Electromobility: technical solutions for system integration

Impact of massive EV deployment on the power distribution network

Evidence from gravity-based modelling on French substations

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ENEDIS
L'ELECTRICITE EN RESEAU

AEE
Association des Economistes de l'Energie

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Enedis in a nutshell

€ 14.4 bn revenue in 2019

€ 3.99 bn investments in 2018 (7% average annual growth since 2008)

37 million customers

Interventions 24 hours a day

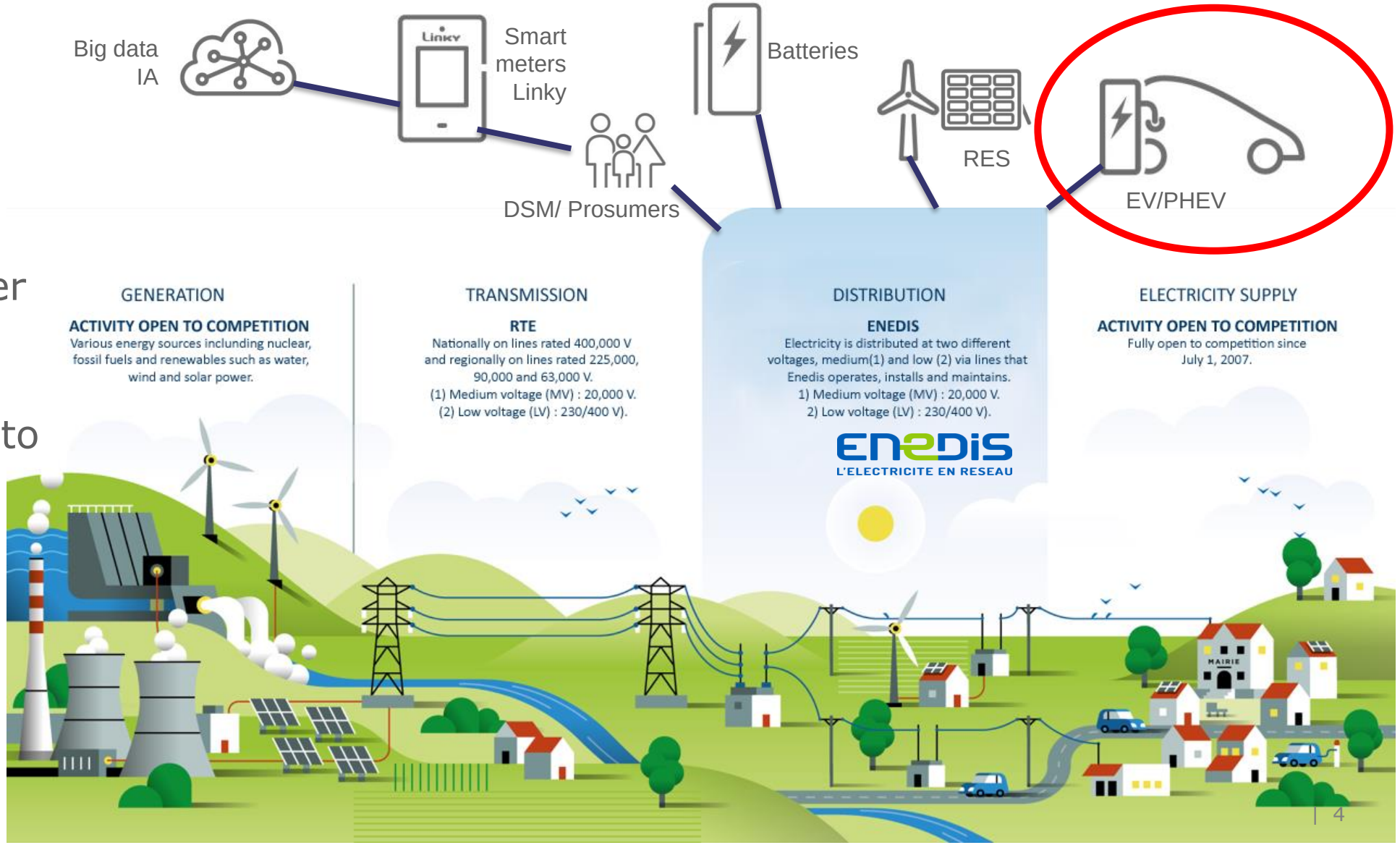
38 754 employees in 2019

410 710 generation facilities connected to the distribution grid in France

Power distribution plays a crucial role in energy transition towards new electricity uses

How to prepare electricity supply sustainability?

- Specify each other responsibilities
- Take system transformation into account



French electric mobility ambitions
What equilavence for USA?

