



Cross subsidies across network users: renewable self-consumption

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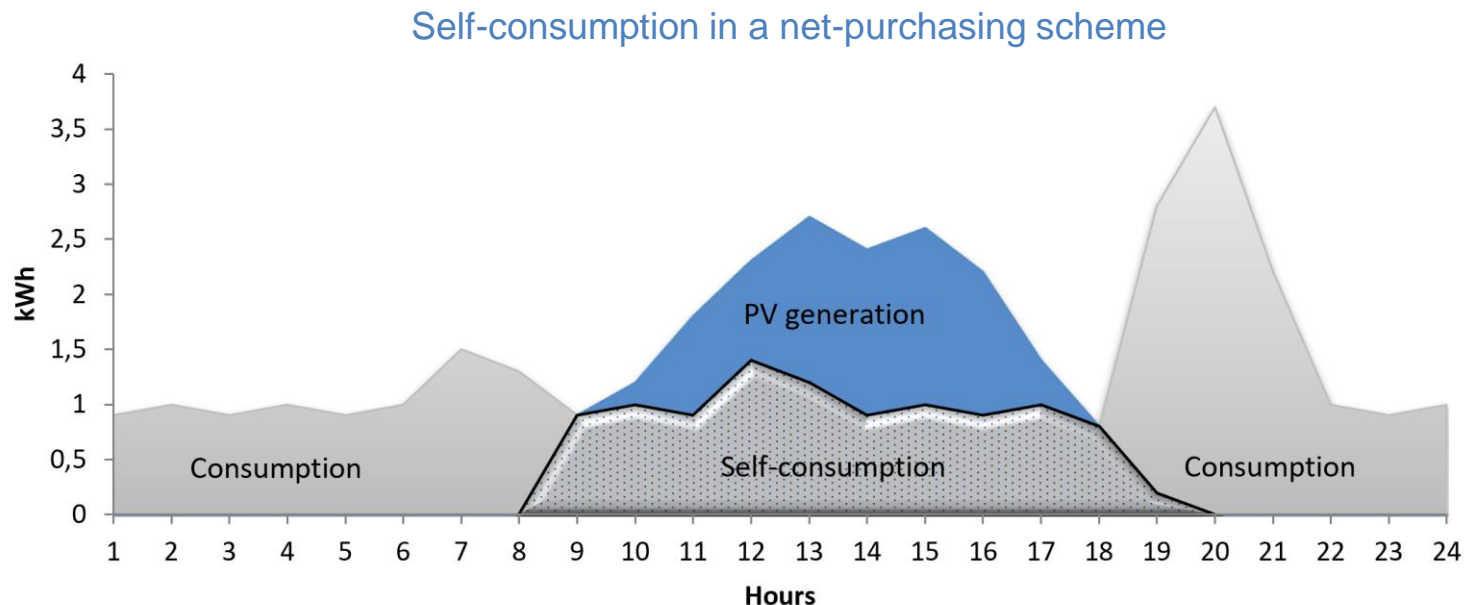
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Introduction

- With the decrease of the photovoltaic (PV) generation cost, some households became prosumers : people who are both **producers** and **consumers**.
- France : new regulation in 2016 that allows the PV owners to self-consume a part of their generation.
- The prosumers save on their electricity bill (net purchasing) and make profit by selling their surplus (blue curve).

