# Do energy communities foster demand-side flexibility? Evidence from a Belgian pilot project

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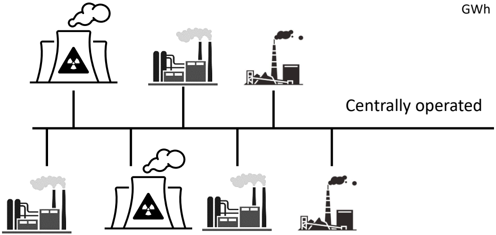
ULB

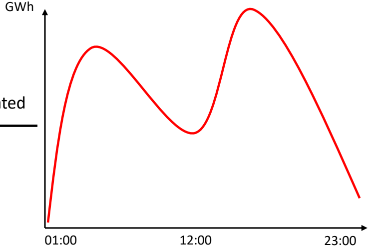
September 28, 2023

**European Electricity Market in the 1990's**

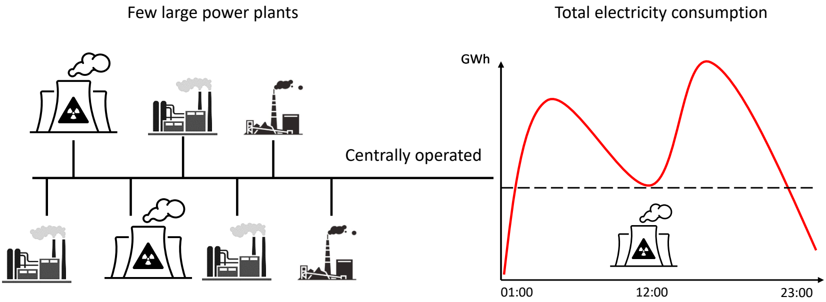
Few large power plants




Total electricity consumption



## European Electricity Market in the 1990's



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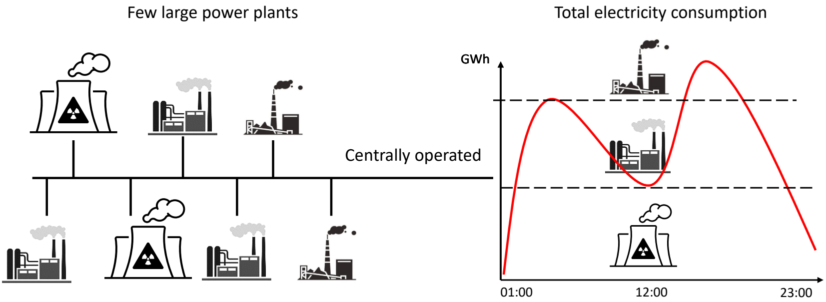
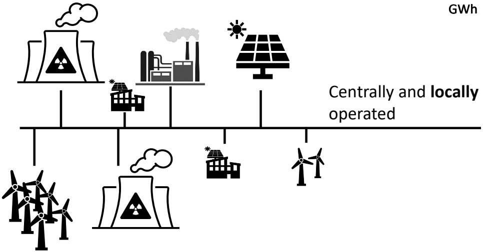
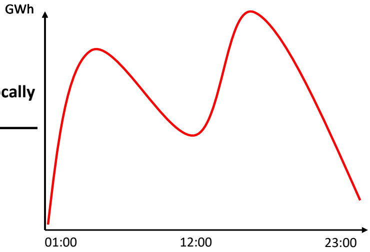


**European Electricity Market today**

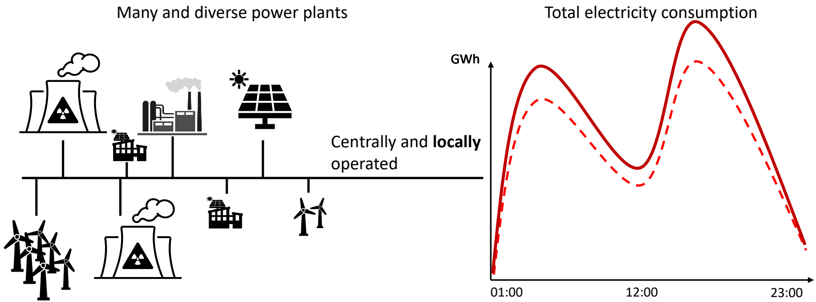
Many and diverse power plants



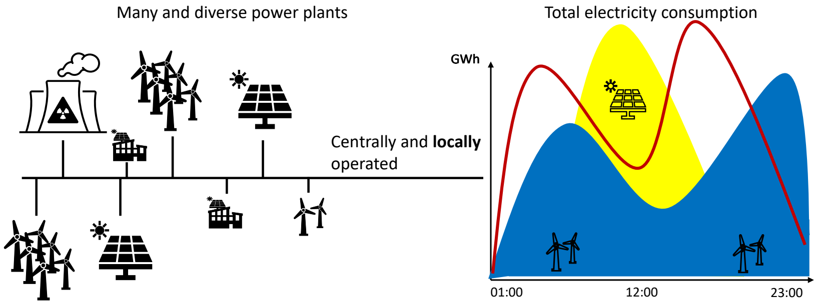

Total electricity consumption



## European Electricity Market today

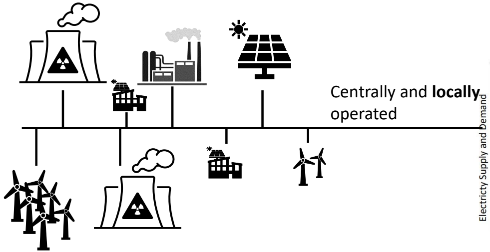


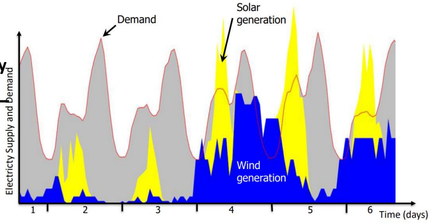
# European Electricity Market in the future



**European Electricity Market in the future**

Many and diverse power plants



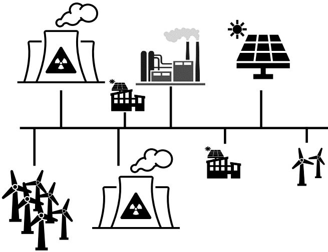




To **integrate renewable sources** and **manage the grid scarcity**

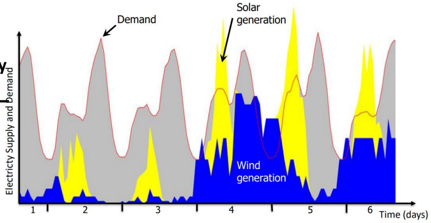
- Storage
- Increase grid capacity
- Demand-response

## European Electricity Market in the future

Many and diverse power plants



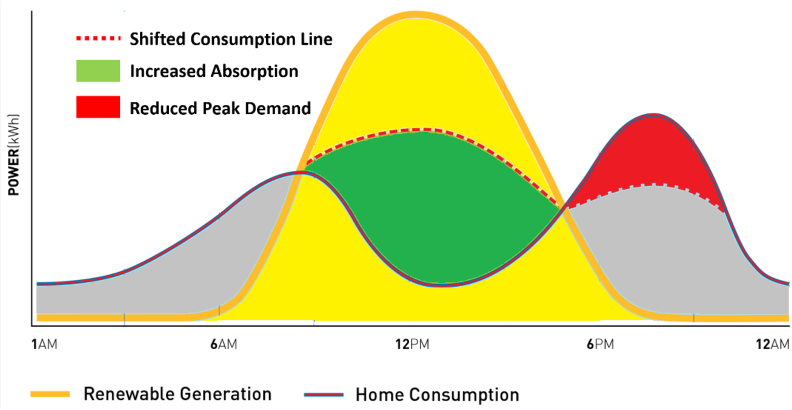
Centrally and **locally** operated




To **integrate renewable sources** and **manage the grid scarcity**

- Storage
- Increase grid capacity
- **Demand-response**

# Demand response: definition



# Demand response: challenges

**Electricity consumers**

- Are almost always not exposed to time-variable electricity prices
- When they are, they are *inelastic* (Ito (2014), Fabra et al. (2021), Fowlie et al. (2021))

