Incentive policies for small PV in France

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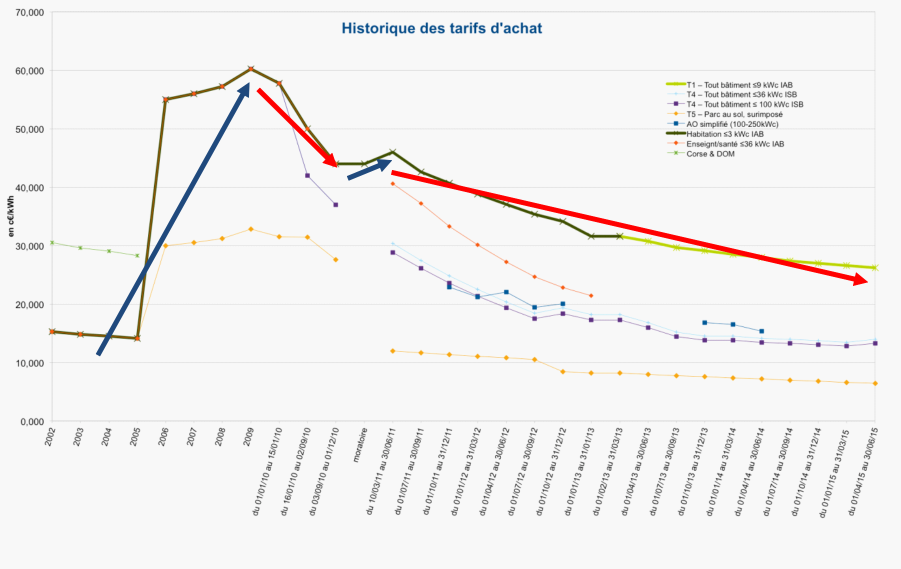
April 2016

Motivation

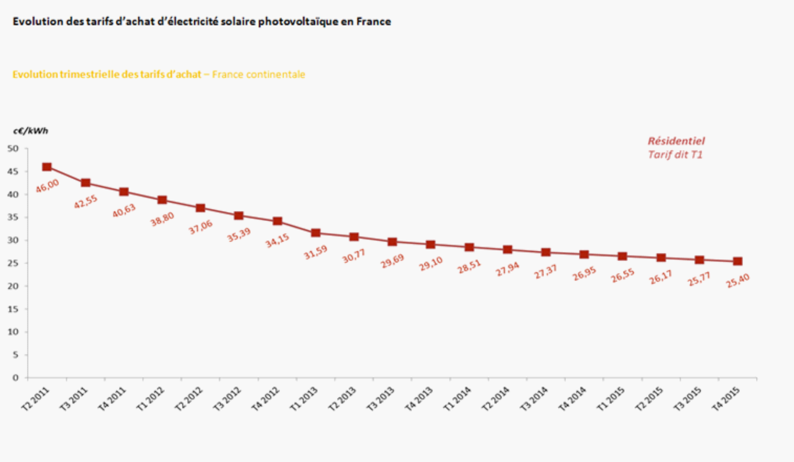
- Technology with a fast market increase
- Policy debate on the various incentive measures (feed-in, R&D subsidies, tradable green certificates, renewable portfolio standard, net metering) coupled with the European 2020 target and in our case study, with the 2030 objectives of the French ¨Transition Energetique¨.

Projections in France

Context: ups and downs



Context (II): zoom in



Questions and modelling strategy

- Do we really need Feed In Tariffs (FIT) for French residential consumers?
  - Which is the level of learning achieved in the small PV market?
- Which is the optimal path of the capacity to be installed to reach a predetermined target (32%) for 2030?

What we do:

1. We link profitability of Photovoltaic (PV) investment & annual installed capacity (in this context we estimate learning).
2. We simulate the optimal path on a panel of small PV installations across France and find the FIT that induces such path.

