

Flexibility of EV charging : Use-Cases, actors and technologies

Bruno Robisson

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NEEMO

Networking for Excellence in Electric Mobility Operations

www.NEEMO-project.eu

TRAINING

FLEXIBILITY OF EV CHARGING: USE-CASES, ACTORS AND TECHNOLOGIES



Bruno Robisson, *CEA Cadarache*

Wednesday 3rd February 2021, 12:30-13:15 (UTC+1)

In collaboration with

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

AGENDA

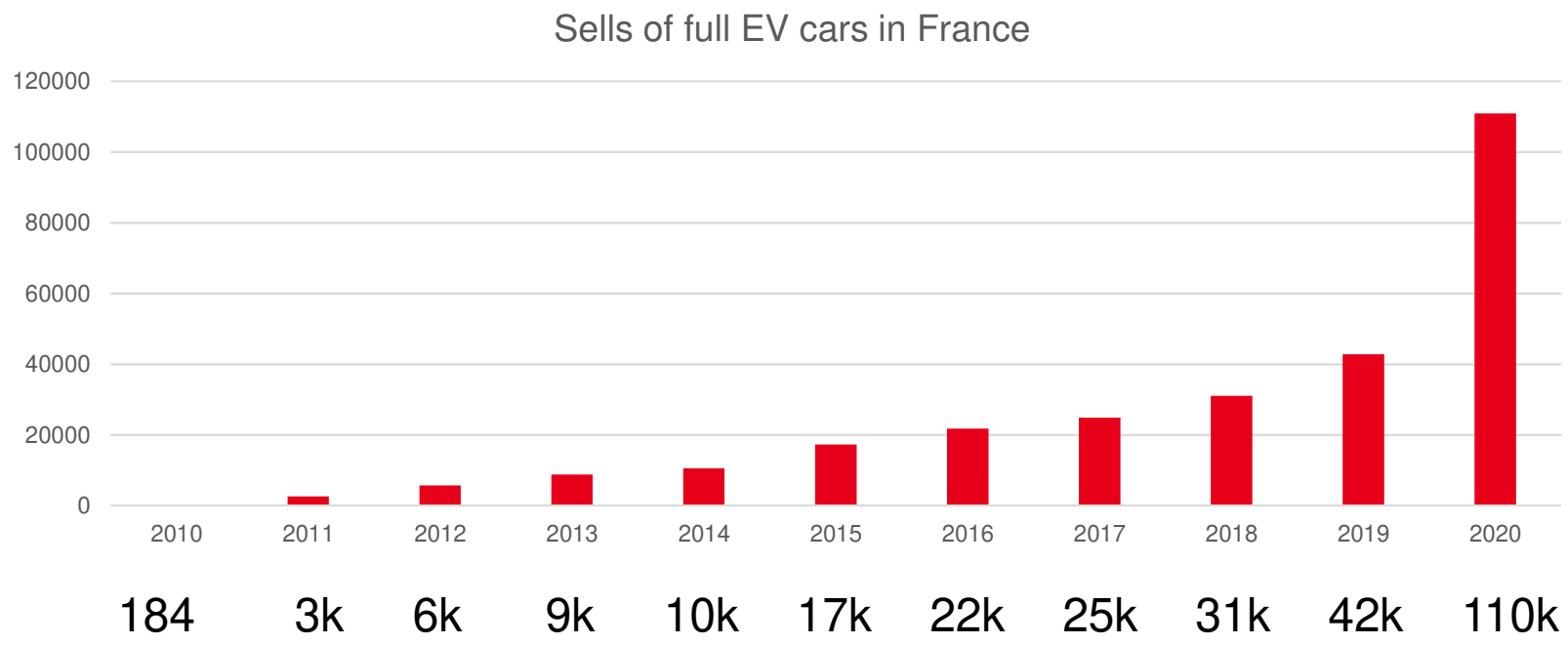
- **Panorama of the french full electric vehicles (EV) market**
- **Charging an EV**
  - Modes
  - The plug and socket zoo
  - Wallbox and Charging stations
  - The french charging infrastructure
- **Smart charging an EV**
  - Use Case 1: Charging stations for employees within the company
    - Smart charging need: max power reduction
    - Principle and setup
  - Use Case 2: Charging commercial vehicules in depots
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  - Use Case 3: Charging stations at home
    - Smart charging need: Autoconsumption increase
    - Principle and setup
  - Use Case 4: "Opportunist' charging stations

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PANORAMA OF THE FRENCH EV MARKET

Sales of full Electric Vehicles (EV) in France [1]



Total: ~ 276485 EV from 2010

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TOP TEN SALES – FRANCE 2020

Manufacturer	Model	Capacity	Autonomy	Charging power		#units	price
		kWh	Km (WLTP)	AC (kW)	DC(kW)		€
Renault	Zoé	52	395	22	0-50	37409 (33.7%)	32-38k€
Peugeot	E-208	46	340	7-11	100	16557 (14,9%)	32-34k€
Tesla	Model-3	50-75	448-580	11	250	6477 (5,8%)	44-60k€
Hyundai	Kona	40-64	289-482	7	77	5156 (4,7%)	34-46k€
Kia	E-Niro	40-64	289-455	7	77	5089 (4,6%)	38-46€
Volkswagen	Id3	45 58-77	350 424-549	11 11	50 100-125	4187 (3,8%)	34k€ 38-49k€
Nissan	Leaf	40-62	273-385	6	50-100	3395 (3,1%)	35-45k€
Peugeot	E-2008	46	320	7-11	100	2933 (2,6%)	37-40k€
DS	DS3	50	320	7-11	100	2710 (2,4%)	39-46k€
Mini	Cooper	33	234	11	50	2481 (2,2%)	38-41k€

Total: 110900 EV (6.7%)

Source : [1]

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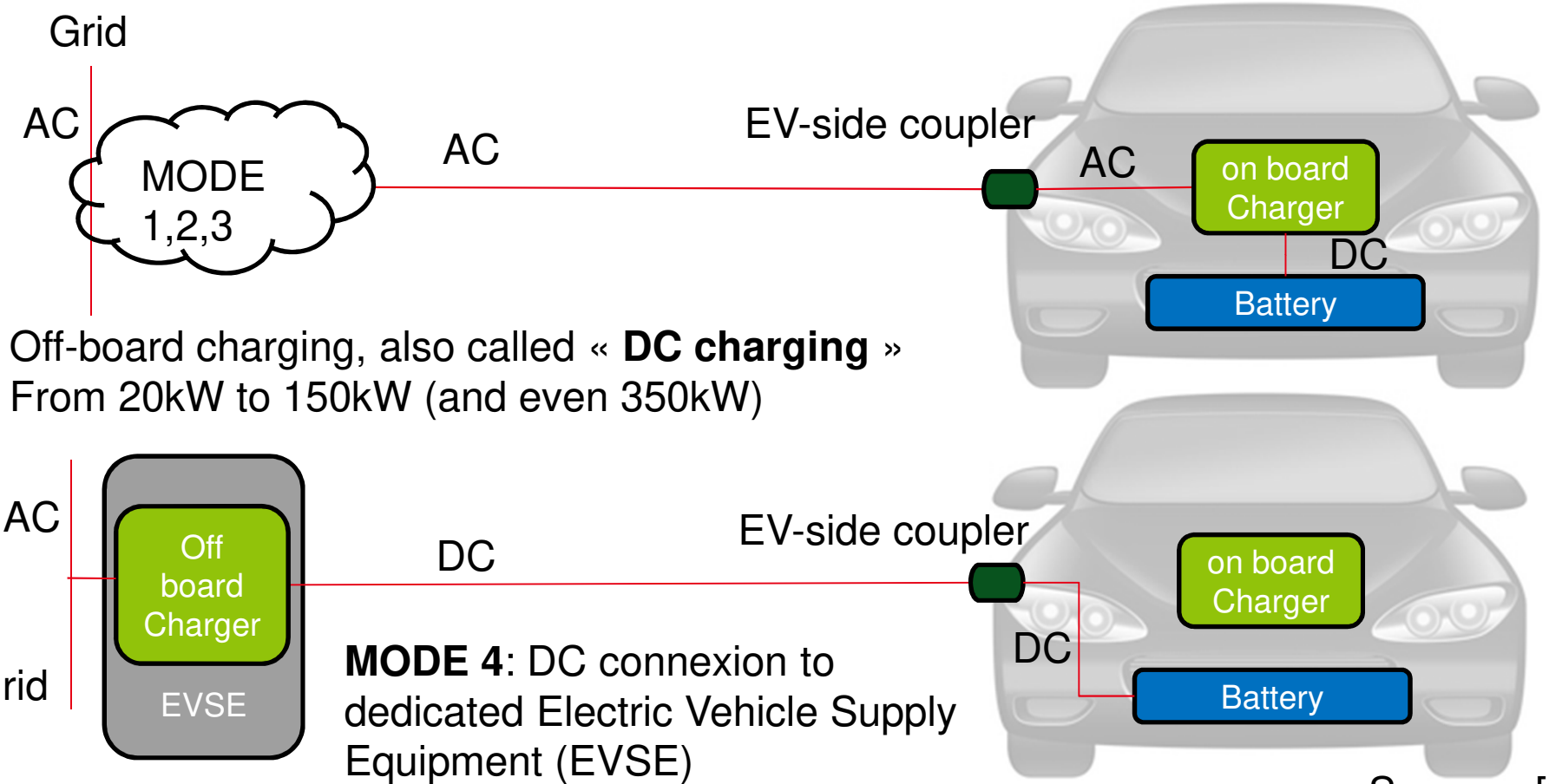
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CHARGING MODE (IEC 61851 STANDARD)

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



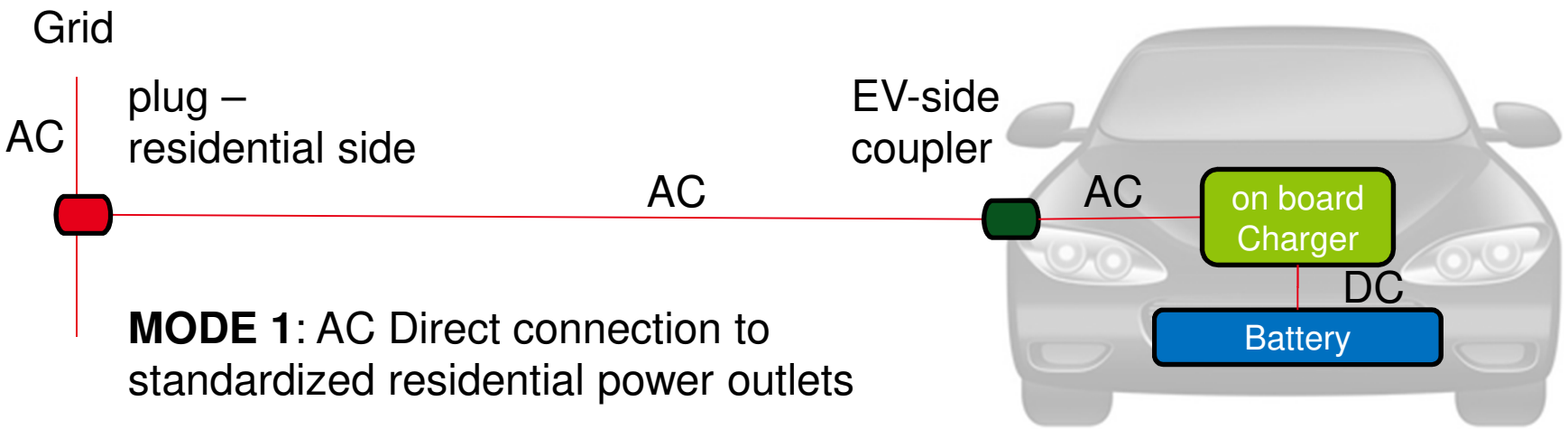
Off-board charging, also called « **DC charging** »
From 20kW to 150kW (and even 350kW)

