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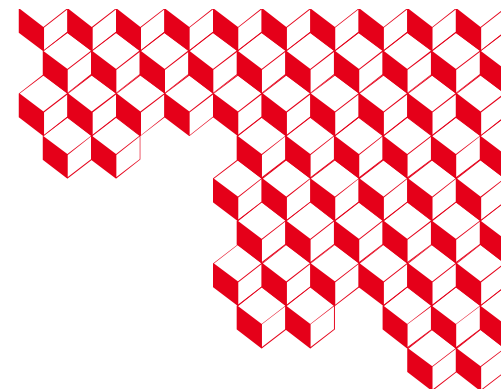
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Pre-Sizing method for photovoltaics charging stations

Bruno Robisson, Van-Lap Ngo, Laurie Marchadier, Mohammed-Farouk Bouaziz
and Alexandre Mignonac

Workshop 'Coupler l'énergie solaire avec la mobilité électrique pour les transports : une opportunité à saisir' – Mougins - 3 October 2023

03/10/2023

T-IPV - French Contribution to IEA PVPS T17 - PV & Transport

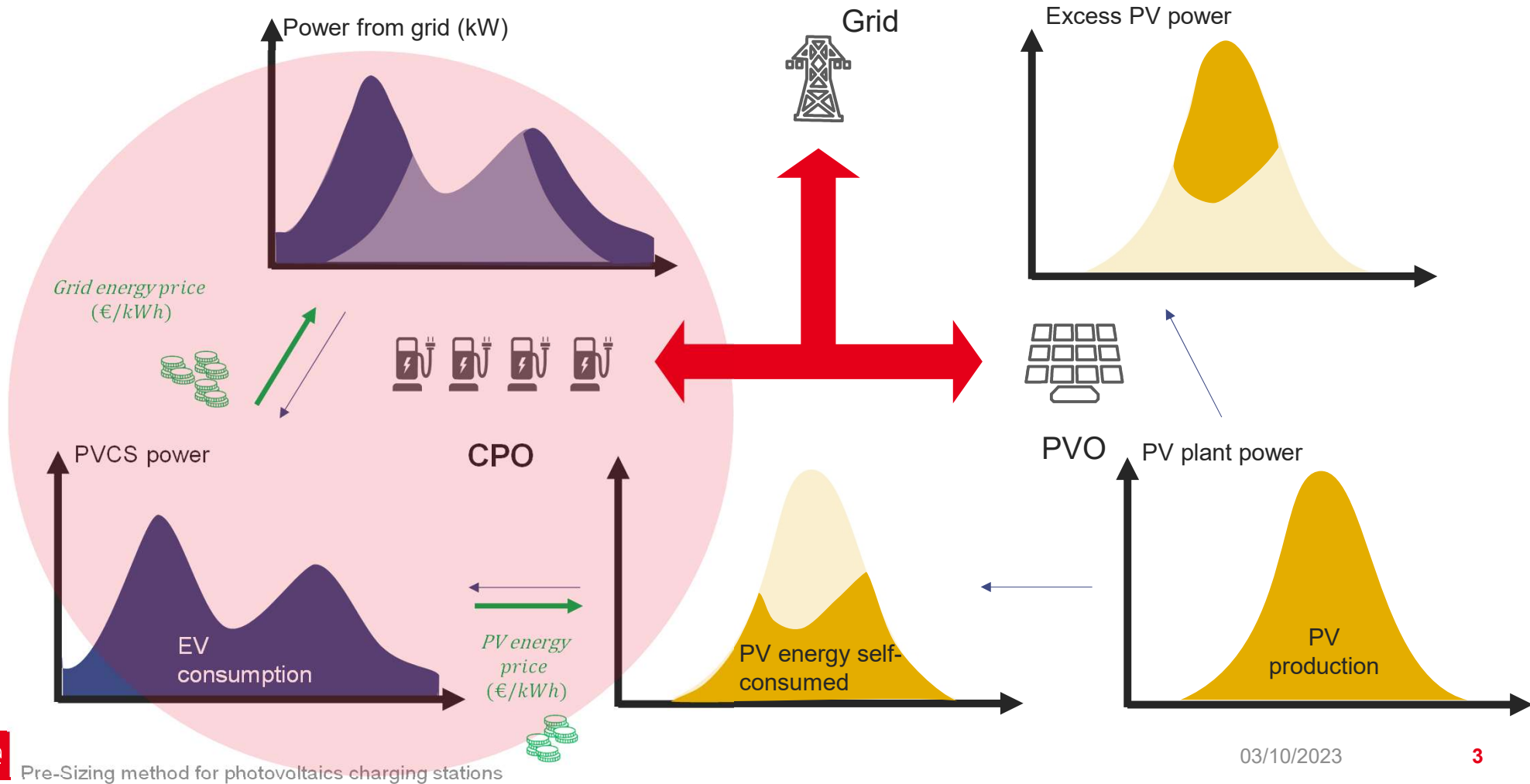


International Energy Agency
Photovoltaic Power Systems Programme
T17 PV & Transport

Agenda

- 1. Issue**
- 2. Principle & interest of the method**
- 3. Application of the method**
- 4. Conclusion & perspectives**

Issue





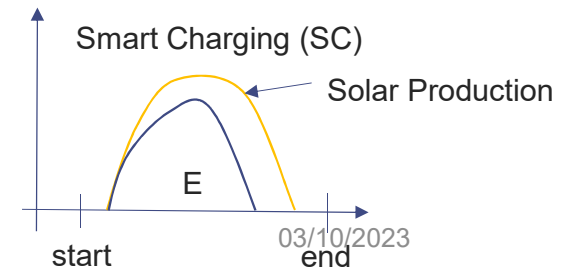
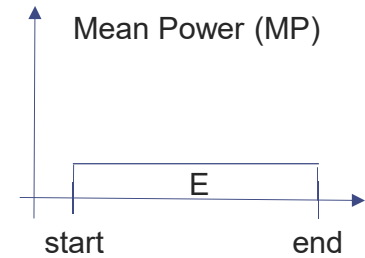
