CIRCE is energy

31 YEARS OF R&D&i SERVICE TO COMPANIES, THE SOCIETY AND THE ENVIRONMENT

MISSION

To improve the competitiveness of **companies** by generating and transferring **technology** through market-oriented R&D&I and training activities in the field of sustainability and resource efficiency, energy networks and renewable energies.

We are a technology centre funded in 1993, seeking to provide innovative solutions for a **SUSTAINABLE DEVELOPMENT**.

Our research centre consists of a highly qualified and multidisciplinary team, composed by **more than 300 professionals**.

We work towards improving the competitiveness of enterprises through generation of technology transfer by means of R+D activities and market-oriented training within the field of resource sustainability and effectiveness, energy grids and renewable energies.

CIRCE's purpose is to anticipate and transfer technological solutions for their sustainability and competitiveness.

CIRCE in 2024

RESEARCH

+11 M€
Competitive Funds Executed

TRANSFER AND SERVICES

+9 M€
Private Turnover Volume

+25%
Annual Growth

TALENT

+300
Employees

+30
Doctors

EDUCATION

210
Training Courses

+500
Students

11377
Training Hours

Activity lines

INNOVATION FOR THE INDUSTRIAL SECTOR

01

RENEWABLE ENERGY

WIND

SOLAR

BIOMASS

RENEWABLE ENERGY INTEGRATION IN GRID

02

FUTURE ELECTRIC GRIDS

ELECTRIC NETWORKS

ICTs

SMART GRIDS

POWER ELECTRONICS & ENERGY STORAGE

03

SMART MOBILITY

ELECTRIC VEHICLE

SUSTAINABLE MOBILITY

04

INDUSTRY 4.0

COMBUSTION

ICTs

MONITORING

05

ENERGY EFFICIENCY

INDUSTRIAL ENERGY EFFICIENCY

SUSTAINABLE CONSTRUCTION

SOCIAL ENERGY RESPONSIBILITY

06

CIRCULAR ECONOMY AND SUSTAINABILITY

EFFICIENT USE OF THE RESOURCES

WASTE & EMMISSIONS REDUCTION

SUSTAINABLE ECONOMY

ENVIRONMENTAL, ECONOMIC AND SOCIAL IMPACT ANALYSIS

Research

LEADERS IN APPLIED COLLABORATIVE R&D

74 Horizon 2020 projects
> 22 coordinated

31 Horizon Europe projects
> 7 coordinated

+50% success ratio in the Project proposals completely elaborated by CIRCE

Participation in other European programs
> Interreg SUDOE
> Erasmus+
> Art. 185 EMPIR

Participation in national calls
> Cervera Centros Tecnológicos
> Convocatorias CDTI

+100 million €

for our partners in the European projects CIRCE coordinates

CHAdeMO V2G charger INCIT EV PROJECT

ANTONIO M. MUÑOZ-GÓMEZ– amimunoz@fcirce.es

15/10/2024 · ONLINE

INCIT EV

Overall Project Introduction

CHAdeMO

circe TECHNOLOGY CENTRE

INCIT-EV is a European project **led by CIRCE** in which **electric vehicle charging technologies** are developed and validated in **five European countries**, thus improving the user's perception of electric mobility.

REFERENCE CITIES IN EUROPE

INCIT-EV PROJECT

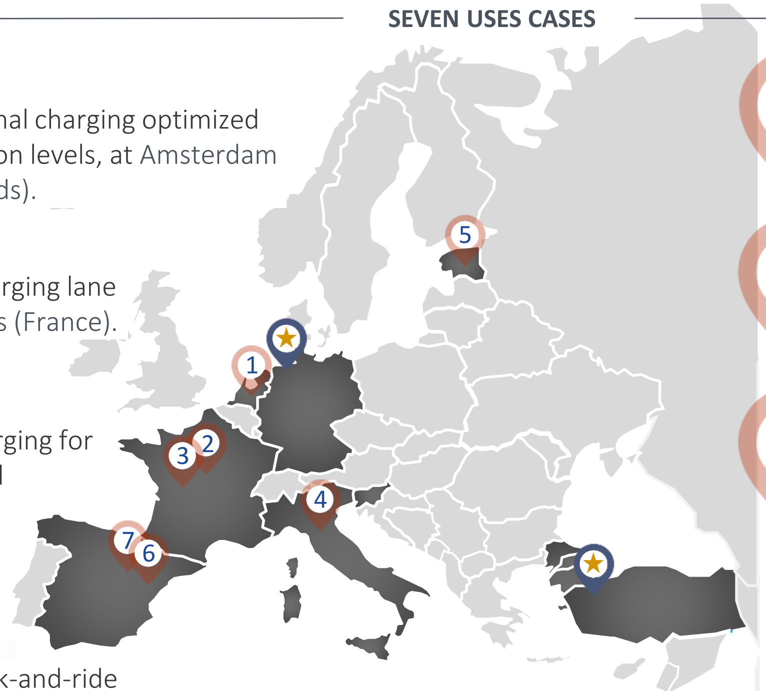
SEVEN USES CASES

UC1
Smart and bi-directional charging optimized at different aggregation levels, at Amsterdam & Utrecht (Netherlands).

UC2
Dynamic wireless charging lane in urban area, at Paris (France).

UC3
Dynamic wireless charging for long distance – e-road prototype, at Satory (Versailles, France).

UC4
Charging hub in a park-and-ride facility, at Turin periphery (Italy).



UC5
Superfast charging systems for European corridors, at Tallinn periphery (Estonia).

UC6
Low power DC bidirectional charging infrastructure for EV, including two-wheelers, at Saragossa (Spain).

UC7
Opportunity wireless charging for taxi queue lanes in airports/central stations, at Saragossa (Spain).

TWO FOLLOWER LOCATIONS

Bursa (Turkey)

Norderney (Germany)

INCIT-EV

INCIT-EV in figures

18,6M€ budget
15M€ funded by the European Commission
32 partners are directy involved in the project
52 months long. January 2020 - June 2024
More than 7 innovative solutions

INCIT-EV

Comsortium

CIRCE coordinates the INCIT-EV project, to improve the experience of electric vehicle (EV) driving with a consortium of **33 partners from 8 countries**

Use cases deployment and demonstration Summary

CHAdeMO

UC-6 "Low power DC bidirectional charging infrastructure for EV, including two-wheelers"

circe

CIRCE V2G EV charger with CHaDeMO and CSS2.

idneo

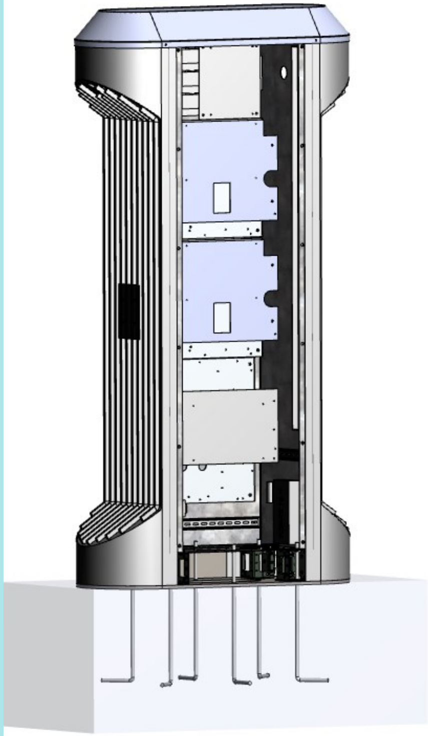
IDNEO designed a light electric vehicle rack.

Zaragoza
AYUNTAMIENTO

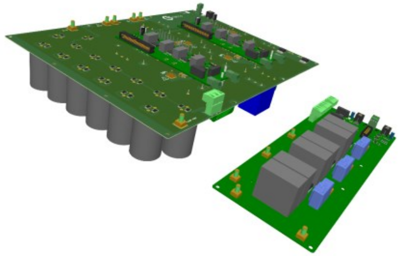
Low Power DC Bidirectional Charging in Zaragoza 25kW CHAdeMO + CCS Charging Station.

