Intuitive Smart Charging services for improving user charging experience

Partners involved : NEXXTLAB, VUB, SMATRIC, VERBUND, BSM and CEA

Sothun HING (CEA)

Final Event - 7 November 2024
Barcelona - Spain

Intuitive Smart Charging services for improving user charging experience

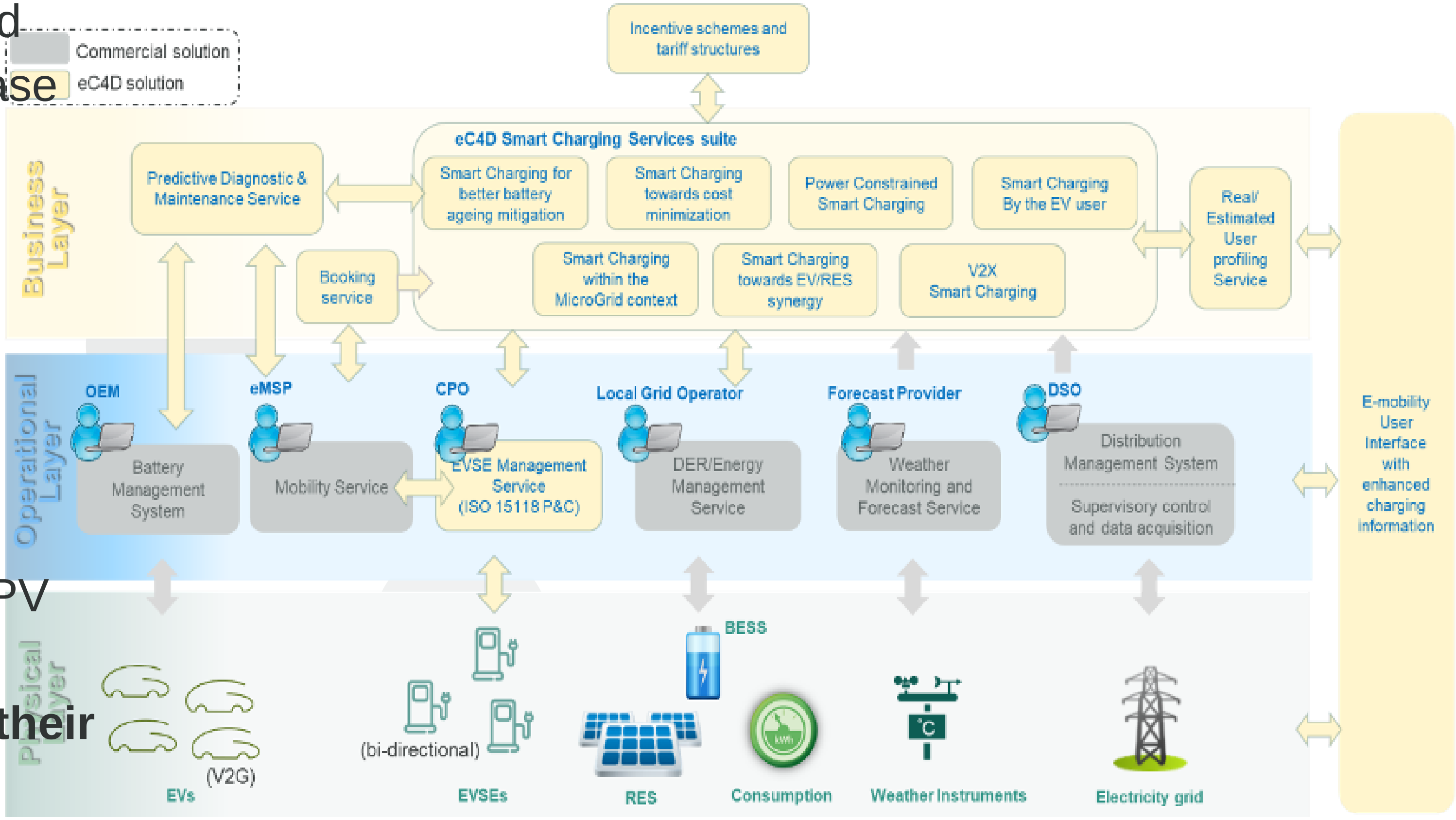
Context :

- ✓ More EV deployment leading high power peak request and energy for charging on the grid
- ✓ Power limitation of existing grid in some case
- ✓ No users centric experience