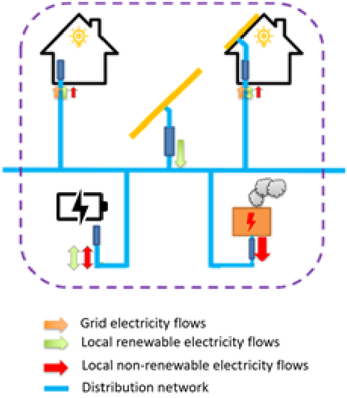
**But why ?**

- Electricity is a *low interest* product (Fischer (2008))
- Its costs is relatively complex to understand and usually does not make up for an important share of a household's budget (Borenstein (2009))

# Energy communities: shifting from passive to active ?

**Energy communities are often considered as challengers to this low-elasticity paradigm (Koirala et al. (2016), Rossetto (2023))**

# Energy communities: exposing consumers to time-variable electricity prices




Source: Adapted from Wallonie énergie SPW

Graphical example

# Summarising motivation

- Demand-response is needed in the electricity system to integrate renewable sources and manage the grid scarcity.
- Energy communities with energy sharing can challenger this low-elasticity paradigm

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- Energy communities with energy sharing can challenger this low-elasticity paradigm
- To spread these incentives, energy communities often benefit from **network tariffs adjustments or exemption**. Examples

# Summarising motivation

- Demand-response is needed in the electricity system to integrate renewable sources and manage the grid scarcity.
- Energy communities with energy sharing can challenger this low-elasticity paradigm
- To spread these incentives, energy communities often benefit from **network tariffs adjustments or exemption**. Examples
- However, the impact of energy sharing incentives on driving desired demand-response outcomes remains uncertain.

# Summarising motivation

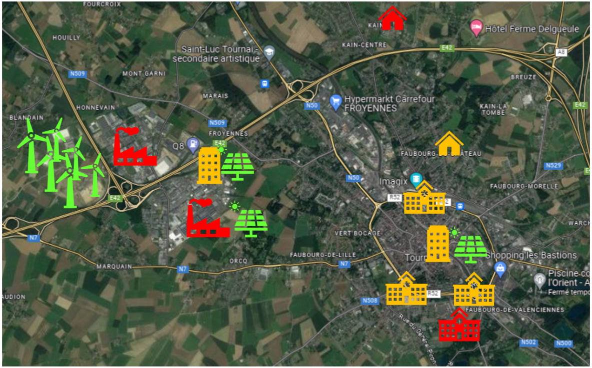
- Demand-response is needed in the electricity system to integrate renewable sources and manage the grid scarcity.
- Energy communities with energy sharing can challenger this low-elasticity paradigm
- To spread these incentives, energy communities often benefit from **network tariffs adjustments or exemption**. Examples
- However, the impact of energy sharing incentives on driving desired demand-response outcomes remains uncertain.
- **In my case study analysis I find no proof of grid beneficial outcomes after energy sharing incentives' implementation.**

# Case study: Dataset description

**List of variable per quarter hour from 1/10/2020 to 28/02/2021 for each participant of the pilot project** Summary tables Graphical example

- Consumption (kWh)
- Self-consumption (kWh)
- Residual consumption (kWh)
- Coefficient (distribution key)
- Production (kWh)
- Allocated production (kWh)
- Non-allocated production (kWh)
- Surplus injected to the grid (kWh)

# Case study : REC pilot project in Wallonia




**Phase 1**
- Hospital
- Hospital
- Nursing home
- Psychiatric centre
- Offices
- Offices

**Phase 2**
- Nursing home
- Psychiatric center
- Small company
- Small industrial company

# Case study : REC pilot project in Wallonia

**1/11/2020** | **1/11/2021** | **28/02/2023**

| | Phase 1 | Phase 2 |
|---|---|---|
| **Allocation key** | Static distribution key by time range (day, night, week-end) | **Dynamic proportional distribution key** |
| **Network tariff adjustment** | - Reduced proportional tariff for self-consumption<br>- Specific public service and non-periodic tariff | - Specific public service and non-periodic tariff |

# Empirical strategy

The empirical analysis involves a two-fold approach.

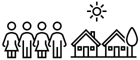
1. Characterization of incentives from energy sharing, including energy and network tariff components throughout project phases, computation of the energy bills saving
2. Estimation of the impact of the implementation of energy sharing incentives

# 1 - Characterising the incentives

+

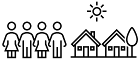
Phase 1

Phase 1



**Electricity self-consumed with energy sharing**

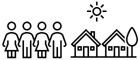
Phase 1



**Electricity self-consumed with energy sharing**

= 5076 MWh

Phase 1



**Electricity self-consumed with energy sharing**

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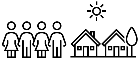
**Residual electricity provided by supplier**

Phase 1



**Electricity self-consumed with energy sharing**

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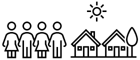
**Residual electricity provided by supplier**

= 14400 MWh

Phase 1



**Electricity self-consumed with energy sharing**

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**Energy component**

**Residual electricity provided by supplier**

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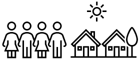
**Energy component**

Phase 1



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**Network component**

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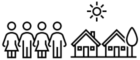
Phase 1



**Electricity self-consumed with energy sharing**

= 5076 MWh

**Energy component**

Fixed allocation key

**= 52.3€/MWh on average**

**Network component**

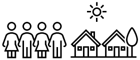
**Residual electricity provided by supplier**

= 14400 MWh

**Energy component**

**Network component**

Phase 1



**Electricity self-consumed with energy sharing**

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**= 52.3€/MWh on average**

**Network component**

Adjustment

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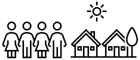
**Residual electricity provided by supplier**

= 14400 MWh

**Energy component**

**Network component**

Phase 1



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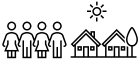
**Energy component**

**Network component**

Phase 1



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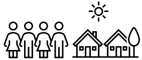
**Energy component**

Supply contracts

**between 109.7 and 180.3€/MWh**

**Network component**

Phase 1



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**Residual electricity provided by supplier**

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**Energy component**

Supply contracts

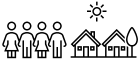
**between 109.7 and 180.3€/MWh**

**Network component**

**= 125.2€/MWh on average**

**= 270.2€/MWh on average**

Phase 1



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**Residual electricity provided by supplier**

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**Energy component**

Supply contracts

**between 109.7 and 180.3€/MWh**

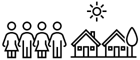
**Network component**

**= 125.2€/MWh on average**

**= 270.2€/MWh on average**

**Savings on the energy bills from 21% to 31%**

Phase 1



**Electricity self-consummed with energy sharing**

= 5076 MWh

**Energy component**

Fixed allocation key

**= 52.3€/MWh on average**

~~**Network component**~~

~~Adjustment~~

~~**= 15.1€/MWh on average**~~

**Residual electricity provided by supplier**

= 14400 MWh

**Energy component**

Supply contracts

**between 109.7 and 180.3€/MWh**

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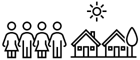
Phase 1



