



## **EvoLVE: Smart charging at CEA**

Bruno Robisson, Sylvain Guillemin, Gérald Vignal, Alexandre Mignonac

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## NEEMO SCHOOL-1: e-Mobility on Islands

### EVOLVE: SMART CHARGING AT CEA



**Bruno Robisson\***, Sylvain Guillemain\*, Gérald Vignal†, Alexandre Mignonac\*

\*CEA Cadarache

†RTE

Tuesday 16 March 2021, 16:00-18:00 (UTC+1)

- **Evolve Project**
- **CEA EVCI & PV**
  - CEA EVCI
  - Charging modes
  - Evolve @INES
  - Evolve @Cadarache
- **Transaction analysis**
  - Transactions
  - Energy Consumption v. Transaction Duration (EC v. TD)
  - Flexibility definition & estimation
  - Beginning / end of transactions
- **Load curves**
  - Reconstruction
  - Analysis
- **Smart charging**
  - IT infrastructure
  - Autoconsumption rate
  - Examples of simulation results
  - First experimental results

### Partners

RTE : Réseau de Transport d'Electricité

CEA: Commissariat à l'Energie Atomique et aux Energies Alternatives

### Objective

This project aims to synchronize the charge of a fleet of EVs with an “off-site” photovoltaic production.

### Tasks

1. Defining the experimental framework
2. Design and setup equipments, IT infrastructure and control algorithms
3. Monitor and evaluate the experiments

### Planning

Kick-off: January 2020

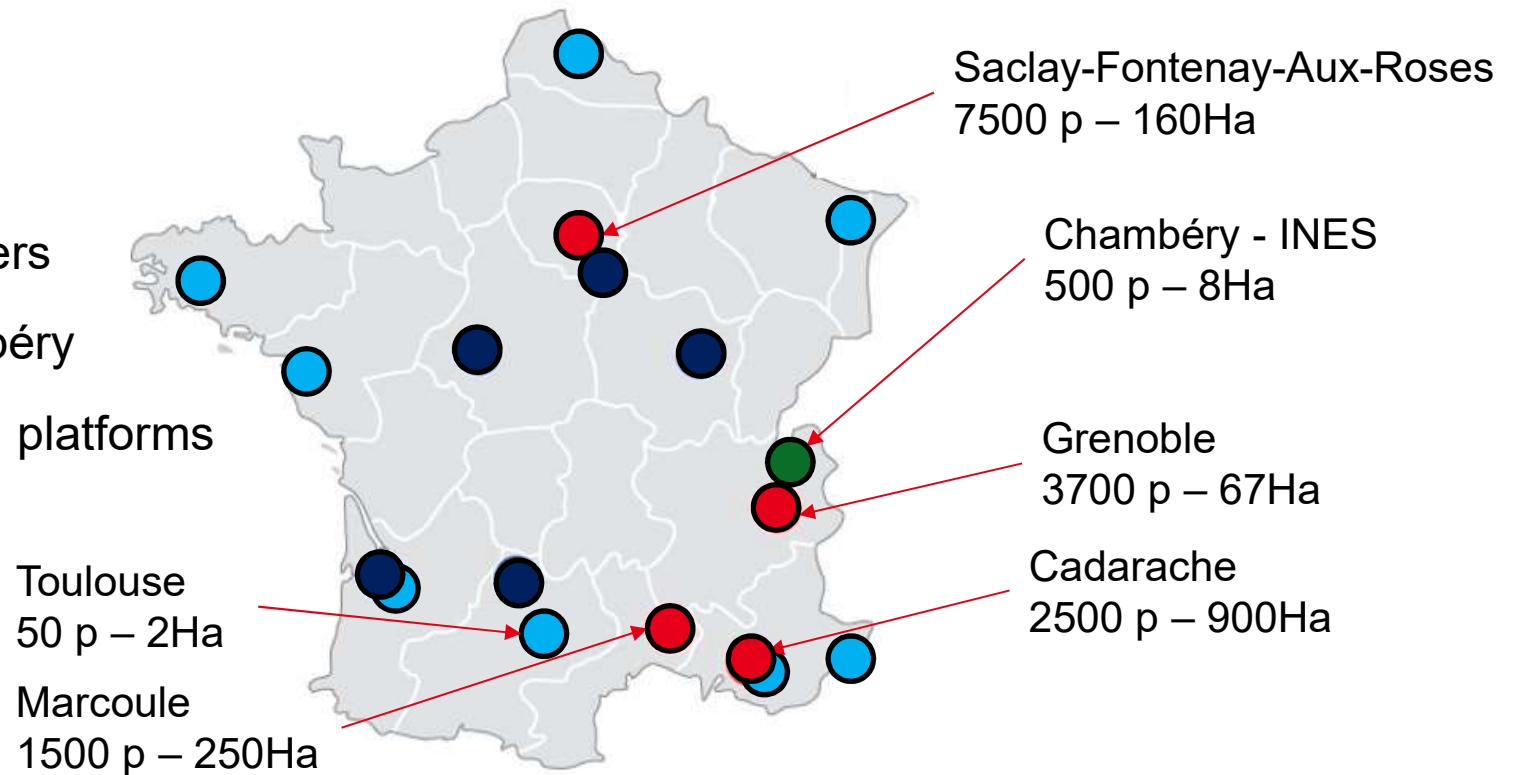
Tasks 1 & 2 : 01/2020 -> 05/2021

Task 3 : 06/2021 -> 05/2022



- **EvoIVE Project**
- **CEA EVCI & PV**
  - CEA EVCI
  - Charging modes
  - EvoIVE @INES
  - EvoIVE @Cadarache
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- Civil centers
- Military centers
- INES Chambéry
- Technological platforms



- **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 : ELECTRIC VEHICLES CHARGING INFRASTRUCTURE (EVCI)



INES



Toulouse



Grenoble



Cadarache

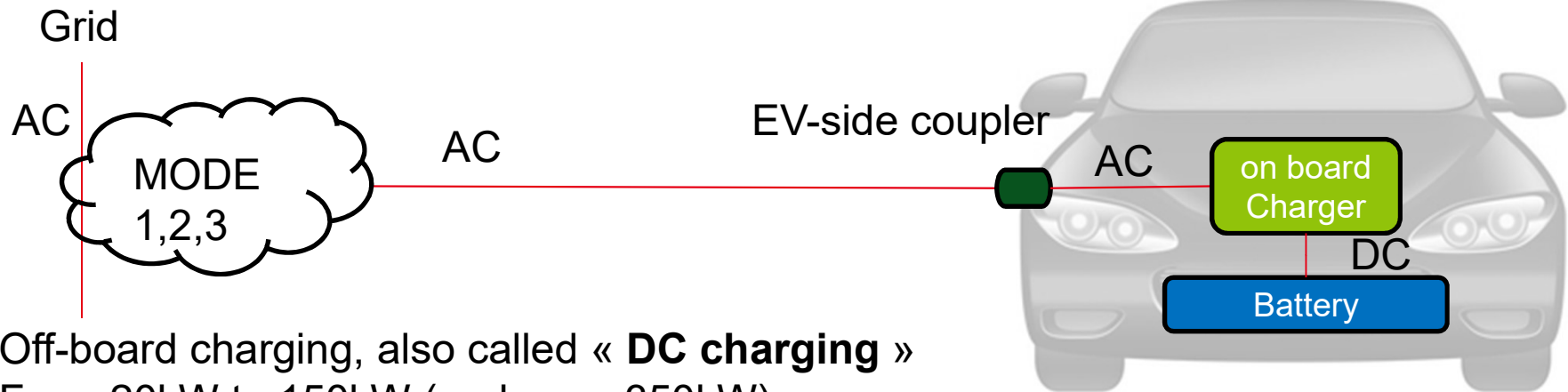
Normal	<11kW
Accelerated	>11kW & <24kW
Fast	>24kW

AC				DC		
Mode 1&2	Mode 3 (and 1&2)			Mode 4		
3kW AC	7kW AC	11kW AC	22kW AC	10kW DC	30kW DC	50kW DC
			81			
			3			
	4		2	1		2
	40					
			20		1	
70	51		4			
22		16				
	92	95	16	1	1	2

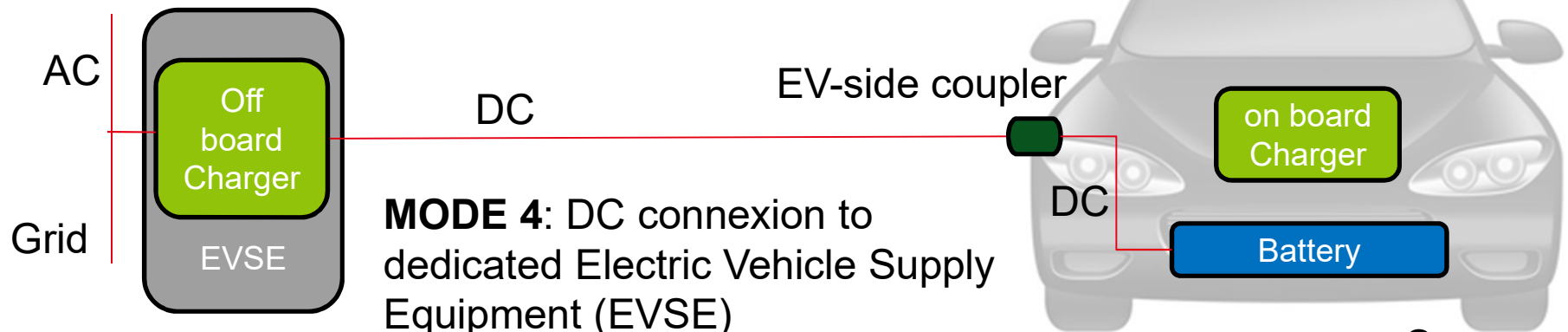
CEA employees	Surface (Ha)	Center		3kW AC	7kW AC	11kW AC	22kW AC	10kW DC	30kW DC	50kW DC	TOTAL
2500	900	Cadarache					81				81
50	2	Toulouse	Actual				3				3
			Forecast		4		2	1		2	9
7500	160	Saclay			40						40
500	8	Ines					20		1		21
3700	67	Grenoble		70	51		4				125
1500	250	Marcoule		22		16					38
		TOTAL			92	95	16	1	1	2	317

## CHARGING MODE (IEC 61851 STANDARD)

On board charging, also called « **AC charging** »  
From 3kW to 22kW (and even 43kW for Zoé first generation)



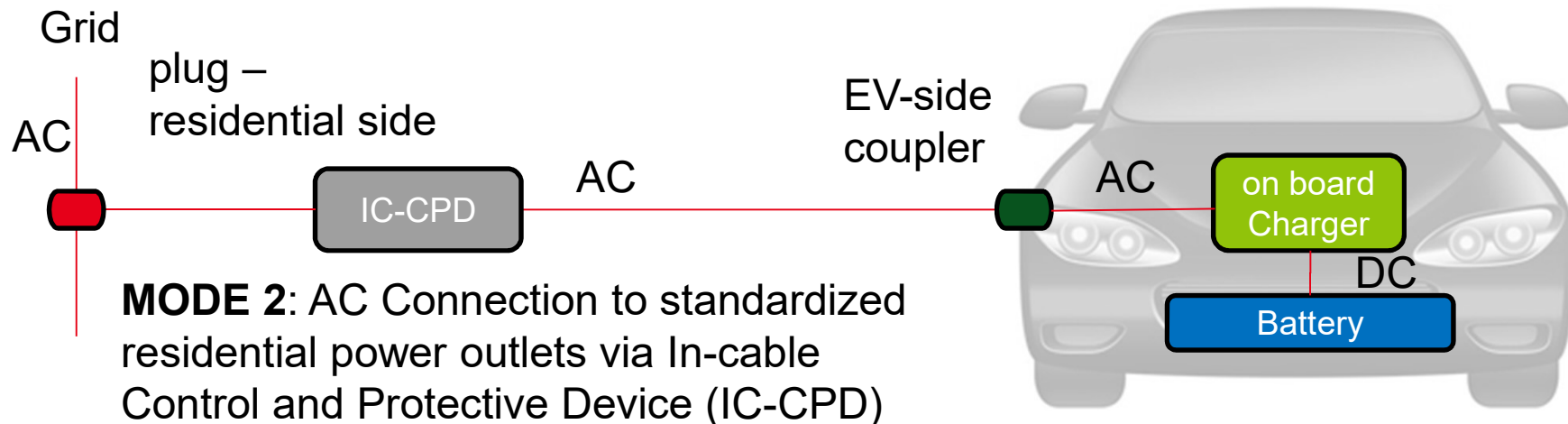
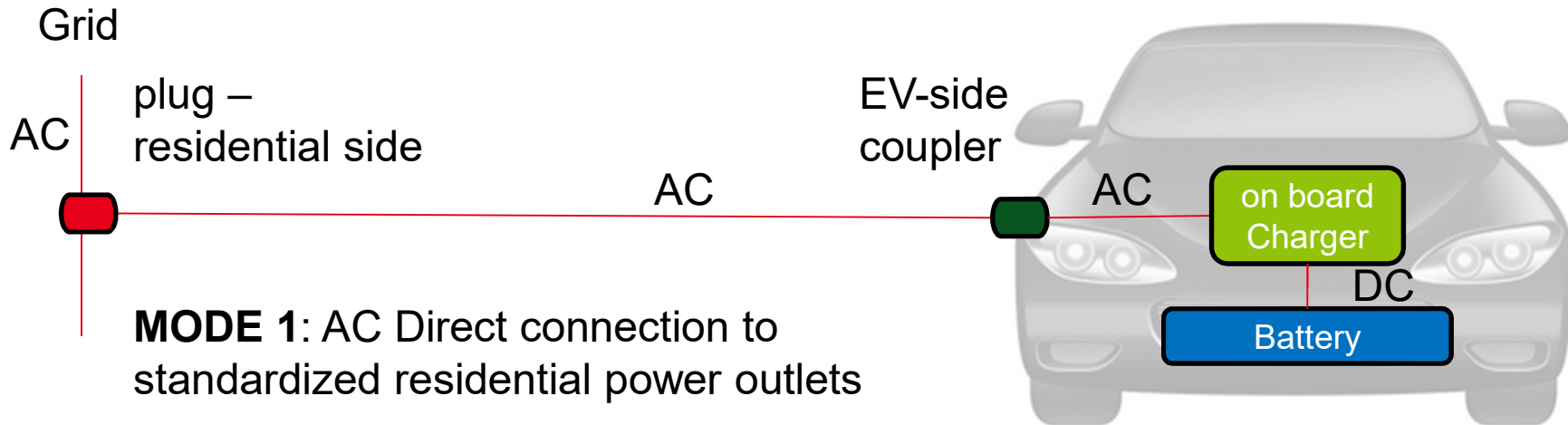
Off-board charging, also called « **DC charging** »  
From 20kW to 150kW (and even 350kW)



**MODE 4:** DC connexion to  
dedicated Electric Vehicle Supply  
Equipment (EVSE)

Source : [1]

## AC CHARGING MODE: MODE 1, 2



Source : [1]



## THE PLUG AND SOCKET ZOO – MODE 2



Type E (CEE 7/17) Mono-p  
230V

70@Grenoble

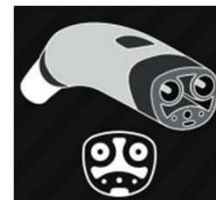
22@Marcoule



Blue: « camping »  
socket Mono-p  
230V



Red: Industrial socket  
Tri-p 400V



Tesla coupler

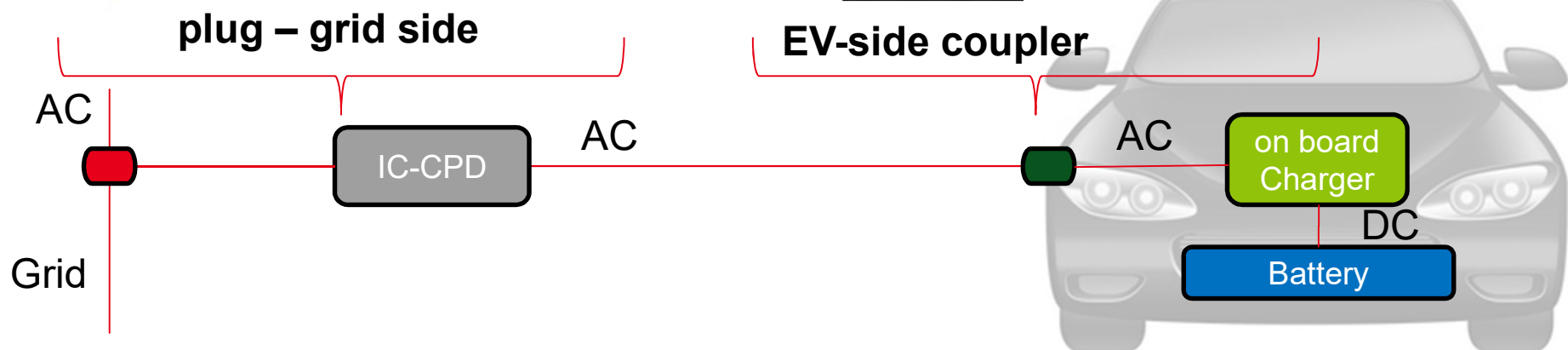


Type 1 coupler

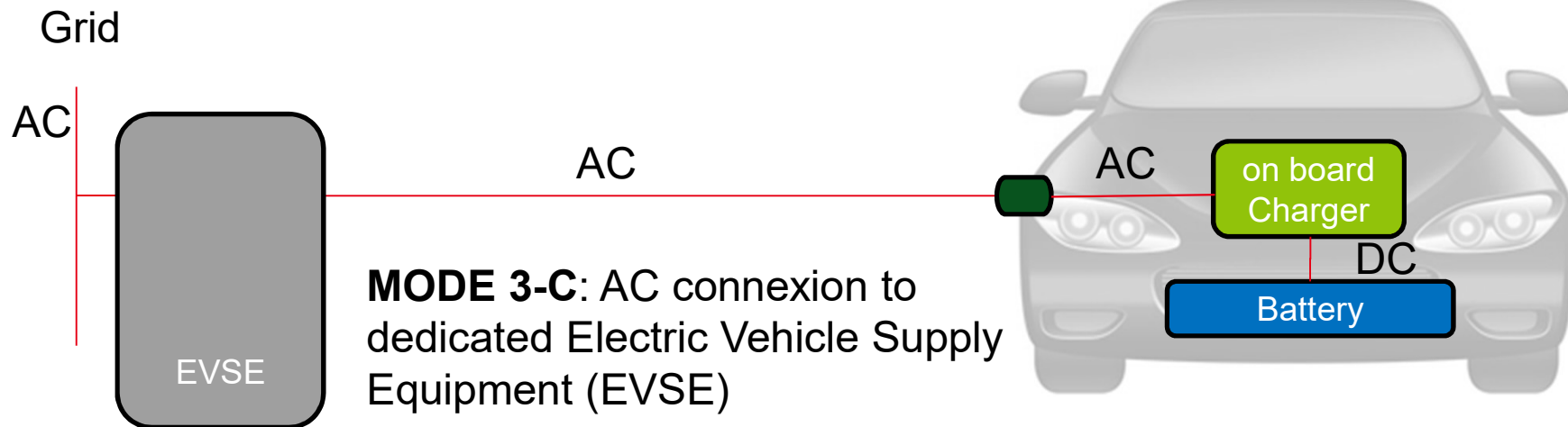
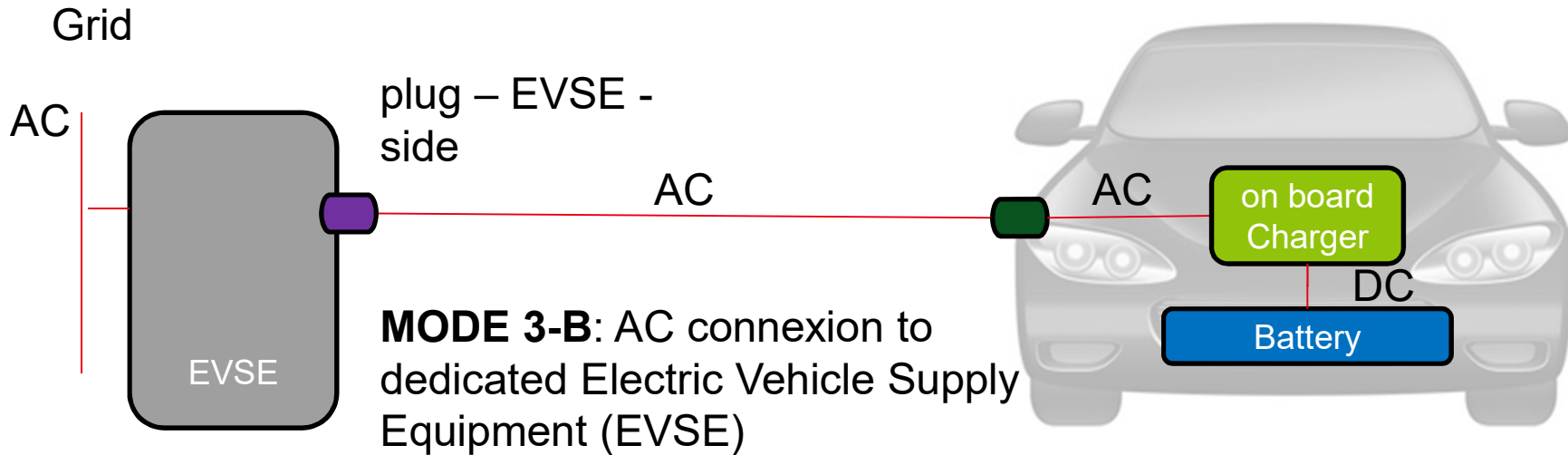


Type 2 coupler

Depends on the vehicle



## AC CHARGING MODE: MODE 3



Source : [1]

## THE PLUG AND SOCKET ZOO – MODE 3 B



Type 2  
outlet

7@Toulouse  
42@Grenoble  
18@INES  
40@Saclay  
81@Cadarache  
16@Marcoule

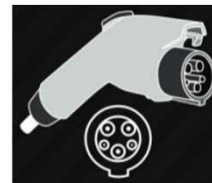


Type 3  
outlet

9@Grenoble



Tesla coupler

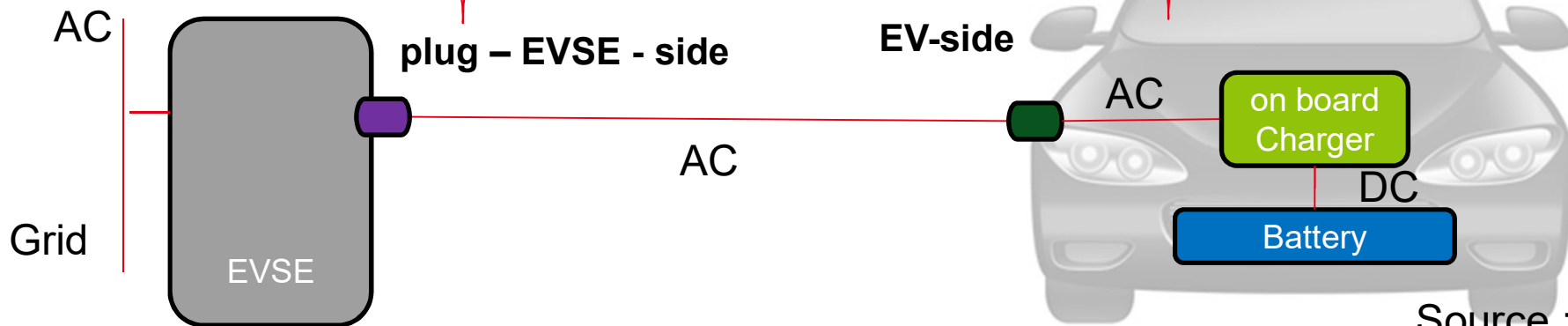


Type 1 coupler



Type 2 coupler

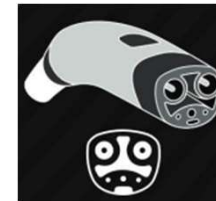
Depends on the vehicle



Source : [1,2]