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

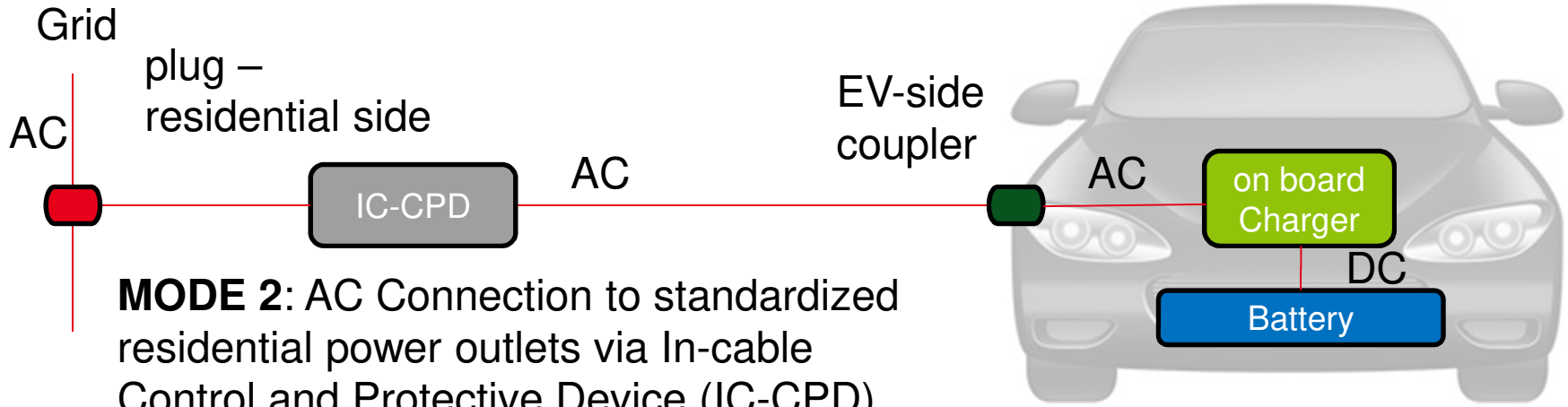
Source : [2]

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AC CHARGING MODE: MODE 1, 2



MODE 1: AC Direct connection to standardized residential power outlets



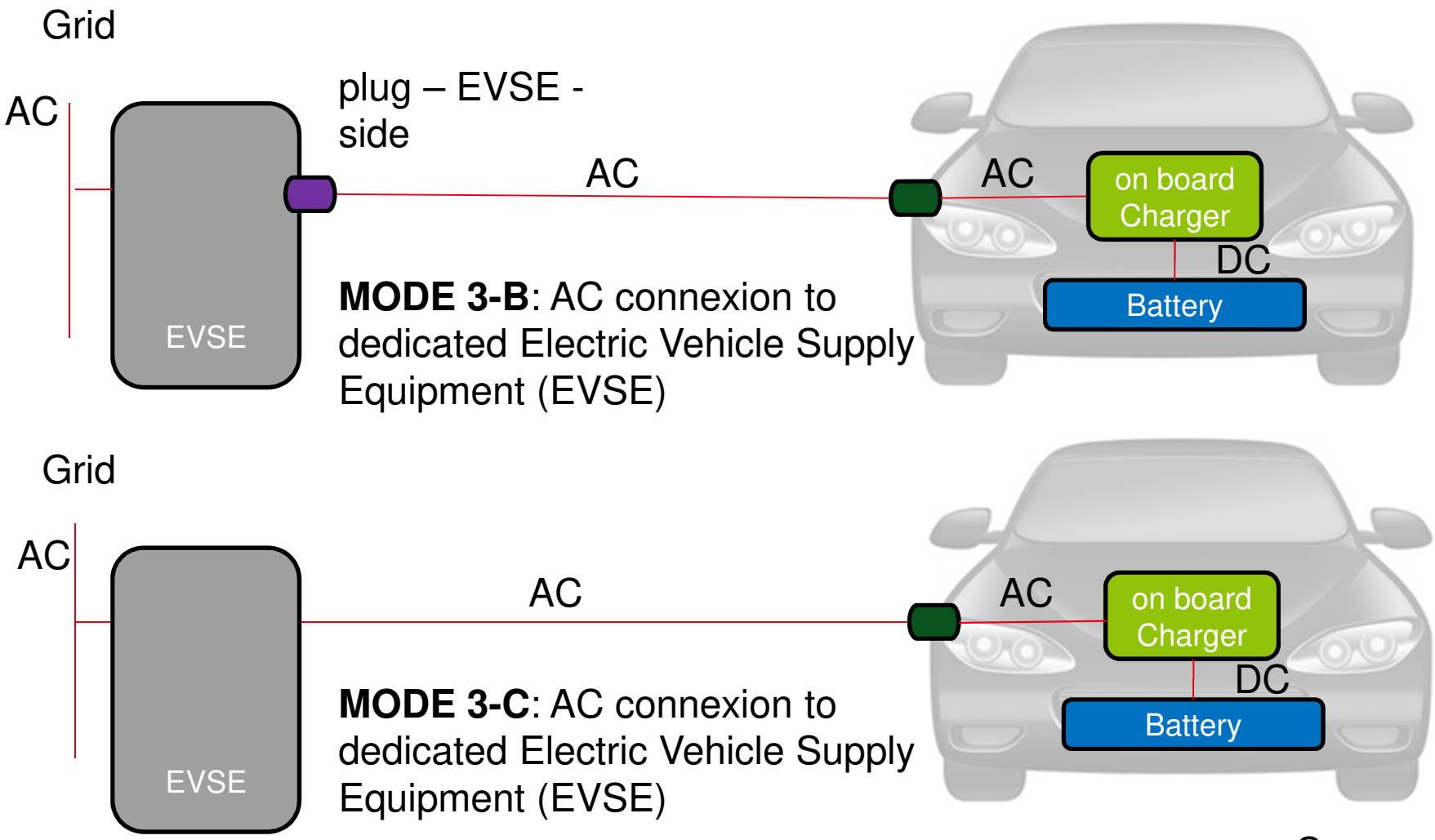
MODE 2: AC Connection to standardized residential power outlets via In-cable Control and Protective Device (IC-CPD)

Source : [2]

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AC CHARGING MODE: MODE 3



Source : [2]

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THE PLUG AND SOCKET ZOO – MODE 2



« Green-up » : type E (CEE 7/17) Mono-ρ 230V



Tesla coupler



Blue: « camping » socket Mono-ρ 230V



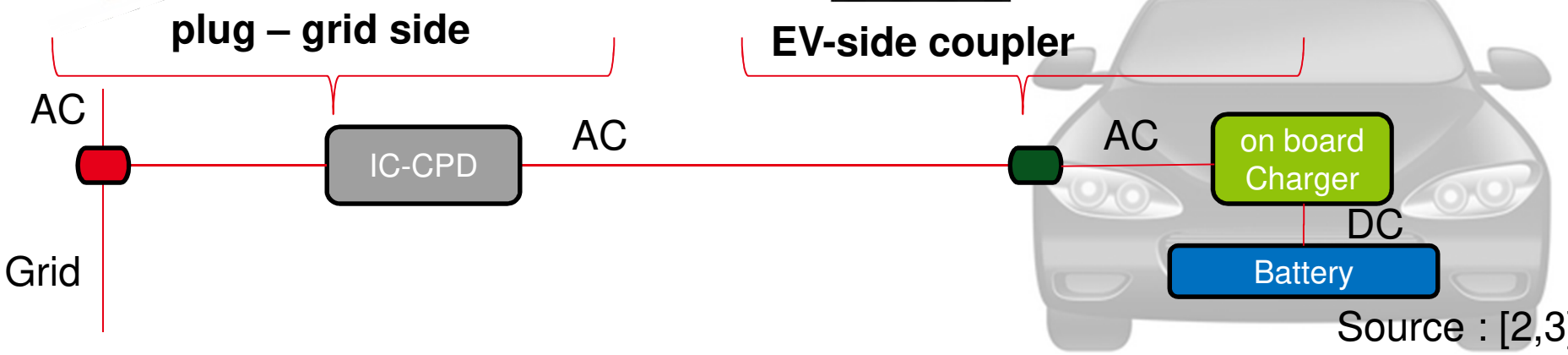
Type 1 coupler



Red: Industrial socket Tri-ρ 400V



Type 2 coupler



Source : [2,3]

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THE PLUG AND SOCKET ZOO – MODE 3



Type 2 outlet



Type 3 outlet
(out of date)



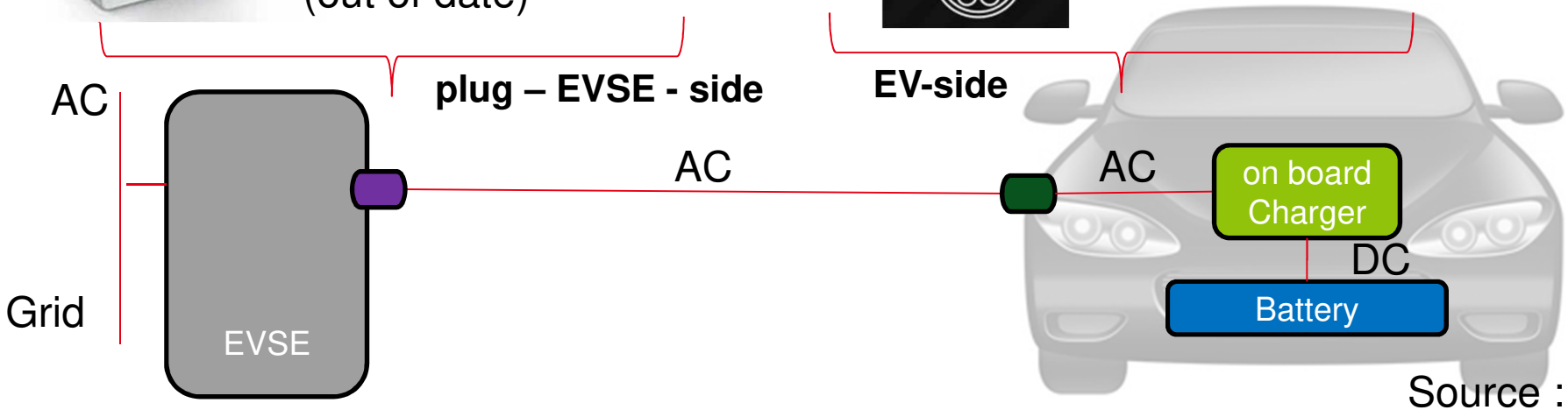
Tesla coupler



Type 1 coupler



Type 2 coupler



Source : [2,3]

