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EvoLVE: Smart charging at CEA

Bruno Robisson, Sylvain Guillemin, Gérald Vignal, Alexandre Mignonac

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Networking for Excellence in Electric Mobility Operations

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SCHOOL



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)



The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857484

- **EvoIVE Project**
- **CEA EVCI & PV**
 - CEA EVCI
 - Charging modes
 - EvoIVE @INES
 - EvoIVE @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

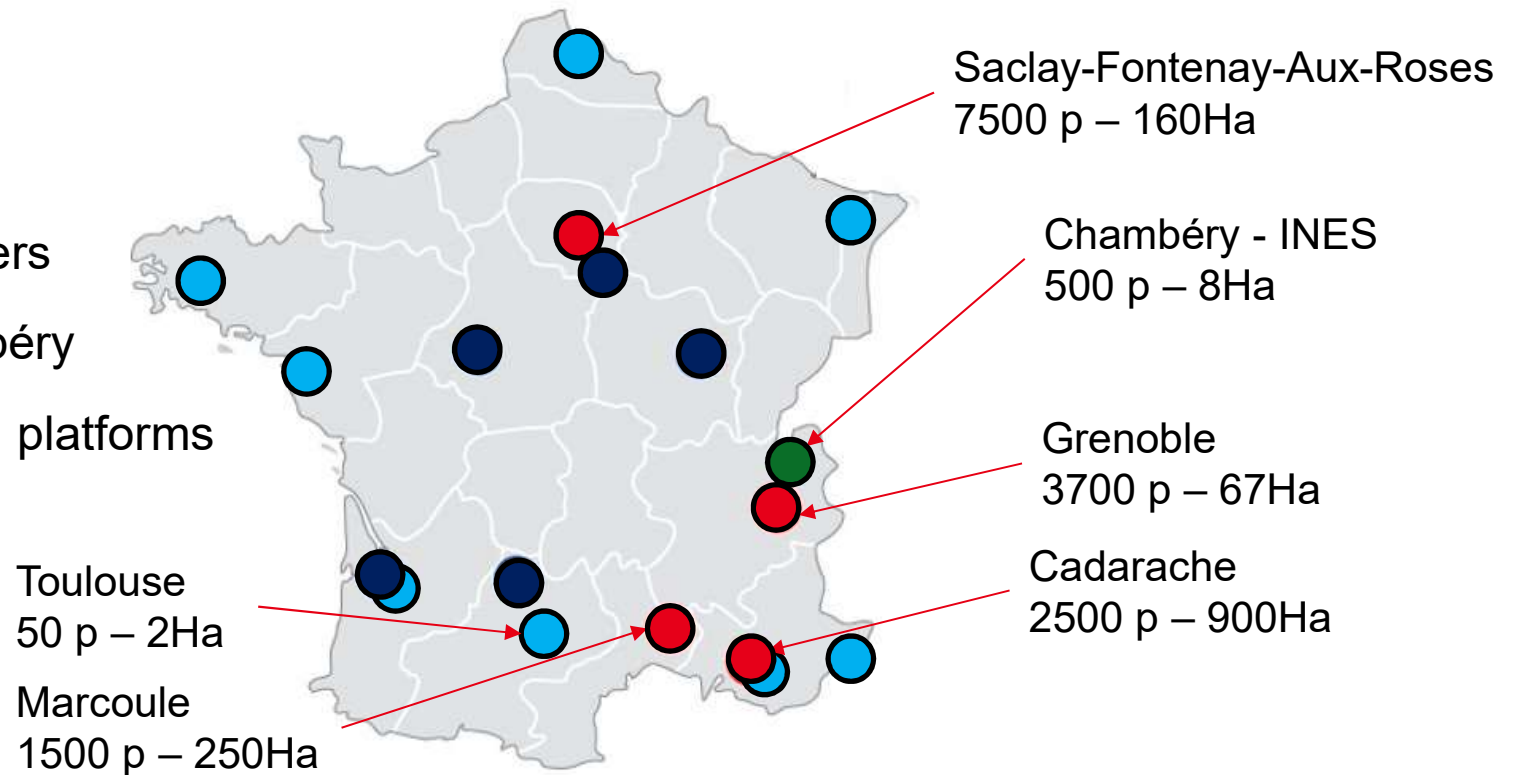
Kick-off: January 2020

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

Task 3 : 06/2021 -> 05/2022

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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)



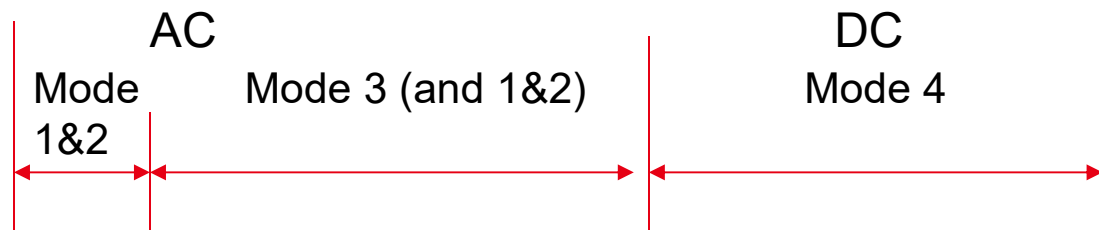
INES

Toulouse

Grenoble

Cadarache

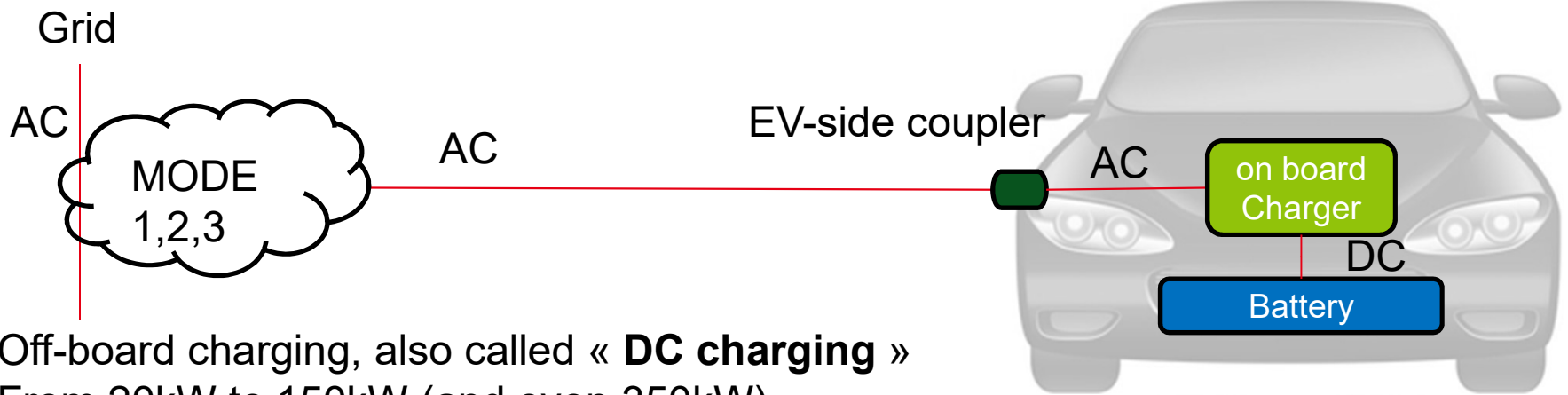
Normal	<11kW
Accelerated	>11kW & <24kW
Fast	>24kW



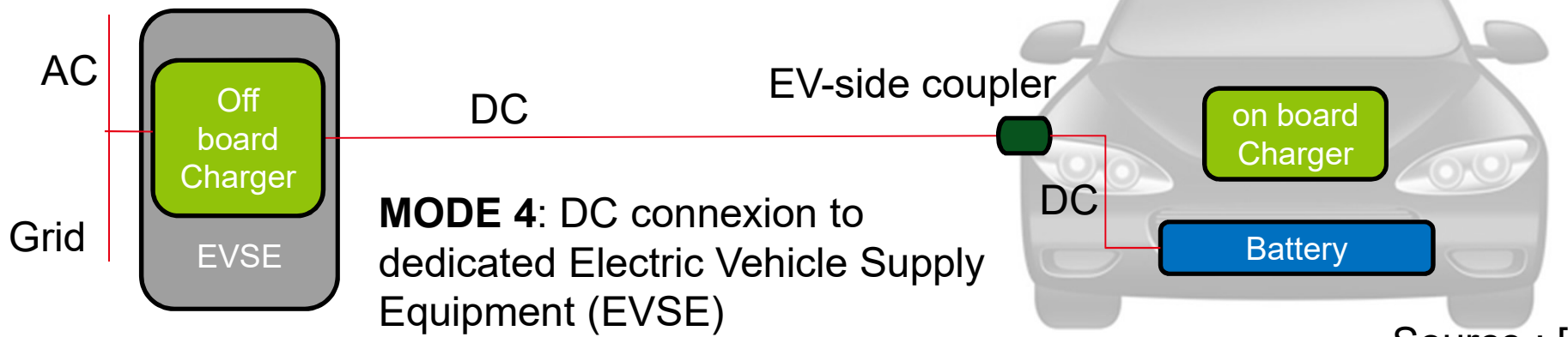
CEA employees	Surface (Ha)	Center		AC				DC			TOTAL	
				3kW AC	7kW AC	11kW AC	22kW AC	10kW DC	30kW DC	50kW DC		
2500	900	Cadarache					81				81	
50	2	Toulouse	Actual				3				3	
			Forecast		4		2	1		2	9	
7500	160	Saclay			40						40	
500	8	Ines					20		1		21	
3700	67	Grenoble		70	51		4				125	
1500	250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

CHARGING MODE (IEC 61851 STANDARD)

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



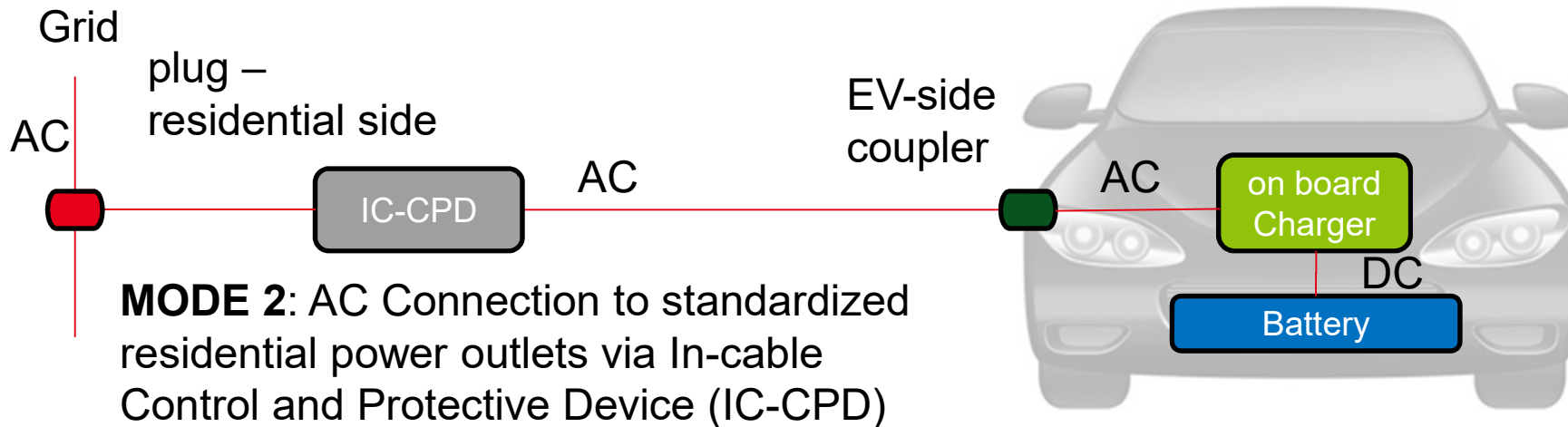
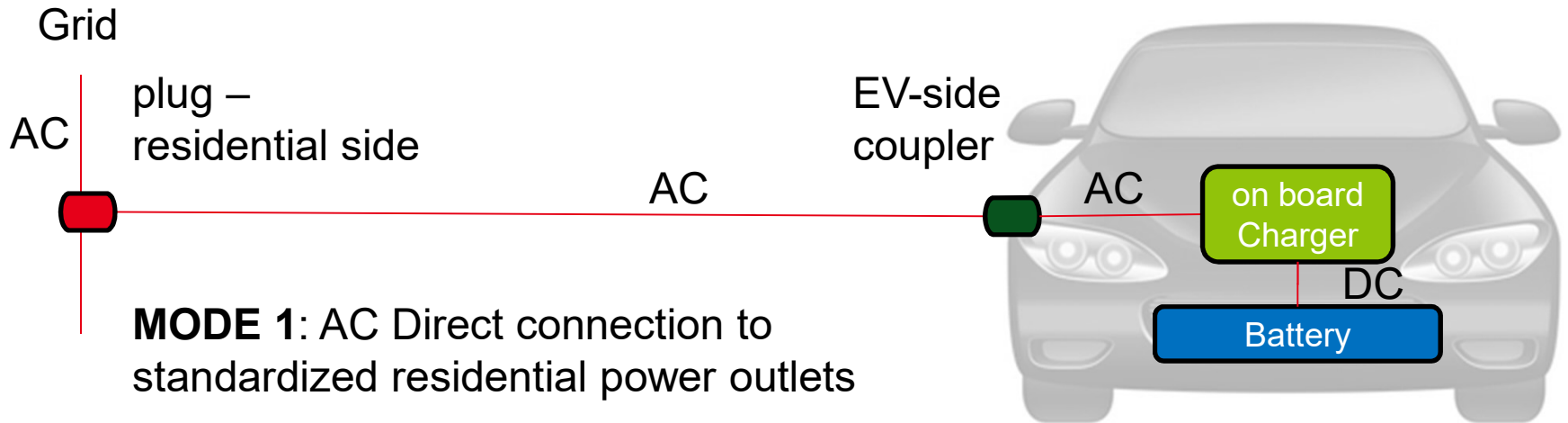
Off-board charging, also called « **DC charging** »
From 20kW to 150kW (and even 350kW)



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



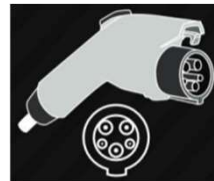
Blue: « camping »
socket Mono-p
230V



Red: Industrial socket
Tri-p 400V



Tesla coupler

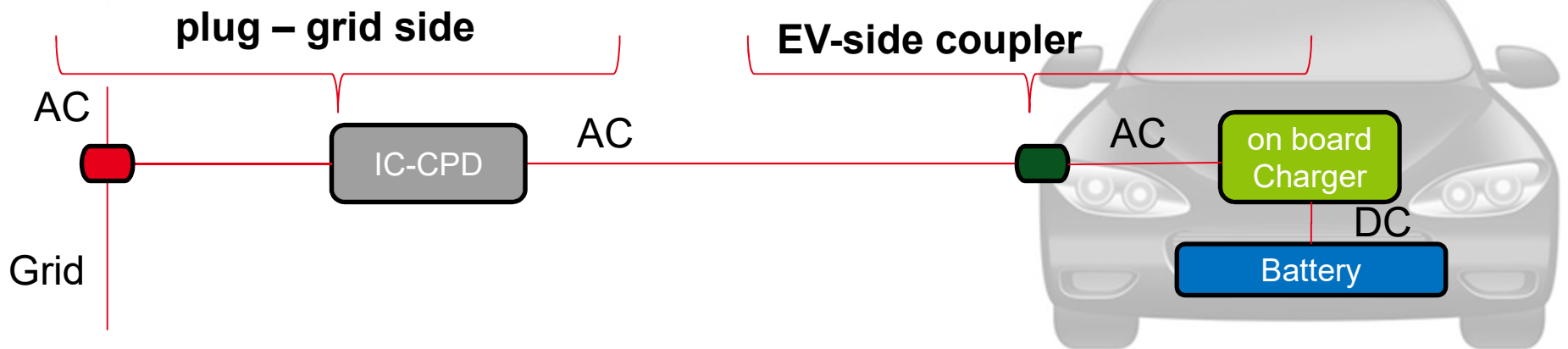


Type 1 coupler

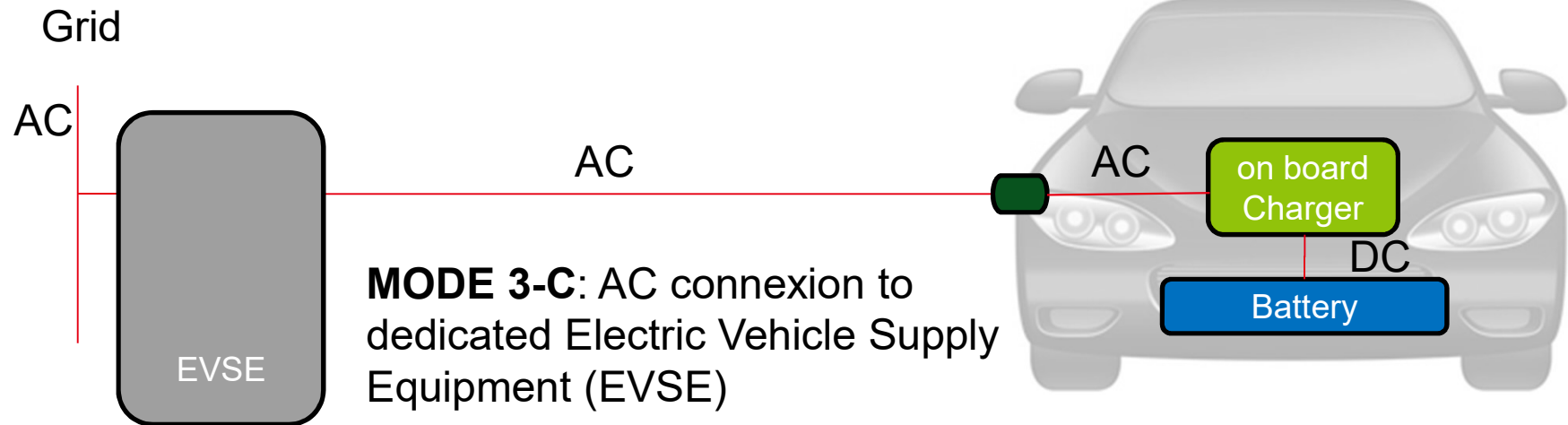
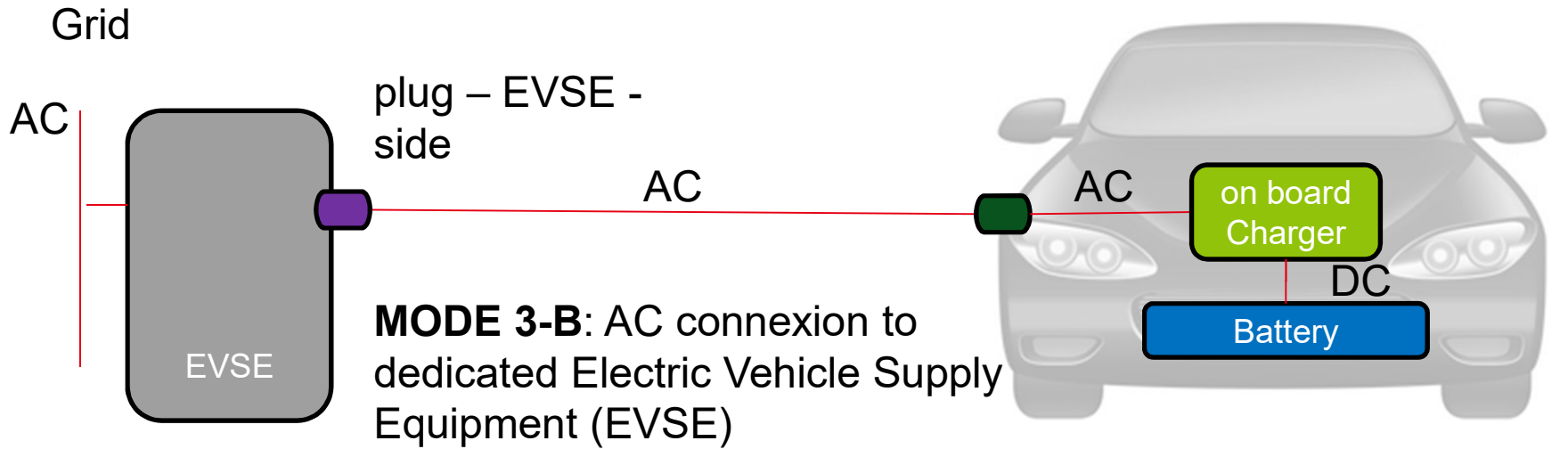


Type 2 coupler

Depends on the vehicle




AC CHARGING MODE: MODE 3



Source : [1]