A brief summary of the related literature (I)

- Learning curve: PV prices decrease as the amount of technology deployed increases (seminal works: Shaeffer et al. 2004, Nemet, 2006; Pillai 2015, Rubin 2015)
  - Limits: sensitivity to data, complexity of the technology and factors of cost reduction other than learning.
- Deployment: diffusion of innovation are often described by logistic functions or "S-curves" (the Bass model-Gerowski, 2000, Guidolin and Mortarino, 2010)
  - Limits: these models do not take into account the incentive policies such as subsidies and feed-in tariffs.
- Profitability of PV investment: values of investments in different countries in Europe, Japan, Germany in presence of incentive schemes (Dusonchet and Telaretti, 2010, Zhang and Hamori, 2011, etc...).
  - Limits: no link with long term targets on terms of installed capacity.

Drivers vs. barriers in small PV adoption

	Motivation	Barrier
Financial	- Save or earn money from lower fuel bills and government incentives - Increase value of my home	- Costs too much to buy/install - Cannot earn enough/save enough money - Lose money if I move home - High maintenance costs
Environmental	- Help improve environment	- Environmental benefits too small
Security of supply	- Protects against future high energy costs - Makes households more self-sufficient/less dependent on utility companies - Protects against household power cuts	- Would make more self-sufficient/independent
Uncertainty and trust	- Use an innovative/high-tech system	- Home/location not suitable - System performance or reliability not good enough - Energy not available when I need it - Hard to find trustworthy information or advice - Hard to find trustworthy builders to install
Inconvenience	- None identified	- Hassle of installation - Disruption or hassle of operation - Potential requirement for planning permission - Reserving space on rooftops
Impact on residence	- Improve the feeling and atmosphere within my home - Show my environmental commitment to others	- Take up too much space - The installation might damage my home - Would not look good - Neighbour disapproval/annoyance

Source: Largely based on Balcombe et al. (2013, p.658), incorporating Wolsink (2012).

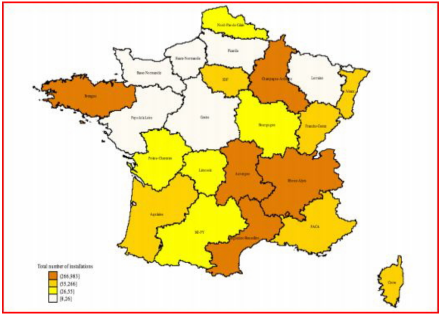
- We account for financial motives

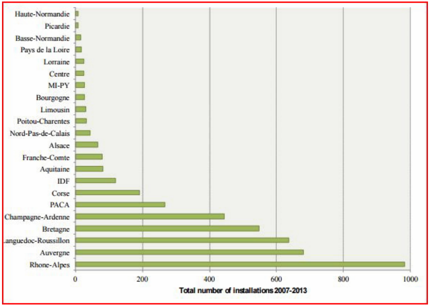
An overview of the Database (I)

- **180 observations** spread over 22 French regions: yearly observations on residential PV installations -quantity and price both of materials and installation- generating less than 3 kWp.
- France has **added 13.08 MWp** of solar capacity from residential sector during 2007-2013.
- **Yearly growth rate** has decreased from 94,3% in 2008 to 5,93% in 2013.

Further description

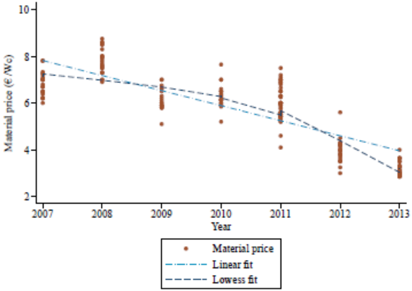
An overview of the Database (II)

