Energy transition
Integrating renewables into the grid

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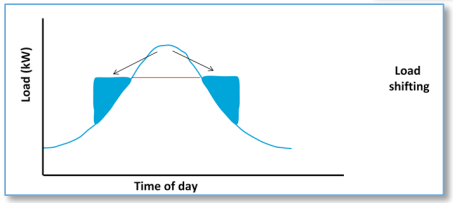
Energy transition to a greener energy system

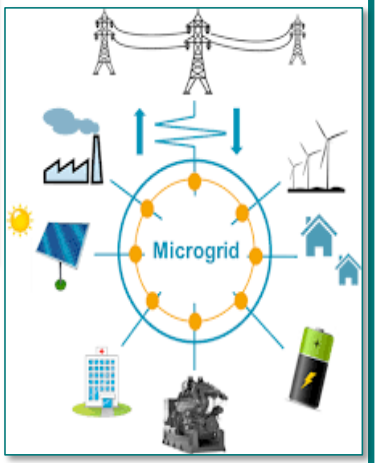
- New role for the consumers:

Exchange
Storage

Production

Consumption





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New role for the grid

- Power injection by residential « prosumers »
- Local exchanges between consumers
- Micro grid
- Storage
- The grid tariff should provide adequate price signal to encourage « good » behavior and deter « bad » behavior
- Currently the grid tariff is regulated and it is not cost reflective

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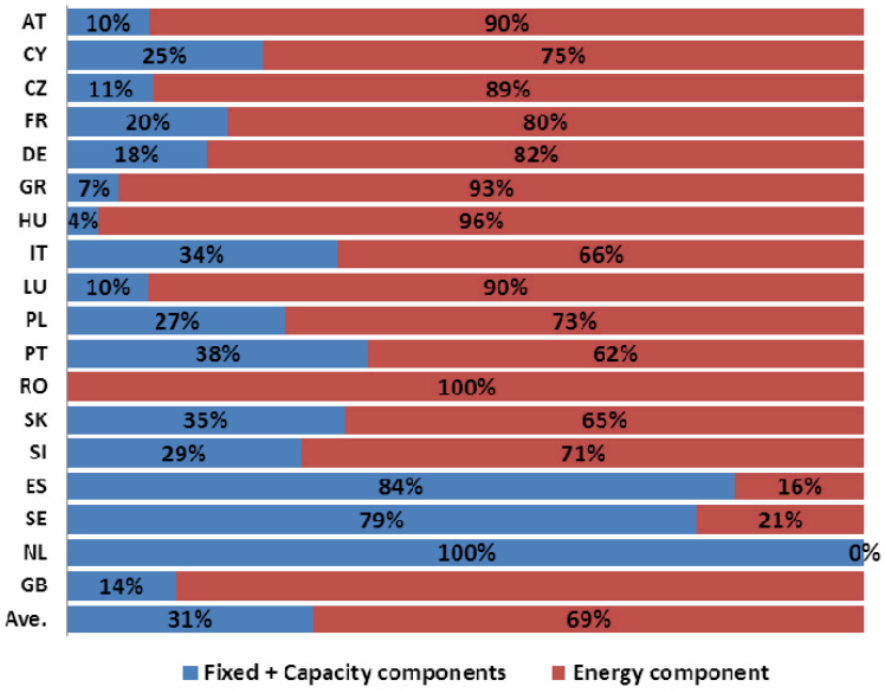
Grid tariff is based on kWh in Wallonia

Grid tariff have fixed (capacity, fixed) and variable components (KWh)
Wallonia -> 96% variable



Source: Study on tariff design for distribution systems (2015) prepared for the EU

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Research project « TECR »: overview

- TECR= Transition énergétique: consommateurs et réseaux
- Research project « TECR » on the *interplay* between consumers and the grid
- Funded by the Walloon Region DGO4 (Belgium), period 2016-2018
- Objectives

1. Understand the behavior of consumers (consumption, production, storage)
2. Provide adequate incentives to consumers -> tariff design to implement encourage value creating conducts and to deter inappropriate ones
3. Application to the local context (Wallonia)

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Road map

1. Decision to invest in a DPU (with J. Jacqmin)
2. Evidences based on survey data
3. Rebound effect (with N. Boccard)
4. Conclusion on tariff design