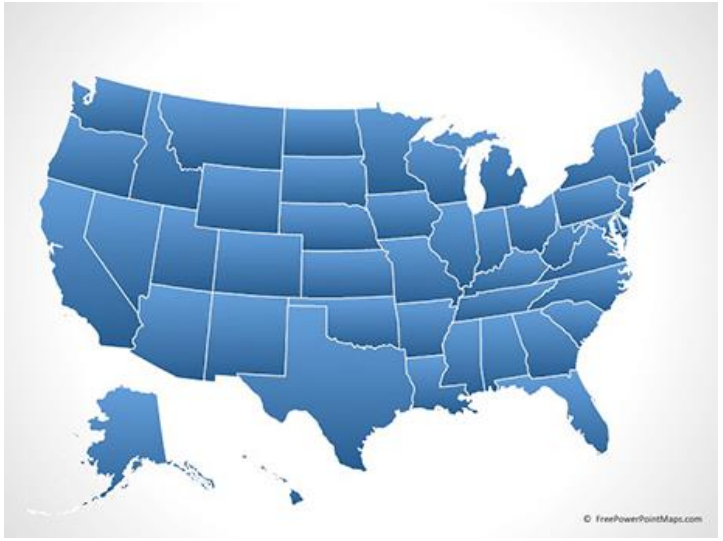
France

- Population: 68M
- Vehicles fleet:30M
- Nr EV 2035: 15M

50%

50%

- Area : 550,000 km2
- Density: 100k/km2



USA

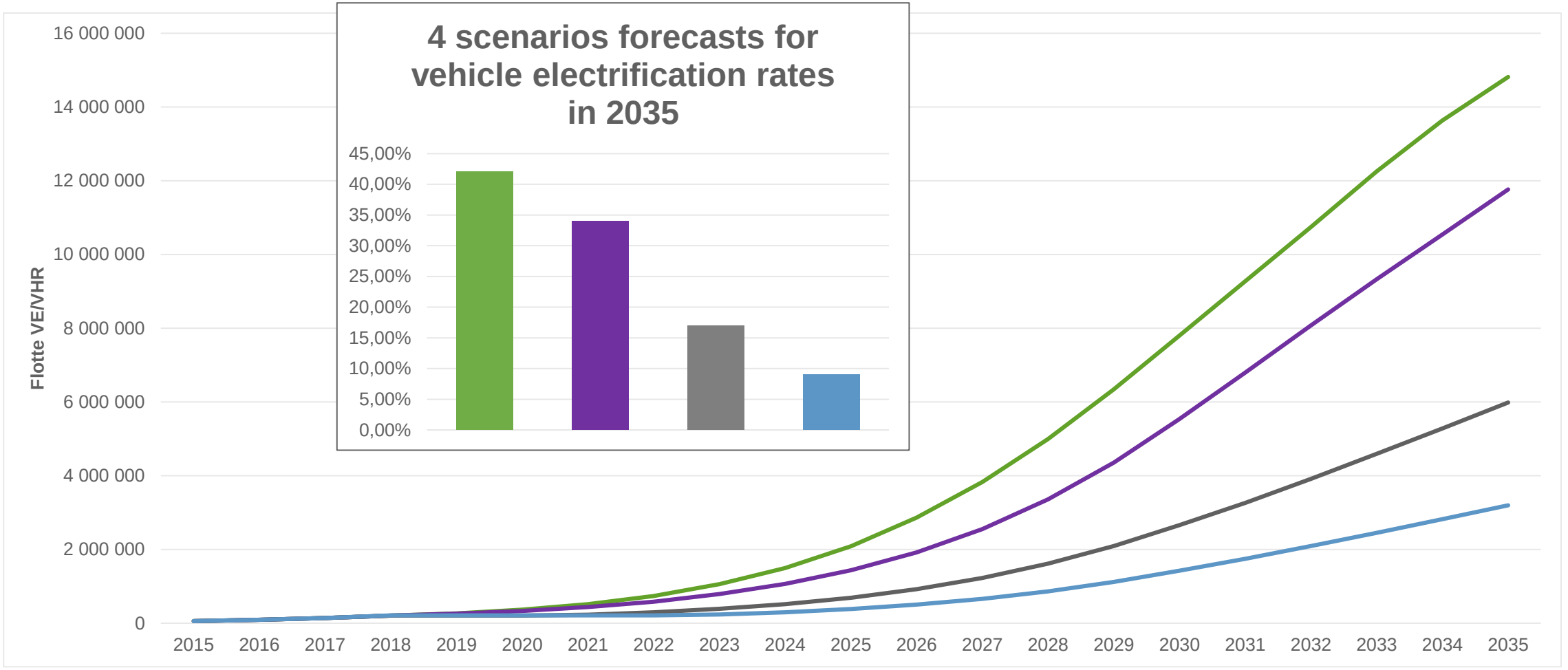
- Population: 327M
- Vehicles fleet:275M
- Nr EV 2035: 140M

85%

50%

- Area: 9,833,000 km2
- Density: 33k/km2

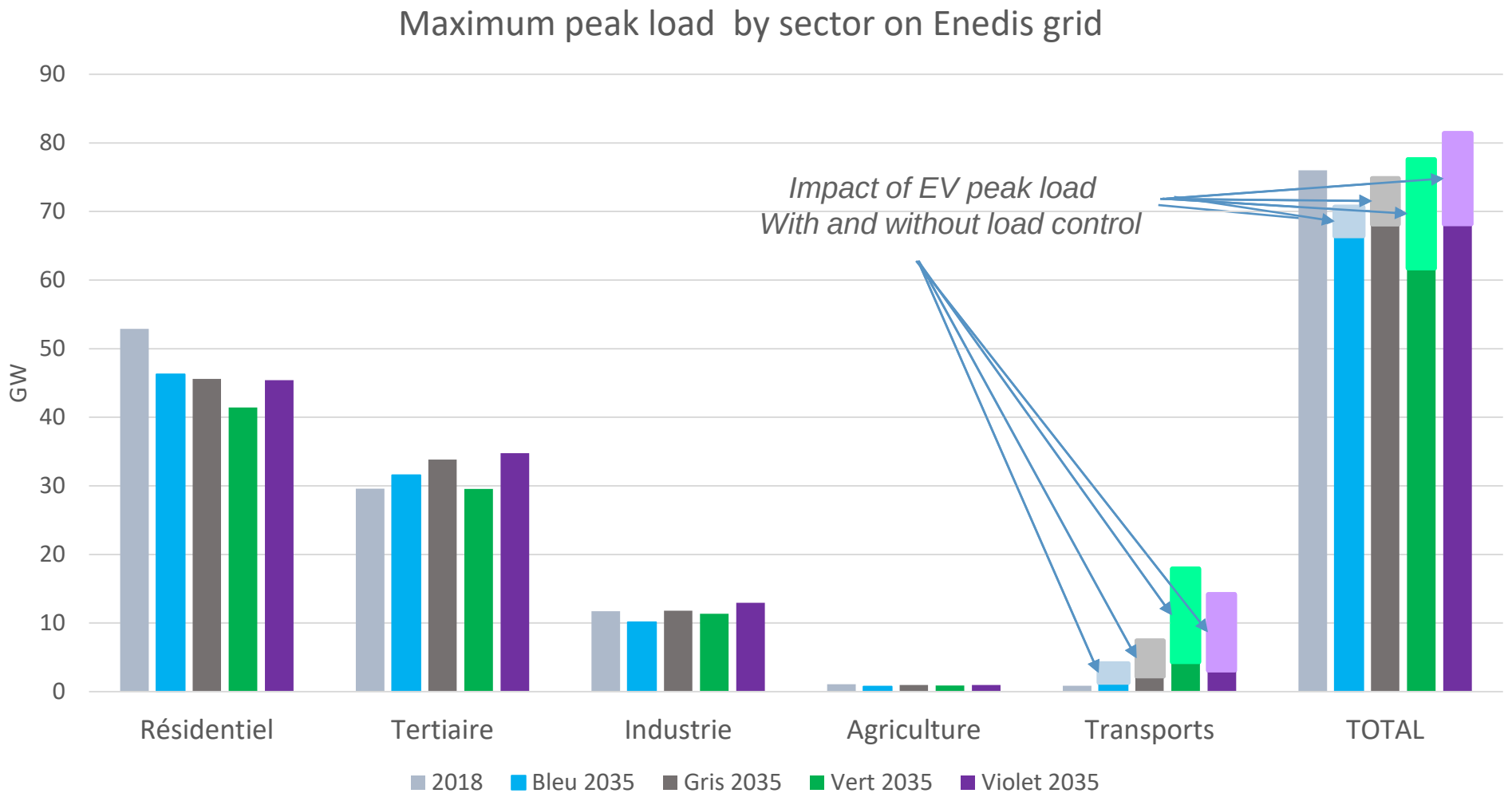
French electric vehicles development forecast