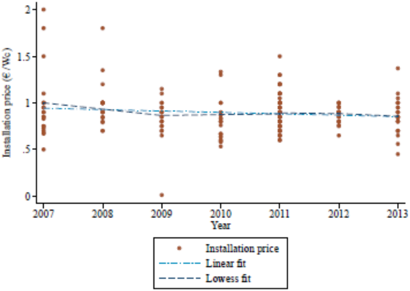




Cost Evolution

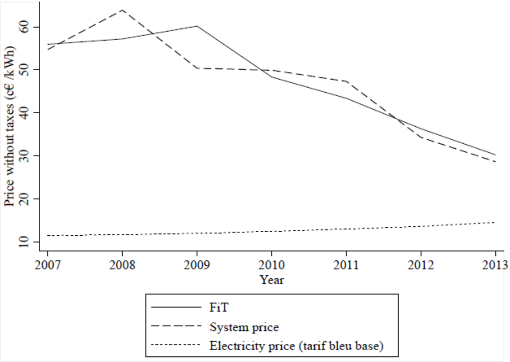
- **Material price** accounts in mean for **80%** of adoption costs despite regional differences.
- Material price decreases (in mean from 6.64 in 2007 to 3.13 in 2013) while **installation price** is **stable** (highest for L-R).





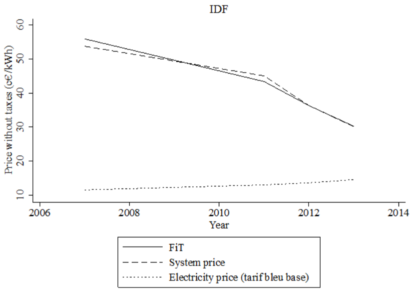
Comparing the FiT with PV costs

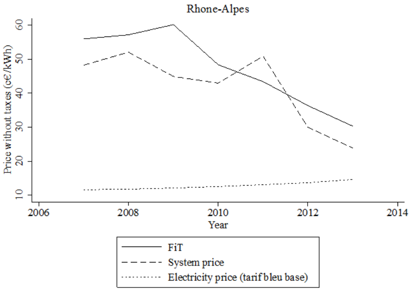
- **FiT** (granted 20 years) for PV integrated to buildings started in 2006, in 2009 reached 60,17 euros and then unevenly decreased (starting in 2011 suspended for bigger PV installations).
- **Limited profitability** overall (Fit and Price very close).
- **Grid parity** is **not** achieved since Price is much higher than the electricity price throughout the period.



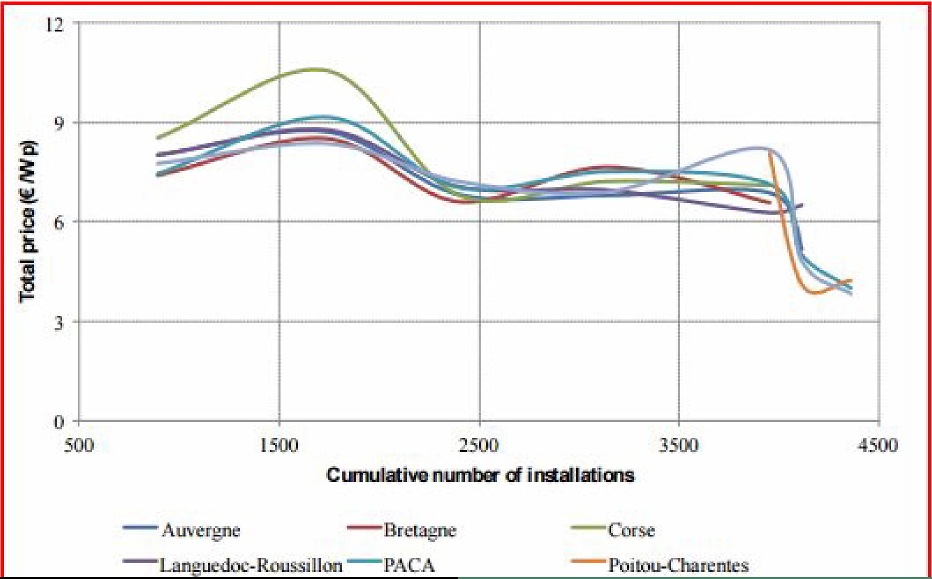
Comparing the FiT with PV costs (II)

