Electric vehicles as flexible resources in the grid – ongoing activities in ACDC and EV4EU projects

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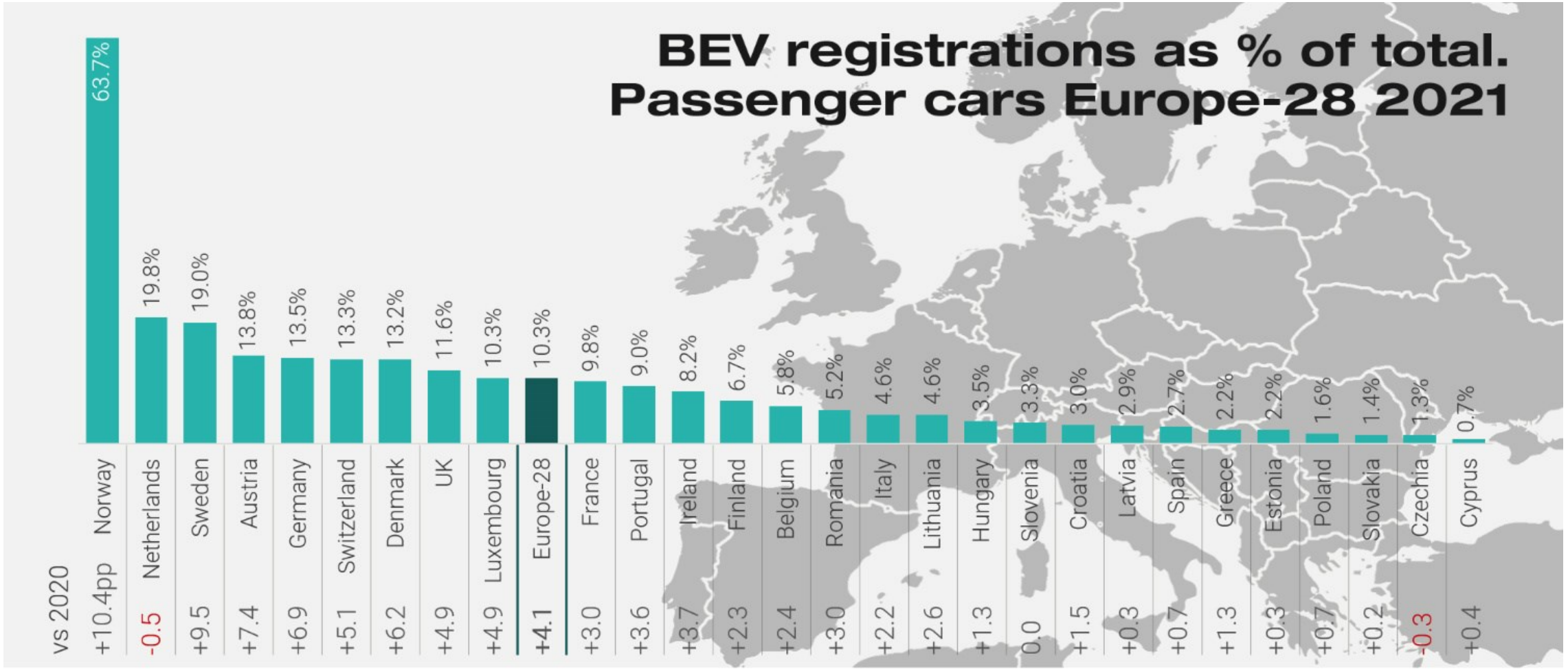
E-mobility progress in Europe (pure EVs)



JATO https://www.best-selling-cars.com/electric/2021-full-year-europe-best-selling-electric-car-models-and-brands/

Section for E-mobility and Prosumer Integration (EMP)

Electrification of mobility and other prosumers solutions are at the center of our research. This includes grid-tied power converters for the pro-active grid integration of mobility assets.

EV-technology | Charging flexibility and infrastructure | Power electronics | Battery energy systems | Hybrid AC-DC systems

https://wind.dtu.dk/Research/research-divisions/power-and-energy-systems/EDITE-mobility-and-Prosumer-Integration

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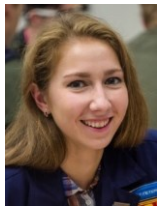

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ACDC (Autonomously Controlled Distributed Chargers) project

Project timing: April 2020 – September 2023

Overall budget: 17.7 MDKK (9 MDKK supported by EUDP)

Website: www.acdc-bornholm.eu

Project leader: Prof. Mattia Marinelli (DTU)