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THE PLUG AND SOCKET ZOO – MODE 4



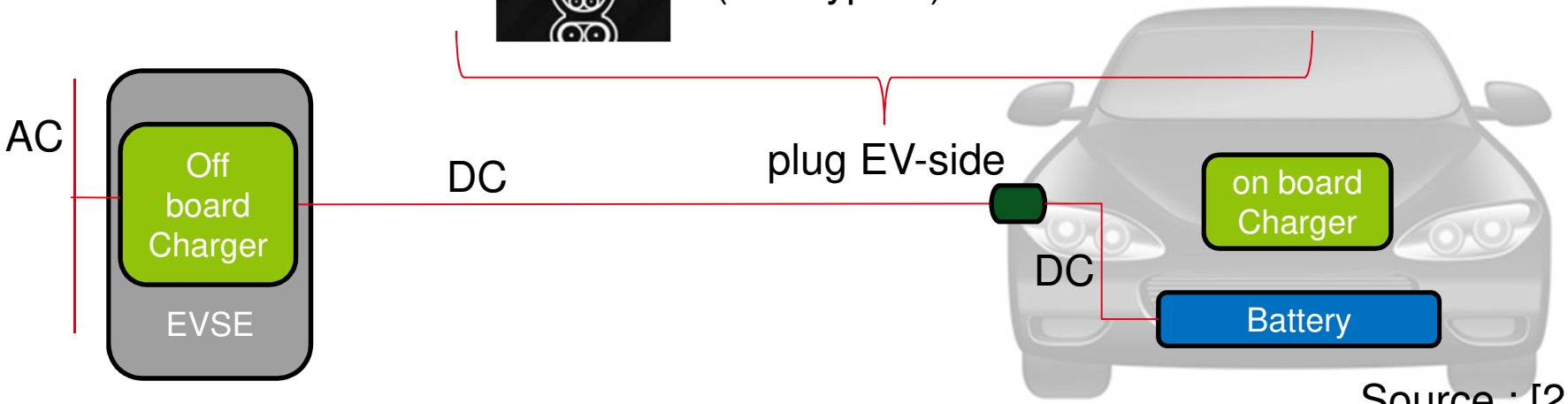
Tesla plug



CHAdeMO
(DC only)



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



Source : [2,3]

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CHARGING STATION

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Cost (charging point only)

	Private area	Public area
Mode 2 : < 22 kW	0.3-1.2k€ 	
Mode 3: 7.4 kW AC (32A mono) 22kW AC (32A tri) 43kW AC (64A tri)	0.7-2k€ 	2-6k€ 
Mode 4: 22kW DC 150kW DC 350 kW DC		>10k€ 
		~30k€ 

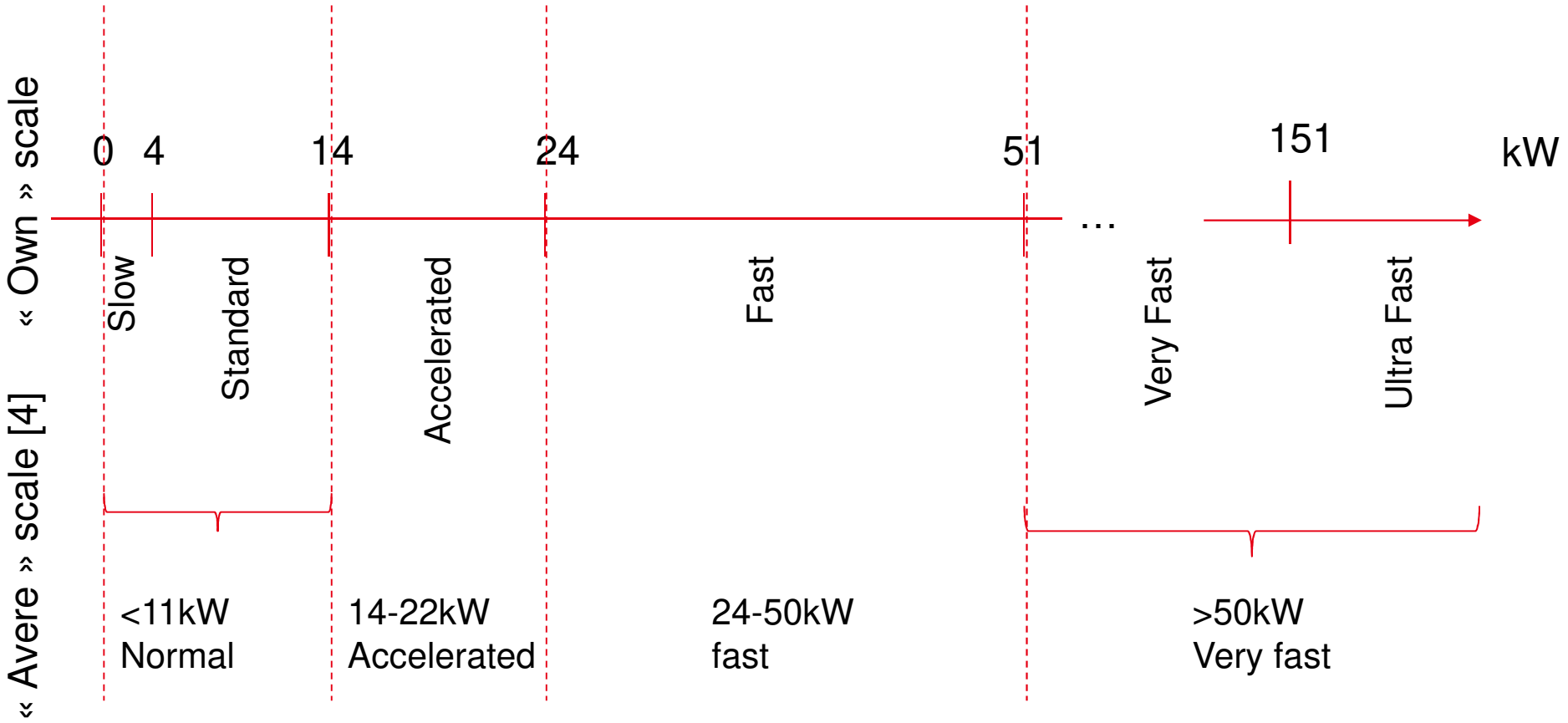
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FRENCH VEHICLE CHARGING INFRASTRUCTURE DEFINITIONS

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Charging points speed range



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FRENCH VEHICLE CHARGING INFRASTRUCTURE DEFINITION

Number of station: 1
Number of Charging Points : 5
2*22 kW AC Type 2
+ 50 kW DC CHAdeMo
+ 50 kW DC CCS2
+ 43 kW AC Type2
Installed Power (sum (on each charging point) of the max power) : 187 kW



106 Avenue de Compiègne 02200 Soissons



Source : [5]

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FRENCH VEHICLE CHARGING INFRASTRUCTURE

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Public charging points

	InstalledPowerCPO	NumberOfStation	NumberOfCP
	MW	Units	Units
TOTAL	533.91	9260	20475

https://www.data.gouv.fr/* [6]

Own classification	Slow	Standard	Accelerated	Fast	Veryfast	Ultrafast	TOTAL
	0-4	4-14	14-24	24-51	51-151	>151	
Units	1886	348	16431	1438	28	344	20475
%	9.21	1.70	80.25	7.02	0.14	1.68	

https://www.data.gouv.fr/ *

Avere classification	Normal	Accelerated	Fast	Very fast	
	0-14	14-24	24-51	>51	
Units	2234	16431	1438	372	
In pourcents	10.91	80.25	7.02	1.82	
Avere Data					
Units	7093	19959	1102	774	28928
%	24.52	69.00	3.81	2.68	

AVERE [4]

*Without Tesla charging points
~500 DC very fast chargers

- Predominance of “accelerated” charging points (i.e. 22kW AC)
- Few fast, very fast and ultra fast charging points

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USE - CASE 1 - CHARGING STATIONS FOR EMPLOYEES WITHIN THE COMPANY [7]

- The charging points are used, during the working hours, for the vehicles of employees which commutes.
- The charging points are generally "normal“ or “accelerated” and located in the company parking lot.

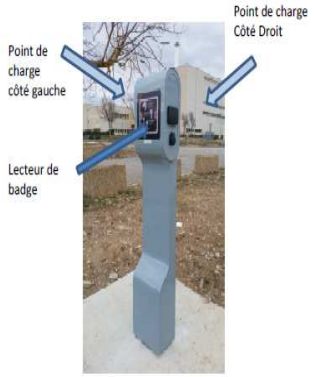
Examples:
SAP Labs / Mougins Sophia-Antipolis + Caen + Paris
85 CP @ AC
2 CP @50 kW DC
1 CP @150 kW DC
~250 EV users [8]





