PV adoption in Wallonia: The role of distribution tariffs under net metering

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Introduction

Motivation

Starting point

How to integrate decentralized production units (like residential photovoltaic panels) in the energy system?

- Do not only consume their own energy
- New forms of exchange with the grid
  - *Export:* when the electricity produced is not consumed
  - *Import:* when production is insufficient to cover consumption

$\Rightarrow$ Investments in PVs should depend on how these new kind of exchanges are priced via the tariff system!

Introduction

Goal of this paper: Use municipality-level data from Wallonia, to study the impact of grid tariffs on residential PV investments

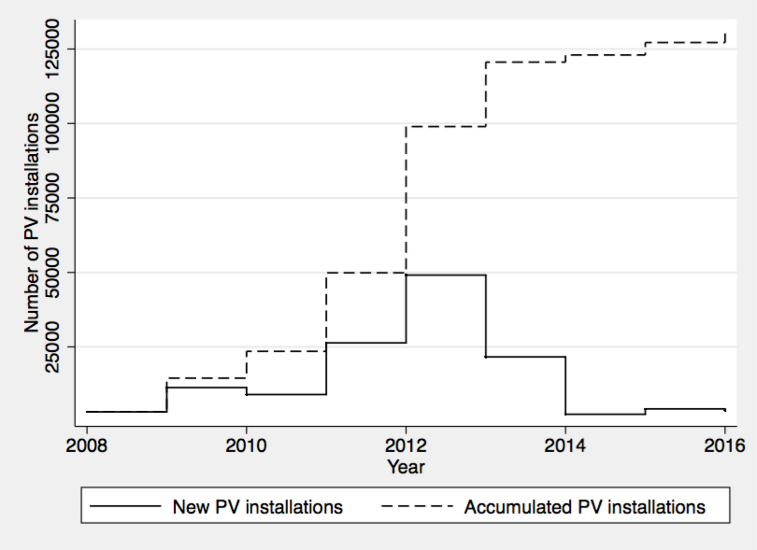
- Support to PV in Wallonia
  - Net/single metering system: the meter runs backward
  - The PV production is valued at market price

$$p_{energybill} = p_{retail} + tariff$$

  - Additional subsidies to support PV production
    - Investment subsidies (mainly income tax rebate)
    - Tradable green certificate (granted for 10 or 15 years): less generous from 2013 on
    - Up-front subsidies from the region and some municipalities

Residential PV in Wallonia

Diffusion rate: ±10% of households



Energy distribution in Wallonia

- 13 DSO active on the territory!
- No uniform pricing
- 40% of the (average) electricity bill is made up of tariffs
- Mostly volumetric tariffs (on average only 6% of the bill comes from the fixed part)

Approach: Under net metering, a higher tariff increases the profitability of the investment

Main result:

An increase by one eurocent per kWh leads to an increase in 5% of the amount of new PV installations, everything else being equal

Literature review

Determinants of PV adoption

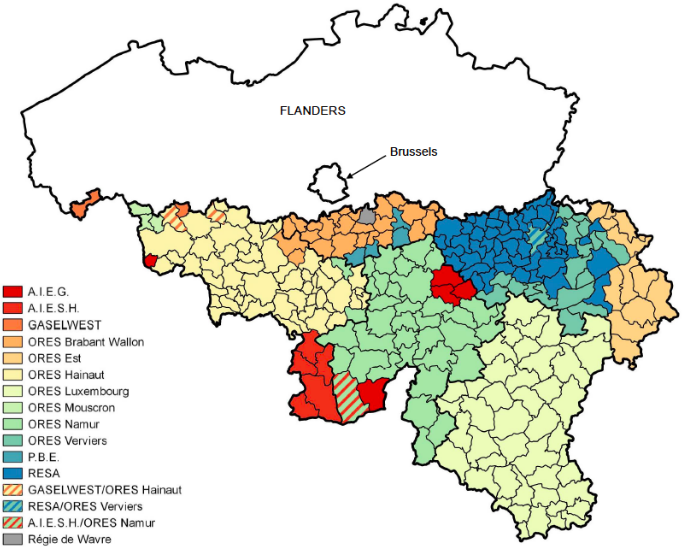
- General approach: De Groote et al. (2016)
- The role of social spillovers/peer effects: Rode and Weber (2016)
- The role of policy incentives: Crago and Chernyakhoskiy (2017)

How to regulate natural monopolies?