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I Investment in PV

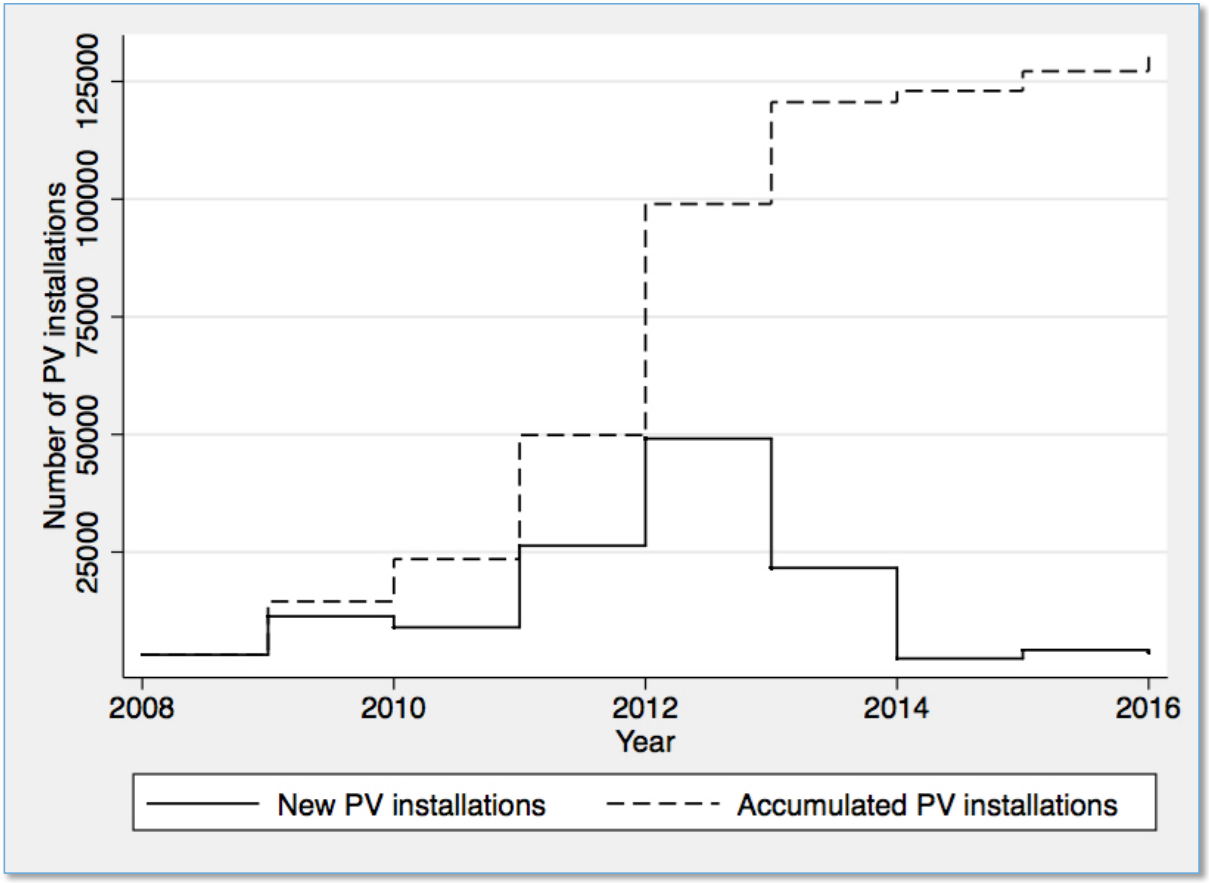
- **SOLWATT (2007-2014)**
- 7 TGC per MWh produced during 15 years

- **Net metering**: the meter runs backward when production exceeds consumption
  - The grid is a "free" storage facility
  - The value of the solar production is equal to the **retail price**
  - Limit -> zero bill if production exceeds consumption (no payment for excess supply)

- Important development of solar installations in Wallonia
  - More than 25,000 installations per year
  - Very high return on investment (>20% in 2012)

- Replaced by Qualiwatt in 2014, no more support after June 2018

PV installations in Wallonia



A huge success but at a high cost

€/MWh	Hydro	Eolien	Biomasse	Solaire
Wallonie	67	87	88	588
Belgique	46	95	98	414
France	13	34	52	487
Allemagne	42	43	132	371
Pays-Bas	101	75	75	388
Royaume Uni	64	71	60	245