Objective: **Smart charging service**

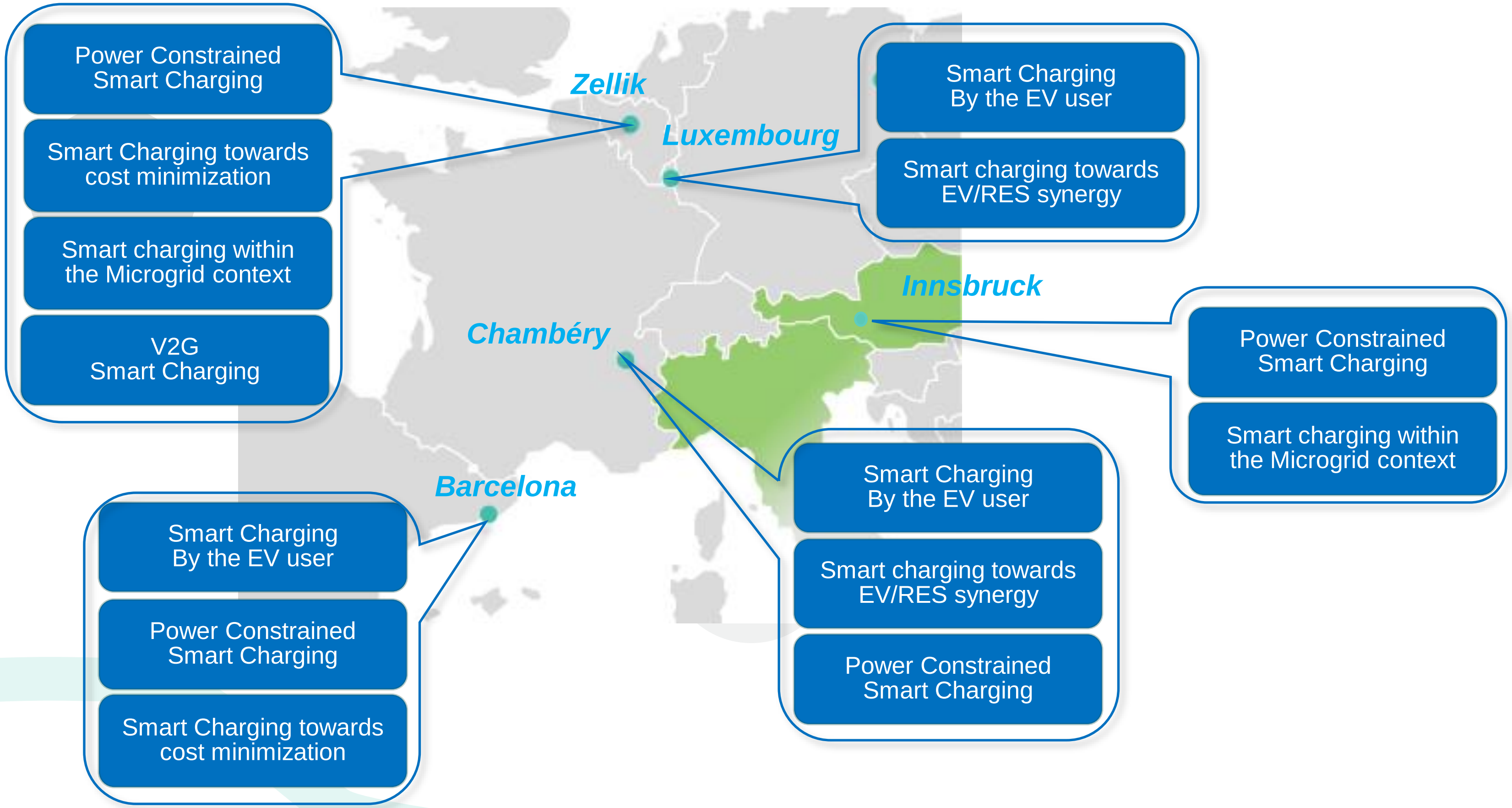
- ✓ Improvement of user charging experience
- ✓ Development/integration/test of Smart Charging **EMS**, **interfaces** connected to different actors (CPO, local grid operator, PV plant, PV forecast provider...) and the **EV user's APP** able to follow up and **control their charging session**

eCharge4Drivers – Smart Charging Solutions



Intuitive Smart Charging services for improving user charging experience

The **Intuitive Smart Charging services** has demonstrated in **Spain, France, Luxembourg, Belgium, and Austria** offering tangible benefits to EV users and enabling them to control the charging process.