DTU Wind

Department of Wind and Energy Systems

Circle Consult

NISSAN

BORNHOLMS ENERGI & FORSYNING

Vestas

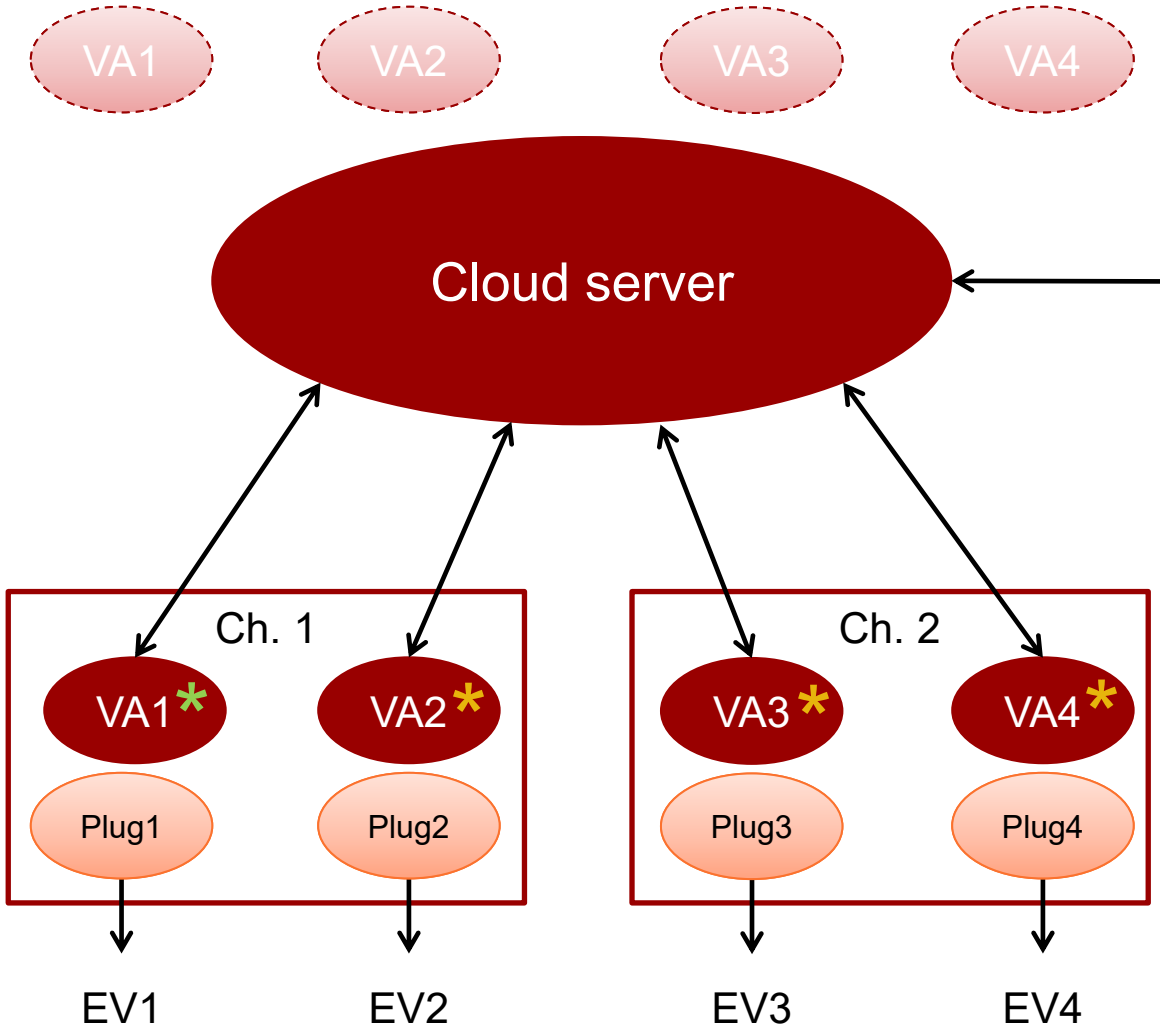
EL-NET ØST A/S

1. Domestic cases: one charger with one/two outlets 11+11 kW; Roskilde, Aarhus, Rønne

2. Parking lot cases: multiple chargers with two outlets 11+11 kW
Risø, Roskilde: 8 chargers
BEOF, Rønne: 3 chargers