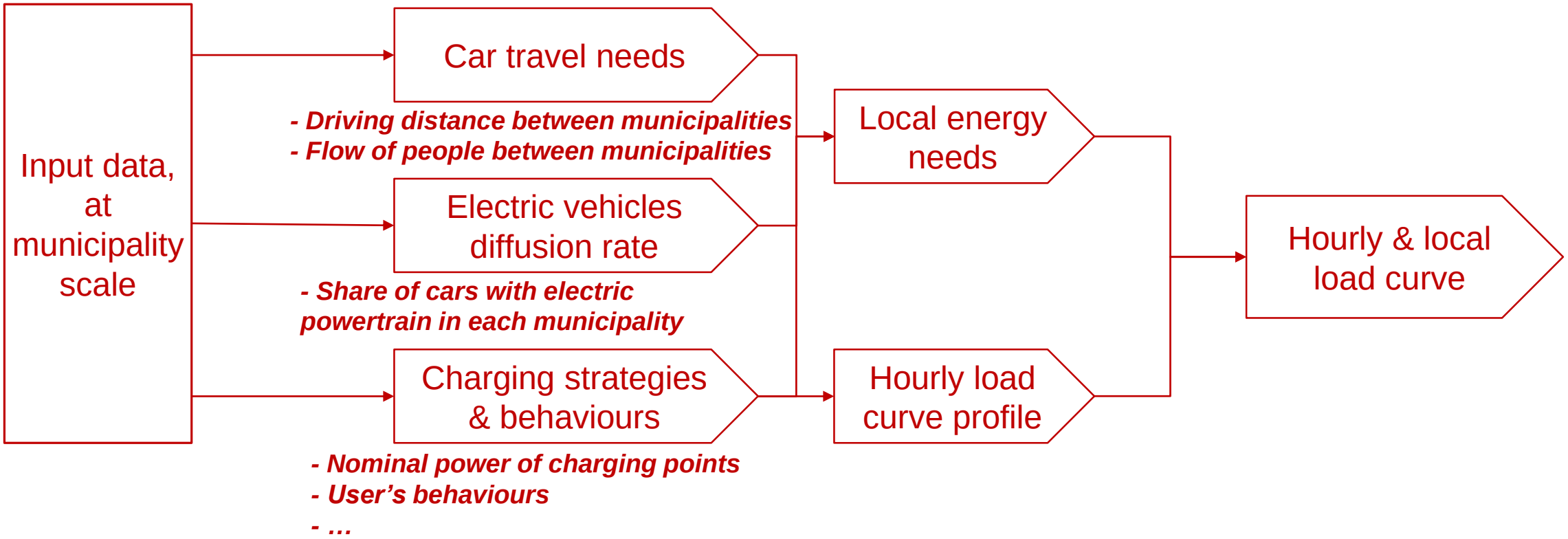
Source : Enedis – Strategy Dpt

4 scenarios : the total off-peak offset of EV recharging would lead to a substantial decrease in the total peak load

- The maximum synchronous peak load of the load curve is less than the sum of the synchronous peak load of each sector.
- The total synchronous off-peak offset of EV recharging (maximum piloting) would lead to a substantial decrease in the total maximum peak load

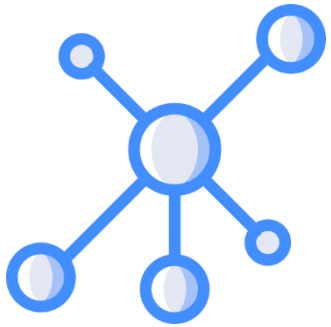


Global architecture

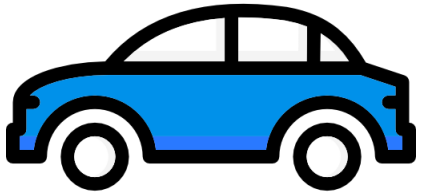


Compute a load curve that takes into account local socio-economic specificities, at municipalies level

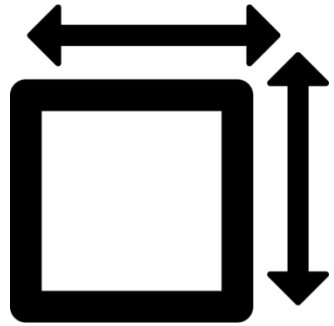
Travel needs computation
Multiple factors taken into account



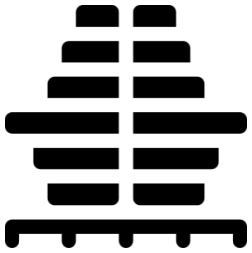
Geography: level of isolation, road infrastructure, etc.