Tableau 3: Soutien aux énergies renouvelables en Europe

Source: Gautier & Boccard (2015), Reflets et perspectives de la vie économique

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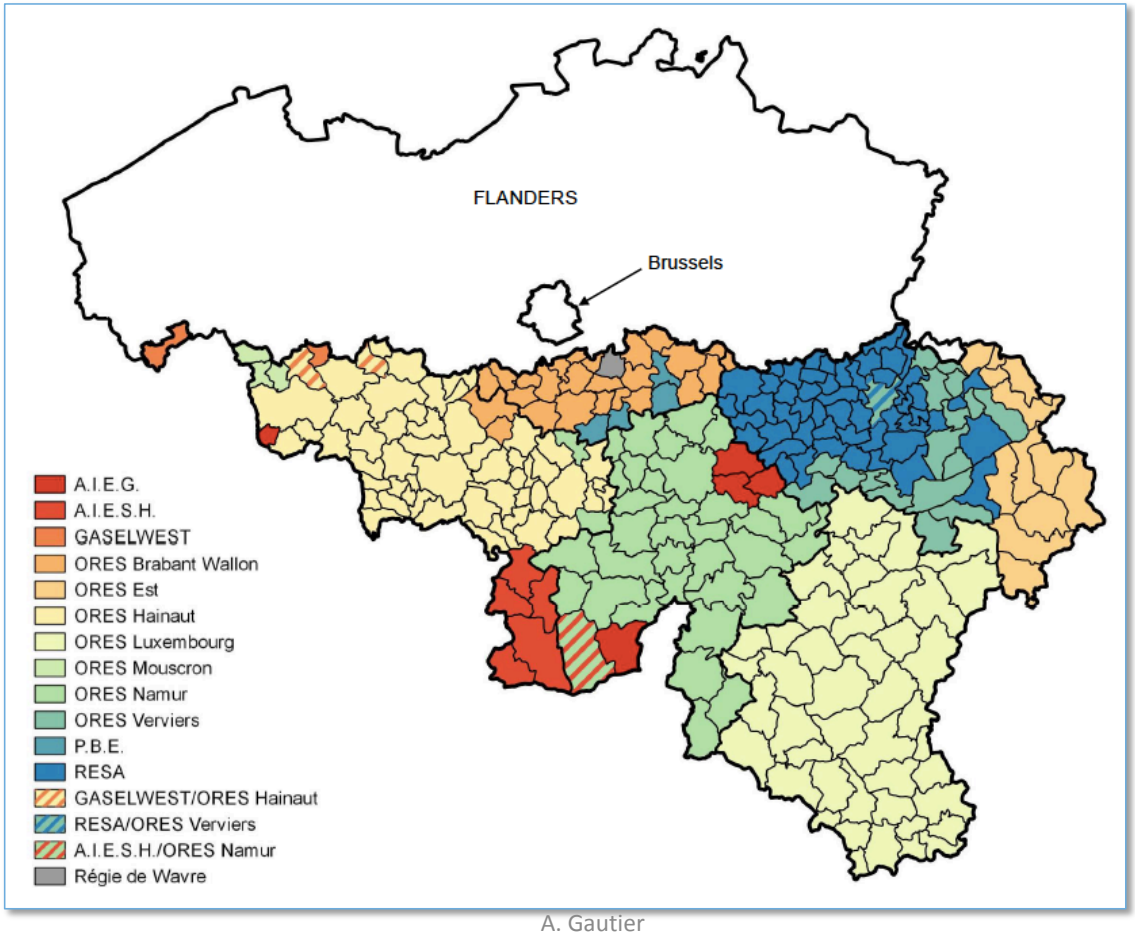
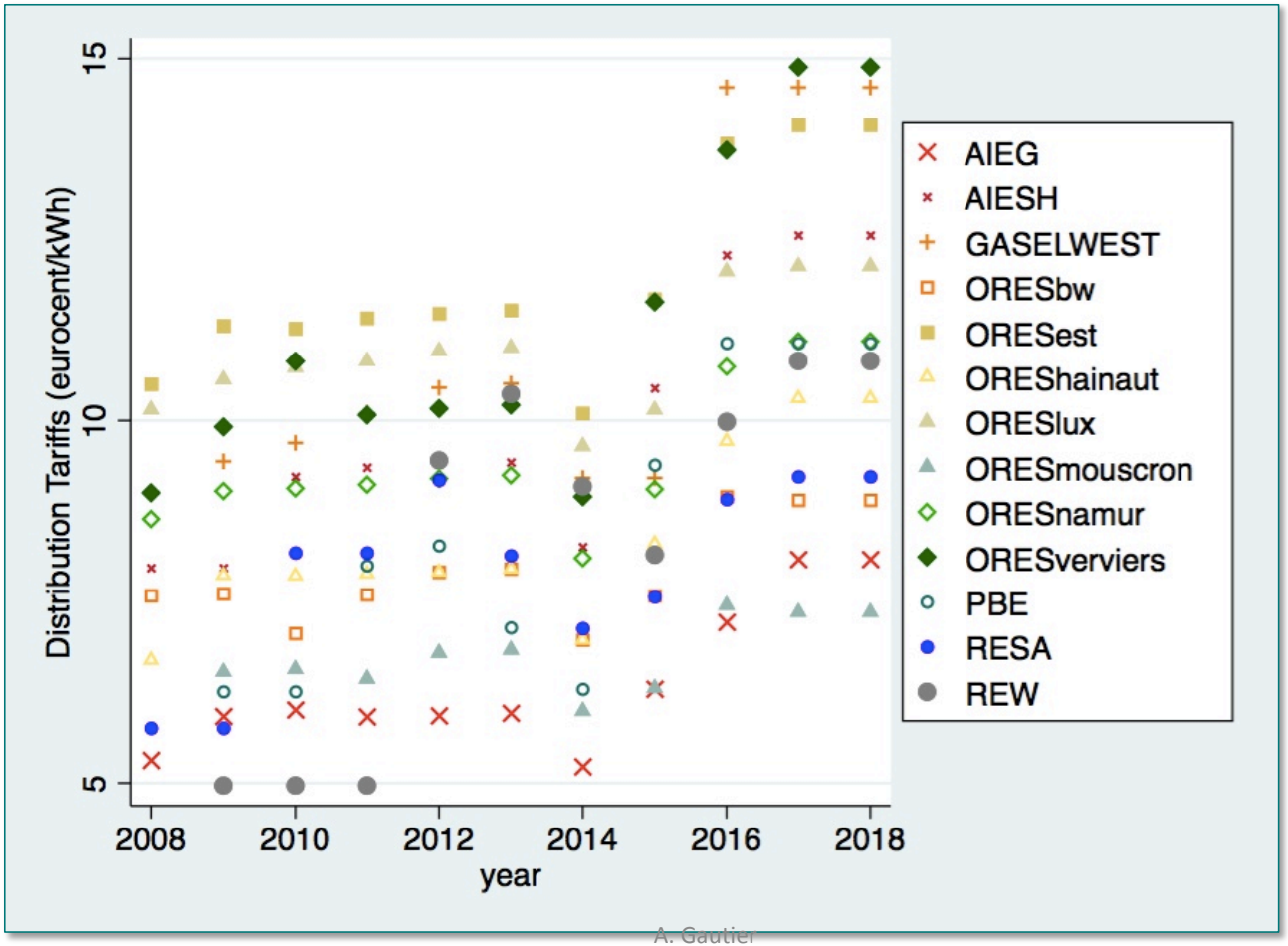
13 different DSO in Wallonia