THE PLUG AND SOCKET ZOO – MODE 3 B



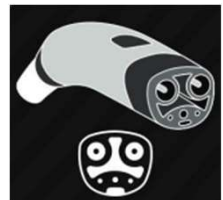
Type 2 outlet

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



Type 3 outlet

9@Grenoble



Tesla coupler

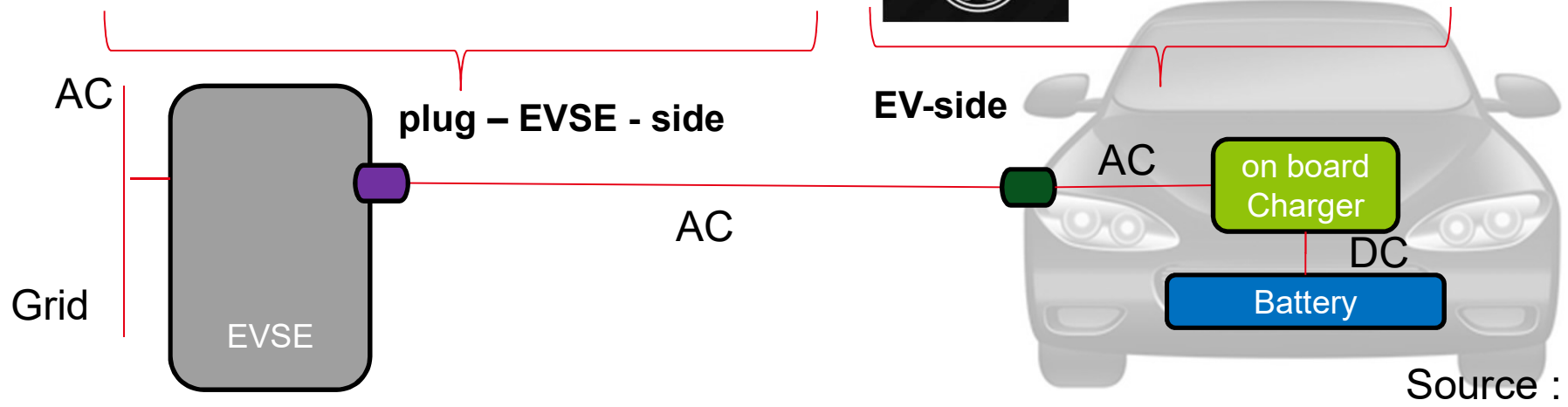


Type 1 coupler



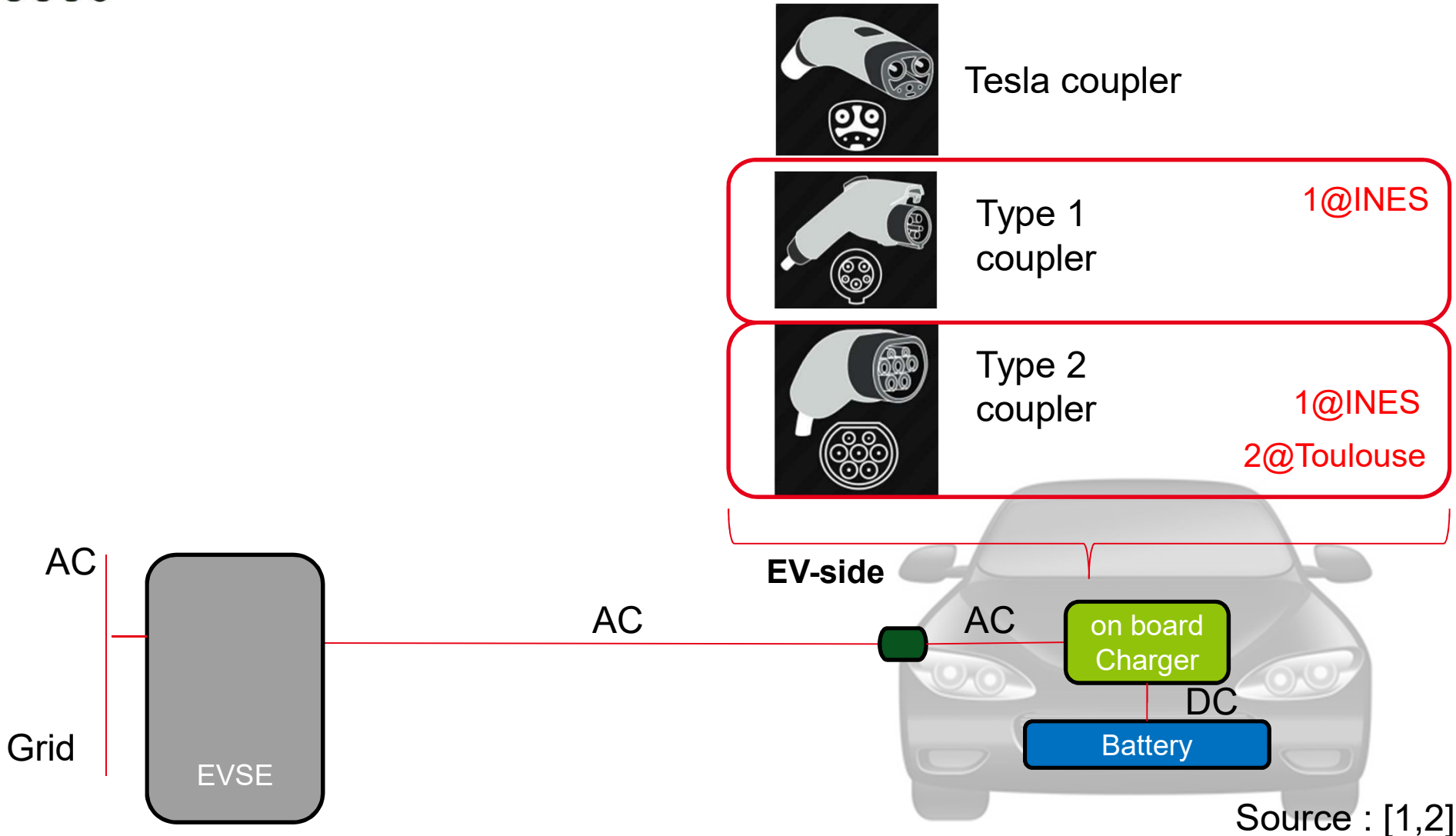
Type 2 coupler

Depends on the vehicle



Source : [1,2]

THE PLUG AND SOCKET ZOO – MODE 3 C



THE PLUG AND SOCKET ZOO – MODE 4



Tesla plug



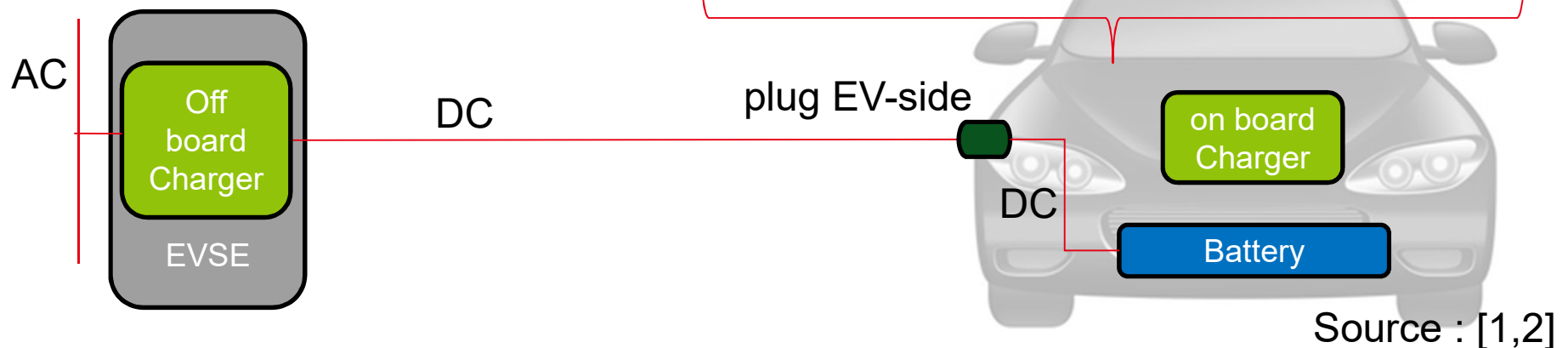
CHAdeMO
(DC only)

2@Toulouse
1@INES

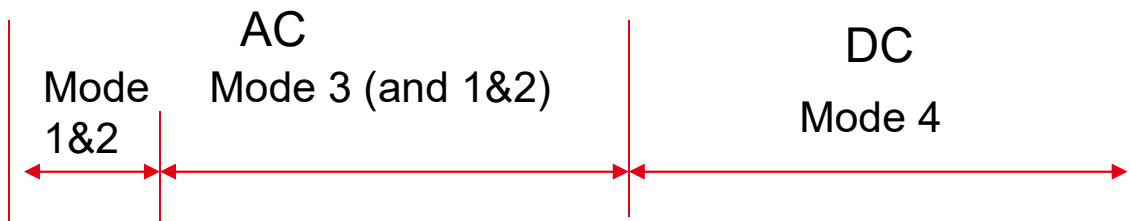


Combo 2 : Combined
Charge System CCS
(DC+type 2)

1@Toulouse



ELECTRIC VEHICLE CHARGING INFRASTRUCTURE (EVCI)



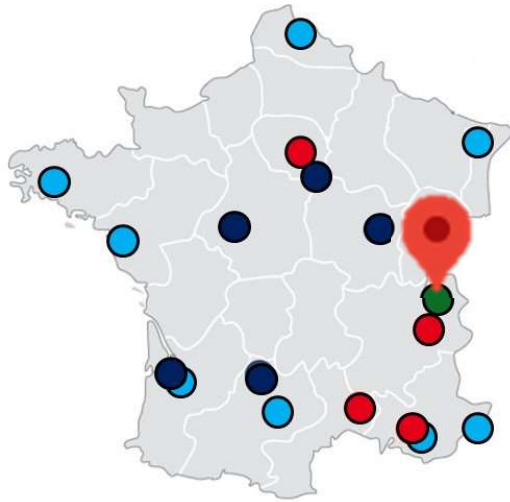
CEA employees	Surface (Ha)	Center	AC				DC			TOTAL	
			3kW AC	7kW AC	11kW AC	22kW AC	10kW DC	30kW DC	50kW DC		
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500	8	Ines	20					1		21	
3700	67	Grenoble	70	51		4			125		
1500	250	Marcoule	22		16				38		
		TOTAL		92	95	16	110	1	1	2	317

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)

3 Driveco
 (Kino One
 1*22kW)

2 Driveco
 (Kino One
 2*22kW)

1 Hager
 (Witty Park
 2*22kW)

1 Cahors
 (Access
 2*22kW)



Mode 3B



Mode 3B



Mode 3B & 3C



Mode 3B



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

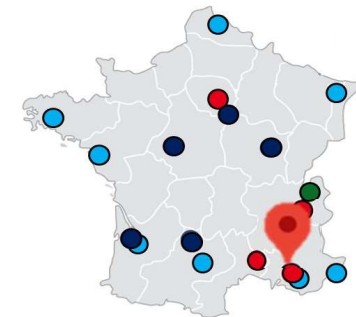
75 km of water distribution network (drinking water station, industrial water, purification station)

Private power network

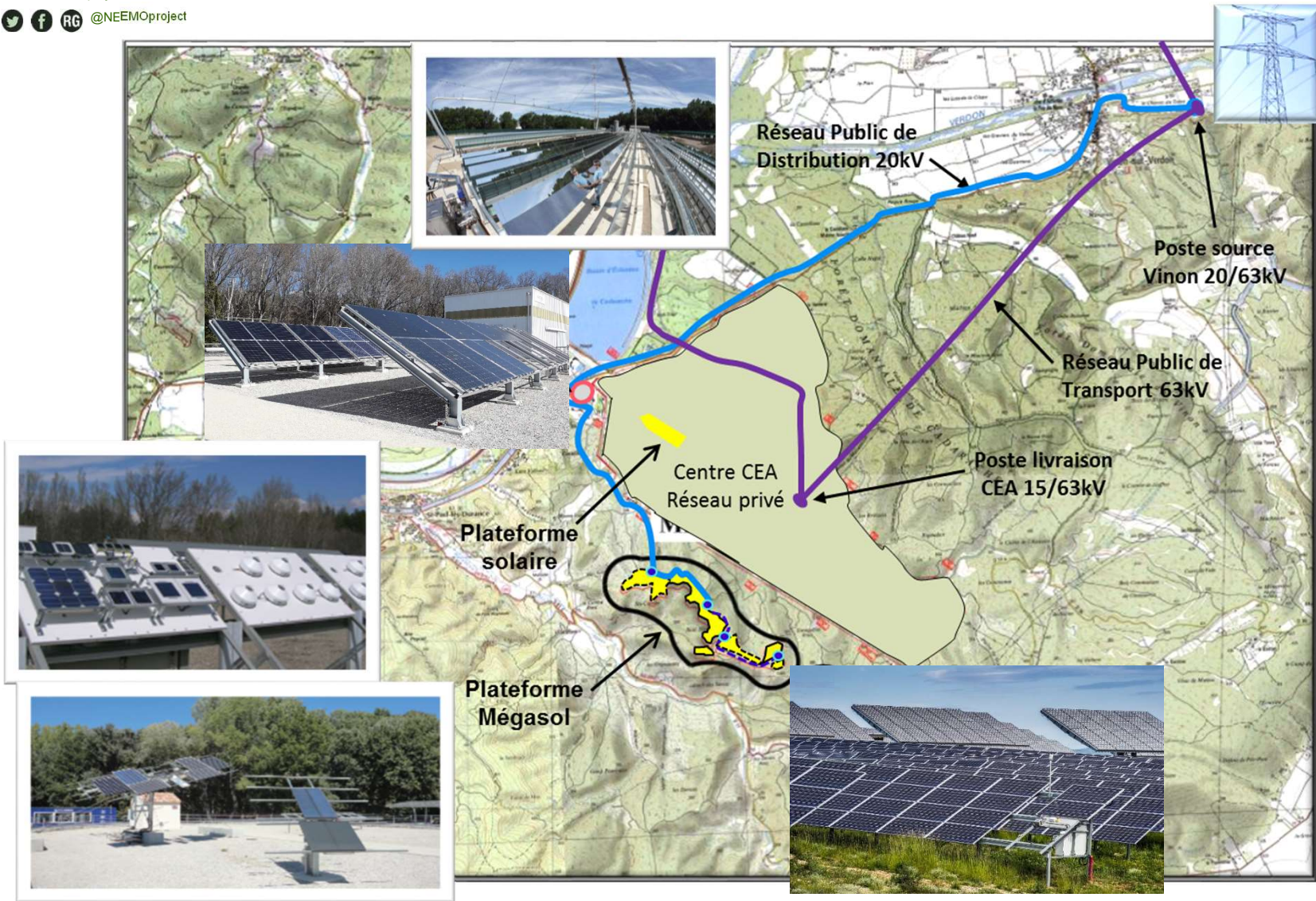
- 63kV / 15kV substation
- 18 MV loops (85km of 15kV underground lines)
- EVCI : 81 charging points at 22kVA
- 3kV public lighting network



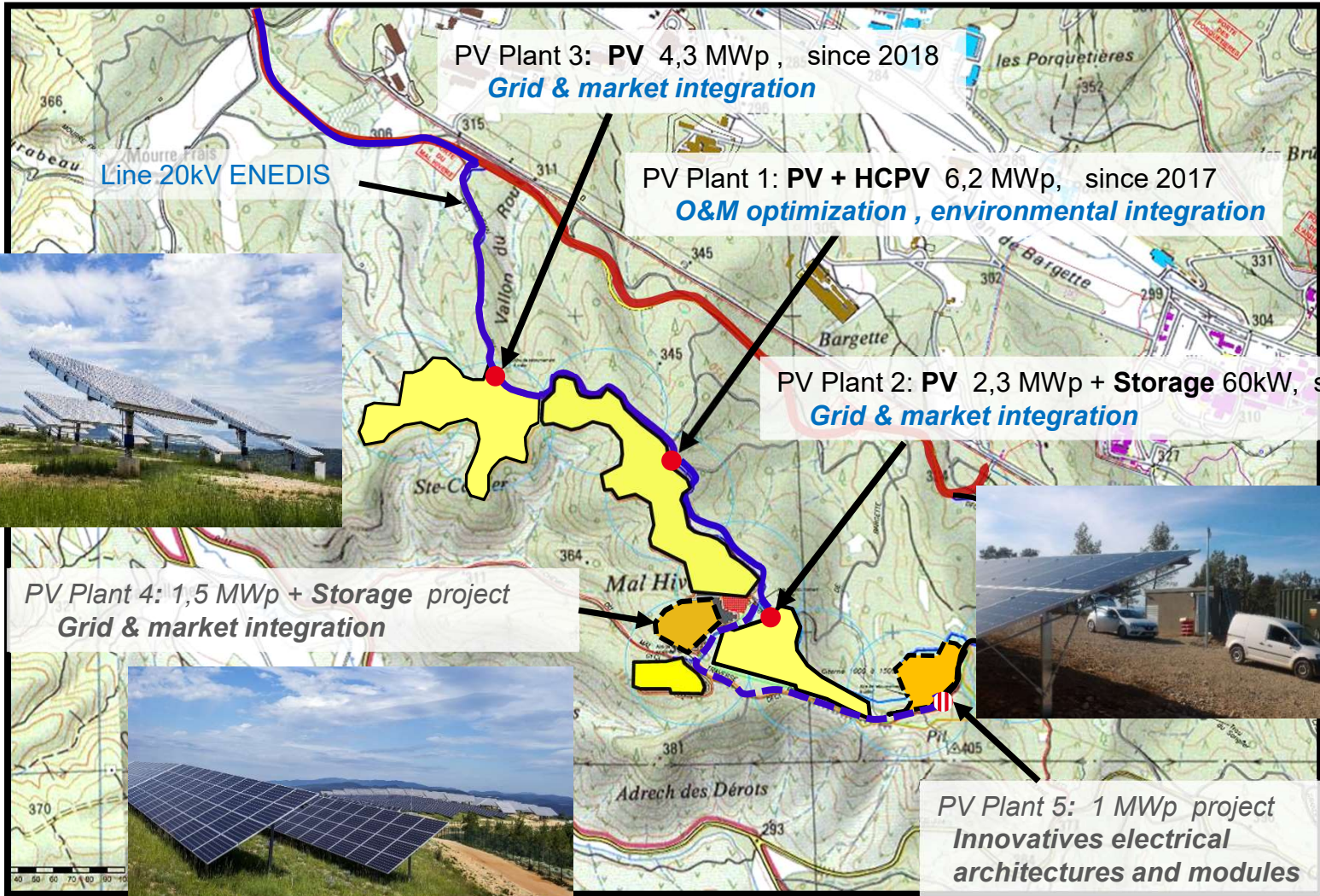
63kV / 15kV substation



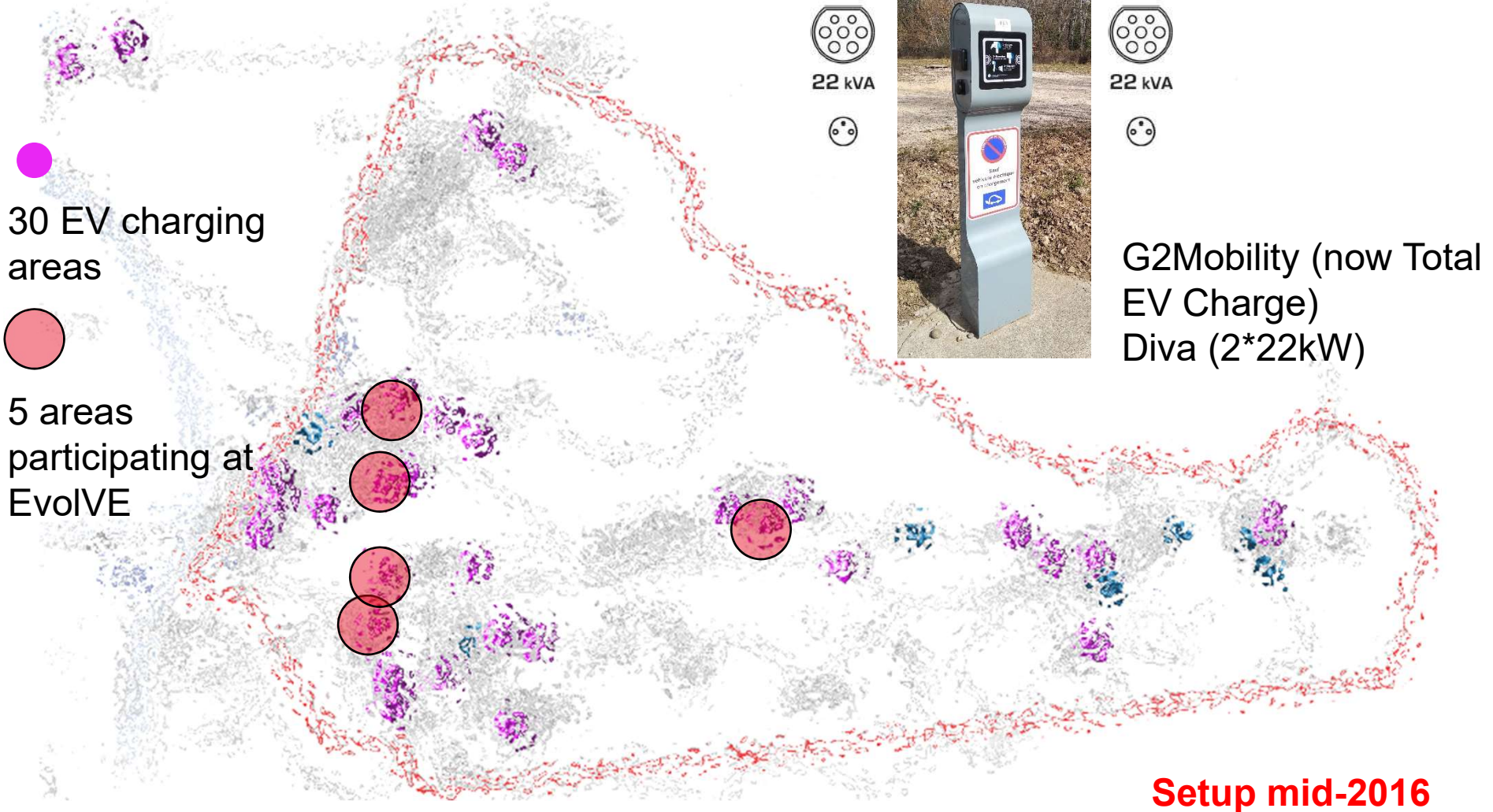
CEA CADARACHE – SOLAR R&D



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

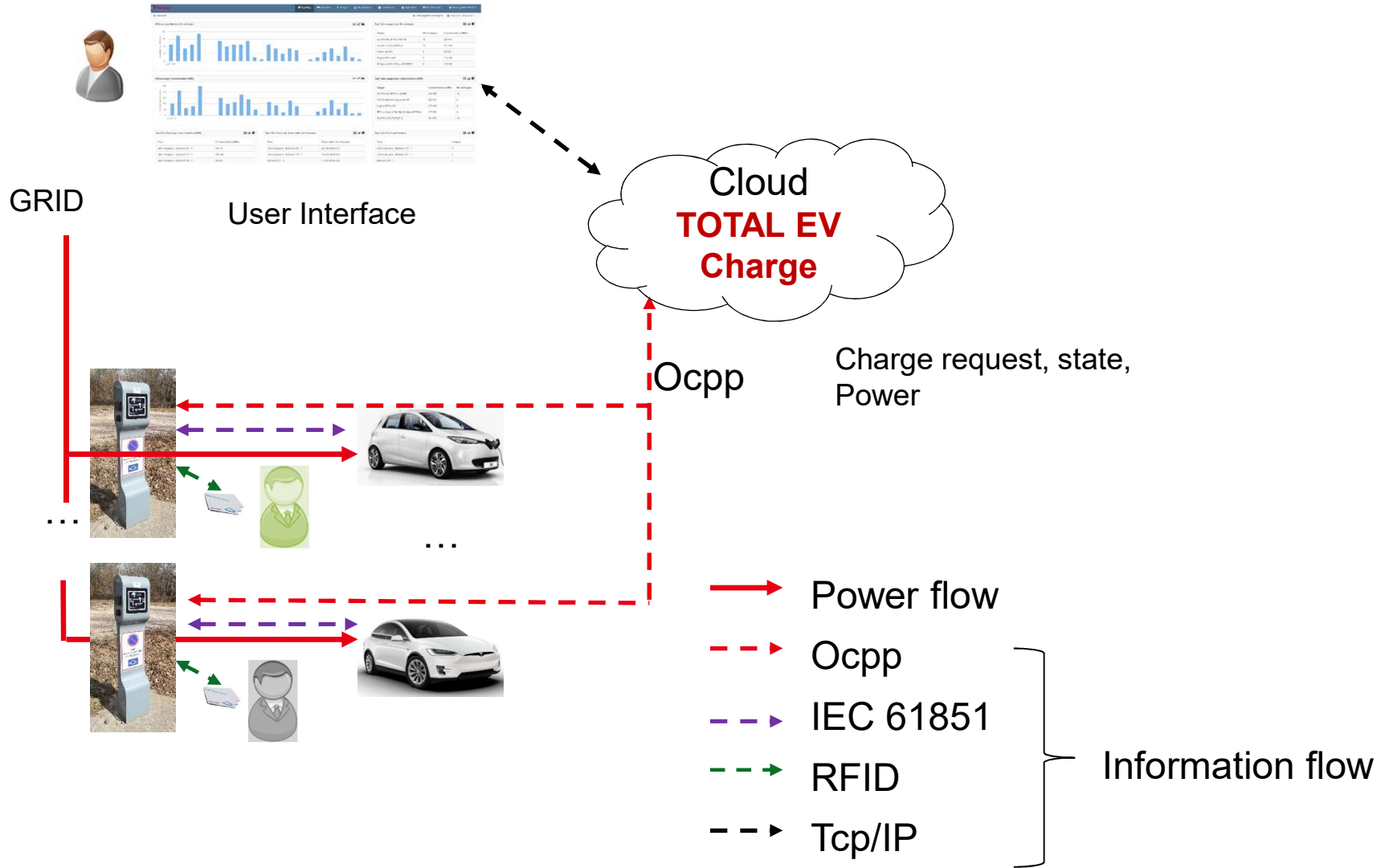
67 service vehicles
51 personal vehicles
3 taxis
5 external companies vehicles