3. Virtual power plant case: wind farm case with 1000 chargers (geographically distributed) with two outlets 11 kW.

Control architecture – 2 chargers 4 EVs

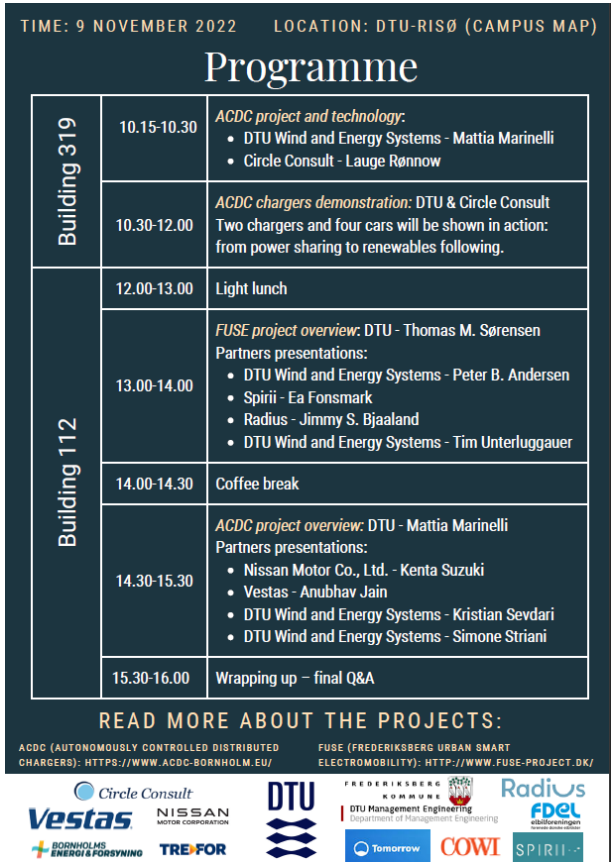


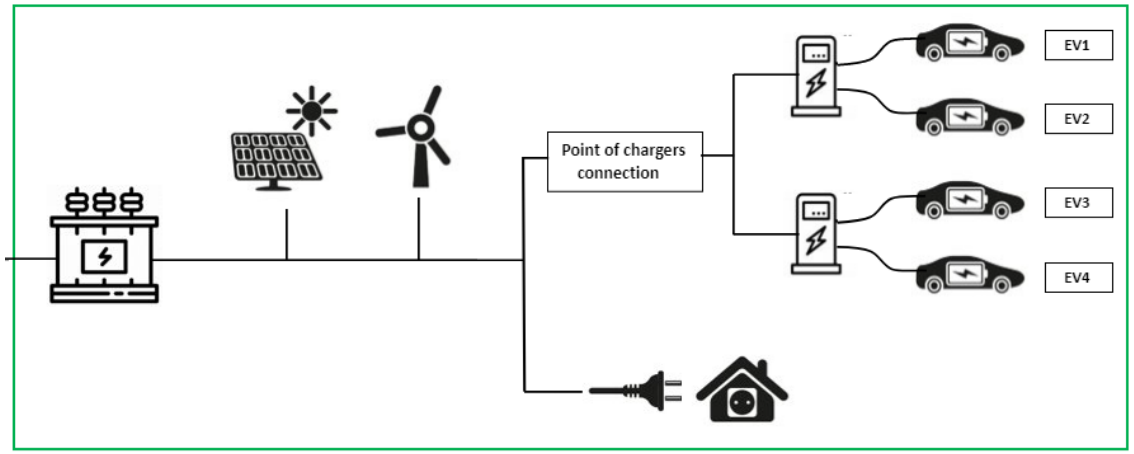
Input:
- Trafo
- Price
- User preference
- kWh desired
- Etc.

Legend:
- Data communication
- * Decision making
- * Partial decision making
- VA — Virtual aggregator (VA)
- VA — Cloud twin VA