With 13 different grid tariffs



Decision to invest

- The meter runs backward
  - An increase by 0.01€ of the grid tariff increases the benefit of the solar PV by 10€ per MWh produced
  - Average yearly production of 6 MWh

- The benefit of investment is higher in places where the grid tariff is higher

- Estimation of the sensitivity of investment to grid tariff using panel data
  - Municipal level, period 2007-2015

$$Y_{i,t} = \alpha + \beta tariff_{i,t-1} + \gamma X_{i,t} + \mu_i + \phi_t + \epsilon_{i,t}$$

Decision to invest

A 0.01€ increase in the grid tariff increases the number of PV installations by 6%

Table 3: Results

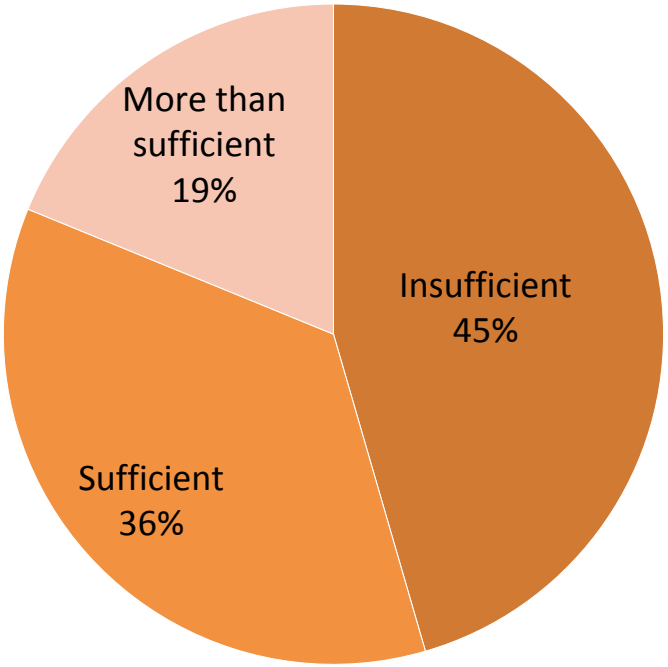
Dep. var. # of PV installations	(1)	(2)	(3)
Tariff (t)	0.026*		0.028**
	(0.0137)		(0.014)
Tariff (t-1)		0.058***	0.041***
		(0.015)	(0.015)
Year FE	yes	yes	yes
Municipality FE	yes	yes	yes
N	2031	1776	1776
log likelihood	-7216.93	-6359.13	-20530.22

Heteroskedasticity-consistent standard errors in parentheses.
Statistical significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

II Survey data

- Survey conducted in Nov/Dec 2017
- PV owners registered at the regulators
- 2500 contacts, approx. 1000 answers
- Objective:
  - Do consumers adapt their behavior after the installation of PV panels ?
  - If yes, how? Are these changes beneficial to the system?

Q1: Is your installation sufficient to cover your consumption ?