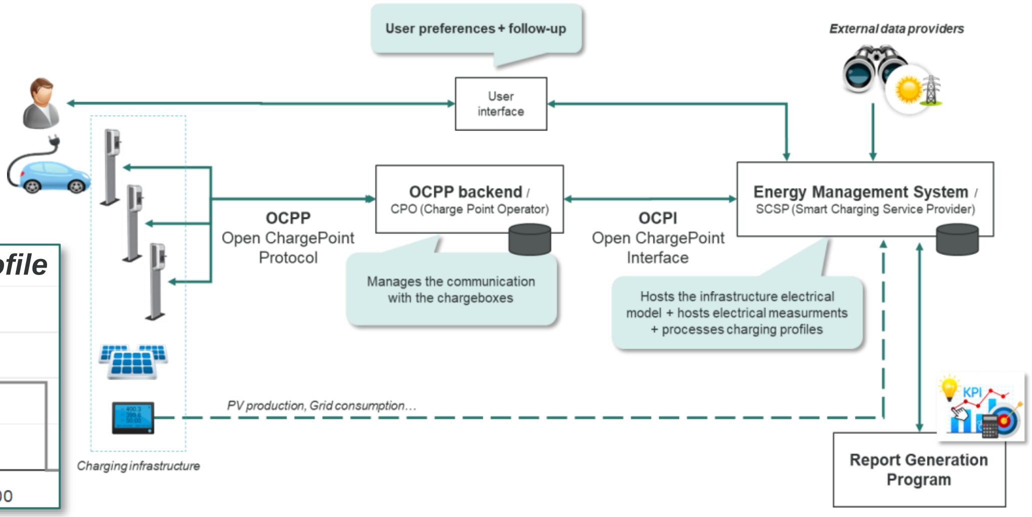


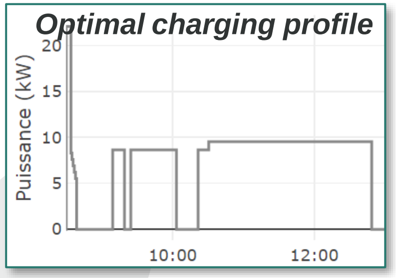
Intuitive Smart Charging Services

Demonstration site : Barcelona / CEA

Objective : maximize PV self-production ratio and reduce charging cost

Overview of architecture solution deployed at Barcelona/CEA



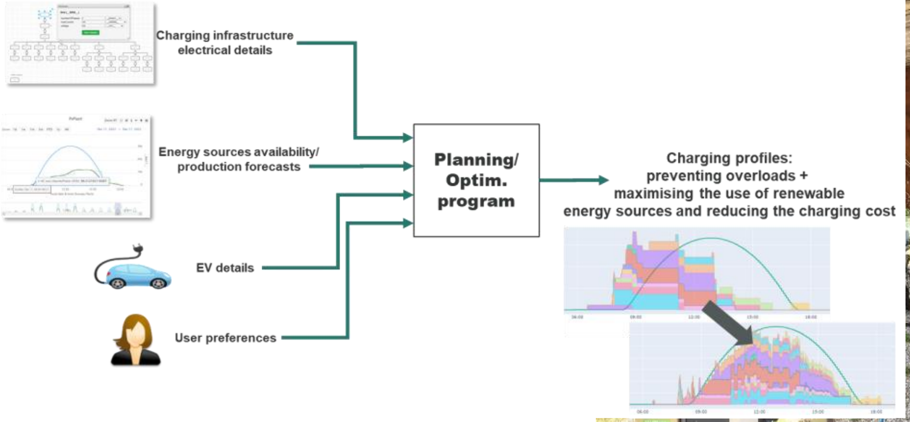


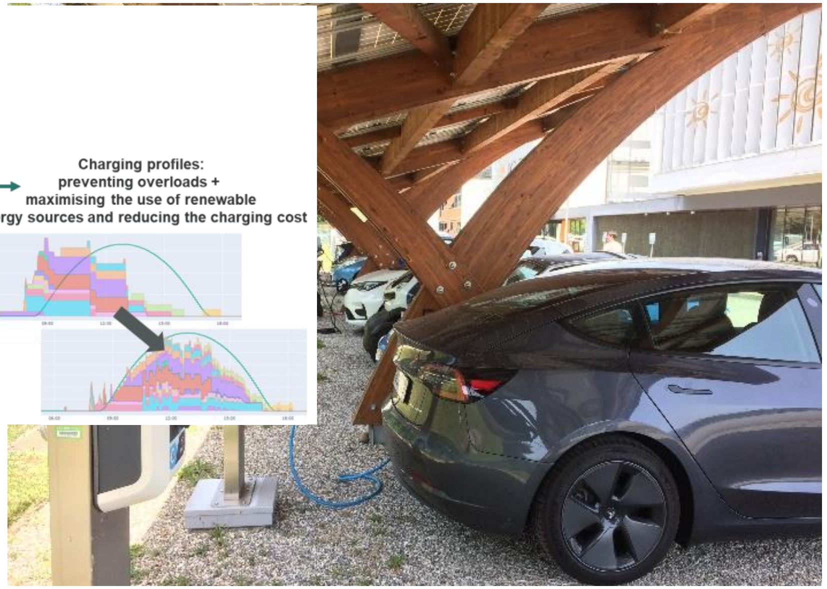
Main development achievements :

- ✓ ***Modular and interoperable EMS** developed :*
  - ✓ *Interface with any CPO back-end with OCPI protocol*
  - ✓ *Configurable with one objective given for the optimization or combining of several objectives for optimization*
- ✓ *User mobile APP for INES-CEA*
- ✓ *Implementation and test on **two use cases** :*
  - ✓ *EVCI at Office building - CEA facility*
  - ✓ *EVCI in a public car park in Barcelona, managed by BSM*

Demonstration infrastructure

- ✓ *Use case : at office building*
- ✓ *30 users*
- ✓ *12 charge points: 6 x 7 kW and 6 x22 kW*
- ✓ *Standard equipment & protocols OCCP 1.6 / OCPI 2.2*
- ✓ *43 kVA grid power*
- ✓ *Local 35 kWp PV power*





