EV Solar charging at CEA: experimental results
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EV (SOLAR) CHARGING @CEA: EXPERIMENTAL RESULTS
BRUNO ROBISSON, SYLVAIN GUILLEMIN, ALEXANDRE MIGNONAC

PV2E_MOBILITY
French Contribution to IEA PVPS T17 - PV & Transport

Virtual Task 17 Meeting T17 18-19 November 2021
AGENDA

• CEA EVCI & PV
  • CEA EVCI
  • EV charging & PV @Cadarache
  • Objectives

• Smart charging
  • Control architecture
  • User journey
  • Definitions
  • Control algorithm

• Experimental results

Associated R&D projects:
**EvolIVE** Project with RTE
G. Vignal

**Neemo** Project with MCAST
http://neemo-project.eu/
B. Azzopardi & R. Mikalauskiene

**INES.2S**
https://www.ines-solaire.org/ines-2s/

**PV2e_Mobility**
M. Sechilariu
CEA CENTERS

- **9** research centers (5 civil / 4 military)
- **8** technological platforms
- **20 181** employees (included 1 233 PhD students and 176 postdoctoral researchers)
- **Budget of 5 billion** euros
CEA CADARACHE – NEAR AIX-EN-PROVENCE

5500 workers

1600 Ha 900ha fenced (22 km of fence)

480 buildings and 500 000 m2 of floor

70 Km of paved roads, 6 km of landscaped footpath, around 5500 people / day on site

29 Bus lines carrying a thousand employees

75 km of water distribution network (drinking water station, industrial water, purification station)

Private power network

• 63kV / 15kV substation
• 18 MV loops (85km of 15kV underground lines)
• EVCI : 81 charging points at 22kVA
• 3kV public lighting network
30 EV charging areas
81 22kW Charge points

G2Mobility (now Total EV Charge)
Diva (2*22kW)

Setup mid-2016
## EVCI CADARACHE – EV & USERS

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</table>

TOTAL = 332

3 involvement levels:
- Control, information = 48 people
- No control, information = 28 people
- No control, no information = 256 people
OBJECTIVES

Production → Network → Consumption

Network + Production = Consumption

Control algorithm: maximize

Selfproduction rate = (PV & consumption) / consumption
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CONTROL ARCHITECTURE

GRID

User Interface

Charge request, state, power

Departure time Initial SoC

Supervision SIGE

Planning Simulation KPI

SIGE

- Information system
  - Solar forecast & Measures
  - Charge request
  - Users & Vehicles
  - Electrical network
  - Charging station state

- Planning
- Simulation
- Key Performance Indicators

Solar production forecast & measures

Physical flows

Information flows

24 out of the the 81 22kW charge points @ Cadarache

FOR 328 E

PV2e_Mobility | Robisson B. – Guillemin S. - Mignonac A.
USER JOURNEY

• The user connects his EV and passes his badge
• The supervision software sends an SMS inviting the user to confirm his departure time and the SOC of his car (default values are proposed).
• The EV is supplied with a test profile.
• Optimization and recharging are made on the basis of these data
DEFINITION: AVAILABLE POWER

**Available Power** = **CorrectedPowerForecast**
DEFINITION: AVAILABLE POWER

- rawPowerForecast
- clearskyPower
- powerForecast

- Power
- CorrectedPowerForecast
DEFINITION: LEAD TIME

The lead time is the difference between the amount of time before departure and the amount of time to fill up the battery at PMax.

Estimate the SOC(t_n) of the EV

Power

PMax

Time to fill up @Pmax

Energy to fill up the battery @SOC(t_n)

Time before departure

Lead Time

DepartureTime = t_d

| t |
CONTROL ALGORITHM - PRINCIPLE

Estimate the SOC of all the EVs and the lead time of the controlled EV

‘Distribute’ the available power

if LT(ev4) < LT(ev2) < LT(ev3)

Available Power

No Control, PMax1

Control, PMax2

Control, PMax3

Control, PMax4

Current Time = \( t_0 \)

\( t_1 = t_0 + \Delta t \)

\( \ldots \)

\( t_n = t_0 + n\Delta t \)

\( \text{SP}(ev,t) \) is the setpoint at time \( t \) of the charging point on which the ev is connected.
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EXPERIMENTAL RESULTS

- 19/10/2021: Cloudy day
- 16 charging sessions
- PV plant = 160kWp

Cumulated simulated charging power without control:

- PV measurements: KO
- ClearSkyPower
- CorrectedPowerForecast
EXPERIMENTAL RESULTS

Cumulated power setpoints with control:
EXPERIMENTAL RESULTS

Cumulated measured charging power with control:

Large increase of the self-production ratio thanks to control
Cumulated measured charging power with control:

Users’ behaviour strongly influences the results
PERSPECTIVES

- Follow the experiments during at least 9 months
- Increase the participants number
- Integrate the participants feedback in the control algorithm
- Improve the EV charging models and parameters estimation
- Improve the planning algorithm
- Add KPI, for example, that estimate the state of half of the batteries with and without control
- Improve the human-machine interfaces
Thank you for your attention

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