LIVE DEMO at Risø Campus (Roskilde) - 9/11/2022

Registration → https://dtu.events/acdc-fuse/





Test cases

-) Power sharing

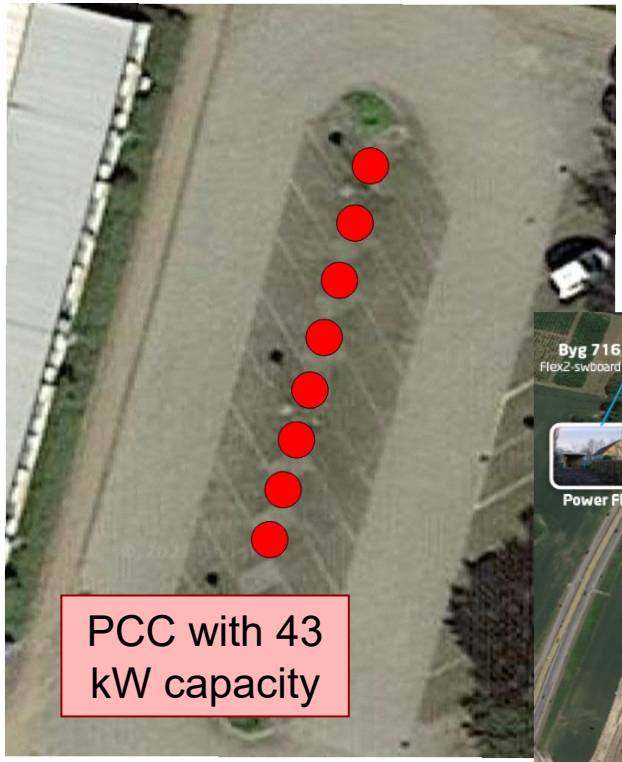
-) Follow the (renewable) generation

-) Power limitation

Designing the parking lot case at Risø (B330) – 8 chargers – 16 EVs

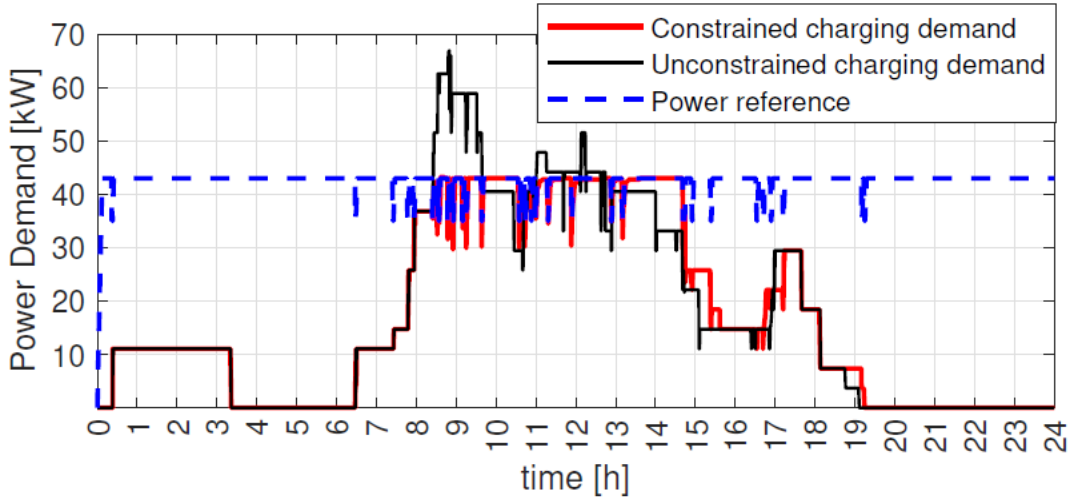
Objectives - 8 chargers (up to 16 cars connected)

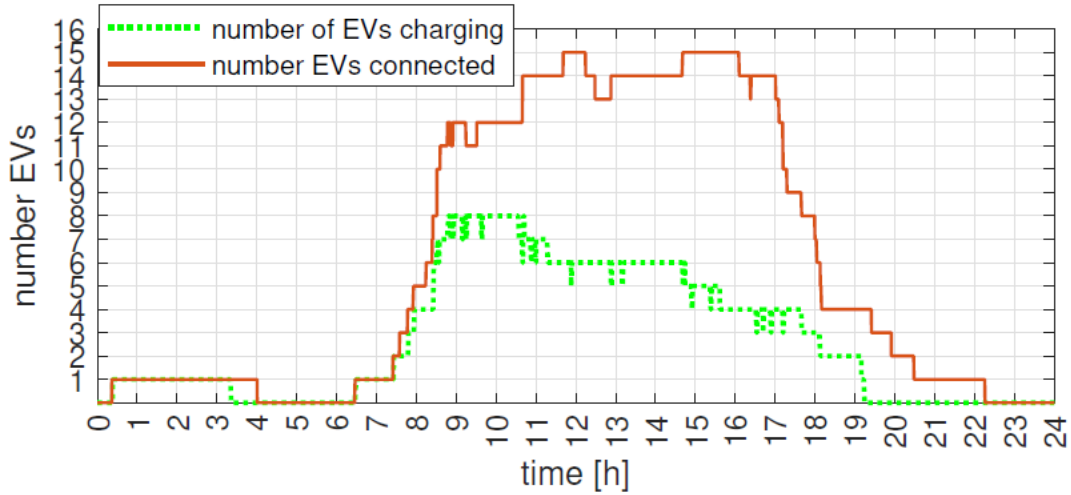
- Power limitation/sharing (considering various mixes of cars)
- Follow the (renewable) generation
- Phase balancing
- Energy scheduling (priorities)
- Charge by price/CO2 (spot-based)
- Robustness against loss of comm. (low power mode)
- Frequency control