25 kW V2G charging station:

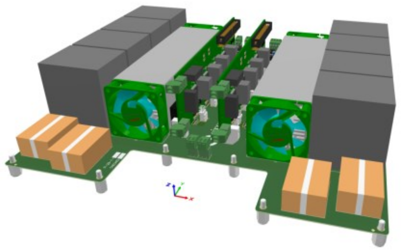
- 25-kW bidirectional charger
- CHAdeMO & CCS
- Power electronic based on SiC with galvanic isolation

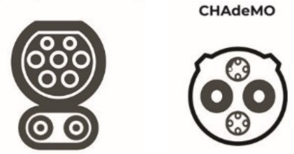


AC/DC



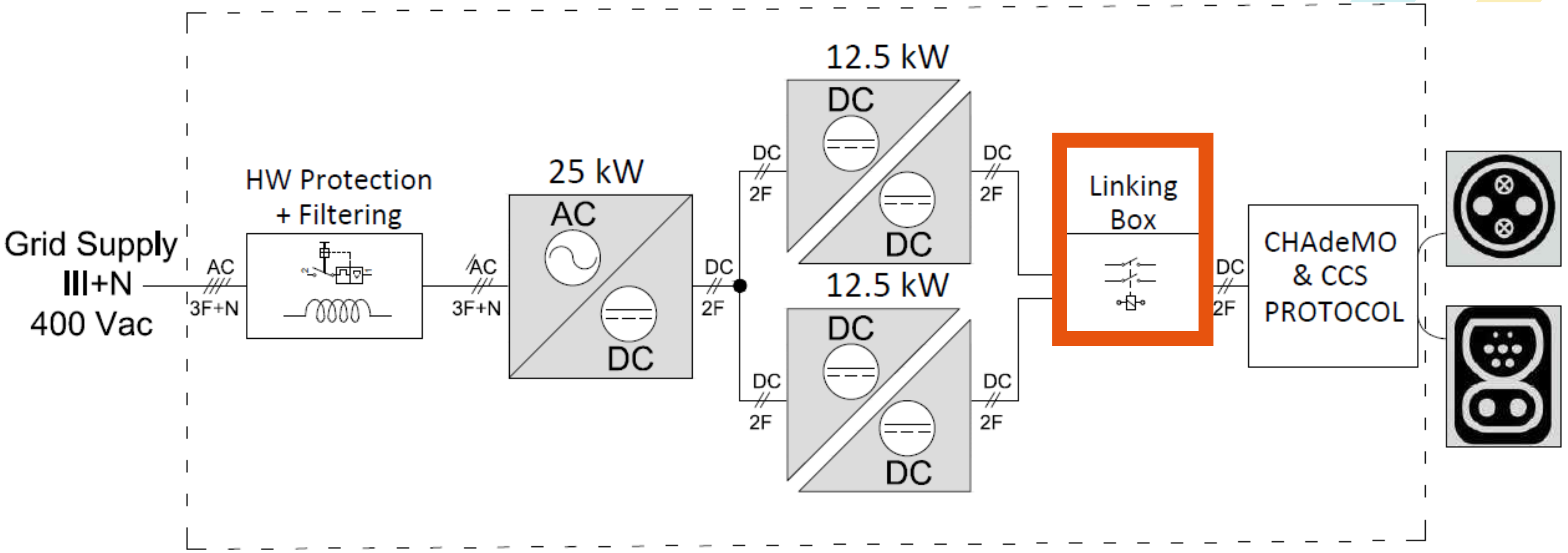
DC/DC





Low Power DC Bidirectional Charging in Zaragoza
25kW CHAdeMO + CCS Charging Station.

The charging station is internally divided into a 25 kW AC/DC and two 12.5 kW DC/DC converters to provide a modular, scalable, and cost-effective proposal.

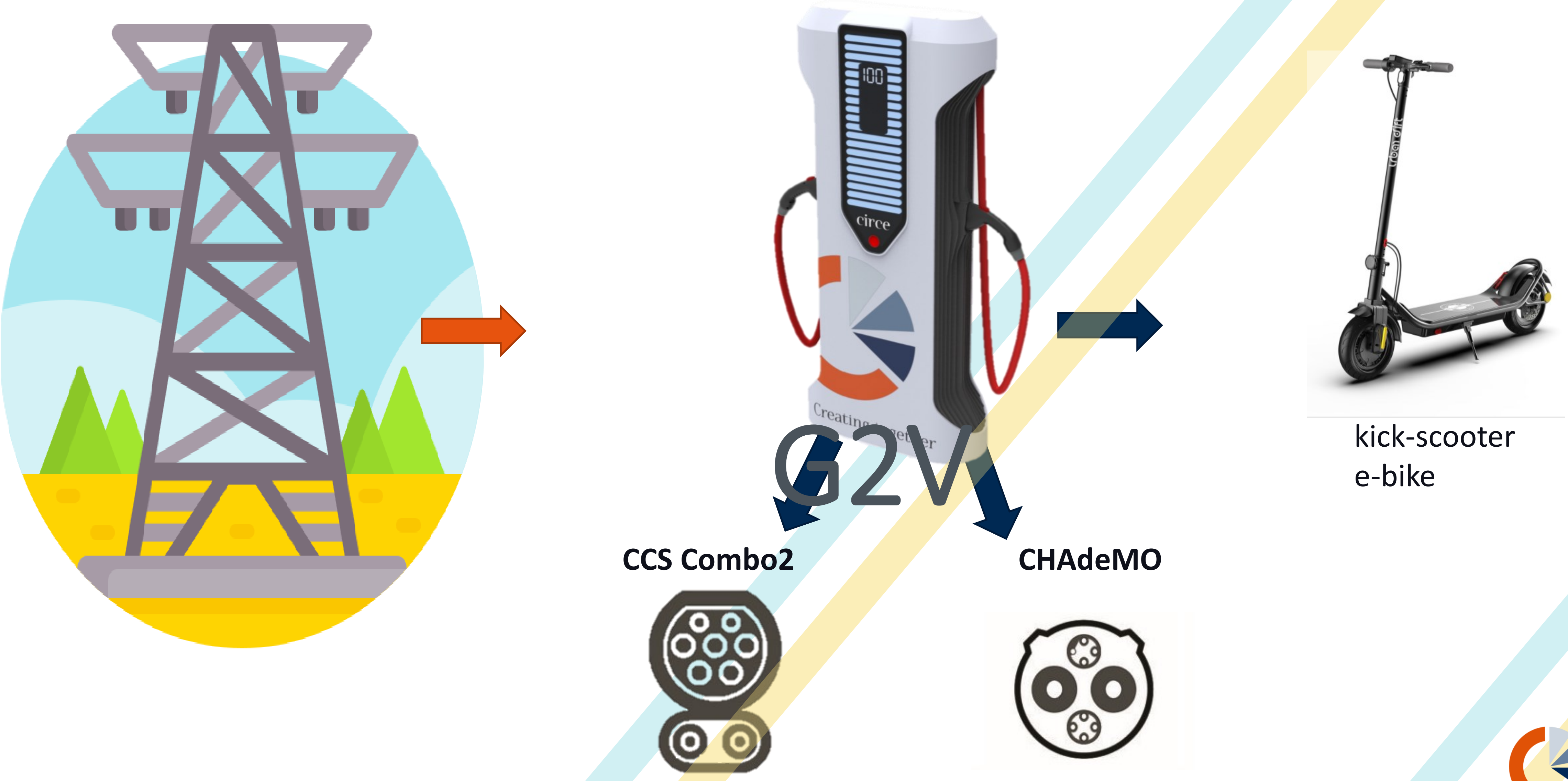


CCS or CHAdeMO DC/DC
- **parallelized**
- **serialized**

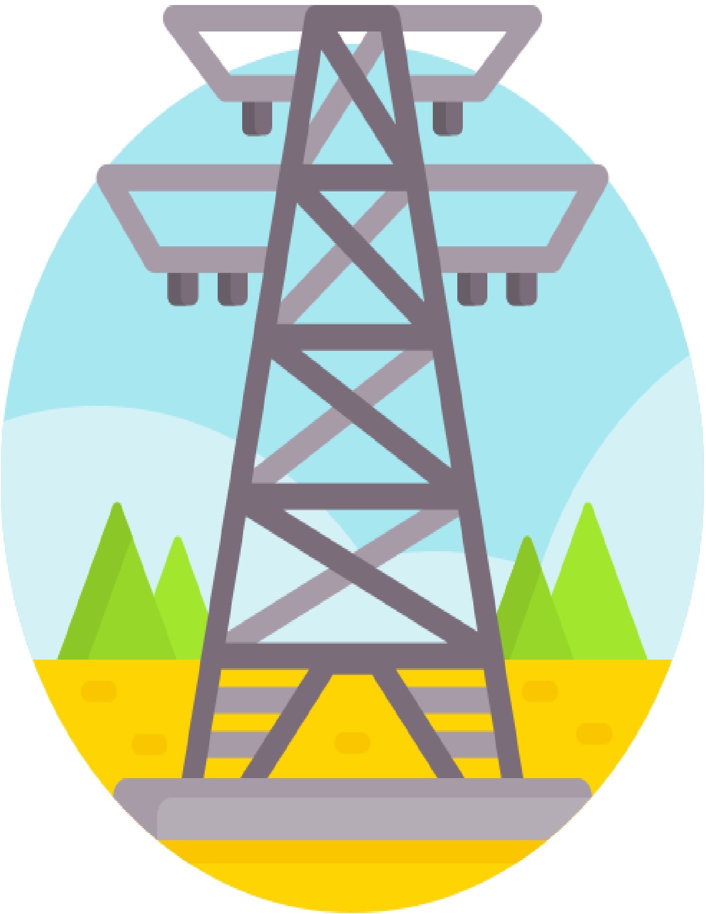
Benefits:

- During charging protocol **handshaking,** the output can be configured as
  1000Vdc with half-current (25kW)
  500Vdc with full-current (25kW)
- Full power at **25kW** reached at 800Vdc or at 400Vdc **without component oversizing**.