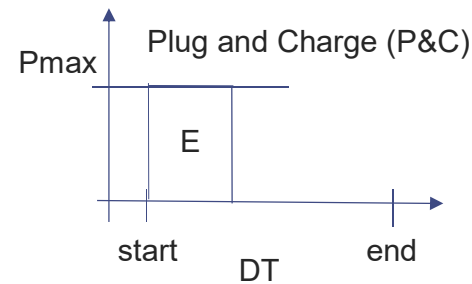
Issue

$$\text{PVCS Energy (kWh)} = \text{Energy from Grid (kWh)} + \text{PV energy self-consumed (kWh)}$$

$$\begin{aligned} \text{PVCS Energy cost (€)} = & \text{Grid energy price } \left(\frac{\text{€}}{\text{kWh}} \right) * \text{Energy from Grid (kWh)} \\ & + \text{PV energy price } \left(\frac{\text{€}}{\text{kWh}} \right) * \text{PV energy self-consumed (kWh)} \end{aligned}$$

Impact on PVCS energy cost:

- Number of EVs
- Size of the PV plant (in terms of PV peak power)
- Charging strategy (amongst Plug&Charge, MeanPower and SmartCharging)



Issue



We propose a method that help a CPO to study the impacts of these three parameters (#EV, PV size and charging strategy) on the PVCS energy cost.

Very first steps of the design → give « only » orders of magnitude

Two levels of usage:

- Expert
- Basic



Principle of the method

Input data

Grid and PV energy prices
Business model

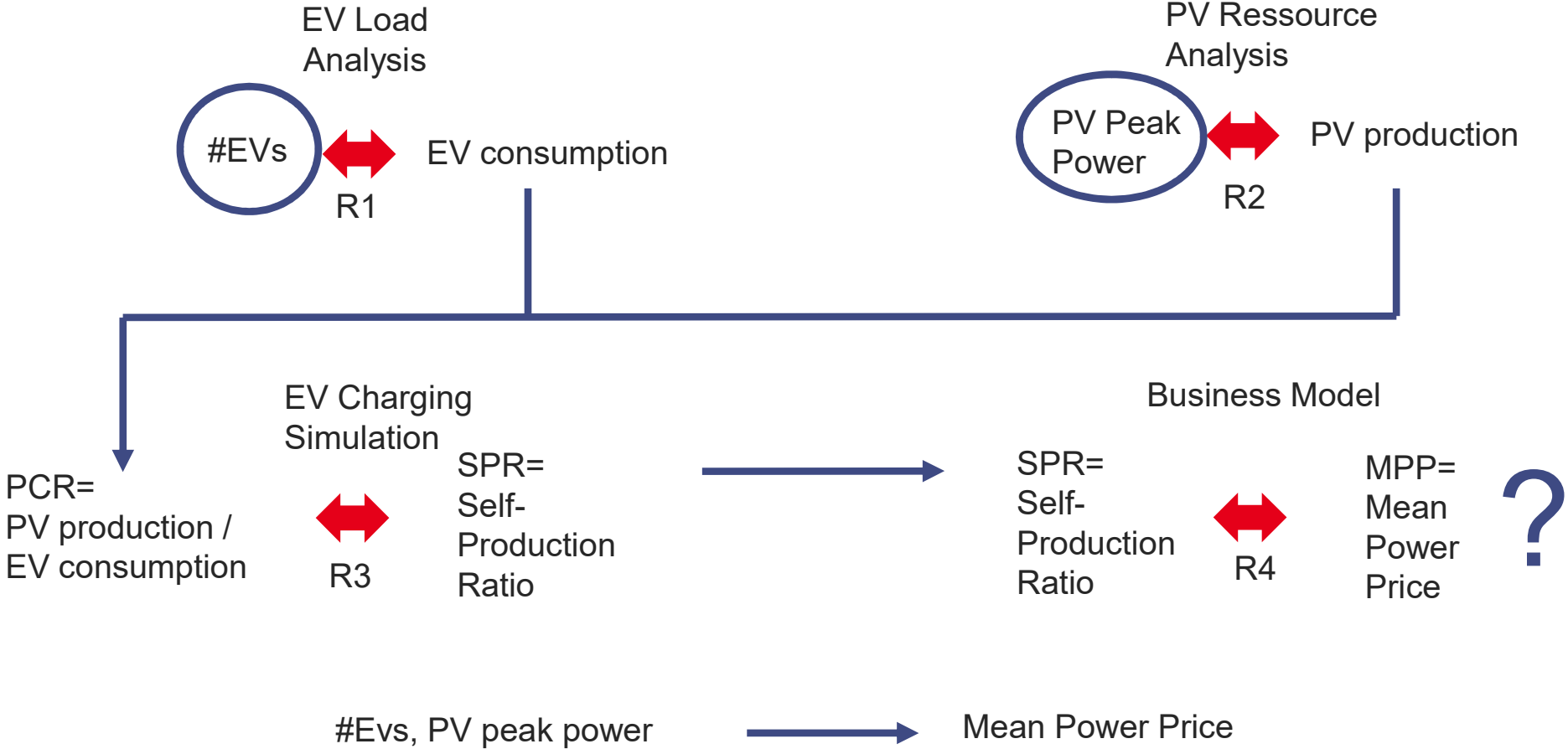
Basic:

- Yearly PVs production per kWp
- Yearly EVs consumption per EV

Expert:

- PV plant characteristics
- Environment of the PV plant
- Charging session history
- EV characteristics (charging power, battery capacity)
- EV charging station characteristics (#charging points, charging power)
- Charging Strategy (amongst PlugAndCharge, MeanPower, and SmartCharging)

Principle of the method





Interest of the method

Modular approach. Each module may be **adapted** to the considered use-case.

Takes advantage of previous studies to **speed-up drastically** the application of the method.