Responses : 712

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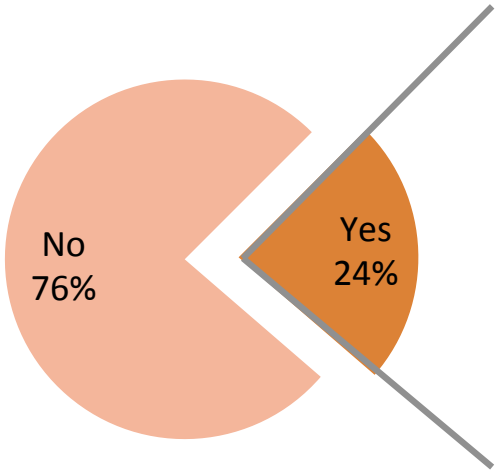
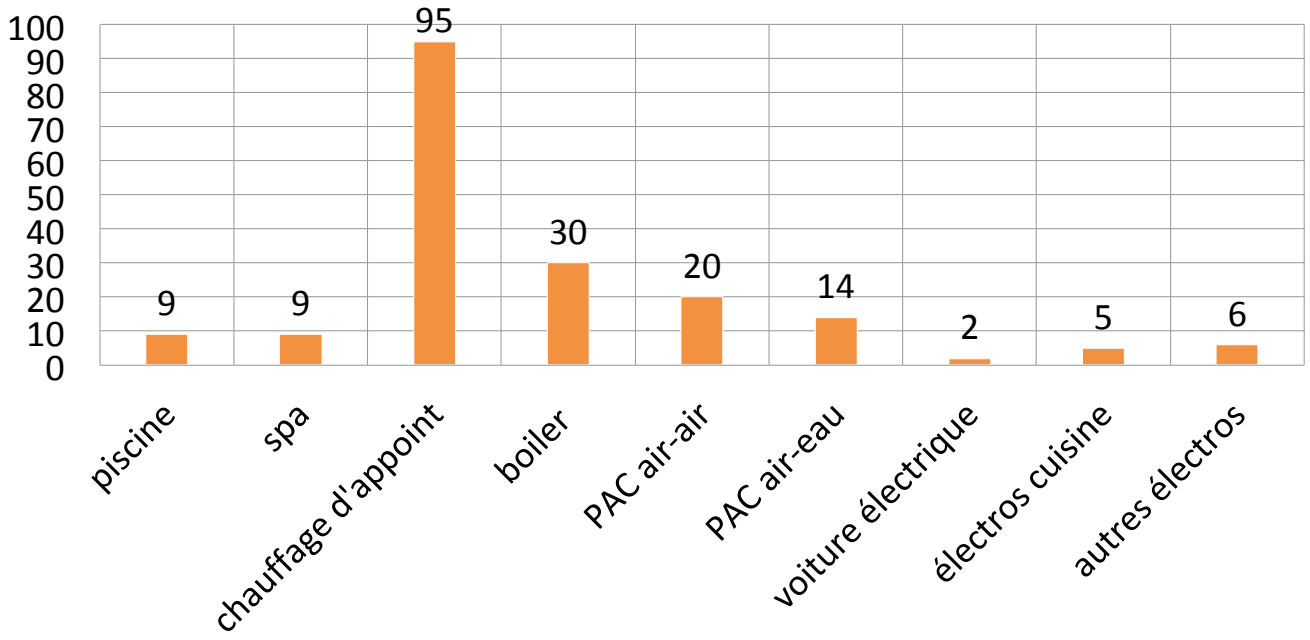
Q2: Since the installation of solar PV, did you acquire new electrical devices to use your production surplus (if any)?

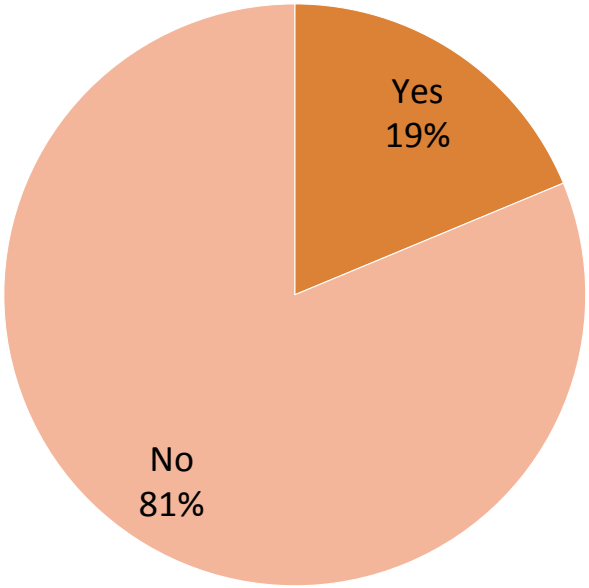
If yes, which one?





Responses : 667

Q3) Since the installation of PV, has your consumption increased?



