June 2021

Application of a scaling down method to study long term effects of wind and solar on the French TSO tariff

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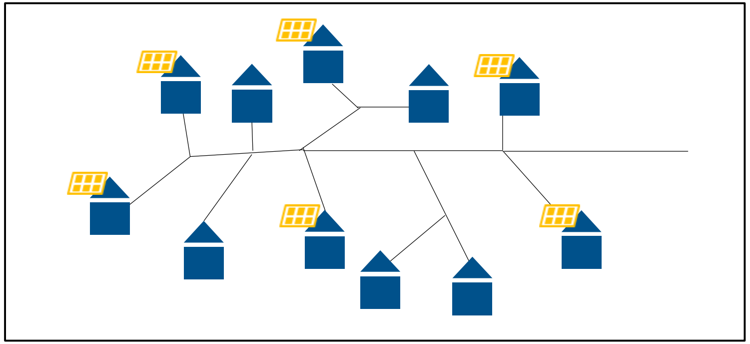
Contextualization

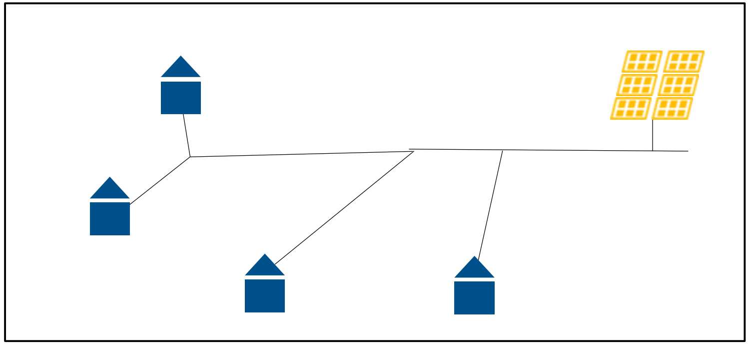
A lot of articles and reports study national prospective electricity mixes …

Articles and reports study electricity mixes and the consequences for the power system

… that also have local consequences …

Two different ways to geographically allocate solar panels





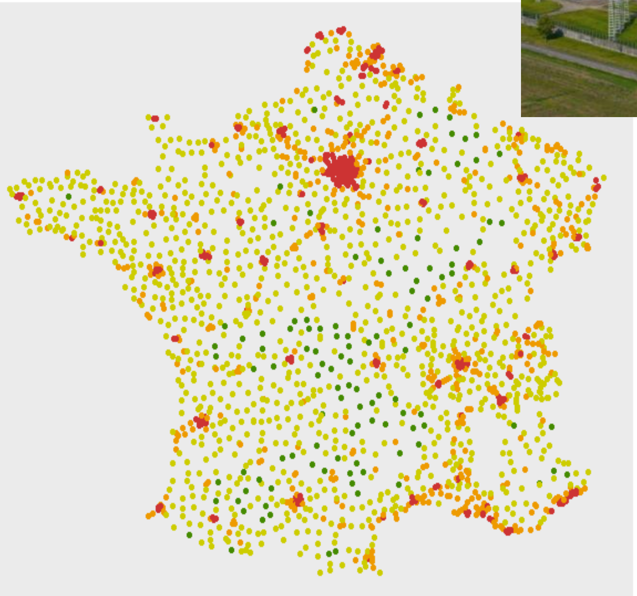
The geographical allocation of a national capacity can be done in several ways

The choice of the allocation will impact:

- Power flow
- Dimensioning
- Flexibility
- Environment
- …

… for the substations of a TSO

Map of the French substations



Intermediate populated area | Very populated area | Very parsely populated area | Parsely populated area

Substations are the interface between the TSO and its clients

Those clients can be DSO or important factories

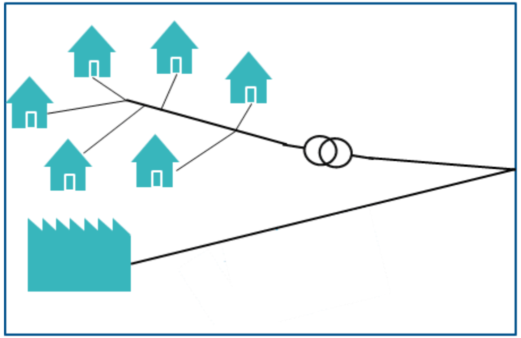
Substations are nodes of the high voltage power grid : knowing the residual load curves of each substations is useful for the grid exploitation