Intuitive Smart Charging Services

Demonstration site : Barcelona / CEA

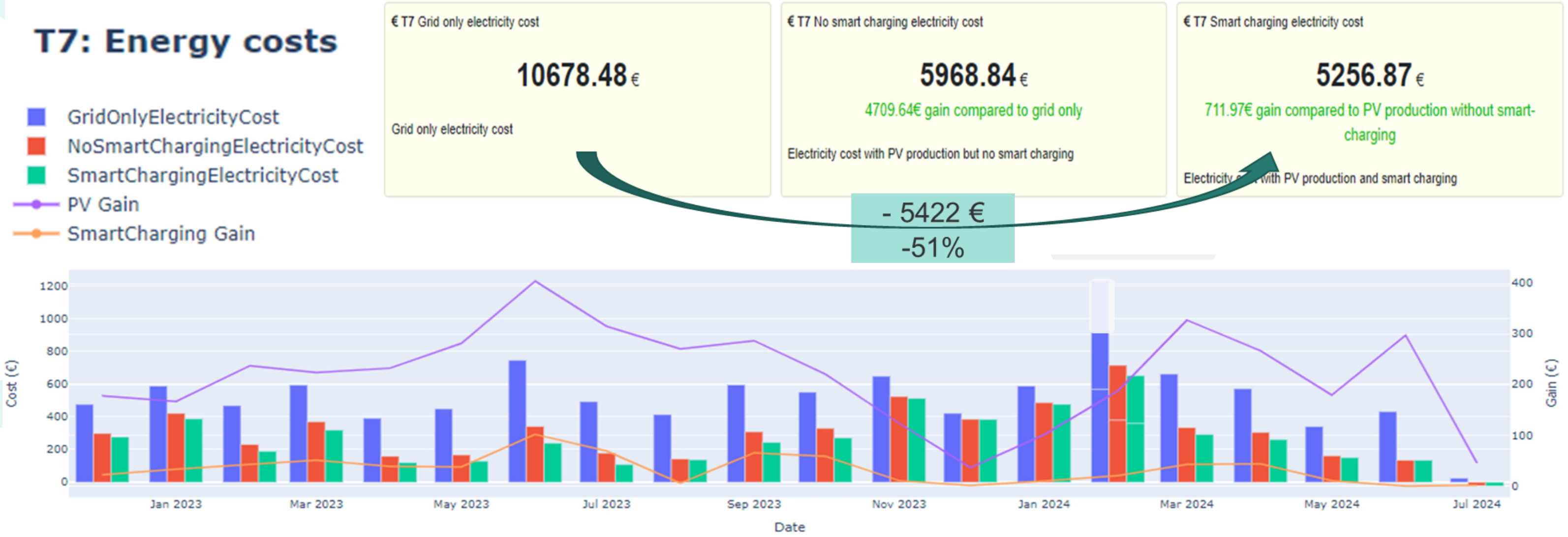
Objective : maximize PV self-production ratio and reduce charging cost

Main key results :

- ✓ *Period of demonstration: **December 2022 – July 2024***
- ✓ *Nb of charging sessions: **+ 4350 charging sessions***
- ✓ *Energy transferred to vehicles : **~ 46.5 MWh (~310 330 km)***
- ✓ *Main KPI analysis:*
  - ✓ *Charging **cost reduction** with smart charging using PV energy : **~ 51 %***
  - ✓ *Average EV energy per session : ~ **10 kWh***
  - ✓ *Self-production ratio : average **56 %***
  - ✓ *Charging time flexibility given by EV users : average **3.1 hours***
  - ✓ *Loyalty to charging site **: 84 %***
  - ✓ *Frequency of use of smart charging : **> 83 %***

Lessons learned :

- ✓ *As a modular structure in the design, the EMS can be easily configured with different objectives: for example maximizing the self-production ratio using the local RES in the case of CEA facility or and minimize the charging cost for the Barcelona demonstration facility.*
- ✓ *Using standard equipment and protocol in the EMS design facilities the wide deployment with any CPO back-end.*
- ✓ *The software based on AI (machine learning) can be used to estimate the user's preferences based on the history of their charging sessions and minimize, thus, the need for interaction with the user.*



Intuitive Smart Charging Services

Demonstration site : *Luxembourg, NEXXTLAB*

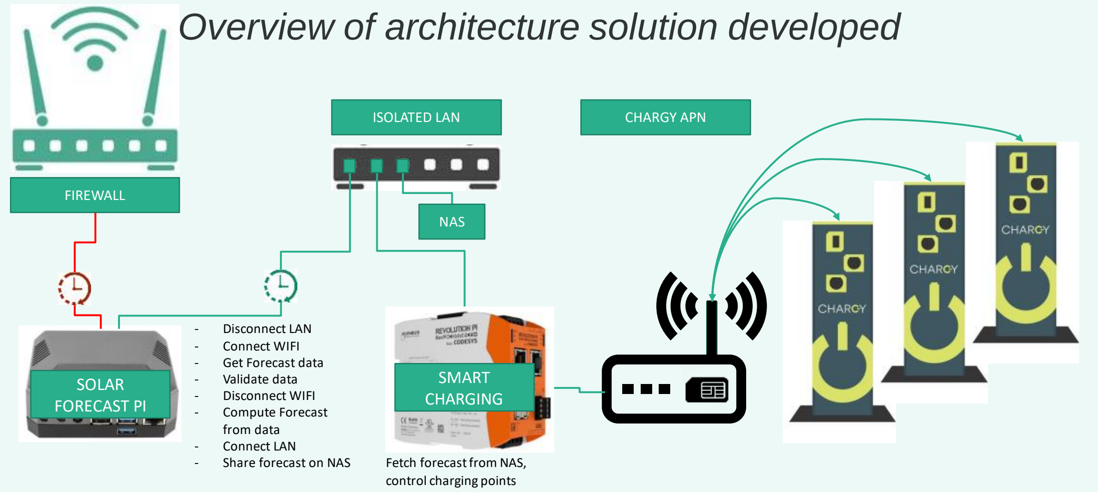
Objective : Charge more locally produced green electricity

Main development achievements :

Development of a Smart Charging System with

- *Input of user preferences (range needed, anticipated duration of stay)*
- *Local solar energy forecast integration*
- *Control of charging sessions on connected charging point*
- *Setup of secure infrastructure integration on a fully operational site (Park & Ride)*