## THE PLUG AND SOCKET ZOO – MODE 3 C

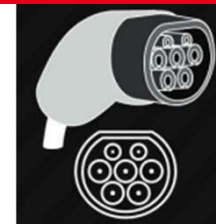


Tesla coupler



Type 1  
coupler

1@INES

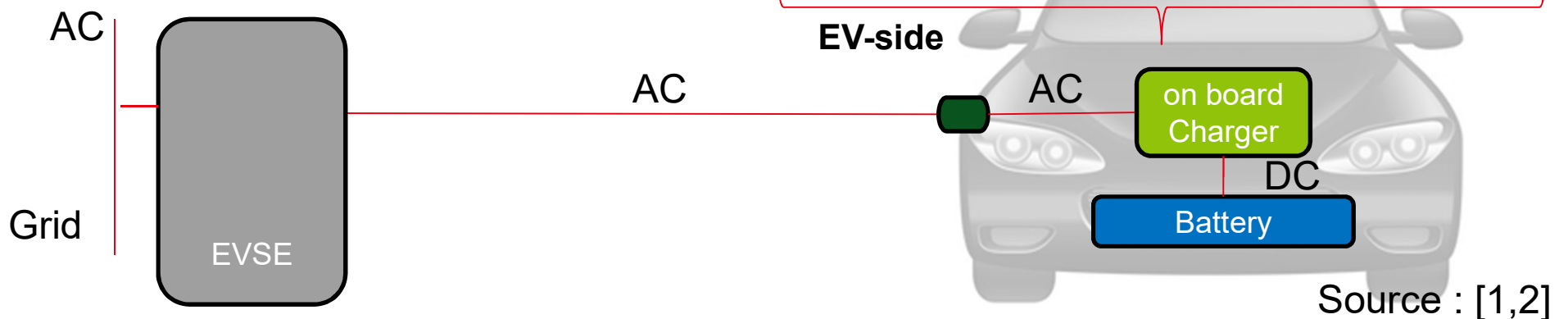


Type 2  
coupler

1@INES

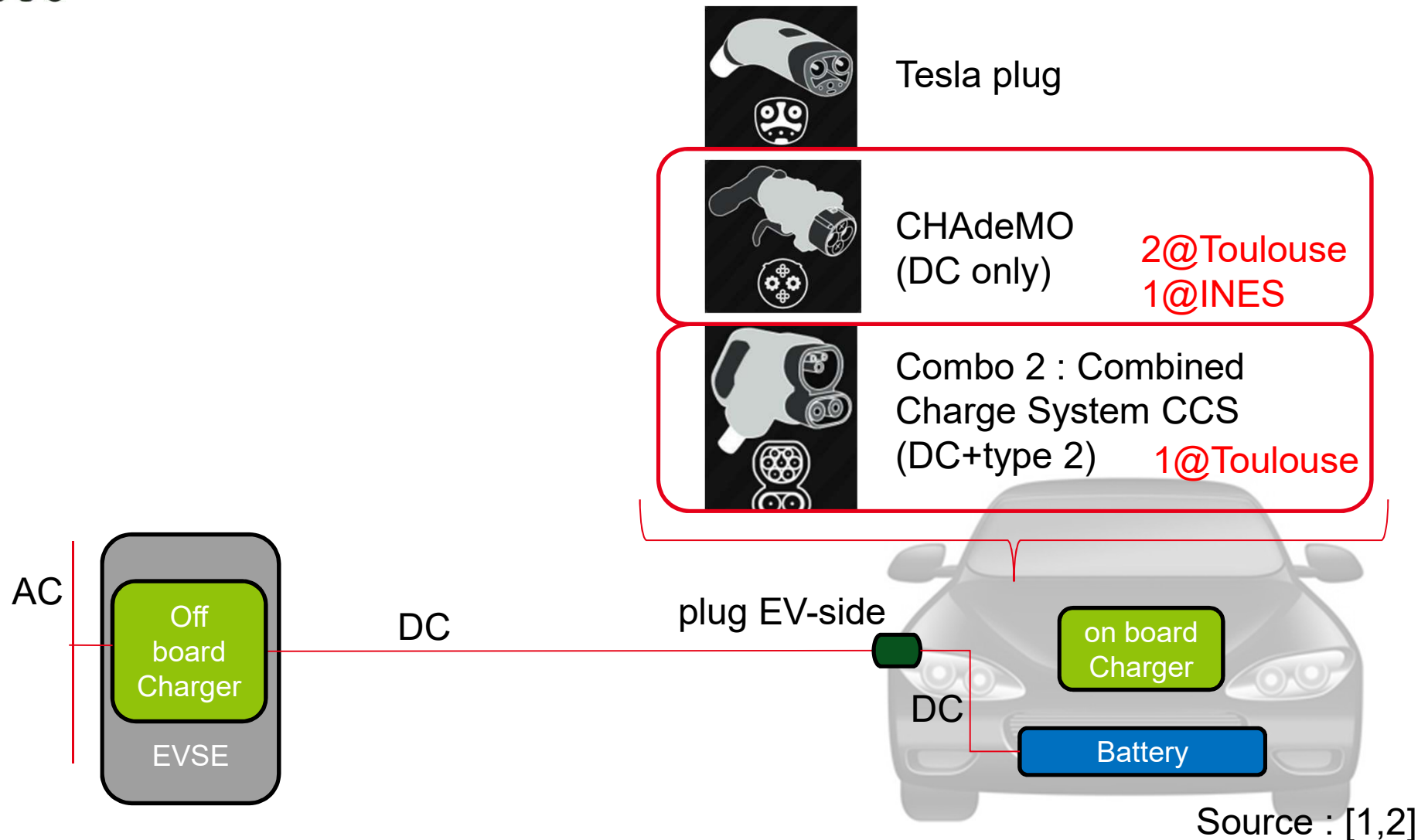
2@Toulouse

EV-side



Source : [1,2]

## THE PLUG AND SOCKET ZOO – MODE 4



## ELECTRIC VEHICLE CHARGING INFRASTRUCTURE (EVCI)

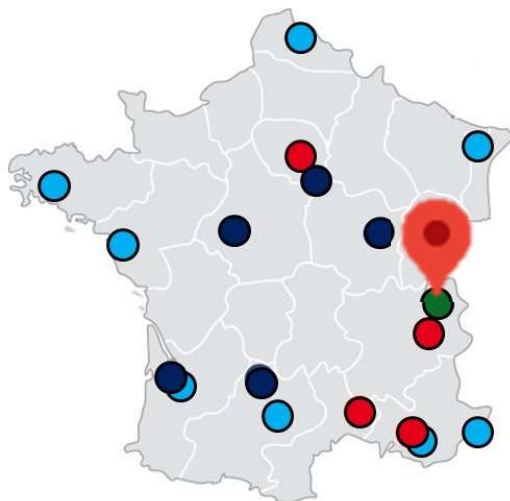
CEA employees	Surface (Ha)	Center		AC				DC			TOTAL
				Mode 1&2	Mode 3 (and 1&2)	Mode 3 (and 1&2)	Mode 3 (and 1&2)	Mode 4	Mode 4	Mode 4	
				3kW AC	7kW AC	11kW AC	22kW AC	10kW DC	30kW DC	50kW DC	
2500	900	Cadarache					81				81
50	2	Toulouse	Actual				3				3
			Forecast		4		2	1		2	9
7500	160	Saclay			40						40
500	8	Ines					20		1		21
3700	67	Grenoble		70	51		4				125
1500	250	Marcoule		22		16					38
		TOTAL		92	95	16	110	1	1	2	317

EvoIVE

1/4 of the 81 AC-EVSE in INES : 20 EVSE

100% of the 20 AC-EVSE in Cadarache : ~ 20 EVSE

**➡ INES + CADARACHE = 40 \* 22kW AC mode 3 (and mode 1&2)**



INES research center  
@Chambéry



- 20 parking places
- 12 of them are above a 21kWp solar carpot
- 10-15 EV users



9 e-totem  
(e-smart  
1\*22kW )



Mode 3B

3 Driveco  
(Kino One  
1\*22kW)



Mode 3B

2 Driveco  
(Kino One  
2\*22kW)



Mode 3B & 3C

1 Hager  
(Witty Park  
2\*22kW)



Mode 3B

1 Cahors  
(Access  
2\*22kW)



Mode 3B

20 \* 22kW EVSE

## CEA CADARACHE – NEAR AIX-EN-PROVENCE

5500 workers

1600 Ha **900ha** fenced (22 km of fence)

480 buildings and **500 000** m2 de planchers

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

29 Bus lines carrying a thousand employees

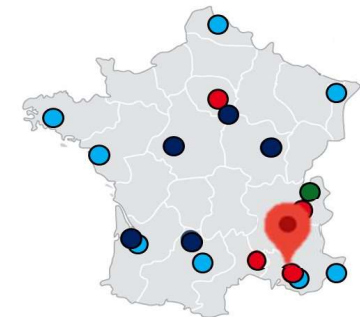
75 km of water distribution network (drinking  
water station, industrial water, purification  
station)

Private power network

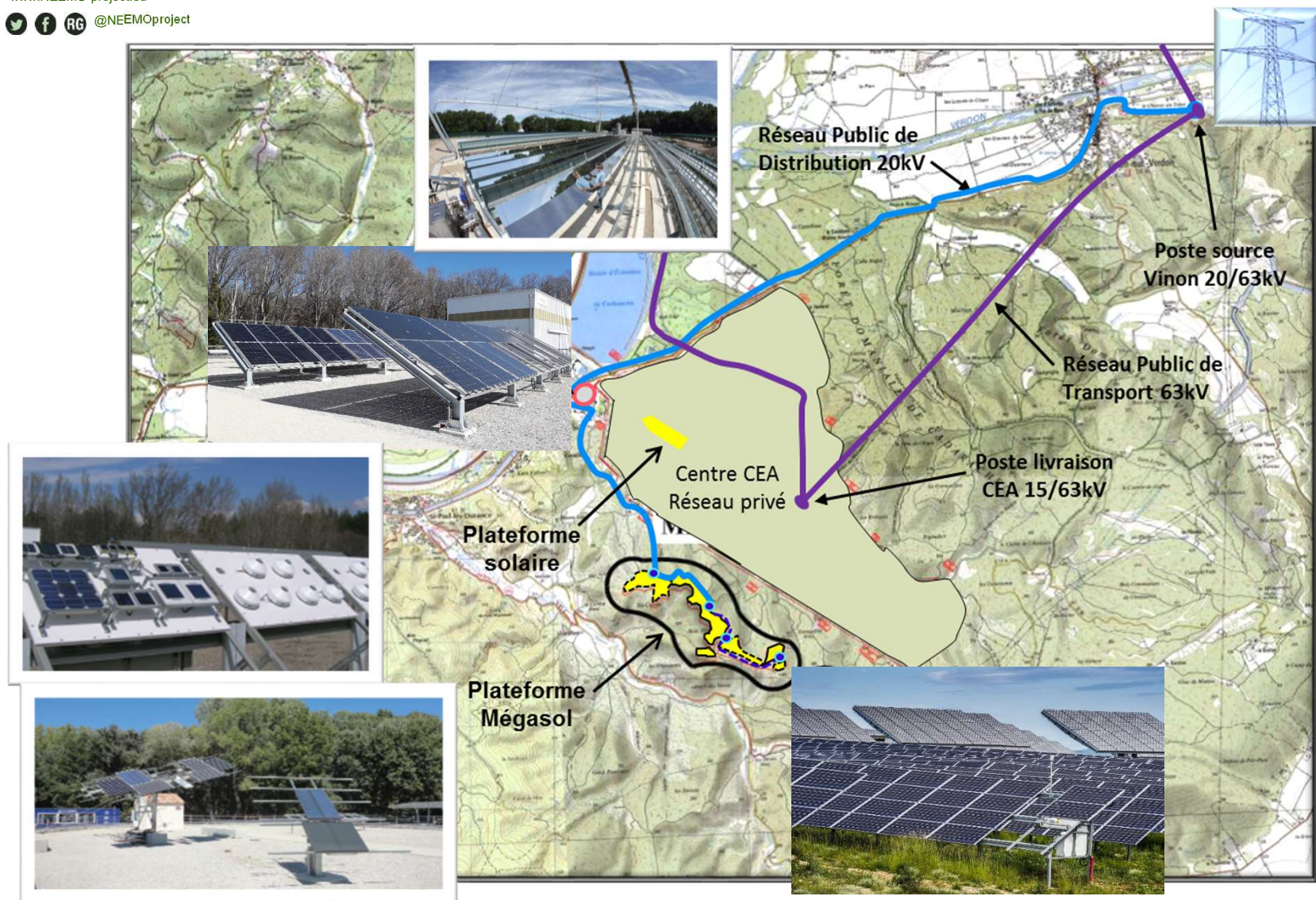
- 63kV / 15kV substation
- 18 MV loops (85km of 15kV underground  
lines)
- EVCI : 81 charging points at 22kVA
- 3kV public lighting network



63kV / 15kV substation

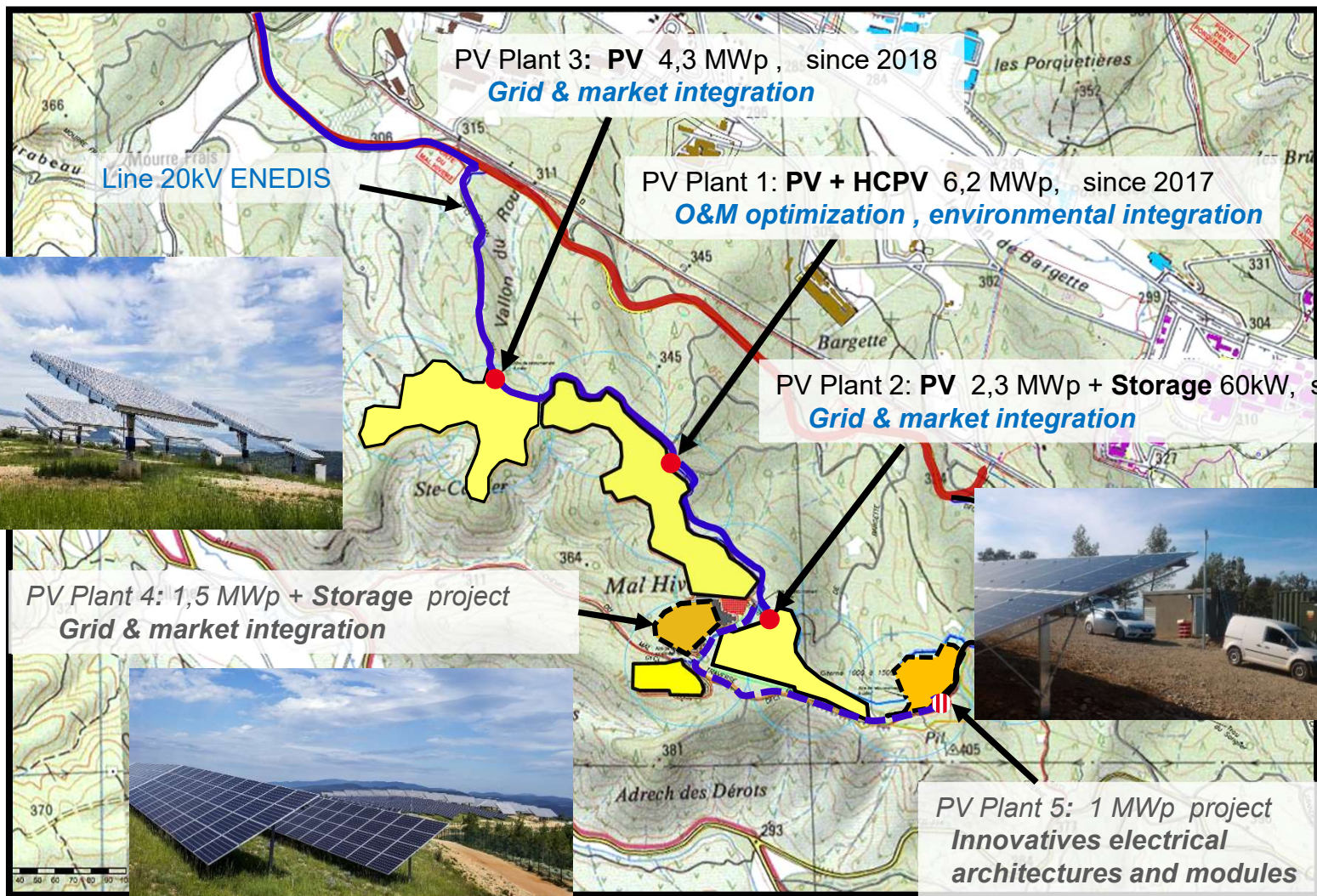






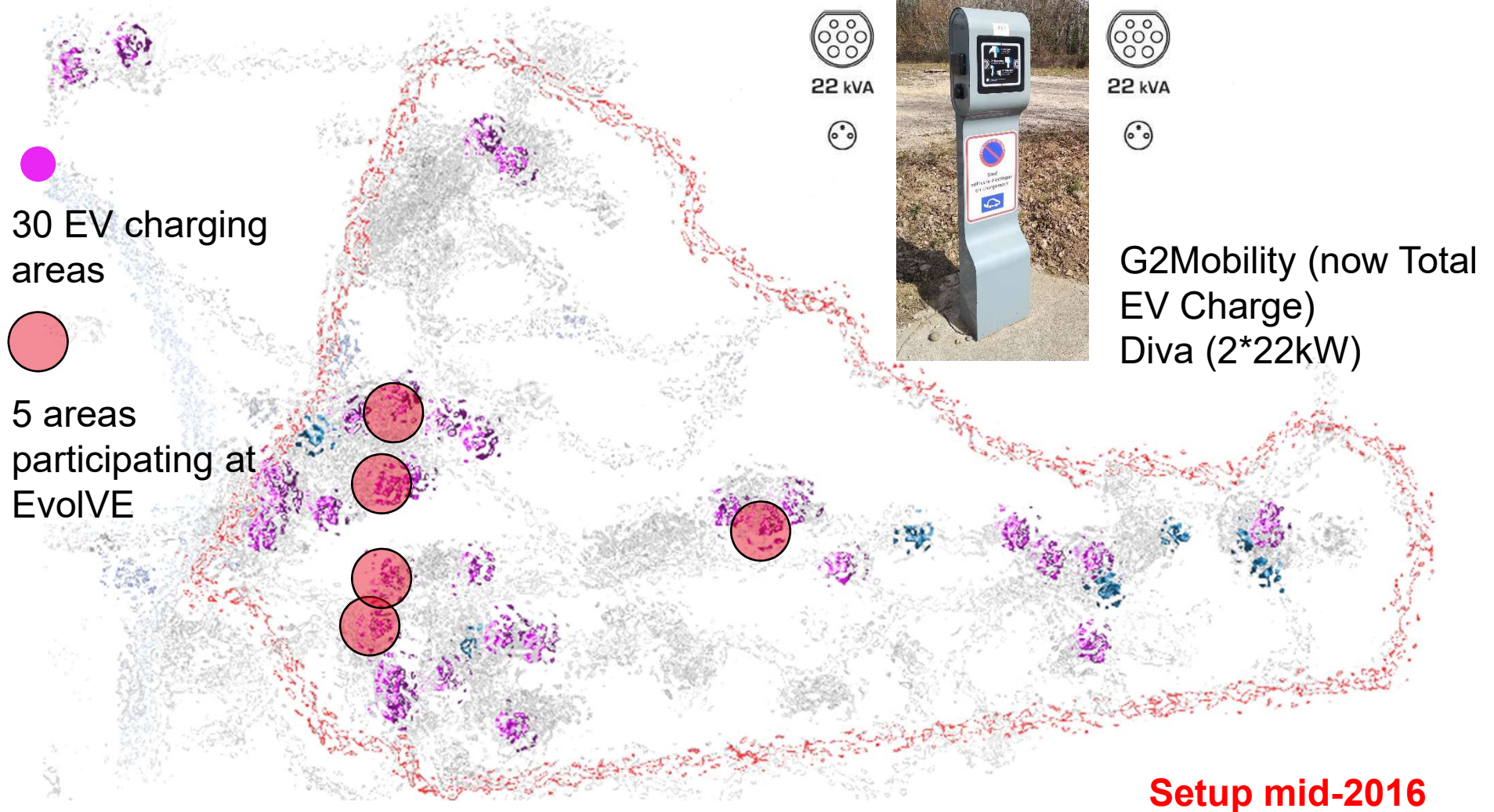


# MÉGASOL PLATFORM (13 MWP)





## EVCI CADARACHE – CHARGING STATION



Modele	Nombre
Zoé	126
M3	4
MS	3
Kangoo	14
Golf GTE	3
Twizy	4
Fortwo	2
Leaf	11
Berlingo	4
Autre	14
e208	2
Ion	1
Partner	1
Ioniq	2
C-Zéro	1
330e	1
E-Niro	1
Outlander	2
Think city	1

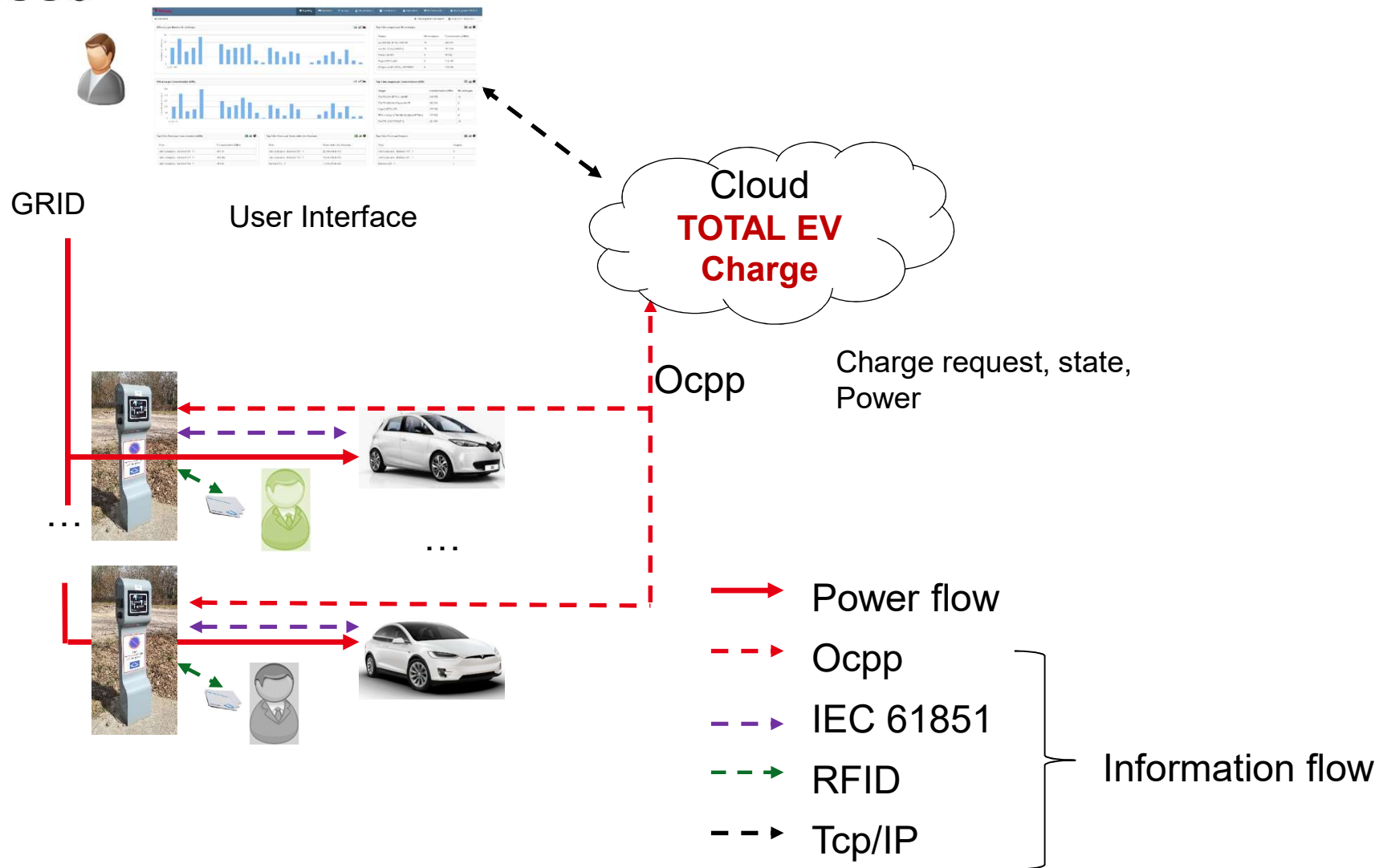
67 service vehicles  
51 personal vehicles  
3 taxis  
5 external companies vehicles