Car use rate & average number of trips per person



Municipality's superficy

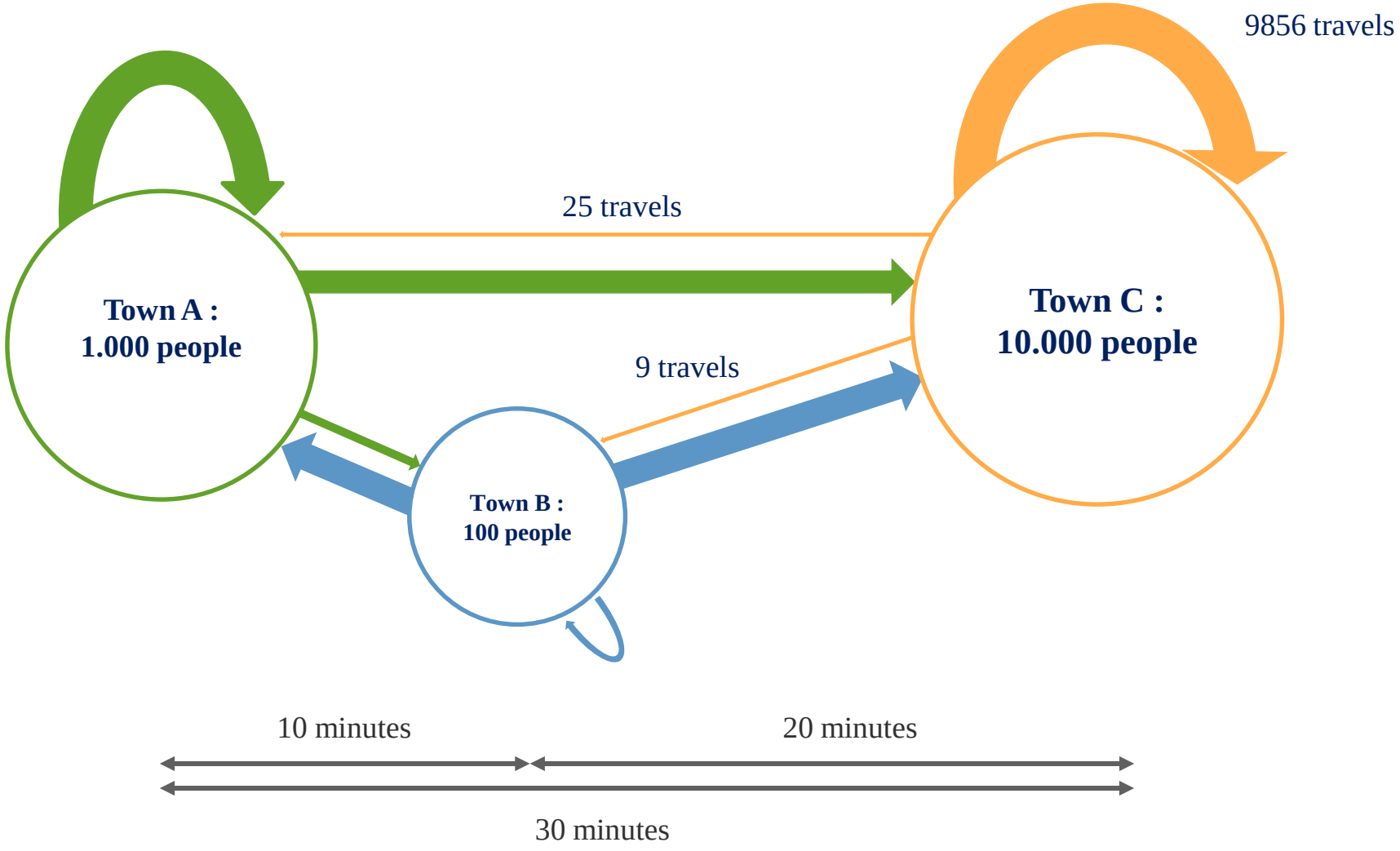


Demography & Workforce

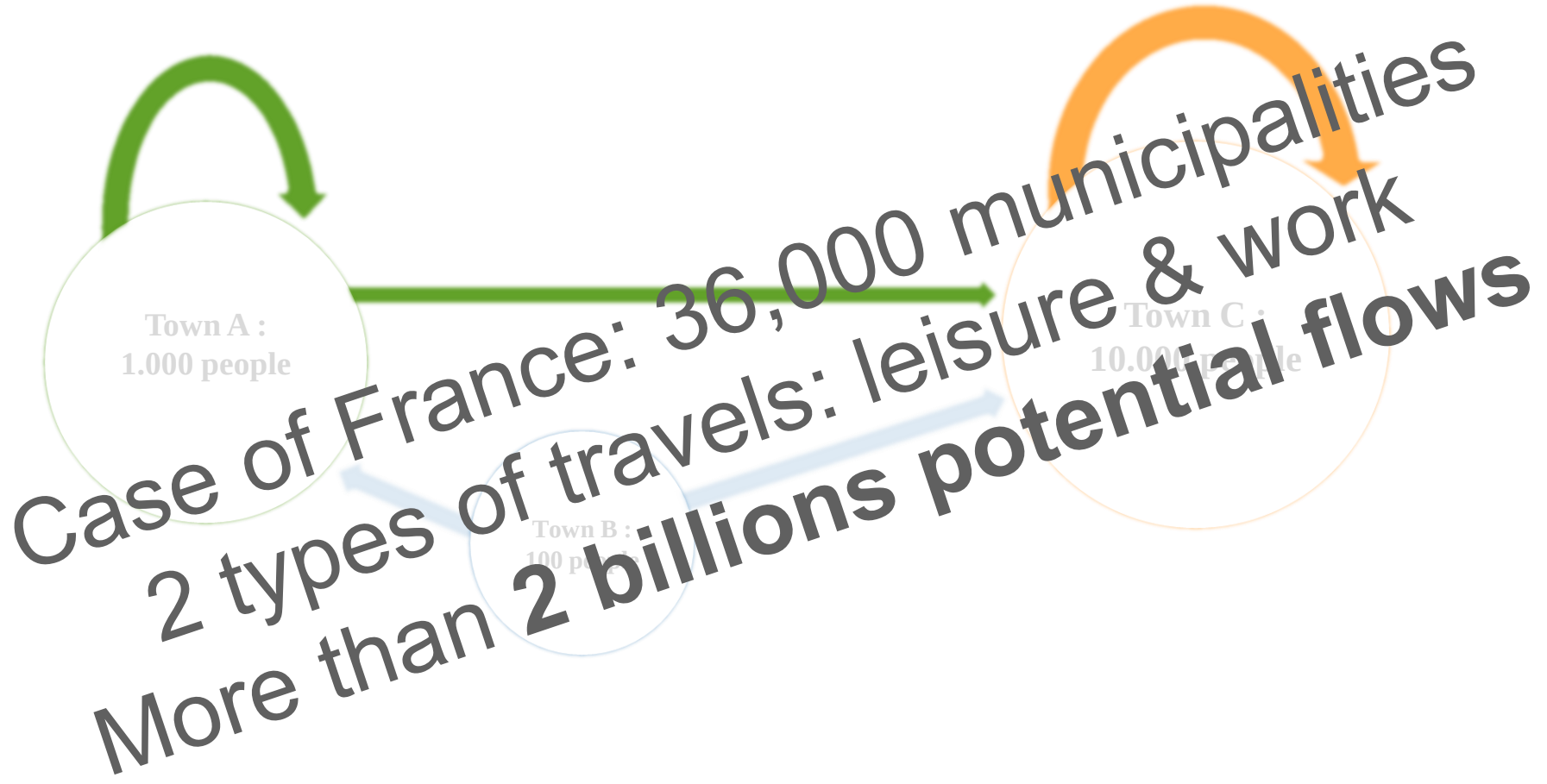
Carpooling rates

Transport time
Average speed

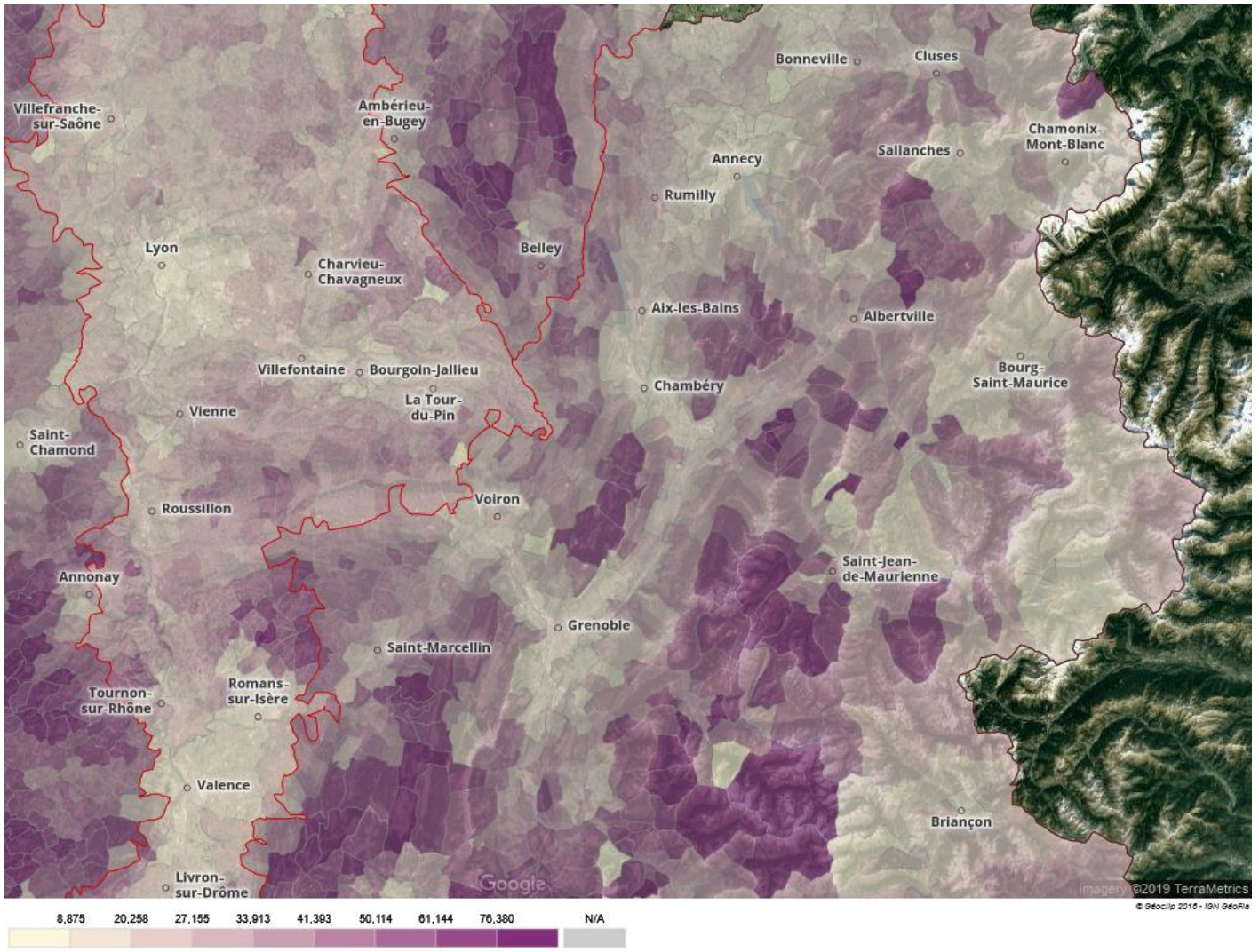
Travel needs computation
A dedicated gravity-based model