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}	22 or 43 (Mode 3) or 2.3 (Mode 2)
Leaf	{24;30;40;60}	6.7 or 3.3 or 2.3
Tesla M3	{52;77}	11 or 2.3
Tesla MS	{40;60;70;75;85;90;100}	22 or 16.5 or 11 or 2.3
Smart	17.6	22 or 2.3
Golf GTE	35.8	3.6 or 2.3
Twizy	{6;8}	3.3 or 2.3 (mode 1)
Berlingo	22.5	6.7 or 3.3 or 2.3
Kangoo	{22;33}	7 or 3.7 or 3.2 (mono)



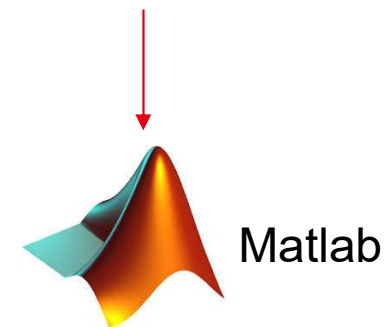
EVCI CADARACHE - DATA COLLECTION



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 Pow Fin Power	Consomm	Type de pr	Emp	
août 2018	01/08/2018	CU-BAT31	CEA-CADA Batiment	CU-BAT31 1E6C4366	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 DEF04466	01/08/2018 07:36:25	01/08/2018 16:05:38	3261776	3266772	4.996	EF	G2M
août 2018	01/08/2018	CU-BAT35	CEA-CADA Batiment	CU-BAT35 4E184466	01/08/2018 08:01:15	06/08/2018 08:16:38	1361887	1372856	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 CE94366	01/08/2018 08:22:13	01/08/2018 16:04:57	5818841	5845881	27.04	T2	G2M
août 2018	01/08/2018	CU-BAT35	CEA-CADA Batiment	CU-BAT35 2E64366	01/08/2018 08:22:40	01/08/2018 12:48:43	4225127	4146367	21.24	T2	G2M
août 2018	01/08/2018	CU-BAT15	CEA-CADA Batiment	CU-BAT15 1E6C4566	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 1E6C4566	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-BAT27	CEA-CADA Batiment	CU-BAT27 3E6C026A	01/08/2018 08:51:41	01/08/2018 18:28:49	2708165	2733006	24.841	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 253CE63	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 0E64366	01/08/2018 11:26:24	01/08/2018 12:09:45	1314629	1327456	12.837	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	5334336	5371005	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 16:35:40	2976024	3004133	28.109	T2	G2M
août 2018	01/08/2018	CU-BAT22	CEA-CADA Batiment	CU-BAT22 9E8E4566	01/08/2018 12:31:22	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



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)

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

of the user

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 CO₂ avoided

Year of purchase: 2020

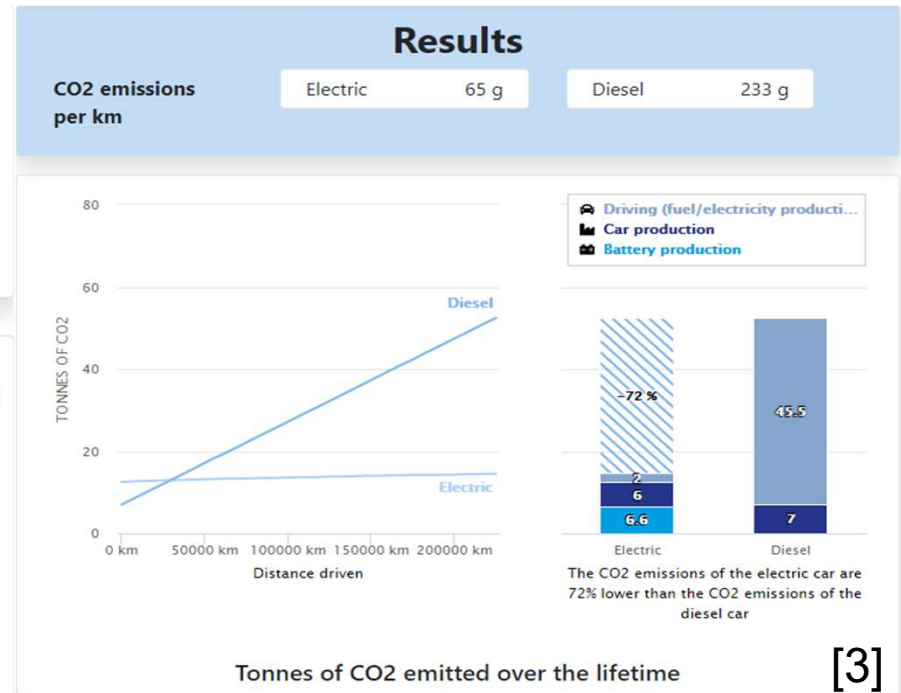
Vehicle Segment: Medium car (ex: Volkswagen Golf)

VS

Technology: Electric vs Diesel

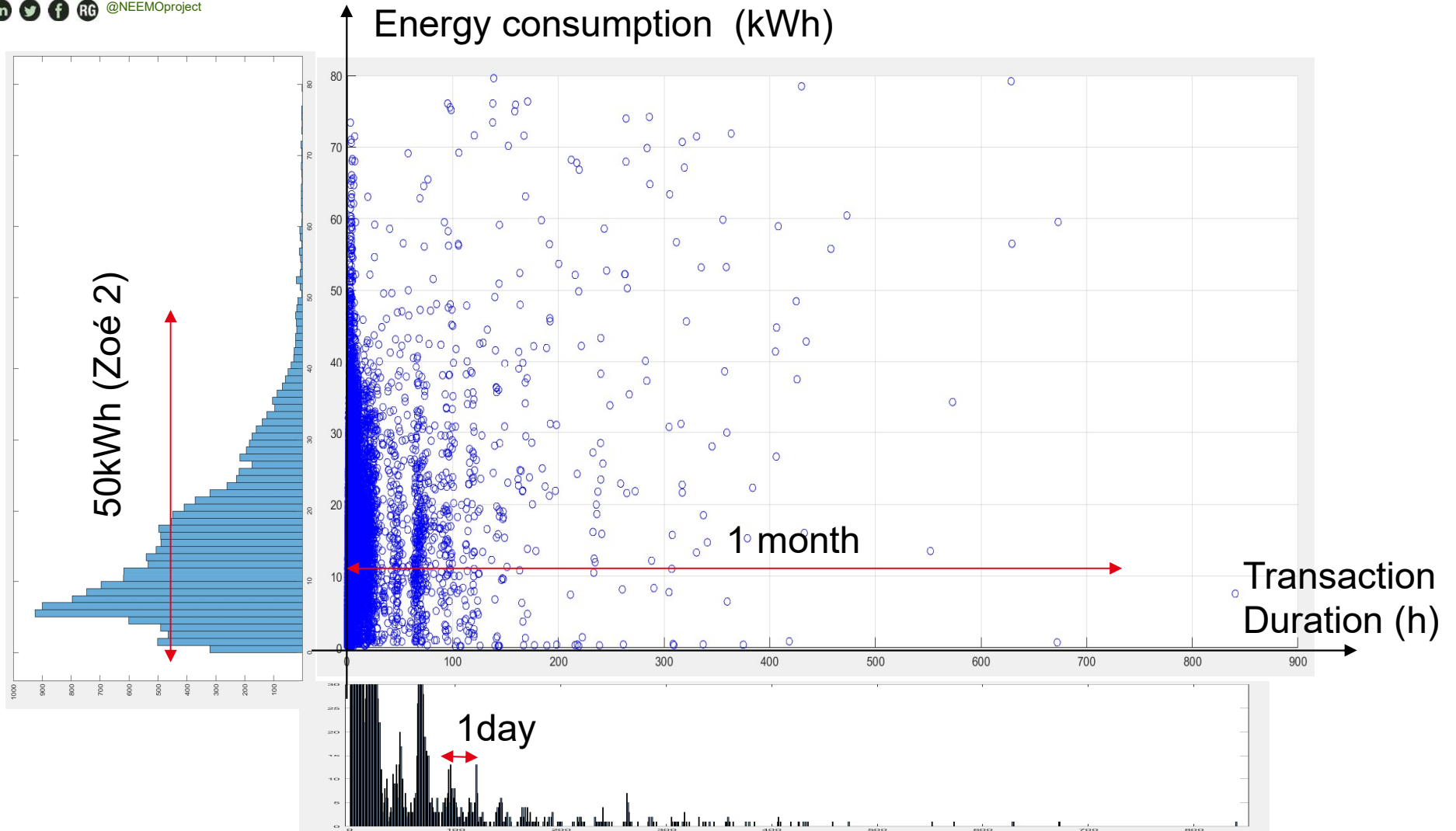
Electricity used for battery production: China vs EU average

Country where the electric car is driven: France vs Sweden



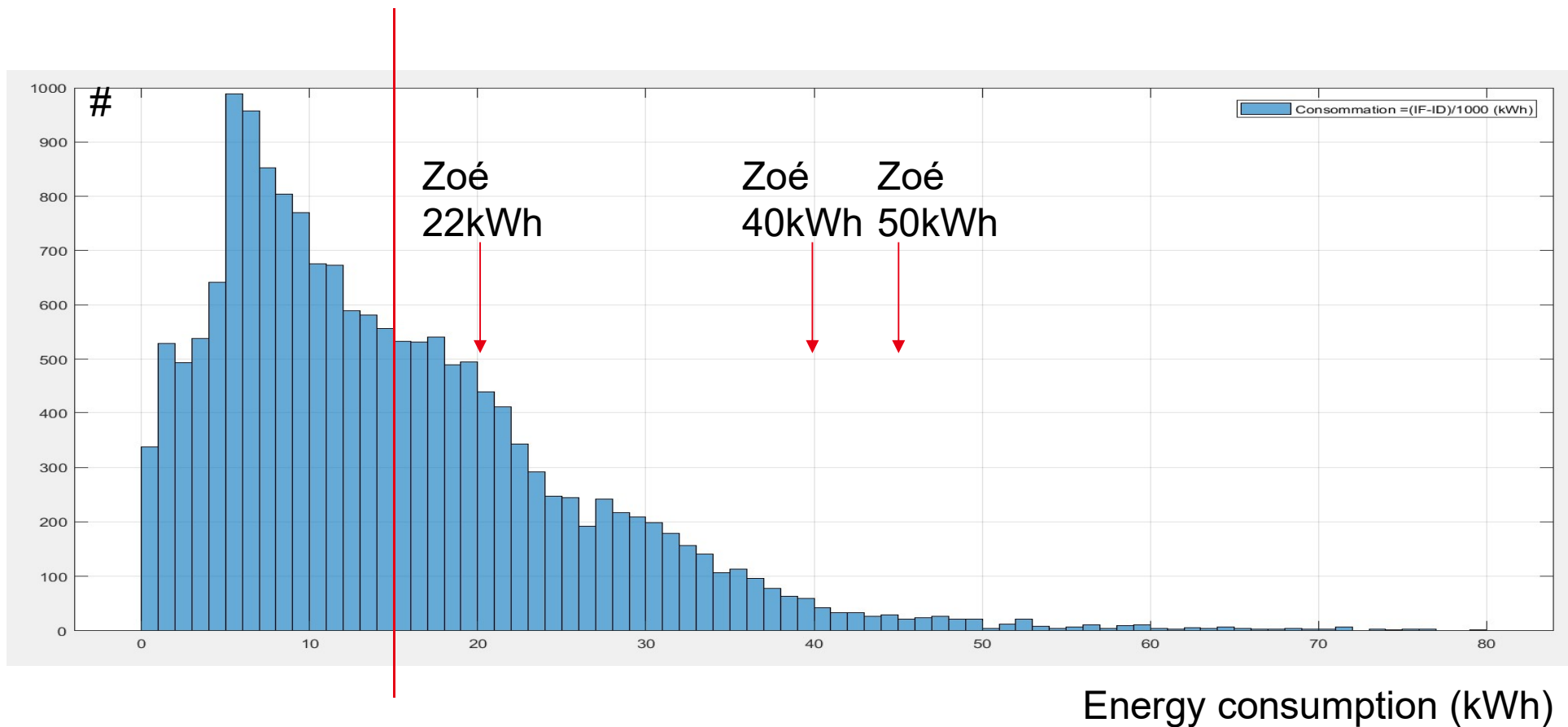
For more details on the assumptions and the methodology, please see [T&E's explanatory note](#)

STATISTICS ON TRANSACTIONS



ENERGY CONSUMPTION / TRANSACTION

Mean of the energy consumption per transaction : 14.8 kWh

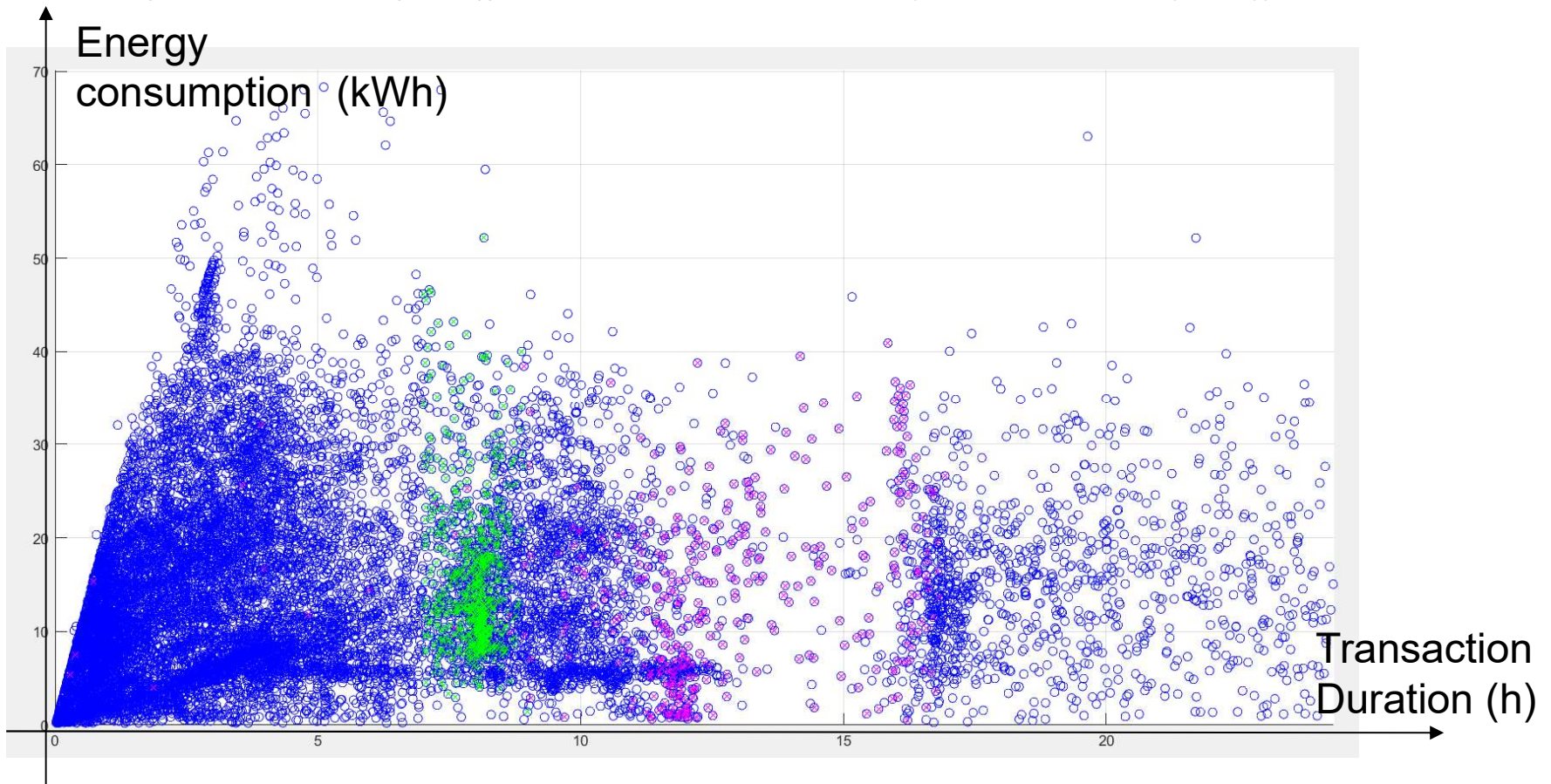


STATISTICS ON TRANSACTIONS



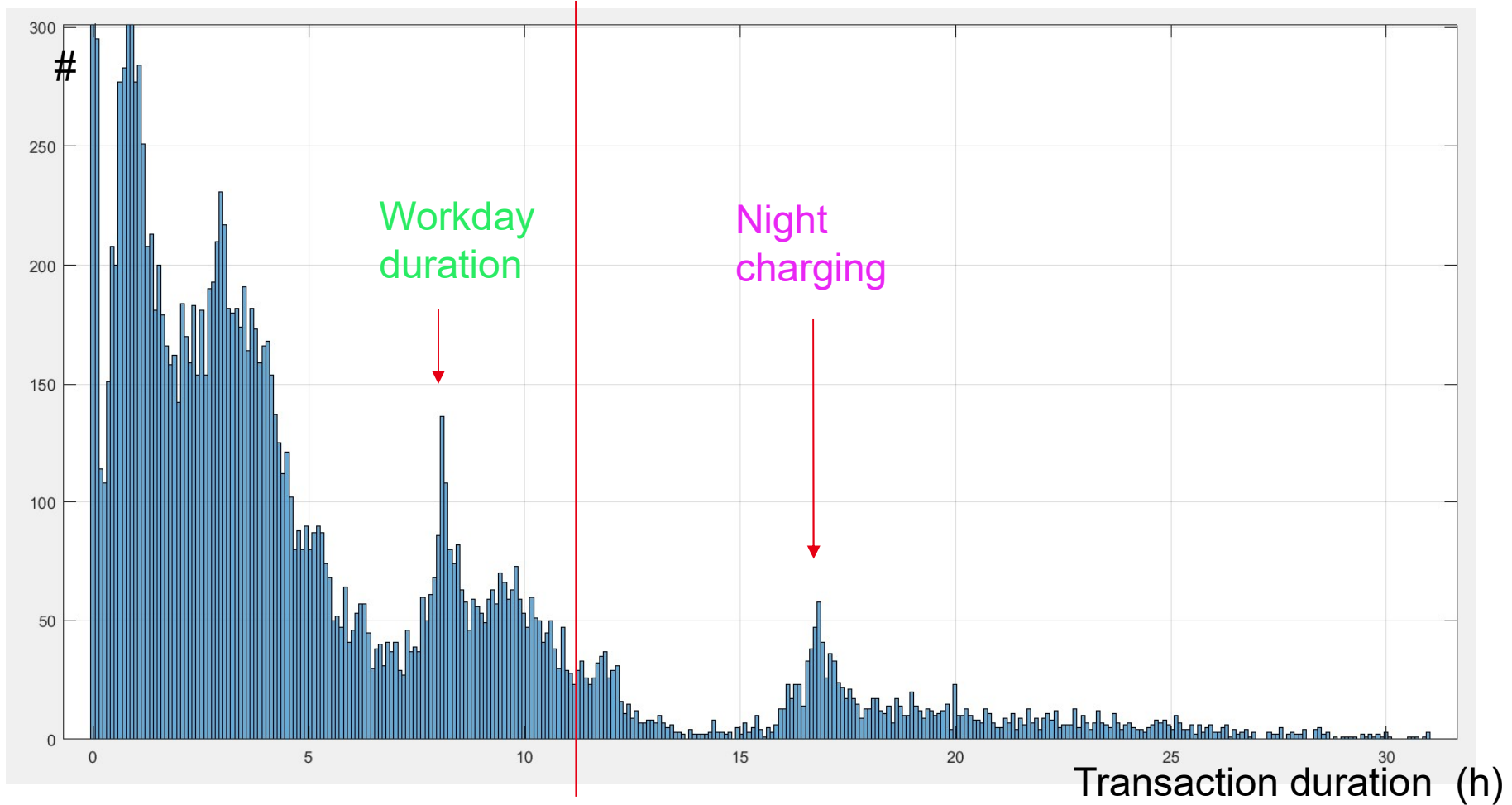
Full workday charging i.e
 -start after 7h and finish before 17h the same day
 -and charge duration greater than 7h
 (743 occurrences (4.7%))