Use cases deployment and demonstration in areas. Tests



Use cases deployment and demostration in areas. Tests



V2G

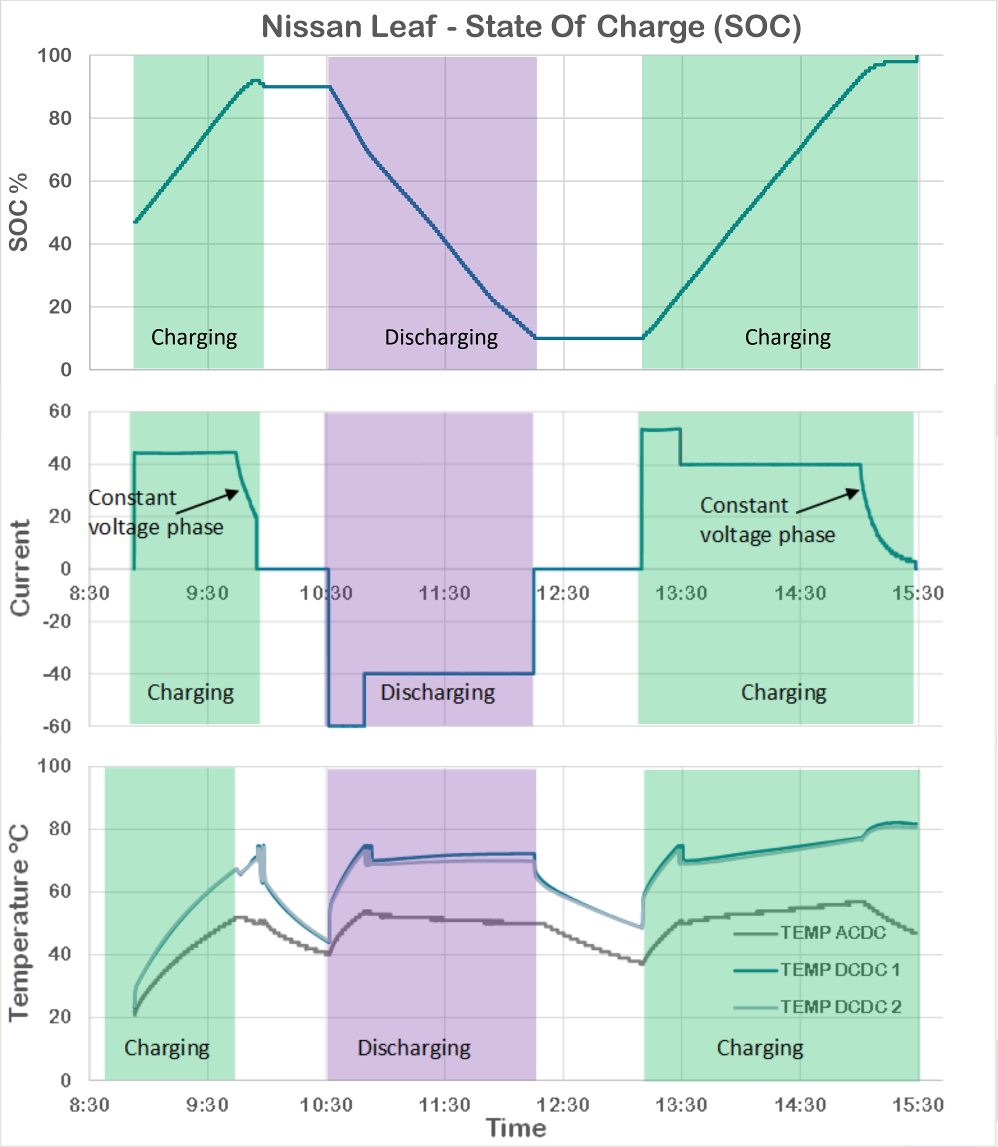
kick-scooter
e-bike

CCS Combo2

CHAdeMO

Low Power DC Bidirectional Charging in Zaragoza
25kW CHAdeMO + CCS Charging Station.

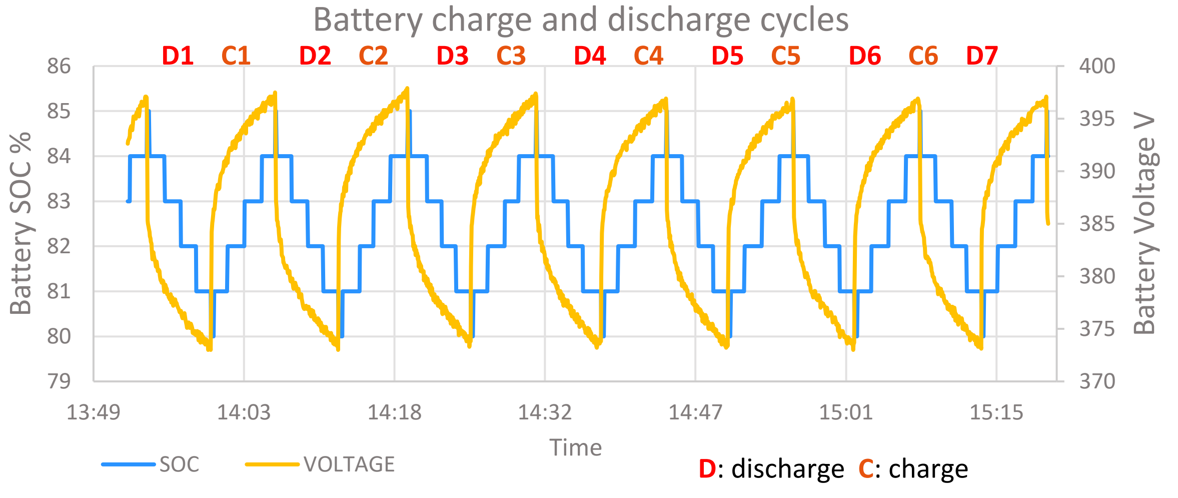
EV tested – Nisan leaf

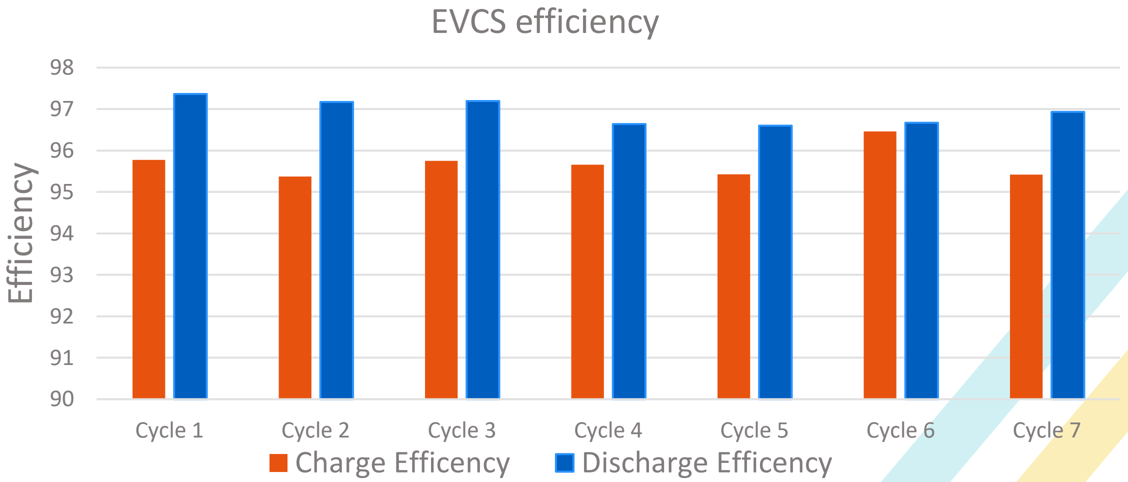


V2B services during working hours test

WP 7 – UC6 Low Power DC Bidirectional Charging in Zaragoza
25kW CHAdeMO + CCS Charging Station.

