

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