Regional differences





Accounting for learning



Adoption Equation

- We define the demand q_t as the probability of adoption P_t times the potential market sizes M_{it} in each region (now NE, SE, NW, SW, Bretagne) at each point in time:

$$q_t = M_{it}.P_t \text{ where } P_t = \frac{\exp(V_{it})}{1 + \exp(V_{it})}$$

$$V_{it} = NPVu_t = FIT_t.E.\sum_{k=1}^{N} \frac{1}{(1+\delta)^k} - \frac{p_t}{E}$$

$$p_t = p_0.\left(\frac{x_t}{x_0}\right)^{-b} \text{ where } b = \frac{\log(1-\eta)}{\log 2}$$

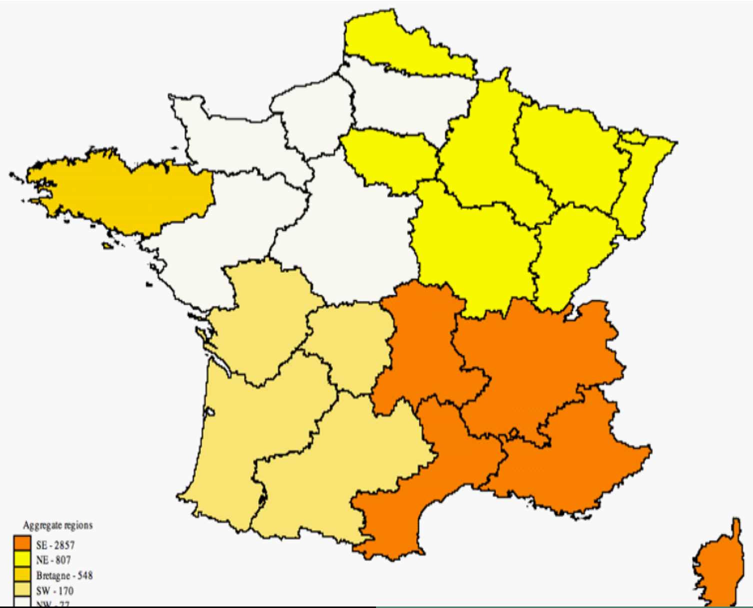
where b **is an elasticity coefficient**, η **is the learning rate**.

- In average, coefficient $b = -0.3387$ and $\eta = 0.209$: the average system **price is reduced** by **21%** each time that installed **capacity doubles**.
- Combined with the logit equation, after assuming that $q_t/M_{it} < 1$ and $M_{it} = M_i$, and applying a log transformation gives $\log(q_t) = NPVu_t$, that is

$$\log(q_t) = a_1.\log(NPV_{it}). + a_2\log(x_{it}) + a_{3it} + \varepsilon_t,$$

where x_{it} accounts for the diffusion.

Our Regionalization



Estimation Results

Variable	(1)	(2)	(3)	(4)
ln(NPV)	2.54***	0.50***	0,84	0.45**
Diffusion	0.56***	0.57***	0.66***	0.59***
After 2011		-1.23***	-1.25***	
Bretagne			-1,8	
NW			-0,97	
NE			-0,6	
SW			-0,75	
SE			-1,05	
Bretagne				-1.70*
NW x after 2011				-1.54***
NE x after 2011				-1.02***
SW x after 2011				-1.13***
SE x after 2011				-1.55***
Cons.	-3.66***			
N	85	85	85	85
R2	0,53	0,92	0,92	0,91

legend: * p<.1; ** p<.05; *** p<.01

Interpretation

- Model (1) both the NPV and diffusion effect are significant.
- Model (2) both the FiT and the diffusion effect remain significant but the coefficient values attached to these variable change dramatically due to decrease in demand after **2011**.
- Model (3) results are mainly driven by the 2011 dummy.
- Model (4) shows that indeed the **decrease** in the development of the PV market is **different among regions**: Bretagne is particularly affected, followed by NW and SW.