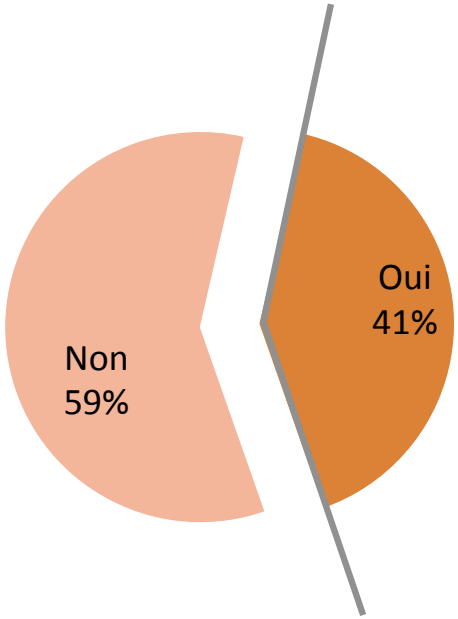
Responses : 662

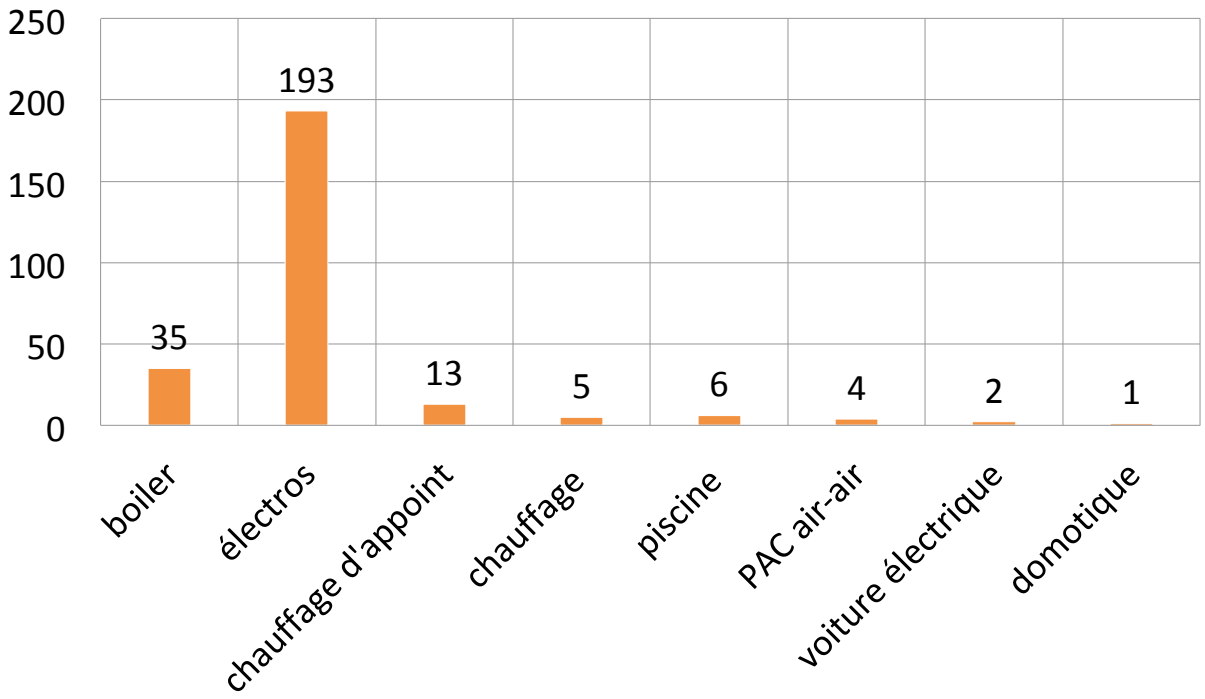
Consumption increase & rebound effect

- Strong incentives to increase consumption
- Heating is the most commonly used device to increase consumption
- Econometric results show that the likelihood of increasing consumption is larger for
    - Oversized installation
    - Older installation
    - Fuel-based heating
    - Financial motivations

  And lower for those reporting environmental motivations.

Q4) Since the installation, do you try to **synchronize** your consumption with your production of electricity ?
If yes, **how**?

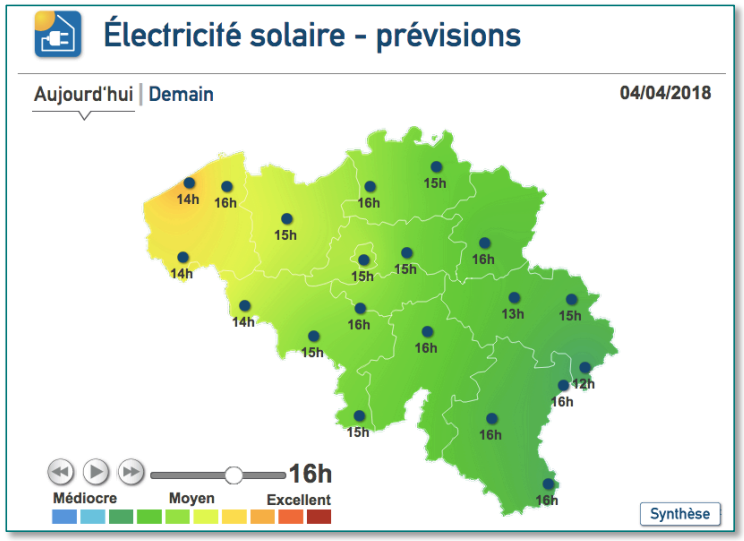




Responses : 668

Synchronization

- Synchronization reduces exchanges with the grid
- No financial incentives to increase synchronization
- Still, 40% of the respondents try to increase their auto-consumption
- Non-monetary incentives (Nudge)



Source: Apere

III Rebound effect

- Subsidy of 588€/MWh (TGC) + Compensation (meter running backward) 250€/MWh -> Profitable investment
- Does the investment in Solar PV change consumption ?
  - Net income effect
  - Zero-marginal price effect is the installation is over-sized
- Consumption data from GRD + Estimation of production
  - >100.000 observations
  - Preliminary exercise
- Substantial zero-marginal price effect