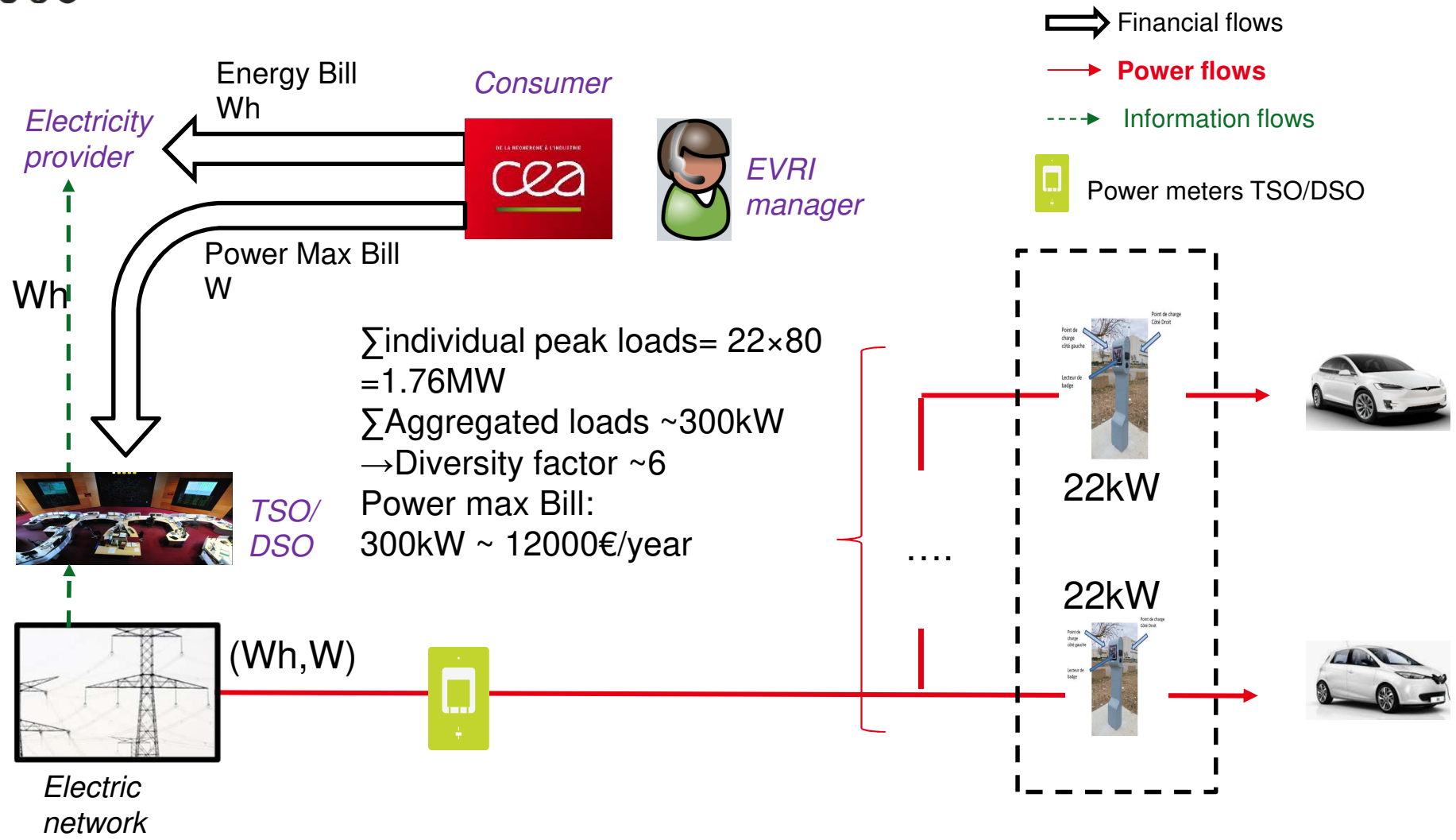
source [8]

CEA / Marcoule + Saclay + Cadarache
22 CP @ 3kW AC
40 CP @ 7kW AC
16 CP @ 11kW AC
80 CP @ 22kW AC
~400 EV users



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USE - CASE 1 – SMART CHARGING 1 – MAX POWER REDUCTION

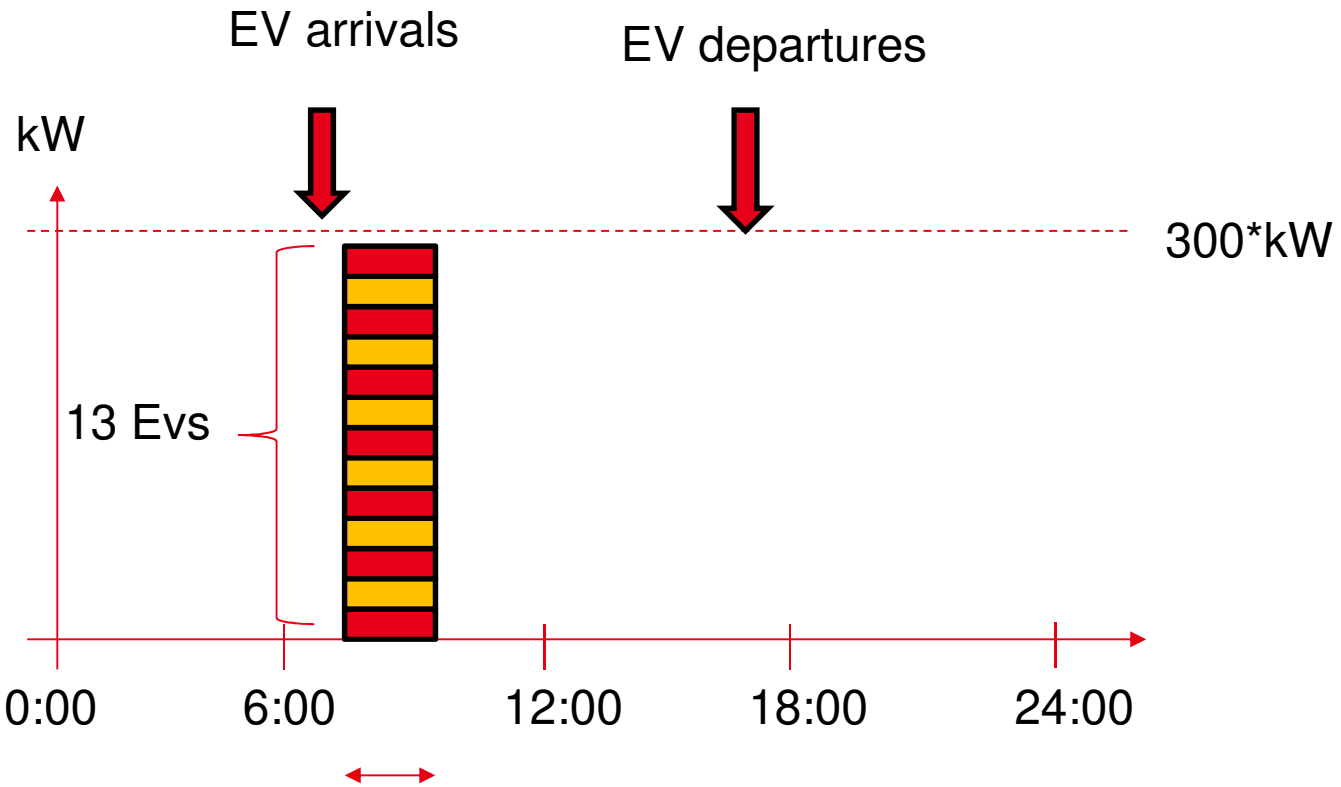


How to reduce the max power bill due to the EV charging?

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USE - CASE 1 – SMART CHARGING 1 – MAX POWER REDUCTION - PRINCIPLE

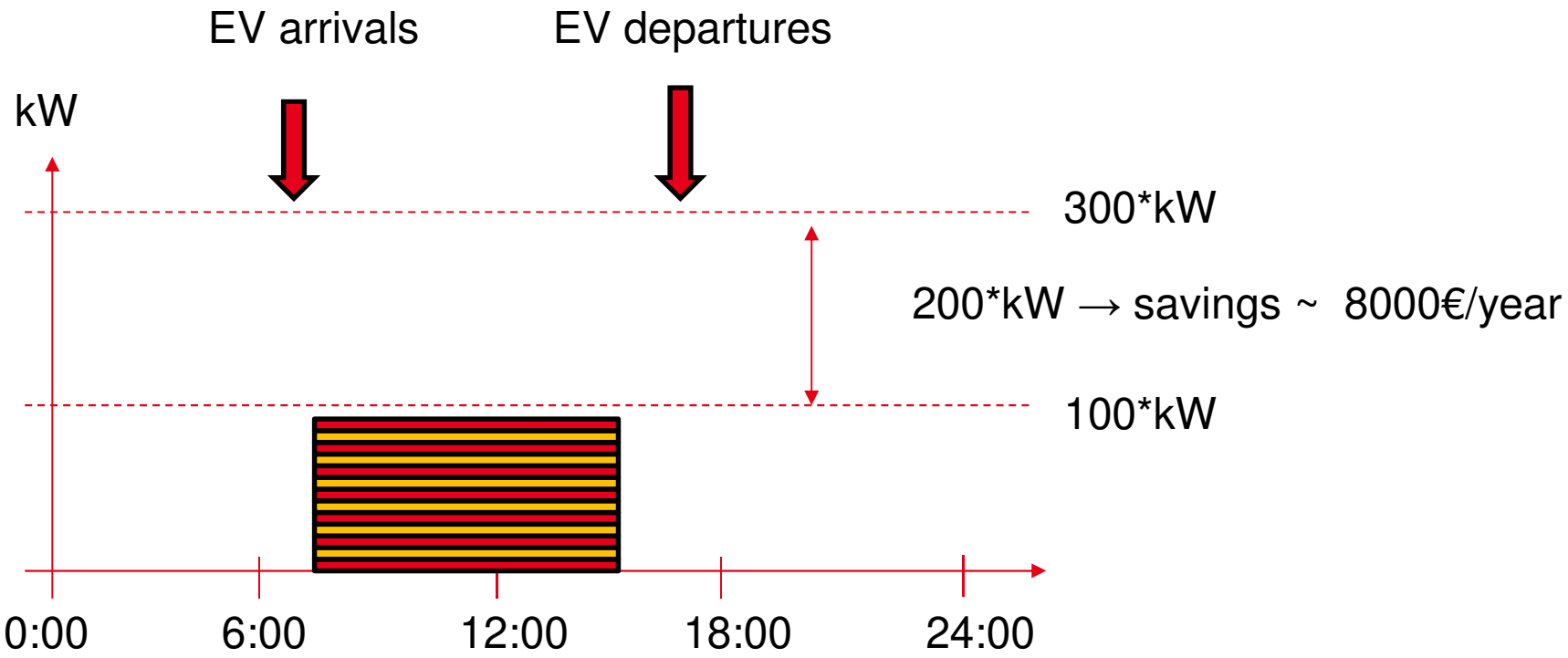
Without max power management : 13 EV Max @ 22kW charging during 8:00 and 10:00