Overview of architecture solution developed



Demonstration infrastructure

- ✓ *16 charging points of 22 kW each on a site with 54 charging points in total provide by Chargy / Creos Luxembourg S.A.*
- ✓ *User interface to capture the user preferences on charging points*
- ✓ *Control of charging points via OCPP over 4G radio network*
- ✓ *Smart charging controller developed by Nexxtlab*
- ✓ *Solar forecast for a virtual local PV system*
- ✓ *Automatic session evaluation for defined KPIs on a Raspberry Pi*

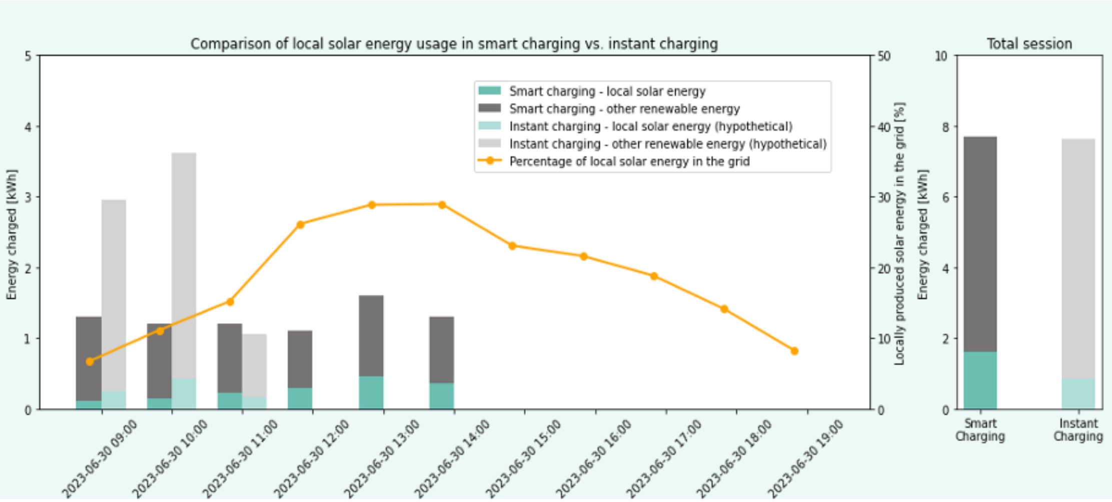
Intuitive Smart Charging Services

*Demonstration site : **Luxembourg,** NEXXTLAB*

Objective : Charge more locally produced green electricity

Main key results :

*Period of demonstration: **April 2022 – June 2024***
*Nb of charging sessions: **3648 charging sessions***
*Unique users: **901 (unique RFID cards)***
*Main KPI analysis: **A typical user, arriving between 6 and 8 AM** on the park & ride, indicating stay of 8 hours, charged **135% more locally produced solar energy** on average.*
*The **cost of sourcing the electricity**, if acquired on the day-ahead market, was **lowered by 6 %** or 0.08 EUR per kWh on average.*



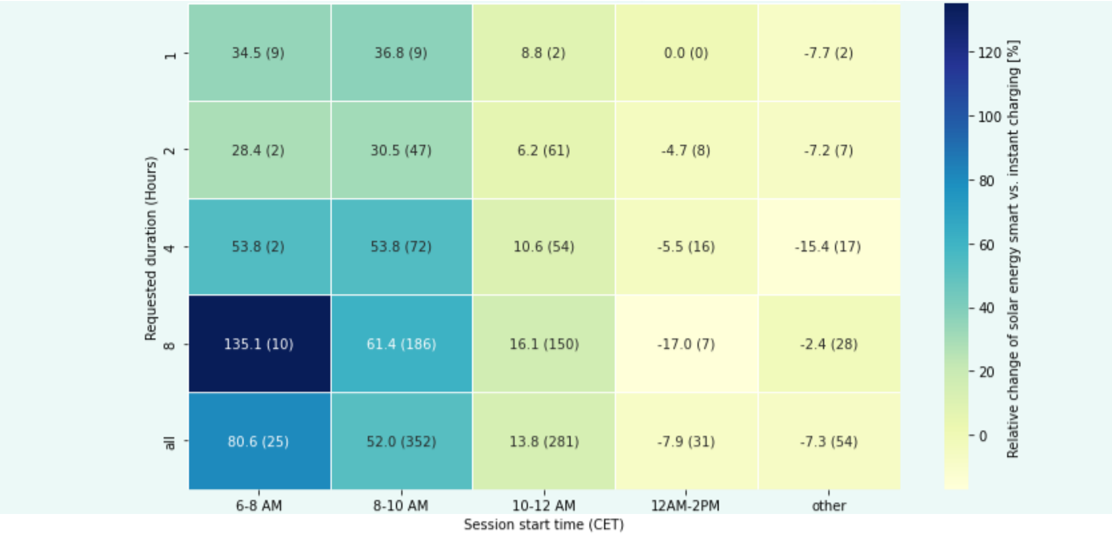
Lessons learned

Time-wise flexibility of the users to delay and adapt the charging profile of the EV proved to deliver the following benefits:

- ✓ ***Improved integration of locally produced renewable (solar) electricity***
- ✓ ***Reduced cost for grid usage and electricity supply***

Most users provided time-wise flexibility with realistic indications of the duration of their stay.

If users arrived later during the day (i.e. after solar noon), smart charging was not beneficial compared to instant charging.