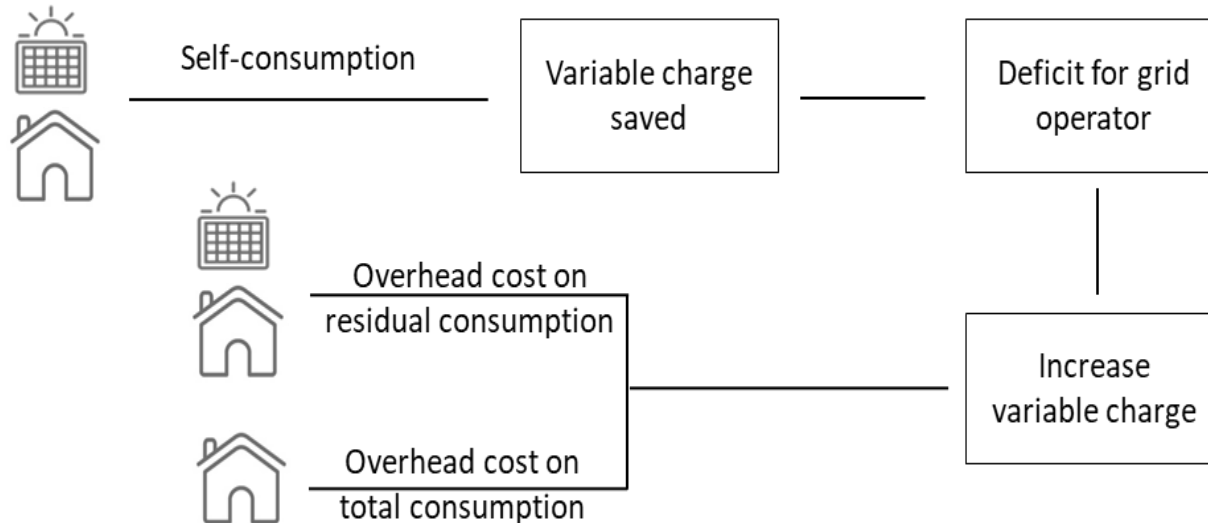


Introduction

- At the end of 2017 : 20 000 prosumers but 3.8 million expected in 2030 according to the transmission grid operator.
- However, in Europe, the network tariff is mainly based on a volumetric component whereas the grid costs are mainly fixed costs (Joskow, 2007).
- As the electricity withdrawal from the grid decreases with the development of self-consumption, the grid operators face a financial deficit.
- Who will pay to finance the grid infrastructures?

Introduction

- With the current regulation, the grid operator has to raise the grid tariff for every customer.
- So, self-consumption creates cross-subsidies from consumers to self-consumers (Felder and Athawale, 2014).



Introduction

- Eid et al (2014), McLaren (2015), Simshauser (2016)
➔ Estimate the amount of cross-subsidies in different countries.
 - Jargstorf et al (2015), Picciariello et al (2015)
➔ Computed a specific network tariff for the prosumers based on the costs that they induce to the grid.
 - Castenada et al (2017), Muaafa et al (2017), Kubli (2018), Prata & Carvalho (2018)
➔ Dynamic studies to capture the death spiral effect over a period of 20 years.
- ➔ More and more grid operators charge customers based on a dynamic tariff. Need to estimate load curves to assess cross-subsidies across periods.

Research question

With the current grid tariff, what would be the amount of cross-subsidies in France in 2021?

1) Methodology to estimate the cross-subsidies

1.1) Data and assumptions

Forecast of PV capacities

- The development of PV capacities under 100 kW is based on the government's goals.
- PV above 100 kW : evolution regulated by call for tenders.
- Starting with 2018, all PV rooftops are supposed to self-consume.

MW	Annual capacities	Cumulative capacities 2021	Total 2021
Residential	175	700	1.9 GW
Firms	175	700	
Tenders	90-150	490	

1.1) Data and assumptions

Prosumer's characteristics

- The profiles are based on the Enedis' typology which are used by the French regulator to set the grid tariffs. There are 2 profiles for both residential consumers and firms.
- Average consumption is based on a sample provided by the french regulator.

	Annual consumption	Contracted power	PV capacity
RES 1	3 MWh	6 kW	3 kW
RES 2	5,7 MWh	6 kW	3 kW
ENT 1	160 MWh	74 kW	74 kW
ENT 3	2 000 MWh	500 kW	300 kW

1.2) Grid tariffs

- Grid rates are set until 2021 and we assume that all prosumers have a Time-of Use rate expected for households with a small consumption.
- Grid rates depend on the season and the hour of the day

Consumers profiles	Households/Residential consumers			Firms/Industrial consumers		
	Periods	RES1	RES2	Periods	ENT1	ENT2
Variable part of the network tariffs (€/kWh)	High rate winter	0.0367	0.0563	High rate winter	0.0481	0.0192
	Low rate winter		0.0325	Low rate winter	0.0295	0.0120
	High rate summer		0.0131	High rate summer	0.0218	0.0088
	Low rate summer		0.0098	Low rate summer	0.0179	0.0077