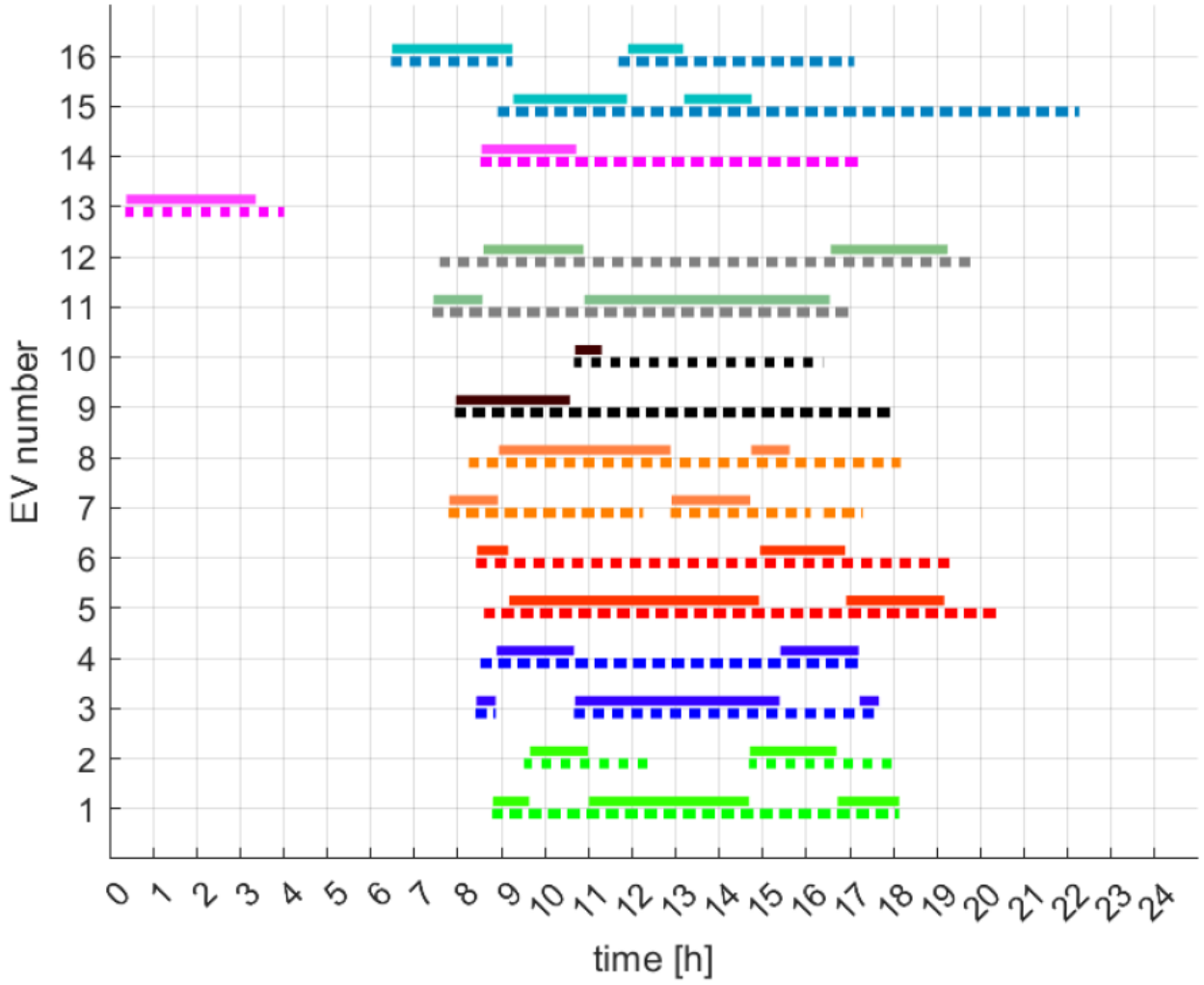


- **Timeline: Installation in December 2022**
- Grid capacity 43 kW (63A 3p) → 25% utilization factor (43 kW vs 176 kW).
- The setup is part of the test facility SYSLAB →