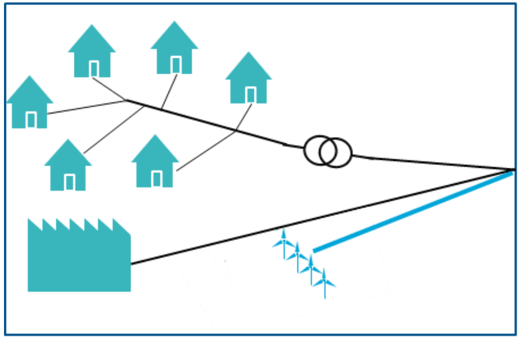
Residual load curves =
Local load – Local production

The geographical allocation will have impact on the residual load curves of each substation

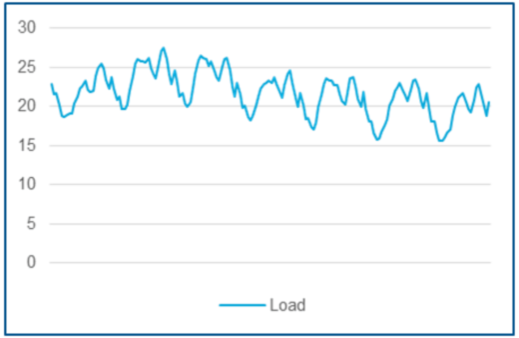
… for the substations of a TSO

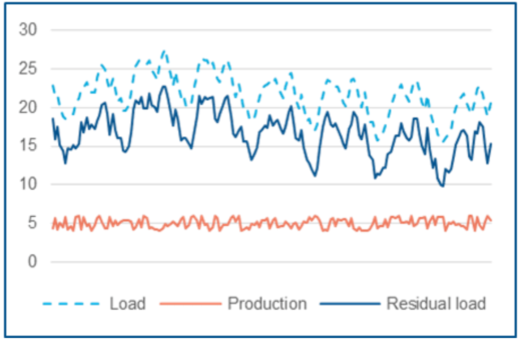
A TSO client





Demand curves





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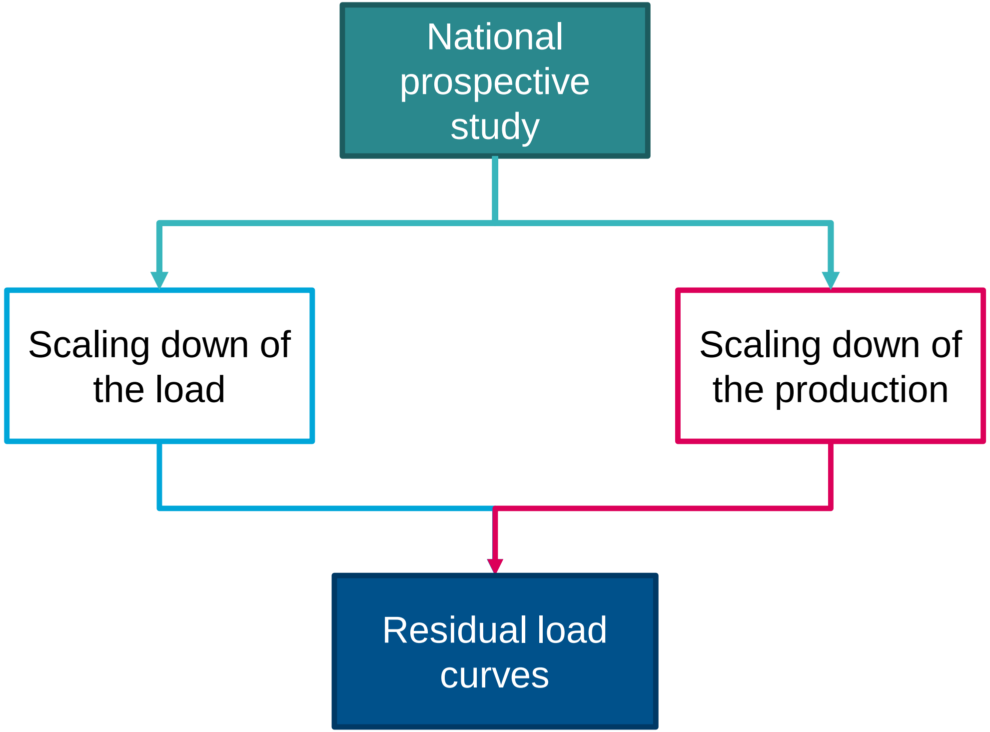
Model and data