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



DURATION OF TRANSACTION

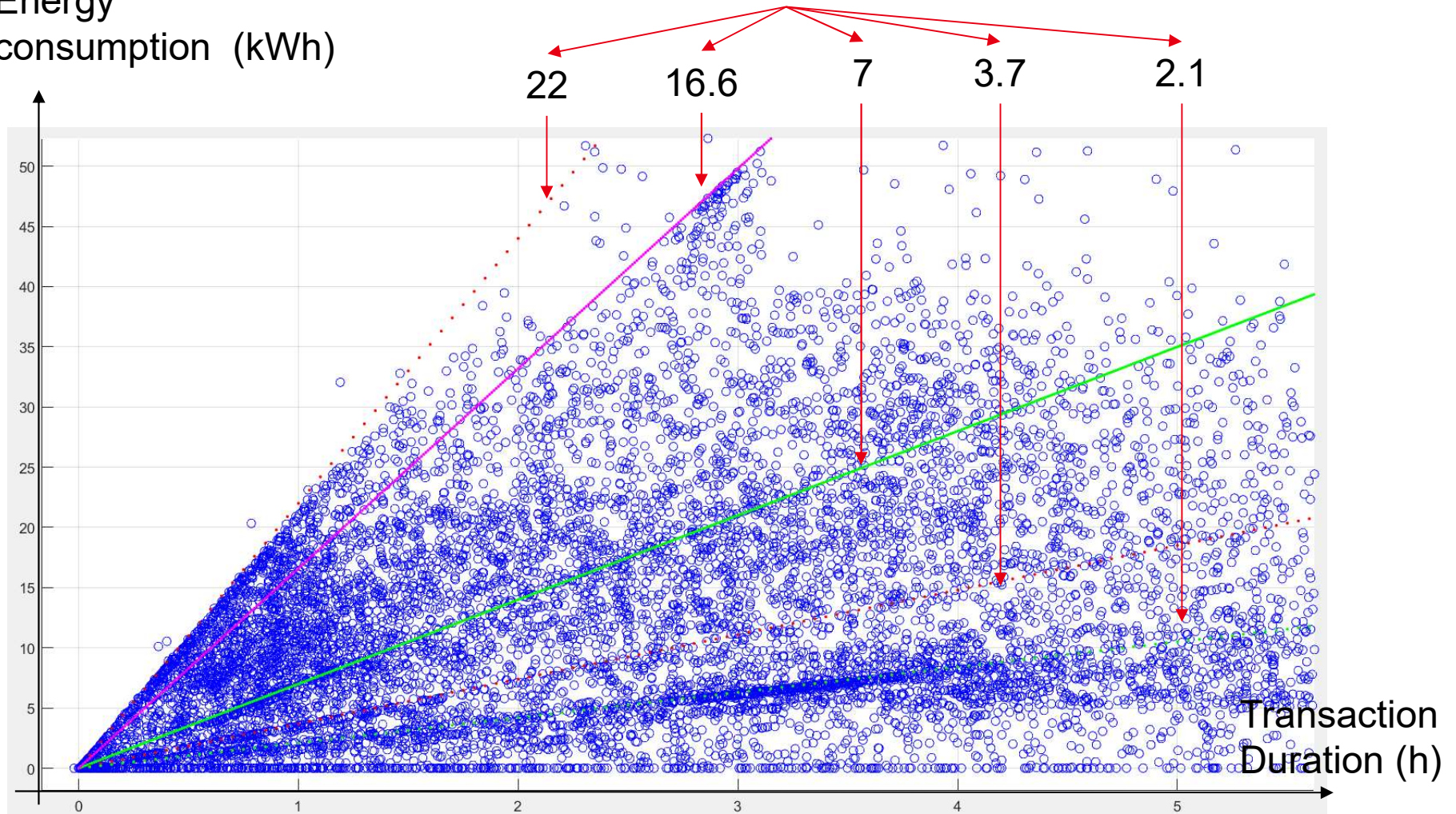
Mean of the transaction duration : 12.4h



STATISTICS ON TRANSACTIONS

Energy
consumption (kWh)

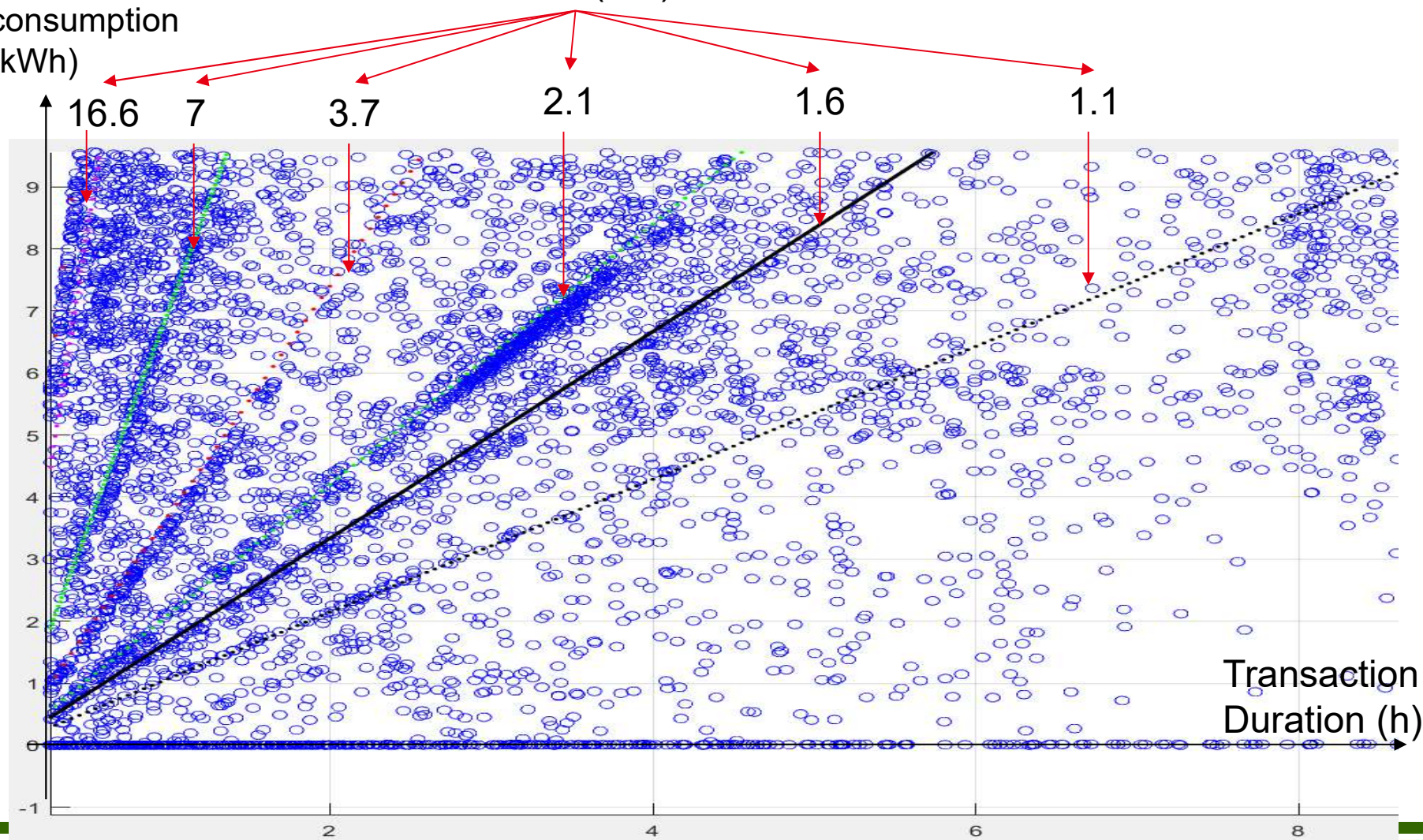
$$EC = \text{Power (kW)} * TD$$



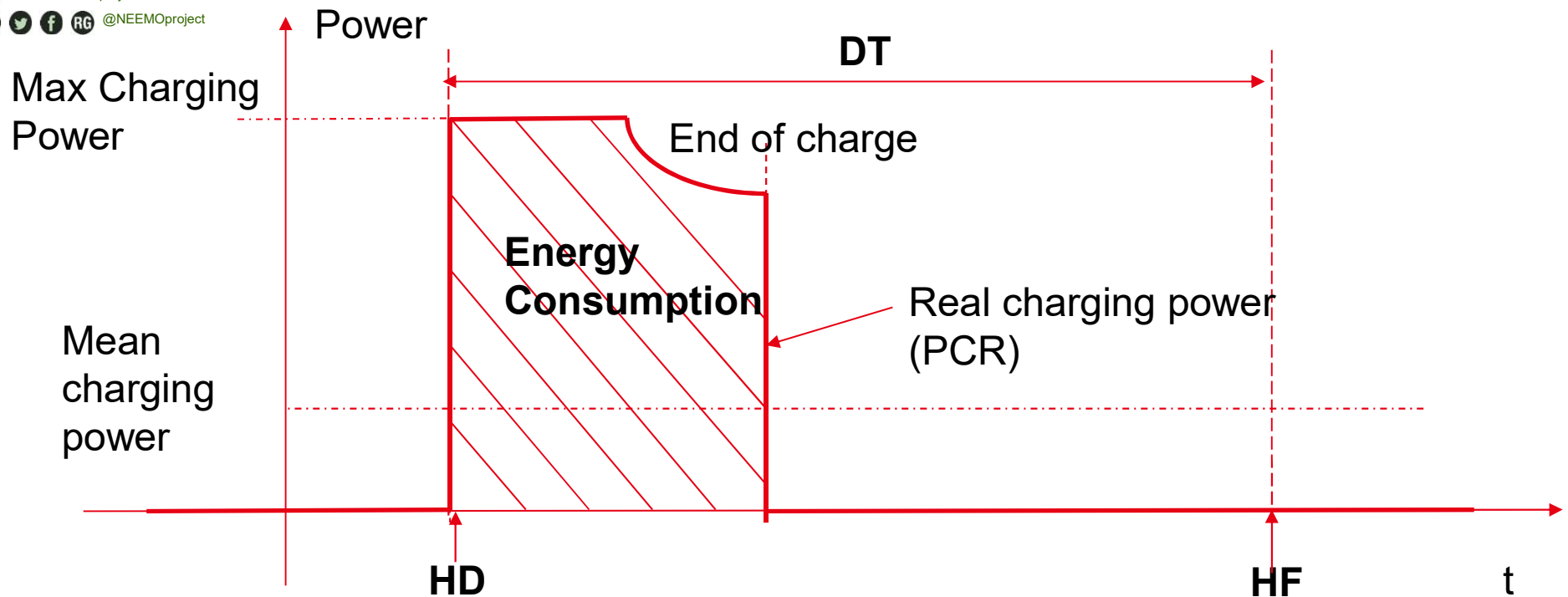
STATISTICS ON TRANSACTIONS

Energy consumption (kWh)

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



DEFINITIONS : PARAMETERS OF CHARGE



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

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

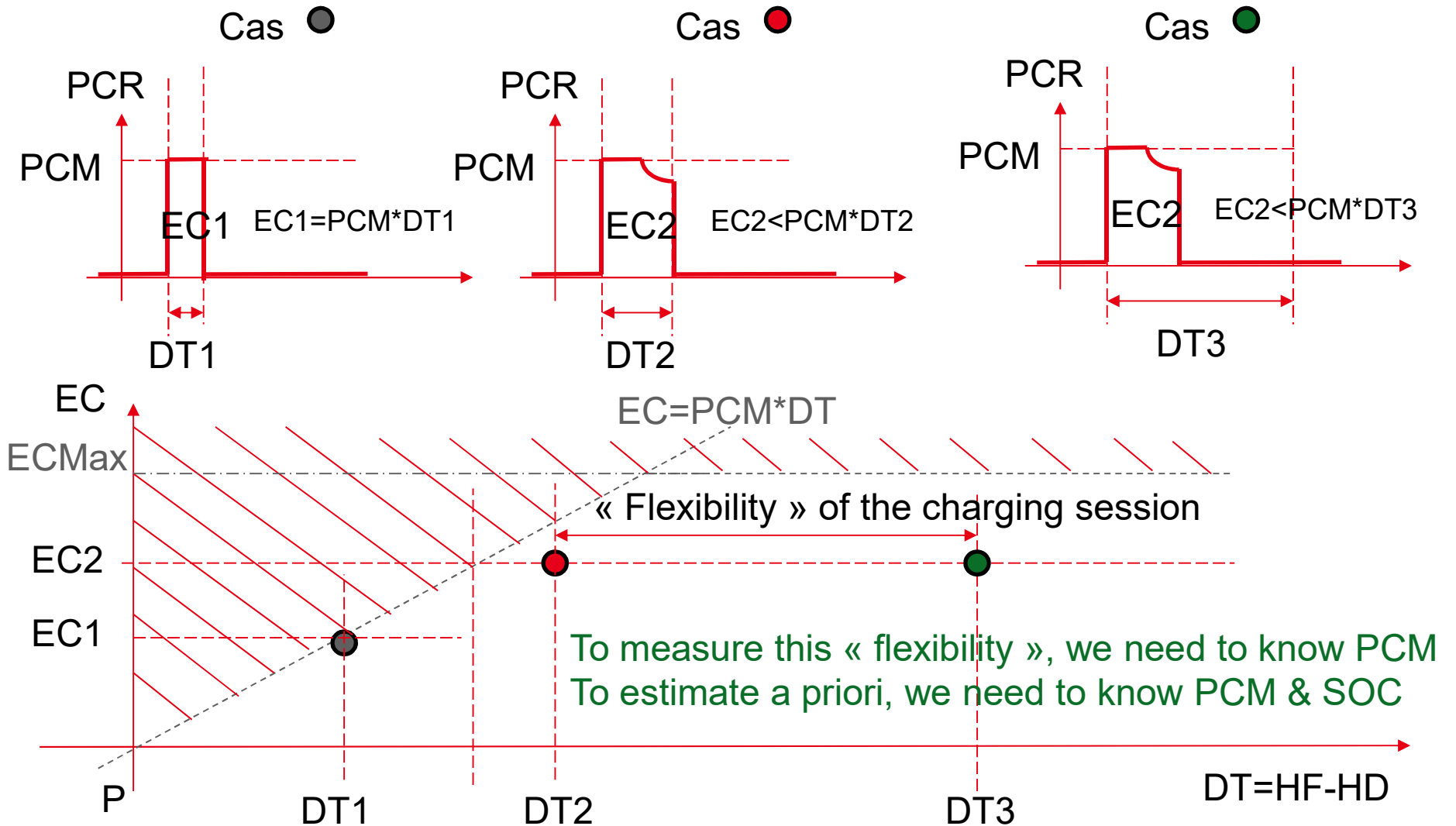
Energy Consumption = $EC = ID - IF$ => recorded in the transaction file

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 = $PCMean = EC/DT$ => can be calculated

DEFINITION : FLEXIBILITY

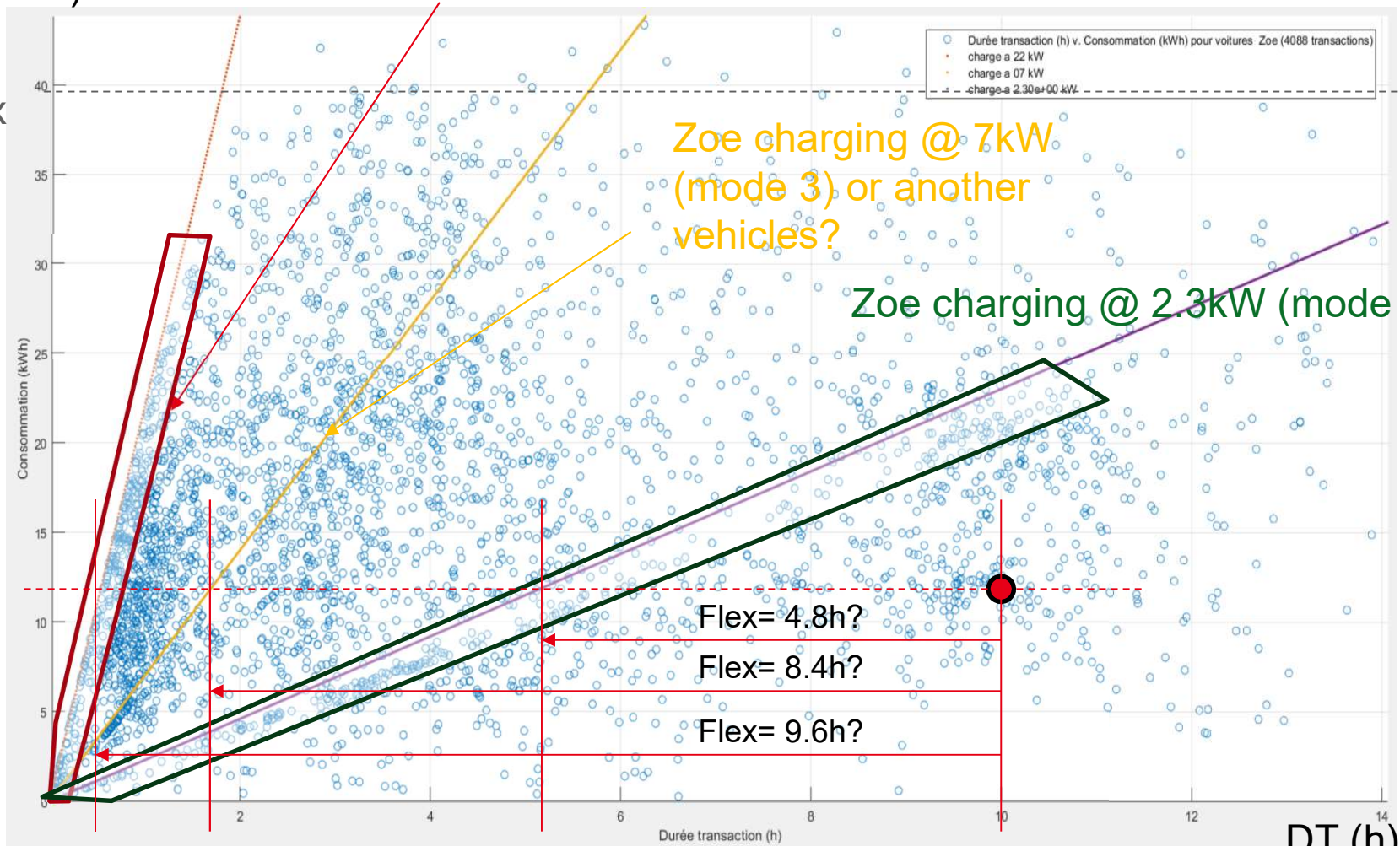


EXAMPLE : ALL THE ZOE

Zoe charging @ 22kW (mode 3)

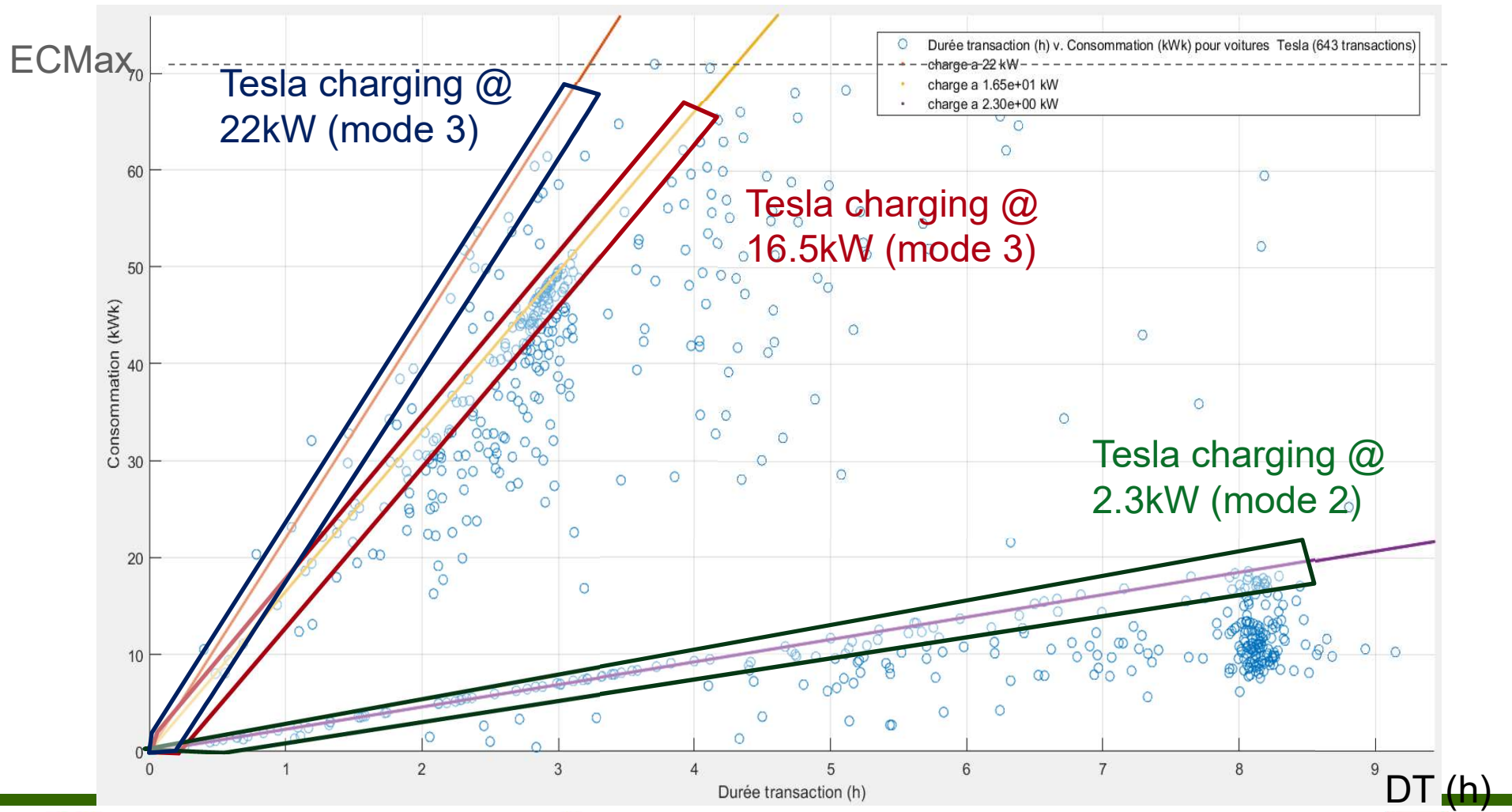
EC (kWh)