Optimal FIT trajectories

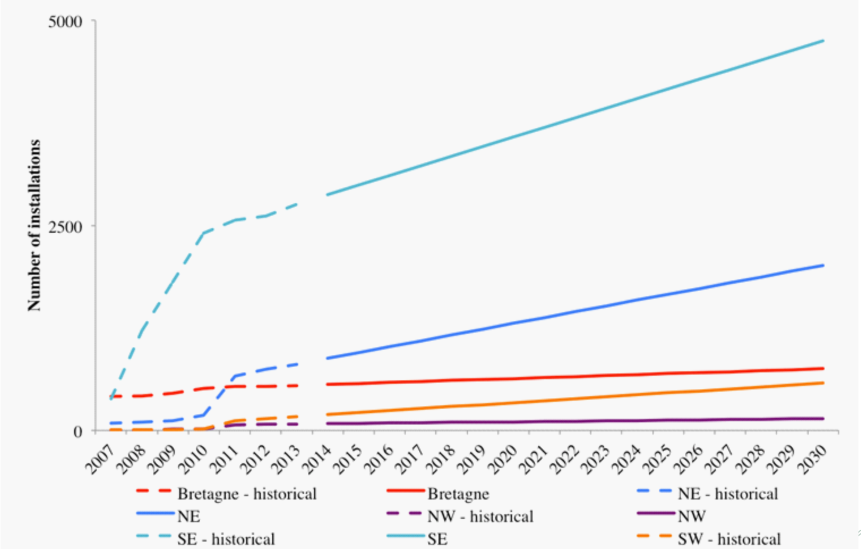
Assume 3 alternative expansion objectives:

1. **Current growth rate until 2030**: we continue the trend after 2011.(at national level adds 203 units per year, 7810 in total).
2. **Doubling capacity in 2030** as compared to 2013 (256 per year nationally)
3. **Sustained growth rate until 2030**: 5% per year (exponential expansion path with 9991 installations in total by 2030).
    - Both in national and regional cases.

For each scenario we determine a **path** for the level of adoption at each period until 2030. Using the adoption level determined by each scenario, we calculate the corresponding **net present value** per period. Then, **considering learning** coefficient estimated, we are able to calculate the (decreasing) **price** of panels and consequently the **optimal FiT** needed to reach the net present value calculated.

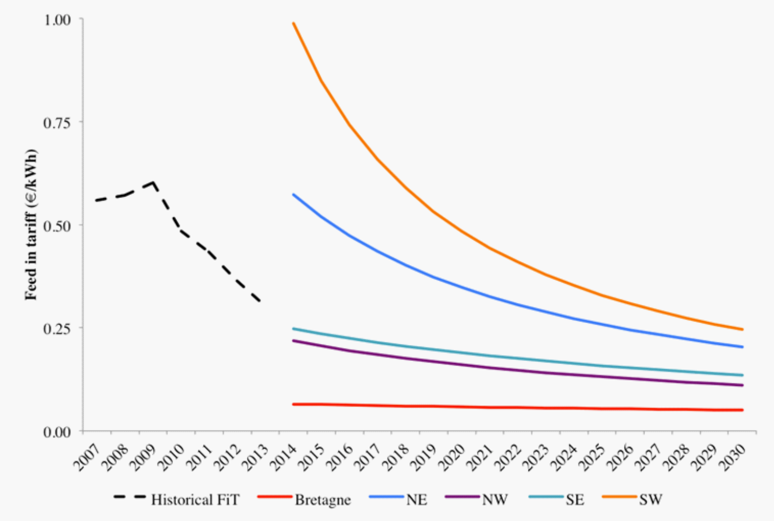
Current growth scenario by region

Trajectories



Current growth scenario by region

FiT



Current expansion interpretation

- For **SW** to follow this path, a very high FiT of nearly 1 €/kWh is required in the short run quickly decreasing to 25 c€/kWh in 2030.
- **NE** requires a FiT of 57 c€/kWh first, gradually reducing to 20 c€/kWh in 2030.
- In contrast, **NW** and **SE** regions where solar panels are the least and the most developed, respectively, this scenario allows the government to gradually lower the FiT rates from about 25 c€/kWh to about 12 c€/kWh.
- **Bretagne** shows slow growth rate in recent years so continuing in this trend only requires a low FiT of 5-6 c€/kWh.