V2G Efficiency on constant current phase





Average efficiency

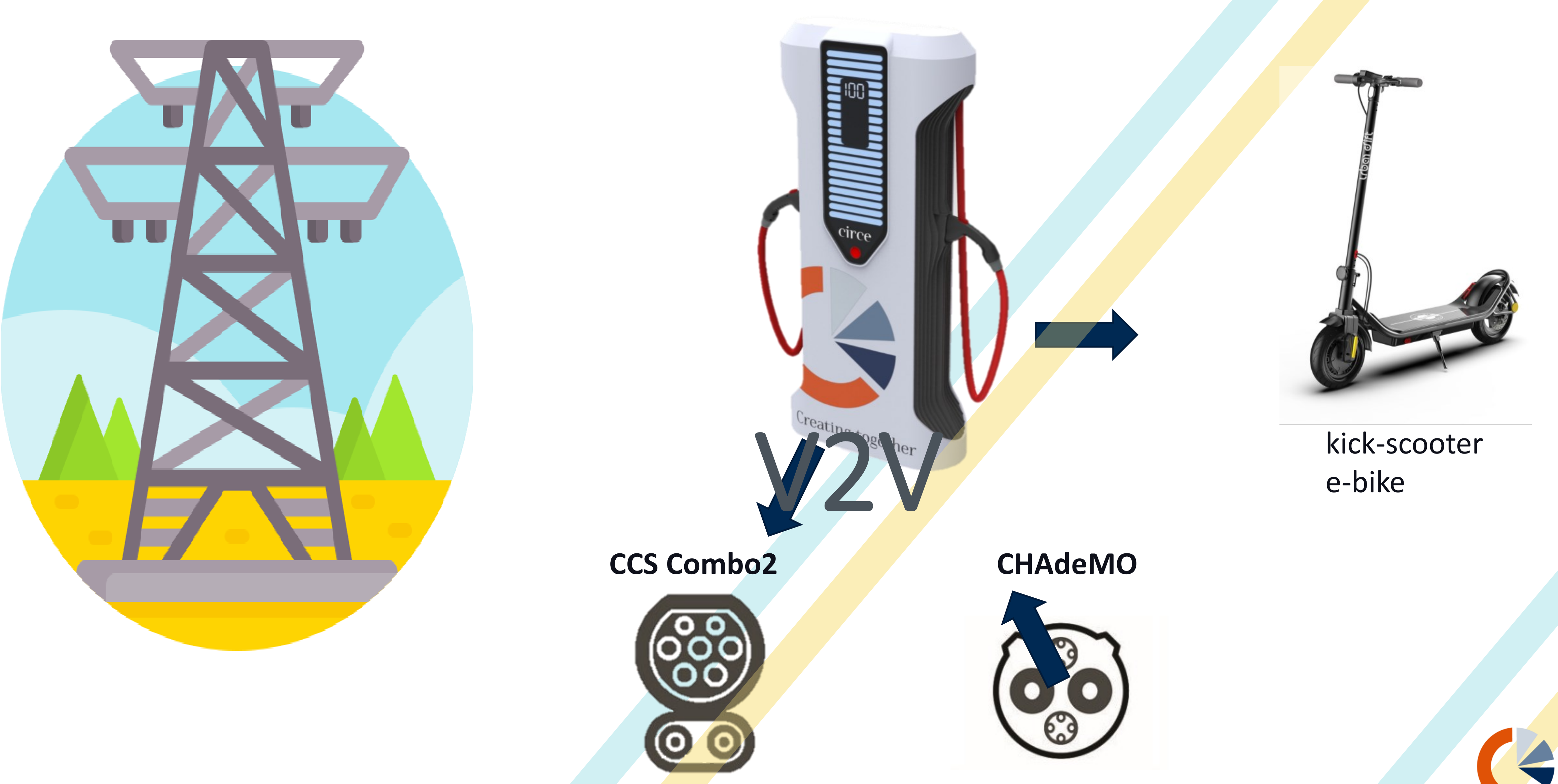
Charging (2 stages AC/DC + DC/DC) 95.69%

Discharging (2 stages AC/DC + DC/DC) 96.94%

Nissan e-nv200 battery (80 to 85% SOC) 95.88%

Consequently, the complete V2G process, including the AC/DC and DC/DC stages, the batteries, and the losses on cables and connectors between the EV and EVCS, was **88.94%.**

WP07 Use cases deployment and demostration in areas.
Task 7.4: UC6 - Tests

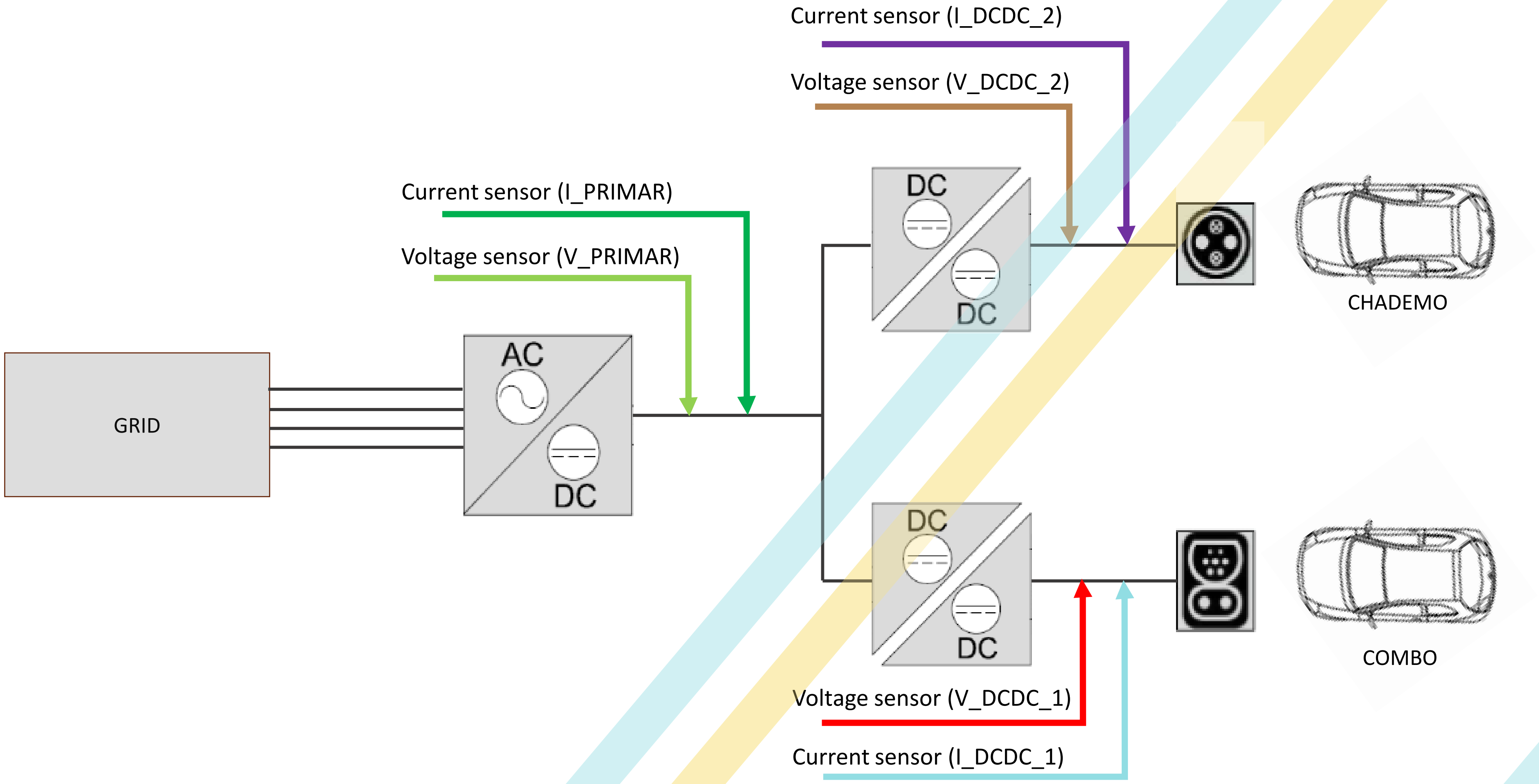


CHAdeMO + CCS V2G EV Charging Station.

V2V test with a CHAdeMO and CCS electric vehicle conducted at UC6 site.

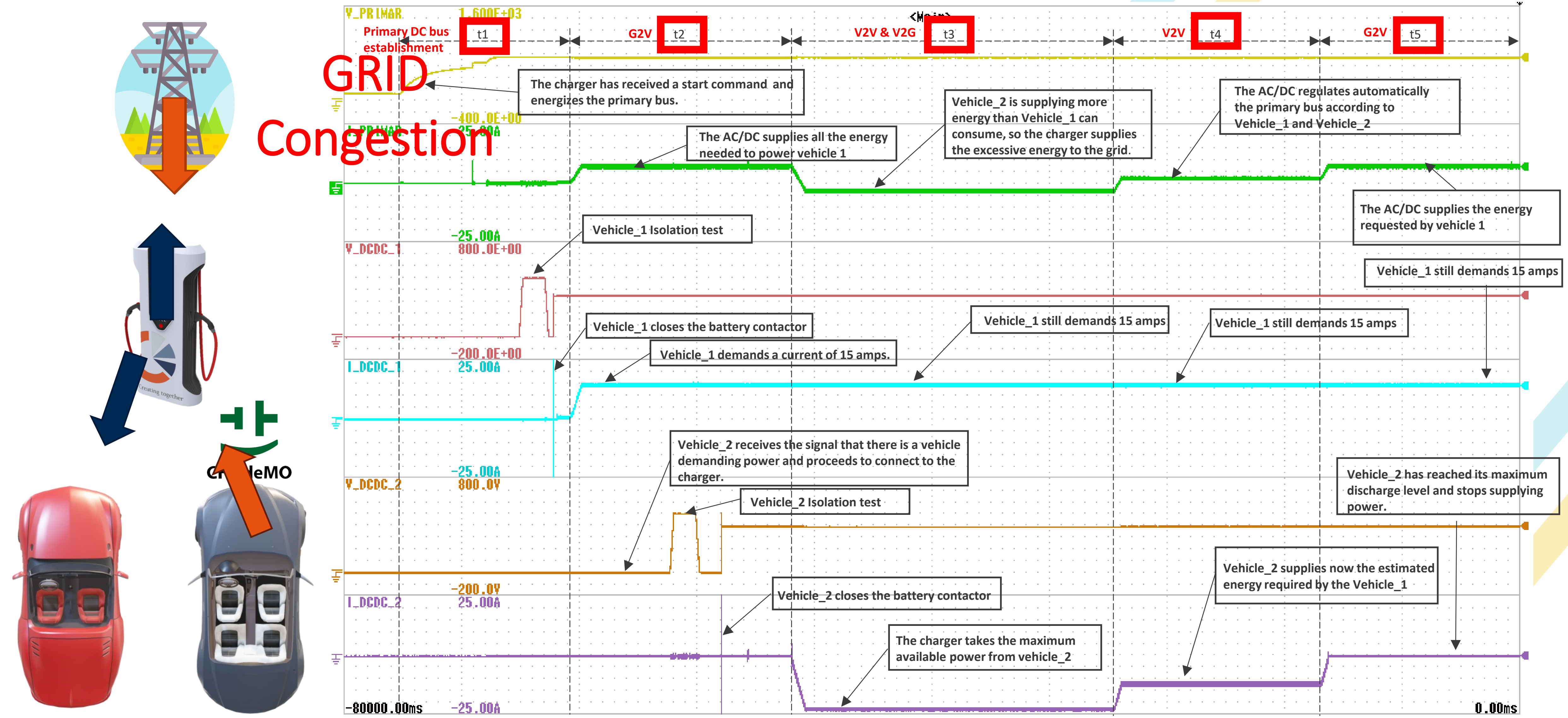
WP 7 – UC6 Low Power DC Bidirectional Charging in Zaragoza 25kW CHAdeMO + CCS Charging Station.