Type	#
External companies	17
Personal	85
Service	90
Taxi	3
	TOTAL= 195

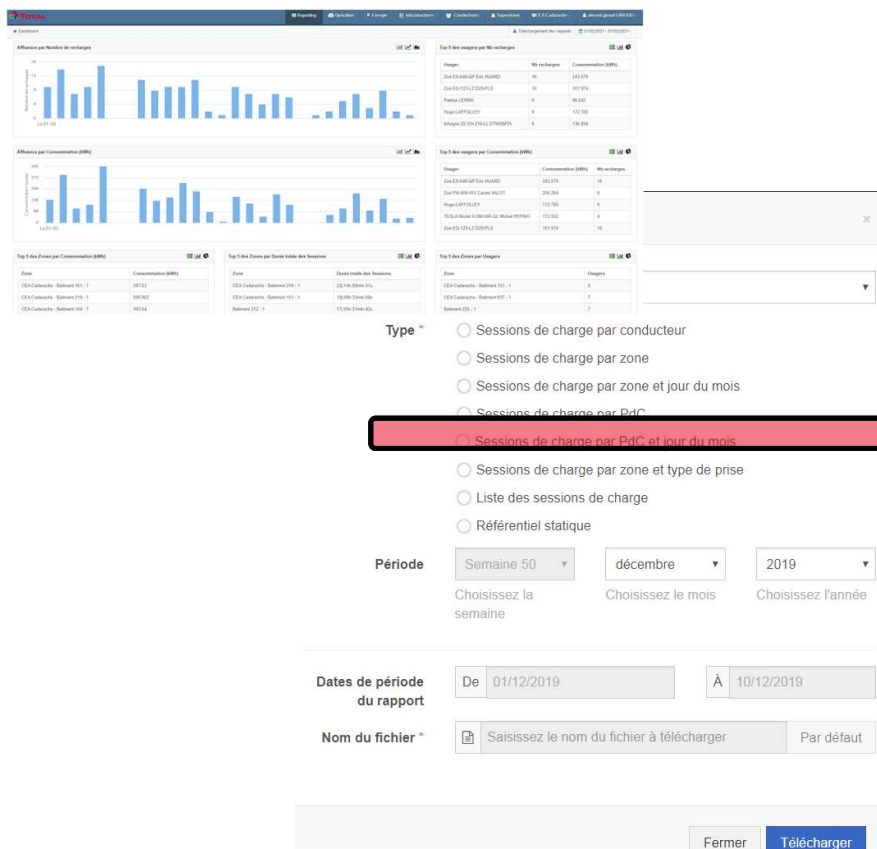
Figures at march 2020  
Increase ~50 EV /year

	Mode 1 et 2	Mode 3
Diva	Up to 3,7kW (AC)	Up to 22kW (AC)

Model	Battery capacity (kWh)	Max AC charging power (kW)
Zoé	{22;41;52}	<b>22</b> or 43 (Mode 3) or <b>2.3</b> (Mode 2)
Leaf	{24;30;40;60}	<b>6.7</b> or 3.3 or <b>2.3</b>
Tesla M3	{52;77}	<b>11</b> or <b>2.3</b>
Tesla MS	{40;60;70;75;85;90;100}	<b>22</b> or <b>16.5</b> or <b>11</b> or <b>2.3</b>
Smart	17.6	<b>22</b> or <b>2.3</b>
Golf GTE	35.8	3.6 or 2.3
Twizy	{6;8}	3.3 or <b>2.3</b> (mode 1)
Berlingo	22.5	6.7 or <b>3.3</b> or <b>2.3</b>
Kangoo	{22;33}	<b>7</b> or <b>3.7</b> or 3.2 (mono)



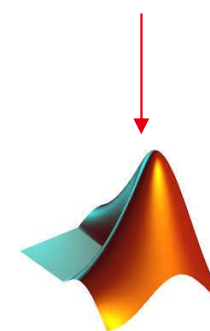
## EVCI CADARACHE - DATA COLLECTION



Raw data can be downloaded from the user interface

Log of charging sessions (.xls) :

Mois	Jour	Transaction	ZoneId	Nom de la PdC	Badge	Début Session	Fin Session	Début Pwr	Fin Pwr	Consomm	Type de pr	Empr
août 2018	01/08/2018	CU-BAT31	CEA-CADA	Batiment	CU-BAT31 1EC84366	01/08/2018 06:52:54	01/08/2018 13:33:45	1697218	1710825	13.607	T2	G2M
août 2018	01/08/2018	CU-BAT12	CEA-CADA	Batiment	CU-BAT12 00000000	01/08/2018 07:23:00	01/08/2018 15:49:13	1649877	1655158	5.281	EF	G2M
août 2018	01/08/2018	CU-BAT21	CEA-CADA	Batiment	CU-BAT21 DEF84466	01/08/2018 07:36:25	01/08/2018 16:05:38	1261776	1266772	4.996	EF	G2M
août 2018	01/08/2018	CU-BAT51	CEA-CADA	Batiment	CU-BAT51 4EF84466	01/08/2018 08:01:15	06/08/2018 08:16:38	1361887	1372896	11.009	EF	G2M
août 2018	01/08/2018	CU-BAT78	CEA-CADA	Batiment	CU-BAT78 DE254566	01/08/2018 08:04:46	01/08/2018 13:26:03	886570	904657	18.087	T2	G2M
août 2018	01/08/2018	CU-BAT35	CEA-CADA	Batiment	CU-BAT35 00000000	01/08/2018 08:09:14	01/01/1970 01:00:00	4019320	-1	-4019.32	EF	G2M
août 2018	01/08/2018	CU-BAT15	CEA-CADA	Batiment	CU-BAT15 C19D4366	01/08/2018 08:22:13	01/08/2018 16:04:57	5818841	5845881	27.04	T2	G2M
août 2018	01/08/2018	CU-BAT51	CEA-CADA	Batiment	CU-BAT51 2EC44366	01/08/2018 08:22:40	01/08/2018 12:48:43	4125127	4146367	21.24	T2	G2M
août 2018	01/08/2018	CU-BAT15	CEA-CADA	Batiment	CU-BAT15 1EC64566	01/08/2018 08:27:02	01/08/2018 08:27:03	1217299	1217299	0	T2	G2M
août 2018	01/08/2018	CU-BAT15	CEA-CADA	Batiment	CU-BAT15 1EC64566	01/08/2018 08:27:23	01/08/2018 17:39:36	1217299	1247841	30.542	T2	G2M
août 2018	01/08/2018	CU-BAT85	CEA-CADA	Batiment	CU-BAT85 8E05E97E	01/08/2018 08:48:50	01/08/2018 12:36:07	876509	884835	8.326	EF	G2M
août 2018	01/08/2018	CU-BAT72	CEA-CADA	Batiment	CU-BAT72 3EC1D25A	01/08/2018 08:51:41	01/08/2018 18:28:49	2708165	2733006	24.841	T2	G2M
août 2018	01/08/2018	CU-BAT51	CEA-CADA	Batiment	CU-BAT51 AE954366	01/08/2018 09:12:56	01/08/2018 11:22:42	4232119	4239817	7.698	T2	G2M
août 2018	01/08/2018	CU-BAT31	CEA-CADA	Batiment	CU-BAT31 CEDE4366	01/08/2018 09:15:53	01/08/2018 15:30:36	2015542	2058889	43.347	EF	G2M
août 2018	01/08/2018	CU-BAT23	CEA-CADA	Batiment	CU-BAT23 253CE6E3	01/08/2018 10:56:57	01/08/2018 11:54:08	685929	700308	14.379	EF	G2M
août 2018	01/08/2018	CU-BAT27	CEA-CADA	Batiment	CU-BAT27 6EC74366	01/08/2018 11:26:24	01/08/2018 12:09:45	1314629	1327456	12.827	T2	G2M
août 2018	01/08/2018	CU-BAT35	CEA-CADA	Batiment	CU-BAT35 3E8D4566	01/08/2018 11:55:55	01/08/2018 14:27:26	2334336	2371005	36.669	EF	G2M
août 2018	01/08/2018	CU-BAT15	CEA-CADA	Batiment	CU-BAT15 AE493666	01/08/2018 16:35:40	01/08/2018 12:14:56	2976024	3004133	28.109	T2	G2M
août 2018	01/08/2018	CU-BAT22	CEA-CADA	Batiment	CU-BAT22 9E8E4566	01/08/2018 12:33:22	02/08/2018 10:34:36	1444657	1453020	8.363	EF	G2M
août 2018	01/08/2018	CU-BAT85	CEA-CADA	Batiment	CU-BAT85 8E05E97E	01/08/2018 12:42:58	01/08/2018 16:46:45	884835	893789	8.954	EF	G2M



Matlab

Data analysis



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## LOG OF CHARGING SESSIONS

**HD:** Date/Time at the beginning of the session (UTC)

**HF:** Date/Time at the beginning of the session (UTC)

Name of the charging station

**ID:** Value of the powermeter at the beginning of the session (Wh)

# of the user

**IF:** Value of the powermeter at the end of the session (Wh)

DebutSessionUTC	FinSessionUTC	PointdeCharge	Badge	IndexDebut	IndexFin	TypedePrise
07/06/2016 11:38	07/06/2016 13:31	CU-BAT1011-13CEA-3	7490E56D	75873	80847	T2
08/06/2016 06:15	08/06/2016 11:43	CU-BAT1511-13CEA-3	CE14EB7E	74156	76878	T2
08/06/2016 11:47	08/06/2016 11:52	CU-BAT1011-13CEA-3	7490E56D	80906	81679	T2
08/06/2016 12:02	08/06/2016 13:46	CU-BAT1011-13CEA-3	7490E56D	81679	91062	T2
08/06/2016 12:22	08/06/2016 17:17	CU-BAT1011-13CEA-2	D527CEE3	29009	35782	T2
08/06/2016 12:34	08/06/2016 15:23	CU-BAT1511-13CEA-3	85F1D2E3	76878	81364	T2
08/06/2016 12:42	08/06/2016 12:57	CU-BAT8371-13CEA-2	6468EB6D	2686	3142	T2
08/06/2016 12:59	09/06/2016 08:38	CU-BAT8371-13CEA-2	6468EB6D	3145	66192	T2
08/06/2016 13:04	08/06/2016 13:08	CU-BAT8371-13CEA-6	6503DCE3	765	1566	T2

Transaction Duration (h)=(HD – HF)

Energy Consumption (kWh)=(IF – ID )/1000

Unreliable

Period 01/06/2016 to 31/05/2020 :

- 17045 transactions
- Sum of consumptions : 253.2 MWh
- ~1500000km @17kWh/100km
- 252 t de CO<sub>2</sub> avoided

Year of purchase  
2020

Vehicle Segment  
Medium car (ex: Volkswagen Golf)

**VS**

**Technology**  
Electric

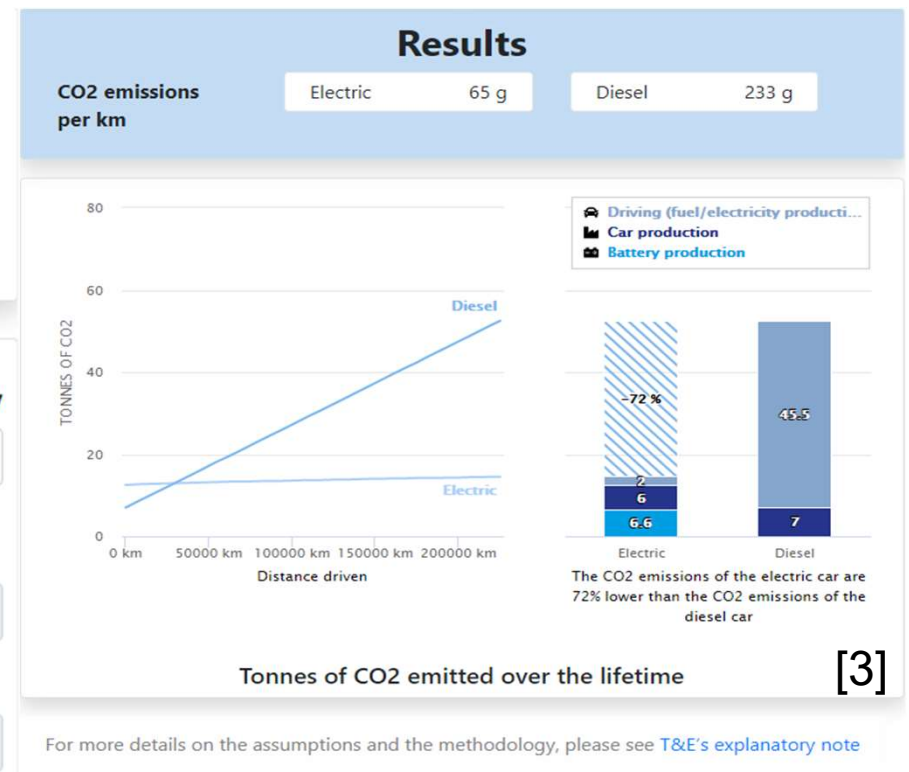
Electricity used for battery production ⓘ  
China

Country where the electric car is driven ⓘ  
France

**Technology**  
Diesel

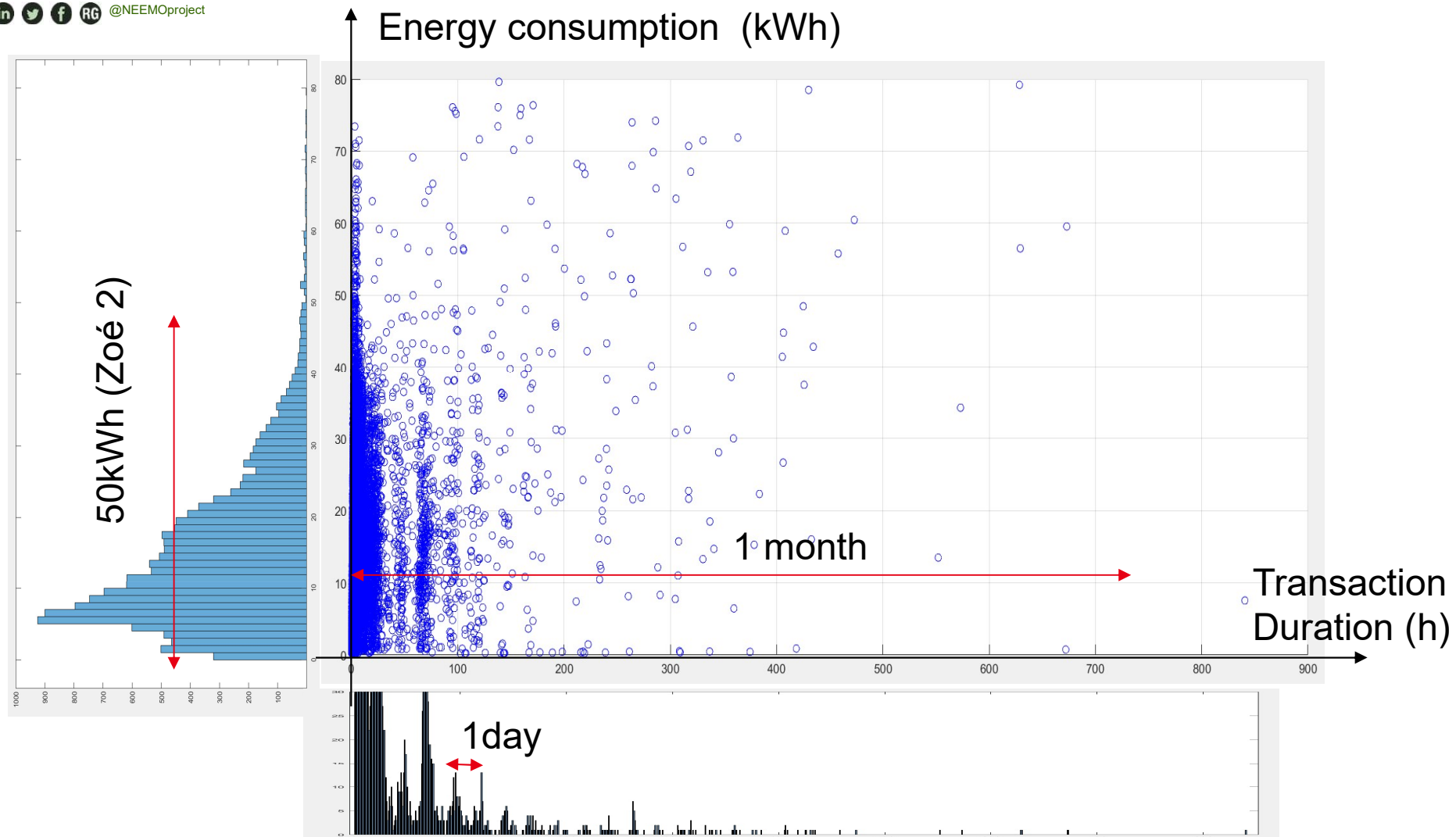
Electricity used for battery production ⓘ  
EU average

Country where the electric car is driven ⓘ  
Sweden



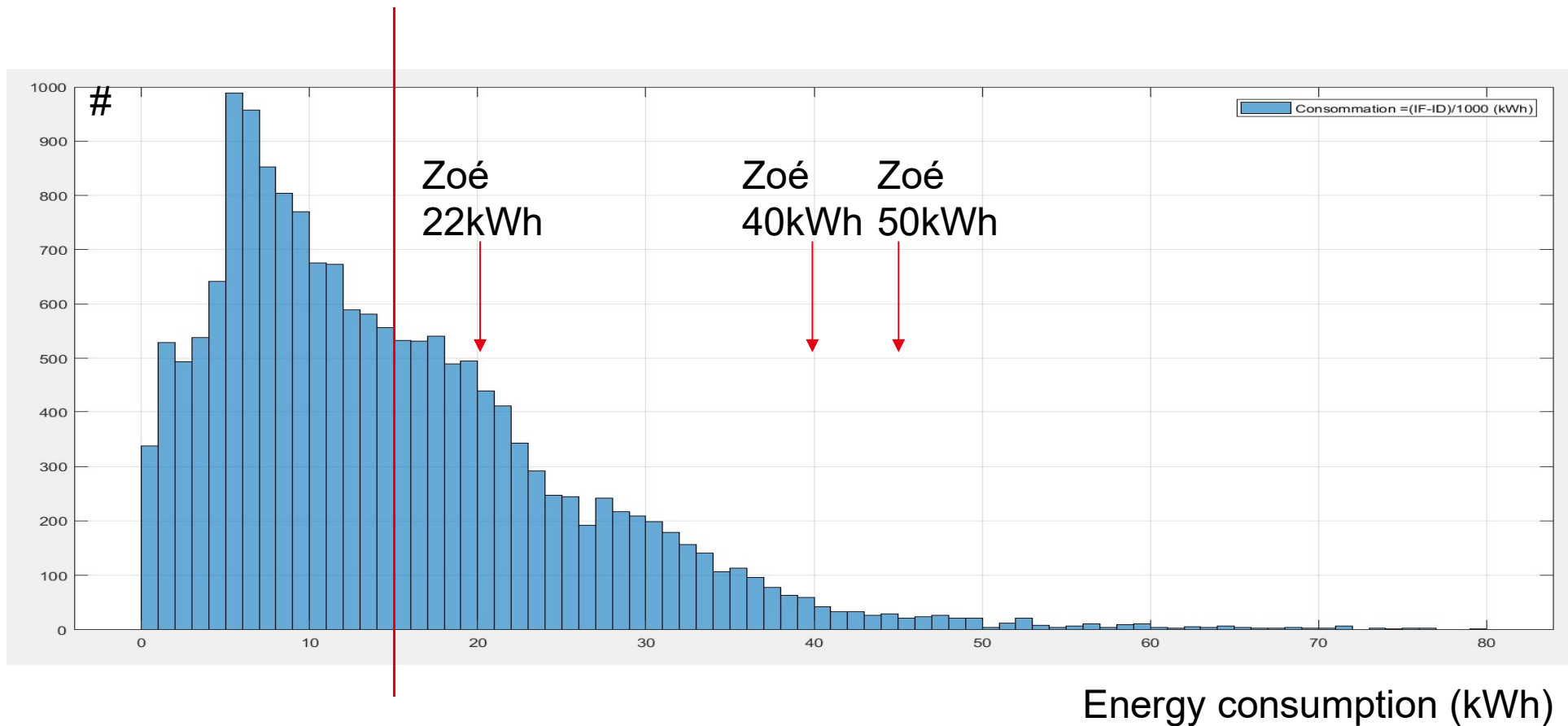


## STATISTICS ON TRANSACTIONS



## ENERGY CONSUMPTION / TRANSACTION

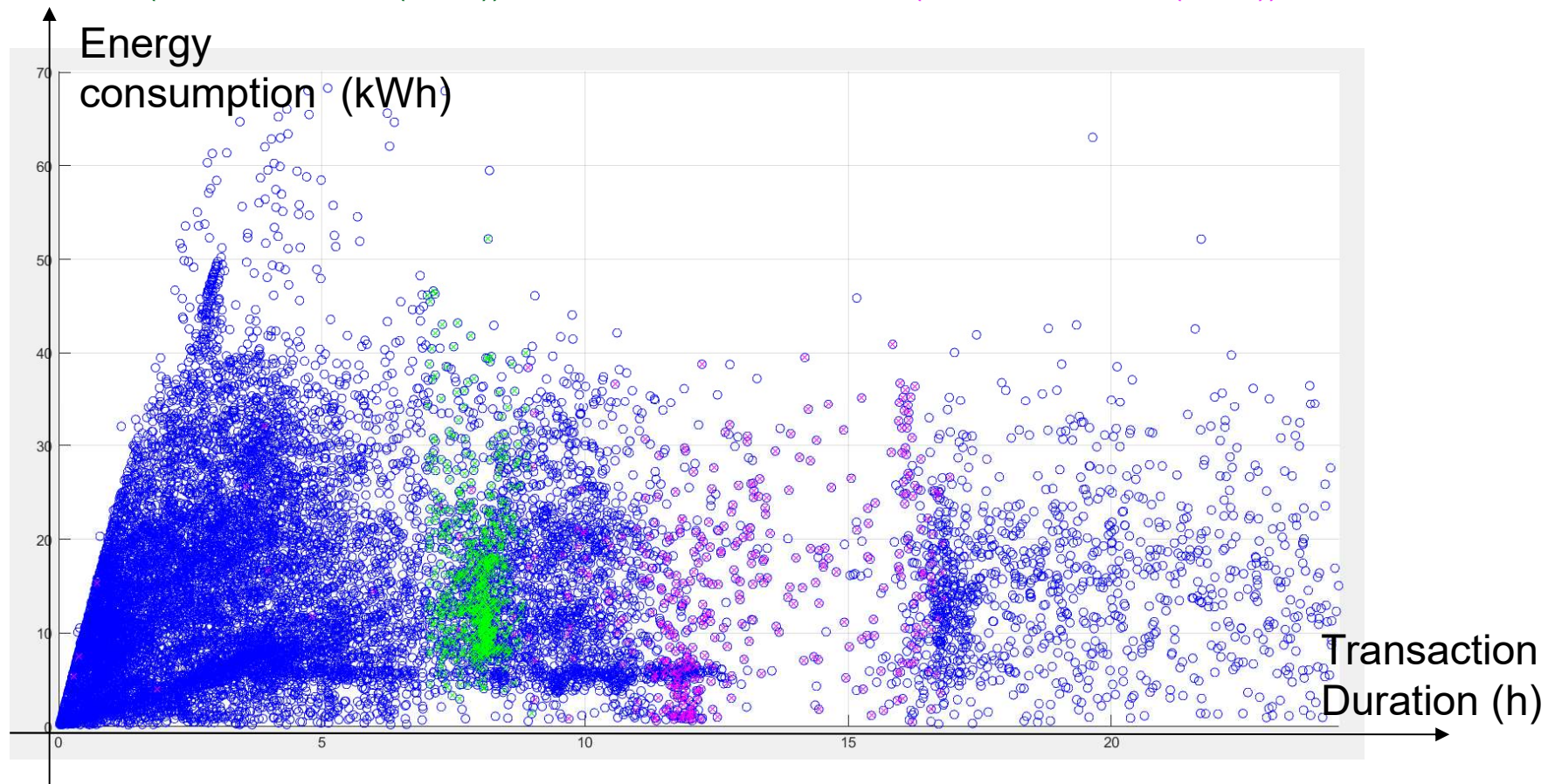
Mean of the energy consumption per transaction : 14.8 kWh