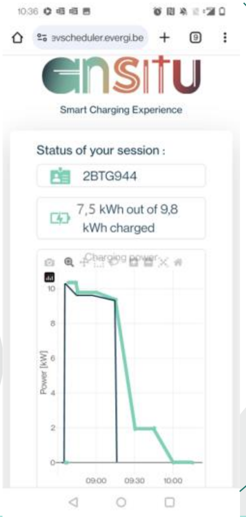
Intuitive Smart Charging Services

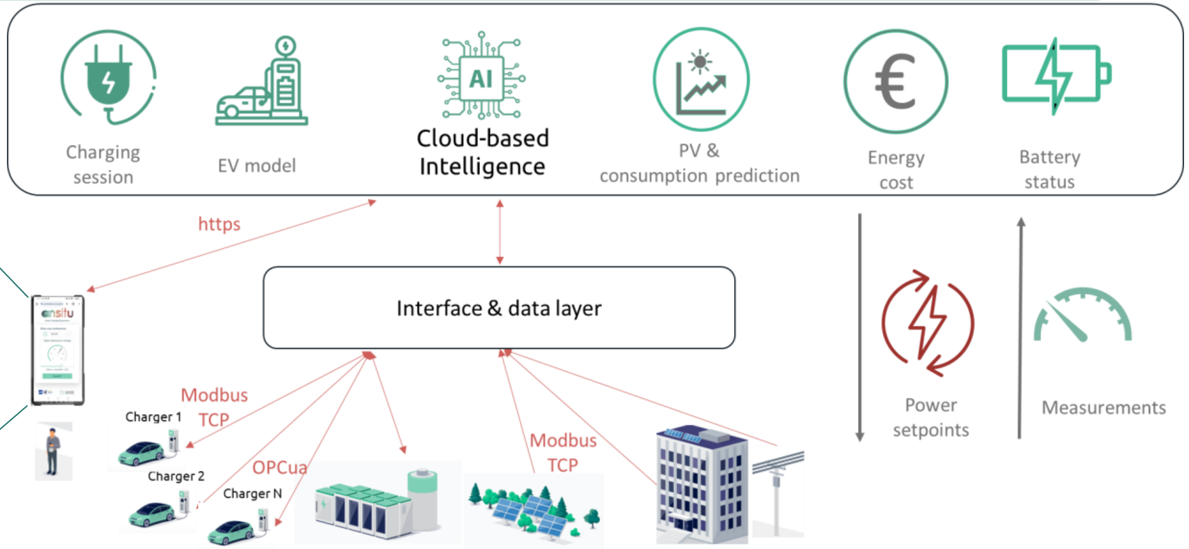
Demonstration site : Zellik, VUB

Objective : Reduce electricity cost and peak loads

Main development achievements :

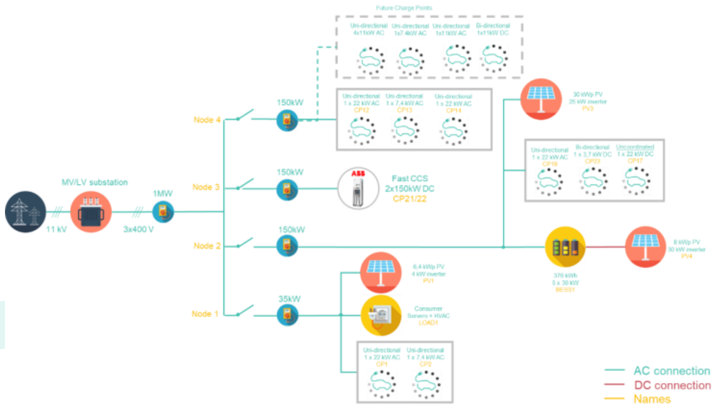
- *Integration of 2x150kW DC ABB charger*
- *Integration of BESS into energy management system*
- *Enhanced driver interface*
  - *Charging preferences*
  - *Session status*





Demonstration infrastructure

- ✓ *2x150kW ABB DC fast charger*
- ✓ *4x11kW Alfen AC CP*
- ✓ *3x11kW, 2x7.4kW AC ABB CP*
- ✓ *1x 376kWh BESS*
- ✓ *1x30kWp, 1x6.4kWp, 1x8kWp PV*



Intuitive Smart Charging Services

*Demonstration site : **Zellik,** VUB*

Objective : Reduce electricity cost and peak loads

Main key results :