National prospective studies are scaled down to the substations of the French TSO



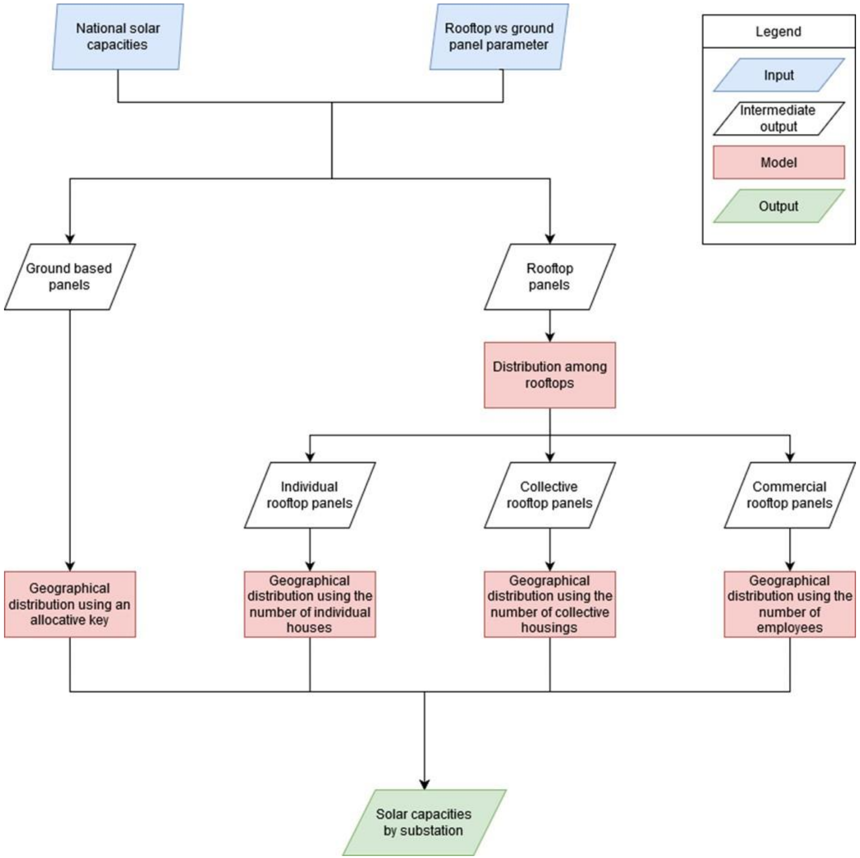
The model uses national prospective studies as input

It scales separately the national **load** and **production** to calculate the residual load curves of the substations

The **load** is scaled down using data from the French TSO

The **production** is scaled down using socioeconomic and grid data

Scaling down of the production



The model uses two inputs :

- ➔ National wind and solar capacities
- ➔ Rooftop vs ground based panel parameter

Then the production sites are geographically allocated :

- ➔ **Rooftop panels**: Socio economic hypothesis are used
- ➔ **Onshore wind production & Ground based panels**: method used in the French TSO network development plan

The geographical allocation of onshore wind farms & Ground based panels rely on three allocation keys

The model set capacities in high potential area while taking into account the trend of installation