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Empirical strategy

- Two groups of prosumers
  - Group 1 (under-sized): PV capacity < past consumption
  - Group 2 (over-sized): PV capacity > past consumption
- For each prosumer estimate the consumption before/after the installation of the DPU
  - Before= registered consumption
  - After = registered consumption + estimated production
- Econometric analysis to explain the difference in consumption

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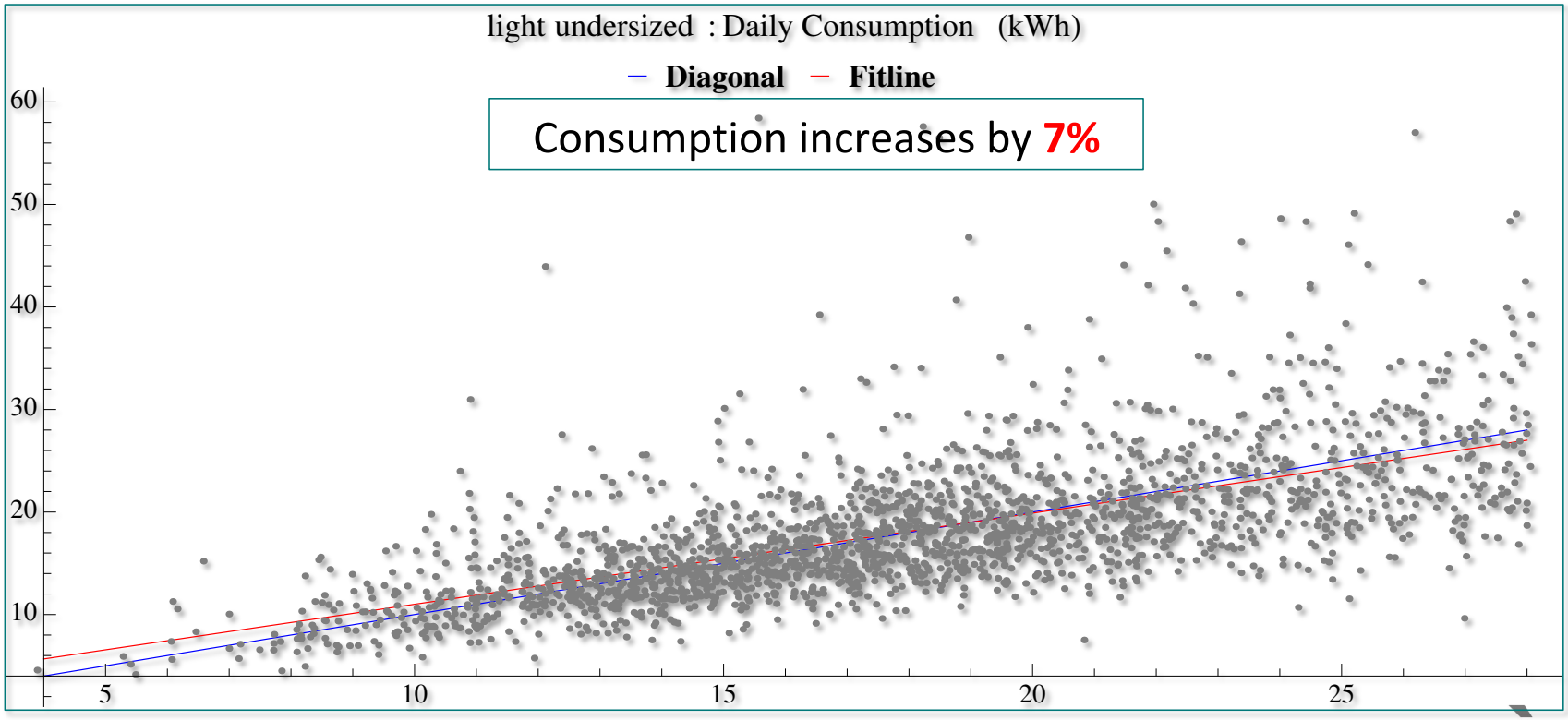
Income effect: undersized group