ECMax



EXAMPLE : ALL THE TESLA

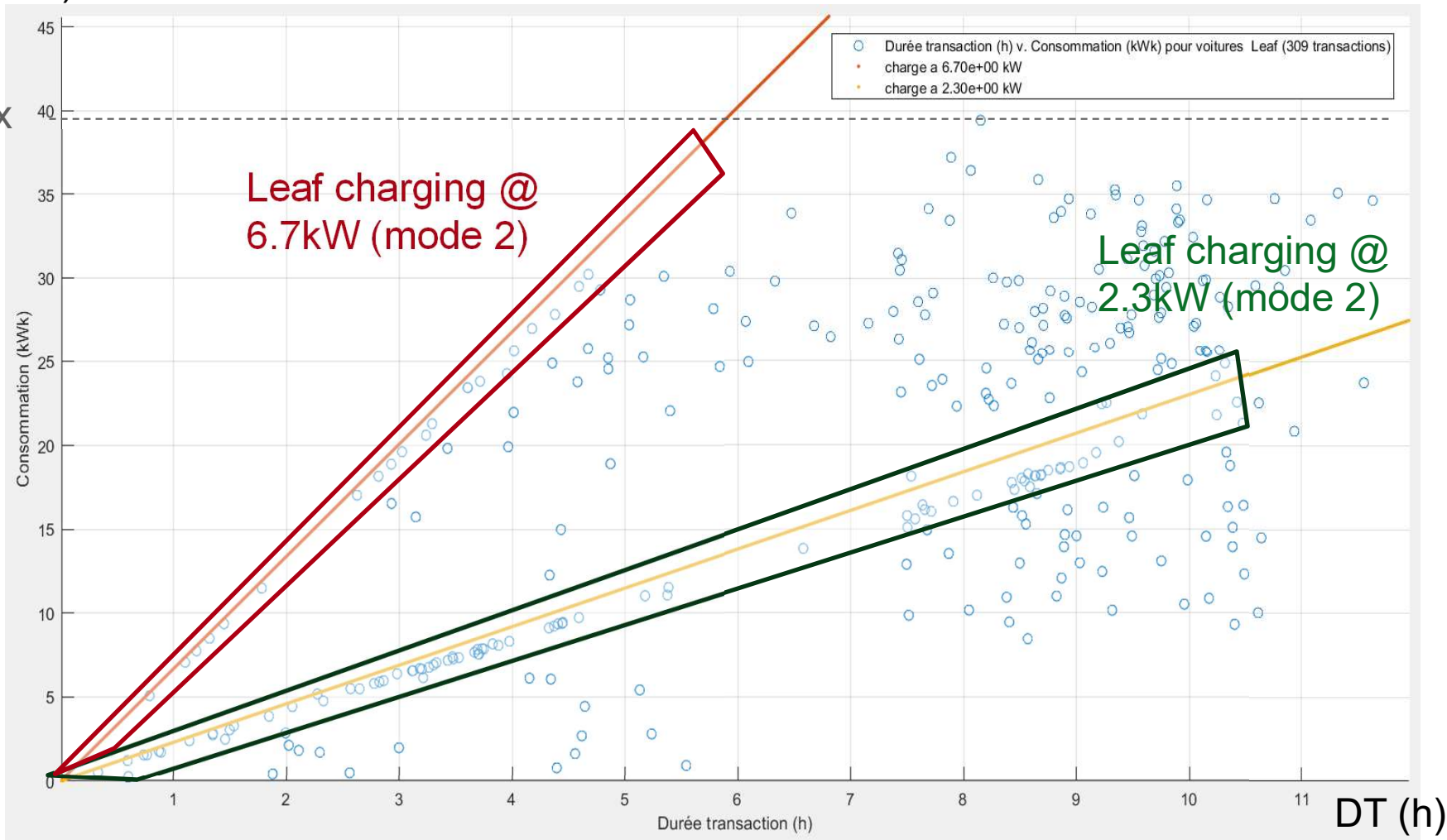
EC (kWh)



EXAMPLE: ALL THE LEAF

EC (kWh)

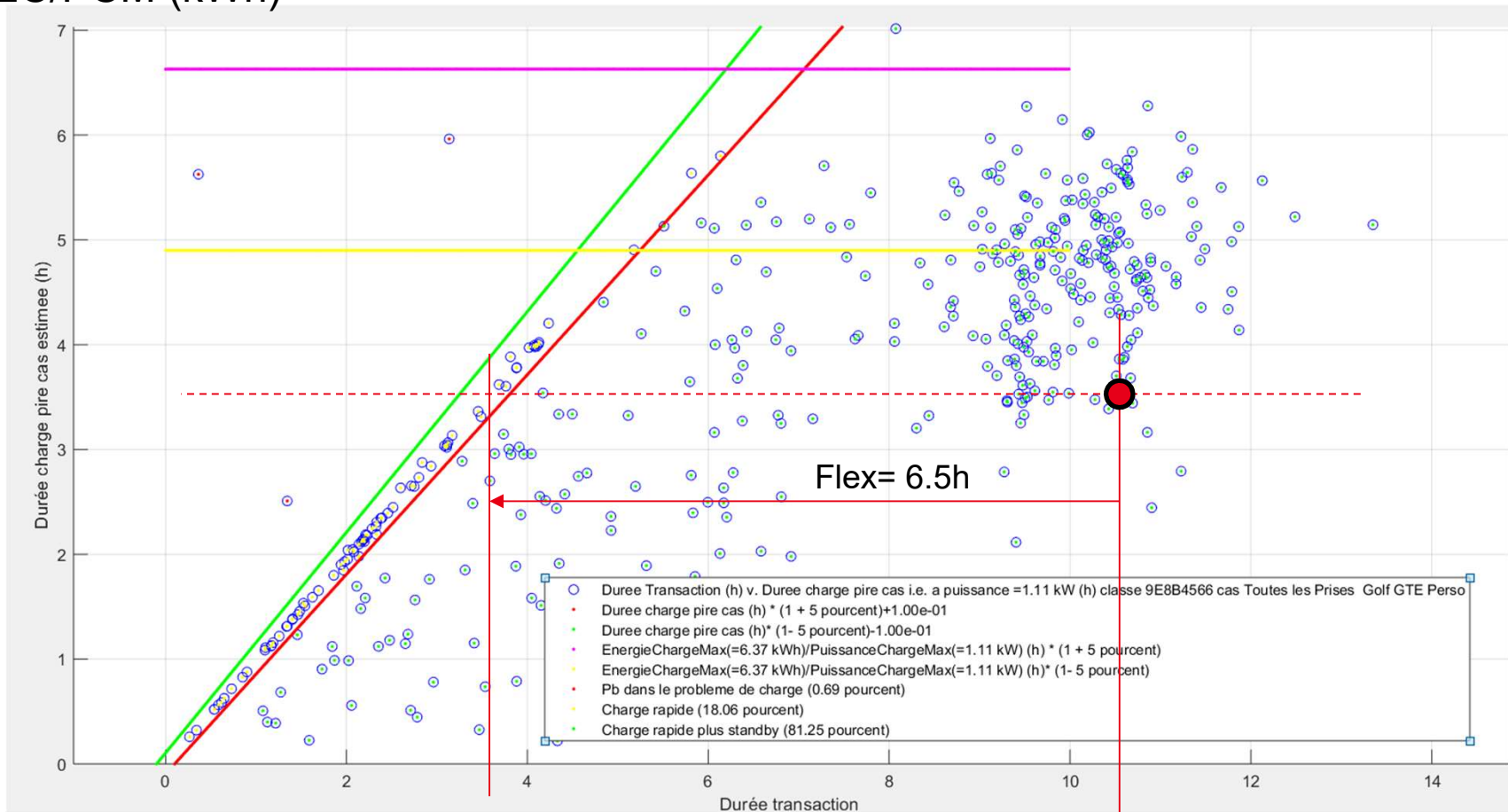
ECMax



EXAMPLE: ONE GOLF GTE (PHEV)

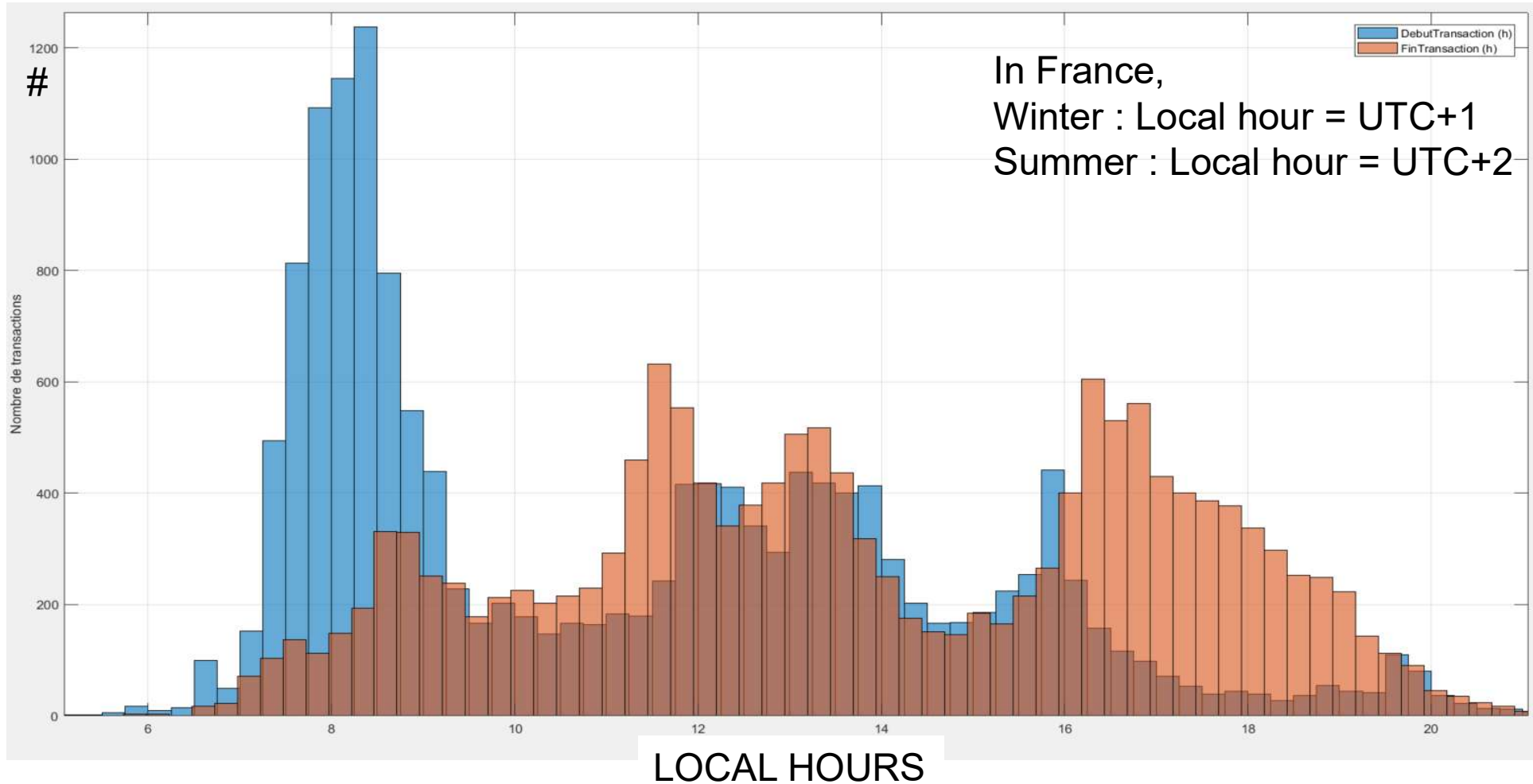
Estimation of PCM = 1.1 kW (mode 3 with T2 connector)

EC/PCM (kWh)

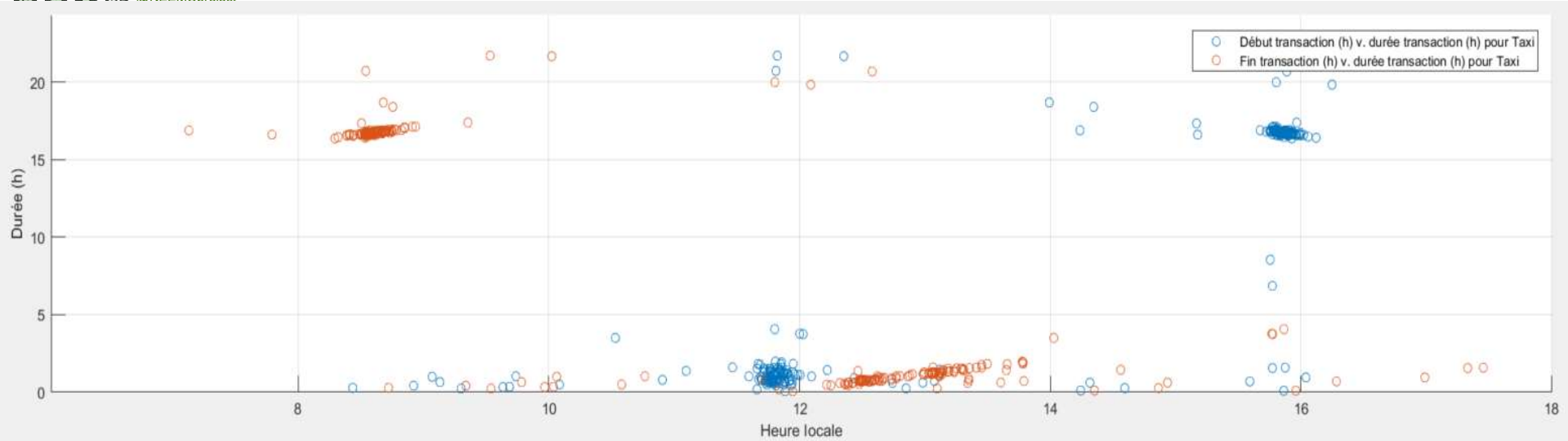


TD (h)

START/END OF TRANSACTIONS



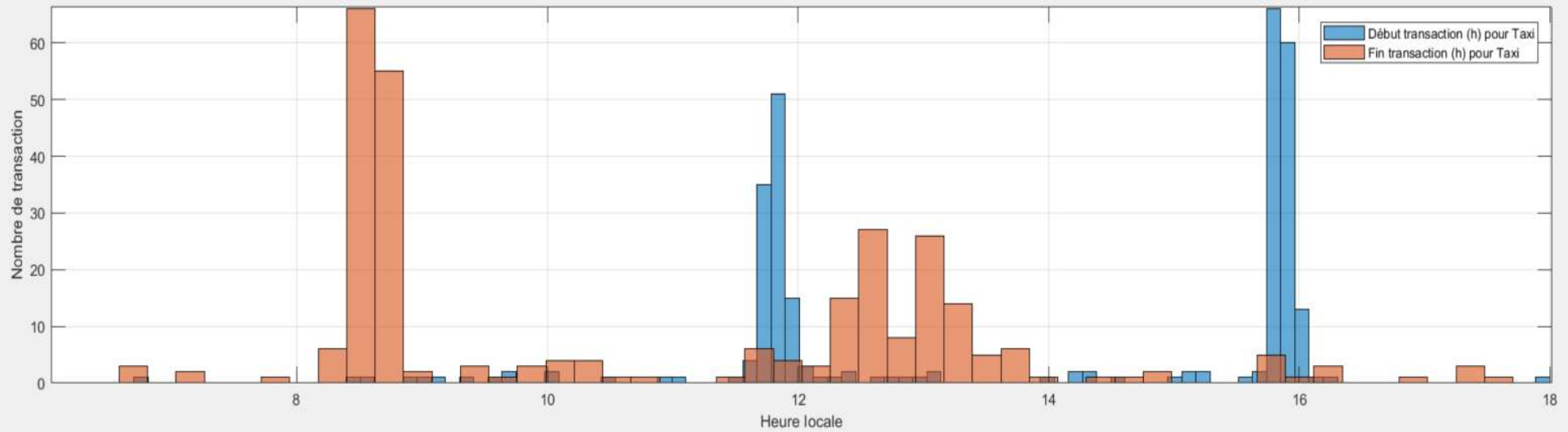
START/END OF TRANSACTIONS : 'TAXI'



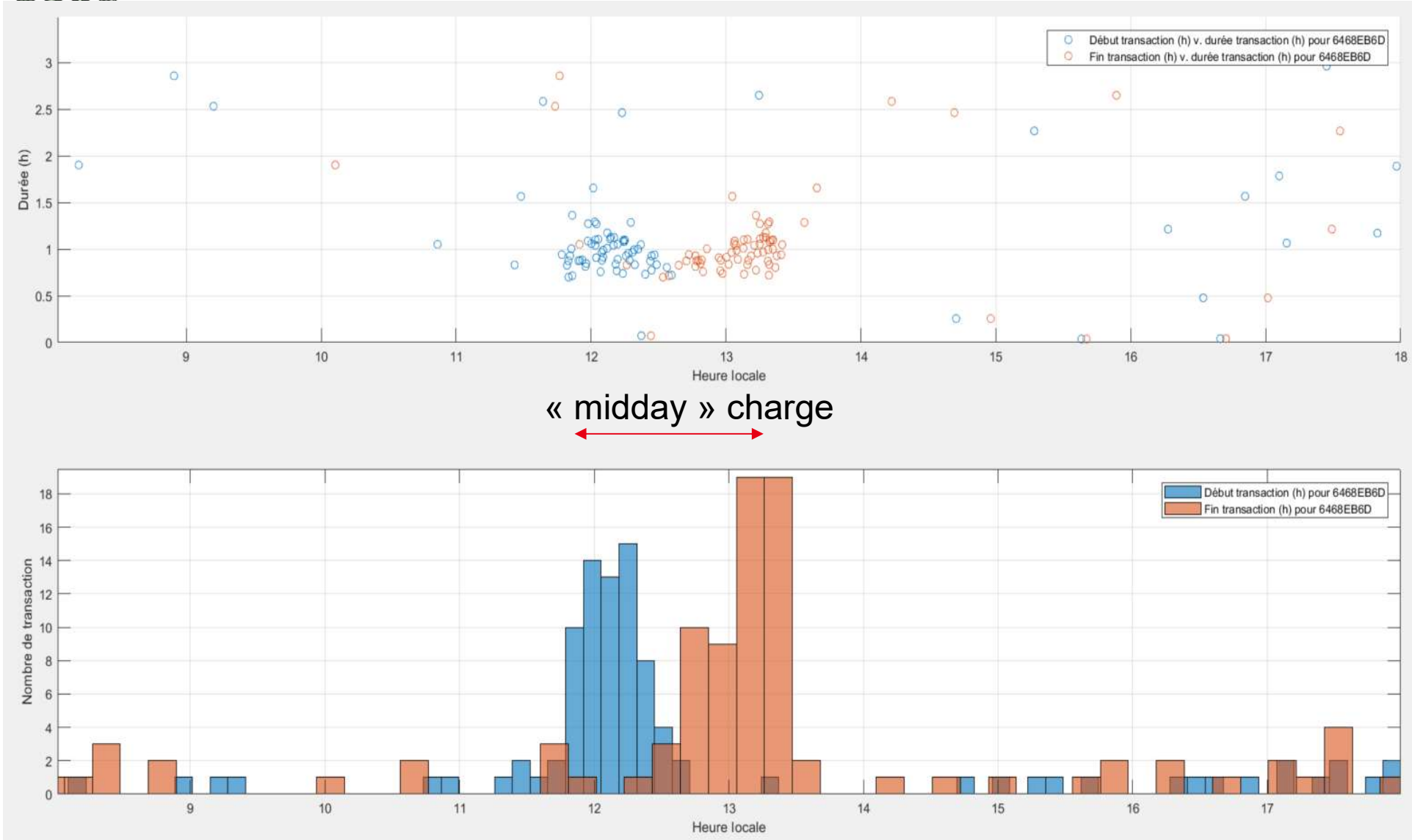
« night » charge

« midday » charge

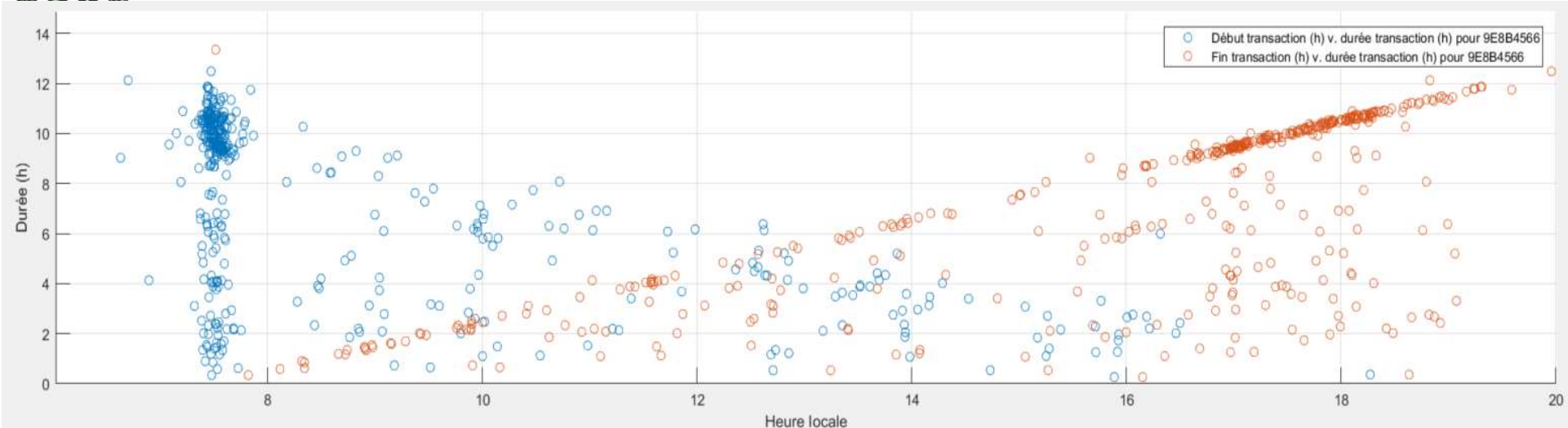
« night » charge



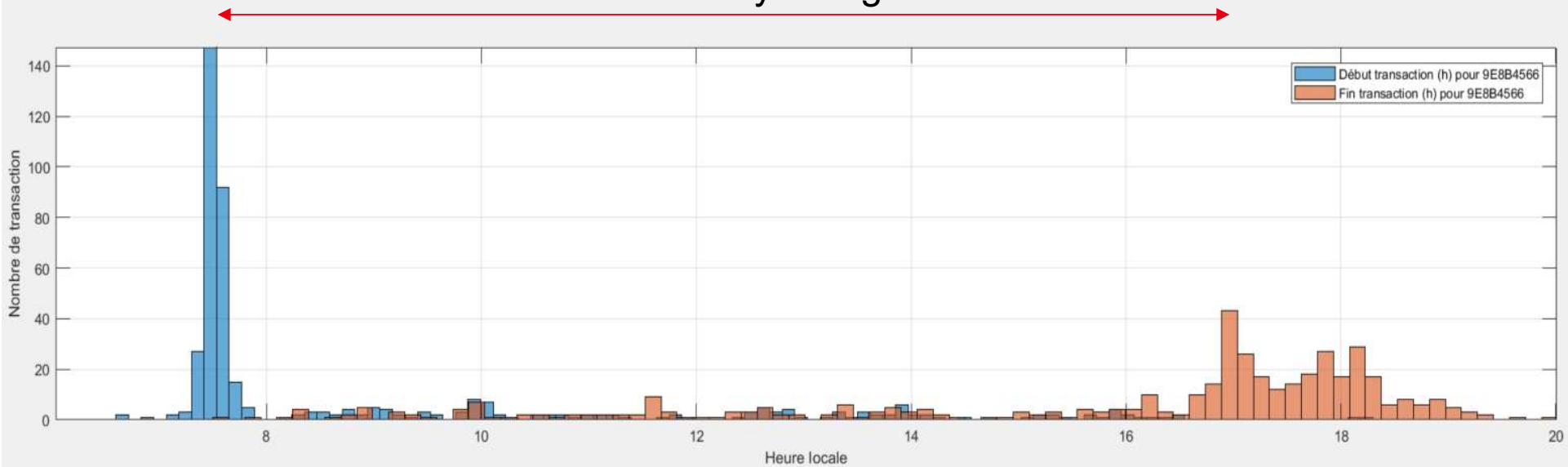
START/END OF TRANSACTIONS : SERVICE VEHICLE