1	2	3
From national to regional	**From regional to departmental**	**From departmental to substations**
National capacity is allocated according to the potential estimated by the producers	Allocation according to the last year installed capacity	Repartition according to capacity reserved for the implementation of the DER defined by the S3REnR

We evaluate the consequences of DER on the French TSO using two elements

Variables of interest

We calculate indicators of the residual load curves for each substation:

- ➔ Withdrawn energy
- ➔ Subscribed power

Current variables used to calculate the bill

- ➔ Injected energy
- ➔ Injected power
- ➔ Dimensioning power

Cost model

We calculate the transformer reinforcement cost induced by DER at each substations

We assume a linear relation between transformer reinforcement cost and dimensioning power

It is to note that this model only represents a fraction of the grid reinforcement cost

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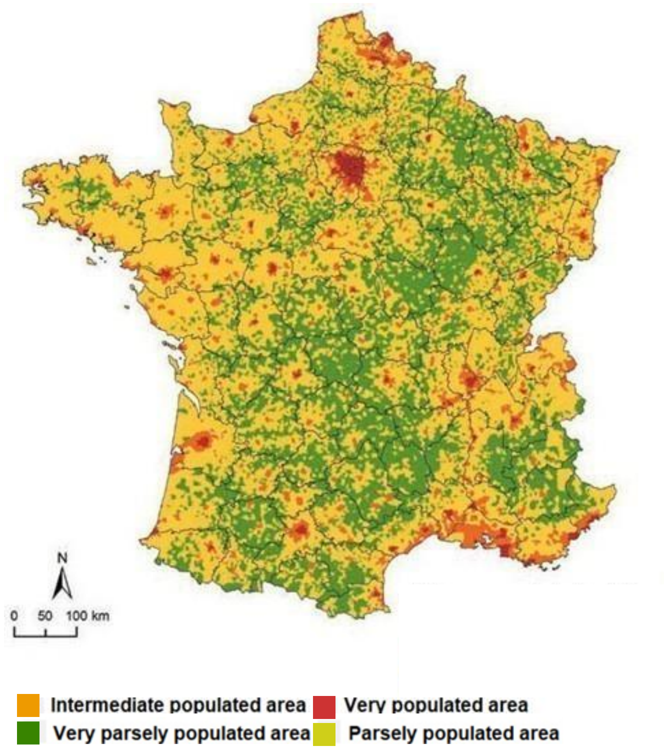
Results