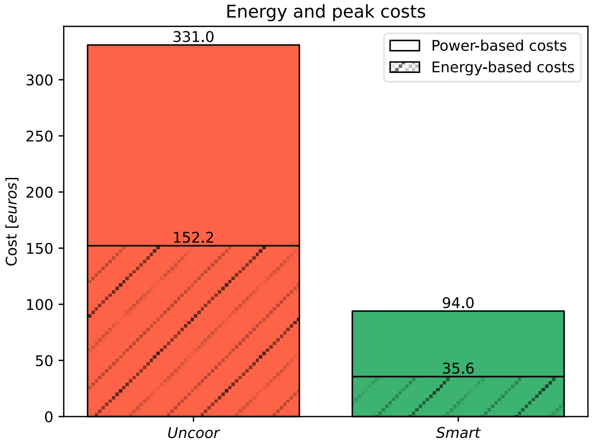
4 Months demonstration

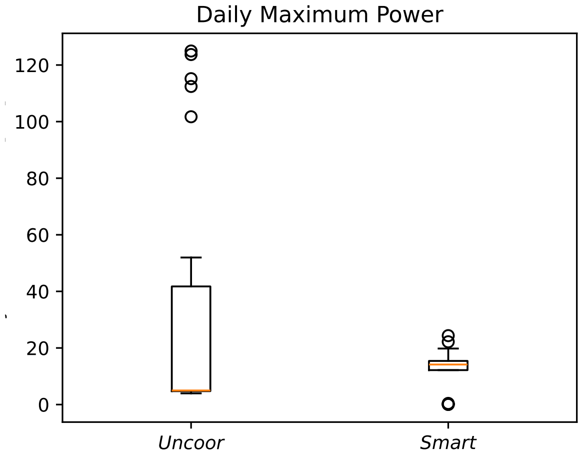
200 charging sessions from 35 drivers

KPI comparison to simulated system without BESS and no smart charging (“uncoordinated”)

Introduction of battery with smart charging service allows to:

- *Drastically reduce peak powers*
- *Reduce electricity costs (both energy-based and power-based)*
- *Self-consumption & self-sufficiency is increased significantly*





Lessons learned

- ✓ *Cost-effectiveness and performance of smart charging system is very dependent on use case (sizes of loads, PV, BESS, aggregated charging power)*
- ✓ *BESS has big effect on peak powers and electricity cost but has to be evaluated on TCO basis for cost-effectiveness . At current BESS prices & power-based tariffs, BESS is not cost-effective.*
- ✓ *Good information to driver is key if you want to engage them into smart charging (due to additional actions required and perceived loss of comfort). Financial incentives would help to engage drivers.*

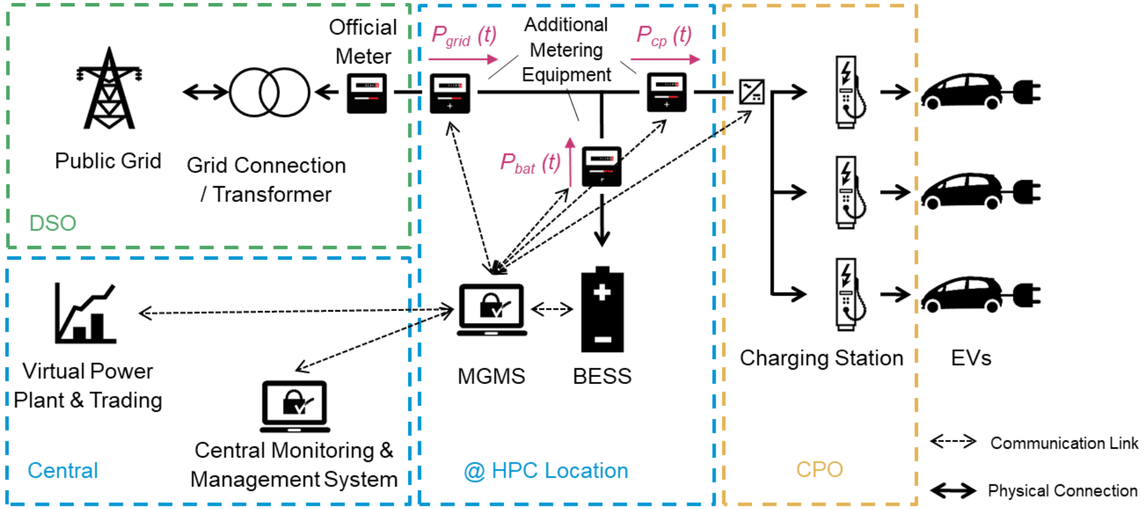
Intuitive Smart Charging Services

Demonstration site : Innsbruck, SMATRICS & VERBUND

Objective : Provision of additional Power for HPC

Main development achievements

VERBUND has upgraded the hard- & software of the micro-grid management system (MGMS), which controls the power flows at the high-performance charger-location of SMATRICS in Innsbruck. The location was equipped with a stationary battery energy storage system (BESS) as part of the CEF-Study SYNERG-E. An additional communication link between the chargers and the micro grid management system allows dynamic allocation of power from the stationary energy storage system and chargers and thus better service to the CPO and charging EV-drivers at the location by providing additional power and lower grid costs.



Demonstration infrastructure

Location (City / Country)	Innsbruck / Austria
GPS Coordinates (Lat DD, Lon DD)	47.2581984, 11.37595191
Core Network Corridor / Urban Node	Scandinavian-Mediterrenean
HPC location partner / CPO	SMATRICS
HPC type	HYC x 300 kW
Date of Installation	18.07.2023
Battery Energy Storage System	
Type	Lithium-Ion / NMC
Size (Power / Capacity)	500 kW / 500 kWh