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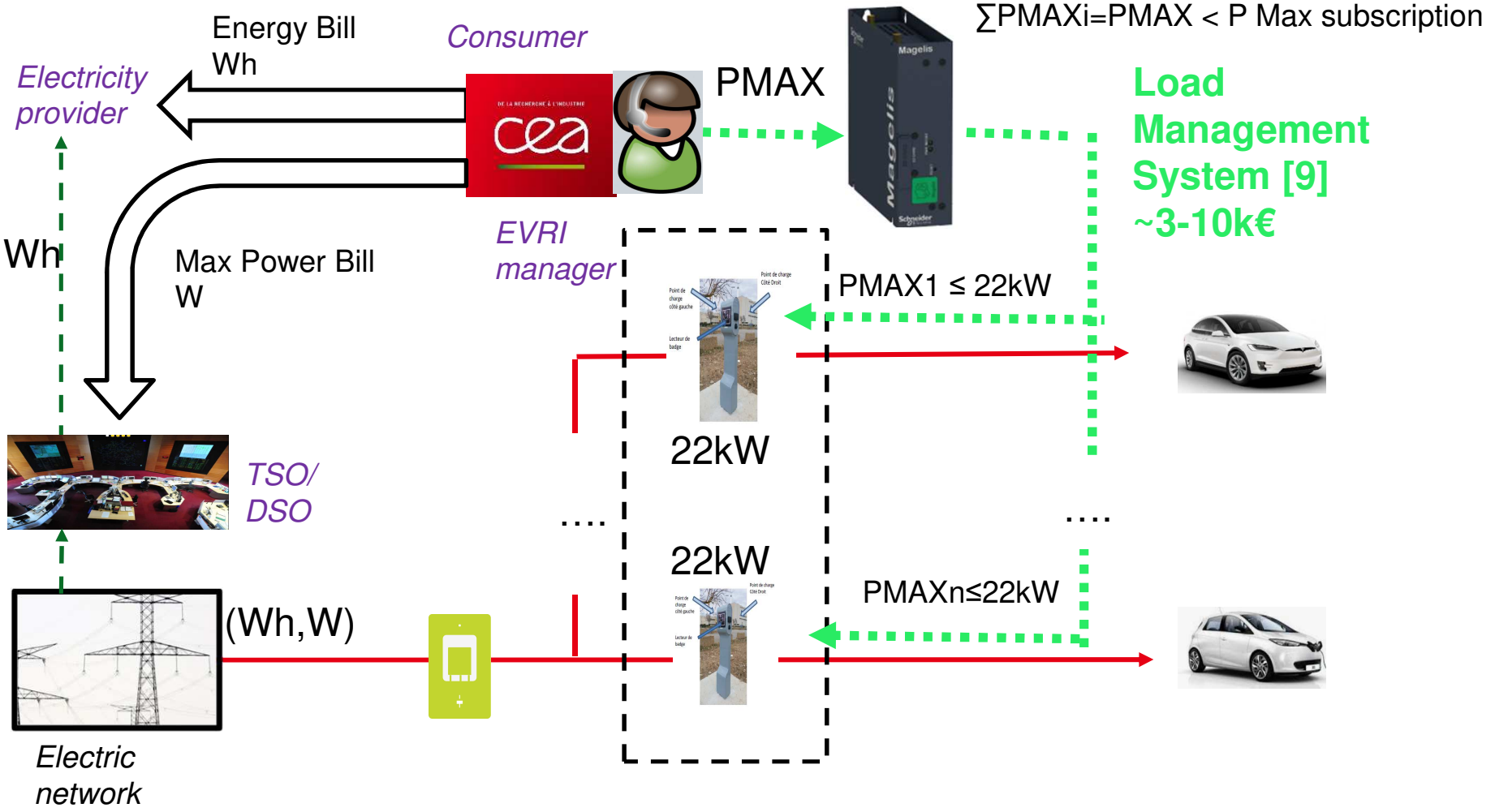
USE - CASE 1 – SMART CHARGING 1 – MAX POWER REDUCTION – PRINCIPLE

With max power management:
13 EV @ 7.4kW during 8:00 and 14:00



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USE - CASE 1 – SMART CHARGING 1 – MAX POWER REDUCTION - SETUP



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USE - CASE 2 - CHARGING COMMERCIAL VEHICULES IN DEPOTS [7]

- The charging points are used, the night, for the fleets of utility vehicles (used by delivery people, postmen, repairers, bus drivers, etc.) providing their service during the day.
- The charging points are generally slow and located in the company depot.

Enedis:
1880 EV [10]



EDF / Bugey nuclear plant :
276 charging points
110 EV (Renault Zoé) [11]

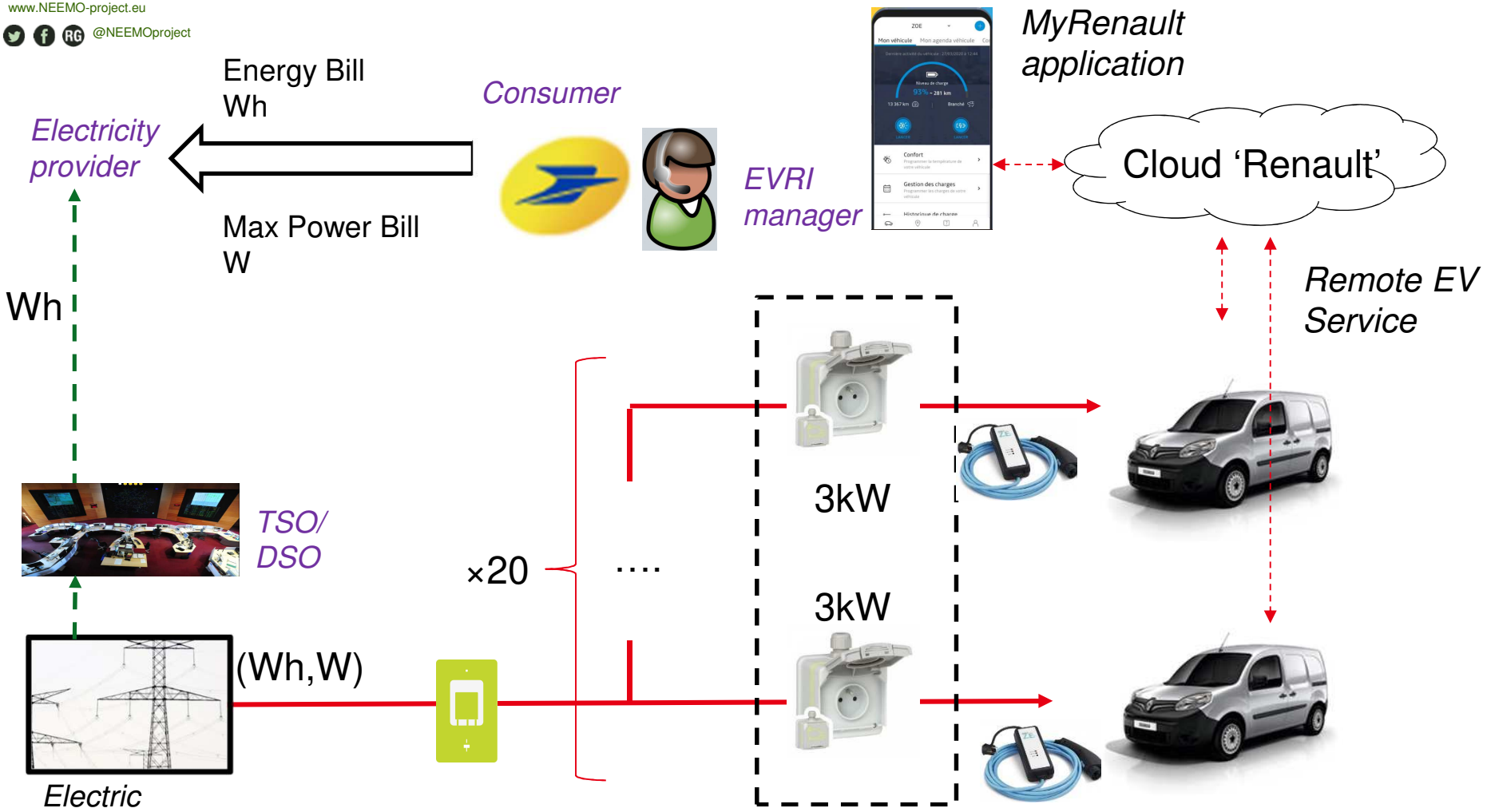


La Poste :
300 establishments
7000 light commercial EV (mostly Renault Kangoo) [12]



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USE - CASE 2 – SMART CHARGING 2 – ENERGY COST REDUCTION



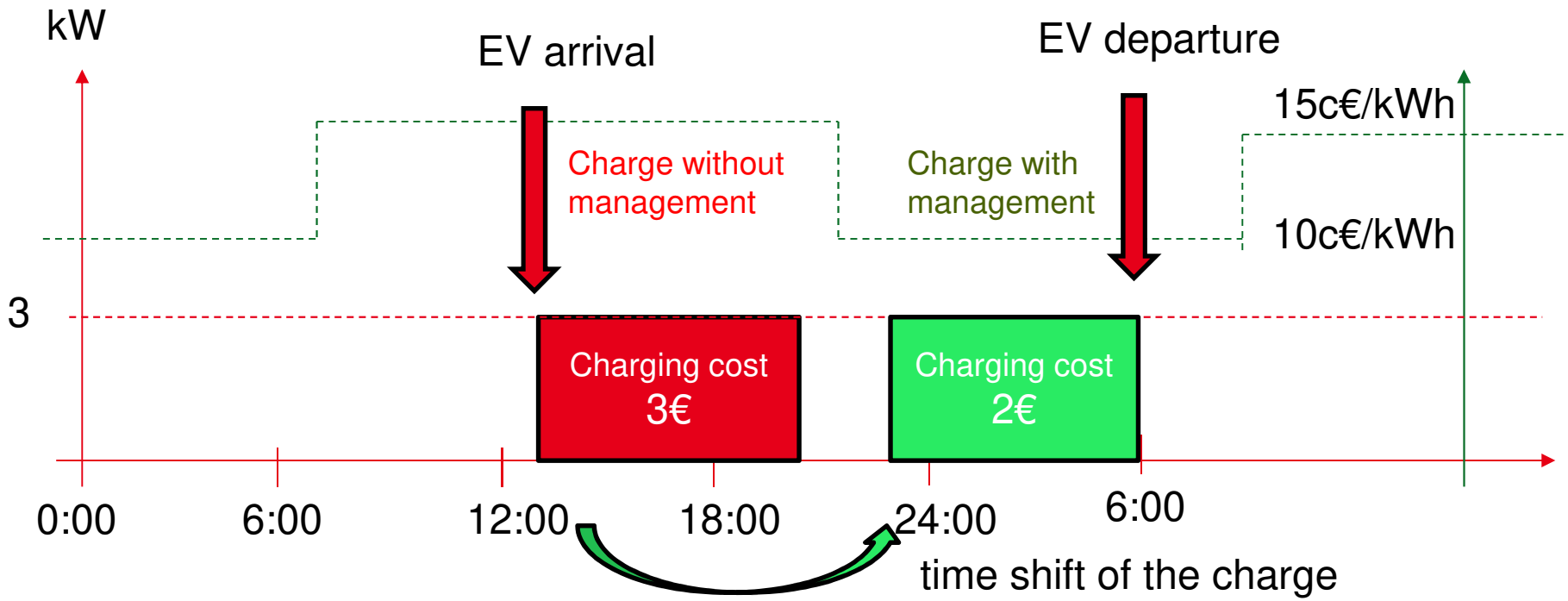
How to reduce the energy bill due to the EV charging?
+At lowest cost