## STATISTICS ON TRANSACTIONS

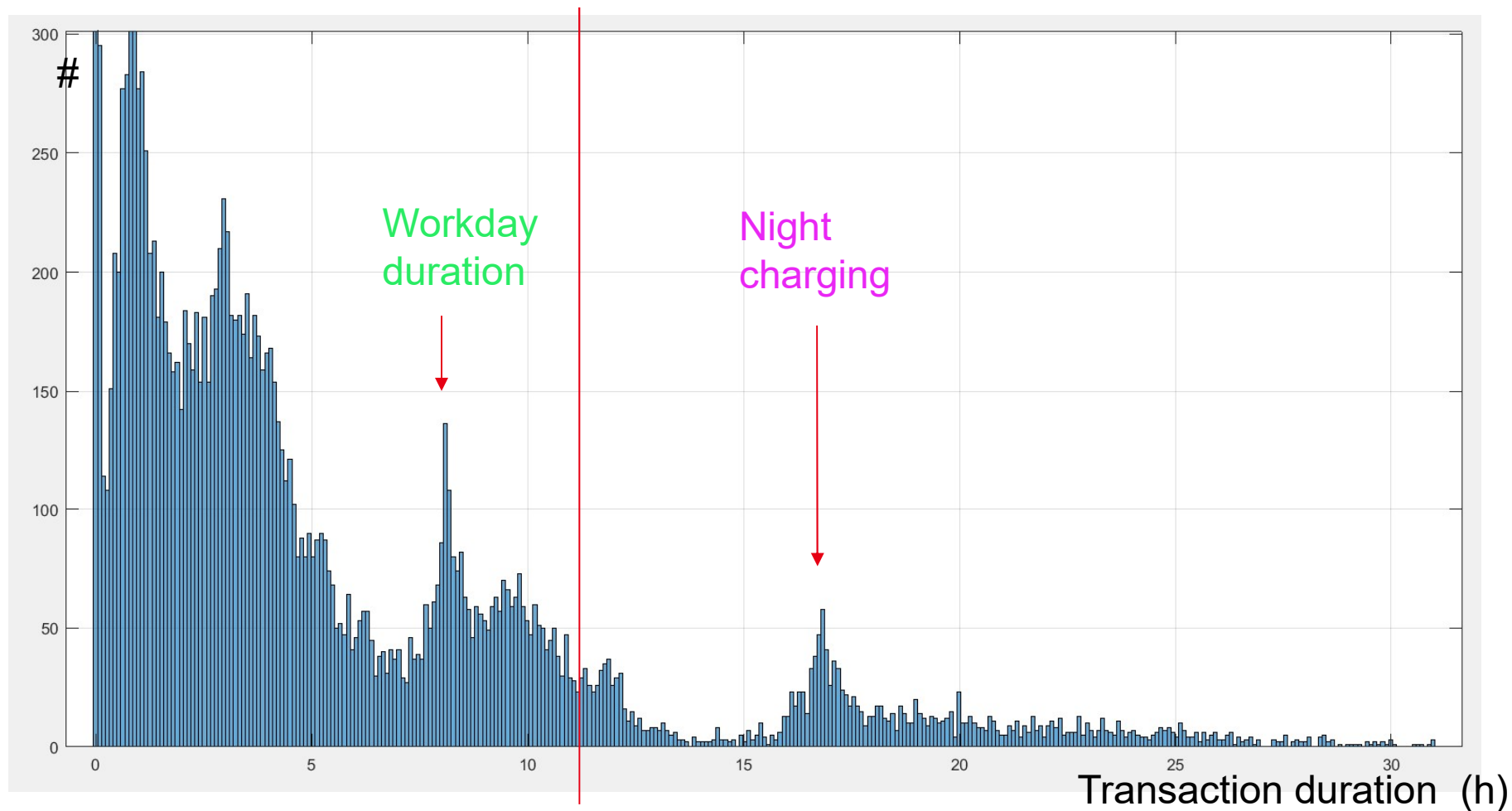
Full workday charging i.e  
-start after 7h and finish before 17h the same day  
-and charge duration greater than 7h  
(743 occurrences (4.7%))

Full night charging i.e  
-start after 15h and finish before 9h the  
following day  
(430 occurrences (2.7%))



## DURATION OF TRANSACTION

Mean of the transaction duration : 12.4h

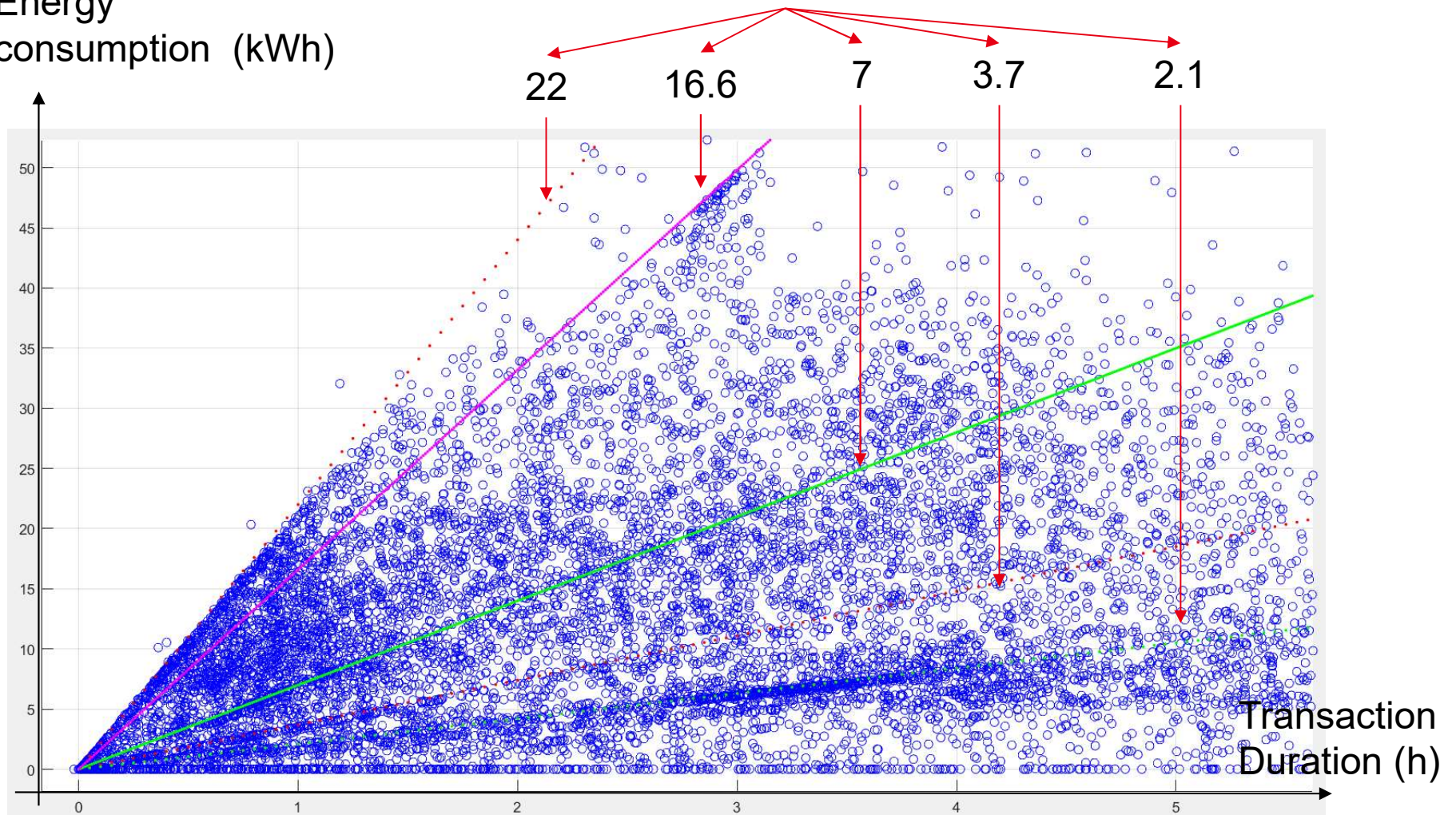




## STATISTICS ON TRANSACTIONS

Energy  
consumption (kWh)

$$EC = \text{Power (kW)} * TD$$

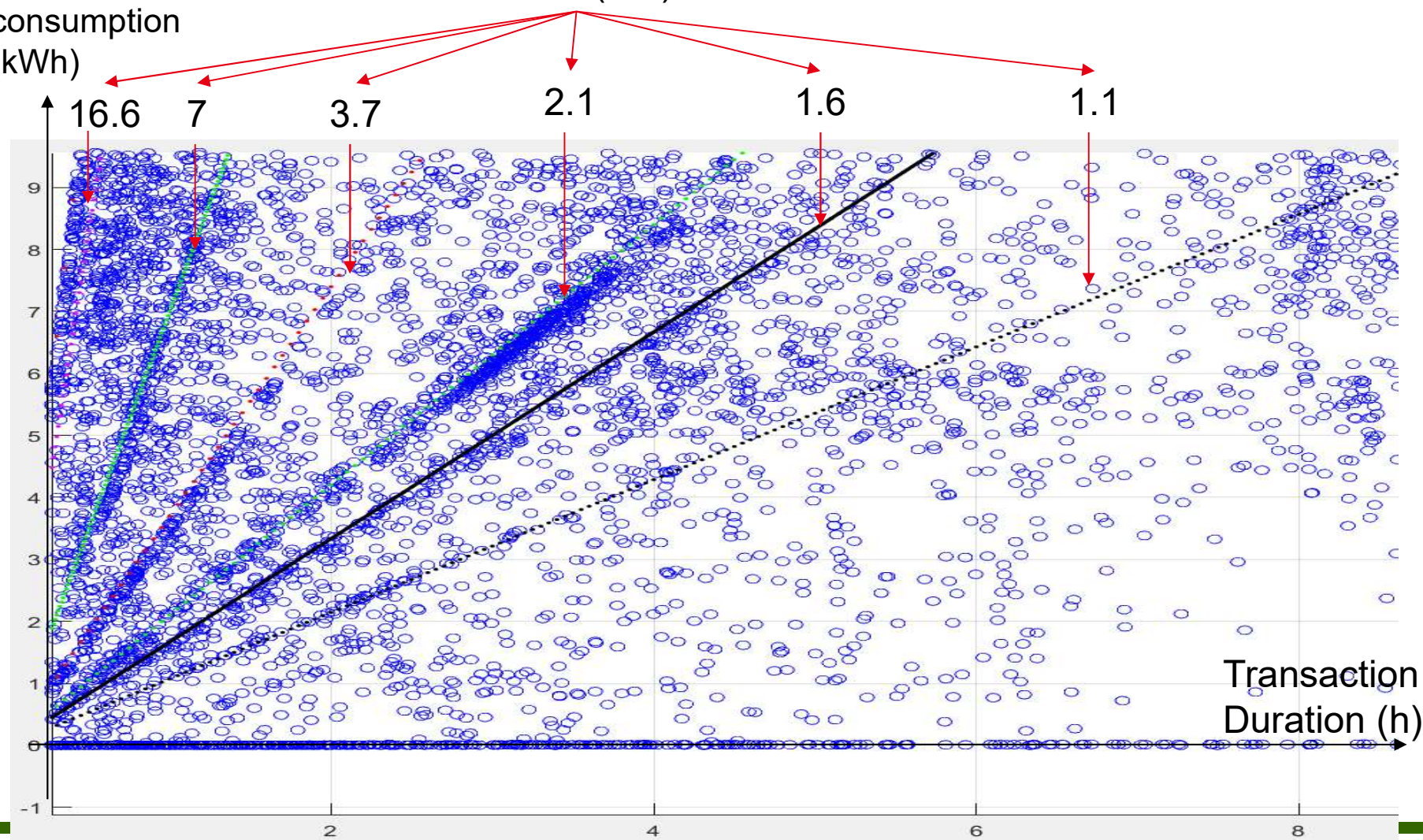




## STATISTICS ON TRANSACTIONS

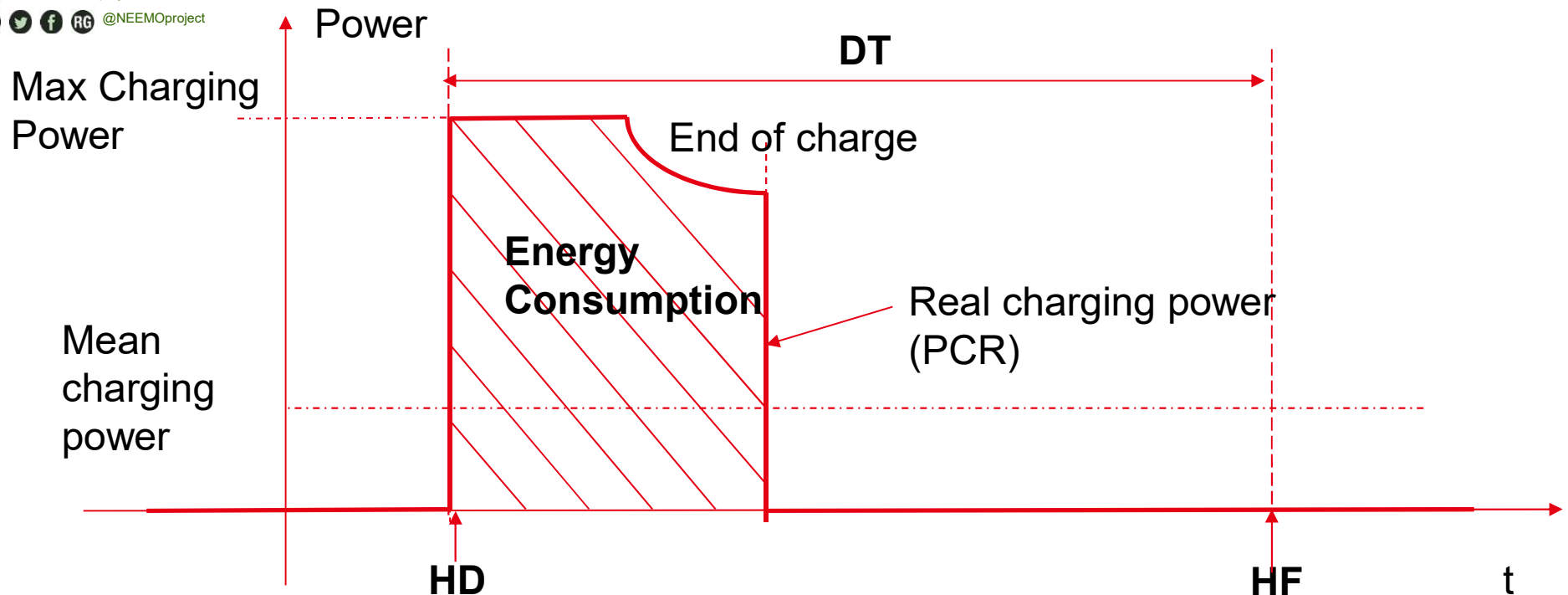
Energy  
consumption  
(kWh)

$$EC = \text{Power (kW)} * TD$$



Transaction  
Duration (h)

## DEFINITIONS : PARAMETERS OF CHARGE



Real Charging Power = PCR => not recorded ; could be estimated

Transaction duration=  $DT = HF - HD$  => recorded in the transaction file

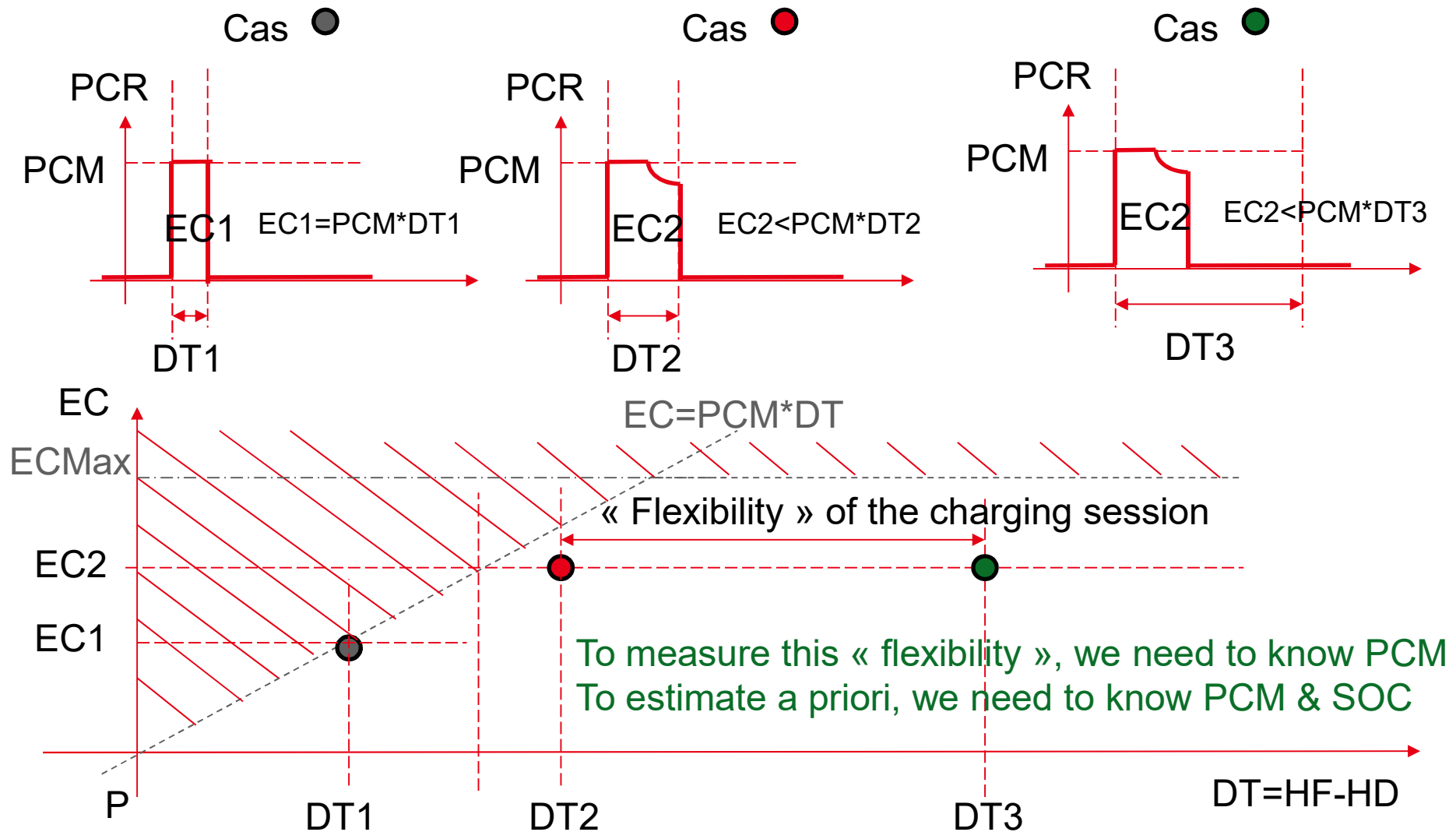
Energy Consumption = EC =  $ID - IF$  => recorded in the transaction file

Battery capacity = Max of energy consumption =  $EC_{Max}$  => depends of the EV model

Max Charging Power = PCM => depends of the EV model

Mean charging power =  $PC_{Mean} = EC / DT$  => can be calculated

## DEFINITION : FLEXIBILITY



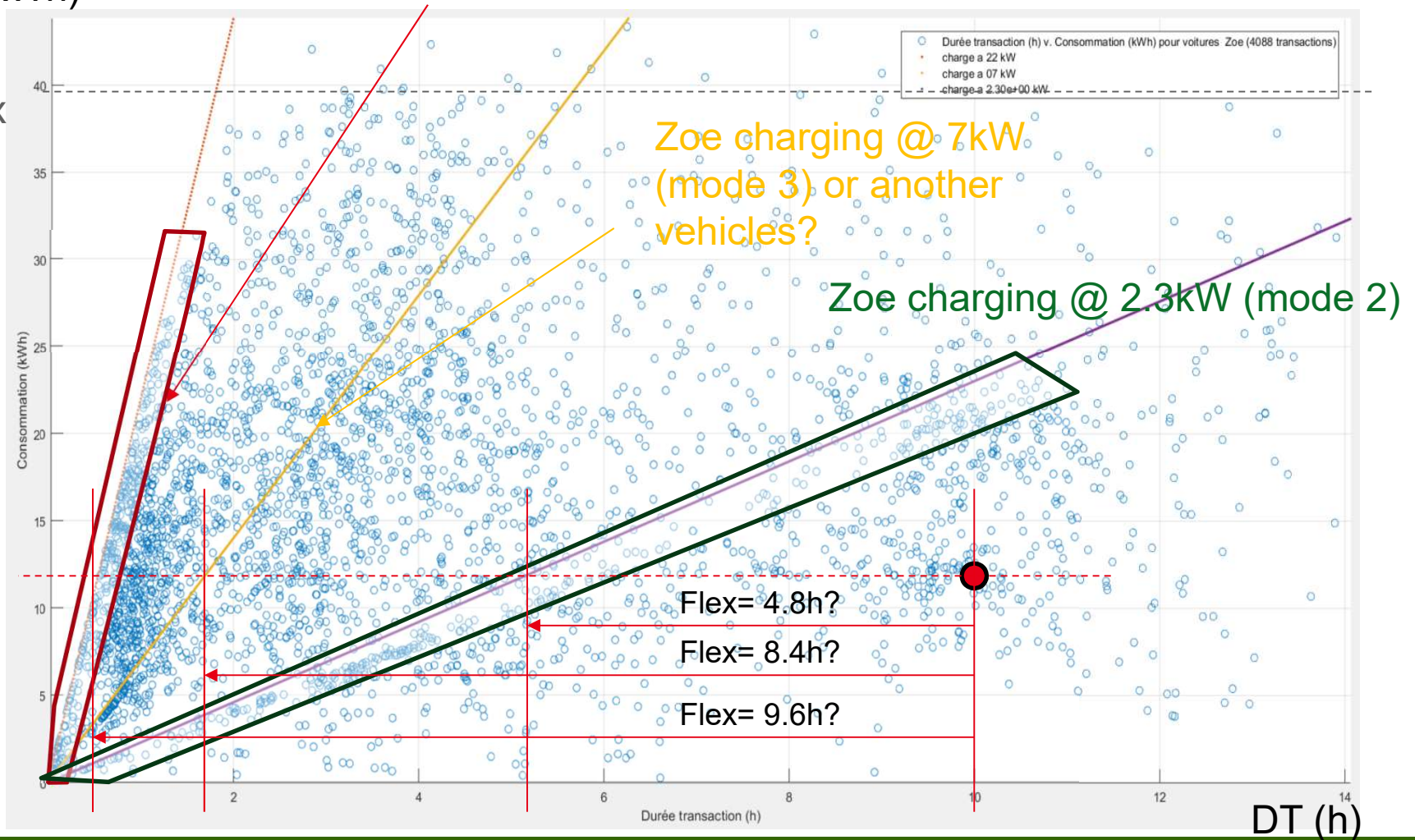


## EXAMPLE : ALL THE ZOE

EC (kWh)

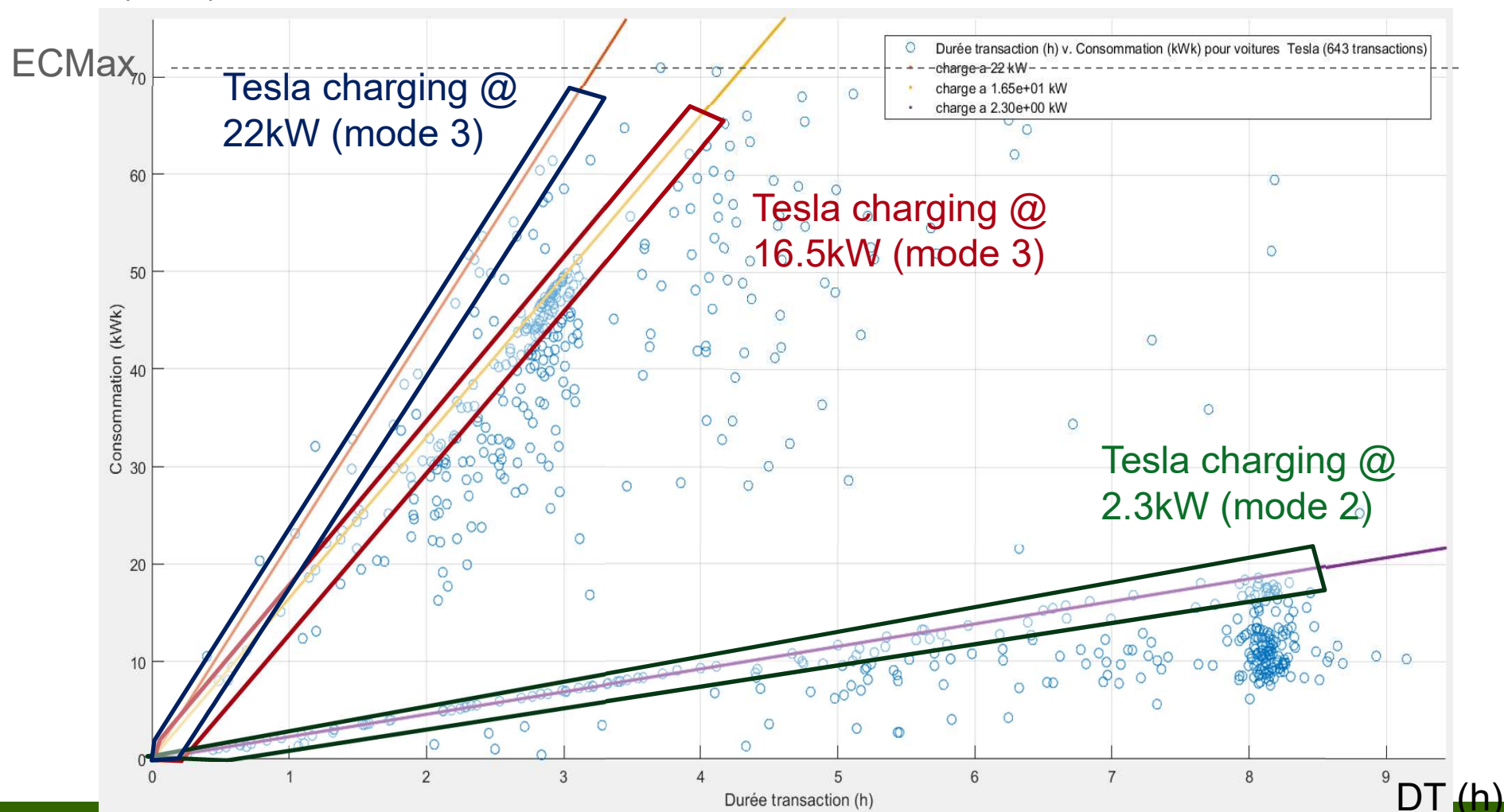
Zoe charging @ 22kW (mode 3)