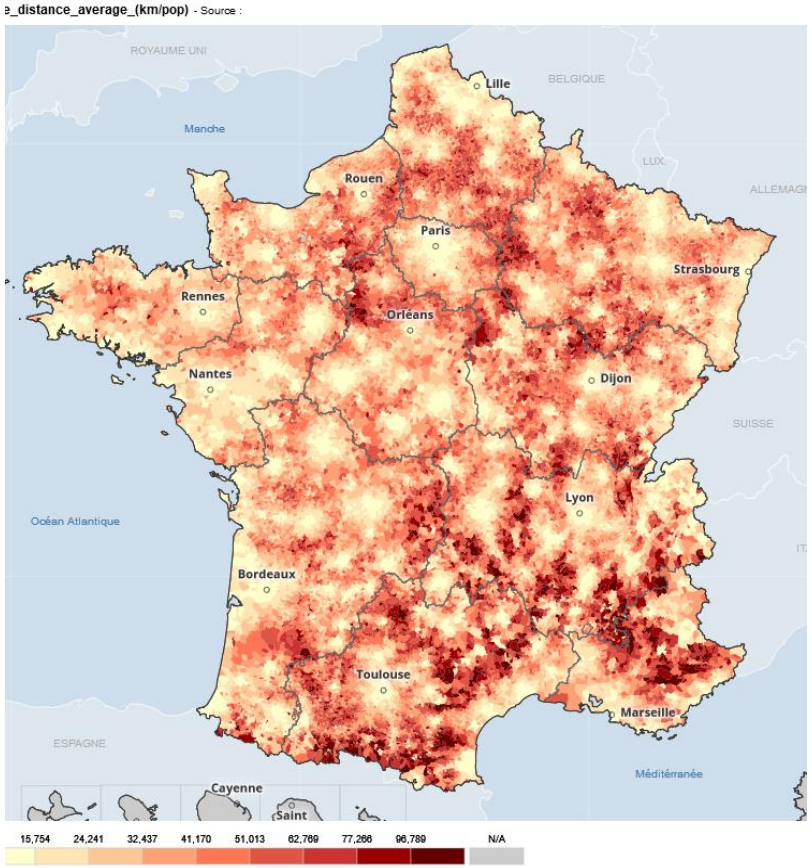
Travel needs computation
A dedicated gravity-based model



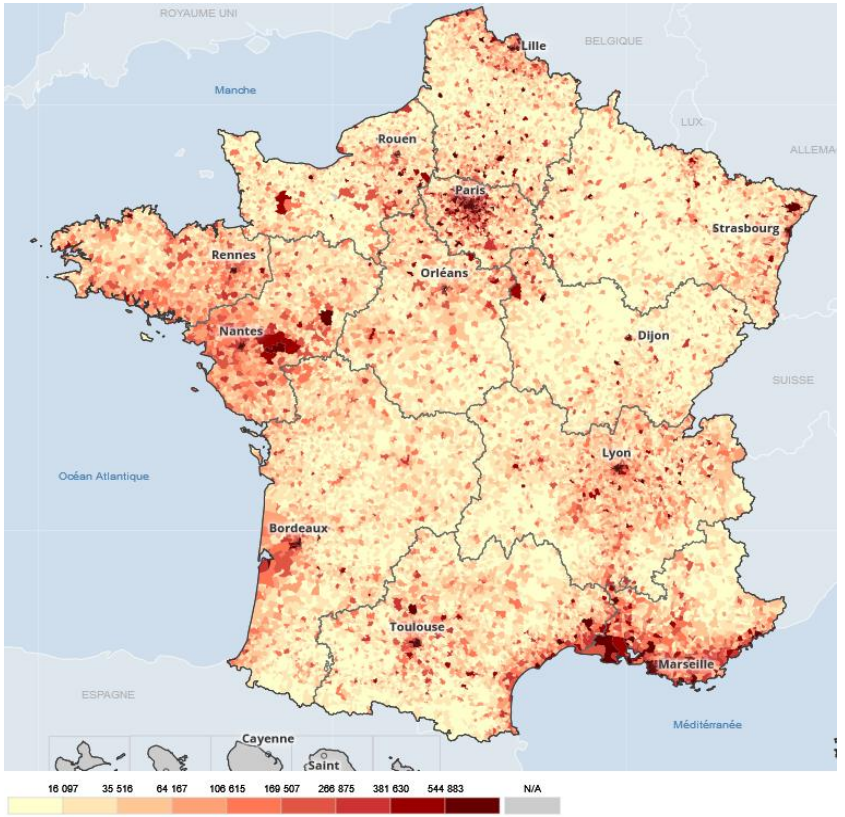
Map of average travel time in cars on a Sunday (min/hab)