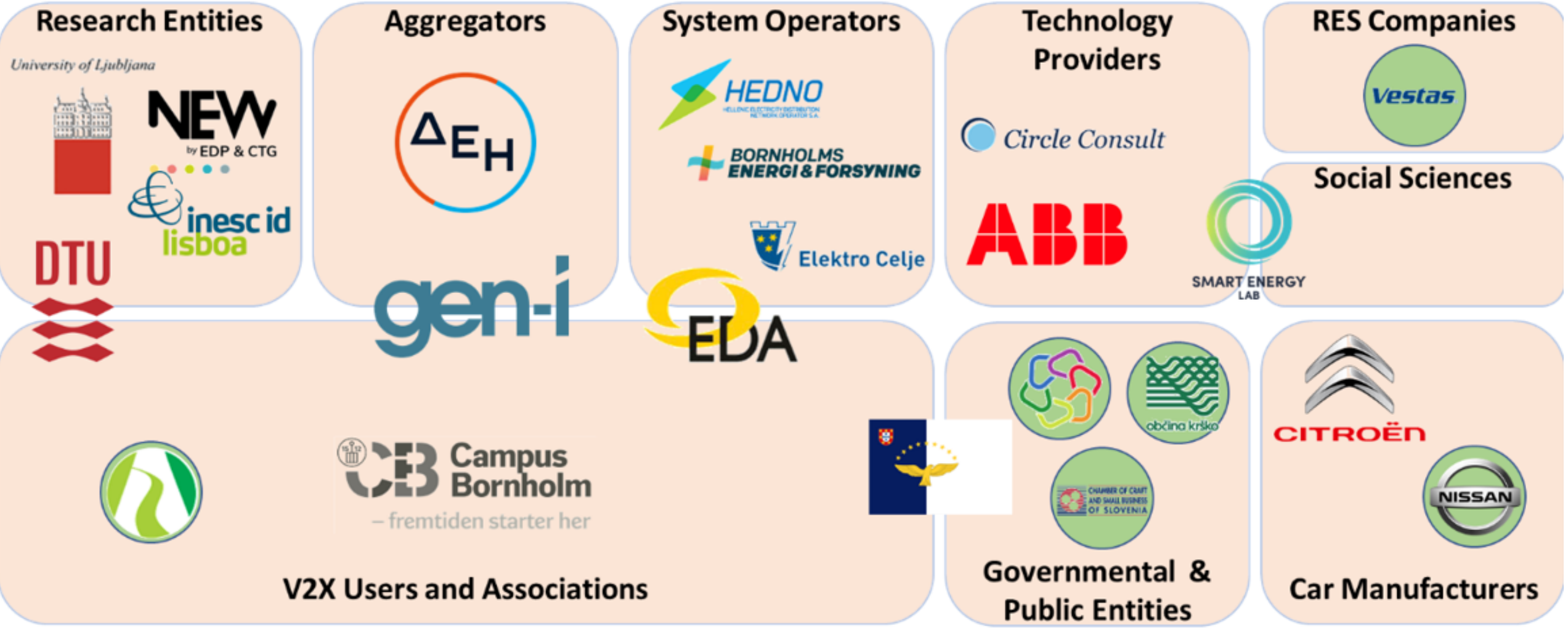
Designing the parking lot case at Risø (B330) – 8 chargers – 16 EVs (simulation results)







EV4EU project (June 2022 – Dec 2025) – partners
9 M€ funding from Horizon Europe



EV4EU project (June 2022 – Dec 2025) – USE CASES

Use Case 1
Cost-effective V2X station
- Multi-Outlet management strategies
- V2X capability
- Sharing Charging Business Model

Use Case 2
Open V2X Management Platform
- Demonstrate the exchange of information
- Demonstrate the activation of services
- Standards evaluation

Use Case 3
New DR and Flexibility Contracts
- Test new demand response for V2X
- Flexibility capacity contracts for V2X
- Evaluate user adoption

Use Case 4
V2X management in Houses
- Dynamic control considering devices priority
- Test Opportunity Cost function
- User profiles / perception / interaction

Use Case 5
V2X management in Buildings
- Coordination of V2X and RES
- Maximize self-consumption

Use Case 6
V2X management in companies
- EVs fleet optimal management
- Coordination with RES/Storage
- Sharing Charging Business Model

Use Case 7
V2X management in Parking Lots
- Centralized vs Autonomous V2X management
- Advantages of V2X comparing with V1G
- Compare fast-charging with medium-chargin

Use Case 8
V2X management by a CPO
- Evaluate the user' engagement in new services
- Green Charging Business Model
- Participation in services activated by the

Use Case 9
V2X management by a VPP
- Aggregation with other resources (RES, ESS)
- New probabilistic algorithms for VPPs
- Participation in multiple-services and Markets

Use Case 10
Participation of V2X in electricity markets
- Participation in regional markets
- Participation in ancillary services markets
- Activation by the VPP of procured service

Use Case 11
Participation of V2X in grid services
- Participation in local energy markets
- Participation in grid services
- Services activation by the DSO and VPP