**Electricity self-consummed with energy sharing**

= 5076 MWh

**Energy component**

Fixed allocation key

**= 52.3€/MWh on average**

**Network component**

**= 126.4€/MWh on average**

**= 178.7€/MWh on average**

**Residual electricity provided by supplier**

= 14400 MWh

**Energy component**

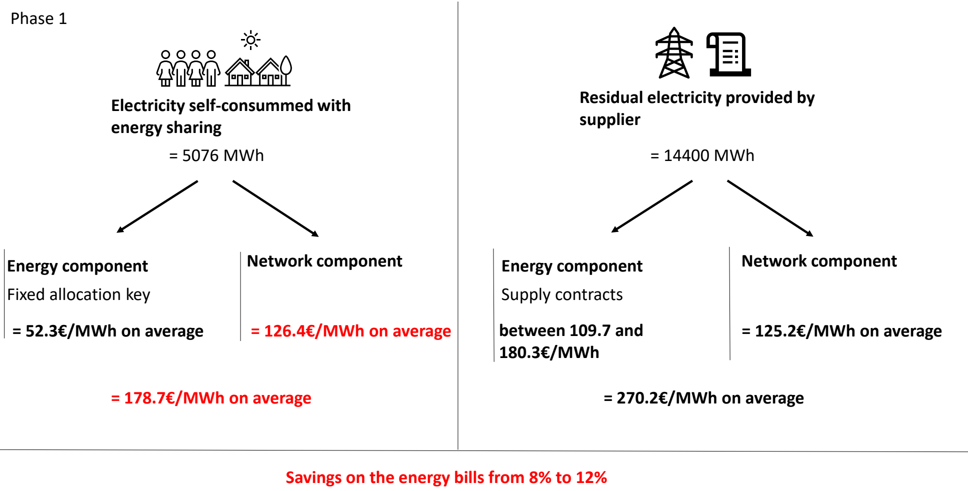
Supply contracts

**between 109.7 and 180.3€/MWh**

**Network component**

**= 125.2€/MWh on average**

**= 270.2€/MWh on average**



Phase 1
Electricity self-consummed with energy sharing
= 5076 MWh
Energy component
Fixed allocation key
= 52.3€/MWh on average
Network component
= 126.4€/MWh on average
= 178.7€/MWh on average
Residual electricity provided by supplier
= 14400 MWh
Energy component
Supply contracts
between 109.7 and 180.3€/MWh
Network component
= 125.2€/MWh on average
= 270.2€/MWh on average
Savings on the energy bills from 8% to 12%

Phase 2

Phase 2

**Electricity self-consumed with energy sharing**

= 6927 MWh

**Energy component**

Dynamic allocation key

**= 53.4€/MWh on average**

**Network component**

Adjustment

**= 30.6€/MWh on average**

**= 84€/MWh on average**

**Residual electricity provided by supplier**

= 9304 MWh

**Energy component**

Supply contracts

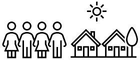
**between 97.6 and 186€/MWh**

**Network component**

**= 125.2€/MWh on average**

**= 253.1€/MWh on average**

Phase 2



**Electricity self-consumed with energy sharing**

= 6927 MWh

**Energy component**

Dynamic allocation key

**= 53.4€/MWh on average**

**Network component**

Adjustment

**= 30.6€/MWh on average**

**= 84€/MWh on average**

**Residual electricity provided by supplier**

= 9304 MWh

**Energy component**

Supply contracts

**between 97.6 and 186€/MWh**

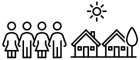
**Network component**

**= 125.2€/MWh on average**

**= 253.1€/MWh on average**

**Savings on the energy bills from 19% to 22%**

Phase 2



**Electricity self-consummed with energy sharing**

= 6927 MWh

**Energy component**

Dynamic allocation key

**= 53.4€/MWh on average**

~~**Network component**~~

~~Adjustment~~

~~**= 30.6€/MWh on average**~~

**Residual electricity provided by supplier**

= 9304 MWh

**Energy component**

Supply contracts

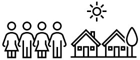
**between 97.6 and 186€/MWh**

**Network component**

**= 125.2€/MWh on average**

**= 253.1€/MWh on average**

Phase 2



**Electricity self-consummed with energy sharing**

= 6927 MWh

**Energy component**

Dynamic allocation key

**= 53.4€/MWh on average**

**Network component**

**= 111.3€/MWh on average**

**= 164.7€/MWh on average**

**Residual electricity provided by supplier**

= 9304 MWh

**Energy component**

Supply contracts

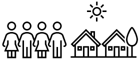
**between 97.6 and 186€/MWh**

**Network component**

**= 125.2€/MWh on average**

**= 253.1€/MWh on average**

Phase 2



**Electricity self-consummed with energy sharing**

= 6927 MWh

**Energy component**

Dynamic allocation key

**= 53.4€/MWh on average**

**Network component**

**= 111.3€/MWh on average**

**= 164.7€/MWh on average**

**Residual electricity provided by supplier**

= 9304 MWh

**Energy component**

Supply contracts

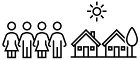
**between 97.6 and 186€/MWh**

**Network component**

**= 125.2€/MWh on average**

**= 253.1€/MWh on average**

**Savings on the energy bills from 7% to 11%**



**Electricity self-consummed with energy sharing**

Phase 1

**= 67.4€/MWh on average**

**= 178.7€/MWh on average**

Phase 2

**= 84€/MWh on average**

**= 164.7€/MWh on average**

**Residual electricity provided by supplier**

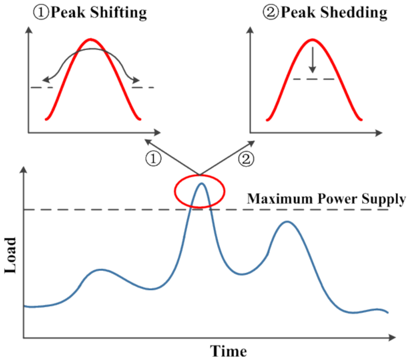
**= 270.2€/MWh on average**

**= 253.1€/MWh on average**

# 2 - Estimation

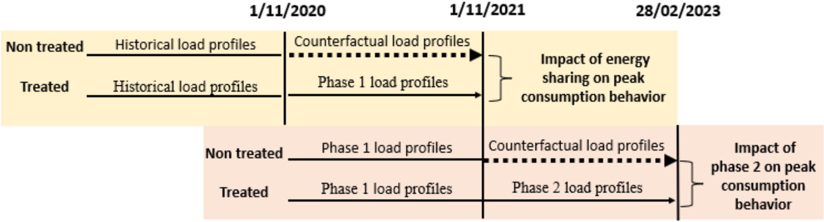
We want to measure the existence of **grid beneficial outcomes** to analyze the energy sharing incentives design.

1. Peak shifting
2. Peak shedding




Source: Xu et al. (2017)

# 2 - Estimation



# 2 - Estimation: Counterfactual construction

- Counterfactual electricity consumption time series for each individual have been computed using three different machine learning techniques (Gonzalez-Briones et al. (2019)):
  - K Nearest Neighbors (KNN) identifies future patterns by averaging the outcomes of 'k' nearest historical neighbors.
  - Random Forest (RF) uses an ensemble of decision trees, trained on subsets of data, and averages their predictions.
  - Gradient Boosting iteratively improves model accuracy by correcting errors, aggregating multiple models' predictions for final outcomes.
- Each of these algorithms have been trained on historical data to predict for each individual the counterfactual based on calendar and weather data. +

# 3 -Estimation method

$$
\begin{aligned}
Y_{it} = & \alpha_{it} + \beta_1(\text{Treatment}_i * \text{Postevent}_t) + \\
& \beta_2 \text{Treatment}_i + \beta_3 \text{Postevent}_t + \text{Controls}_{it} + \epsilon_{it}
\end{aligned}
$$

- Control variables: time-related factors, weather data +, and COVID-19 cases.
- Outcome variables
  - Daily peak consumption to measure whether participants reduced their peak electricity usage after joining the energy community
  - Binary variable indicates whether individuals shifted their daily peak consumption away from system-wide peak hours

# Results

The implementation of the energy sharing incentives led to

- A small increase in the daily peak consumption by participants
- An ncrease in the probability that the peak consumption occurs in traditional system-wide peak hours

+

# Results: peak shedding phase 1

Table: Regression Results: Phase 1 impact on individual daily peak.