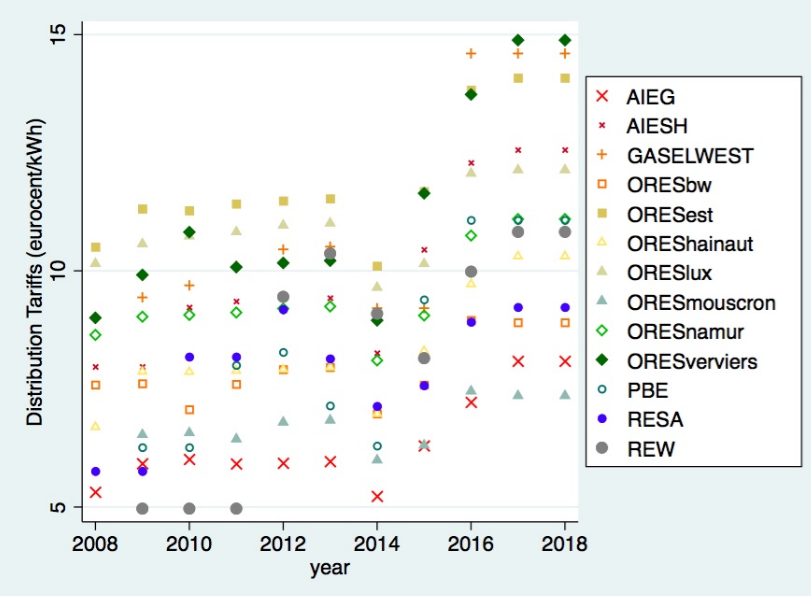
- In the presence of distributed generation: Brown and Sappington (2017) and Gautier et al. (2018)

$\Rightarrow$ Key input for works studying numerically the impact of DPU on regulated tariffs!

Residential PV in Wallonia
Distribution tariff: 13 DSO



Residential PV in Wallonia
Distribution tariffs



Residential PV in Wallonia

Distribution tariffs (volumetric)

Set by the energy regulator of Wallonia: CWaPE

- No uniform tariff across the 13 DSO
- Regulatory period of 4 years but adjusted annually
- Cost-plus like regulation
- Mostly volumetric (94% of the final tariff bill)
- Increased from 7.8 to 10.5 eurocent/kWh in 8 years time (+34%)
- Extra yearly return of 422 € for an installation producing 6MWh in the highest tariff region (2016)

Data

Context:

- Almost all energy policies are set at the regional/national level
- 13 DSO active in the region with highly varying tariffs
- Installation data at the municipality level (256 out of 262)

Data:

- Merge data from CWaPE, Walstat and FPS
- Control for various confounding factors: housing, socioeconomic and political factors.

Data

Dependent variables	Mean	Std. Dev.	Min	Max	Source
Number of PV installations	59.977	85.487	0	1330	CWaPE
Capacity of PV installed	344.95	495.196	0	7527.21	CWaPE
Independent variables					
Tariff (eurocent/kWh)	8.81	1.67	4.967	14.602	CWaPE
% of houses	18.016	12.827	1	56.7	Walstat
% built after 81	21.74	7.01	5.4	40.3	Walstat
% unemployed	12.651	4.476	3.6	28.7	Walstat
Population (log of)	9.062	0.799	7.214	12.225	Walstat
Median Income (log of)	9.995	0.127	9.63	10.445	Walstat
% foreigners	6.526	5.669	1.47	50.4	Walstat
Average age	40.303	1.573	35	46.7	Walstat
Local subsidies (log of)	0.176	2.827	-1.204	7.23	Self-collected
% vote green party	15.007	6.304	4.37	31.83	Federal Public Service

Empirical strategy

Start from a first specification:

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

- Fixed-effect identification approach
- Take various confounding effects into considerations
- Count data
  - Focus on Poisson model but robust to negative binomial and OLS models
  - Few zero observation
  - Due to overdispersion, we use sandwich variance estimator
- Tariffs lagged by one year but robust to contemporaneous comparisons (Ito (2014))

Results and discussion

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)
% of houses	0.021	0.013	0.014
	(0.02)	(0.022)	(0.025)
% built after 81	-0.122***	-0.147***	-0.16***
	(0.032)	(0.035)	(0.037)
% unemployed	-0.079***	-0.08***	-0.072***
	(0.022)	(0.022)	(0.022)
Median income (log of)	1.114	0.858	1.11
	(0.871)	(0.924)	(0.916)
Population (log of)	2.501*	2.599*	3.583**
	(1.49)	(1.558)	(1.605)
% foreigners	-0.053**	-0.046*	-0.039
	(0.027)	(0.027)	(0.03)
Average Age	-0.058	-0.016	0.021
	(0.064)	(0.066)	(0.065)
Local subsidies (log of)	0.008	0.005	0.005
	(0.006)	(0.006)	(0.006)
% vote green party	-0.003	-0.003	-0.003
	(0.008)	(0.009)	(0.009)
Year FE	yes	yes	yes
Municipality FE	yes	yes	yes
N	2031	1776	1776
log likelihood	-7216.93	-6359.13	-20530.22

Results and discussion

	(4) years ≤ 2013	(5) years > 2014	(6) quantity of cap. installed	(7) with transport tariff included	(8) OLS Fixed effects	(9) Negative Binomial
Tariff (t-1)	0.054***	-0.145	0.05***	0.021	0.038**	0.0503***
	(0.016)	(0.207)	(0.015)	(0.013)	(0.016)	(0.013)
% of houses	0.025	0.214	0.015	0.021	0.012	-0.007
	(0.024)	(0.223)	(0.024)	(0.047)	(0.028)	(0.007)
% built after 81	-0.166***	0.212	-0.16***	-0.193***	-0.076*	-0.026***
	(0.038)	(0.159)	(0.037)	(0.043)	(0.042)	(0.01)
% unemployed	-0.096***	-0.151	-0.074***	-0.048**	-0.042*	-0.022
	(0.026)	(0.094)	(0.022)	(0.022)	(0.025)	(0.014)
Median income (log of)	0.825	-1.769	0.983	0.19	-0.134	0.125
	(1.076)	(3.592)	(0.91)	(0.95)	(1.141)	(0.499)
Population (log of)	2.044	2.498	3.591**	3.74**	1.578	0.602***
	(1.799)	(6.856)	(1.604)	(1.74)	(1.953)	(0.083)
% foreigners	-0.064*	-0.432***	-0.039	-0.009	-0.03	-0.048***
	(0.037)	(0.166)	(0.03)	(0.031)	(0.036)	(0.011)
Average Age	-0.05	-0.006	0.024	0.108	-0.07	-0.119***
	(0.082)	(0.234)	(0.065)	(0.082)	(0.058)	(0.028)
Local rebates	0.005	0.031	0.006	0.009	0.006	0.007*
	(0.006)	(0.021)	(0.006)	(0.007)	(0.006)	(0.004)
% vote green party			-0.003	0.009	-0.008	0.014**
			(0.009)	(0.007)	(0.011)	(0.006)
Year FE	yes	yes	yes	yes	yes	yes
Municipality FE	yes	yes	yes	yes	yes	yes
N	1266	510	1776	1530	1776	1776
log likelihood	-4807.77	-590.11	-20570.8	-5145.11		-5403.05

Heteroskedasticity-consistent standard errors in parentheses.

Conclusion

Take home:

We estimate that an increase of one eurocent per kWh of the volumetric electricity tariffs leads to an increase of 5% in investment in PV installations, everything else being equal.

- Net metering system + volumetric tariffs ⇒ overshadowed form of subsidy for PV installations!
- Our elasticity measure is a key ingredient of the utility death spiral!
- Push towards less consumption-dependent tariffs to recover the sunk grid cost (Borenstein (2016) and Schittekatte et al. (2018))