Travel needs assesments: Some results



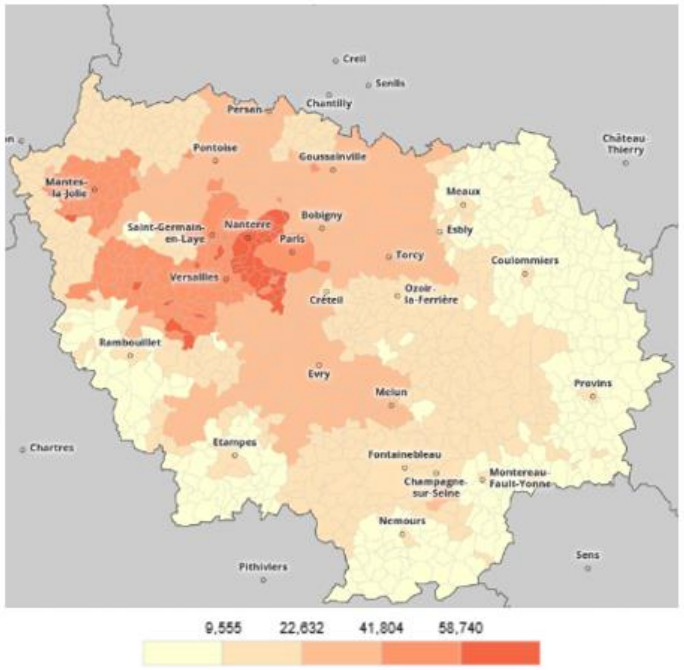
Average distance driven per capita on a Sunday



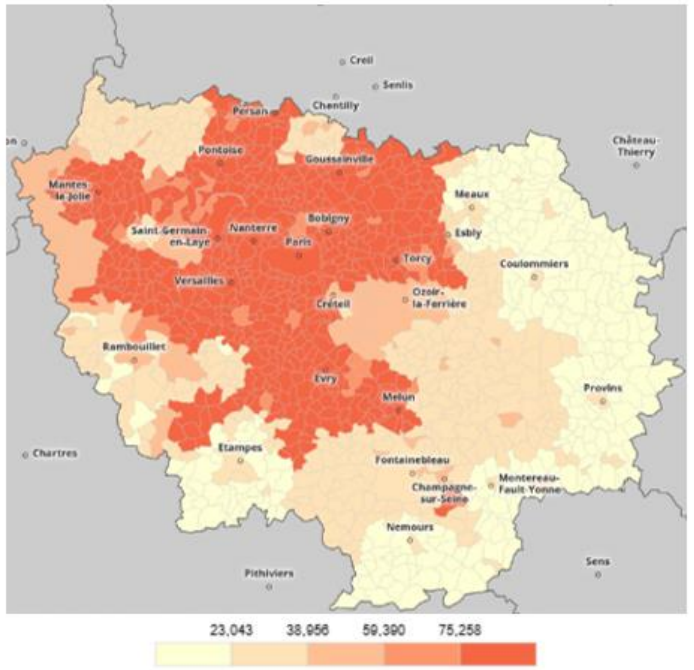
Total distance driven by municipality on a Sunday

Electrification rates for 36,000 municipalities

Example: Paris area electric vehicles development forecast



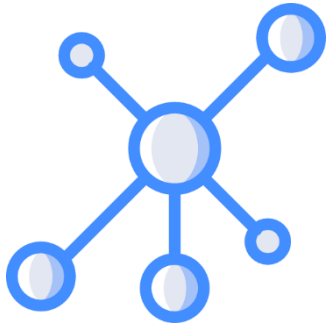
Lower scenario in 2035



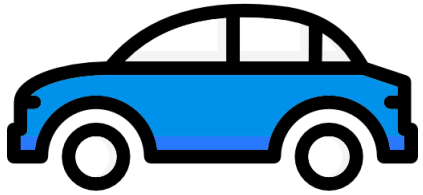
Higher scenario in 2035

Charging strategy computation

Multiple factors taken into account



Travels:
- Distance traveled by cars
- Timing of travels depending of each municipality's sociology



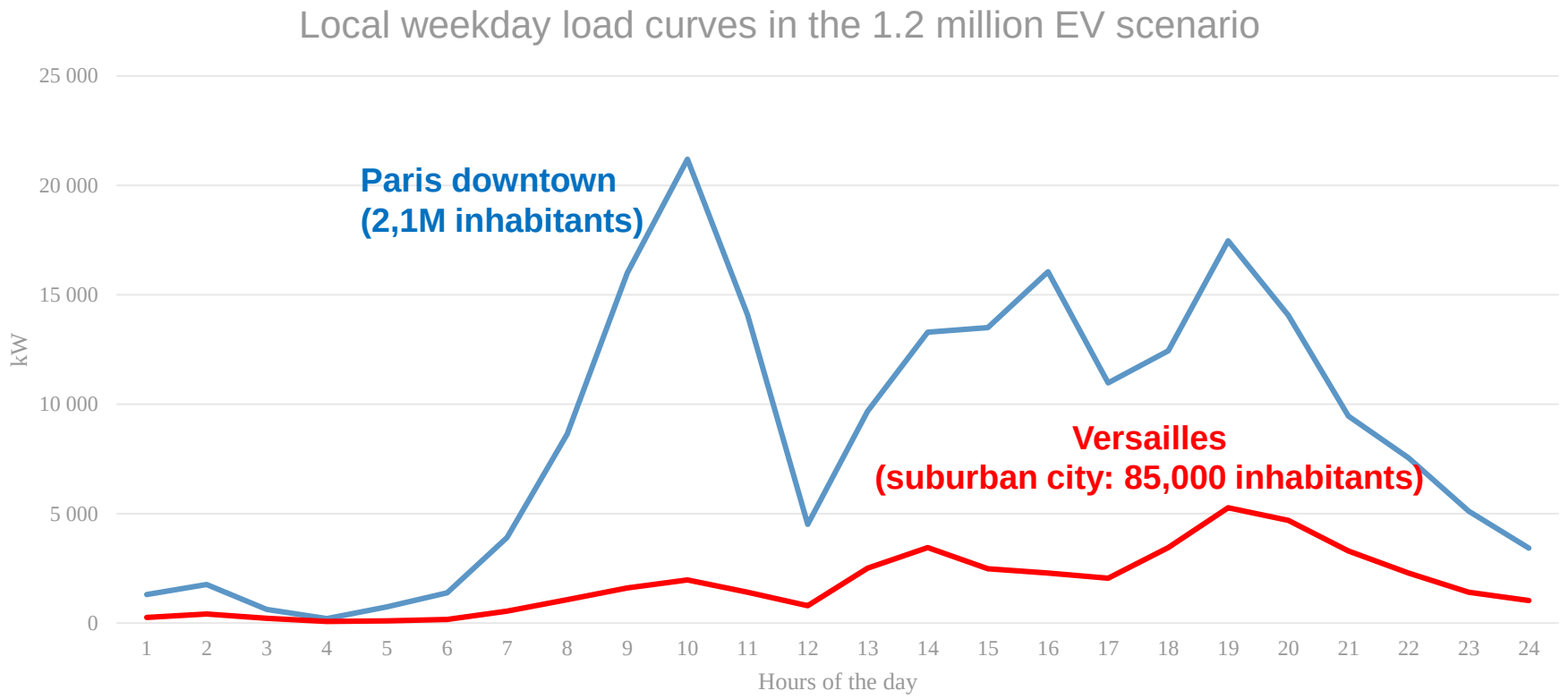
EV's technical spec:
- Mileage efficiency
- Battery capacity