| | *Dependent variable:* Individual daily peak (KNN) | *Dependent variable:* Individual daily peak (RF) | *Dependent variable:* Individual daily peak (XG) |
|---|---|---|---|
| Interaction term | $0.098^{***}$ | $0.109^{***}$ | $0.093^{***}$ |
| | (0.007) | (0.007) | (0.007) |
| Treatment | $-0.081^{***}$ | $-0.087^{***}$ | $-0.073^{***}$ |
| | (0.007) | (0.007) | (0.007) |
| Postevent | $-0.0002^{***}$ | $-0.0002^{***}$ | $-0.0002^{***}$ |
| | (0.00004) | (0.00004) | (0.00004) |
| Observations | 8,760 | 8,760 | 8,760 |
| $R^2$ | 0.088 | 0.095 | 0.089 |
| Adjusted $R^2$ | 0.084 | 0.091 | 0.085 |
| F Statistic | $30.131^{***}$ (df = 28; 8720) | $32.580^{***}$ (df = 28; 8720) | $30.270^{***}$ (df = 28; 8720) |

*Note:* The dependent variable is the individual daily peak, and the mentions KNN, RF, and XG refer to the synthetic counterfactual prediction machine learning methods associated with the estimation. The displayed results in the tables correspond to the coefficients of interest in the estimation. Weather data and calendar data were included as control variables in the analysis but are not shown here. Standard errors are reported in parentheses. Significance levels are denoted as *** for $p<0.01$, ** for $p<0.05$, and * for $p<0.1$.

# Results: peak shedding phase 2

Table: Regression Results: Phase 2 impact on individual daily peak.

| | *Dependent variable:* Individual daily peak (KNN) | *Dependent variable:* Individual daily peak (RF) | *Dependent variable:* Individual daily peak (XG) |
|---|---|---|---|
| Interaction term | 0.333$^{***}$ | 0.354$^{***}$ | 0.347$^{***}$ |
| | (0.006) | (0.006) | (0.006) |
| Postevent | $-$0.331$^{***}$ | $-$0.353$^{***}$ | $-$0.345$^{***}$ |
| | (0.005) | (0.005) | (0.005) |
| Treatment | $-$0.0001$^{***}$ | $-$0.0001$^{***}$ | $-$0.0001$^{***}$ |
| | (0.00002) | (0.00002) | (0.00002) |
| Observations | 14,580 | 14,580 | 14,580 |
| $R^2$ | 0.311 | 0.342 | 0.329 |
| Adjusted $R^2$ | 0.309 | 0.340 | 0.327 |
| F Statistic | 234.398$^{***}$ (df = 28; 14540) | 269.569$^{***}$ (df = 28; 14540) | 254.116$^{***}$ (df = 28; 14540) |

*Note:* The dependent variable is the individual daily peak, and the mentions KNN, RF, and XG refer to the synthetic counterfactual prediction machine learning methods associated with the estimation. The displayed results in the tables correspond to the coefficients of interest in the estimation. Weather data and calendar data were included as control variables in the analysis but are not shown here. Standard errors are reported in parentheses. Significance levels are denoted as *** for p<0.01, ** for p<0.05, and * for p<0.1

# Results: peak shifting phase 1

Table: Regression Results: Phase 1 impact on daily peak in system-wide peak hours.

| | *Dependent variable:* | *Dependent variable:* | |
|---|---|---|---|
| | Daily peak in peak hours (KNN) | Daily peak in peak hours (RF) | Daily peak in peak hours (XG) |
| Interaction term | 0.160$^{***}$ | 0.058$^{***}$ | 0.070$^{***}$ |
| | (0.017) | (0.017) | (0.017) |
| Treament | −0.103$^{***}$ | −0.001 | −0.005 |
| | (0.017) | (0.017) | (0.017) |
| Postevent | −0.0002$^{**}$ | −0.0001 | −0.00001 |
| | (0.0001) | (0.0001) | (0.0001) |
| Observations | 8,760 | 8,760 | 8,760 |
| $R^2$ | 0.223 | 0.251 | 0.248 |
| Adjusted $R^2$ | 0.219 | 0.247 | 0.245 |
| F Statistic | 89.339$^{***}$ (df = 28; 8720) | 104.139$^{***}$ (df = 28; 8720) | 102.883$^{***}$ (df = 28; 8720) |

*Note:* The dependent variable is the daily peak in peak hours, and the mentions KNN, and RF refer to the synthetic counterfactual prediction machine learning methods associated with the estimation. System-wide peak hours are defined from 7 to 9 am and from 5 to 8 pm. The displayed results in the tables correspond to the coefficients of interest in the estimation. Weather data and calendar data were included as control variables in the analysis but are not shown here. Standard errors are reported in parentheses. Significance levels are denoted as *** for p<0.01, ** for p<0.05, and * for p<0.1.

# Results: peak shifting phase 2

Table: Regression Results: Phase 2 impact on daily peak in system-wide peak hours.

| | *Dependent variable:* | *Dependent variable:* | |
|---|---|---|---|
| | Daily peak in peak hours (KNN) | Daily peak in peak hours (RF) | Daily peak in peak hours (XG) |
| Interaction term | $0.130^{***}$ | $0.125^{***}$ | $0.105^{***}$ |
| | (0.016) | (0.016) | (0.016) |
| Treatment | $-0.00004$ | $-0.0002^{***}$ | $-0.0001$ |
| | (0.0001) | (0.0001) | (0.0001) |
| Postevent | $-0.038^{***}$ | $-0.015$ | $-0.008$ |
| | (0.014) | (0.014) | (0.014) |
| Observations | 14,580 | 14,580 | 14,580 |
| $R^2$ | 0.031 | 0.027 | 0.027 |
| Adjusted $R^2$ | 0.028 | 0.024 | 0.024 |
| F Statistic | $16.389^{***}$ (df = 28; 14540) | $14.280^{***}$ (df = 28; 14540) | $14.390^{***}$ (df = 28; 14540) |

*Note:* The dependent variable is the daily peak in peak hours, and the mentions KNN, and RF refer to the synthetic counterfactual prediction machine learning methods associated with the estimation. System-wide peak hours are defined from 7 to 9 am and from 5 to 8 pm. The displayed results in the tables correspond to the coefficients of interest in the estimation. Weather data and calendar data were included as control variables in the analysis but are not shown here. Standard errors are reported in parentheses. Significance levels are denoted as *** for $p<0.01$, ** for $p<0.05$, and * for $p<0.1$.

# Conclusion

- The study analyzed energy sharing incentives' impact on demand-response outcomes, focusing on peak shedding and shifting within a renewable energy community.
- Findings indicate that despite substantial incentives, there is no evidence of grid-beneficial outcomes, potentially even worsening peak consumption behaviors.
- These results align with existing literature showing that electricity end-consumers often do not significantly respond to price incentives.
- Public policy expectations of energy communities as drivers of retail demand-response may need adjustment, particularly regarding network tariff adjustments and exemptions.