START/END OF TRANSACTIONS : PERSONAL VEHICLE



Full workday charge

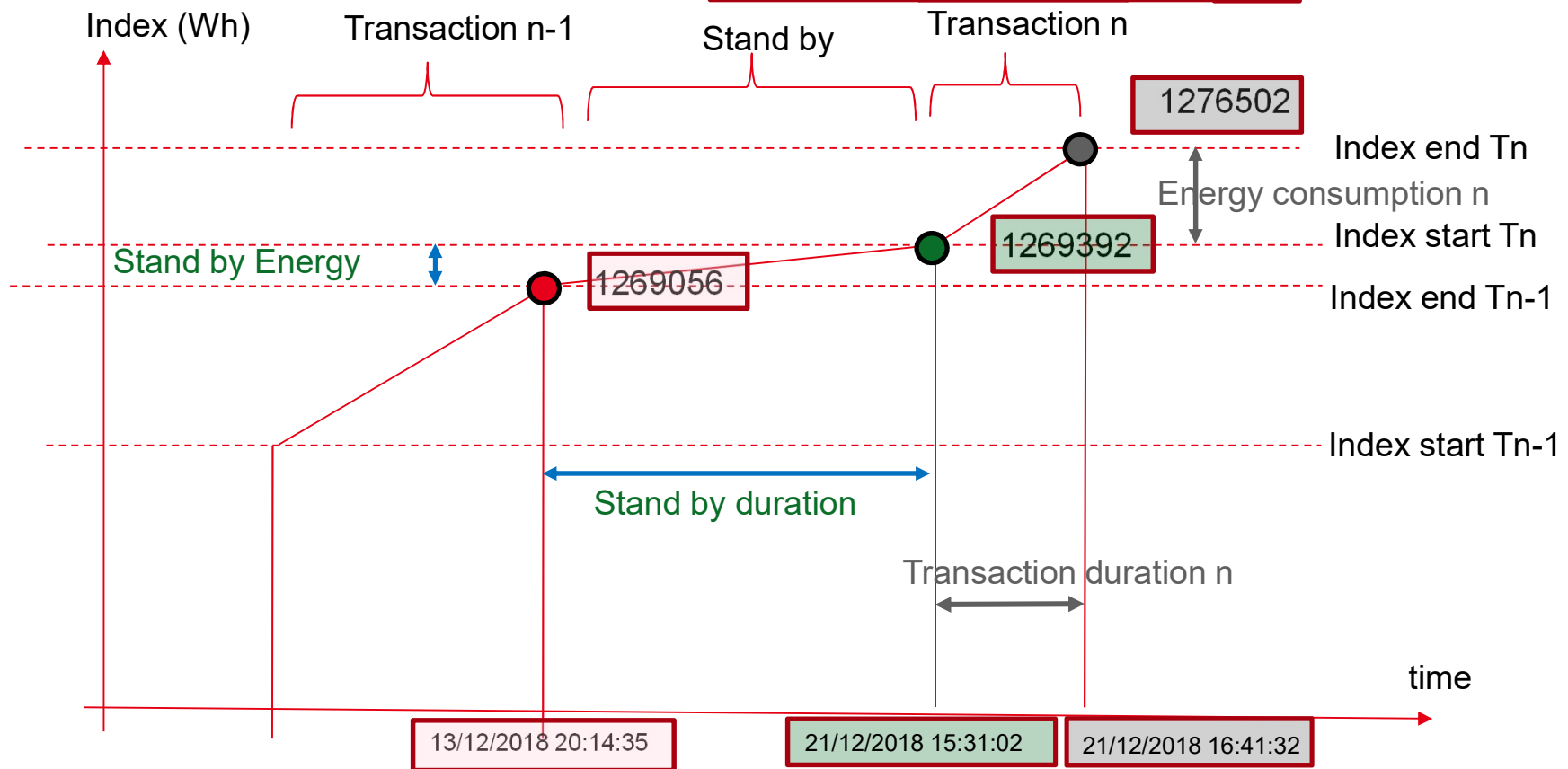


- **EvoIVE Project**
- **CEA EVCI & PV**
 - CEA EVCI
 - Charging modes
 - EvoIVE @INES
 - EvoIVE @Cadarache
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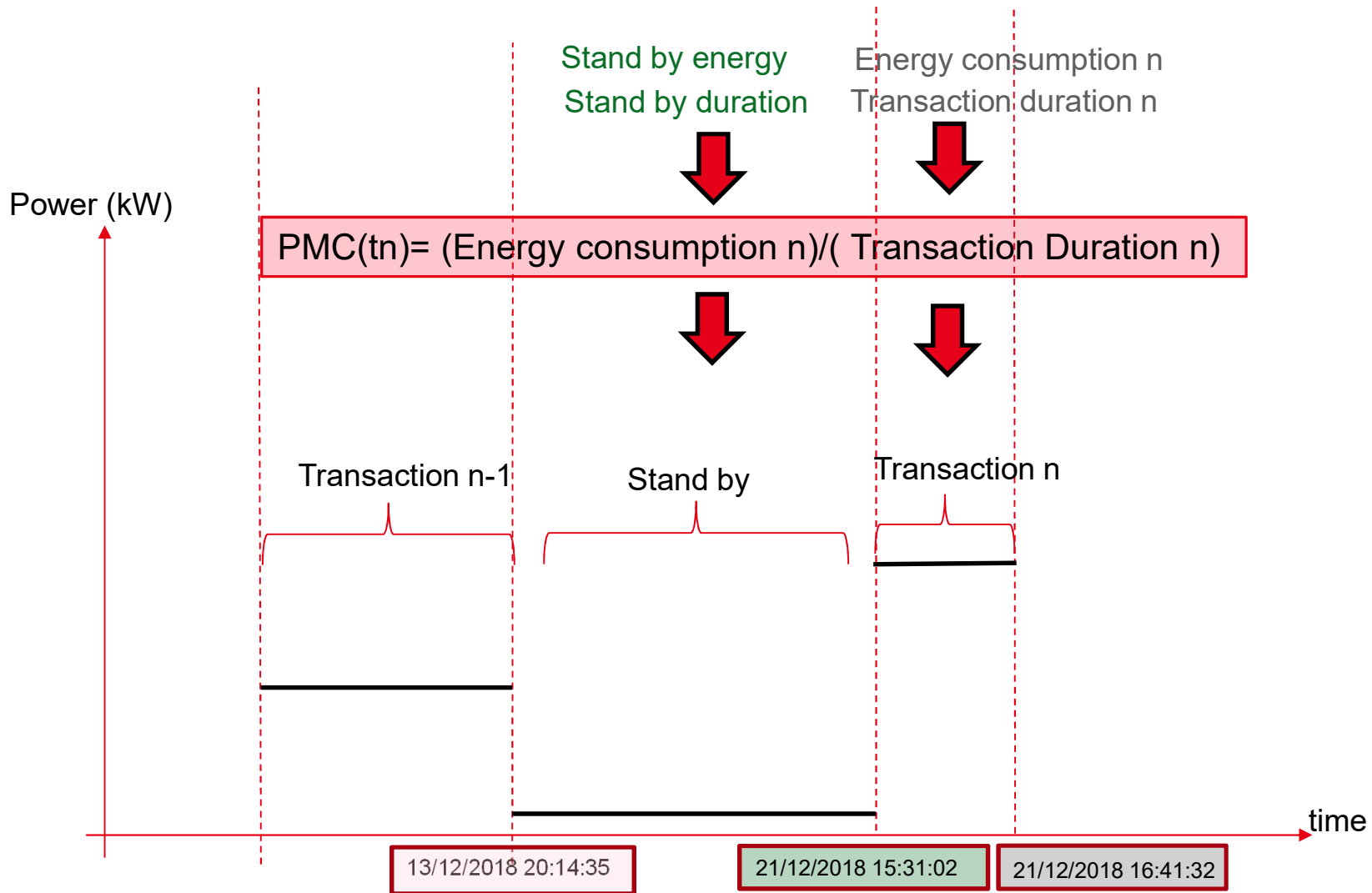
MEAN CHARGING POWER HYP. : PRINCIPLE OF RECONSTRUCTION

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-F	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-F	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-F	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-F	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



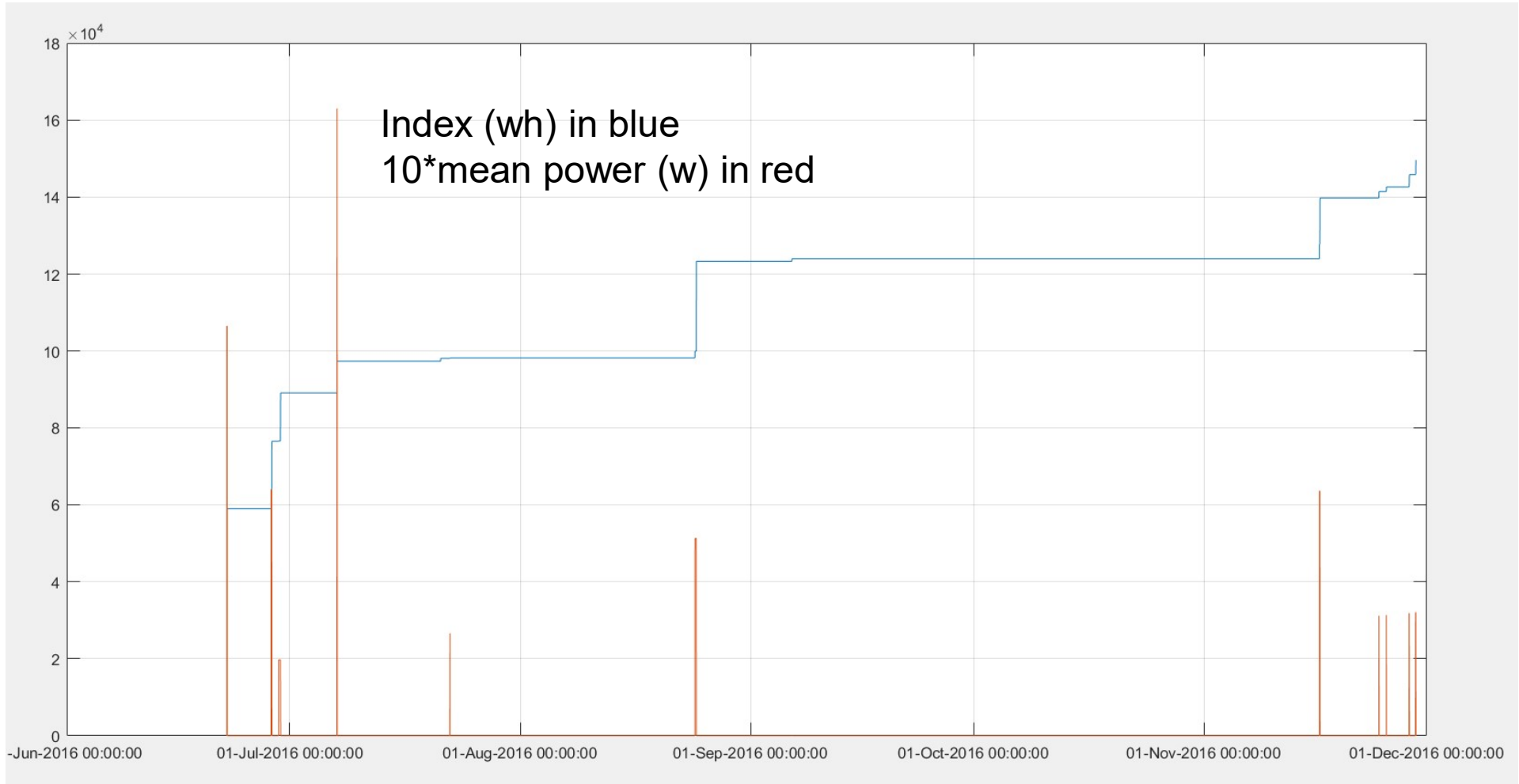
MEAN CHARGING POWER HYP. : PRINCIPLE OF RECONSTRUCTION



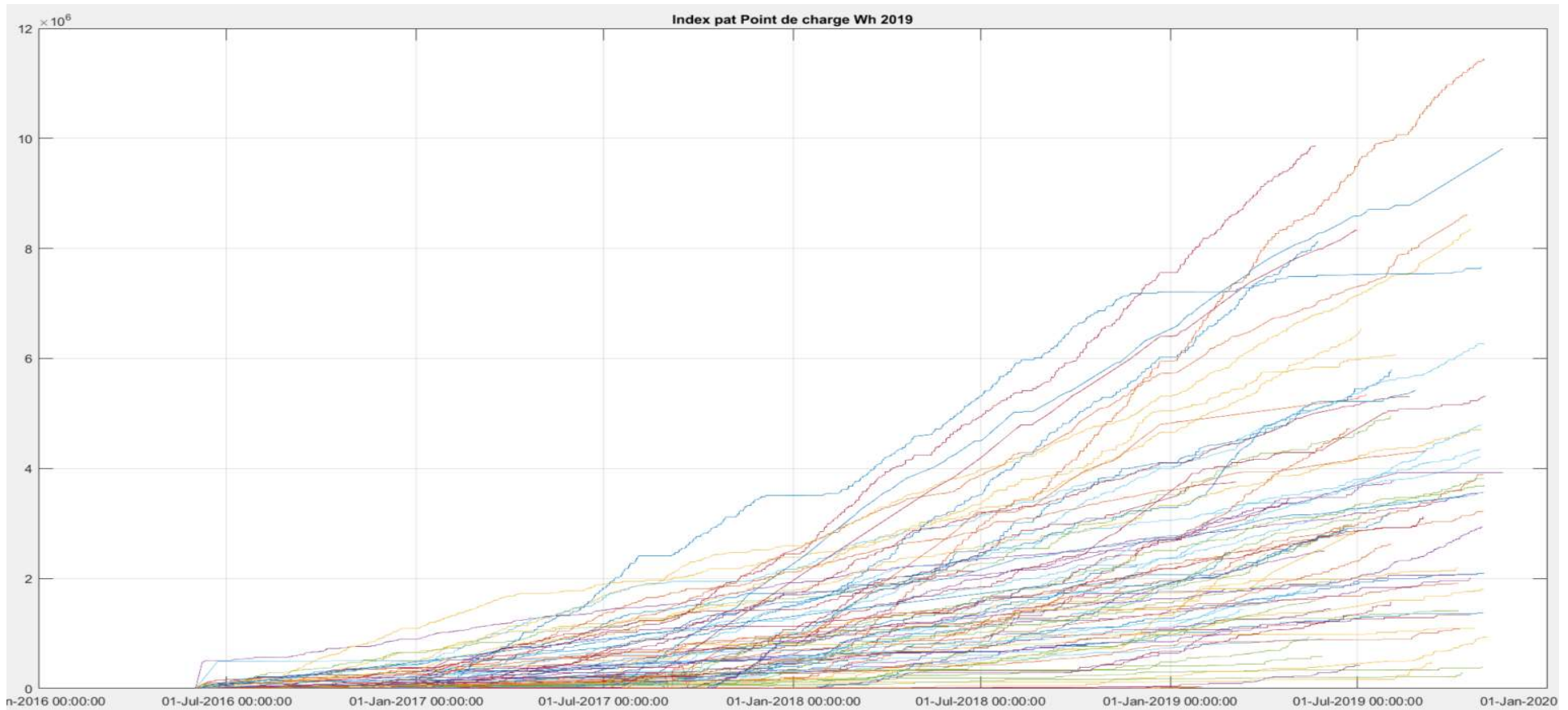
MEAN CHARGING POWER HYP. : EXAMPLES



PdC: CU_BAT1011_13CEA

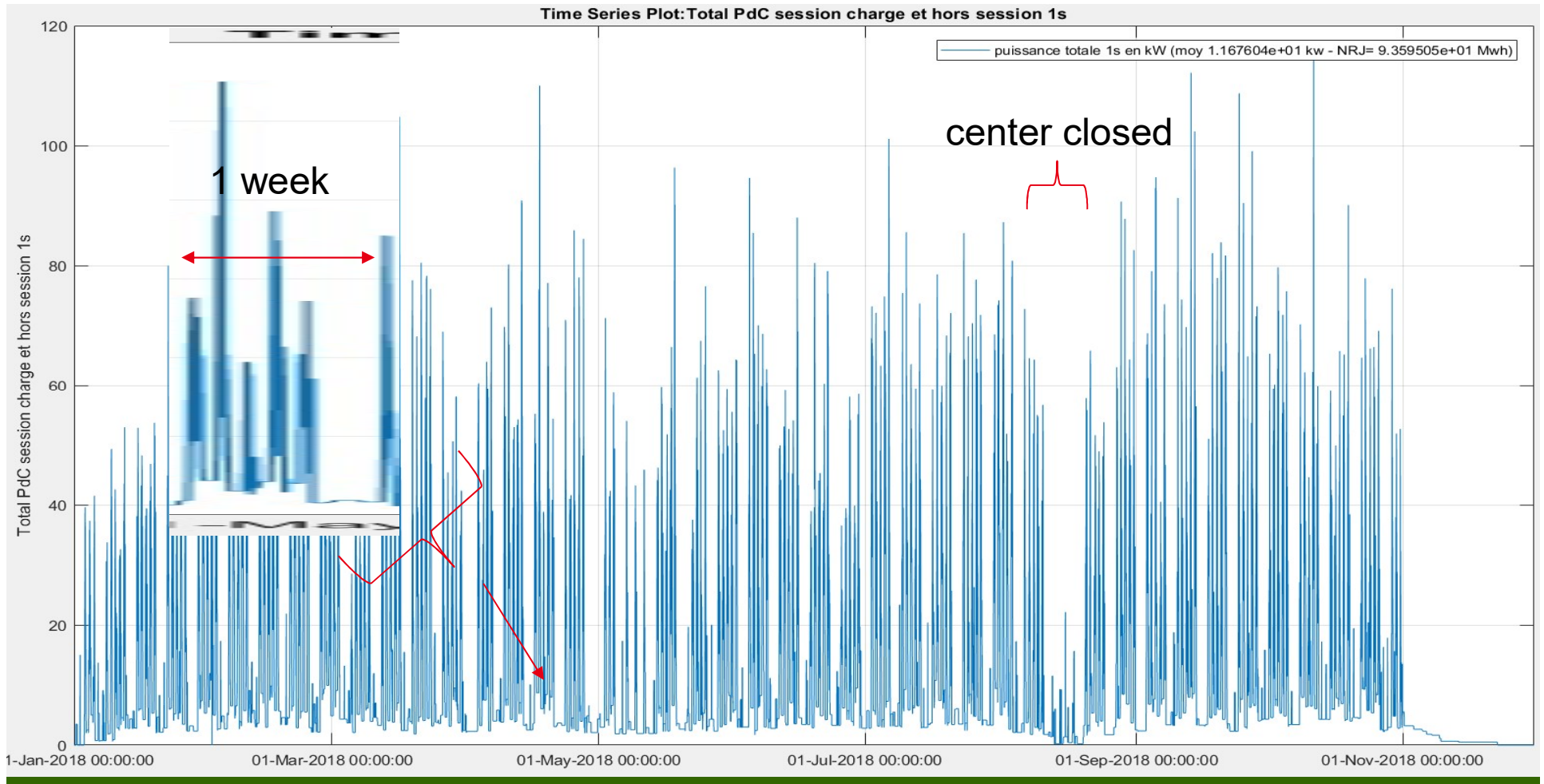


Energy indexes of the 81 charging stations (Wh)