Tests with Zoe (CCS) and Nissan (CHAdeMO) connected to charger



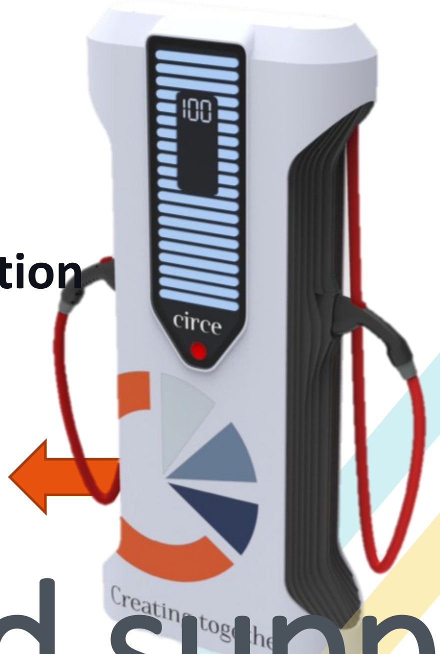
CHAdeMO + CCS V2G EV Charging Station.

Tests with Zoe (CCS) and Nissan Leaf (CHAdeMO) connected to charger



WP07 Use cases deployment and demostration in areas.
Task 7.4: UC6 - Tests

Reactive energy
Power factor correction
Phase balancing
Harmonic filter

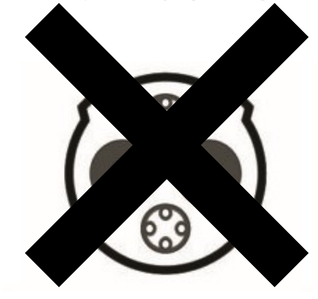


Grid support

kick-scooter
e-bike

CCS Combo2

CHAdeMO



INCIT EV

Business models

Services	Mode
1. Optimized charging & discharging based on ToU tariff	V2B
2. Peak shaving	V2B
3. Optimized charging & discharging based on dynamic tariff	V2B
4. Self-consumption of locally-produced electricity	V2B
5. Redispatch	V2B
6. In-Fleet Energy Transfer	V2V
7. Island mode	V2B
8. Vehicle-to-vehicle emergency charger	V2V
9. Power provision to end user's devices	V2L
10. Intraday Market trading	V2G
11. Frequency regulation	V2G

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CHAdeMO

CHAdeMO V2G charger for grid support functionalities INSULAE PROJECT

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15/10/2024 · ONLINE

INSULAE PROJECT

Objectives of the project

The main goal of INSULAE is to foster the **deployment of innovative solutions aiming to the EU islands decarbonization** by developing and demonstrating at three Lighthouse Islands a set of interventions linked to seven replicable use cases, whose results will **validate an Investment Planning Tool** that will be then demonstrated at four Follower Islands for the development of four associated Action Plans.

insulae

Maximizing the impact of innovative energy approaches in the EU islands

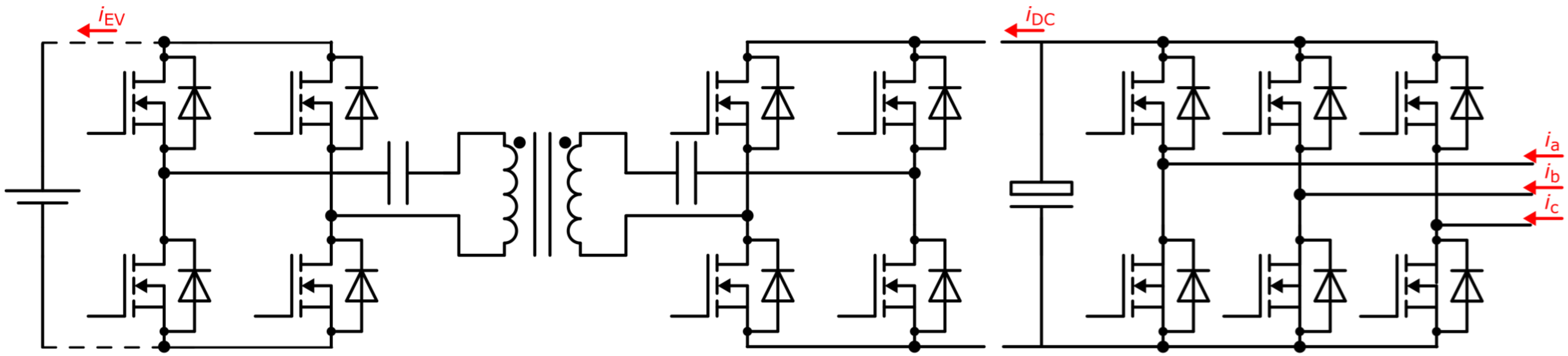
Electrification of the islands' transport looking to grid frequency and voltage regulation

The current charging infrastructure will be upgraded with four 10 kW V2G, two 50 kW quick chargers and one fully SiC 50 kW fast charger, all of them integrating new functionalities for frequency support and voltage regulation. A control system will be developed to manage all the charging infrastructure in an integrated way.

J. Munoz-Cruzado Alba, J. B. Fuertes, A. M. Munoz Gomez, J. F. Sanz Osorio and E. Laporta Puyal, "50-kW Modular V2G SiC Charger Station in Energy Island Microgrids: a Real Use-Case in Madeira Island," PCIM Europe 2022; International Exhibition and Conference for Power Electronics, Intelligent Motion, Renewable Energy and Energy Management, Nuremberg, Germany, 2022, pp. 1-9, doi: 10.30420/565822018.