# Network tariff adjustments

*Table 2 : Main characteristics of interviewed energy communities*

| Name (Region) | Legal status | Applicable EU regulation | Households | Other participants | Production units' ownership | Production technology | Installed power | Energy sharing | Network tariff adjustment |
|---|---|---|---|---|---|---|---|---|---|
| **Allons en Vent (W)** | Cooperative | n/a | 950 | None | All initiative's members | Wind | 800kW | No | No |
| **AltERcoop (W)** | Cooperative | n/a | 430 | SMEs | All initiative's members | CHP | 1350kWe | No | No |
| **BocagEn (W)** | Cooperative | REC | 450 | Local authorities, SMEs | All initiative's members | Solar PV, Hydro power | 300kWc, 240kW | No | No |
| **Brupower (BC)** | Cooperative | CEC | 10 | Local authorities, SMEs | All initiative's members | Solar PV | 0 (obj. 1,5MWc in 2024) | No | No |
| **Courant Alternatif (BC)** | Nonprofit | LEC | 15 | Local authorities, SMEs | Third-party investor | Solar PV | 100kWc | Yes | Yes |
| **Coléco (W)** | Cooperative | REC | 150 | Local authorities, School, SMEs | Prosumers | Solar PV | 450kWc | Yes | No |
| **Enduro Assenede (F)** | Nonprofit | REC | 20 | Local authorities | Third-party investor | Solar PV | 18kWc | Yes | Yes |
| **Energ'Ittre (W)** | Cooperative | REC | 12 | None | Third-party investor | Solar PV | 18kWc | Yes | No |
| **Greenbizz (BC)** | Public company | n/a | 0 | SMEs | Prosumers | Solar PV | 240kWc | Yes | Yes |
| **HospiGREEN (W)** | Nonprofit | REC | 0 | Local authorities, SMEs | Third-party investor | Solar PV, Wind | 200kWc, 2.2MW | Yes | Yes |
| **Illuminous notre quartier (BC)** | Non profit | LEC | 3 | None | Prosumers | Solar PV | - | - | - |
| **Marius Renard (BC)** | Nonprofit | n/a | 150 | Local authorities | Third-party investor for cogen | Cogen, Wind | 72kW (expected) | Yes (cogen only) | Yes |
| **Noordlitch (F)** | Cooperative | REC | 350 | None | All initiative's members | Solar PV, Hydro power | 230kWc | Yes | No |
| **Nos Bambins (BC)** | Nonprofit | LEC | 10 | Local authorities, School, SMEs | Third party investor and prosumers | Solar PV | 44kWc | Yes | Yes |
| **Strommvloed (F)** | Cooperative | REC | 530 | Local authorities | All initiative's members | Wind | NA | Yes | No |
| **Sunsud (BC)** | Nonprofit | n/a | 35 | Local authorities, SISP | All initiative's members | Solar PV | 35kWc | Yes | Yes |
| **ZuidtrAnt (F)** | Cooperative | REC | 750 | Local authorities, School, SMEs | All initiative's members | Solar PV, Storage | 1MWc | Yes | Yes |

Notes: Authors' compilation from online interviews and projects' authorisation information from Brussels-Capital

# Summary tables : 2020

| | CRP GP | ChWapi ND | ChWapi Union | IDETA CITé | CPAS MàC | Négundo | Total REC |
|---|---|---|---|---|---|---|---|
| Total yearly consumption (kWh) | 462 981 | 288 443 | 1 358 301 | 41 515 | 56 990 | 52 277 | **2 260 506** |
| Allocated production (kWh) | 231 244 | 223 724 | 804 982 | 18 709 | 35 103 | 21 437 | **1 335 198** |
| Self-consumption (kWh) | 212 295 | 164 266 | 703 310 | 17 558 | 30 200 | 19 493 | **1 147 123** |
| Self-consumption rate | 92% | 73% | 87% | 94% | 86% | 91% | **86%** |
| Self-production rate | 50% | 78% | 59% | 45% | 62% | 41% | **59%** |
| Distribution coefficient | 17,4% | 16,8% | 60,1% | 1,4% | 2,6% | 1,7% | **100%** |

-

# Summary tables : 2021

| | CRP GP | ChWapi ND | ChWapi Union | IDETA CITé | CPAS MàC | Négundo | Vitrerie Landrieux | Global Net | CPAS HG | CRP KF | Total REC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total yearly consumption (kWh)** | 2 460 135 | 2 442 507 | 8 682 293 | 208 164 | 310 198 | 302 766 | 3 867 | 45 579 | 190 610 | 72 787 | 14 718 906 |
| **Allocated production (kWh)** | 884 421 | 817 602 | 3 041 644 | 72 038 | 132 720 | 89 050 | 878 | 12 308 | 53 424 | 21 880 | 5 125 964 |
| **Self-consumption (kWh)** | 820 540 | 708 012 | 2 790 707 | 65 808 | 116 674 | 81 745 | 846 | 11 871 | 50 567 | 20 522 | 4 667 291 |
| **Self-consumption rate** | 93% | 87% | 92% | 91% | 88% | 92% | 96% | 96% | 95% | 94% | 92% |
| **Self-production rate** | 36% | 33% | 35% | 35% | 43% | 29% | 23% | 27% | 28% | 30% | 32% |
| **Average distribution coefficient** | 17,2% | 15,8% | 59,2% | 1,4% | 2,6% | 1,7% | 0,1% | 1,6% | 7,3% | 2,9% | |

# Summary tables : 2022

| | CRP GP | ChWapi ND | ChWapi Union | IDETA CITé | CPAS MàC | Négundo | Vitrerie Landrieux | Global Net |
|---|---|---|---|---|---|---|---|---|
| **Total yearly consumption (kWh)** | 2 363 876 | 2 922 534 | 8 440 317 | 159 370 | 296 368 | 269 540 | 29 532 | 229 852 |
| **Allocated production (kWh)** | 811 442 | 931 400 | 2 857 594 | 51 259 | 101 946 | 92 482 | 9 957 | 67 566 |
| **Self-consumption (kWh)** | 764 422 | 885 029 | 2 682 019 | 48 483 | 95 962 | 87 598 | 9 457 | 65 559 |
| **Self-consumption rate** | 94% | 95% | 94% | 95% | 94% | 95% | 95% | 97% |
| **Self-production rate** | 34% | 32% | 34% | 32% | 34% | 34% | 34% | 29% |
| **Average distribution coefficient** | 14,61% | 17,43% | 53,12% | 0,98% | 1,84% | 1,66% | 0,18% | 1,28% |

-

# Summary tables : 2023

| | CRP GP | ChWapi ND | ChWapi Union | IDETA CITé | CPAS MàC | Négundo | Vitrerie Landrieux | Global Net | CPAS HG | CRP KF | Total REC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total yearly consumption (kWh)** | 417 307 | 541 816 | 1 288 054 | 23 797 | 49 372 | 41 922 | 8 002 | 35 372 | 165 899 | 70 309 | 2 641 850 |
| **Allocated production (kWh)** | 186 789 | 257 540 | 604 101 | 10 281 | 22 450 | 17 173 | 3 246 | 13 340 | 73 198 | 32 552 | 1 220 669 |
| **Self-consumption (kWh)** | 176 886 | 242 608 | 567 112 | 9 754 | 21 236 | 16 418 | 3 104 | 12 979 | 69 536 | 30 683 | 1 150 316 |
| **Self-consumption rate** | 95% | 94% | 94% | 95% | 95% | 96% | 96% | 97% | 95% | 94% | 95% |
| **Self-production rate** | 45% | 48% | 47% | 43% | 45% | 41% | 41% | 38% | 44% | 46% | 44% |
| **Average distribution coefficient** | 15,6% | 20,1% | 49,8% | 0,9% | 1,9% | 1,5% | 0,3% | 1,2% | 6,1% | 2,7% | |

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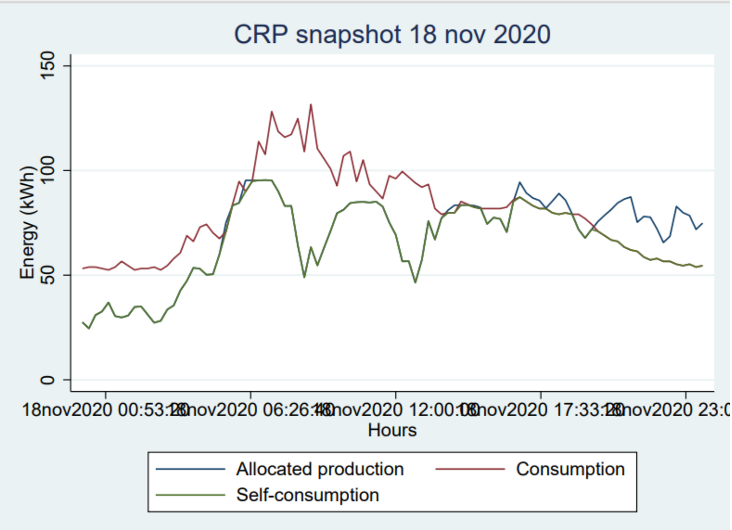