ECMax

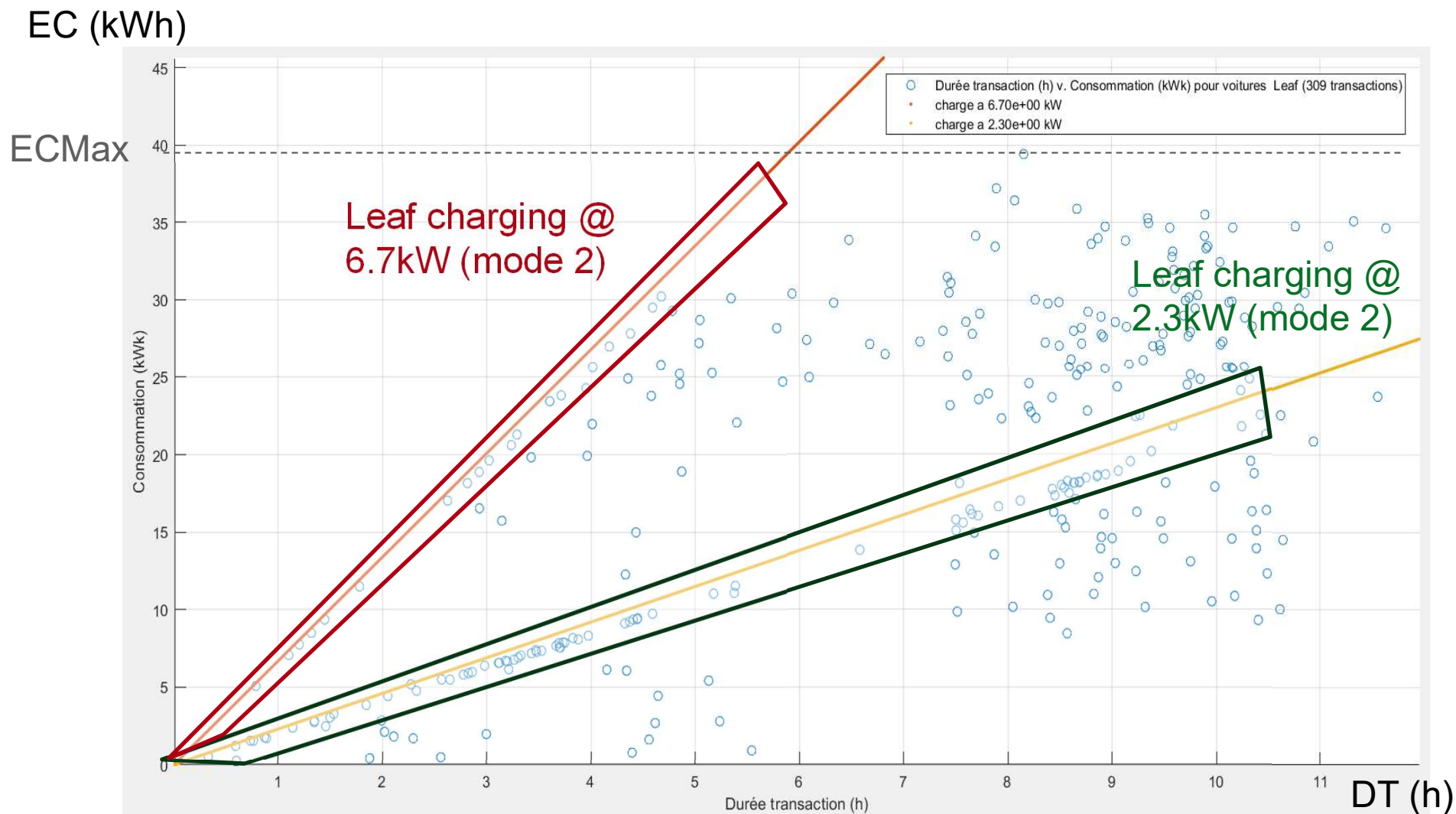


## EXAMPLE : ALL THE TESLA

EC (kWh)



## EXAMPLE: ALL THE LEAF

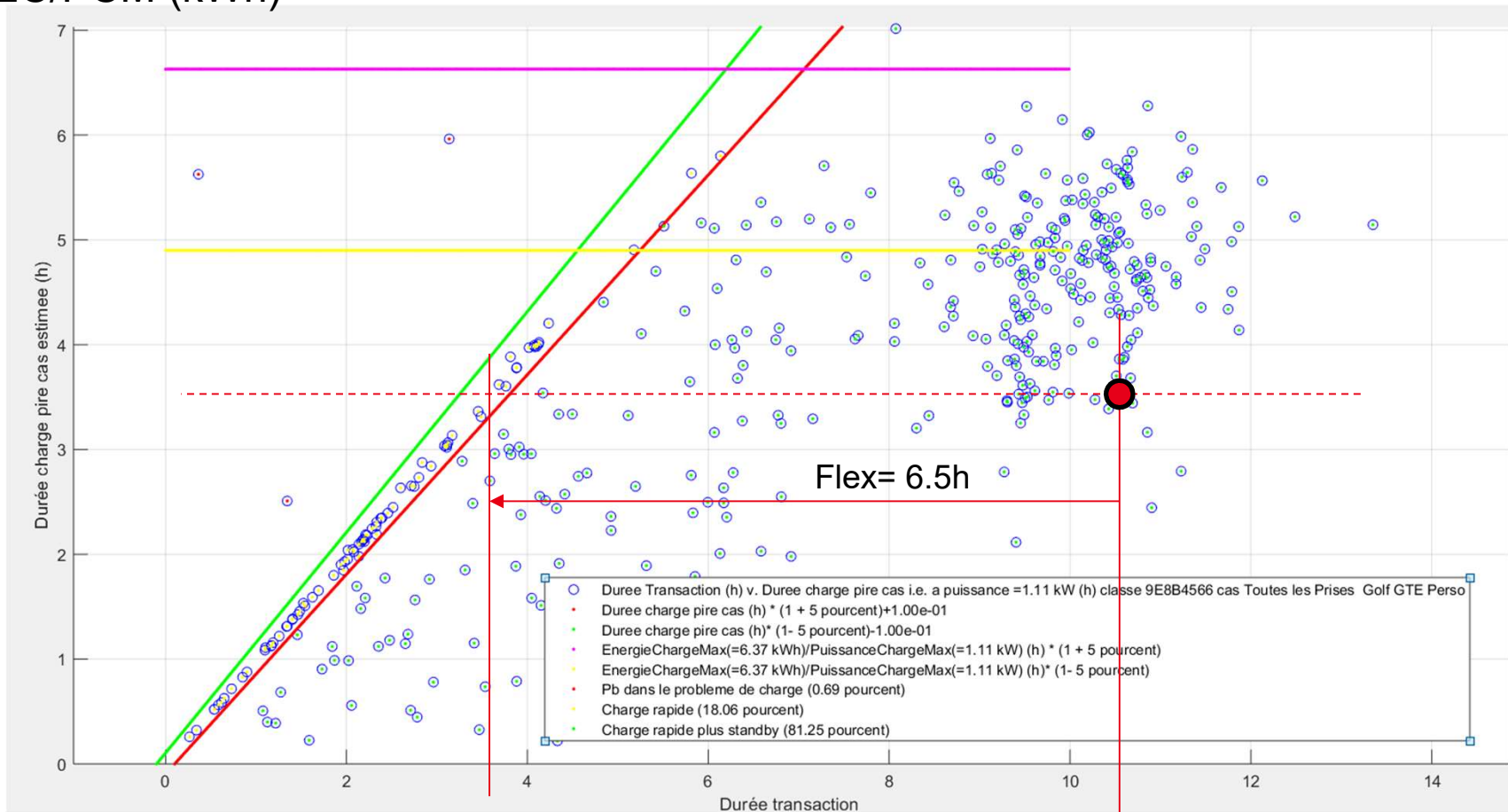




## EXAMPLE: ONE GOLF GTE (PHEV)

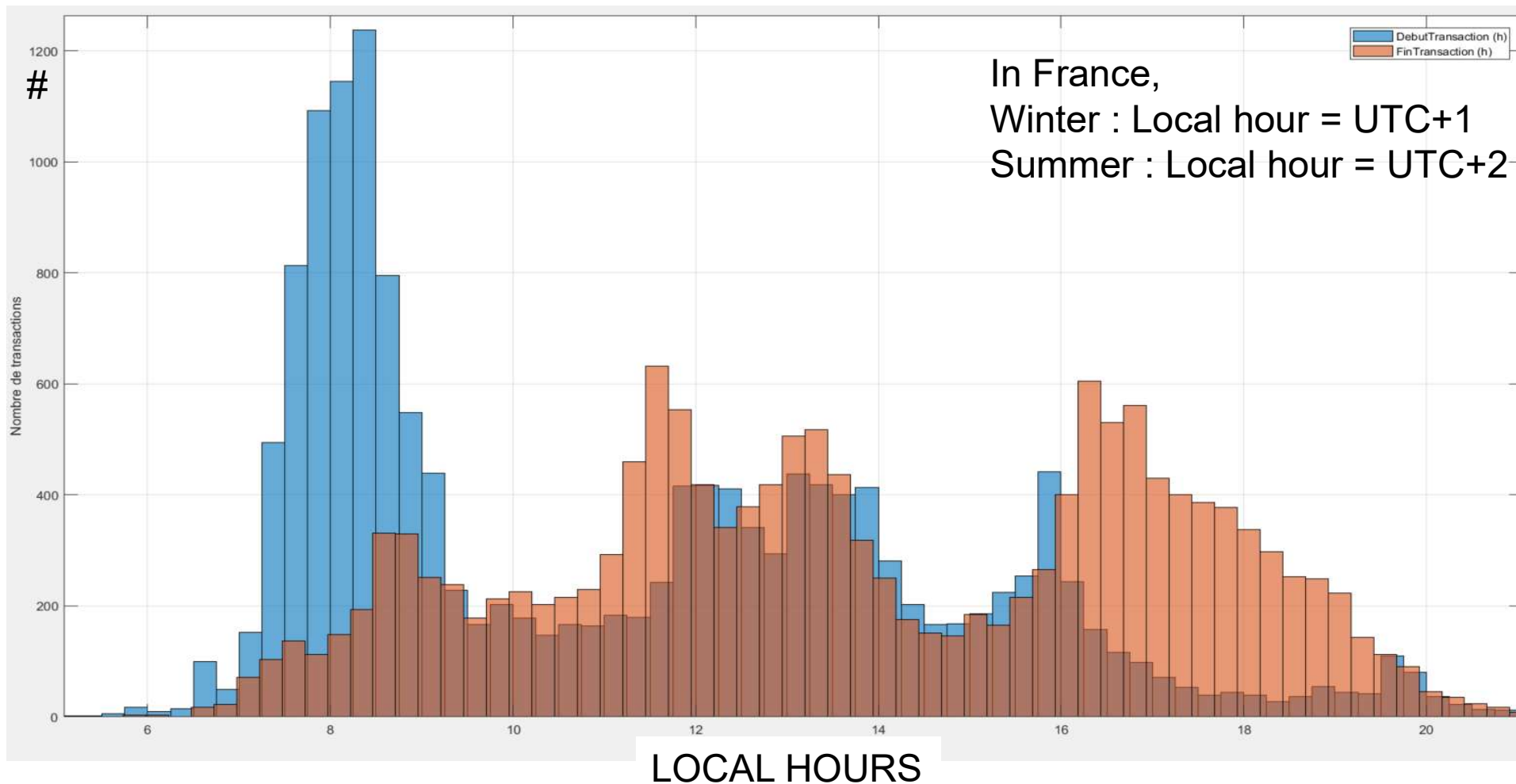
Estimation of PCM = 1.1 kW (mode 3 with T2 connector)

EC/PCM (kWh)



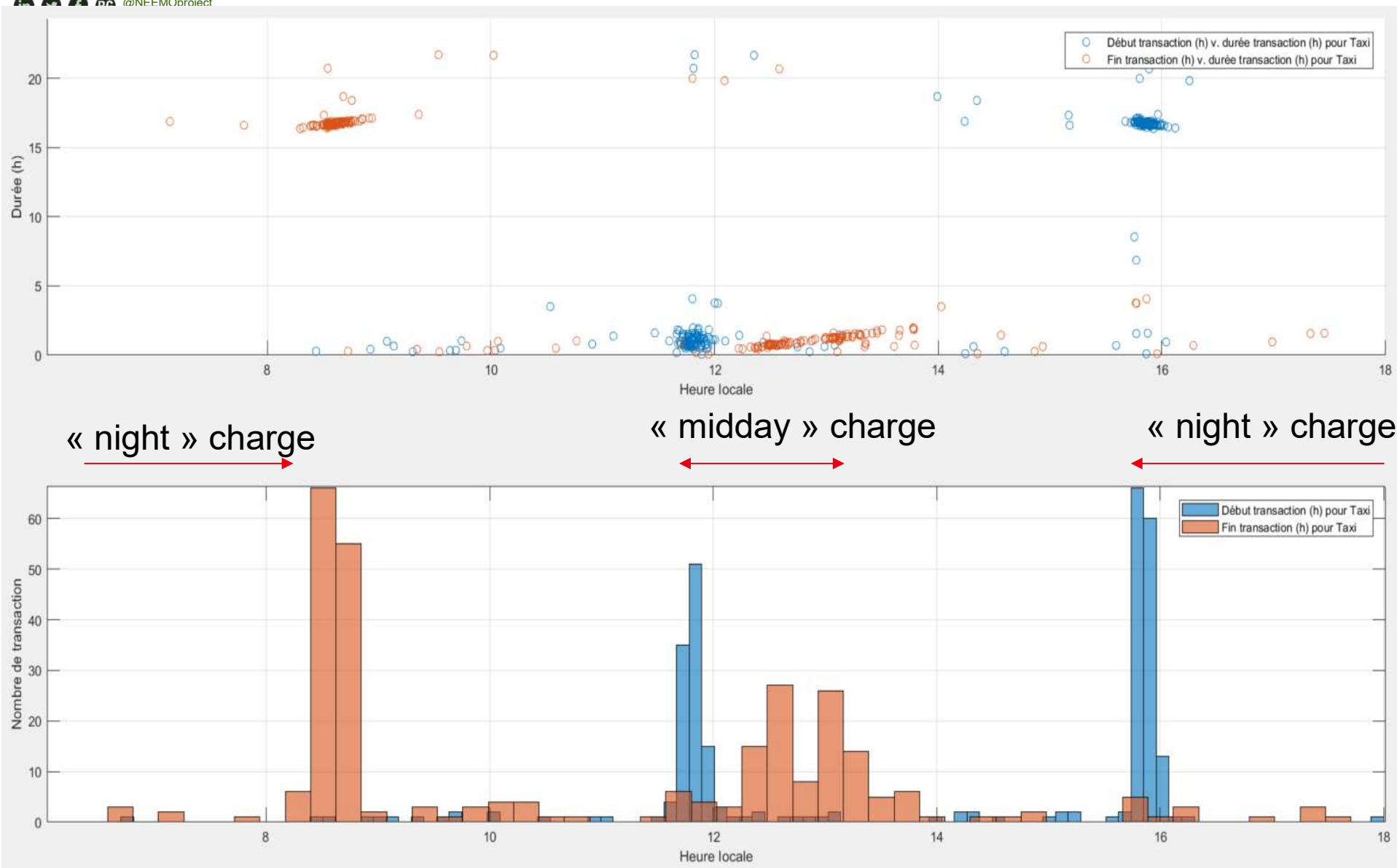
TD (h)

## START/END OF TRANSACTIONS

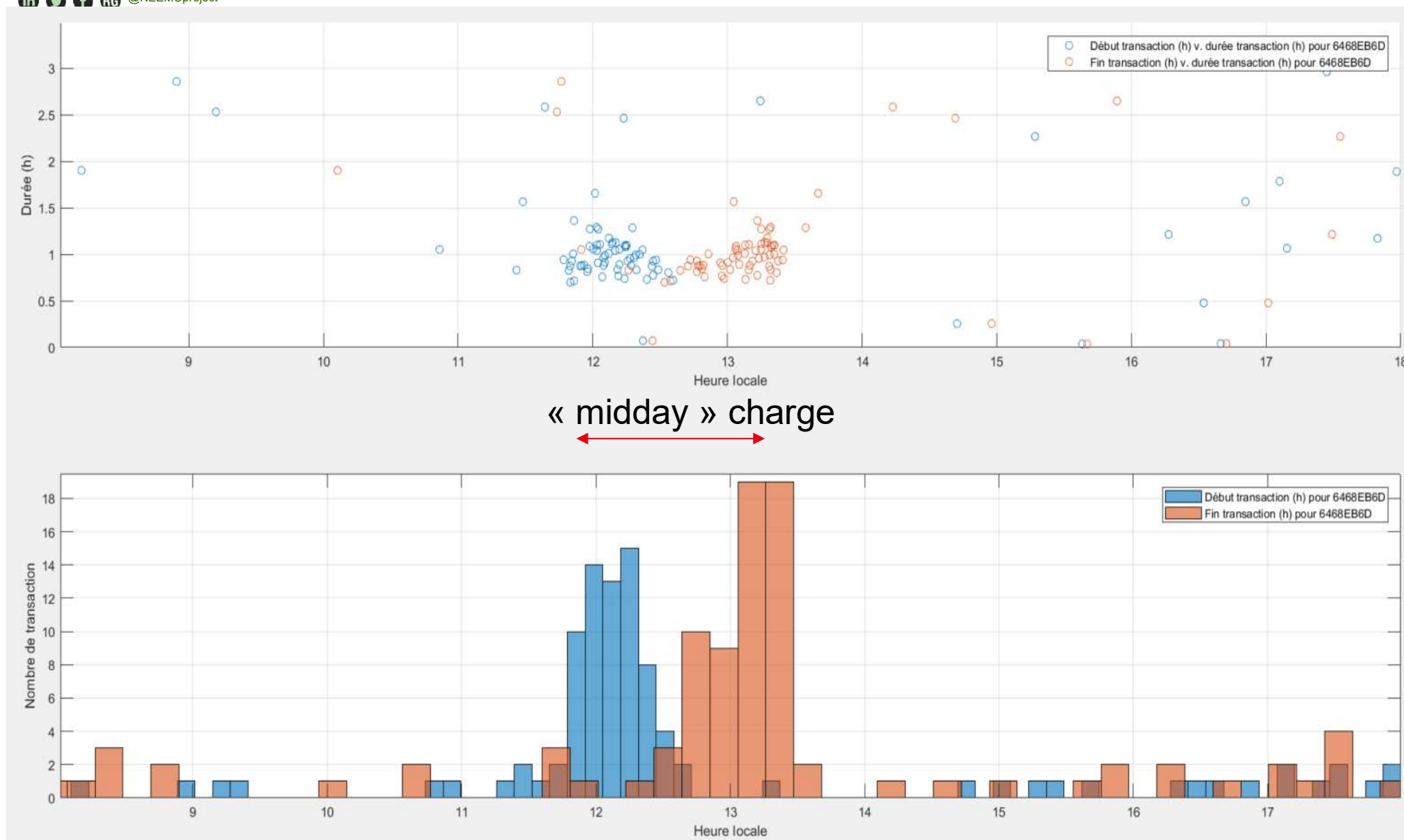




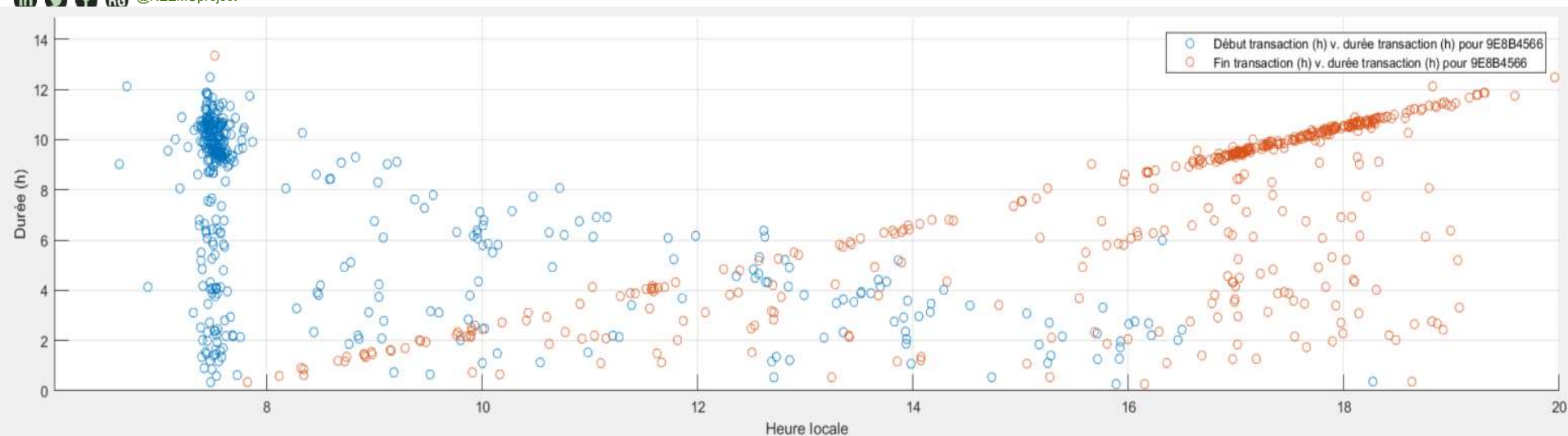
## START/END OF TRANSACTIONS : 'TAXI'



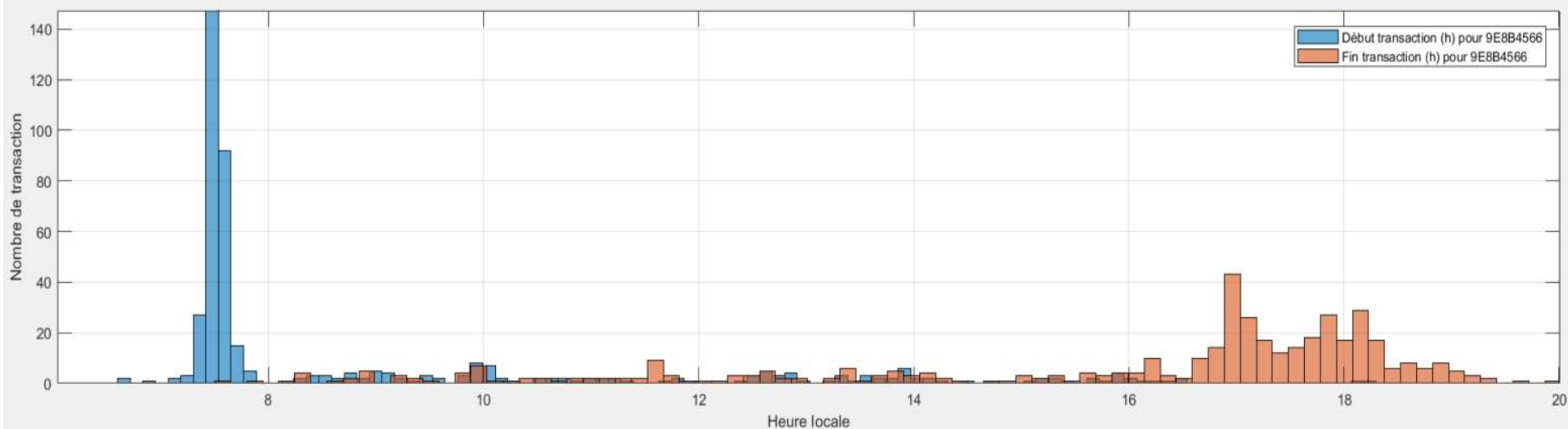
## START/END OF TRANSACTIONS : SERVICE VEHICLE