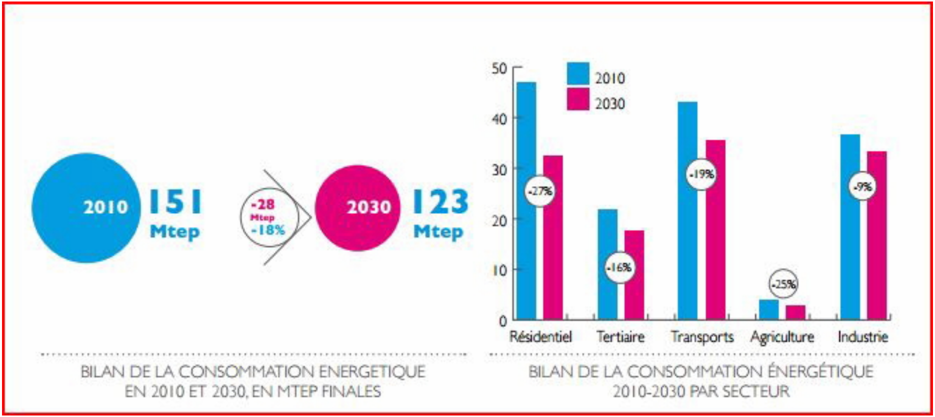
Conclusion

- Notorious slow down in the adoption of small PV.
- Waves of adoption that alternate in different regions.
- Thin profitability and no grid parity: verified by the estimation results where the episode in 2011 has a significant impact: highly dependant on incentive policies.
- Strong learning in small PV (21% decrease in price when capacity doubles) due to decrease in material prices.
- Very ambitious PV development objectives may need an increase in FiT but most realistic scenarios show that, thanks to learning effects, optimal FiTs are generally decreasing.
    - Regional differences should be considered to fix optimal FiTs.

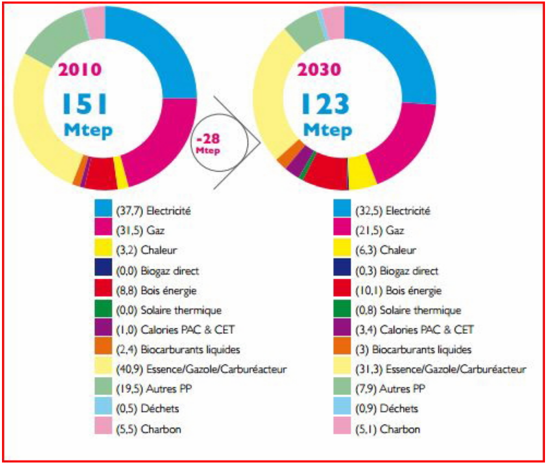
The End

ADEME Projections for 2030

- Total consumption decreases in 18% and buildings are the main contributors with 54% (first two).