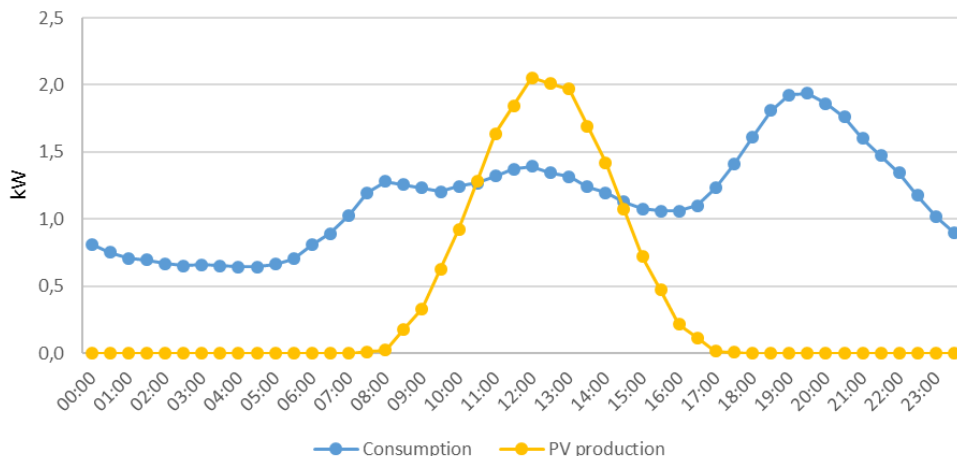
Data : CRE

1.3) Load curves

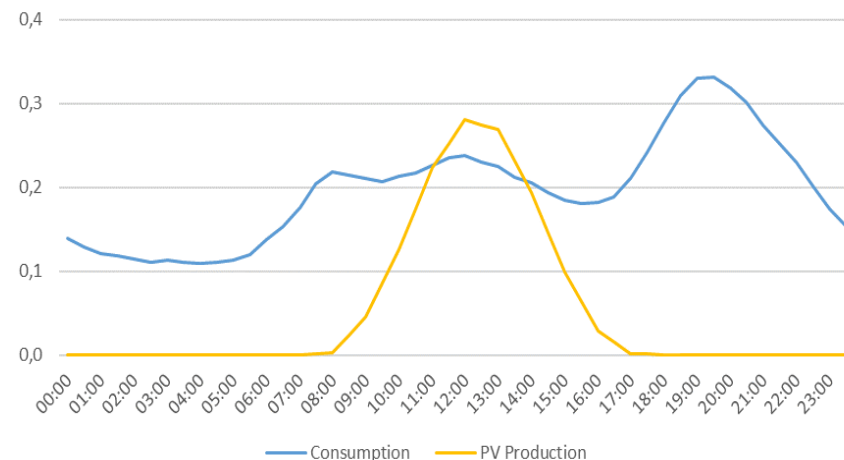
- Enedis's coefficient of profiles are used to estimate consumption and load curves.
- The consumption and the production for each half-hour is given by :

$$Load_{HH} = \sum_{HH=1}^n Coefficient_{HH} * Average\ load\ (kW\ /half\ -\ hour)$$

Consumption and PV production coefficients



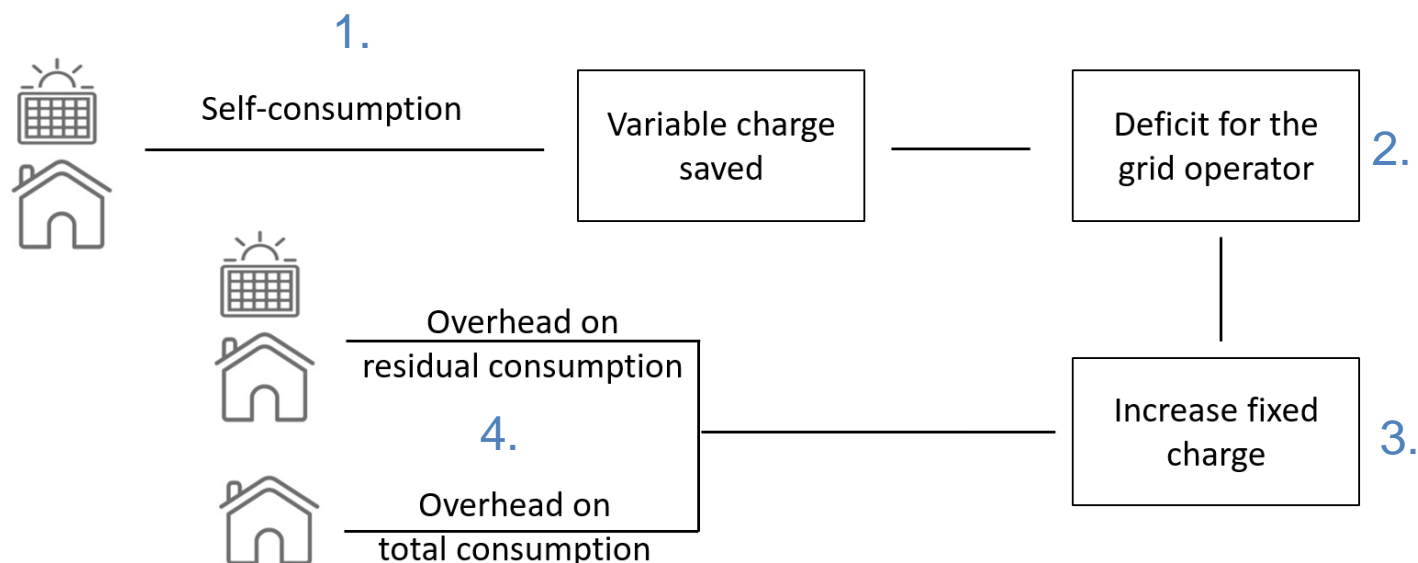
Consumption and PV generation load curves