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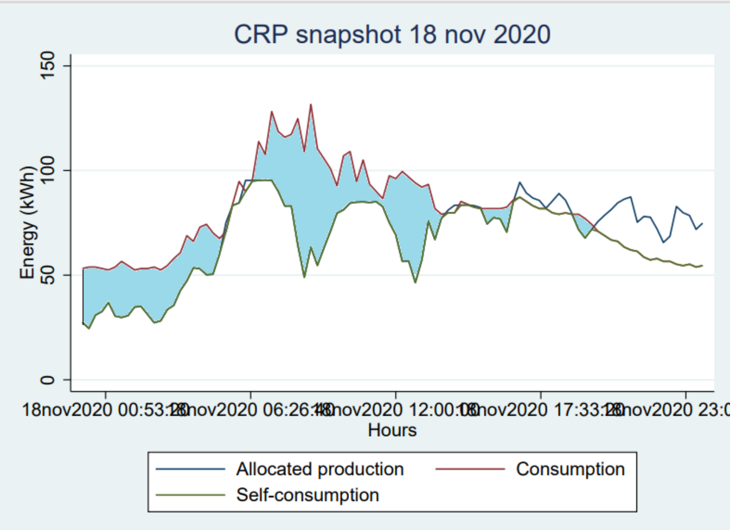

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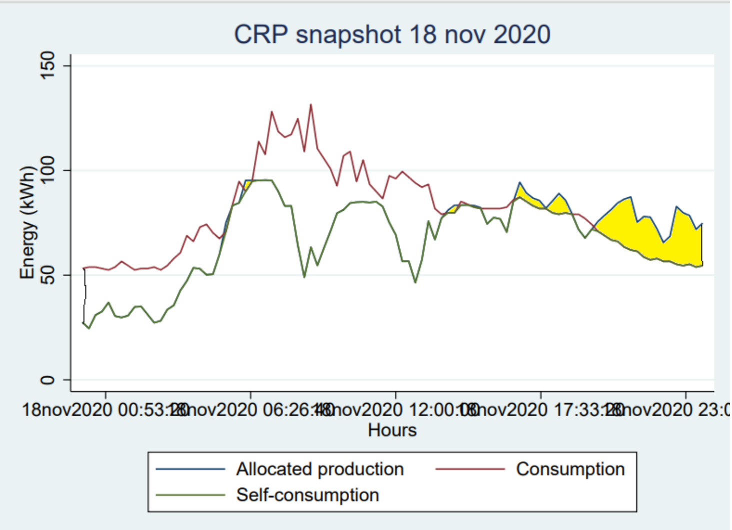

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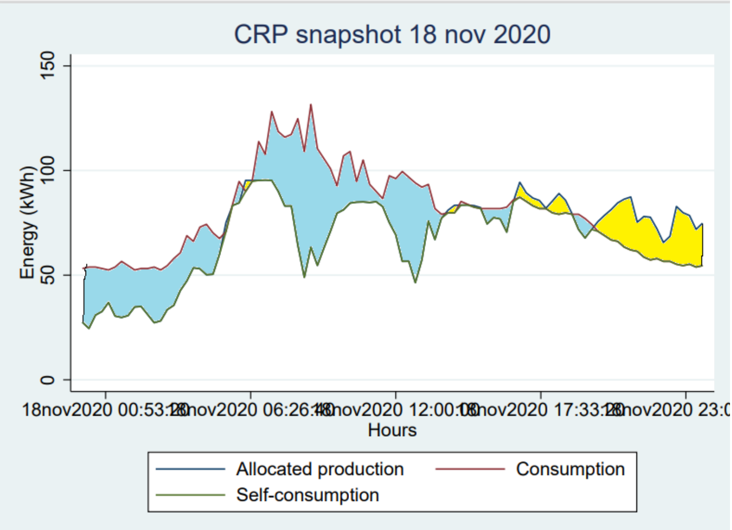

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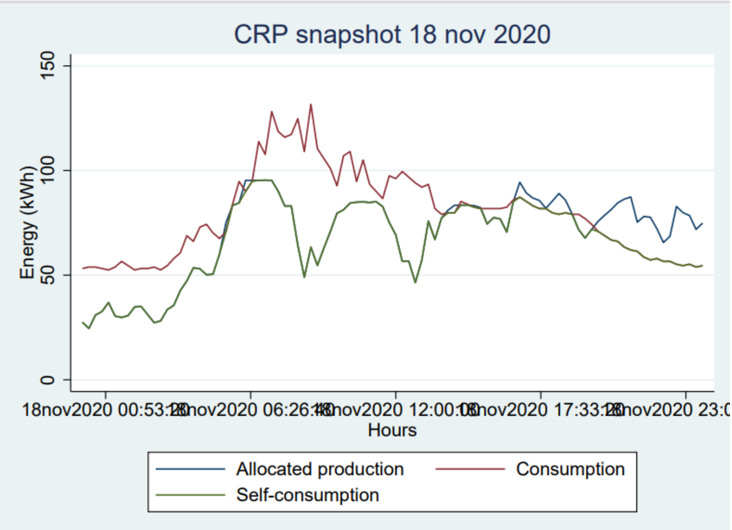

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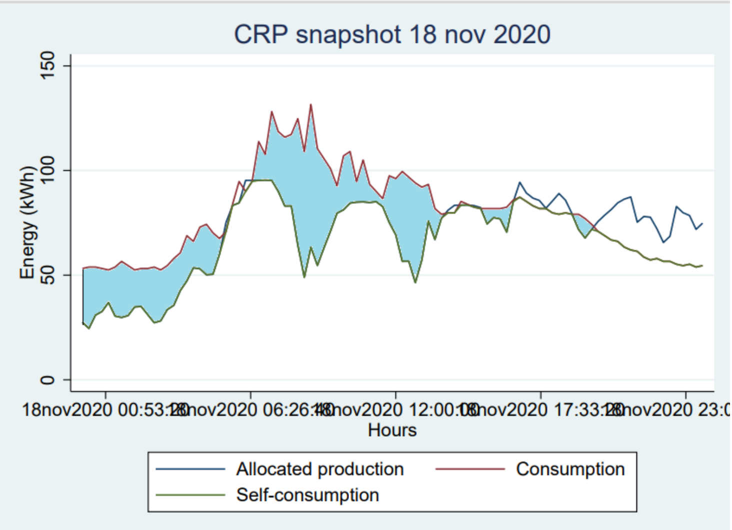

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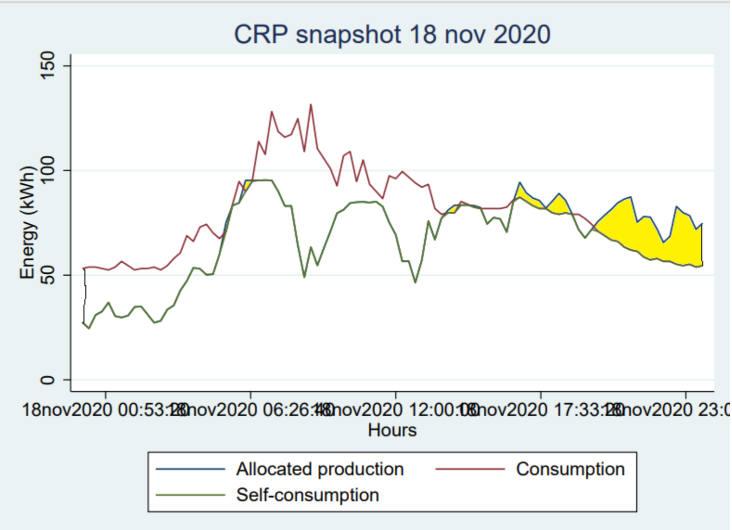