## START/END OF TRANSACTIONS : PERSONAL VEHICLE



Full workday charge

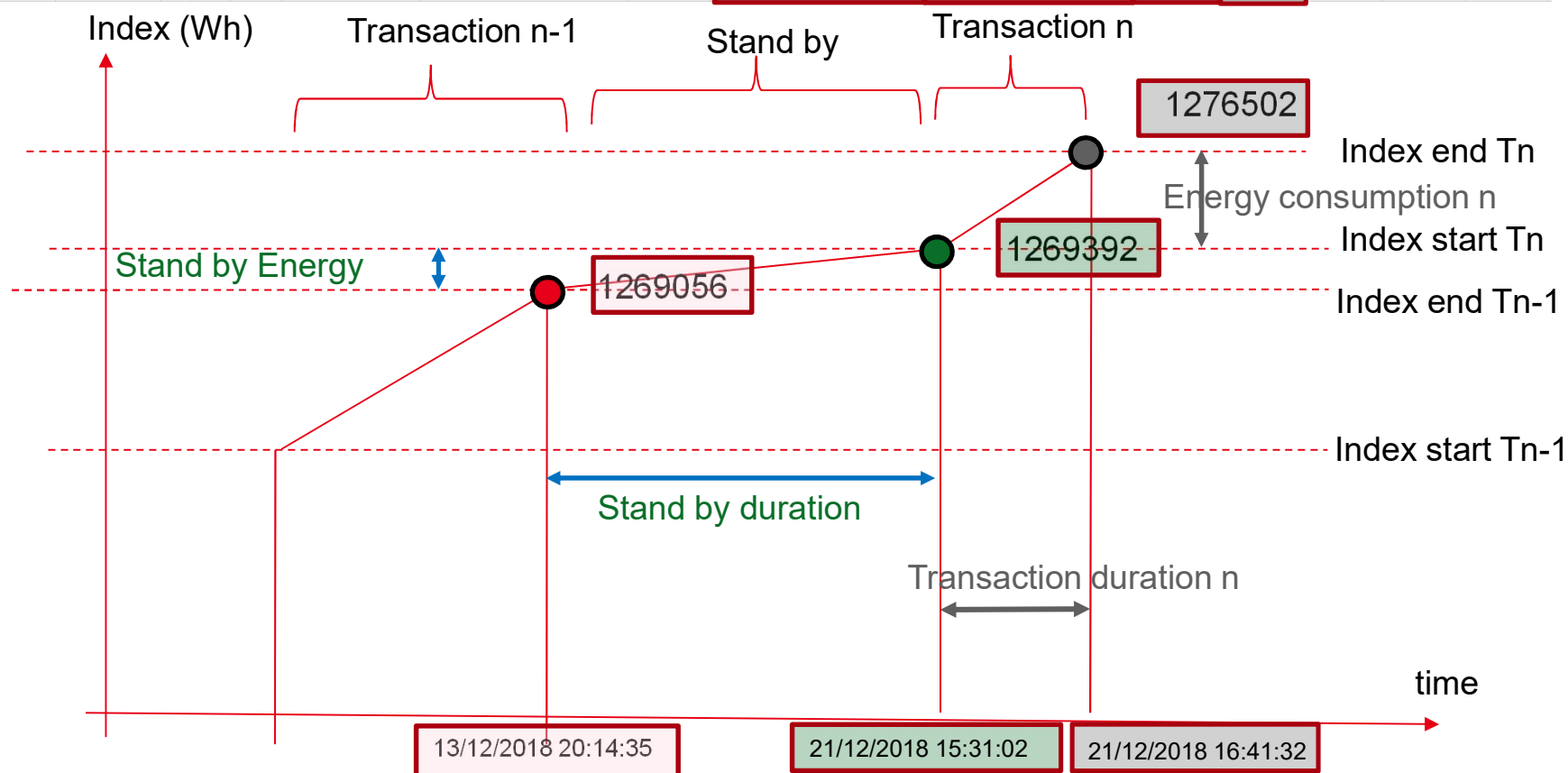


- **Evolve Project**
- **CEA EVCI & PV**
  - CEA EVCI
  - Charging modes
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  - Evolve @Cadarache
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  - Examples of simulation results
  - First experimental results

## MEAN CHARGING POWER HYP. : PRINCIPLE OF RECONSTRUCTION

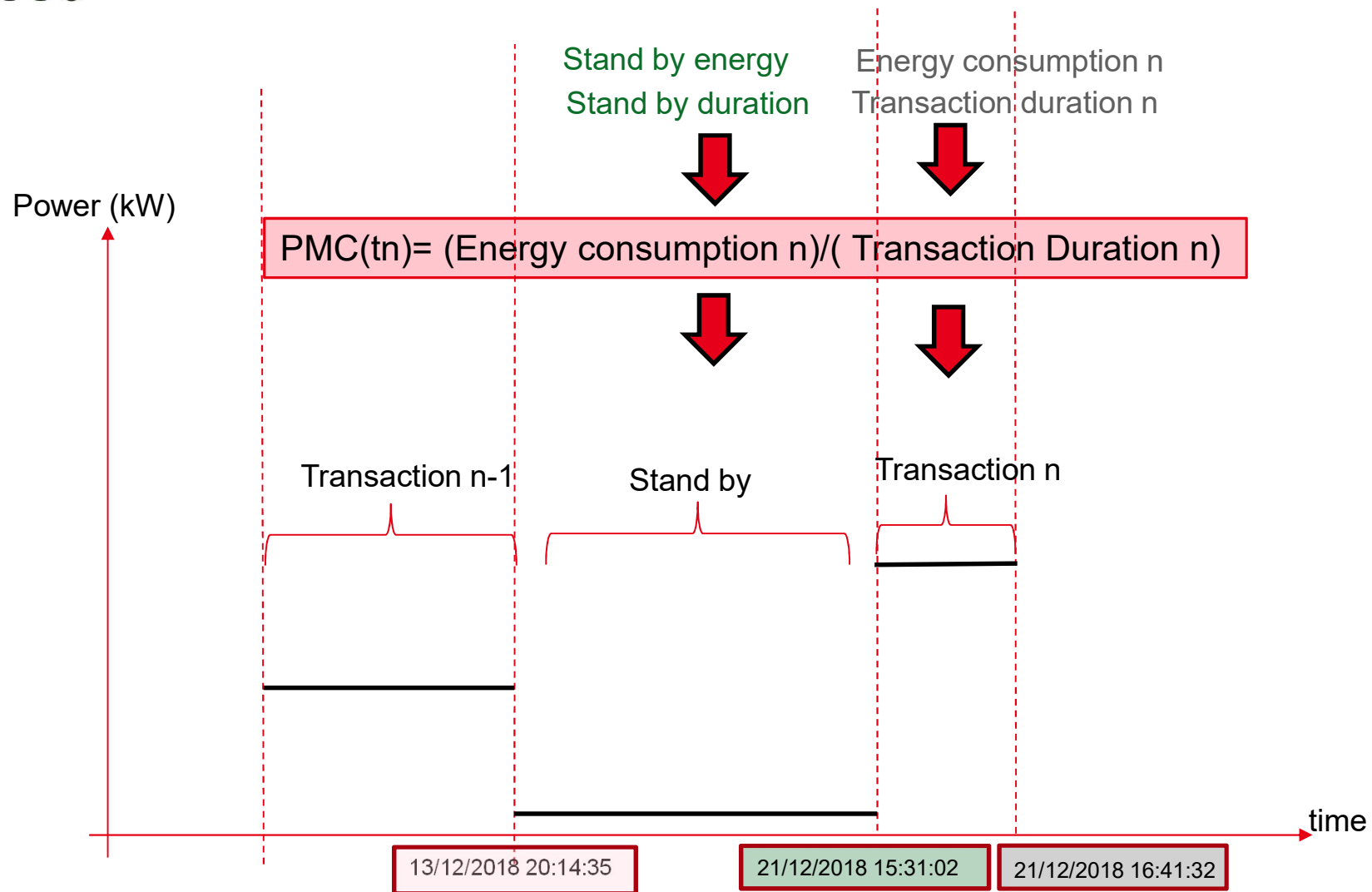
1	Mois	Jour	Uui Tran	Zonelc	Nom de la Zone	PdC	Badge	Début Session	Fin Session	Début Pow	Fin Power	Consomm	Type de pr	Emsp
2	#####	05/12/2018	b81	CU-E	CEA-C Batiment 101 - 1	CU-BAT1011-13CEA-1	7490E56D	05/12/2018 14:50:37	05/12/2018 16:03:58	1227407	1238878	11.471	T2	G2M
3	#####	06/12/2018	20b	CU-E	CEA-C Batiment 101 - 1	CU-BAT1011-13CEA-1	1E974366	06/12/2018 10:12:27	06/12/2018 13:48:08	1238909	1258302	19.393	T2	G2M
4	#####	13/12/2018	749	CU-E	CEA-C Batiment 101 - 1	CU-BAT1011-13CEA-1	4E8E4566	13/12/2018 16:13:56	13/12/2018 20:14:35	1258601	1269056	10.455	T2	G2M
5	#####	21/12/2018	6d4	CU-E	CEA-C Batiment 101 - 1	CU-BAT1011-13CEA-1	3EF7EB7E	21/12/2018 15:31:02	21/12/2018 16:41:32	1269392	1276502	7.11	T2	G2M

n-1  
n



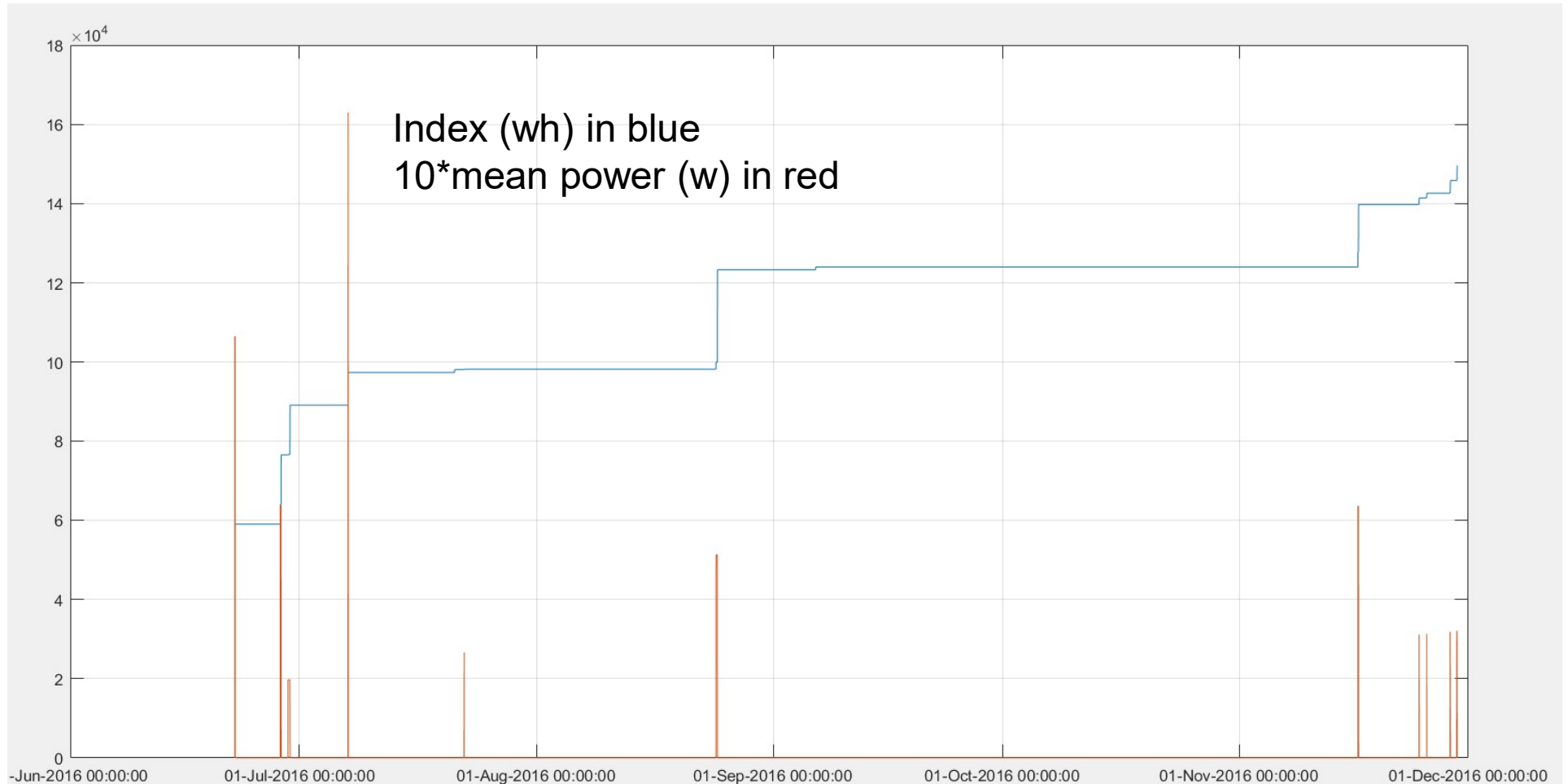


# MEAN CHARGING POWER HYP. : PRINCIPLE OF RECONSTRUCTION



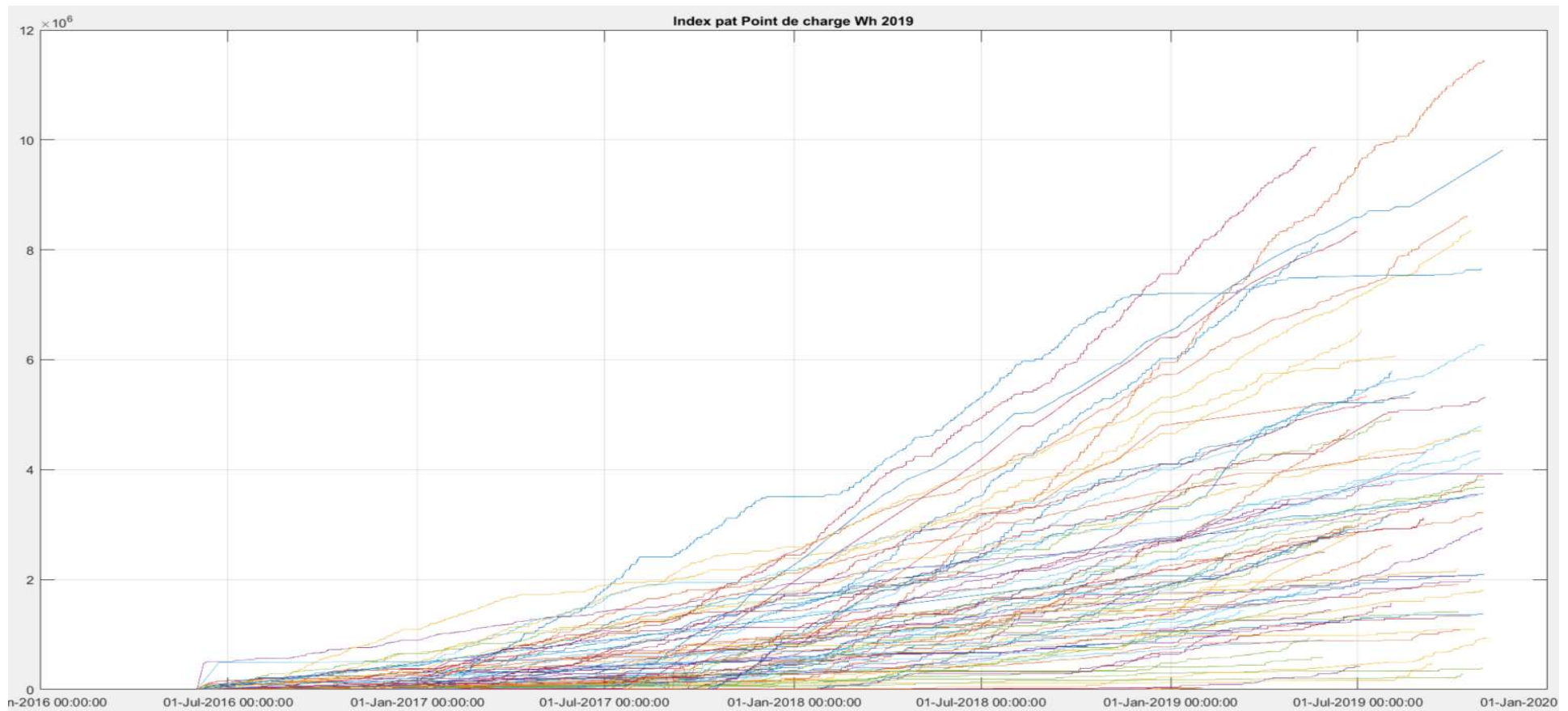
## MEAN CHARGING POWER HYP. : EXAMPLES

PdC: CU\_BAT1011\_13CEA



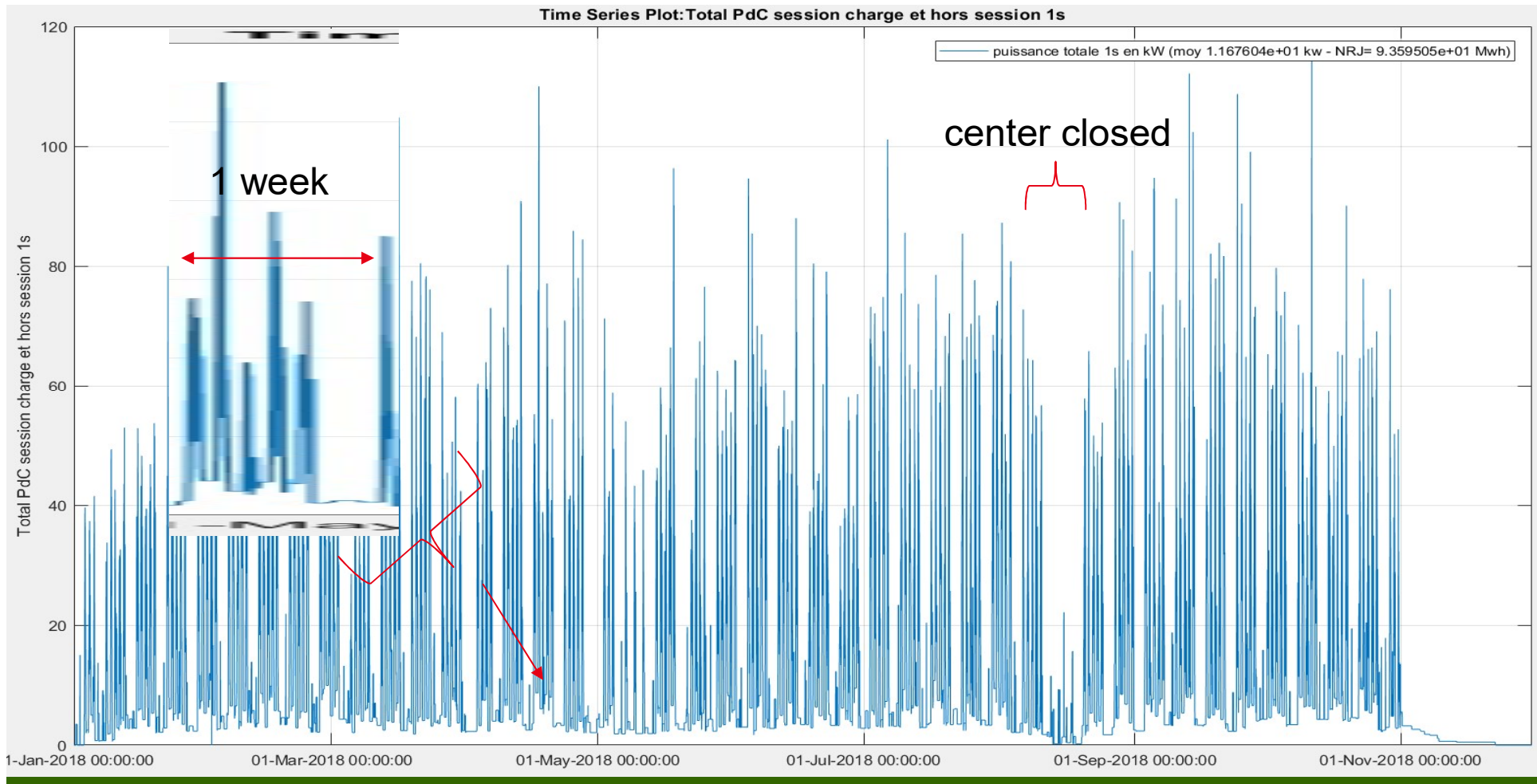
## MEAN CHARGING POWER HYP. : INDEX CURVES

Energy indexes of the 81 charging stations (Wh)



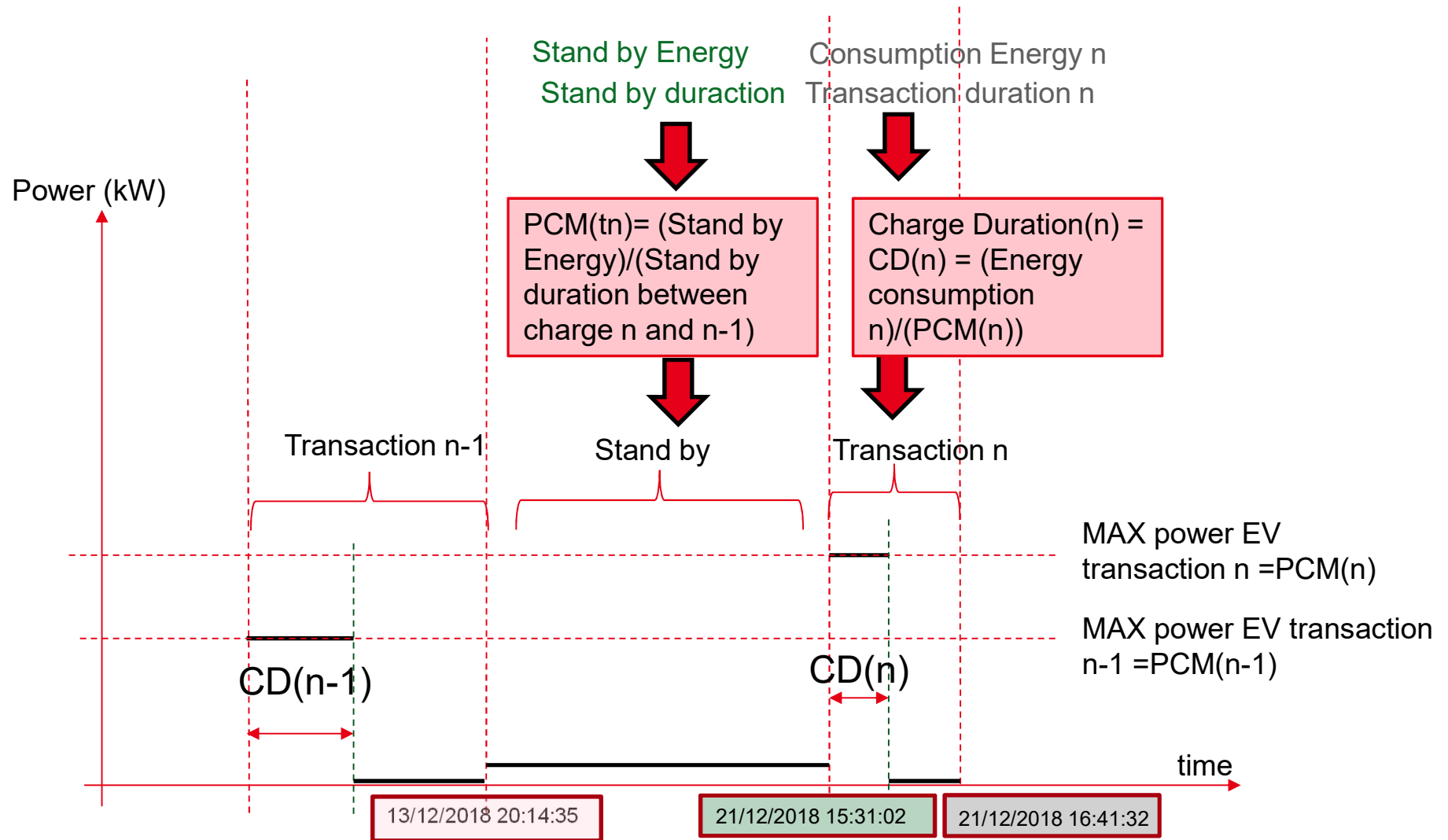
## MEAN CHARGING POWER HYP. : AGGREGATED LOAD CURVE

Total of the mean power for 81 charging stations (year 2018)