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USE - CASE 2 – SMART CHARGING 2 – ENERGY COST REDUCTION - PRINCIPLE

Postman' round from 6AM to 12AM : 120km / day / EV (~20kWh / day / EV)



Potential Savings with *peak / off-peak hours option*
Price(peak)-Price(off-peak) ~5 c€/kWh
i.e. 1 € / day /EV
For 20 EV working 260 days/Years -> ~5000€/year

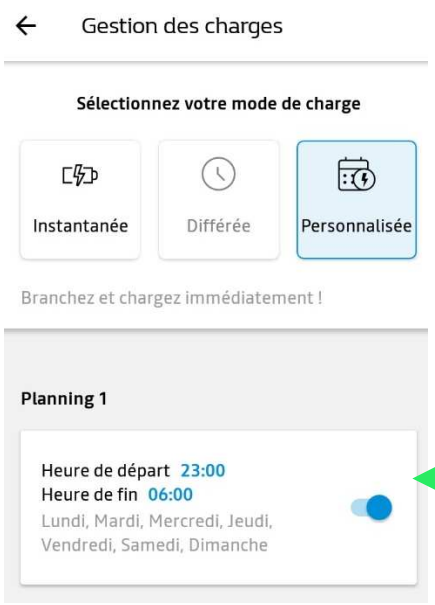
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USE - CASE 2 – SMART CHARGING 2 – ENERGY COST REDUCTION – SETUP 1

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Charge management:
Off-board via MyRenault App or manually
« on board »



MyRenault application

peak / off-peak hours

EVRI manager

Electricity provider

Energy Bill
Wh

Max Power Bill
W

Consumer

Cloud 'Renault'

Wh

TSO/DSO

×20

....

3kW

3kW

(Wh,W)

Electric network

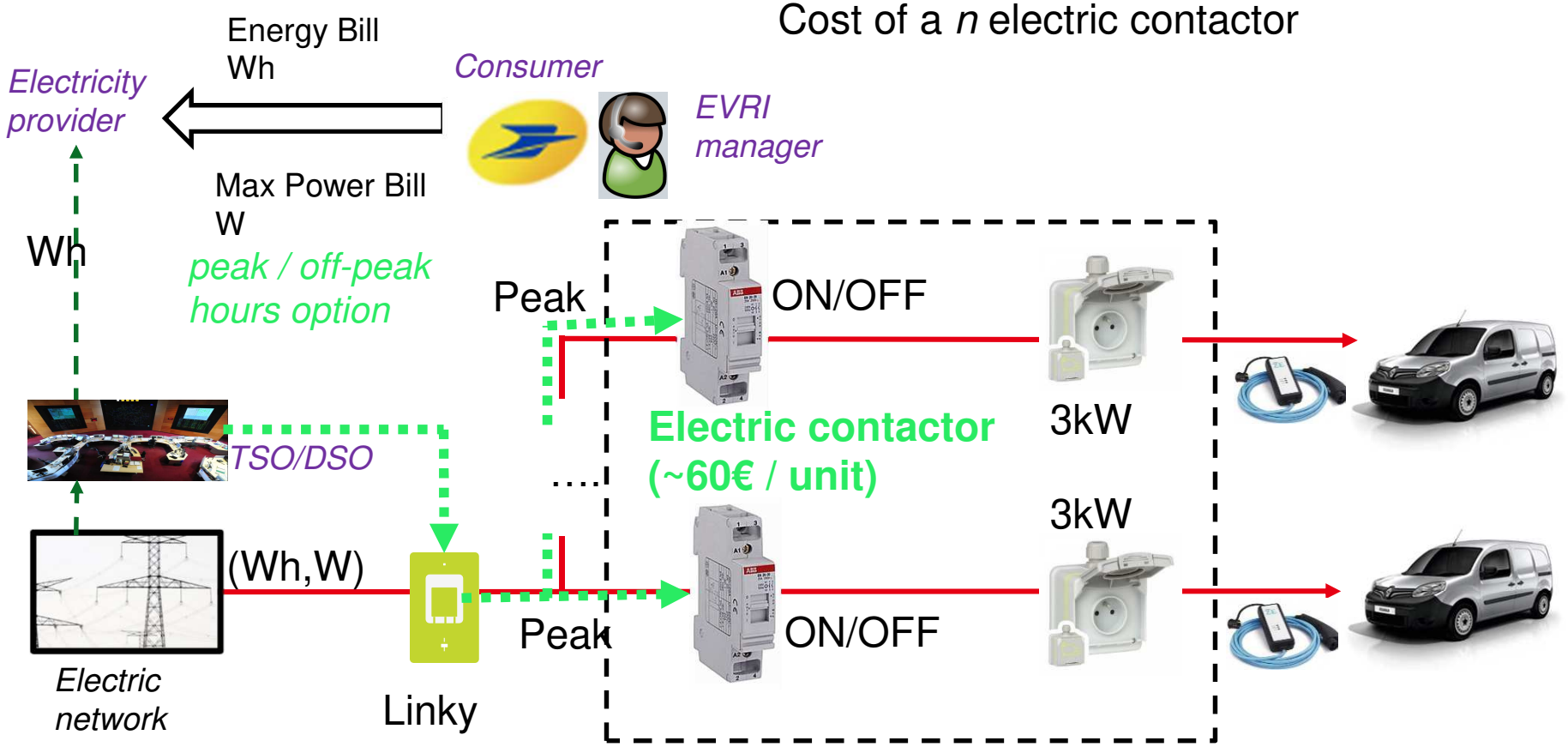
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USE - CASE 2 – SMART CHARGING 2 – ENERGY COST REDUCTION – SETUP 2

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Charge management:
Via Linky and an electric contactor
Cost of a *n* electric contactor



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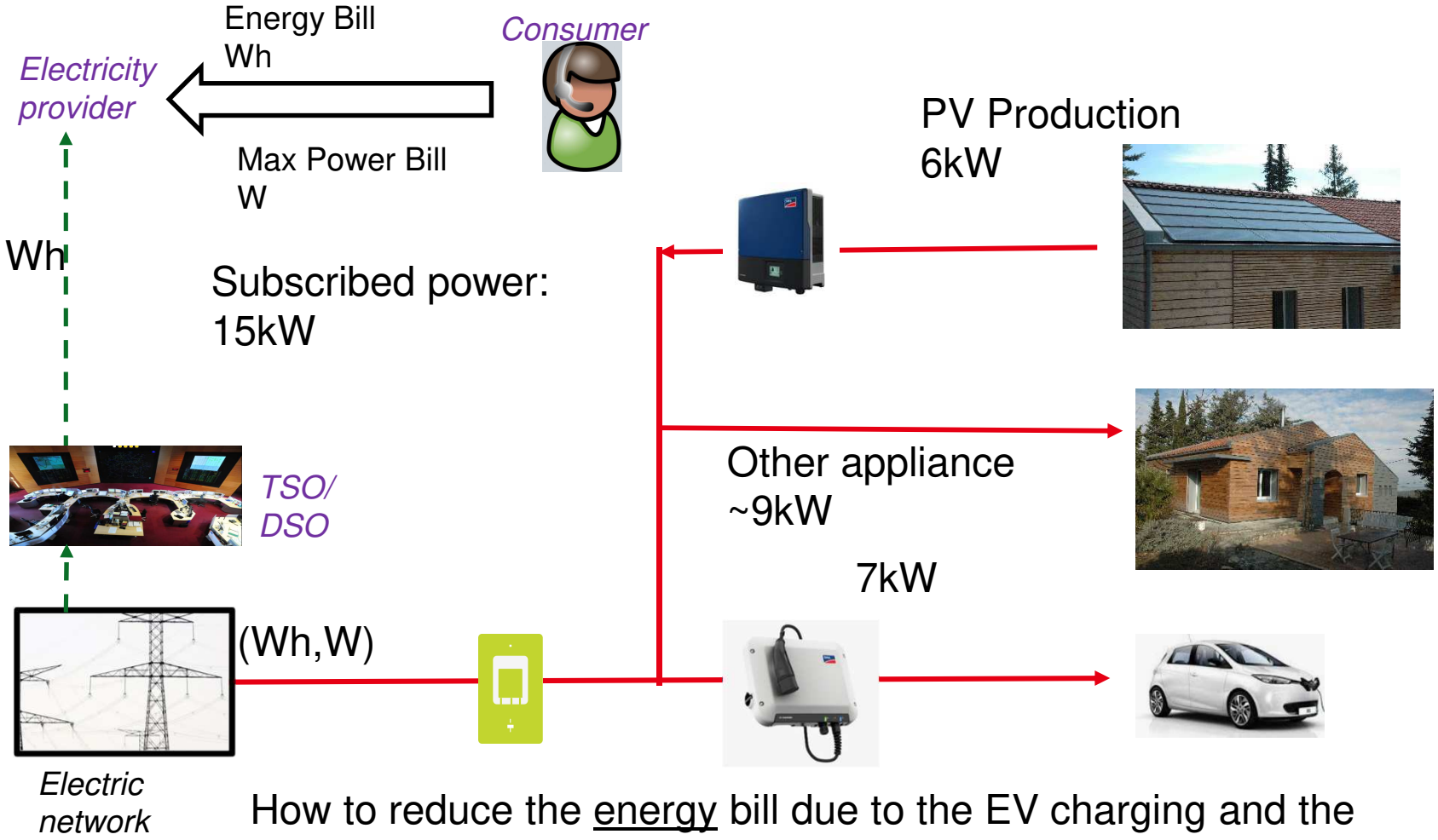
USE - CASE 3 - CHARGING STATIONS AT HOME [7]

- The charging points are used for recharging the EV used for commuting during the working week.
- The charging points are generally slow or accelerated and located in the garage, next the house or in the parking lot of a collective dwelling.

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USE - CASE 3 – SMART CHARGING 3 – AUTOCONSUMPTION INCREASE



How to reduce the energy bill due to the EV charging and the Max power?