CPO with several 'similar' EVCS at workplace:

- Apply the whole method once (at expert level → takes several days) and
- Re-use the results for the similar cases (at basic level → takes only several minutes)



Estimation the Mean Power Price (basic usage)

Use-case SAP

EVs:

- 210 company cars + Several opportunistic charges per day

EV Consumption:

- 240 MWh / year

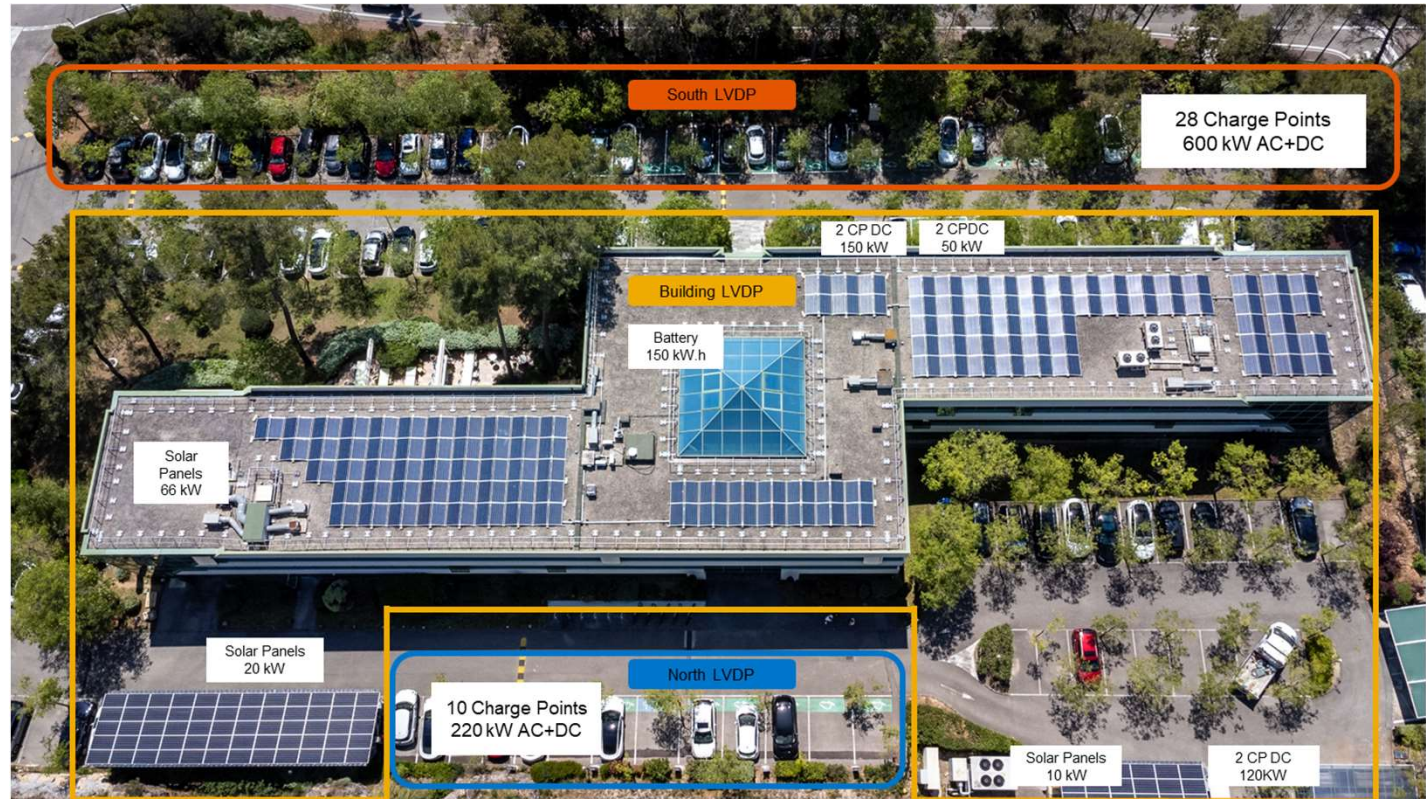
PV Production:

- 96 kWp



Mean Power Price

- Actual PV?
- Increasing PV?