The article studies the impact of DER on the French TSO substations by 2030

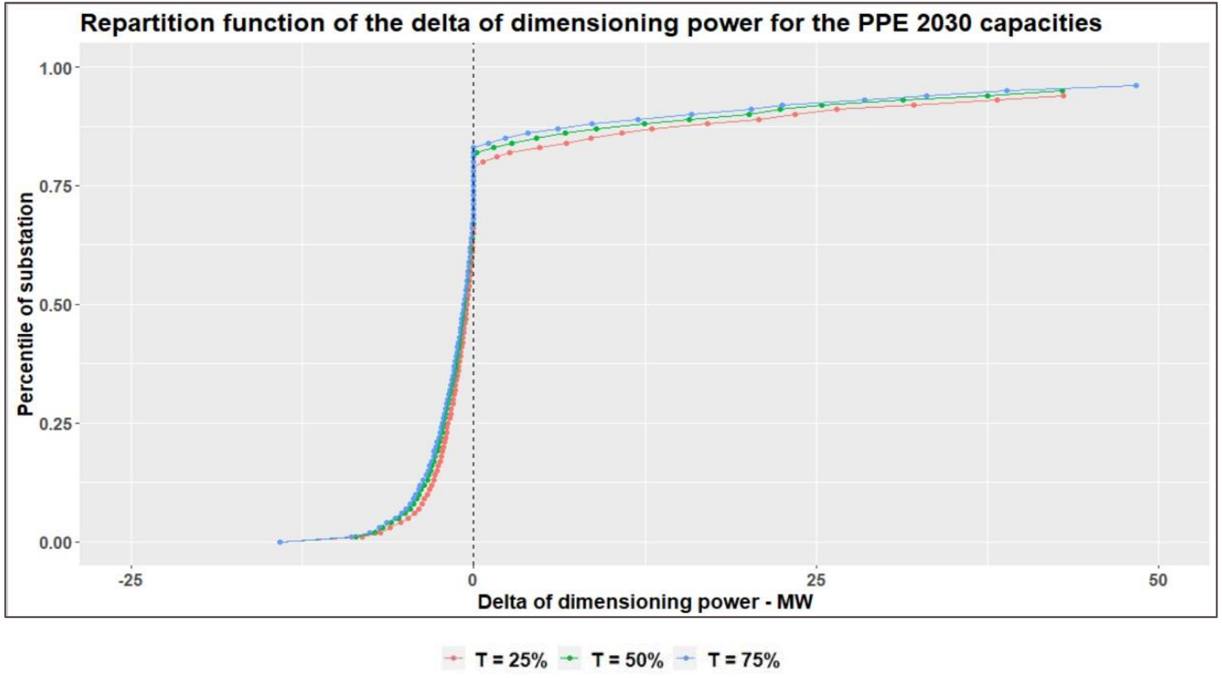


Two **parameters** will vary :

➔ **The national wind and solar production**
BAU scenario:
Solar capacity : 18,5 GW
Wind capacity : 26,7 GW
PPE scenario :
Solar capacity : 47 GW
Wind capacity : 36,4 GW

➔ **The rooftop vs ground panel parameter** referred as T in percentage
➔ Ex : a value of 0% means that all the new solar capacities will be ground panel

The rise of DER will impact the dimensioning power of the substations



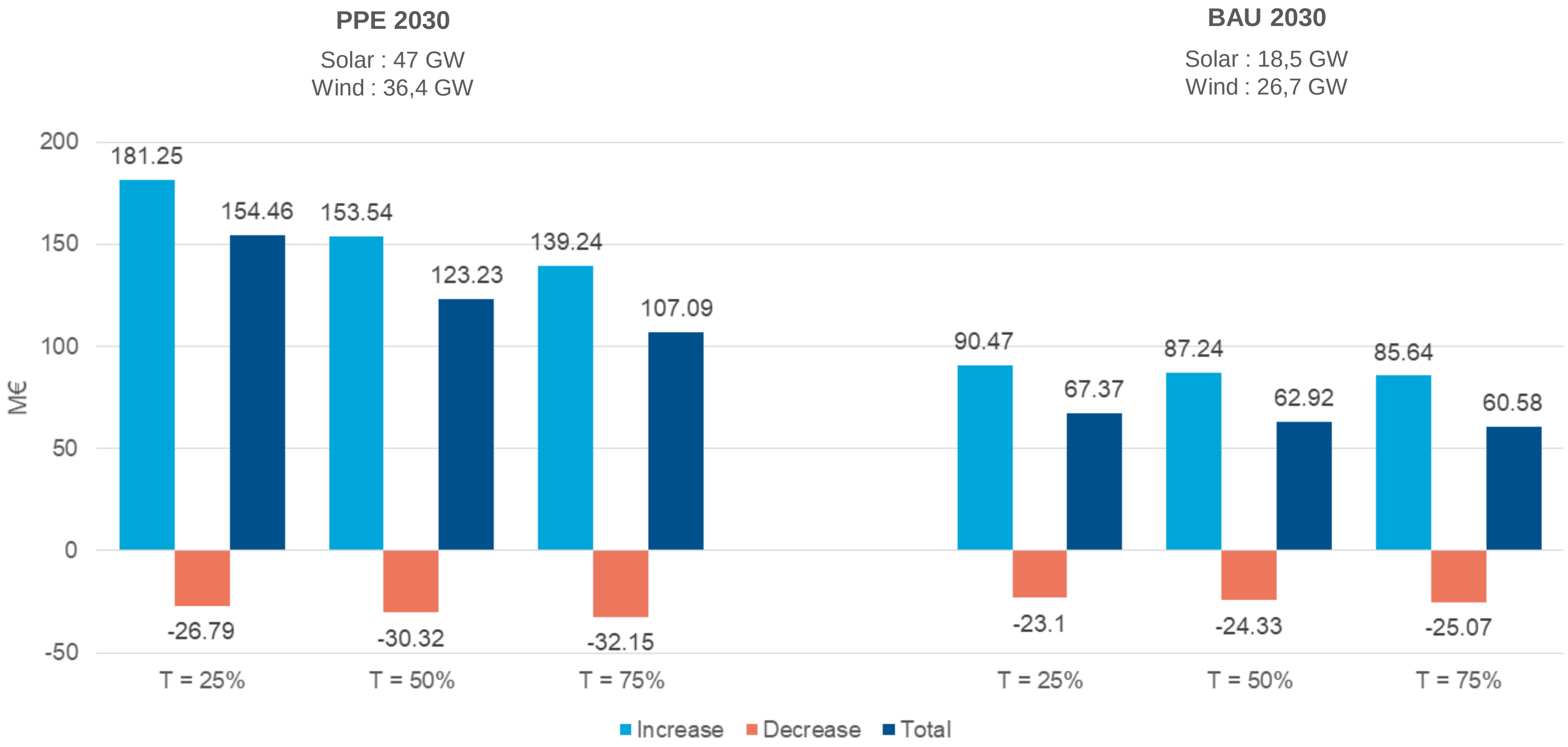
The effect of DER on dimensioning power are heterogeneous :