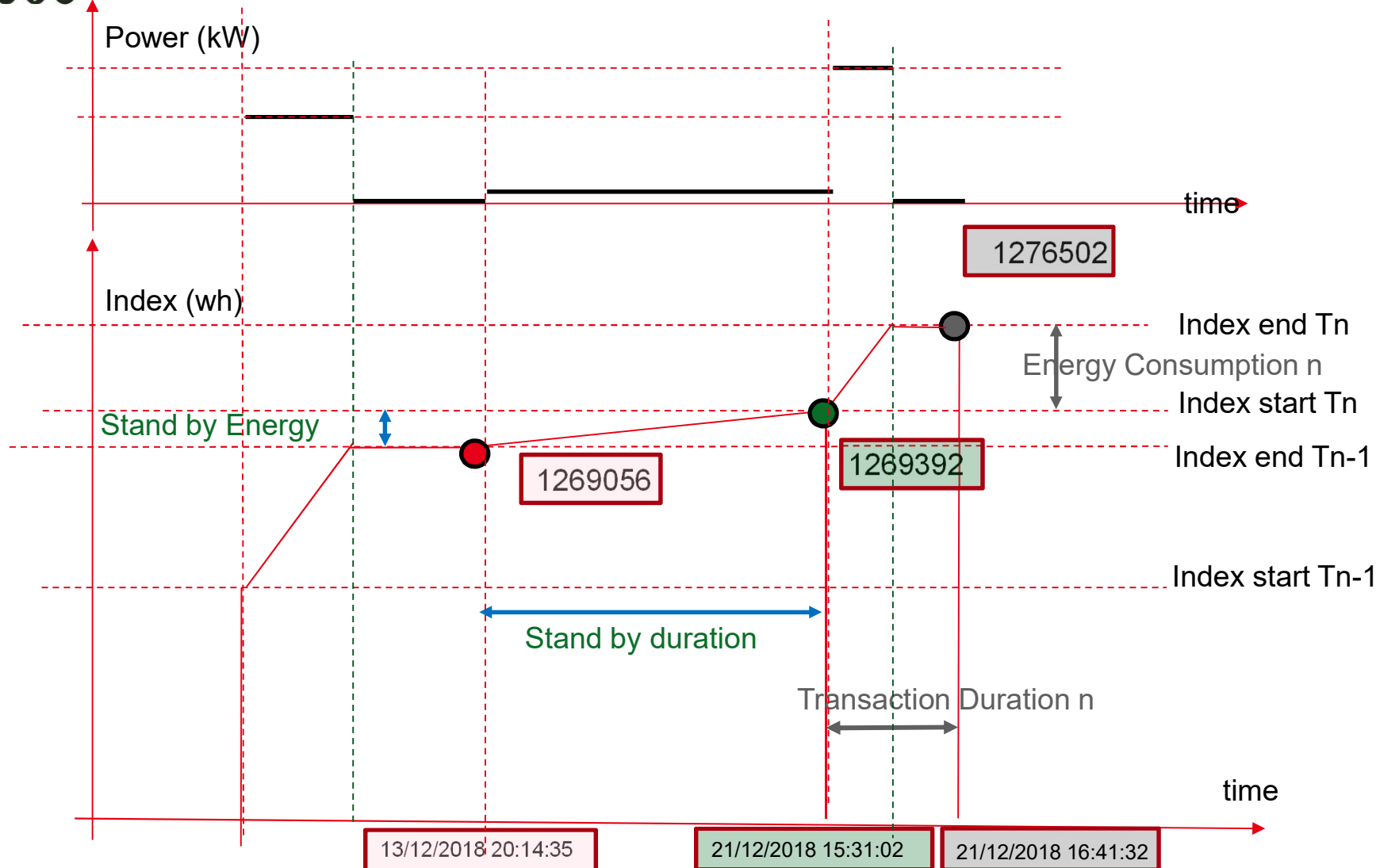




# MAX CHARGING POWER HYP. : PRINCIPLES OF RECONSTRUCTION

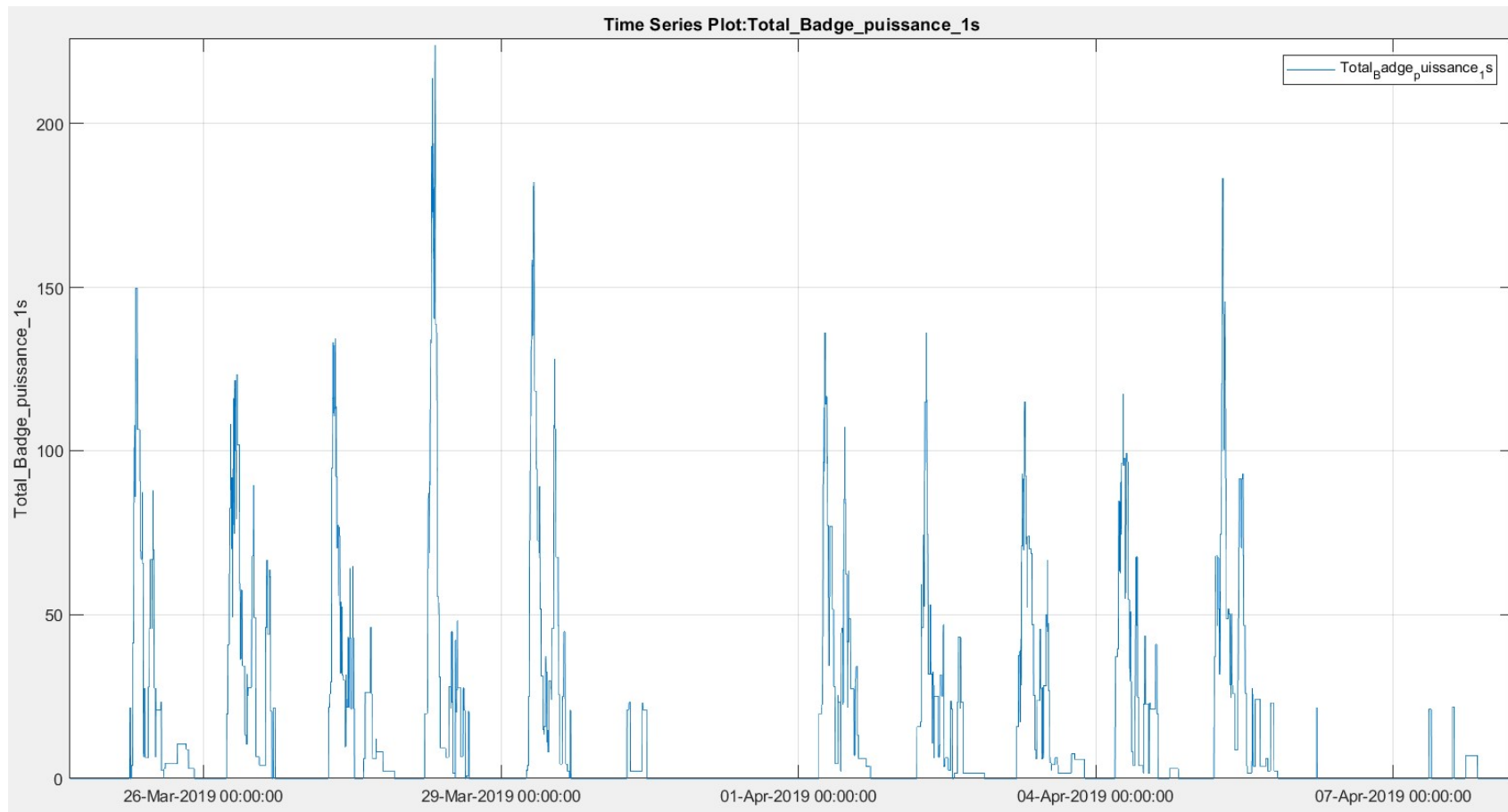


# MAX CHARGING POWER HYP. : PRINCIPLES OF RECONSTRUCTION

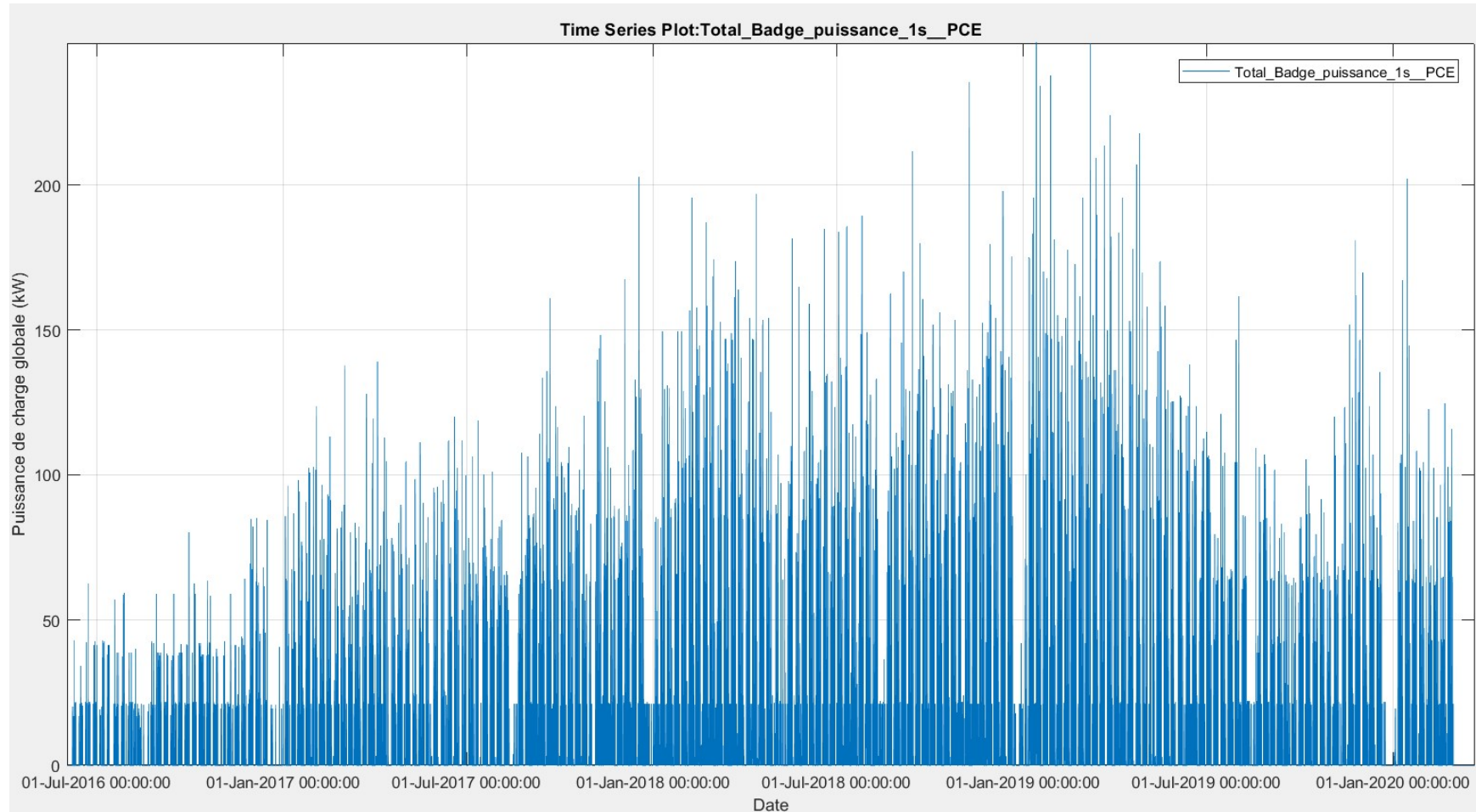


## MAX CHARGING POWER HYP. : LOAD CURVES

Charging power curves during 2 weeks:

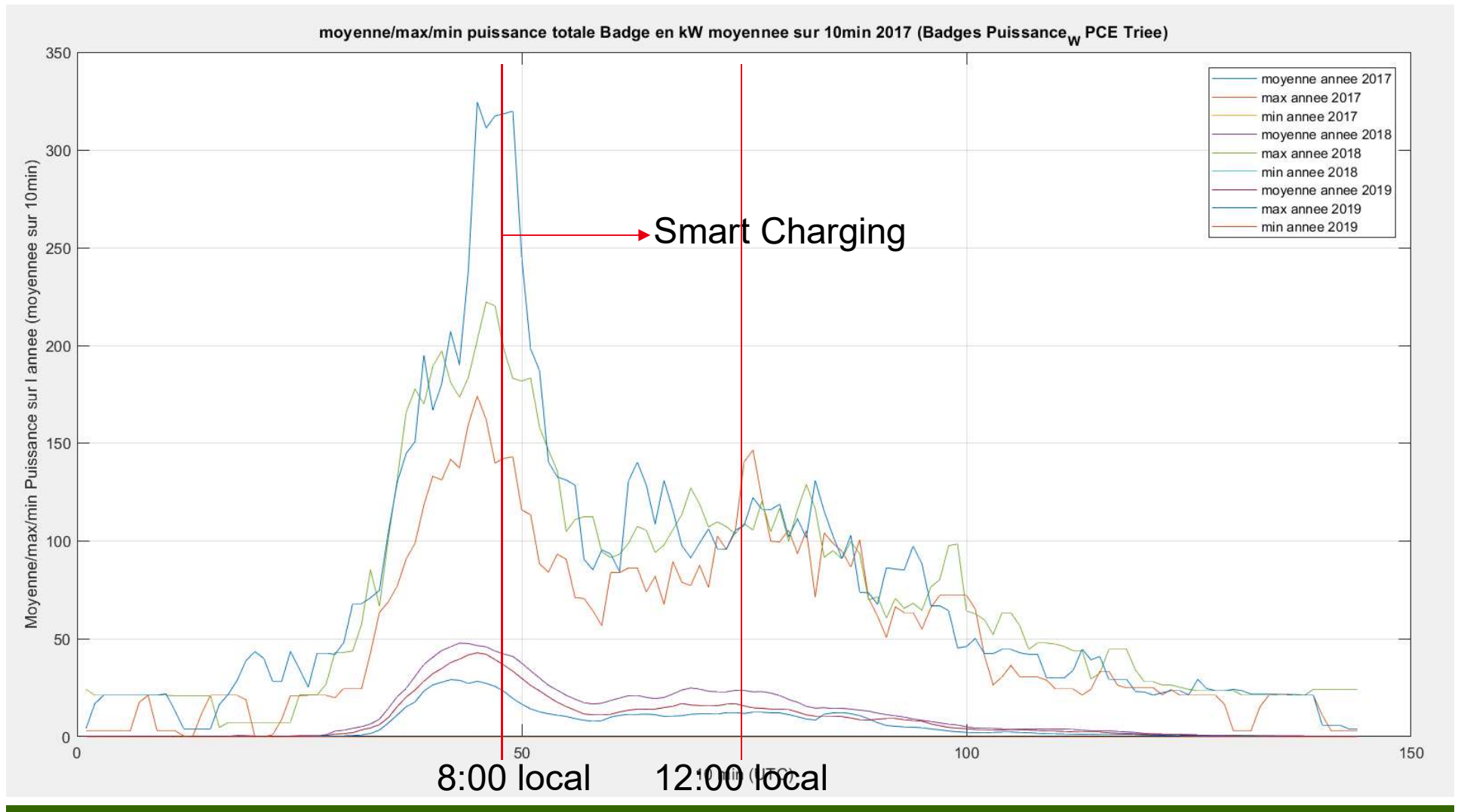


Charging power curves during 3.5 years:

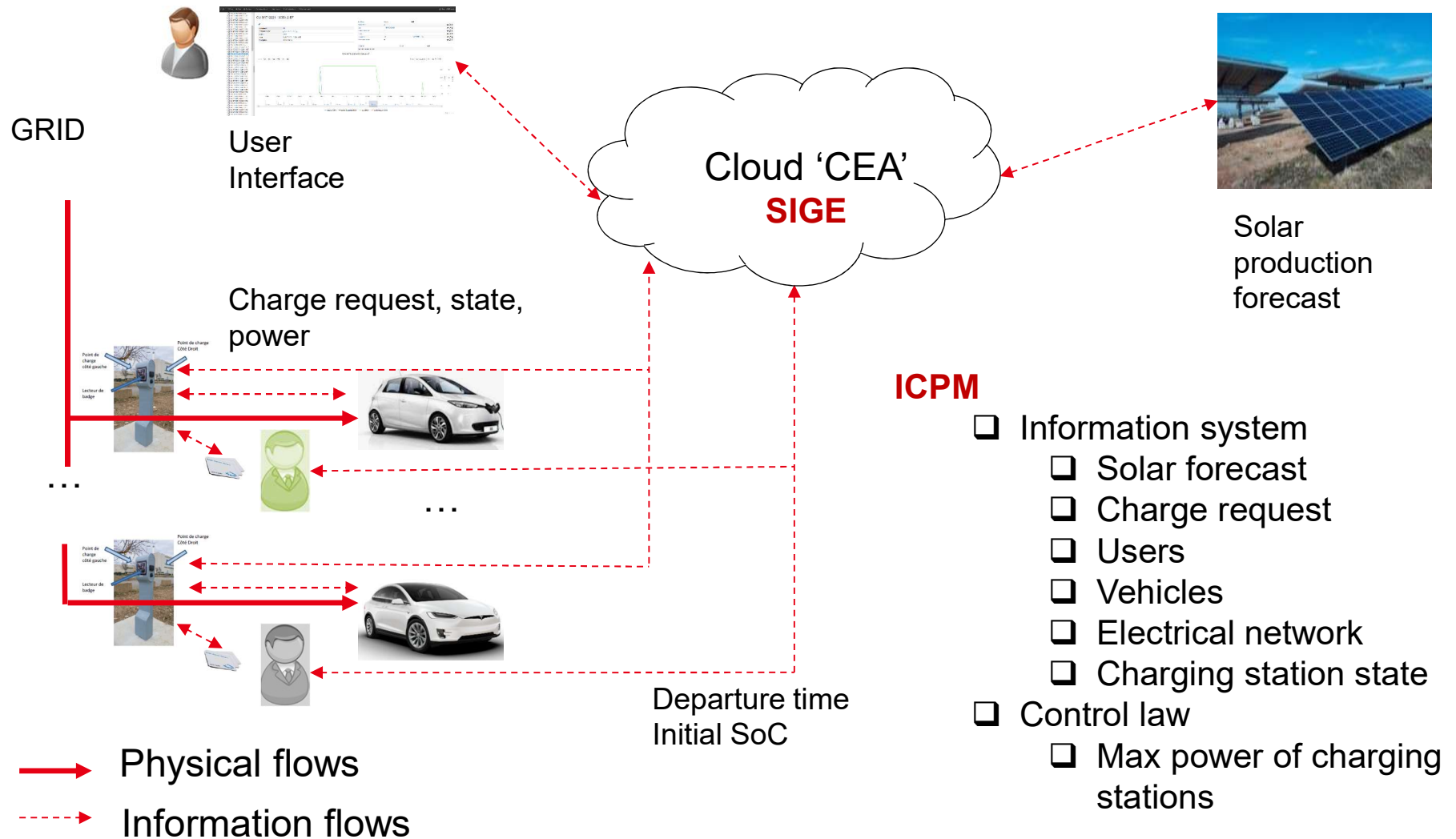


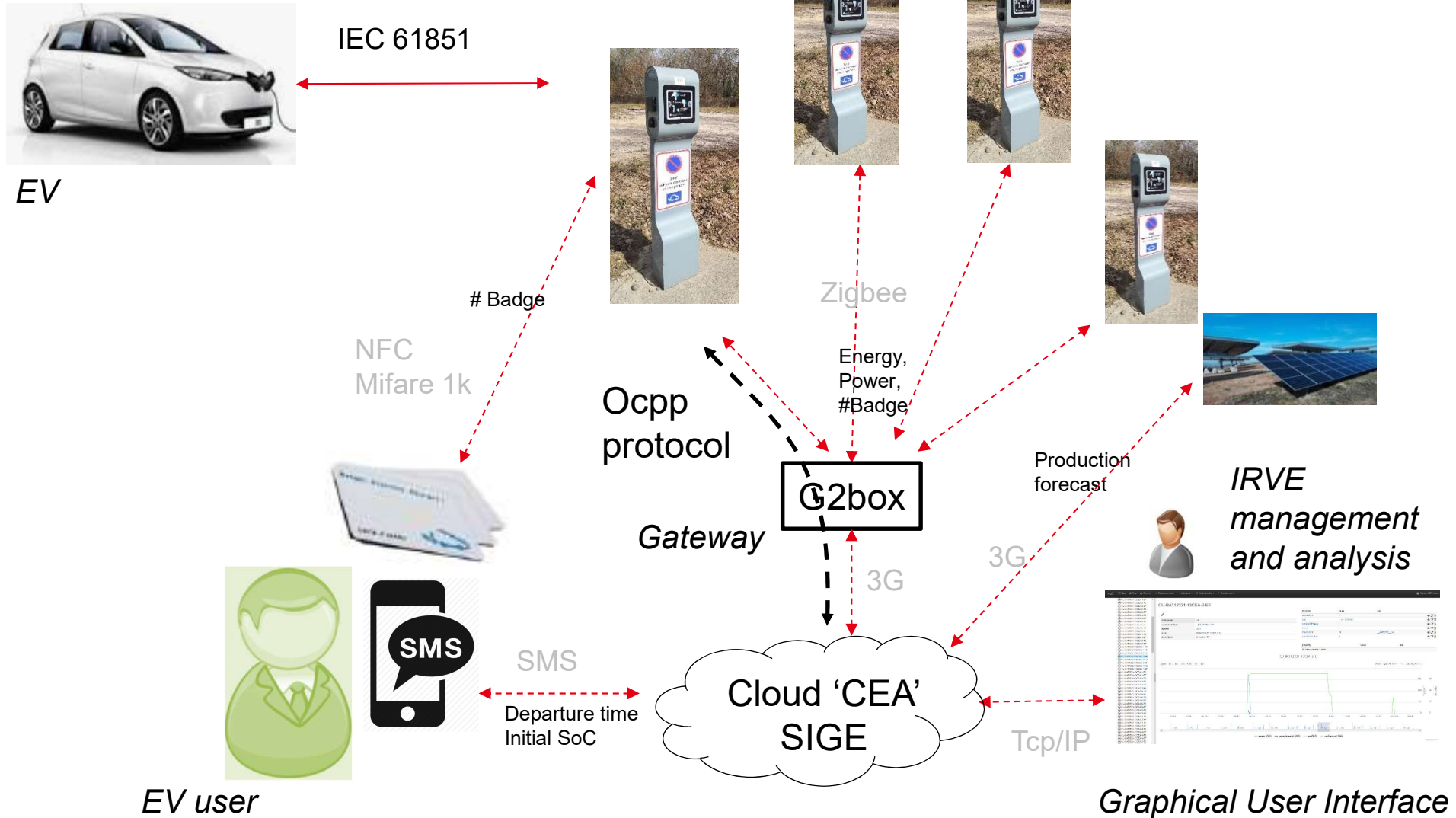


# MAX CHARGING POWER HYP. : MEAN LOAD CURVES PER HOUR



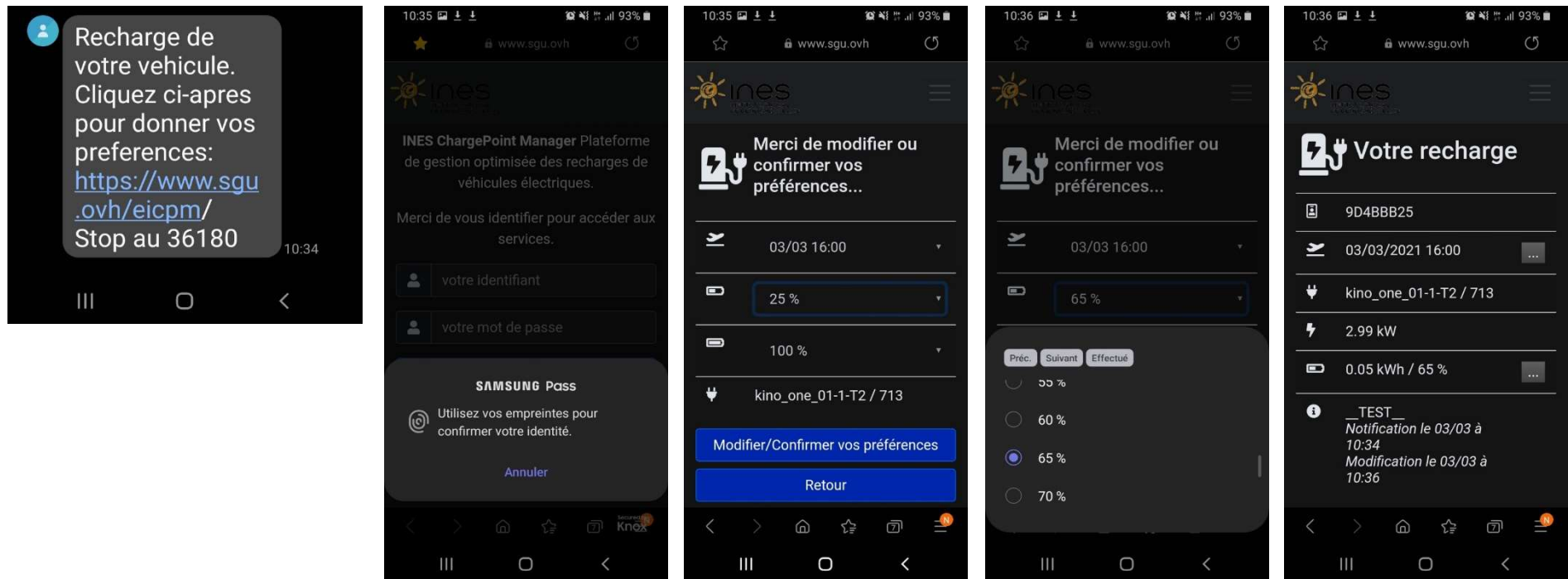
- **EvoIVE Project**
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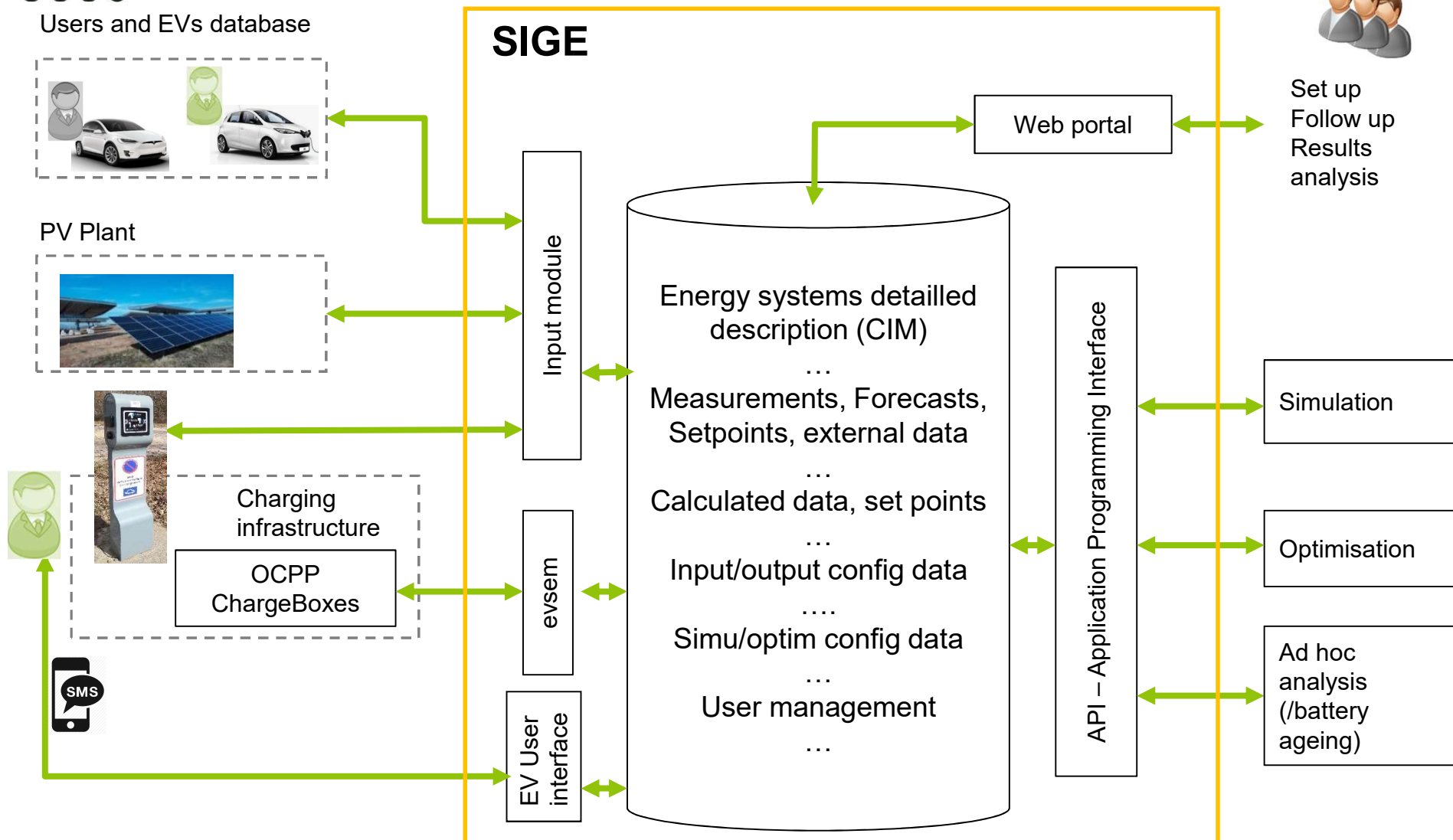