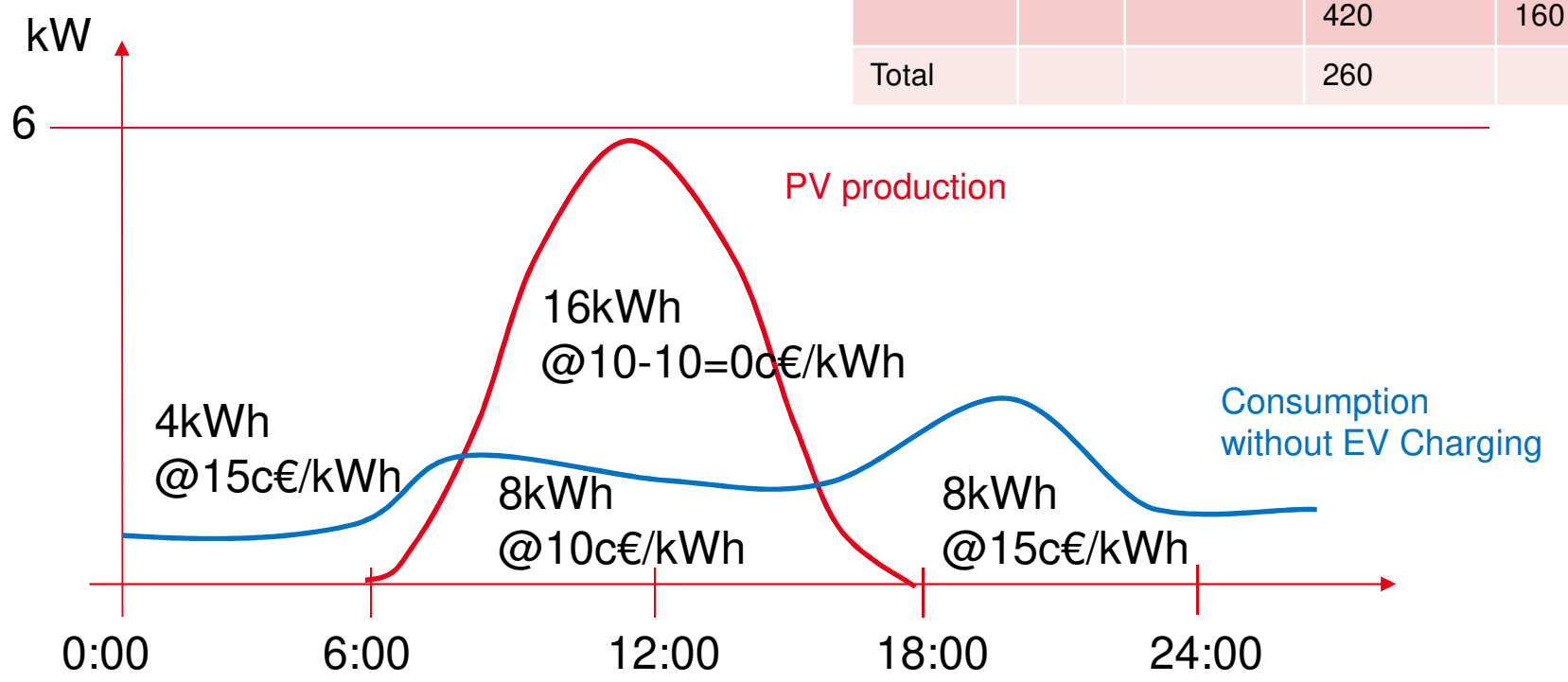
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USE - CASE 3 – SMART CHARGING 3 – ENERGY COST REDUCTION - PRINCIPLE

Cost Price (network)~15 c€/kWh
Cost Price (PV) ~10c€/kWh
Sell Price (PV surplus) ~ 10c€/kWh
PV production : 24kW
Consumption without EV: 20kWh

Period	kWh	Price (c€/kWh)	Cost c€	Sell c€
Morning	4	15	60	
MidDay	8	10	80	
MidDay (Surplus)	16	10	160	160
Evening	8	15	120	
			420	160
Total			260	



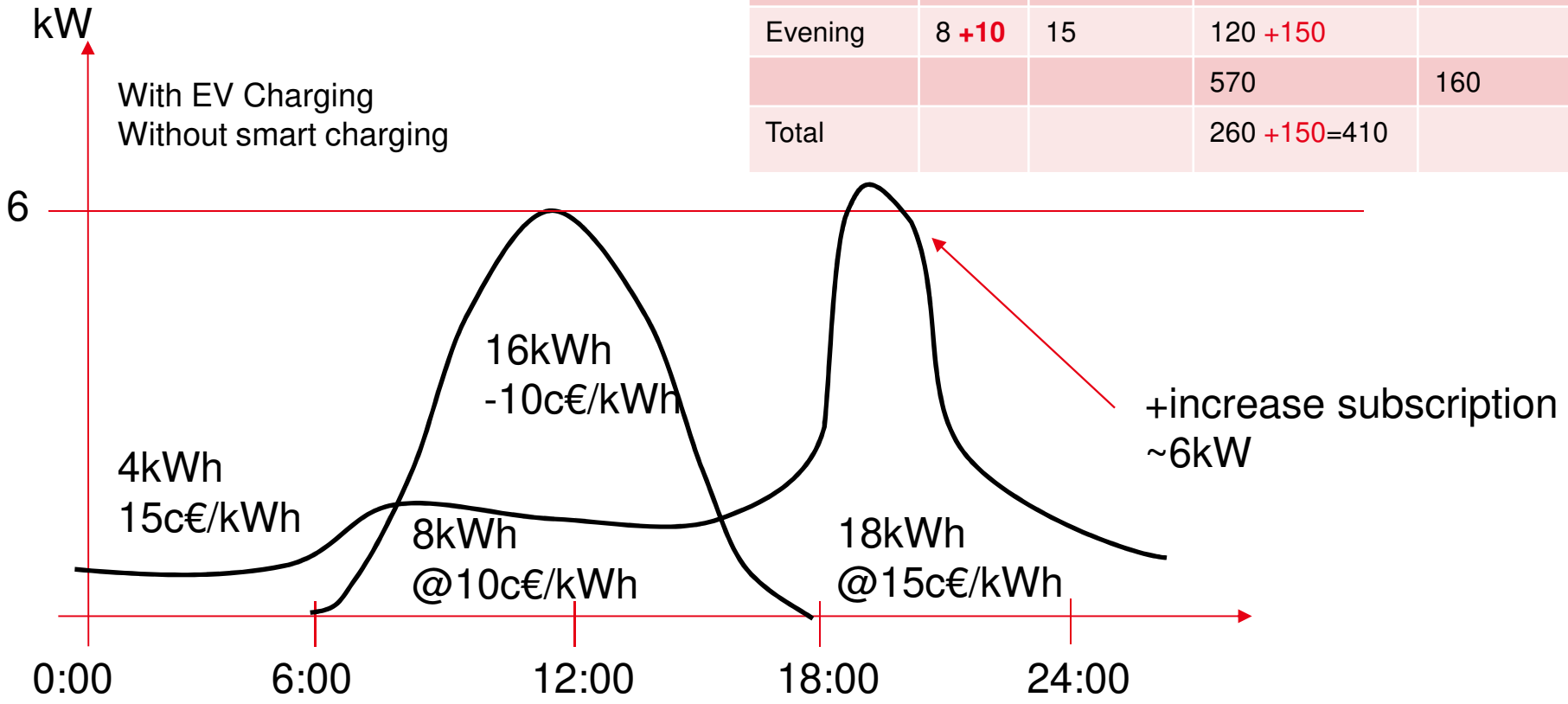
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USE - CASE 3 – SMART CHARGING 3 – ENERGY COST REDUCTION - PRINCIPLE

Consumption of EV :
50 km /day → 10kWh / day

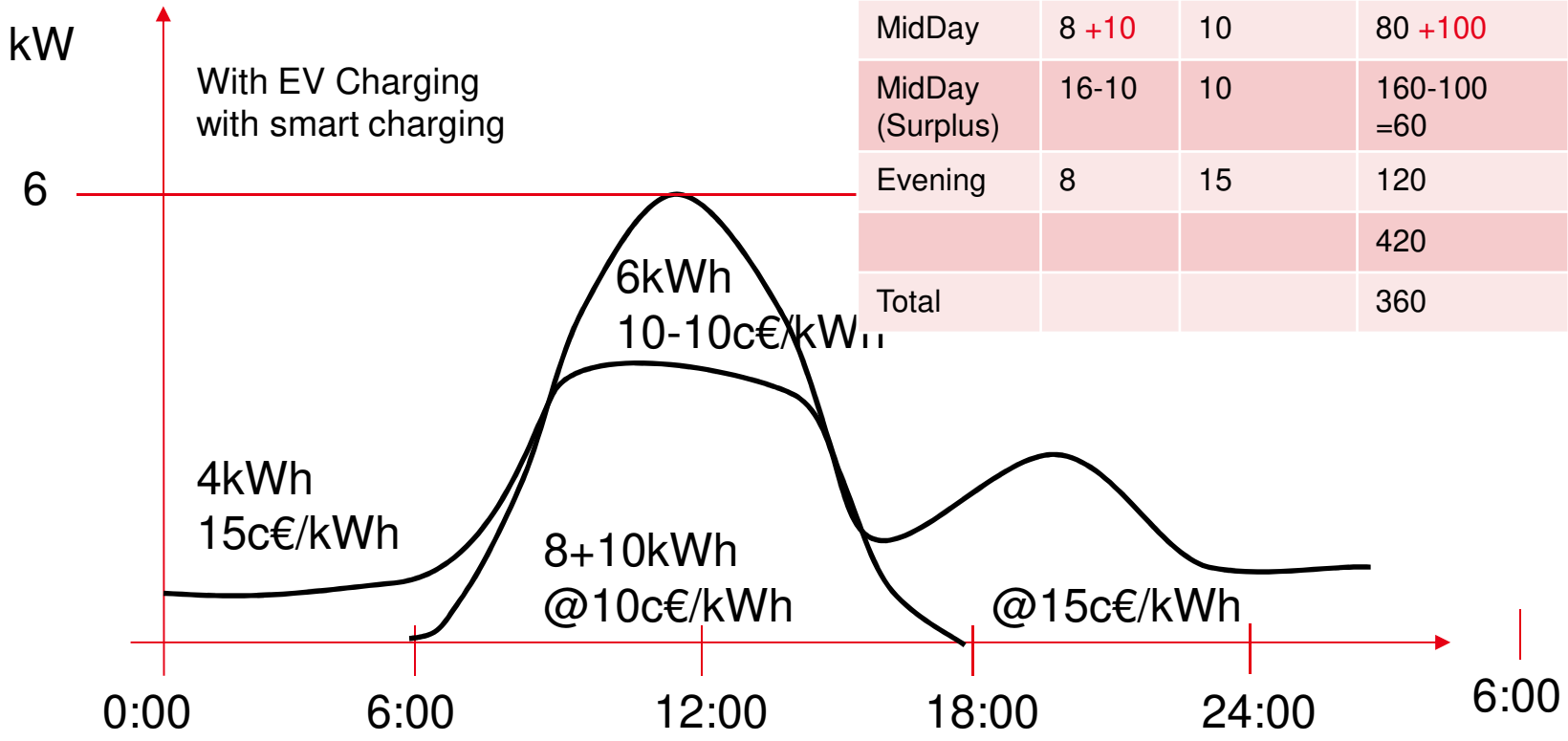
Period	kWh	Price (c€/kWh)	Cost c€	Sell c€
Morning	4	15	60	
MidDay	8	10	80	
MidDay (Surplus)	16	10	160	160
Evening	8 **+10**	15	120 +150	
			570	160
Total			260 +150=410	