Typical daily load curves (Monday 16th January) for the RES 1 profile

Average load consumption = 0,17 kW/half-hour
 Average load generation = 0,20 kW/half-hour

1.4) The simulation of the cross-subsidies



1. Estimate the number of prosumers to compute the whole self-consumption.
2. Grid operator deficit : volume of self-consumption multiplied by the corresponding grid tariff.
3. The grid operator raises the fixed component for every customer
4. Cross-subsidies are computed by multiplying the increase by unit of the fixed charge with the contractual power of each profile.

2) Results

2) Results

- In 2021, there will be almost 245 000 self-consumers in France (371 000 PV rooftops at the end of 2017).

Profiles	2017-18	2018-19	2019-20	2020-21
RES1	35 000	70 000	105 000	140 000
RES2	23 333	46 667	70 000	93 333
ENT1	2 500	5 000	7 500	10 000
ENT3	300	800	1 300	1 633
Total	61 133	122 467	183 800	≈ 245 000

- The volume of self-consumption is higher in summer and especially during the peak rate.

GWh	High rate winter	Low rate winter	High rate summer	Low rate summer	Total
RES1	66		118		184
RES2	54	12	70	16	152
ENT1	175	4	430	12	621
ENT3	110	20	383	65	578
Total	406	36	1 000	92	1 535

2) Results

- The volume of self-consumption is higher in summer but the price effect can be important especially for the RES2 profile

	High rate winter	Low rate winter	High rate summer	Low rate summer	Total
RES1	2 238 665 €		4 134 566 €		6 373 230 €
RES2	2 872 844 €	356 517 €	854 782 €	143 242 €	4 227 385 €
ENT1	7 872 527 €	117 348 €	8 766 222 €	201 465 €	16 957 562 €
ENT3	1 722 031 €	194 523 €	2 745 570 €	408 032 €	5 070 156 €
Total	14 706 066 €	668 388 €	16 501 140 €	752 739 €	32 628 333 €

	Cross-subsidies	Increase of the fixed part
RES1	0,54€	2,08%
RES2	0,54€	1,54%
ENT1	18,5€	1,69%
ENT3	170€	0,61%

The cross-subsidies will be low in 2021 because the self-consumption represents only 0.33% of the total consumption

3) A tariff based on the willingness to pay of the prosumer

- A tariff based on the willingness to pay when the PV plant doesn't provide electricity.
- This tariff represents the Value of Lost Load (VOLL) : cost of failure.
- For households, the VOLL is estimated at 17€ for one hour shortfall.
- With an average load factor of 13% in France, this value would be high.
- Another possibility is to raise the fixed part of the grid rate to allow the cost recovery for the DSO.

Conclusion

- The amount of cross-subsidies will be low in 2021 : less than 1€ for households.
- But, the grid-setting doesn't send efficient signals to self-consumers (Costello, 2014; Picciariello, 2015; Prata, 2018).
- A higher fixed component allows the cost recovery for the DSO and it would be better if it aligns with the structure of the DSO's cost.
- Self-consumption can also provide benefits to the grid.
- Can we make a tariff that rewards positive behaviours from prosumers?

Bibliography

- Athawale R, Felder F, 2016. Residential rate design and death spiral for electric utilities : efficiency and equity considerations. *Future of Utilities – Utilities of the Future*, 193 – 209
- Eid C, Reneses J, Frías P, Hakvoort R, 2014. The economic effect of electricity net-metering with solar PV: consequences for network cost recovery, cross subsidies and policy objectives. *Energy Policy*, 75, 244-254.
- Luthander R, Widén J, Nilsson D & Palm J, 2015. Photovoltaic self-consumption in buildings: A review. *Applied Energy*, 142: 80-94
- Picciariello A, Vergara C, Reneses J, Frias P, Söder L, 2015. Electricity distribution tariffs and distributed generation: Quantifying cross-subsidies from consumers to prosumers. *Utilites Policy*, volume 37, p.23-33.
- Simshauser P, 2015. Distribution network prices and solar PV: resolving rate instability and wealth transfers through demand tariffs. *Energy Economics*, 54, 108-122.

Annexe

- Self-consumption allows a decrease in electric losses :

$$L = aP^2 + bP + c$$

- Where a and b are given by the transmission system operator
- P corresponds to the volume of self-consumption
- There are specific parameters for weeks and week ends