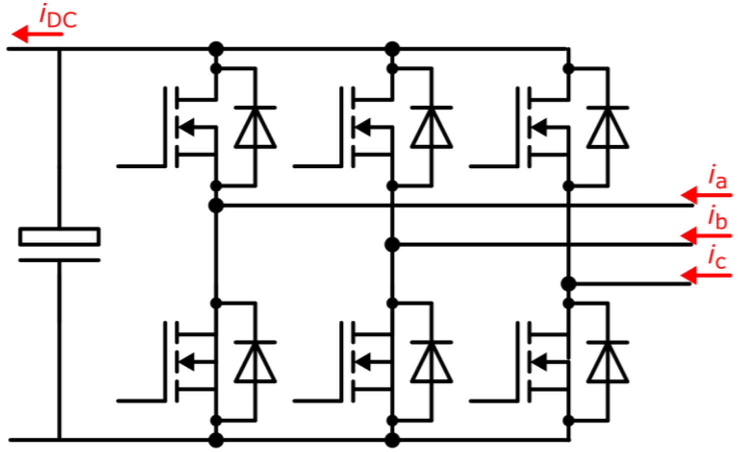
50-kW CHAdeMO V2G charger design

Charger topology



50-kW CHAdeMO V2G charger design

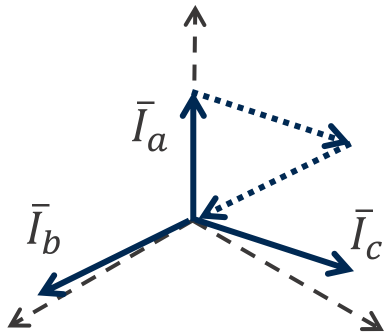
PFC for grid support



3-Phase 3-Wire PFC

$$\bar{I}_n = 0$$

$$\bar{I}_a + \bar{I}_b + \bar{I}_c = 0$$



$$\bar{I}_0 = 0$$

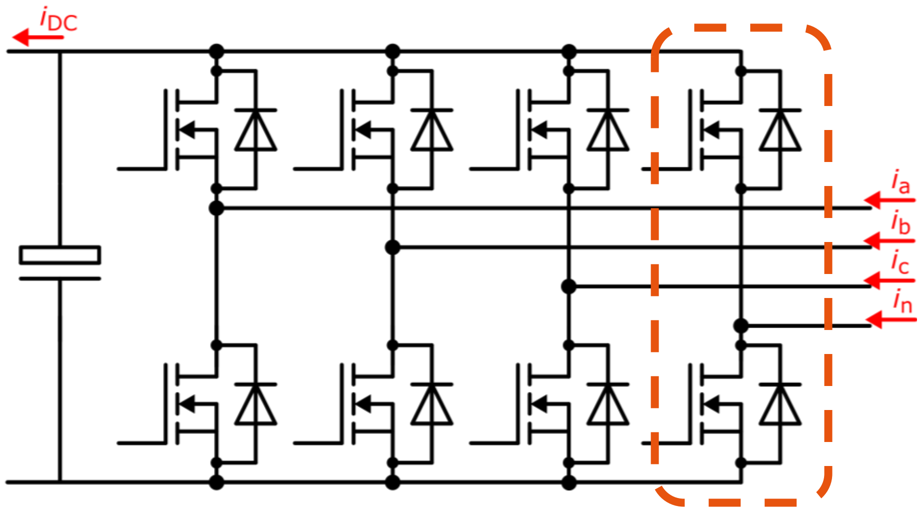
$$\bar{I}_+ \neq 0$$

$$\bar{I}_- \neq 0$$

50-kW CHAdeMO V2G charger design

$\bar{I}_c$

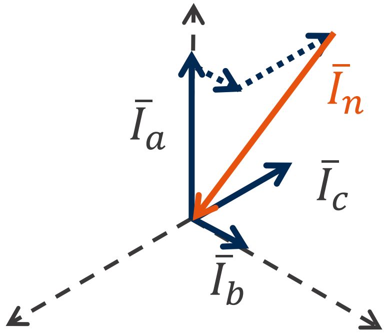
PFC for grid support



3-Phase 4-Wire PFC

$\bar{I}_n \neq 0$

$\bar{I}_a + \bar{I}_b + \bar{I}_c = -\bar{I}_n$

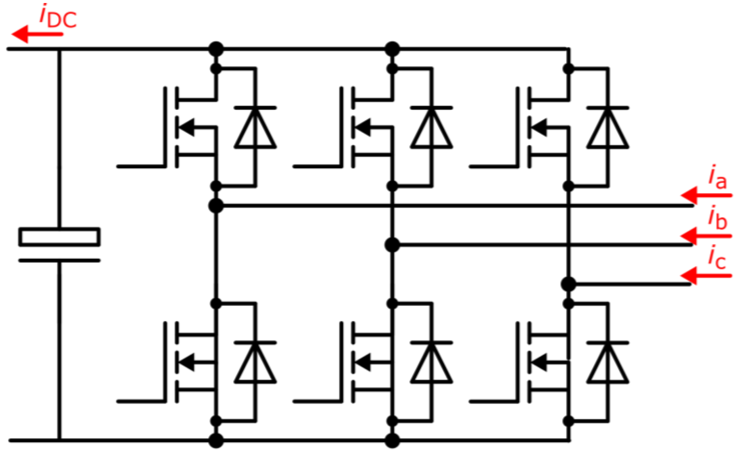


$\bar{I}_0 \neq 0$

$\bar{I}_+ \neq 0$

$\bar{I}_- \neq 0$

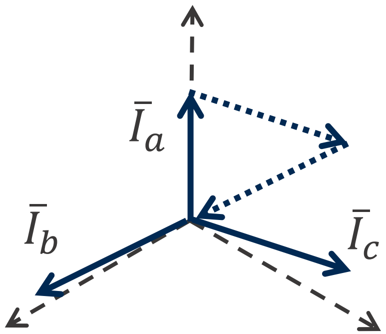
$$\begin{cases} \bar{I}_+ \cdot cos\varphi = 0 \\ \bar{I}_+ \cdot sin\varphi \neq 0 \end{cases}$$



3-Phase 3-Wire PFC

$\bar{I}_n = 0$

$\bar{I}_a + \bar{I}_b + \bar{I}_c = 0$



$\bar{I}_0 = 0$

$\bar{I}_+ \neq 0$

$\bar{I}_- \neq 0$

50-kW CHAdeMO V2G charger design

$\bar{I}_c$

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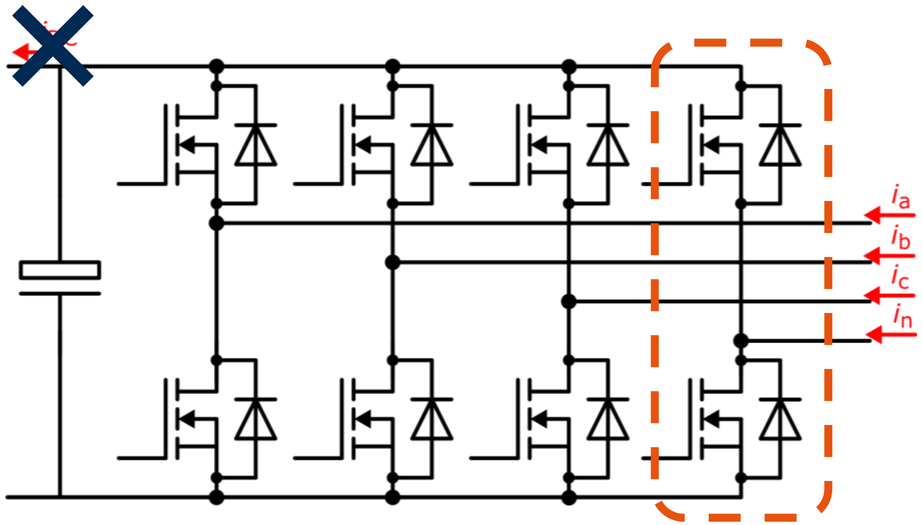
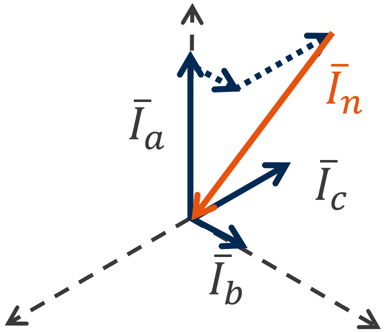
PFC for grid support



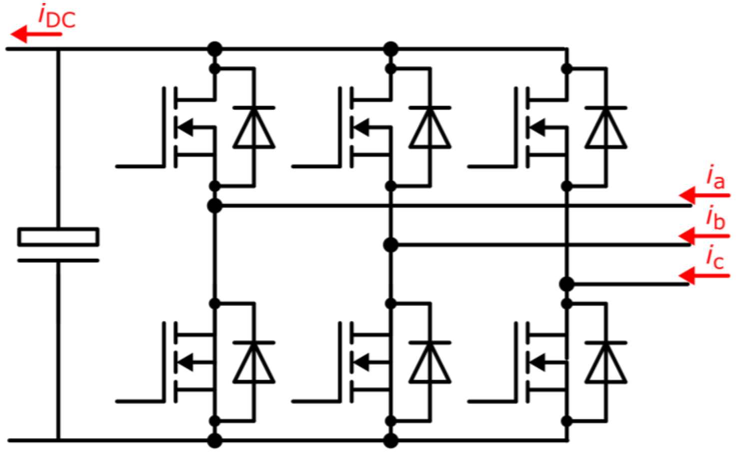
3-Phase 4-Wire PFC

$\bar{I}_n \neq 0$

$\bar{I}_a + \bar{I}_b + \bar{I}_c = -\bar{I}_n$



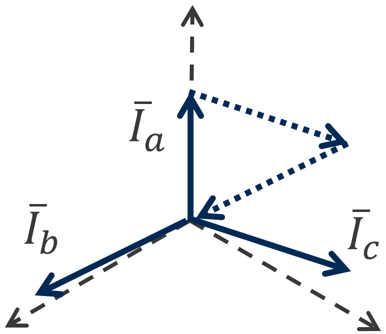
$$\forall \bar{I}_i \text{ with } i \in \{a, b, c\}, \quad \sum_{i=a,b,c} Pi = 0$$