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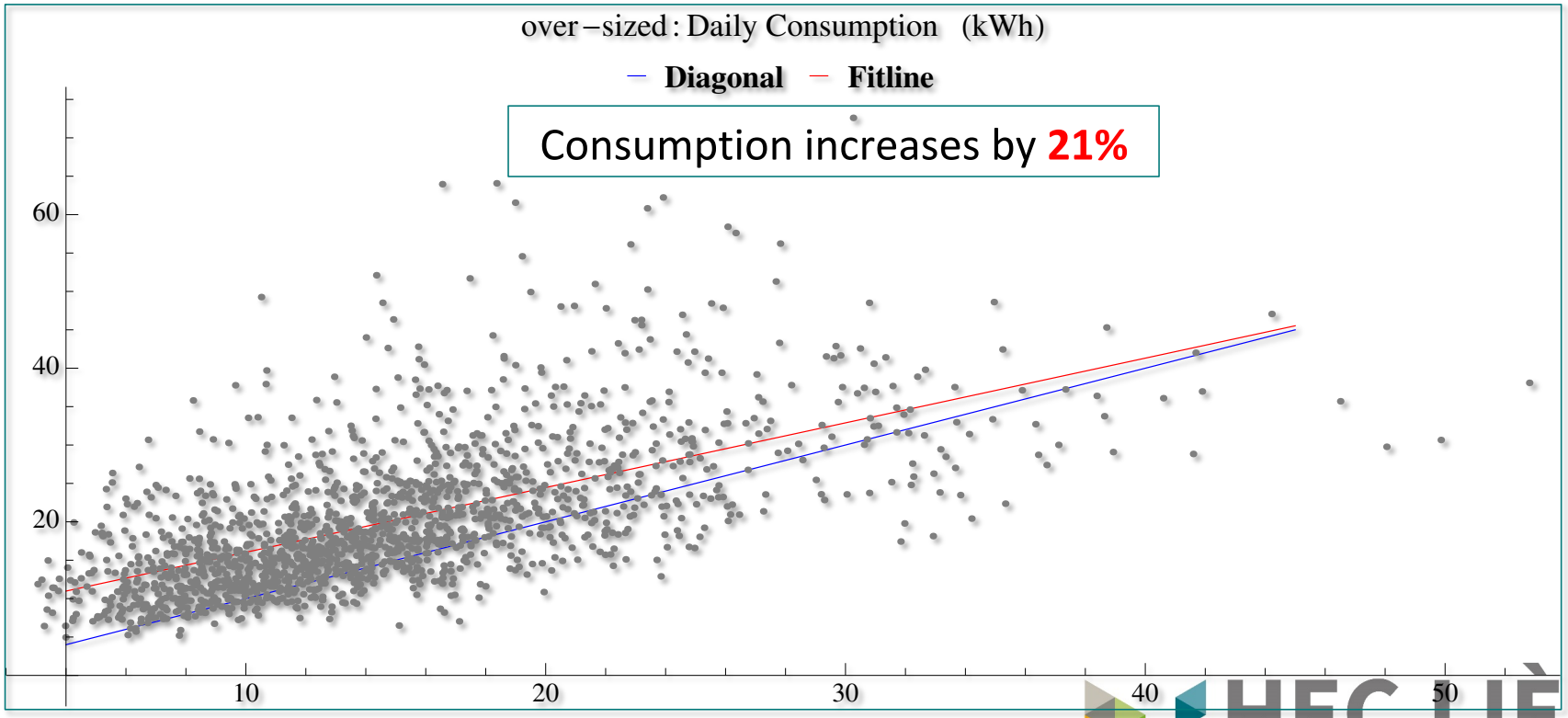
Income effect + Zero MC effects: oversized group



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The prosumers and the grid
Gautier, Jacqmin, Poudou JRegE, 2018

- Compare two metering systems

    1. Net metering (single meter running backward)
    2. Net purchasing (two meters for recording imports and exports)

- Three elements of comparisons

    1. Deployment of DPU
    2. Redistribution
    3. Incentives to synchronize

- Strong case against net metering

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Optimal tariff

- The volumetric tariff is inappropriate for the energy transition
- The grid is offering new services that must be correctly priced
- What is the optimal tariff for a grid ?
  - Tariff structure: Fixed vs. variable fees; net metering vs. net purchasing
  - Incentives to invest in DPU, to synchronize consumption and production, to store energy, to form a micro-grid,…
- Smart meter
- Tariff simulator that includes our estimate for the Walloon region

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Conclusions

- Energy transition calls for new pricing system
- Prices must offer correct signals and encourage/deter value (or welfare) enhancing/reducing behavior. Current prices (in Wallonia) fail to do that!
  - Grid tariffs are not cost reflective
- Incentives are important !
  - Understand the consumers' behavior
  - Measure how they do react to incentives
- Research project -> policy relevant advice
  -> access to many data

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References

- Gautier, A., Jacqmin, J., & Poudou, J.-C. (2018). The prosumers and the grid. *Journal of Regulatory Economics*, 53, 100-126.
- Boccard, N., & Gautier, A. (2015). Le coût de l'énergie verte en Wallonie 2003-2012. *Reflets et Perspectives de la Vie Economique, LIV*(1-2), 71-85.
- Gautier, A. (2015). Repenser la tarification de l'énergie. *Reflets et Perspectives de la Vie Economique, LIV*(1-2), 175-184.
- Coelli, T., Gautier, A., Perelman, S., & Saplacan-Pop, R. (2013). Estimating The Cost of Improving Quality in Electricity Distribution: A Parametric Distance Function Approach. *Energy Policy, 53*, 287-297.
- de Villena Millan, M., Gautier, A., Fonteneau, R., & Ernst, D. (2017). A Simulator to Explore Tarification Designs for Distribution Networks.
- Gautier, A., Jacqmin, J. (2017). PV adoption in Wallonia: the role of distribution tariffs under net metering.

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