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USE - CASE 3 – SMART CHARGING 3 – ENERGY COST REDUCTION - PRINCIPLE

Period	kWh	Price (c€/kWh)	Cost c€	Sell c€
Morning	4	15	60	
MidDay	8 +10	10	80 +100	
MidDay (Surplus)	16-10	10	160-100 =60	160-100 =60
Evening	8	15	120	
			420	60
Total			360	

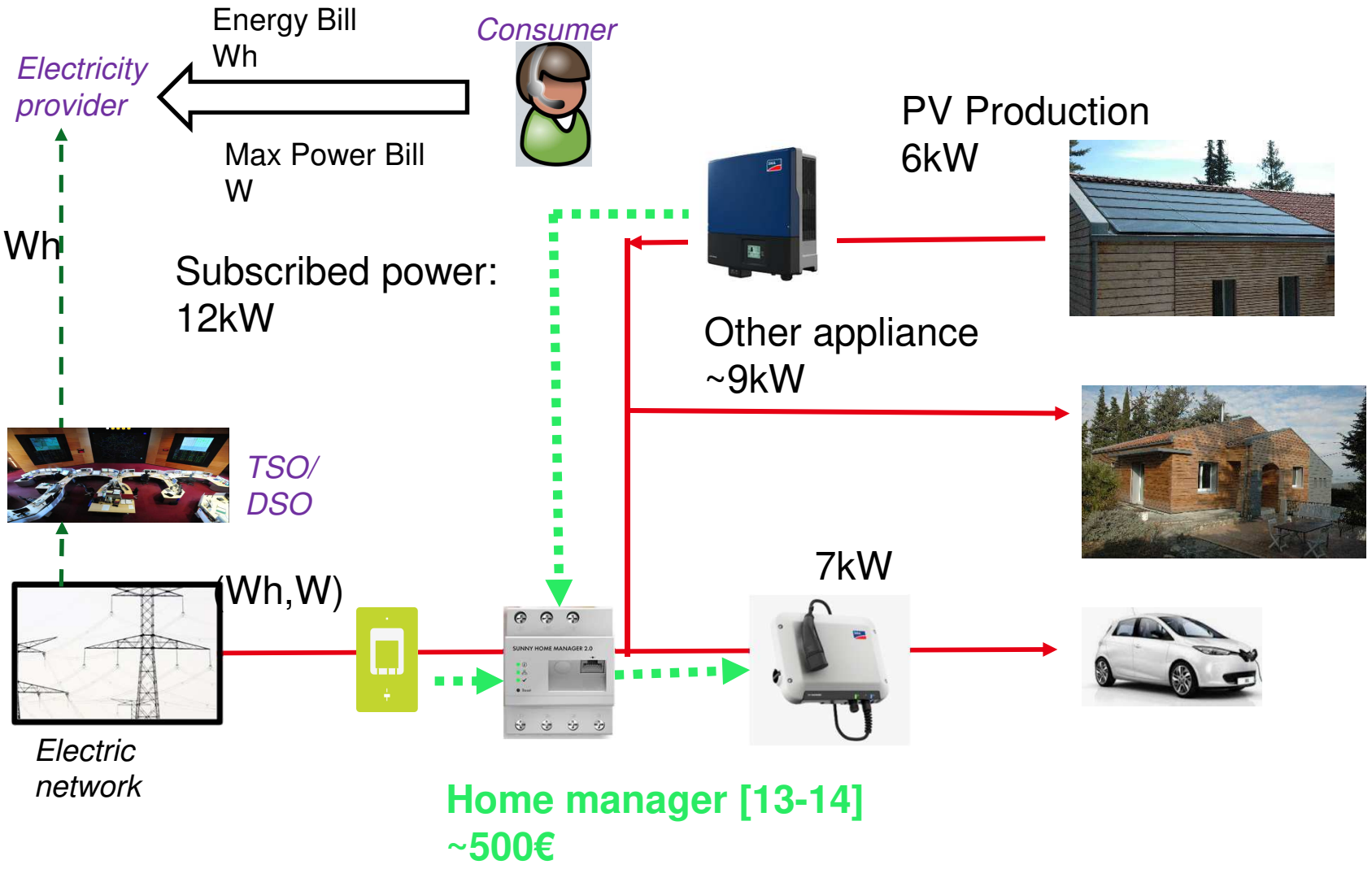


Expected savings:
Subscription 9+3=12kW instead of 9+6=15kW ~30€ /year
If 1 EV used 250 days/years : 3/5 of solar charge -> ~75€/year

~100€ /year

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USE - CASE 3 – SMART CHARGING 3 – AUTOCONSUMPTION INCREASE - SET-UP



In collaboration with

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

USE - CASE 4 - "OPPORTUNISTIC" USE [7]

- **These stations are used on an “ad hoc” and “opportunistic” basis by passing electric vehicles.**
- **These charging stations are normal, accelerated or fast and are installed on public roads, in car parks of shops or shopping centers or on motorway service areas.**

Owners : shops
Lidl: 900 charging points



Owners : territorial collectivity
LaRecharge (Aix-Marseille Metropole)
174 charging points (22kW AC)



Owners : charge point operator
Ionity: 350 charging points (>50kW DC)



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CONCLUSION

- **Nowadays, various smart charging solutions can be setup with commercial equipments and solutions**
- **There exist cheap solutions but also very expensive ones**
- **Other « smarter » solutions exist, based on complex information systems and off-site control of the EV charges.**
  - For example, smart charging of EVs @ CEA Cadarache
- **To setup smart charging solutions, the charging needs of the users have to be precisely studied**

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REFERENCES / SOURCES

- [1] https://www.automobile-propre.com/dossiers/chiffres-vente-immatriculations-france/
- [2] http://www.hrvojepandzic.com/wp-content/uploads/2019/09/Lecture_4_EVs.pdf
- [3] http://ev-institute.com/images/charged_mag.pdf
- [4] http://www.avere-france.org/Site/Article/?article_id=7923
- [5] https://fr.chargemap.com/
- [6] https://www.data.gouv.fr/fr/datasets/fichier-consolide-des-bornes-de-recharge-pour-vehicules-electriques/
- [7] https://www.enedis.fr/sites/default/files/ENEDIS_Rapport_Pilotage_de_la_recharge_12-2020.pdf
- [8] https://www.tesla-mag.com/sap-labs-a-mougins-quand-la-recharge-de-vehicules-electriques-devient-tres-intelligente/
- [9]https://download.schneider-electric.com/files?p_enDocType=User+guide&p_File_Name=SE+EVlink+LMS+User+guide+EN-07.pdf&p_Doc_Ref=DOCA0163
- [10] https://www.enedis.fr/sites/default/files/field/documents/enedis_livret_mobilite_electrique_hd.pdf
- [11] https://www.edf.fr/groupe-edf/nos-energies/carte-de-nos-implantations-industrielles-en-france/centrale-nucleaire-du-bugey/actualites/la-centrale-nucleaire-du-bugey-s-equipe-de-110-vehicules-electriques-et-de-276-bornes-de-recharge
- [12] https://www.lemonde.fr/economie/article/2019/04/08/la-poste-numero-un-mondial-des-flottes-branchees_5447176_3234.html
- [13] https://www.sma.de/fr/produits/surveillance-controle/sunny-home-manager-20.html
- [14] https://files.sma.de/downloads/EVC-10-DS-en-10.pdf

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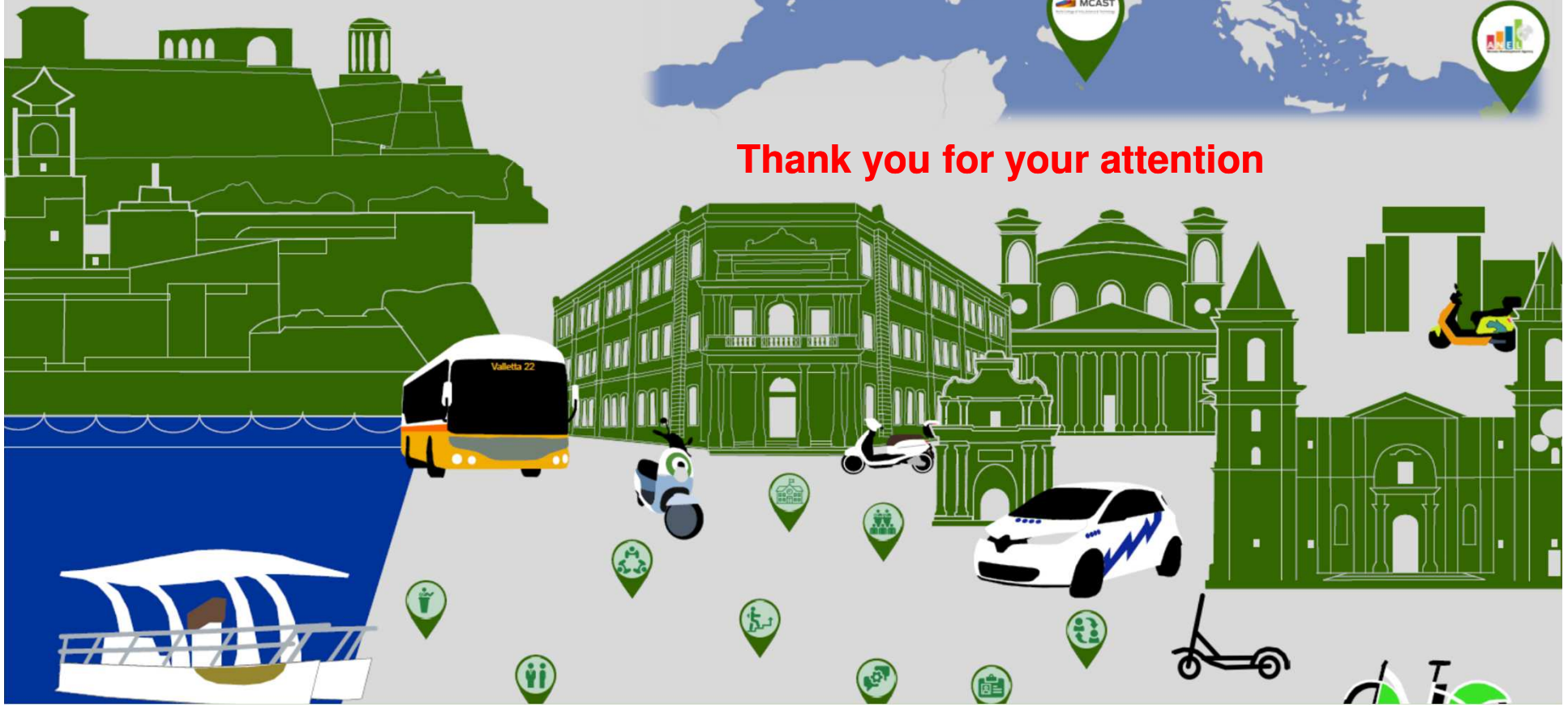
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