3-Phase 3-Wire PFC

$\bar{I}_n = 0$

$\bar{I}_a + \bar{I}_b + \bar{I}_c = 0$



$\bar{I}_0 = 0$

$\bar{I}_+ \neq 0$

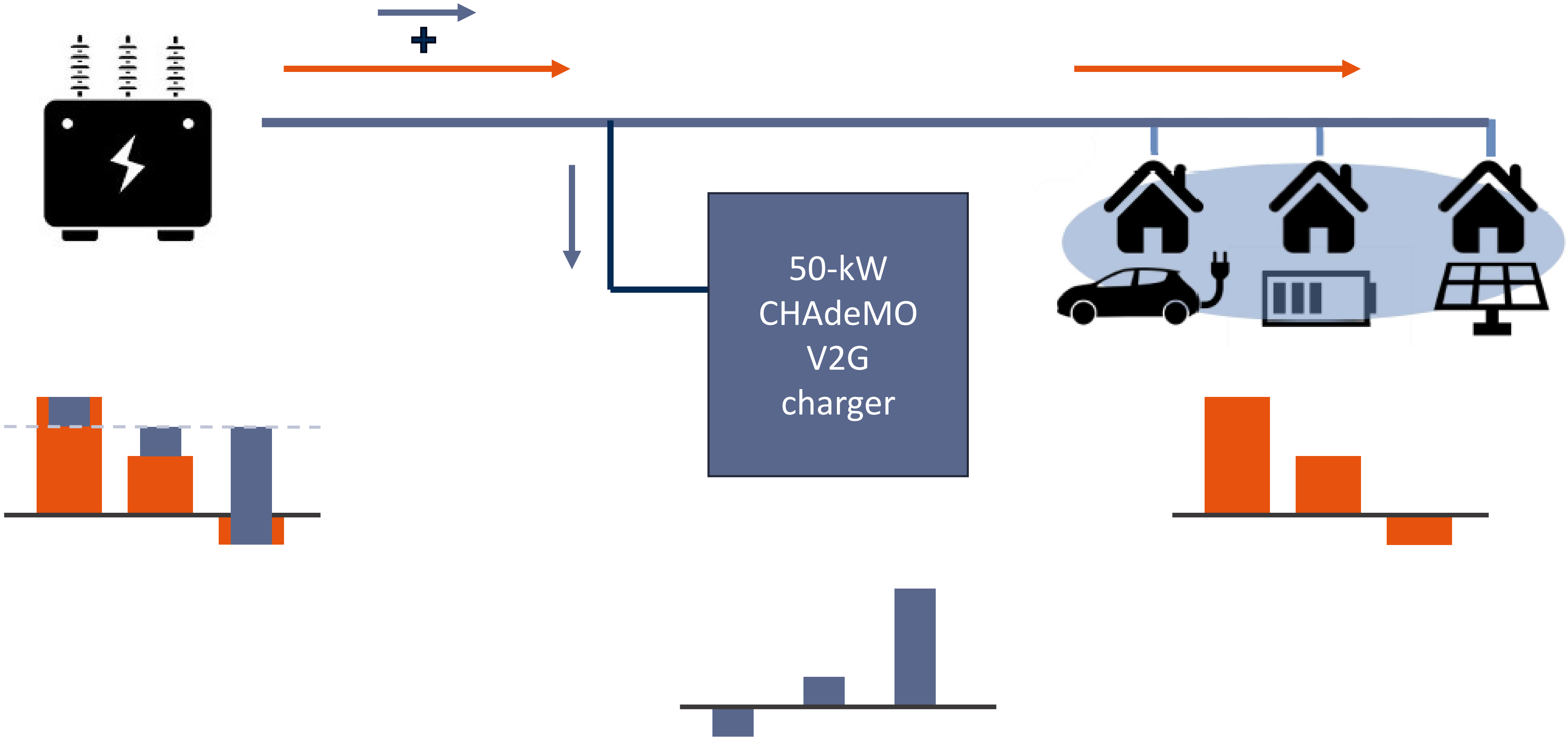
$\bar{I}_- \neq 0$

Validation

Use case

Validation

Use case



Validation

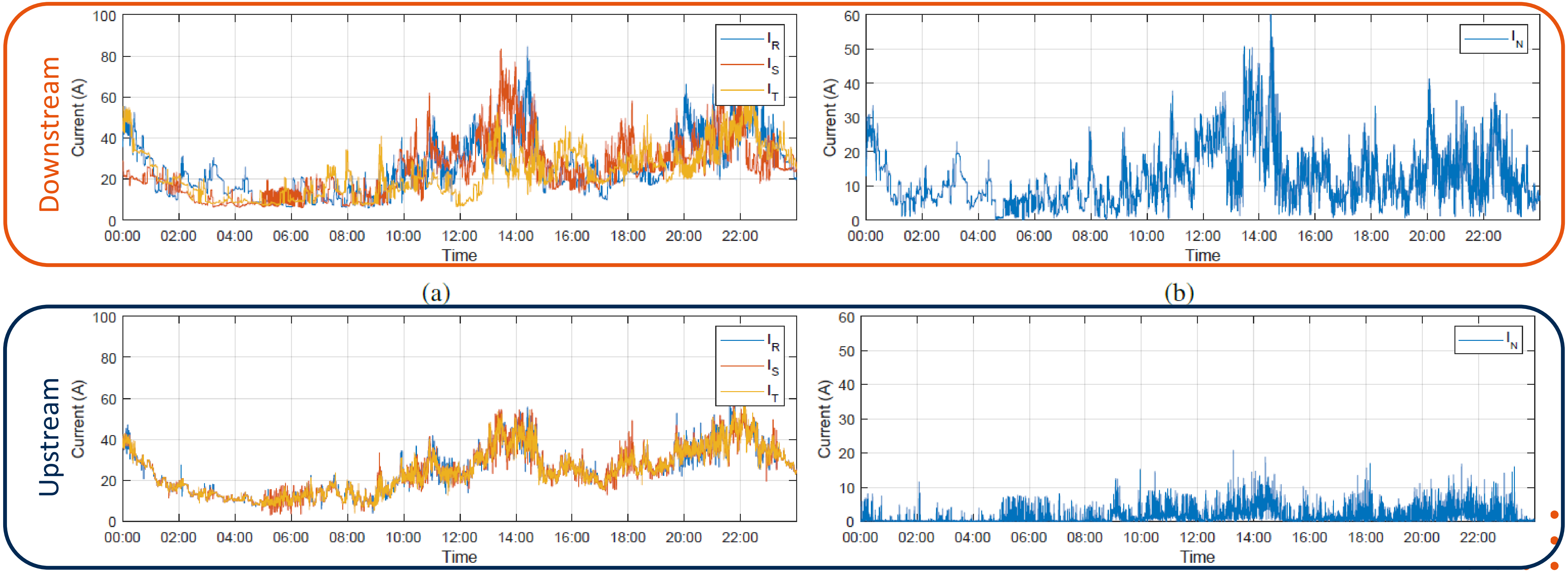
Use case

Data analyzed every 2 seconds for 4 weeks:

- Voltage at PCC
- Downstream
  - Current
  - Active power
  - Reactive power
- V2G charger
  - Current
  - Active power
  - Reactive power

Validation

Results



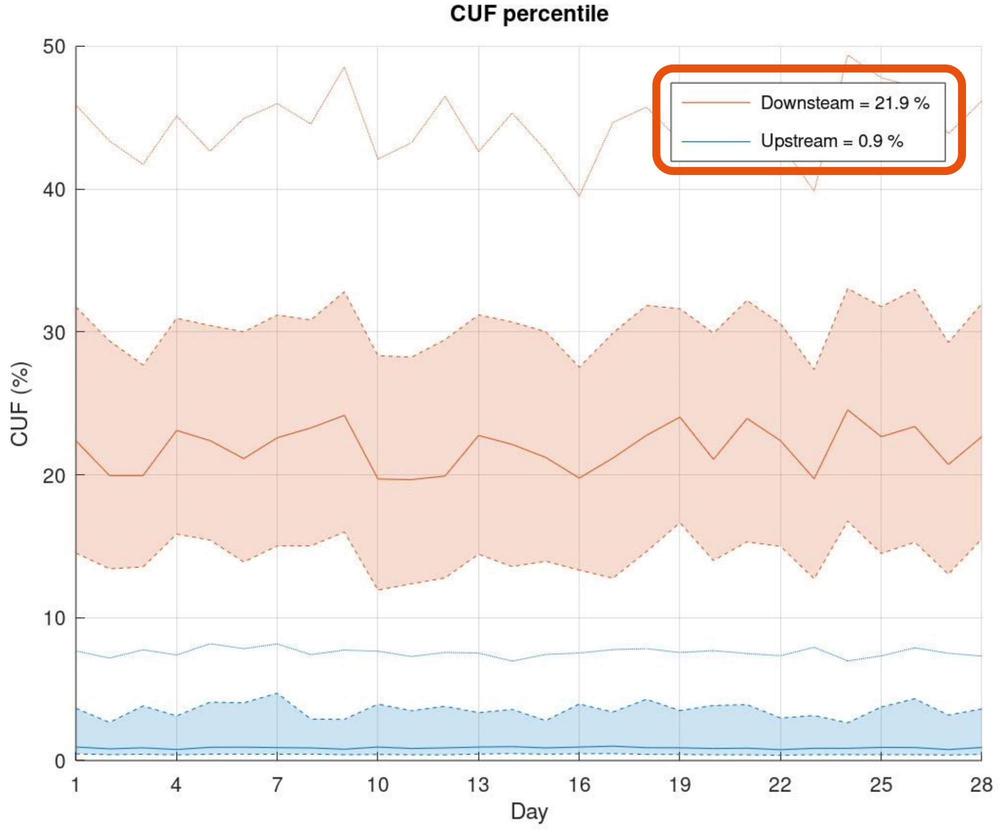
J. Ballestín-Fuertes, J. F. Sanz-Osorio, J. Muñoz-Cruzado-Alba, E. L. Puyal, J. Leiva and J. R. Rivero, "Four-Legs D-STATCOM for Current Balancing in Low-Voltage Distribution Grids," in IEEE Access, vol. 10, pp. 779-788, 2022, doi: 10.1109/ACCESS.2021.3138827.