Charging station's technical spec:
- Nominal power
- Availability at home and at workplace
- Smart-charging solutions

User's behaviour:
- Carpooling rate
- Charging frequency

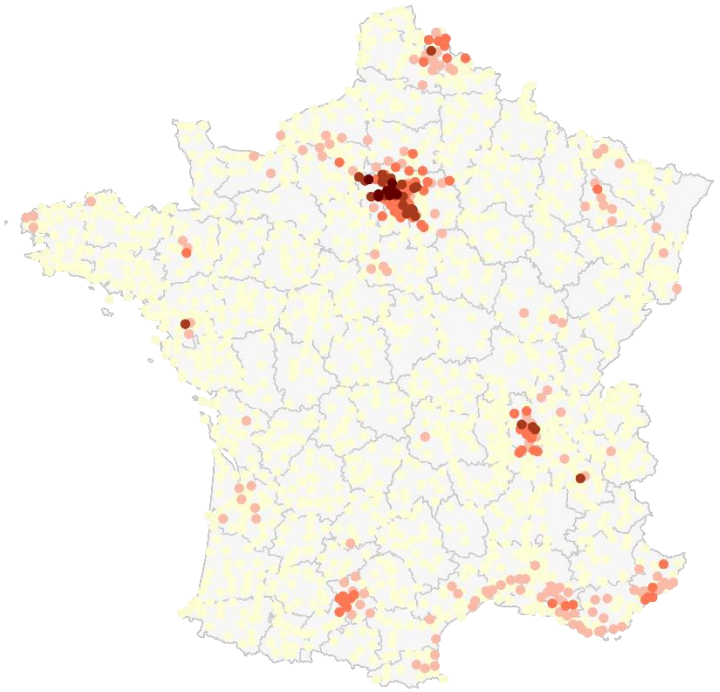
First results

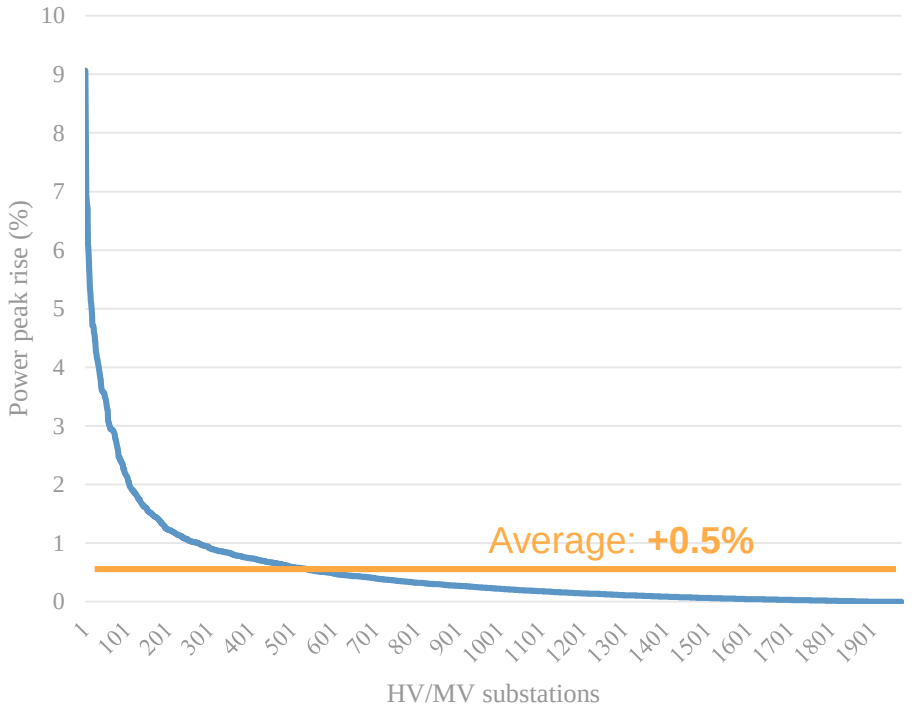
Local load curves



Different load curves between residential towns and « Urban Hubs »