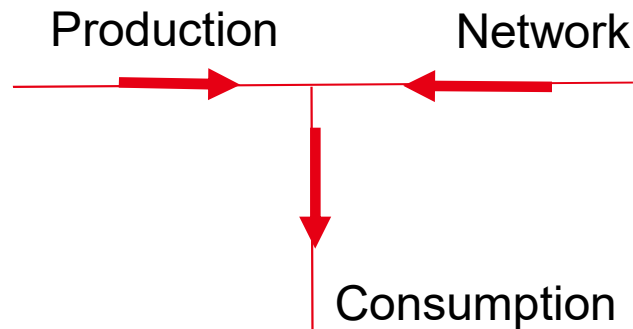
- The user connects his EV and passes his badge
- The supervision software sends an SMS inviting the user to confirm his departure time and the SOC of his car (default values are proposed).
- The EV is supplied with a test profile.
- Optimization and recharging are made on the basis of these data



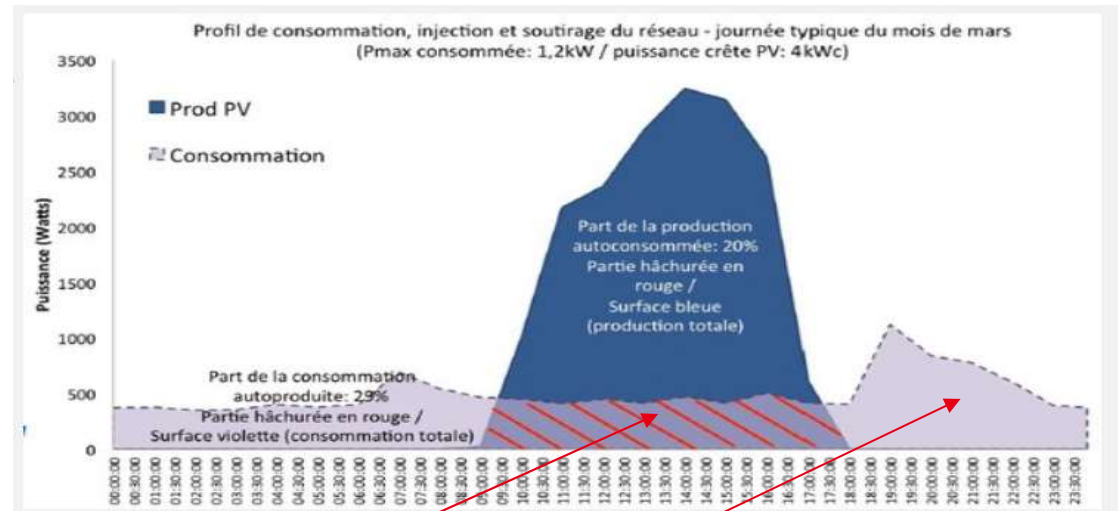
## SOFTWARE ARCHITECTURE



## RECALL AUTOCONSUMPTION/AUTOPRODUCTION



$$\text{Network} + \text{Production} = \text{Consumption}$$



Optimisation process: maximize

$$\text{selfproduction rate} = (\text{PV\&consumption}) / \text{consumption}$$

## View « state of the EVC»

sigE Map Reference data Administration Development Super USER (root)					
Batiment 101 - 1 [5670]					
CU-BAT1011-13CEA-1					
CU-BAT1011-13CEA-2					
CU-BAT1011-13CEA-3					
CU-BAT1011-13CEA-4					
Batiment 101 - 2 [5691]					
CU-BAT1012-13CEA-1					
CU-BAT1012-13CEA-2					
Batiment 103 - 1 [5690]					
CU-BAT1021-13CEA-1					
CU-BAT1021-13CEA-2					
CU-BAT1021-13CEA-3					
CU-BAT1021-13CEA-4					
CU-BAT1021-13CEA-5					
CU-BAT1021-13CEA-6					
Batiment 104 - 1 [5717]					
CU-BAT1041-13CEA-1					
CU-BAT1041-13CEA-2					
CU-BAT1021-13CEA-3					
CU-BAT1021-13CEA-4					
CU-BAT1021-13CEA-5					
CU-BAT1021-13CEA-6					
Batiment 104 - 1 [5717]					
CU-BAT1041-13CEA-1					
CU-BAT1041-13CEA-2					
Batiment 106 - 1 [5822]					
CU-BAT2301-13CEA-1					
CU-BAT2301-13CEA-2					
CU-BAT2301-13CEA-3					
CU-BAT2301-13CEA-4					
Batiment 1222 - 1 [5724]					
CU-BAT12221-13CEA-1					
CU-BAT12221-13CEA-2					
CU-BAT12221-13CEA-3					
CU-BAT12221-13CEA-4					
Batiment 151 - 1 [5737]					
CU-BAT1511-13CEA-1					
CU-BAT1511-13CEA-2					
CU-BAT1511-13CEA-3					
CU-BAT1511-13CEA-4					
CU-BAT1511-13CEA-5					
CU-BAT1511-13CEA-6					
Batiment 155 - 1 [5756]					
CU-BAT1551-13CEA-1					
CU-BAT1551-13CEA-2					
CU-BAT1551-13CEA-3					
CU-BAT1551-13CEA-4					
CU-BAT1551-13CEA-5					
CU-BAT1551-13CEA-6					
Batiment 156 - 1 [5769]					
CU-BAT1561-13CEA-1					
CU-BAT1561-13CEA-2					
CU-BAT1561-13CEA-3					
CU-BAT1561-13CEA-4					
Batiment 156 - 1 [5769]					
CU-BAT1561-13CEA-1					
CU-BAT1561-13CEA-2					
CU-BAT1561-13CEA-3					
CU-BAT1561-13CEA-4					
Batiment 1581-13CEA-1					
CU-BAT1581-13CEA-2					
Batiment 202 - 1 [5988]					
CU-BATB51-13CEA-1					
CU-BATB51-13CEA-2					
Batiment 216 - 1 [5776]					
CU-BAT2161-13CEA-1					
CU-BAT2161-13CEA-2					
Batiment 219 - 1 [5783]					
CU-BAT2191-13CEA-1					
CU-BAT2191-13CEA-2					
Batiment 223 - 1 [5790]					
CU-BAT2231-13CEA-1					
CU-BAT2231-13CEA-2					
CU-BAT2231-13CEA-3					
CU-BAT2231-13CEA-4					
CU-BAT2231-13CEA-5					
CU-BAT2231-13CEA-6					
CU-BAT2231-13CEA-7					
CU-BAT2231-13CEA-8					
Batiment 225 - 1 [5815]					
CU-BAT2241-13CEA-1					
CU-BAT2241-13CEA-2					
CU-BAT2231-13CEA-5					
CU-BAT2231-13CEA-6					
CU-BAT2231-13CEA-7					
CU-BAT2231-13CEA-8					
Batiment 225 - 1 [5815]					
CU-BAT2241-13CEA-1					
CU-BAT2241-13CEA-2					
Batiment 238 - 1 [5835]					
CU-BAT2381-13CEA-1					
CU-BAT2381-13CEA-2					
CU-BAT2381-13CEA-3					
CU-BAT2381-13CEA-4					
Batiment 278 - 1 [5848]					
CU-BAT2781-13CEA-1					
CU-BAT2781-13CEA-2					
CU-BAT2781-13CEA-3					
CU-BAT2781-13CEA-4					
Batiment 312 - 1 [5861]					
CU-BAT3121-13CEA-1					
CU-BAT3121-13CEA-2					
Batiment 313 - 1 [5868]					
CU-BAT3131-13CEA-1					
CU-BAT3131-13CEA-2					
CU-BAT3131-13CEA-3					
CU-BAT3131-13CEA-4					
Batiment 315 - 1 [5881]					
CU-BAT3151-13CEA-1					
CU-BAT3151-13CEA-2					
CU-BAT3151-13CEA-3					
CU-BAT3151-13CEA-4					
CU-BAT3131-13CEA-3					
CU-BAT3131-13CEA-4					
Batiment 315 - 1 [5881]					
CU-BAT3151-13CEA-1					
CU-BAT3151-13CEA-2					
CU-BAT3151-13CEA-3					
CU-BAT3151-13CEA-4					
Batiment 326 - 1 [5894]					
CU-BAT3261-13CEA-1					
CU-BAT3261-13CEA-2					
Batiment 351 - 1 [5901]					
CU-BAT3511-13CEA-1					
CU-BAT3511-13CEA-2					
CU-BAT3511-13CEA-3					
CU-BAT3511-13CEA-4					
Batiment 352 - 1 [5914]					
CU-BAT3521-13CEA-1					
CU-BAT3521-13CEA-2					
Batiment 513 - 1 [5921]					
CU-BAT5131-13CEA-1					
CU-BAT5131-13CEA-2					
Batiment 519 - 1 [5928]					
CU-BAT5191-13CEA-1					
CU-BAT5191-13CEA-2					
CU-BAT5191-13CEA-3					
CU-BAT5191-13CEA-4					
Batiment 782 - 1 [5935]					
CU-BAT7821-13CEA-1					
CU-BAT7821-13CEA-2					
CU-BAT7821-13CEA-3					
CU-BAT7821-13CEA-4					
Batiment 782 - 1 [5935]					
CU-BAT7821-13CEA-1					
CU-BAT7821-13CEA-2					
CU-BAT7821-13CEA-3					
CU-BAT7821-13CEA-4					
Batiment 817 [5948]					
CU-BAT817-13CEA-1					
CU-BAT817-13CEA-2					
Batiment 837 - 1 [5955]					
CU-BAT8371-13CEA-1					
CU-BAT8371-13CEA-2					
CU-BAT8371-13CEA-3					
CU-BAT8371-13CEA-4					
CU-BAT8371-13CEA-5					
CU-BAT8371-13CEA-6					
Batiment 904 - 1 [5974]					
CU-BAT9041-13CEA-1					
CU-BAT9041-13CEA-2					
Batiment 911 - 1 [5981]					
CU-BAT9111-13CEA-1					
CU-BAT9111-13CEA-2					
Batiment XXX [5995]					
CU-BATXXX-13CEA-1					
CU-BAT9041-13CEA-1					
CU-BAT9041-13CEA-2					
Batiment 911 - 1 [5981]					
CU-BAT9111-13CEA-1					
CU-BAT9111-13CEA-2					
Batiment XXX [5995]					
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CU-BATXXX-13CEA-3					
CU-BATXXX-13CEA-4					

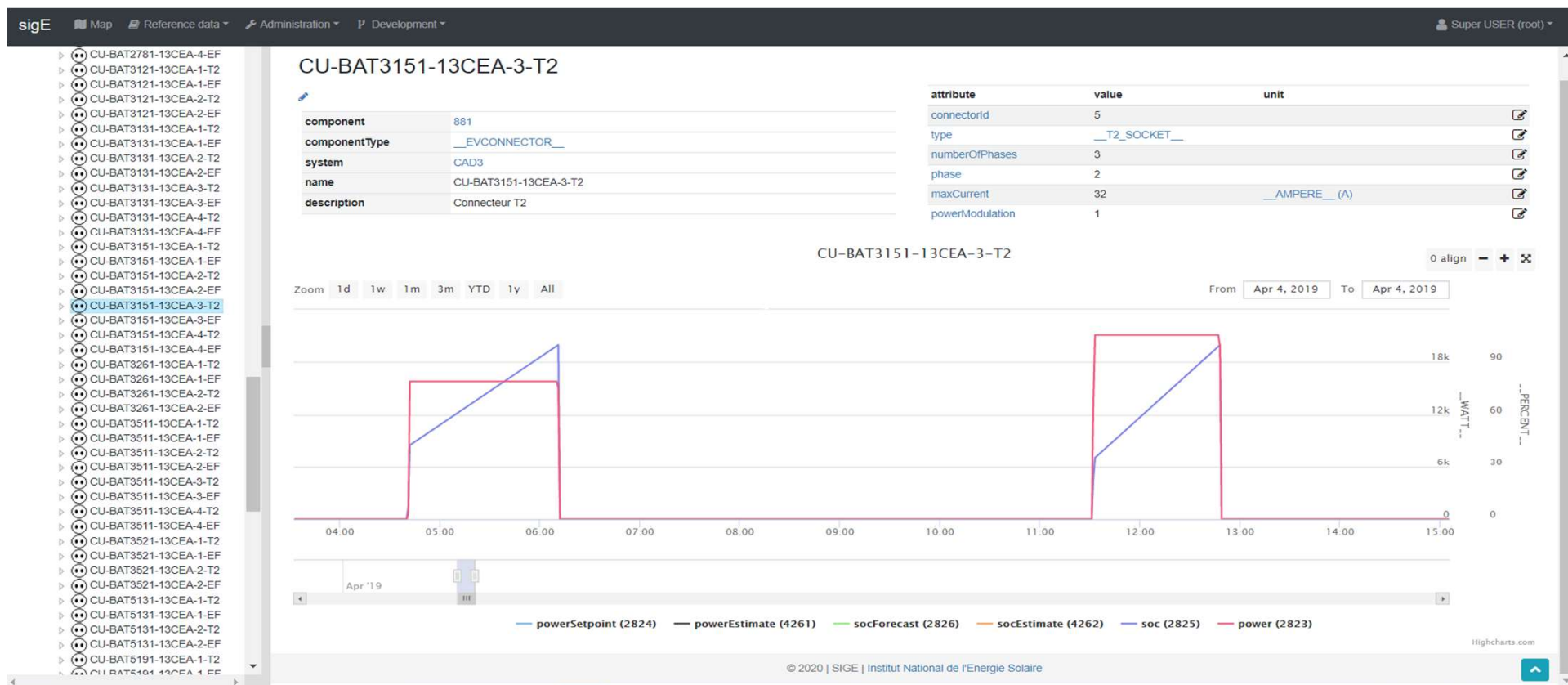
1 2 3 4 5



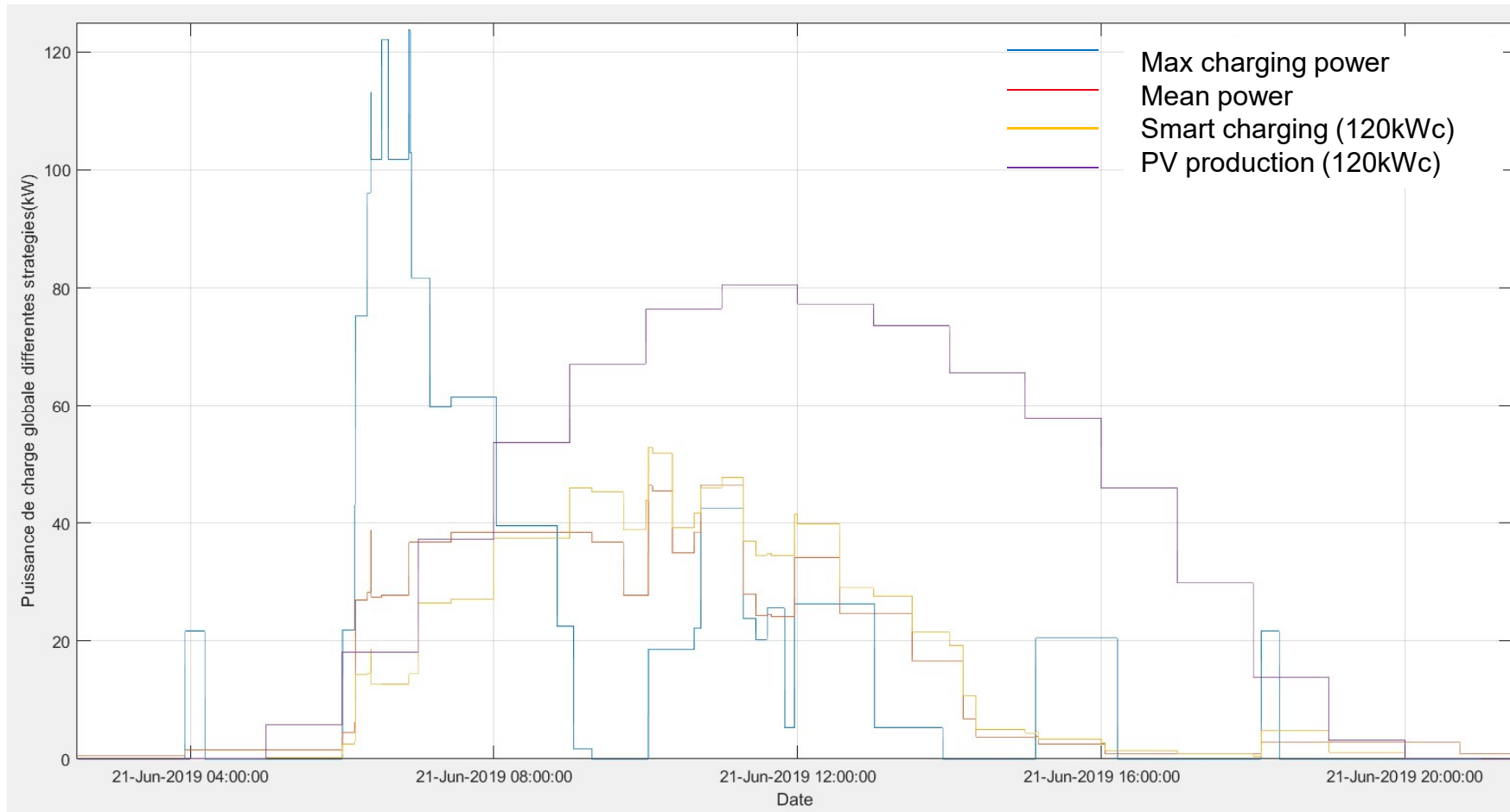
## View « PV plant »



### View « charging station functioning »



## Simulation results





1<sup>st</sup> Tests

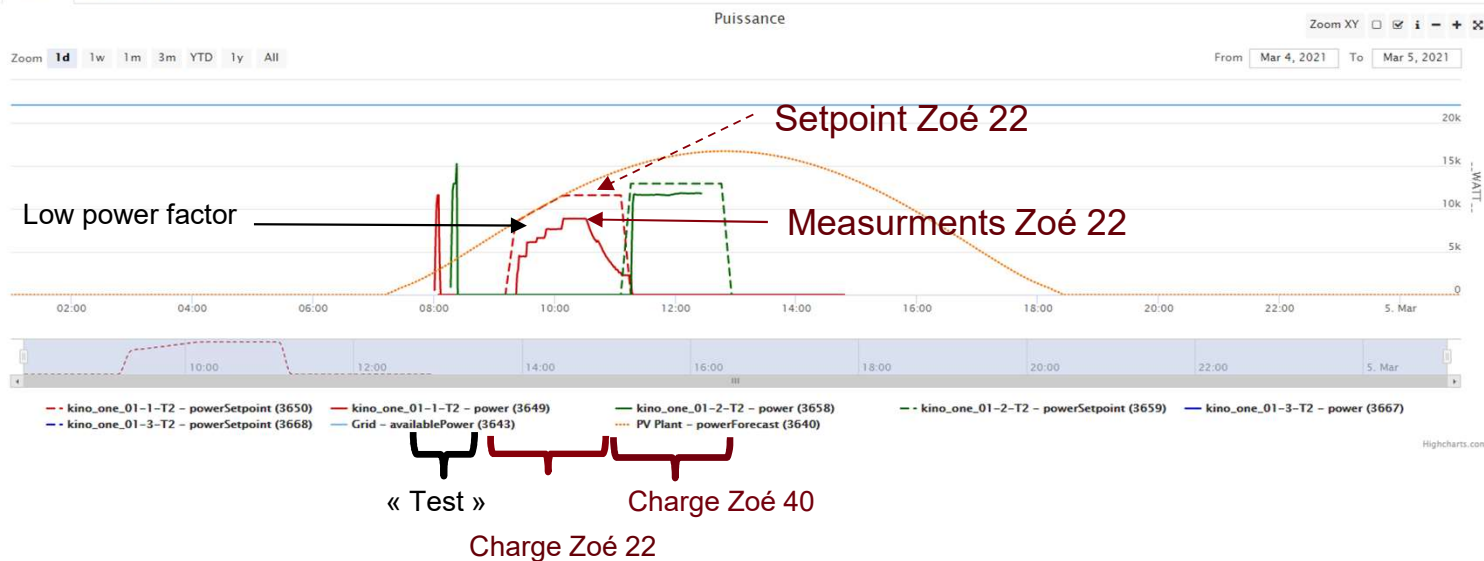
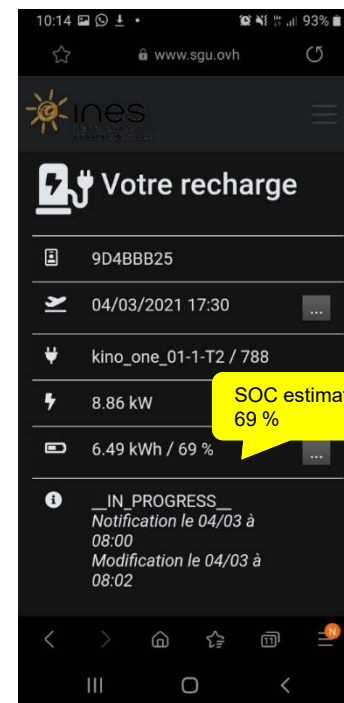
Zoé 22kWh (43kW)    Zoé 40kWh (22kW)

Energy Monitor

Voltage	231   231   230 V
Current	15,17   15,33   15,23 A
RealPower   PowerFactor	8,80 kW   83,5 %
Energy (present session)	6,89 kWh

Web portal of the  
charging station

User web interface





- [1] [http://www.hrvojepandzic.com/wp-content/uploads/2019/09/Lecture\\_4\\_EVs.pdf](http://www.hrvojepandzic.com/wp-content/uploads/2019/09/Lecture_4_EVs.pdf)
- [2] [http://ev-institute.com/images/charged\\_mag.pdf](http://ev-institute.com/images/charged_mag.pdf)
- [3] <https://www.transportenvironment.org/what-we-do/electric-cars/how-clean-are-electric-cars>



**Thank you for your attention**