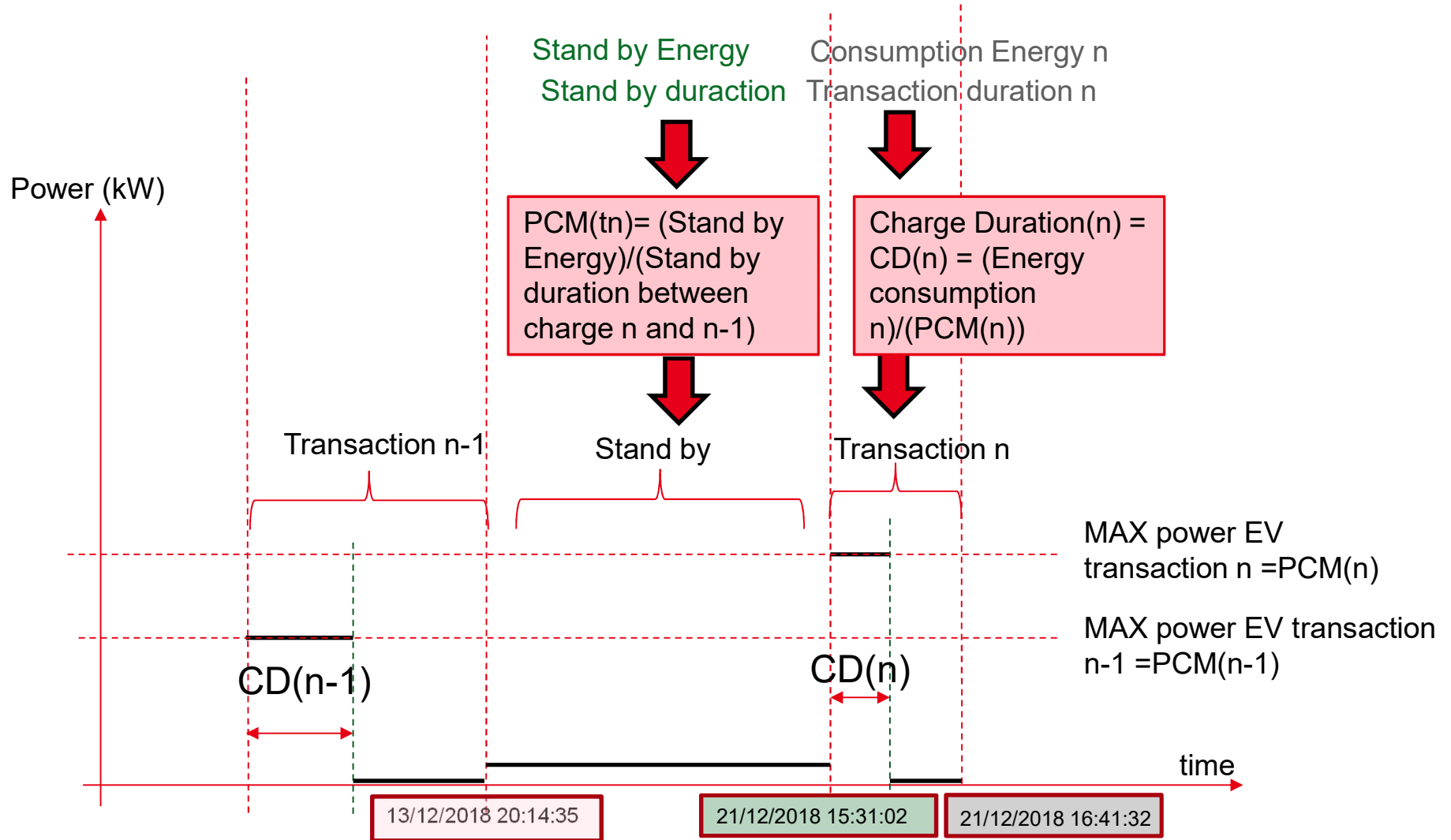


MEAN CHARGING POWER HYP. : AGGREGATED LOAD CURVE

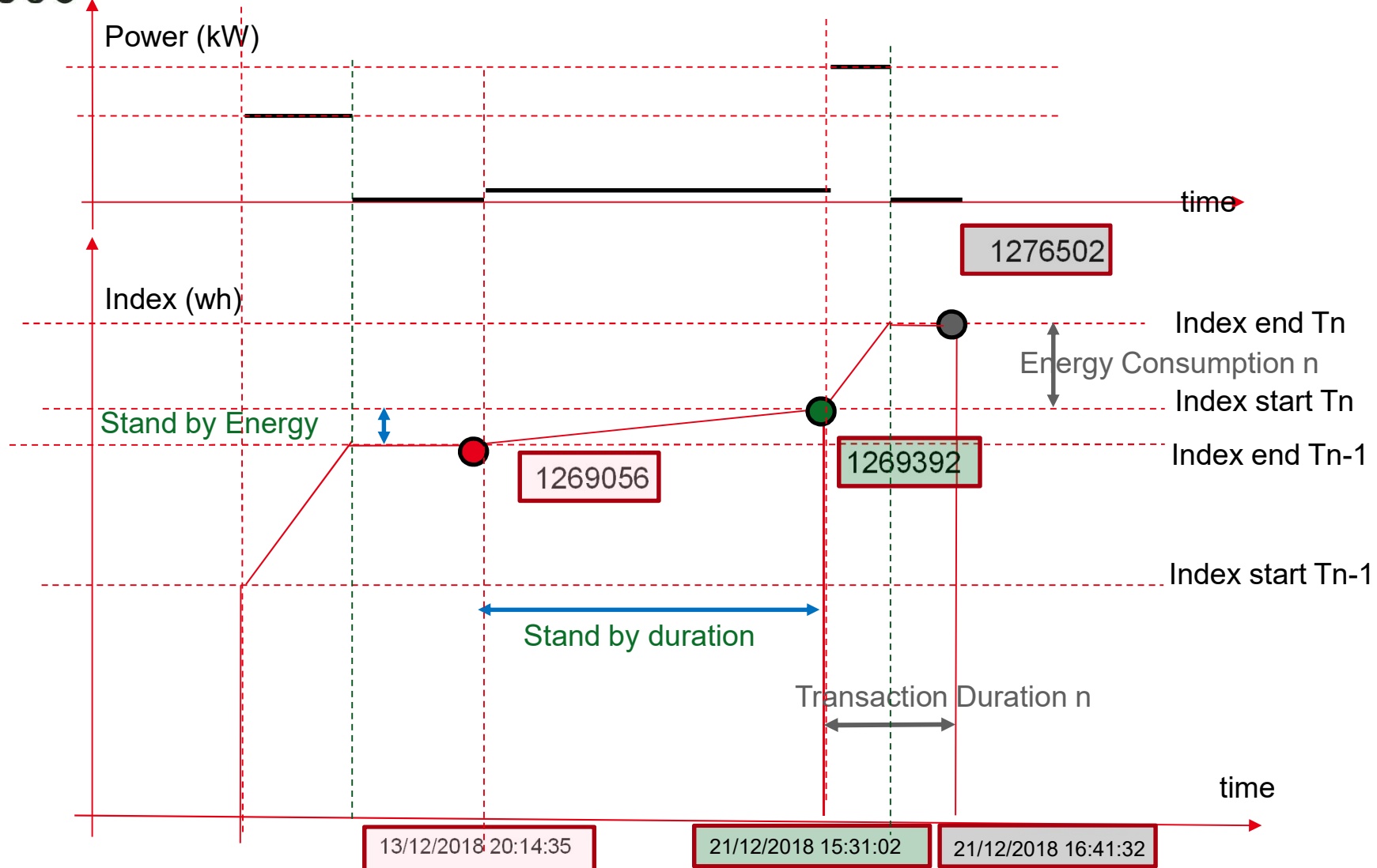
Total of the mean power for 81 charging stations (year 2018)



MAX CHARGING POWER HYP. : PRINCIPLES OF RECONSTRUCTION

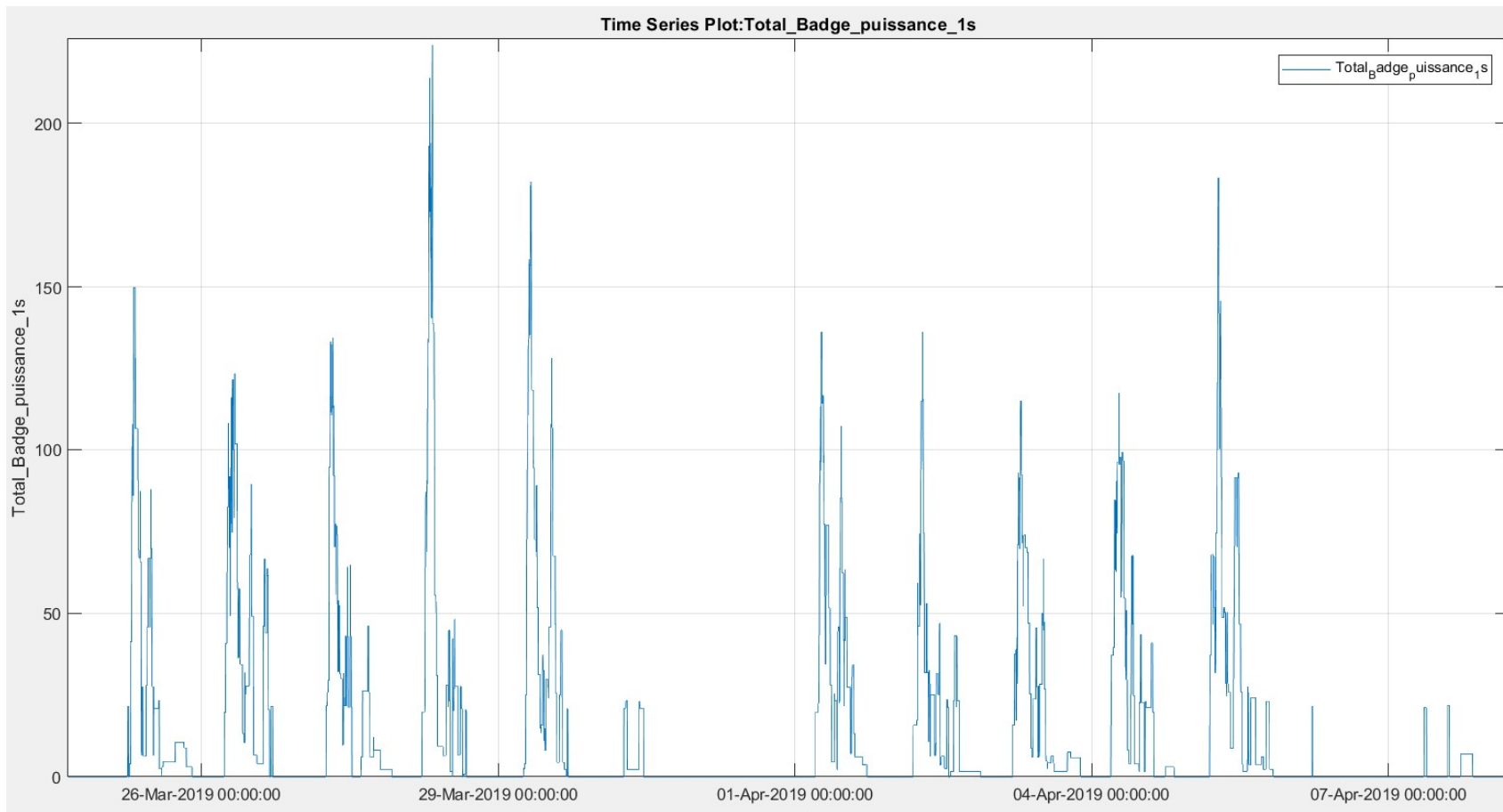


MAX CHARGING POWER HYP. : PRINCIPLES OF RECONSTRUCTION

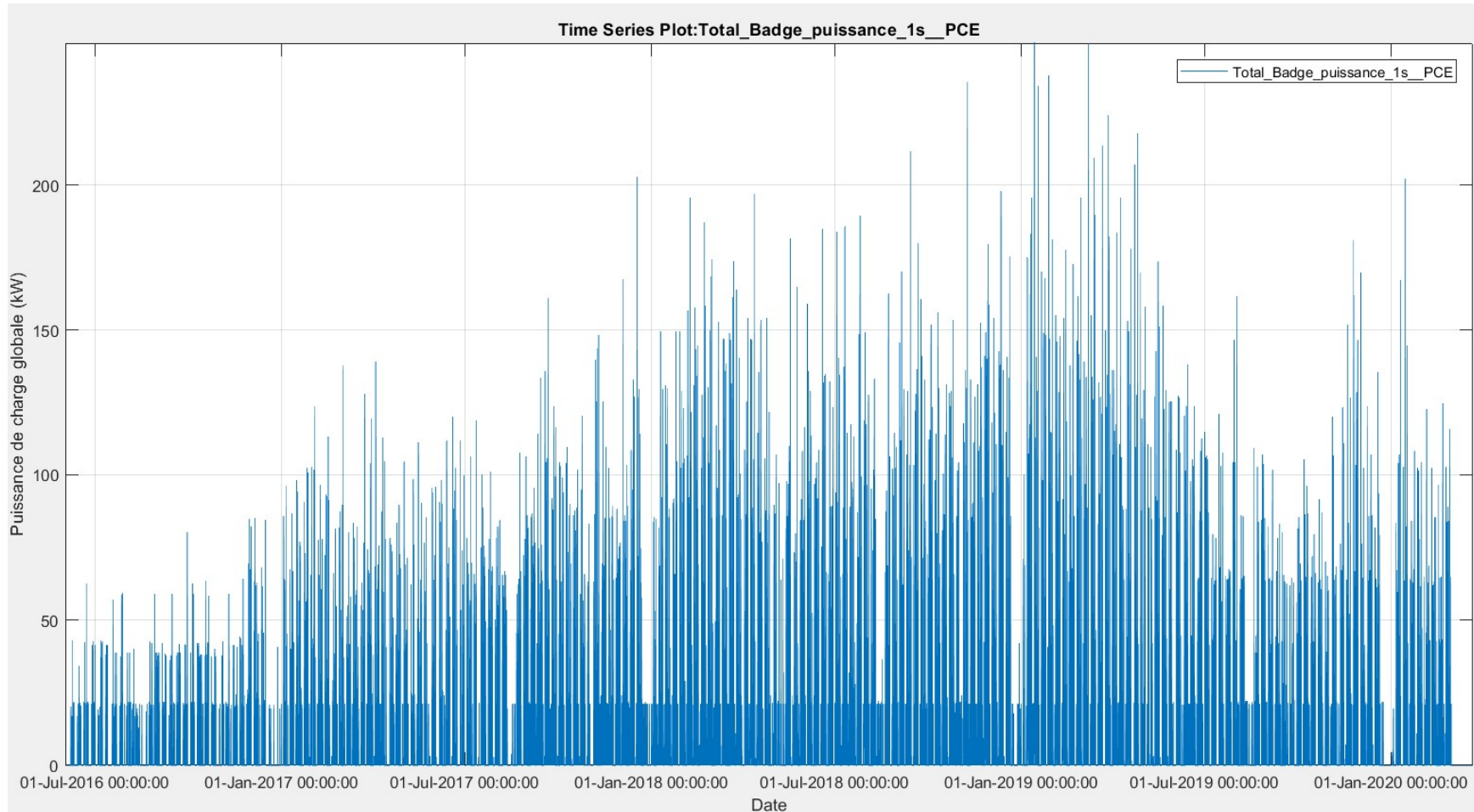


MAX CHARGING POWER HYP. : LOAD CURVES

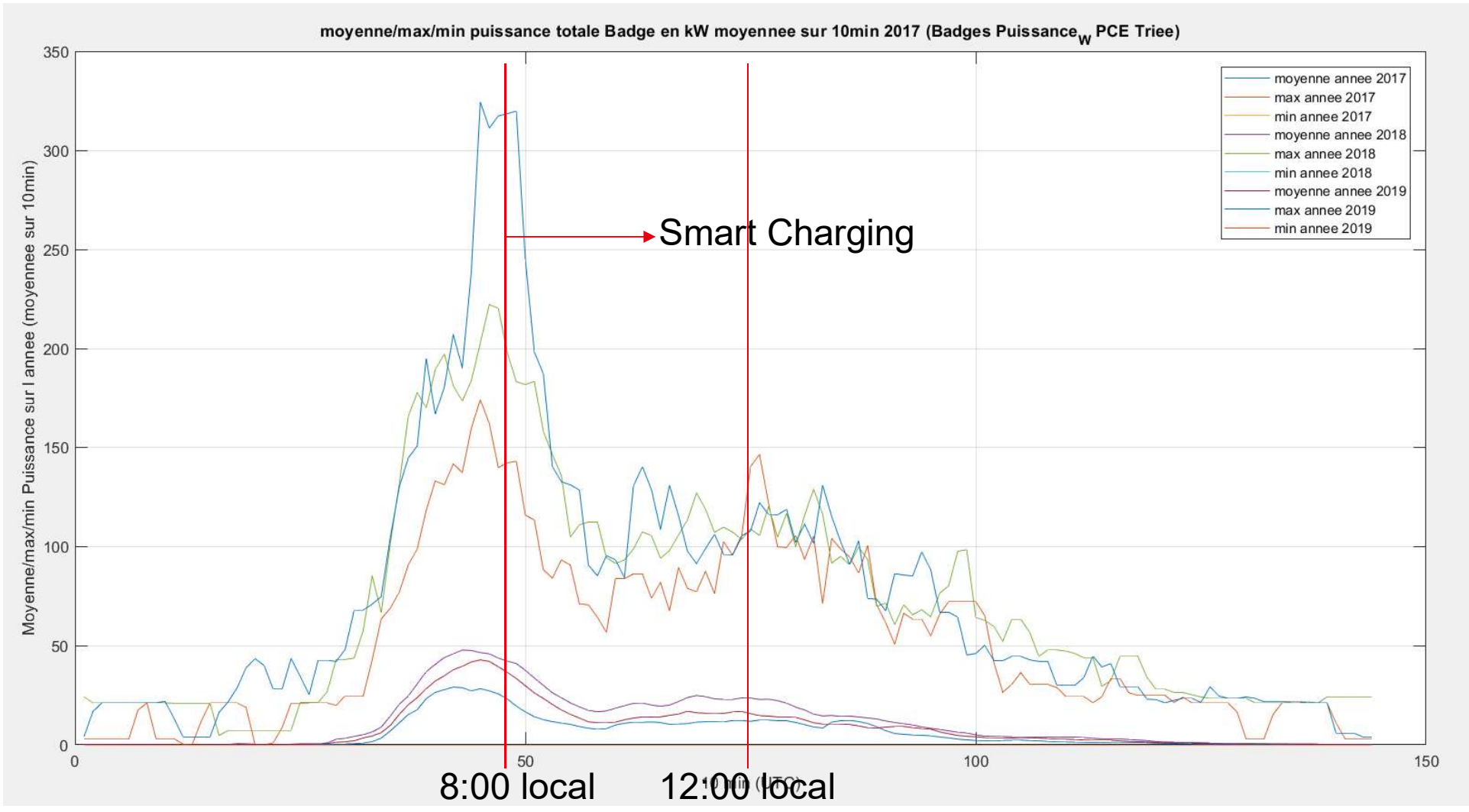
Charging power curves during 2 weeks:



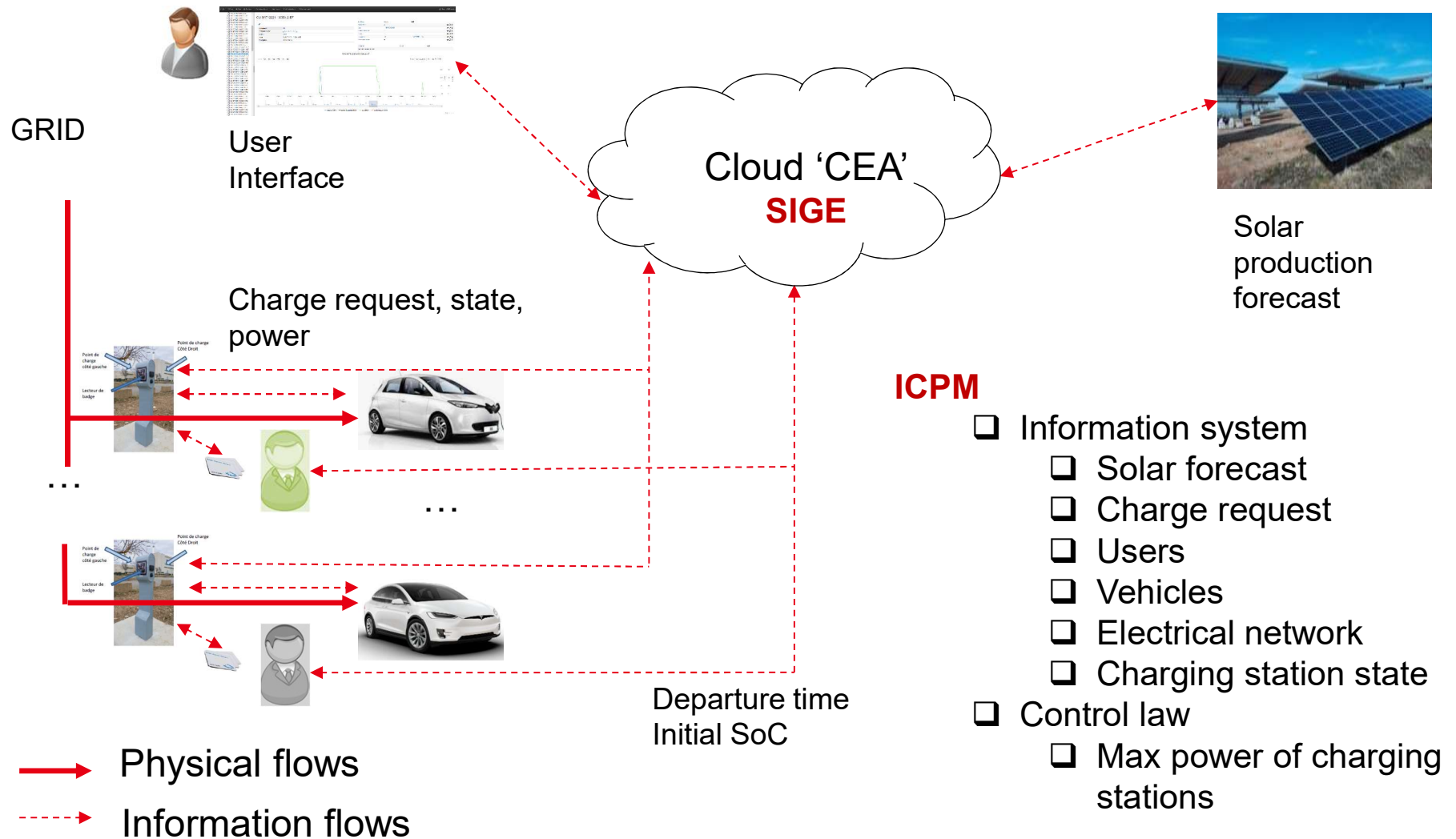
Charging power curves during 3.5 years:



MAX CHARGING POWER HYP. : MEAN LOAD CURVES PER HOUR



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EV

IEC 61851



NFC
Mifare 1k



Badge

Ocpp
protocol

Zigbee

Energy,
Power,
#Badge

G2box

Gateway

Production
forecast

IRVE
management
and analysis



SMS

Departure time
Initial SoC



3G

3G

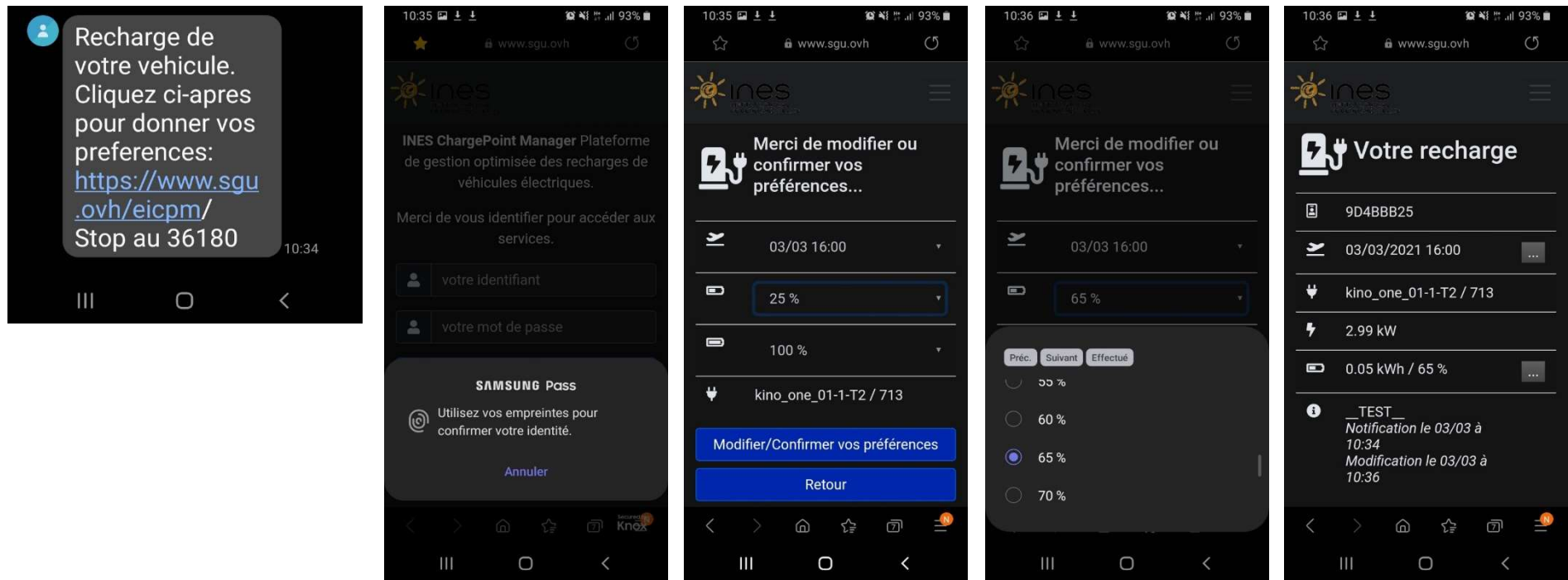
Tcp/IP



EV user

Graphical User Interface

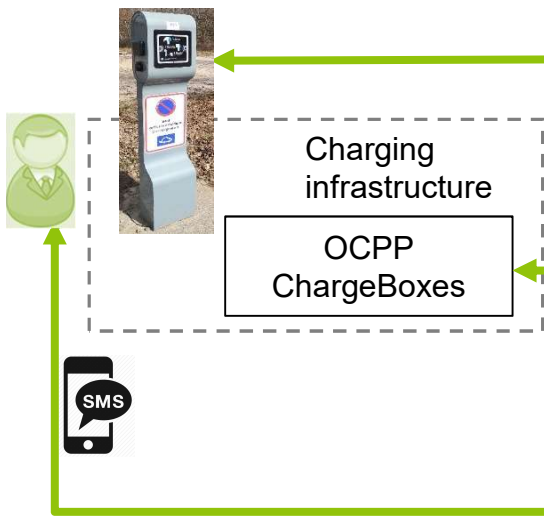
- The user connects his EV and passes his badge
- The supervision software sends an SMS inviting the user to confirm his departure time and the SOC of his car (default values are proposed).
- The EV is supplied with a test profile.
- Optimization and recharging are made on the basis of these data



Users and EVs database



PV Plant

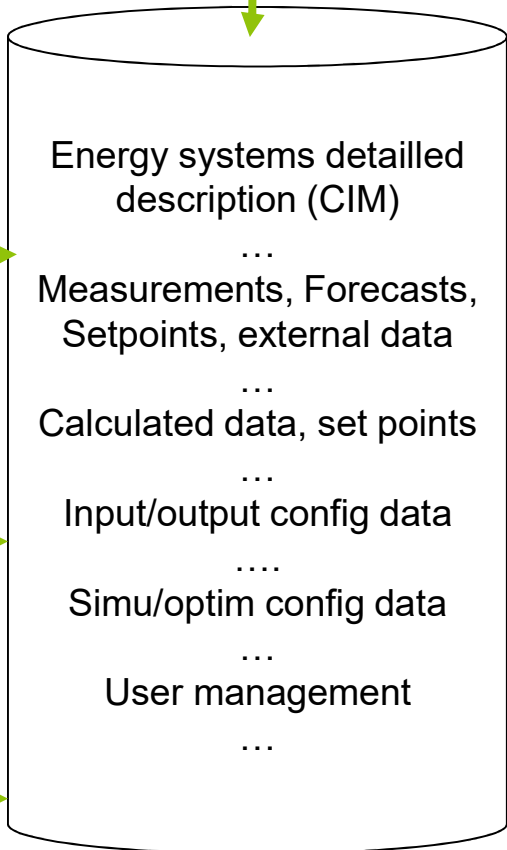


SIGE

Input module

evsem

EV User interface



Web portal

API – Application Programming Interface

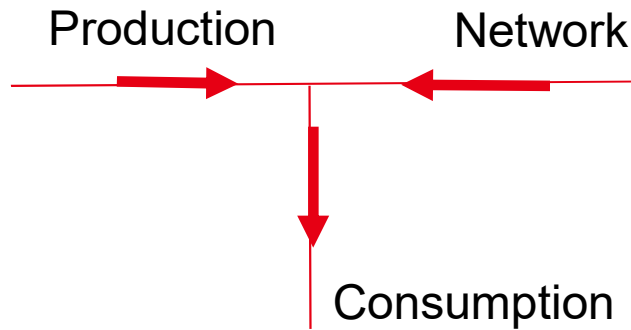
Set up
Follow up
Results analysis

Simulation

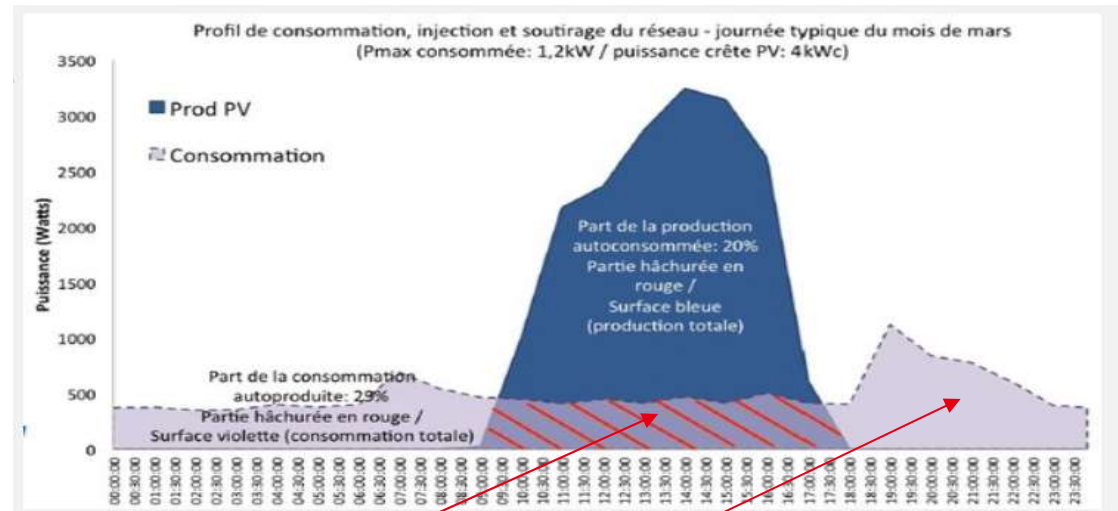
Optimisation

Ad hoc analysis (/battery ageing)

RECALL AUTOCONSUMPTION/AUTOPRODUCTION



Network + Production = Consumption



Optimisation process: maximize

selfproduction rate = (PV&consumption)/consumption

View « state of the EVC »

sigE Map Reference data Administration Development Super USER (root)

<p>Batiment 101 - 1 [5670]</p> <ul style="list-style-type: none"> CU-BAT1011-13CEA-1 CU-BAT1011-13CEA-2 CU-BAT1011-13CEA-3 CU-BAT1011-13CEA-4 	<p>Batiment 101 - 2 [5691]</p> <ul style="list-style-type: none"> CU-BAT1012-13CEA-1 CU-BAT1012-13CEA-2 	<p>Batiment 103 - 1 [5698]</p> <ul style="list-style-type: none"> CU-BAT1021-13CEA-1 CU-BAT1021-13CEA-2 CU-BAT1021-13CEA-3 CU-BAT1021-13CEA-4 CU-BAT1021-13CEA-5 CU-BAT1021-13CEA-6 	<p>Batiment 104 - 1 [5717]</p> <ul style="list-style-type: none"> CU-BAT1041-13CEA-1 CU-BAT1041-13CEA-2 CU-BAT1021-13CEA-3 CU-BAT1021-13CEA-4 CU-BAT1021-13CEA-5 CU-BAT1021-13CEA-6 	<p>Batiment 104 - 1 [5717]</p> <ul style="list-style-type: none"> CU-BAT1041-13CEA-1 CU-BAT1041-13CEA-2 	<p>Batiment 106 - 1 [5822]</p> <ul style="list-style-type: none"> CU-BAT2301-13CEA-1 CU-BAT2301-13CEA-2 CU-BAT2301-13CEA-3 CU-BAT2301-13CEA-4 	<p>Batiment 1222 - 1 [5724]</p> <ul style="list-style-type: none"> CU-BAT12221-13CEA-1 CU-BAT12221-13CEA-2 CU-BAT12221-13CEA-3 CU-BAT12221-13CEA-4 	<p>Batiment 151 - 1 [5737]</p> <ul style="list-style-type: none"> CU-BAT1511-13CEA-1 CU-BAT1511-13CEA-2 CU-BAT1511-13CEA-3 CU-BAT1511-13CEA-4 CU-BAT1511-13CEA-5 CU-BAT1511-13CEA-6 	<p>Batiment 155 - 1 [5756]</p> <ul style="list-style-type: none"> CU-BAT1551-13CEA-1 CU-BAT1551-13CEA-2 CU-BAT1551-13CEA-3 CU-BAT1551-13CEA-4 	<p>Batiment 155 - 1 [5756]</p> <ul style="list-style-type: none"> CU-BAT1551-13CEA-1 CU-BAT1551-13CEA-2 CU-BAT1551-13CEA-3 CU-BAT1551-13CEA-4 	<p>Batiment 156 - 1 [5769]</p> <ul style="list-style-type: none"> CU-BAT1511-13CEA-6 	<p>Batiment 155 - 1 [5756]</p> <ul style="list-style-type: none"> CU-BAT1551-13CEA-1 CU-BAT1551-13CEA-2 CU-BAT1551-13CEA-3 CU-BAT1551-13CEA-4 	<p>Batiment 156 - 1 [5769]</p> <ul style="list-style-type: none"> CU-BAT1581-13CEA-1 CU-BAT1581-13CEA-2 	<p>Batiment 202 - 1 [5988]</p> <ul style="list-style-type: none"> CU-BATB61-13CEA-1 CU-BATB61-13CEA-2 	<p>Batiment 218 - 1 [5776]</p> <ul style="list-style-type: none"> CU-BAT2161-13CEA-1 CU-BAT2161-13CEA-2 	<p>Batiment 219 - 1 [5783]</p> <ul style="list-style-type: none"> CU-BAT2191-13CEA-1 CU-BAT2191-13CEA-2 	<p>Batiment 223 - 1 [5790]</p> <ul style="list-style-type: none"> 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 	<p>Batiment 225 - 1 [5815]</p> <ul style="list-style-type: none"> CU-BAT2241-13CEA-1 CU-BAT2241-13CEA-2 CU-BAT2231-13CEA-5 CU-BAT2231-13CEA-6 CU-BAT2231-13CEA-7 CU-BAT2231-13CEA-8 	<p>Batiment 225 - 1 [5815]</p> <ul style="list-style-type: none"> CU-BAT2241-13CEA-1 CU-BAT2241-13CEA-2 	<p>Batiment 238 - 1 [5835]</p> <ul style="list-style-type: none"> CU-BAT2381-13CEA-1 CU-BAT2381-13CEA-2 CU-BAT2381-13CEA-3 CU-BAT2381-13CEA-4 	<p>Batiment 278 - 1 [5846]</p> <ul style="list-style-type: none"> CU-BAT2781-13CEA-1 CU-BAT2781-13CEA-2 CU-BAT2781-13CEA-3 CU-BAT2781-13CEA-4 	<p>Batiment 312 - 1 [5861]</p> <ul style="list-style-type: none"> CU-BAT3121-13CEA-1 CU-BAT3121-13CEA-2 	<p>Batiment 313 - 1 [5868]</p> <ul style="list-style-type: none"> CU-BAT3131-13CEA-1 CU-BAT3131-13CEA-2 CU-BAT3131-13CEA-3 CU-BAT3131-13CEA-4 	<p>Batiment 315 - 1 [5881]</p> <ul style="list-style-type: none"> CU-BAT3151-13CEA-1 CU-BAT3151-13CEA-2 CU-BAT3151-13CEA-3 CU-BAT3151-13CEA-4 CU-BAT3131-13CEA-3 	<p>Batiment 315 - 1 [5881]</p> <ul style="list-style-type: none"> CU-BAT3151-13CEA-1 CU-BAT3151-13CEA-2 CU-BAT3151-13CEA-3 CU-BAT3151-13CEA-4 	<p>Batiment 326 - 1 [5894]</p> <ul style="list-style-type: none"> CU-BAT3261-13CEA-1 CU-BAT3261-13CEA-2 	<p>Batiment 351 - 1 [5901]</p> <ul style="list-style-type: none"> CU-BAT3511-13CEA-1 CU-BAT3511-13CEA-2 CU-BAT3511-13CEA-3 CU-BAT3511-13CEA-4 	<p>Batiment 352 - 1 [5914]</p> <ul style="list-style-type: none"> CU-BAT3521-13CEA-1 CU-BAT3521-13CEA-2 	<p>Batiment 519 - 1 [5928]</p> <ul style="list-style-type: none"> CU-BAT5191-13CEA-1 CU-BAT5191-13CEA-2 CU-BAT5191-13CEA-3 CU-BAT5191-13CEA-4 	<p>Batiment 519 - 1 [5928]</p> <ul style="list-style-type: none"> CU-BAT5191-13CEA-1 CU-BAT5191-13CEA-2 CU-BAT7821-13CEA-1 CU-BAT7821-13CEA-2 CU-BAT7821-13CEA-3 CU-BAT7821-13CEA-4 	<p>Batiment 817 [5948]</p> <ul style="list-style-type: none"> CU-BAT817-13CEA-1 CU-BAT817-13CEA-2 	<p>Batiment 837 - 1 [5955]</p> <ul style="list-style-type: none"> CU-BAT8371-13CEA-1 CU-BAT8371-13CEA-2 CU-BAT8371-13CEA-3 CU-BAT8371-13CEA-4 CU-BAT8371-13CEA-5 CU-BAT8371-13CEA-6 	<p>Batiment 904 - 1 [5974]</p> <ul style="list-style-type: none"> CU-BAT9041-13CEA-1 CU-BAT9041-13CEA-2 	<p>Batiment 911 - 1 [5981]</p> <ul style="list-style-type: none"> CU-BAT9111-13CEA-1 CU-BAT9111-13CEA-2 	<p>Batiment XXX [5995]</p> <ul style="list-style-type: none"> CU-BATXXX-13CEA-1 CU-BATXXX-13CEA-2 CU-BATXXX-13CEA-3 CU-BATXXX-13CEA-4
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1 2 3 4 5

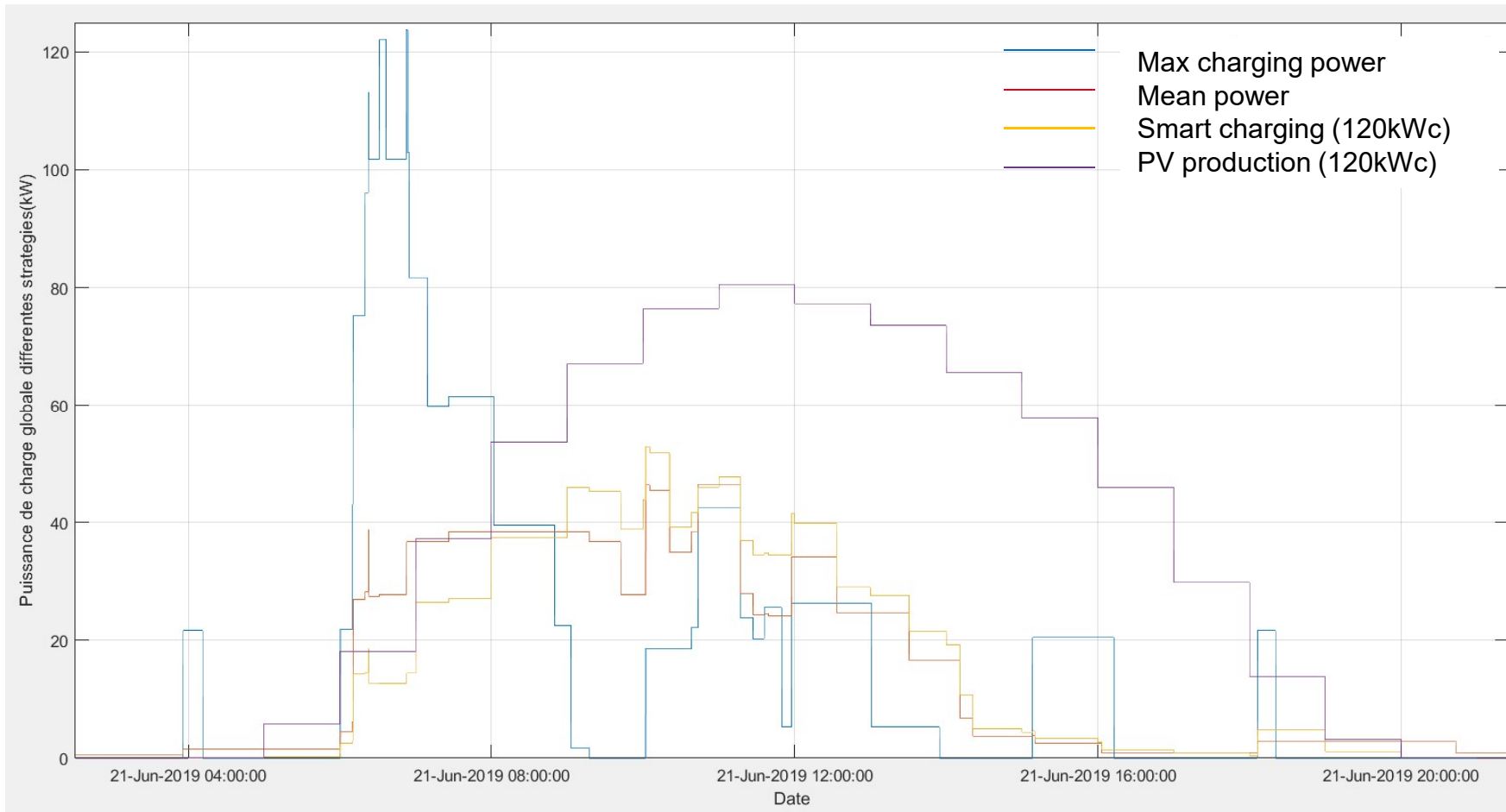
View « PV plant »



View « charging station functioning »



Simulation results





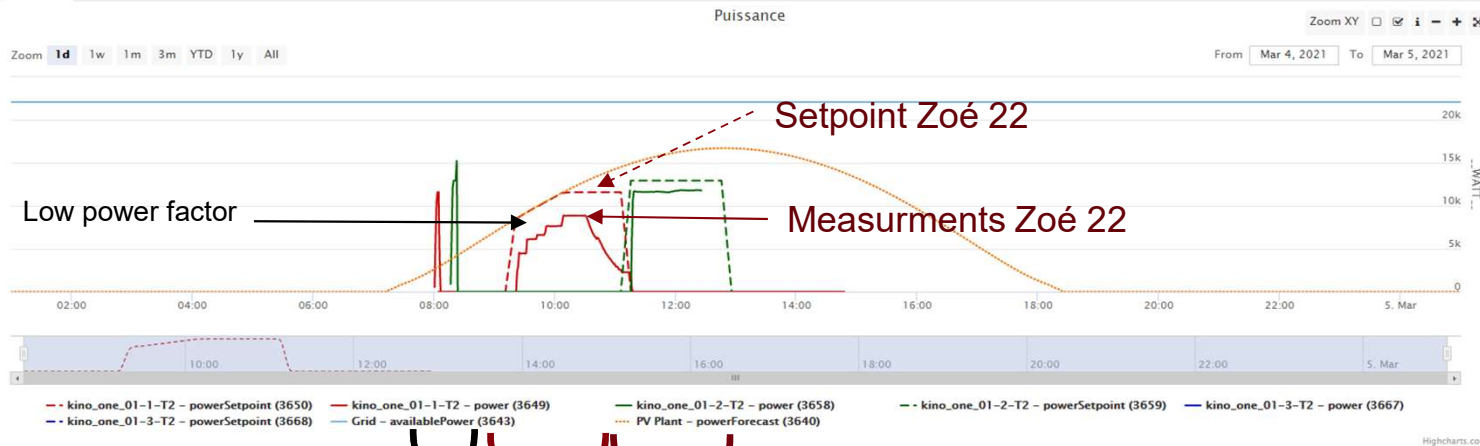
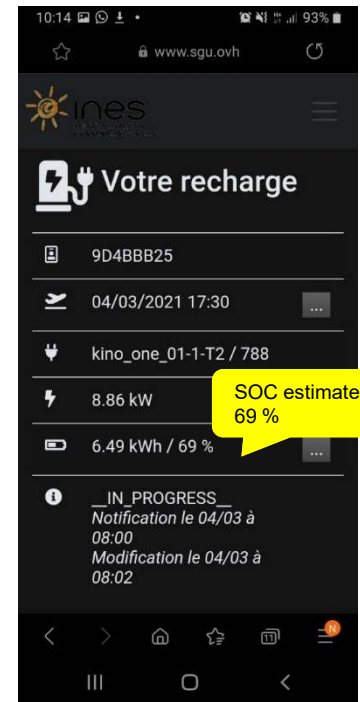
Zoé 22kWh (43kW) Zoé 40kWh (22kW)

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



« Test » Charge Zoé 40
Charge Zoé 22

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

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Thank you for your attention



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