➔ For **most** of the **substations**, the dimensioning power **slightly decreases**

➔ For a **little number** of substations, the dimensioning power increases a lot

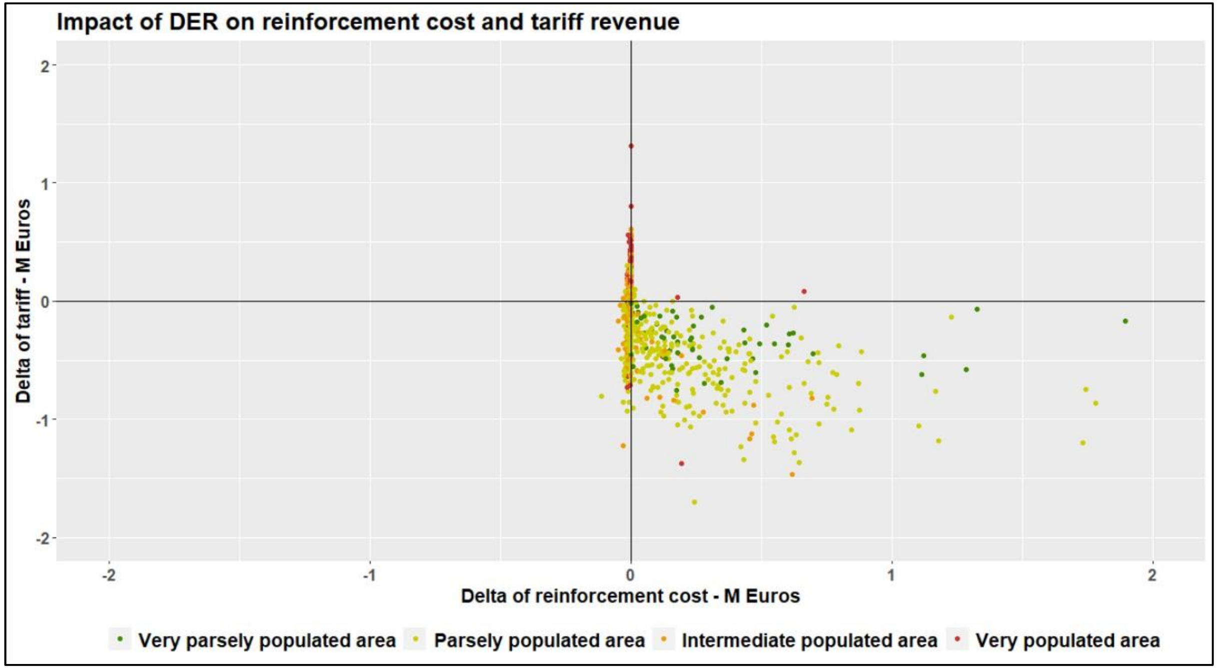
For the PPE capacities, almost 10% of the substations have a dimensioning power increase of more of 20 MW