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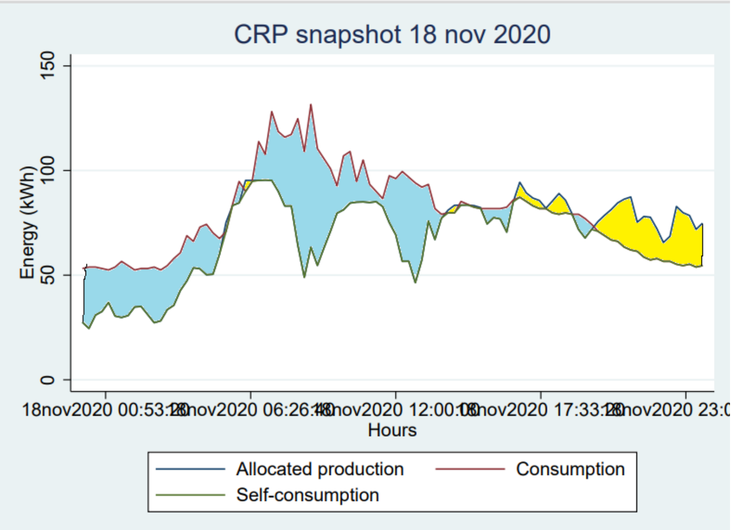

# Weather data

## Hourly data

| | |
|---|---|
| Direction du vent moyen 10 mn | Précipitations dans les 6 dernières heures |
| Vitesse du vent moyen 10 mn | Précipitations dans les 12 dernières heures |
| Température | Précipitations dans les 24 dernières heures |
| Point de rosée | Nébulosité couche nuageuse 1 |
| Humidité | Type nuage 1 |
| Visibilité horizontale | Hauteur de base 1 |
| Temps passé 2 | Nébulosité couche nuageuse 2 |
| Nebulosité totale | Type nuage 2 |
| Nébulosité des nuages de l' étage inférieur | Hauteur de base 2 |
| Hauteur de la base des nuages de l'étage inférieur | Nébulosité couche nuageuse 3 |
| Type des nuages de l'étage inférieur | Type nuage 3 |
| Type des nuages de l'étage moyen | Hauteur de base 3 |
| Type des nuages de l'étage supérieur | Nébulosité couche nuageuse 4 |
| Variation de pression en 24 heures | Type nuage 4 |
| Rafale sur les 10 dernières minutes | Hauteur de base 4 |
| Rafales sur une période | Température (°C) |
| Periode de mesure de la rafale | Température minimale sur 12 heures (°C) |
| Précipitations dans la dernière heure | Température minimale sur 24 heures (°C) |
| Précipitations dans les 3 dernières heures | Température maximale sur 12 heures (°C) |
| Précipitations dans les 6 dernières heures | Température maximale sur 24 heures (°C) |

-

# Incentive table

| Incentive feature | Phase 1 | | Phase 2 | |
|---|---|---|---|---|
| **Self-consumption tariffication** | **Energy tariff** | **Fixed allocation key**<br>**Net cost of purchasing self-consumed commodity**<br>+ Monthly rent for local production units<br>- Collective surplus selling revenues<br>- Green certificates selling revenues<br>+ Management costs<br>**= 52.3€/MWh of self-consumed local energy on average** | **Energy tariff** | **Dynamic proportional allocation key**<br>**Net cost of purchasing self-consumed commodity**<br>+ Monthly rent for local production units<br>- Collective surplus selling revenues<br>- Green certificates selling revenues<br>+ Management costs<br>**= 53.4€/MWh of self-consumed local energy on average** |
| | **Network tariff** | Proportional term adjustement<br>Capacity tariff adjustment<br>= **15.1 €/MWh for self-consumed local energy on average** | **Network tariff** | No more proportional term adjustement<br>No more capacity tariff adjustment<br>= **30.6 €/MWh for self-consumed local energy on average** |
| | **Total** | = **67.4 €/MWh for self-consumed local energy on average** | **Total** | = **84 €/MWh for self-consumed local energy on average** |
| **Residual consumption tariffication** | **Energy tariff** | Traditional supply contracts<br>Between **109.7€/MWh** and **180.3€/MWh** depending on the category of the consumer based on prices in January 2020 | **Energy tariff** | Traditional supply contracts<br>Between **97.6€/MWh** and **186€/MWh** depending on the category of the consumer based on prices in January 2021 |
| | **Network tariff** | No adjustment **125.2€/MWh** for residual electricity consumption | **Network tariff** | No adjustment **111.3€/MWh** for residual electricity consumption |
| | **Total** | = **270.2 €/MWh for residual energy on average** | **Total** | = **253.1€/MWh for residual energy on average** |

-

# Incentive table

| Incentive feature without network tariff adjustment | Phase 1 | | Phase 2 | |
|---|---|---|---|---|
| **Self-consumption tariffication** | **Energy tariff** | **= 52.3€/MWh of self-consumed local energy on average** | **Energy tariff** | **= 53.4€/MWh o** **energy on averag** |
| | **Network tariff** | = **126.4 €/MWh for self-consumed local energy on average** | **Network tariff** | = **111.3 €/MWh** **energy on averag** |
| | **Total** | = **178.7 €/MWh for self-consumed local energy on average** | **Total** | **= 164.7 €/MWh** **energy on averag** |
| **Residual consumption tariffication** | **Energy tariff** | Traditional supply contracts Between **109.7€/MWh** and **180.3€/MWh** depending on the category of the consumer based on prices in January 2020 | **Energy tariff** | Traditional suppl Between **97.6€/** depending on the consumer based |
| | **Network tariff** | No adjustment **125.2€/MWh** for residual electricity consumption | **Network tariff** | No adjustment **1** electricity consu |
| | **Total** | = **270.2 €/MWh for residual energy on average** | **Total** | = **253.1€/MWh** **average** |

# ML cross-validation scores

Based on historical data only

| | Avg R2 score from cross-validation | | |
|---|---|---|---|
| | Random Forest | KNN | XG Boost |
| Consumer 1 | 87% | 76% | 88% |
| Consumer 2 | 90% | 77% | 90% |
| Consumer 3 | 76% | 71% | 78% |
| Consumer 4 | 91% | 84% | 91% |
| Consumer 5 | 58% | 49% | 52% |
| Consumer 6 | 79% | 68% | 76% |

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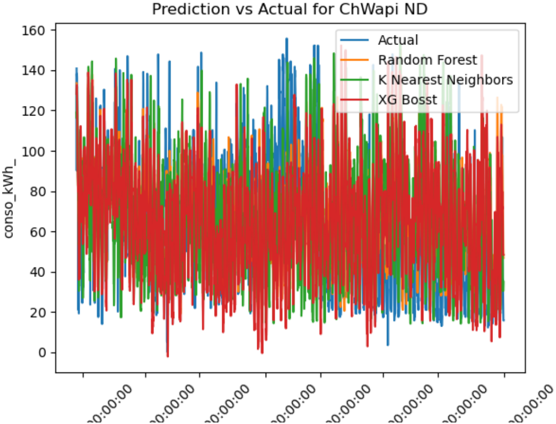
# ML Retrofiting

Based on historical data only

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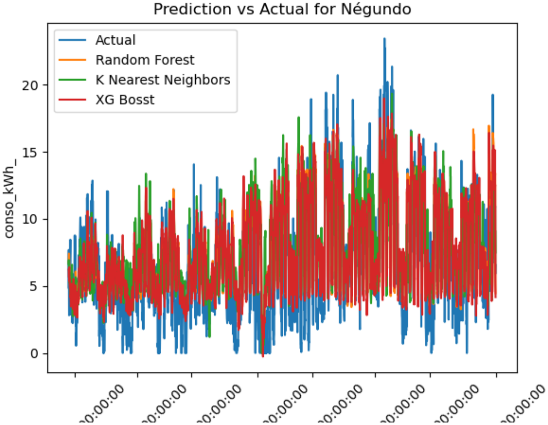