Estimation of the Mean Power Price, actual PV



EV Load Analysis

PV Ressource Analysis

#EVs \leftrightarrow EV consumption
 = 210 \leftrightarrow =240MWh
 ~1.14MWh/an/VE (CPO estimation)

PV Peak Power \leftrightarrow PV production
 =96kWp \leftrightarrow =141MWh
 PVGIS @Mougins

Without PV:
 EnergyCost = 78000€
Savings Solar charging versus Grid charging (Plug&Charge) :
 ~12200€/year
Savings Solar Smart Charging versus Solar Plug&Charge:
 ~6000€/year

EV Charging Simulation

Business Model

PCR= PV production / EV consumption

SPR= Self-Production Ratio

SPR= Self-Production Ratio

MPP= Mean Power Price

141/240=0.58

SPR=24% if PlugAndCharge
 SPR=32% if MeanPower
 SPR=38% if SmartCharging

MPP=274€/MWh if PlugAndCharge
 MPP=257€/MWh if MeanPower
 MPP=246€/MWh if SmartCharging

Formula from CEA Cadarache use-case

Self-consumption Scheme

- Grid energy price : 325€/MWh (yellow tariff)
- PV energy price : 120€/MWh

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Estimation of the Mean Power Price, PV*2



EV Load Analysis

PV Ressource Analysis

#EVs \longleftrightarrow EV consumption
 = 210 $\xrightarrow{R2}$ =240MWh
 ~1.14MWh/an/VE (CPO estimation)

PV Peak Power \longleftrightarrow PV production
 =200kWp $\xrightarrow{R3}$ =294MWh
 PVGIS @Mougins

Without PV:
 EnergyCost = 78000€
Savings Solar charging versus Grid charging (Plug&Charge) :
 ~ 21000€/year
Savings Solar Smart Charging versus Solar Plug&Charge:
 ~ 10000€/year

EV Charging Simulation

Business Model

PCR= PV production / EV consumption

\longleftrightarrow
 R4

SPR= Self-Production Ratio

SPR= Self-Production Ratio \longleftrightarrow R1

MPP= Mean Power Price

294/240=1.25

SPR=41% if PlugAndCharge
 SPR=53% if MeanPower
 SPR=62% if SmartCharging

MPP=238€/MWh if PlugAndCharge
 MPP=216€/MWh if MeanPower
 MPP=197€/MWh if SmartCharging

Formula from CEA Cadarache use-case

Self-consumption Scheme

- Grid energy price : 325€/MWh (yellow tariff)
- PV energy price : 120€/MWh

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Conclusion & perspectives

In this talk:

#Evs, PV peak power \longrightarrow Mean Power Price

But also:

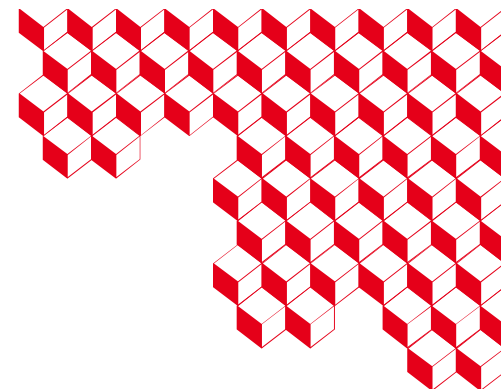
#EVs, Mean Power Price \dashrightarrow PV peak power

PV peak power, Mean Power Price \dashrightarrow #EVs

We plan to compute relationship R3 (PCR \leftrightarrow SPR) for representative use-cases ('template') such as

- Residential park place
- Shopping center
- Fleet at night (with battery)

 Need data from such use-cases



Thanks for your attention

PV2E_MOBILITY / T-IPV
*French contribution
to IEA PVPS-T17*



International Energy Agency
Photovoltaic Power Systems Programme
T17 PV & Transport

CEA/DRT/DTS/SMSP/LSA

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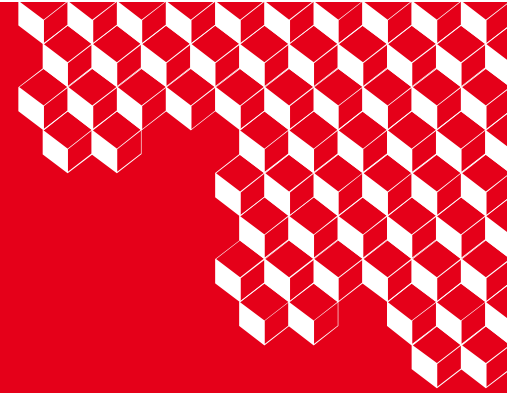
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More details in

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