Intuitive Smart Charging Services

Demonstration site : Innsbruck, SMATRICS & VERBUND

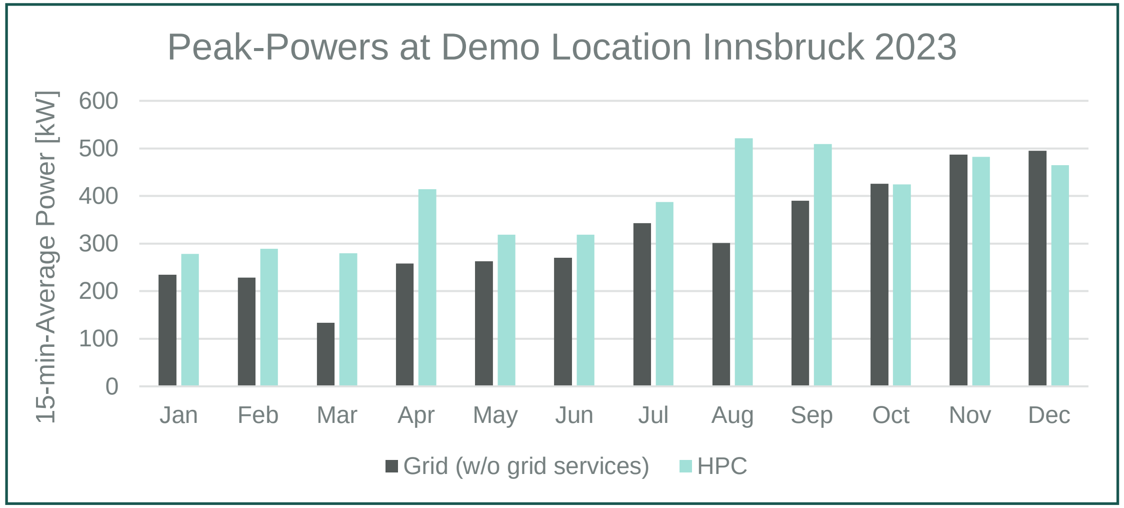
Objective : Provision of additional Power for HPC

Main key results :

Period of demonstration : 1.1. – 31.12.2023

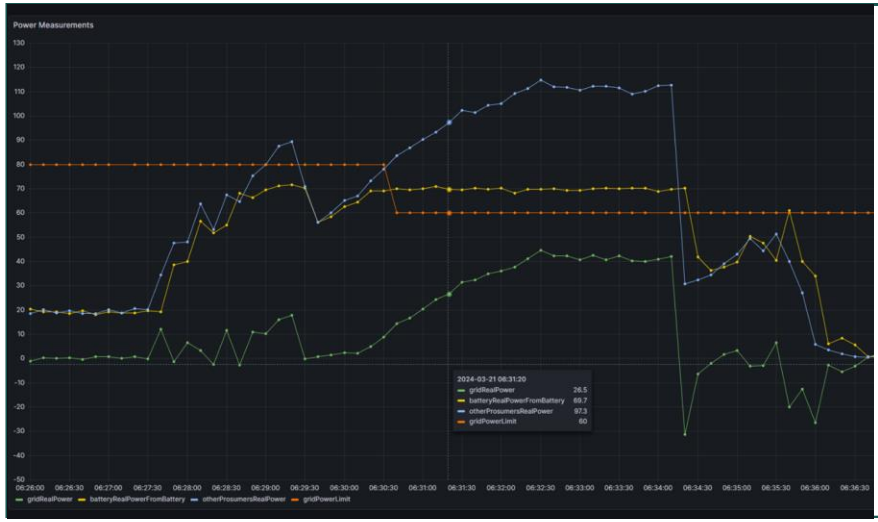
*Main KPI analysis : **Reduction of HPC peak-power needs at grid connection of up to 300 kW (15-minute-average) possible***

The peak-shaving service by the BESS can be clearly seen in the figure, as for most of the months the peak power of the HPC (light green) is higher than the achieved respective peak power at the grid connection point without grid services (dark green).



Lessons learned

- ✓ *A co-located stationary BESS at a HPC location can contribute to lower the peak-power demand from the grid by peak-shaving and provision of additional power capacity when the HPC's demand exceeds the grid connection limit.*
- ✓ *The profitability of a co-location of a stationary BESS at a HPC location is strongly dependent on the height of the grid fees during operation (€/kW), the achievable additional costs savings and revenues (e.g. from grid services) and the future price development of the BESS hardware costs.*
- ✓ *The analysis conducted based on historic demand profiles showed a negative business case at current CAPEX and OPEX prices for the BESS with current power-based grid tariffs in Austria.*



Demonstration of the provision of additional power (blue) exceeding the grid connection capacity (orange)

Intuitive Smart Charging Services

General Conclusions :

- ✓ ***Five Smart Charging EMS systems** were developed and successfully deployed by different Partners in the demonstration sites : Luxembourg, Zellik, Innsbruck, Barcelona and Chambéry.*
- ✓ *Benefits provided by Smart Charging EMS Solutions :*
  - ✓ *By taking the "**User preference**" as a center in the design, the **optimal charging profiles** are computed for better EVCI management.*
  - ✓ *Improved the **self production ratio** with maximizing of EV charging by solar energy locally produced.*
  - ✓ *Reduced globally the **charging cost** with solar energy.*
  - ✓ ***No degradation** of charging service to the EV users observed during the demonstration period.*
  - ✓ ***Good satisfaction** from EV users*
  - ✓ *Drastically reduced **peak powers** with the integration of BESS in the PV&EVCI and can be reduced the electricity costs.*
  - ✓ *A co-located BESS at a HPC location can contribute to **lower the peak-power** demand from the grid by peak-shaving and provision of additional power capacity when the HPC's demand exceeds the grid connection limit.*
- ✓ *Smart charging EMS system continue to operate to this day and after the end of the project for certain demonstration sites (e.g. Chambéry).*
- ✓ ***In perspective, looking for new CPO partners for commercialization of the solution developed and demonstrated***

Thank you for your attention !

eCHARGE 4DRIVERS

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