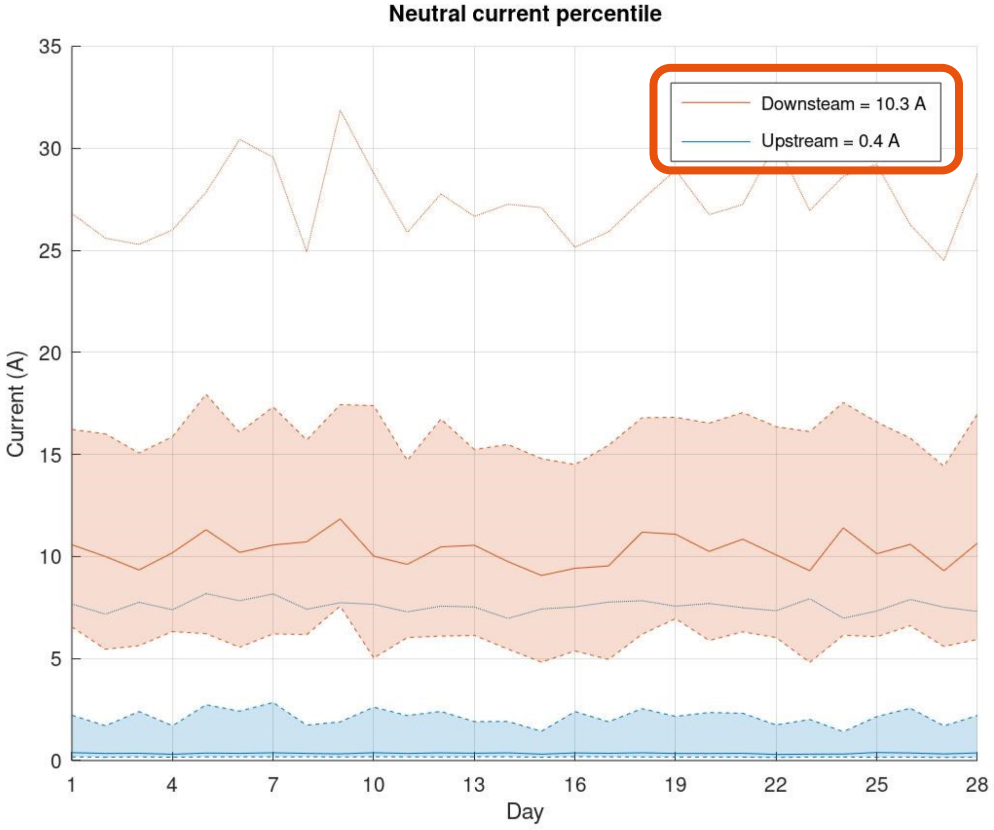
Validation

Results

$$CUF_0 = \frac{\sqrt{|I_-|^2 + |I_0|^2}}{|I_+|}$$

$$|\overline{I_N}| = |\overline{I_a} + \overline{I_b} + \overline{I_c}|$$





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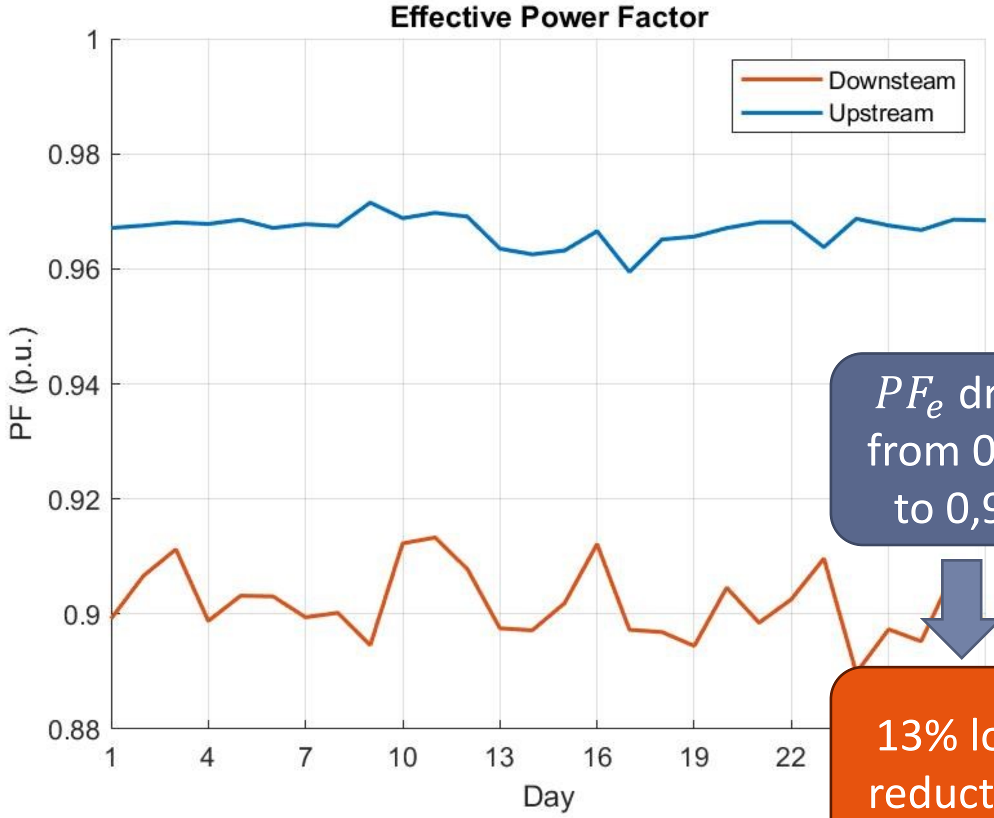
Validation

Results

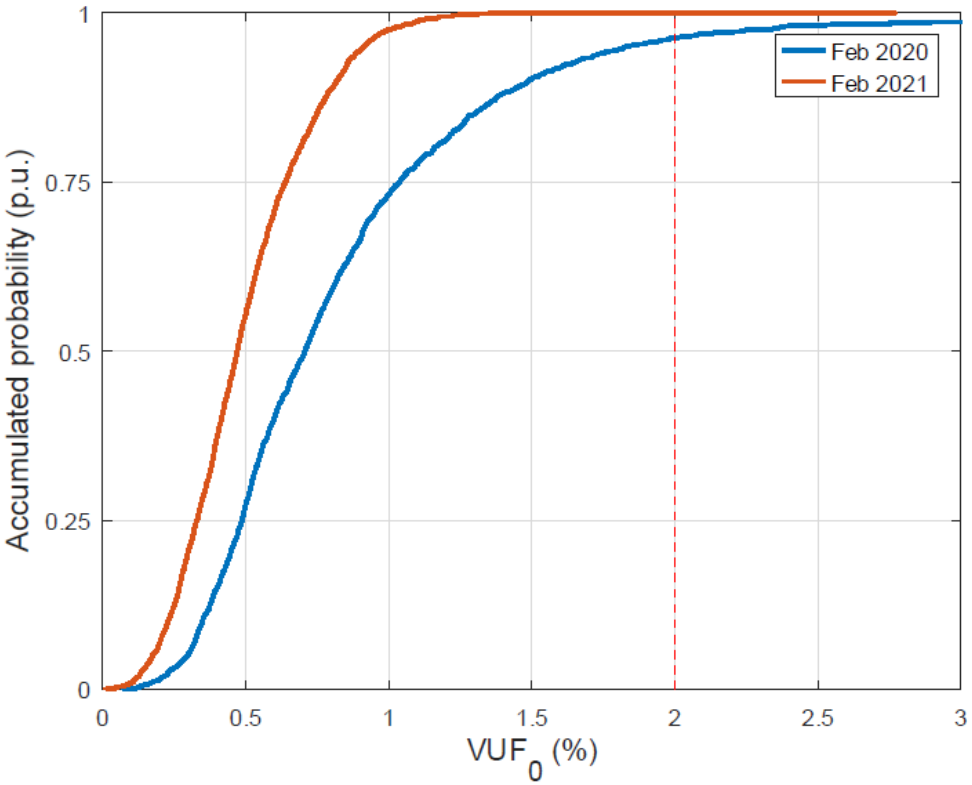
PF_e defined in IEEE 1459



PF_e drop from 0,90 to 0,97

13% lose reduction

$$VUF_0 = \frac{\sqrt{|V_-|^2 + |V_0|^2}}{|V_+|}$$



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Conclusion

- The benefits of implementing **phase balancing have been demonstrated** in a low voltage distribution network.
- The changes required to apply this technique in an EV charger are reduced and have **low impact on the cost of the charger**.
- This solution can be **easily applied to private parking** or company parking spaces due to the limited scope of the solution.
- More research and **regulation to apply it to public chargers** is required. The effects of a massive implementation of these techniques on the network should be studied and regulated to ensure the grid stability.

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Thank you for your attention

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