The rooftop vs ground panel parameter has more effect with higher solar capacity



! The cost model only represents a small portion of the cost of the TSO

Substations with important rise of reinforcement cost also see their tariff bill diminishes



The figure shows two things:

➔ The raise of tariff mostly impact the substations with a decrease of cost

➔ Most of the substations with a raise of reinforcement cost also sees their tariff bill decrease

DER impact differently the variables of interest which will affect the future tariff design

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Conclusion

The scaling down method allows us to evaluate the impact of DER on the French TSO substations

DER will have heterogeneous impact on the dimensioning power of the different substations

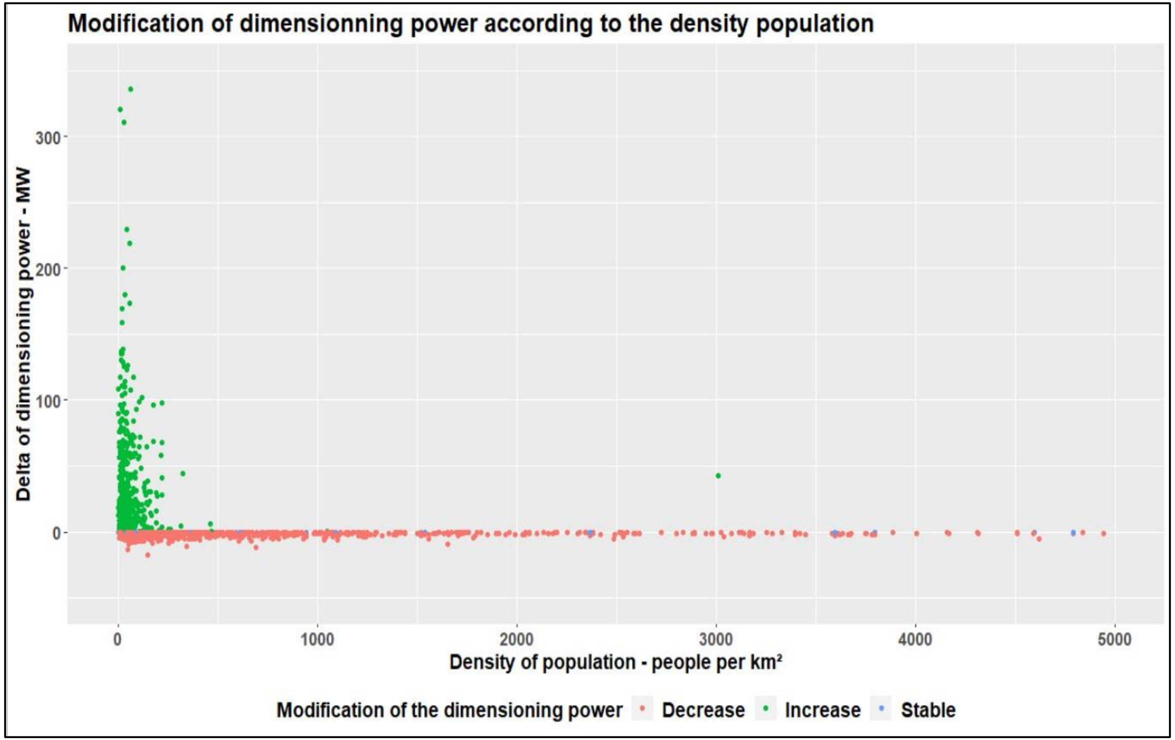
The total installed capacity and their location that also depend on social and political factors highly impact the result

With the current tariff structure, the raise of cost at a substation induced by DER will not necessary induced a raise of tariff for this substation

Further work will study the distributive impacts of the diffusion of DER

Annex

The substations that are the most affected are the ones with the smallest population density



The impact on dimensioning power are higher for low area with a low population density

They are the substations with more local production regarding their local consumption

The rooftop vs ground panel parameter impact the dimensioning power because it impact the nearness between consumption and production sites