ADEME Projections for 2030 (II)



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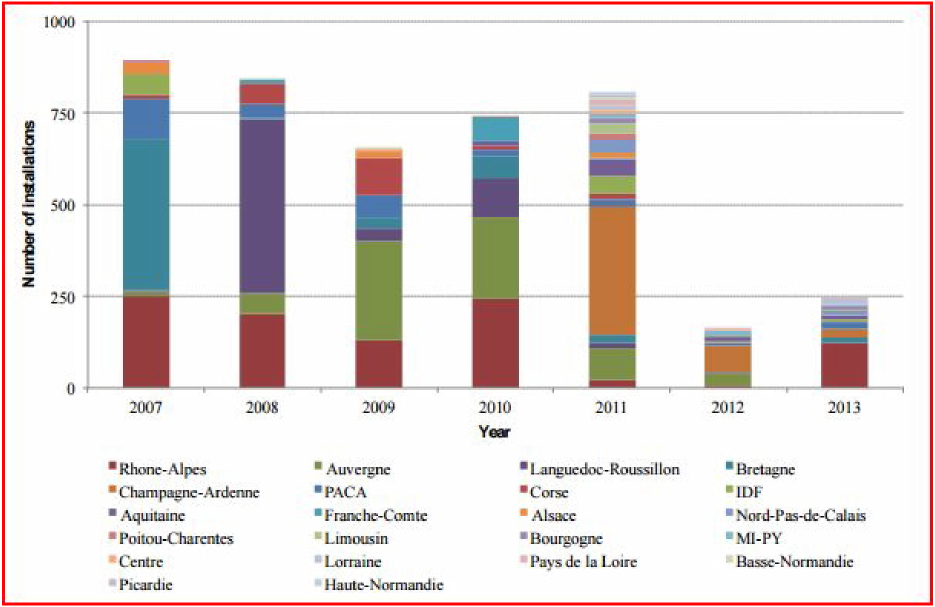
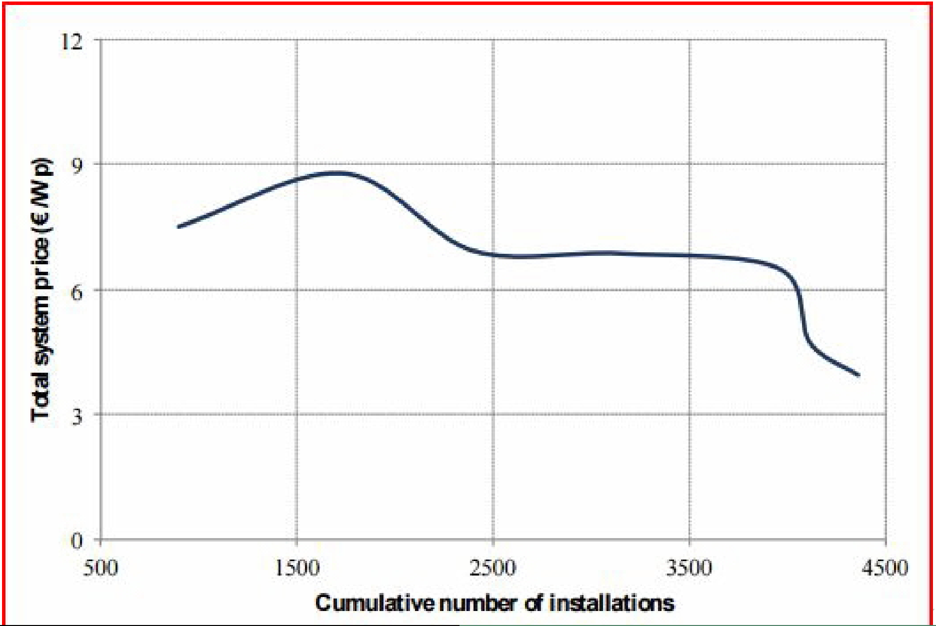


1000
750
500
250
0
Number of installations
2007
2008
2009
2010
2011
2012
2013
Year
Rhone-Alpes
Auvergne
Languedoc-Roussillon
Bretagne
Champagne-Ardenne
PACA
Corse
IDF
Aquitaine
Franche-Comte
Alsace
Nord-Pas-de-Calais
Poitou-Charentes
Limousin
Bourgogne
MI-PY
Centre
Lorraine
Pays de la Loire
Basse-Normandie
Picardie
Haute-Normandie

Back

Exploring the relationship P and Q



PV market in Europe