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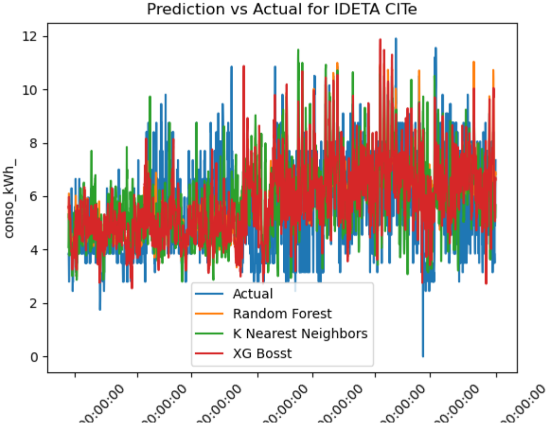

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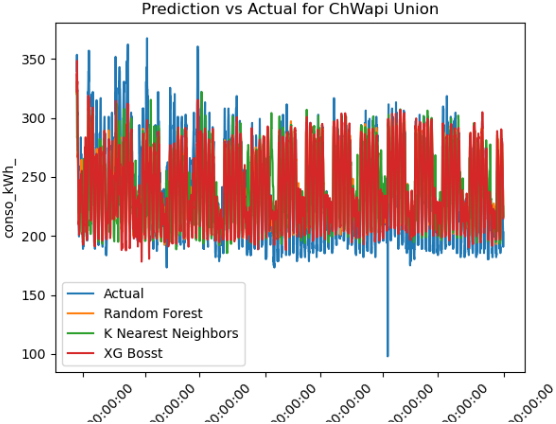

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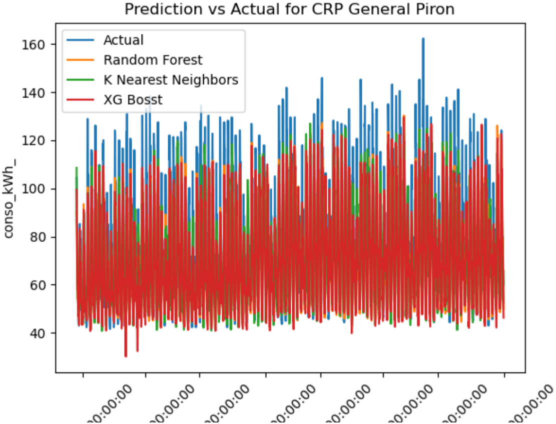

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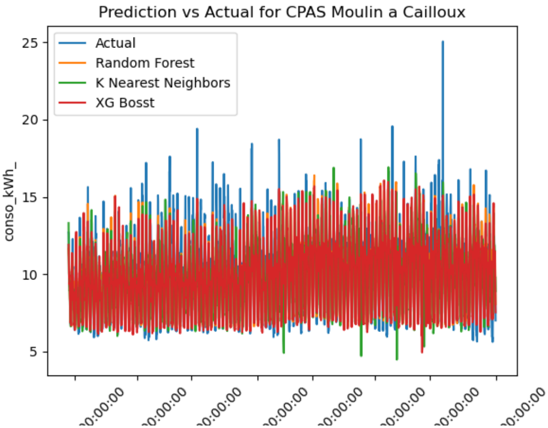
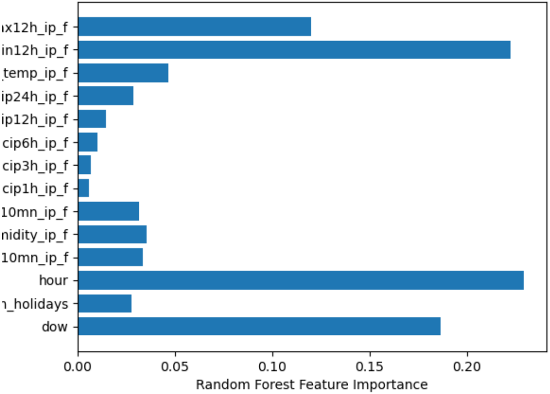
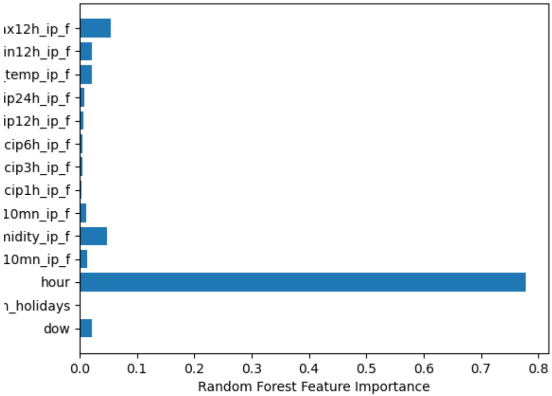


# RF feature importance



# RF feature importance

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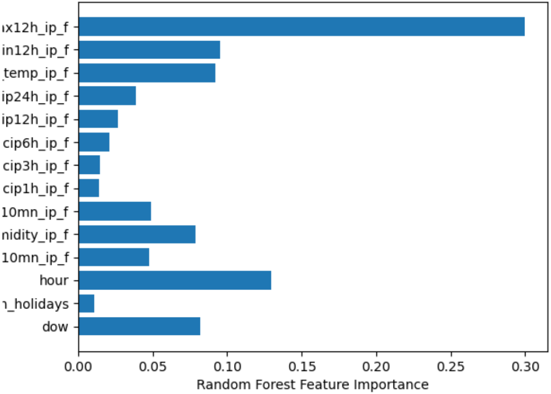
# RF feature importance

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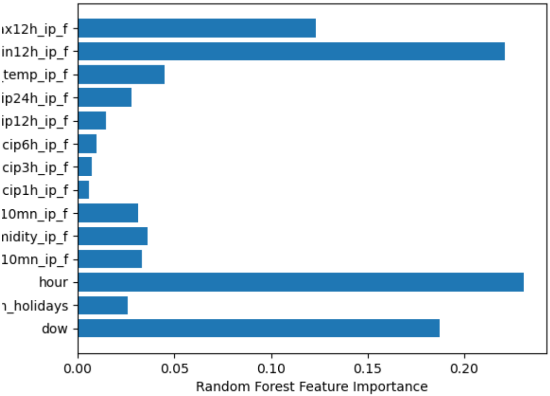
# RF feature importance

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# Event study results

PHASE 1

| Variable | Estimate | Std. Error | Significance |
|---|---|---|---|
| (Intercept) | 7174.69 | (434.03) | *** |
| event_indicator | -53.48 | (62.30) | |
| dm_holidays | 106.58 | (67.12) | |
| dow | 237.04 | (23.13) | *** |
| dm_wk | -1290.24 | (102.40) | *** |
| average_w_wdspeed_10mn_ip_f | 34.17 | (150.66) | |
| average_w_humidity_ip_f | 18.34 | (3.93) | ** |
| average_w_gust10mn_ip_f | -67.33 | (99.31) | |
| average_w_precip1h_ip_f | 11.49 | (274.50) | |
| average_w_precip3h_ip_f | -427.49 | (540.61) | |
| **$R^2$** | | 0.36 | |
| **Adj. $R^2$** | | 0.35 | |
| **Num. obs.** | | 1214 | |

# Event study results

PHASE 2

| Variable | Estimate | Std. Error | t-value | p-valu |
|---|---|---|---|---|
| (Intercept) | 7654.31 | (509.41) | *** | $< 0.00$ |
| event_indicator | -6.01 | (70.14) | | |
| dm_holidays | 54.67 | (81.04) | | |
| dow | 240.47 | (28.34) | *** | $< 0.00$ |
| dm_wk | -1312.85 | (125.23) | *** | $< 0.00$ |
| average_w_wdspeed_10mn_ip_f | -27.05 | (184.23) | | |
| average_w_humidity_ip_f | 14.25 | (4.59) | ** | 0.01 |
| average_w_gust10mn_ip_f | -34.81 | (120.90) | | |
| average_w_precip1h_ip_f | 49.76 | (311.83) | | |
| average_w_precip3h_ip_f | -512.04 | (610.95) | | |
| **$R^2$** | | 0.37 | | |
| **Adj. $R^2$** | | 0.35 | | |
| **Num. obs.** | | 849 | | |

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