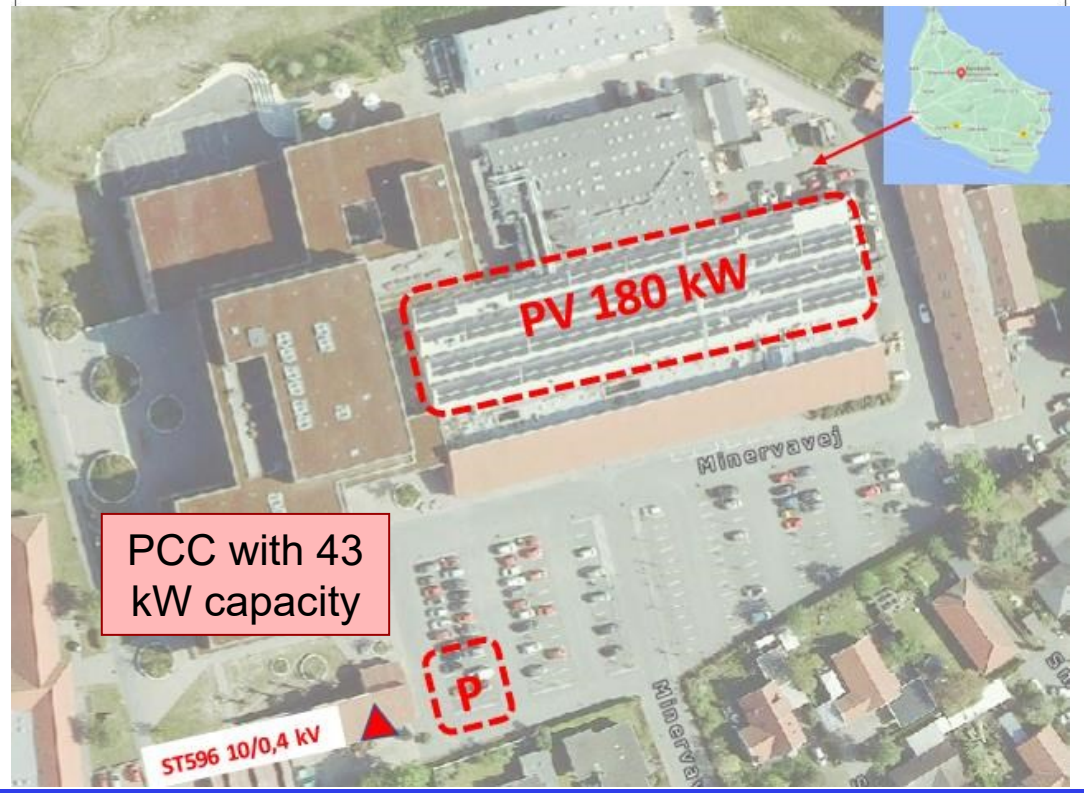
Use Case 12
Activation of V2X services by the D
- Manual activation of V2X services
- Automatic activation of V2X servic
- Green Charging

WP6 – Portuguese Demo WP7 – Slovenian Demo WP8 – Greek Demo WP9 – Danish Demo

New pilot at Campus Bornholm part of EV4EU (Horizon Europe) project

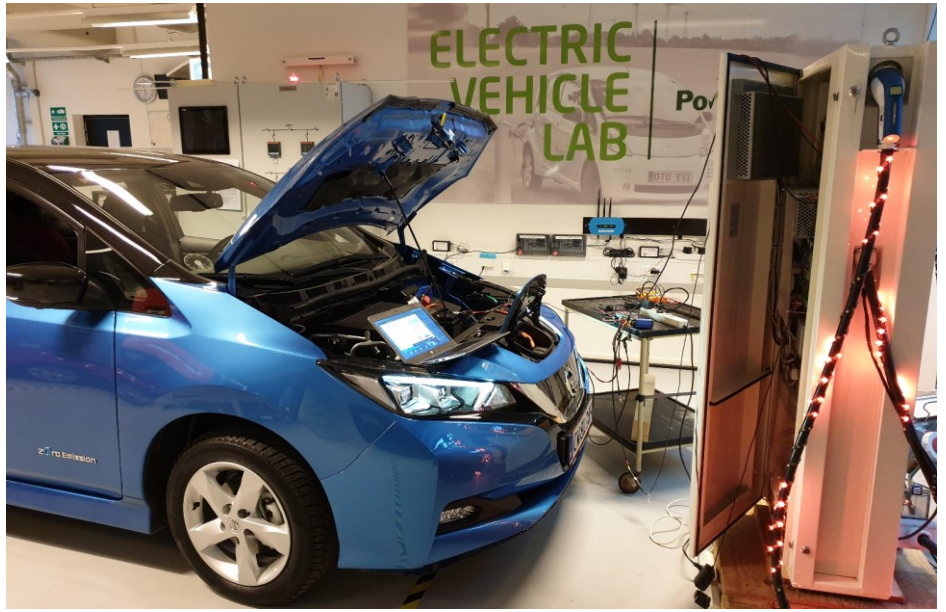
- **Objectives:**
- To demonstrate the technical feasibility of the autonomous distributed charging process of independently controlled EVs to fulfil grid services and maximize utilization of locally produced renewable energy.
- To demonstrate and compare, in parking lots (UC7) and buildings (UC5), the benefits of V1G with V2X
- **To measure the power exchange rates between parking lots and distribution grid considering DR programs (UC3) based on price signals sent by the DSO (UC12).**
- **Timeline: installation to begin in August 2023**
- Grid capacity 43 kW (63A 3p) → 33% utilization factor (43 kW vs 132 kW).