1.2 million EV Scenario: Impact on HV/MV substation's power peak

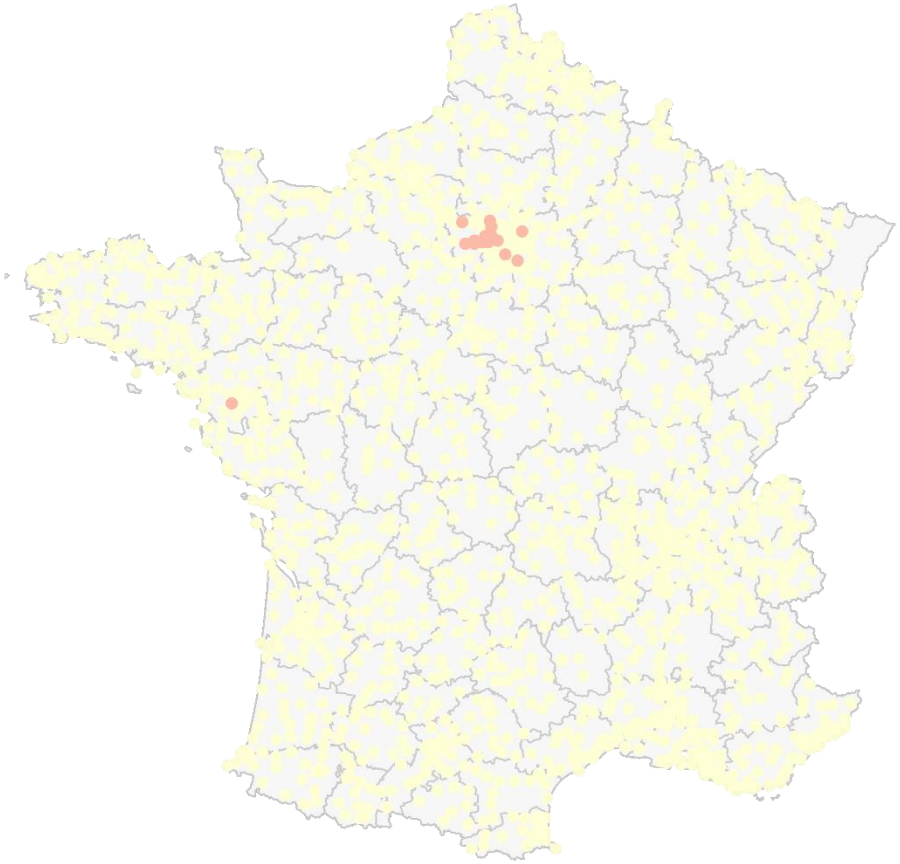




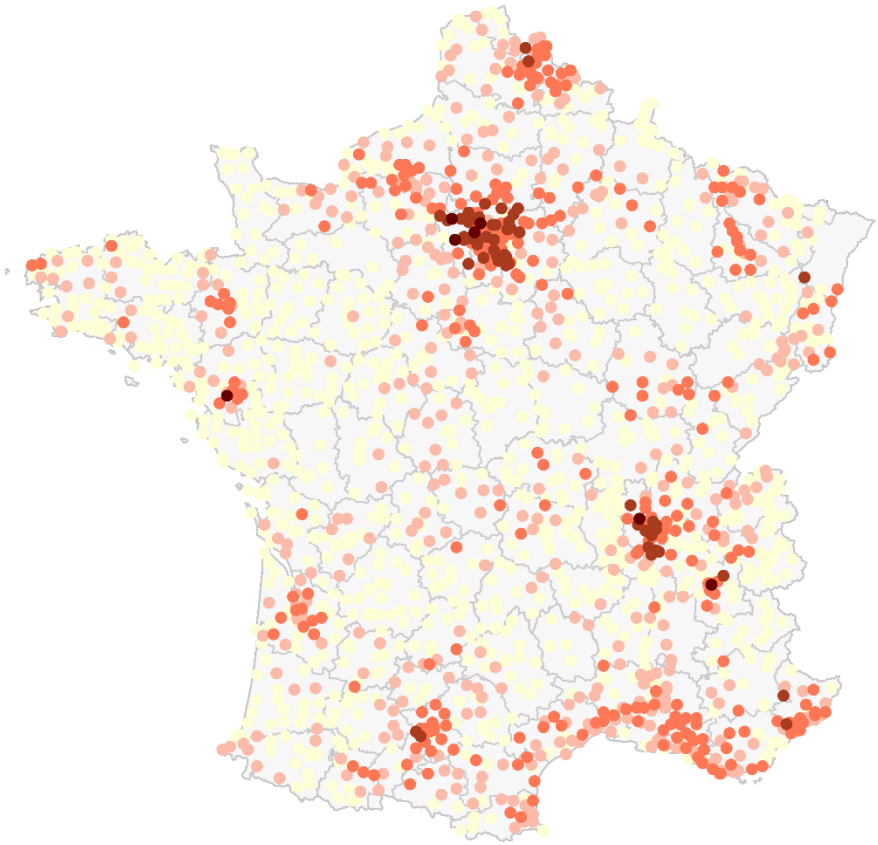
#FFFFD5	#FCBAA9	#FF7755	#A83A1E	#660000
[1 ; 1.01]	[1.01 ; 1.02]	[1.02 ; 1.04]	[1.04 ; 1.06]	[1.06 ; 1.1]
N observations : 1699	N observations : 164	N observations : 75	N observations : 24	N observations : 8

Over 1970 substations, 15 – **0.7%** – would face a power peak rise up to 10%**.**

Comparing it with a 12 million EV Scenario



1,2 millions EV

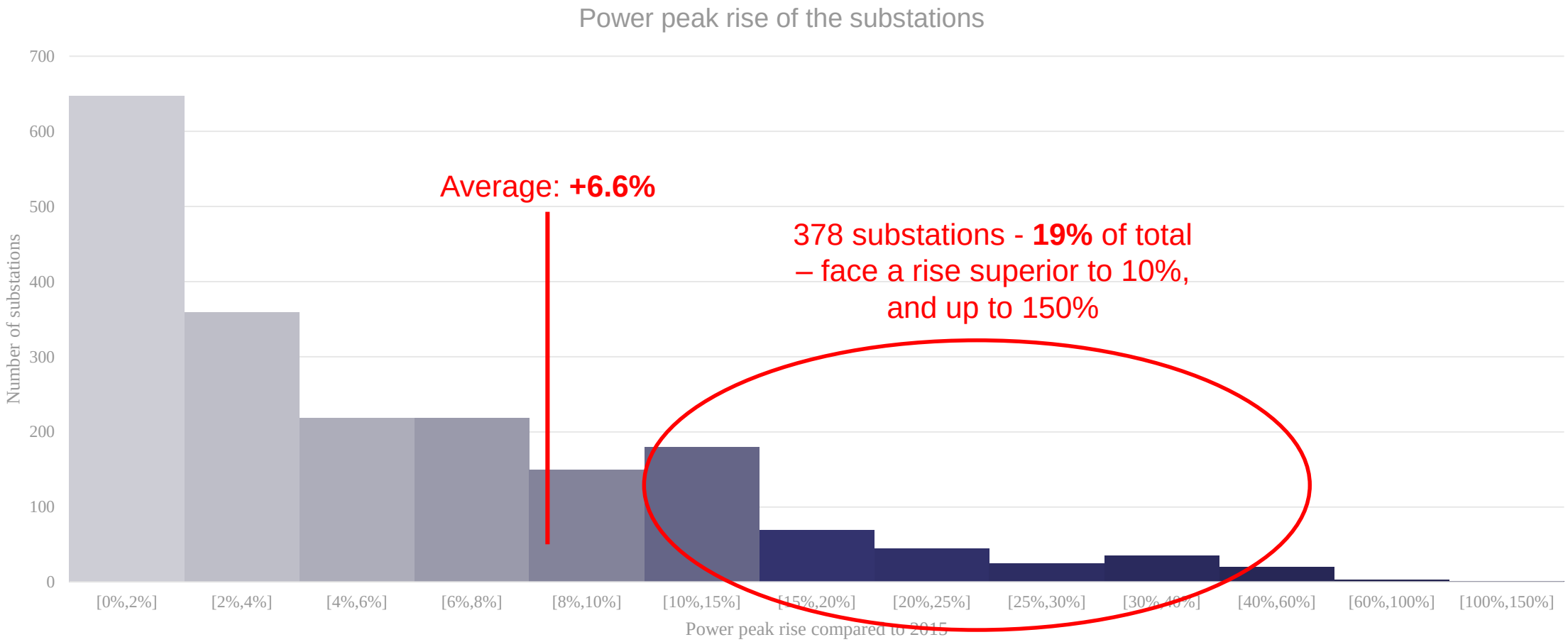


12 millions EV

Power peak multiplication factor compared to 2015:

[1 ; 1.05] [1.05 ; 1.1] [1.1 ; 1.3] [1.3 ; 1.5] [1.5 ; 2.4]

12M EV scenario: a closer look



Electric mobility: assessing global/local grid robustness
Executive summary

- Individual **electric vehicles are becoming a new specific electrical use**, in the same way as heating, air conditioning or lighting. Given its obvious characteristics (mobility, rate of use, etc.), its impact on the public electricity grid must be specifically computed.
- A travel needs computation model at local level (scale of HV/MV substations)
- Importance of: electrification rate of vehicles, ability to control the timing and power of charging, access to charging-points at workplace and rate of battery discharge tolerated by users.
- In 2019, the French government set the **target of 1.2 million EV in 2023**. In such a scenario, and without any form of smart-charging solutions, **less than 1% of French HV/MV substations would face a significant peak power rise (between 5% and 10%)**.
- In 2035, with **12M VE, only 19% will increase** peak demand over 10%, leaving 20 years to adapt these substations.

- Thank you

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