Campus Bornholm Minervavej 1 Rønne Parking lot

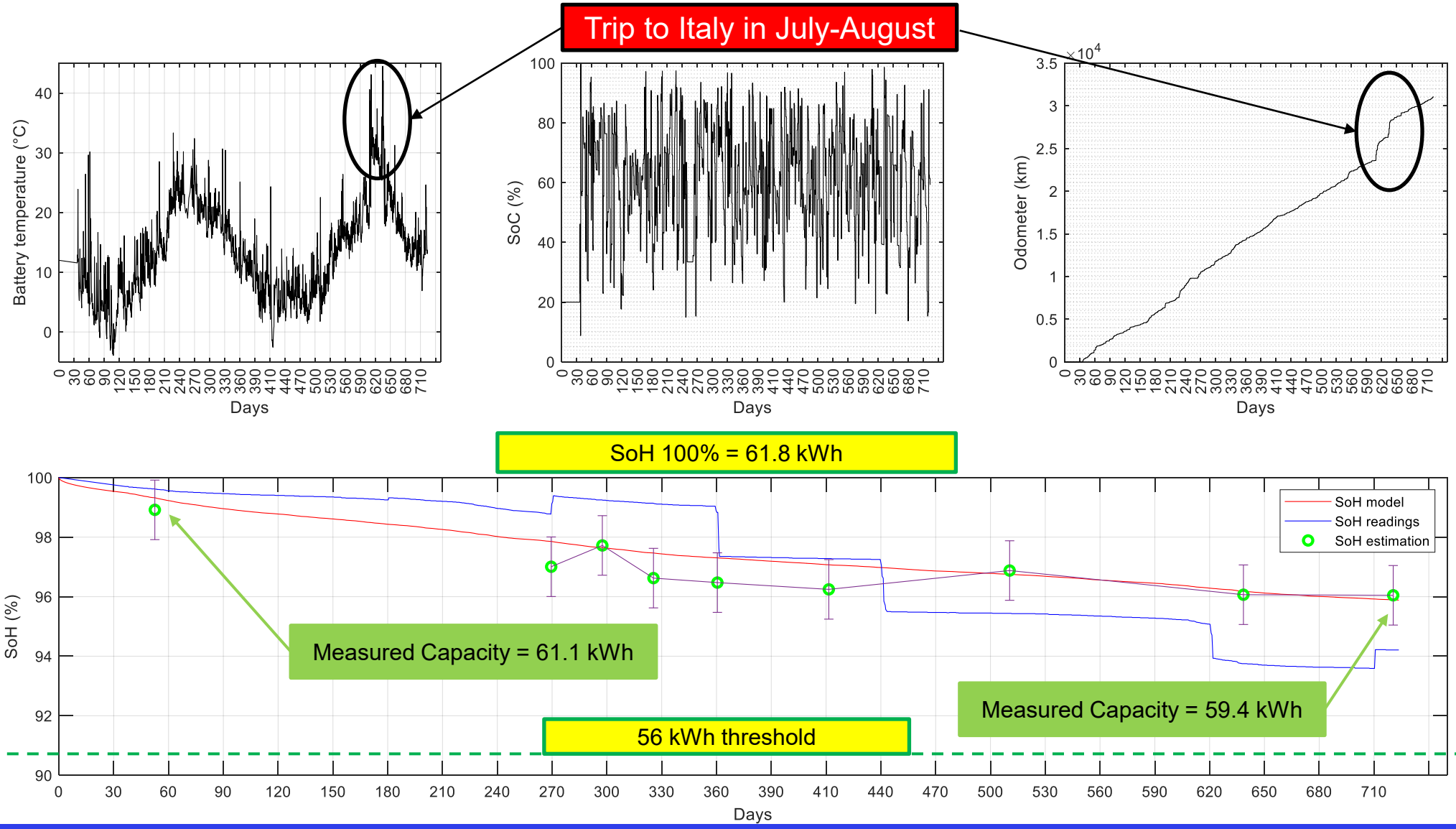


Battery capacity measurements to track degradation

- 24 kWh - 10+2 Nissan eNV-200 in Frederiksberg and Bornholm (driving and frequency control)
- 30 kWh - 2 Nissan LEAF in Bornholm (driving and frequency control)
- 40 kWh - 1 Nissan LEAF in the lab (no driving and no frequency control)
- 62 kWh - 2 Nissan LEAF e+ (Mattia's and DTU's) (driving and daily logs, no frequency control)



Degradation progress of the LEAF e+ (62 kWh nominal, 56 kWh usable)



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