Is mandating smart meters smart?

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  2. What is the business case for a "smart electricity" supplier?
  3. If total benefits from smart meters exceed the total costs, how do we allocate these?

The model

- Joskow and Tirole (2007) model: optimal investment, spot and retail prices, and rationing, when a fraction of customers α faces wholesale spot price, and $(1-\alpha)$ faces a constant retail price
- Equivalent to perfectly competitive long-term outcome
- Uncertain demand. Infinite number of possible states of the world, indexed by $t \geq 0$
- A single demand profile for all customers
- N generation technologies, with marginal cost c_n (increasing in n) and investment cost r_n (decreasing in n)

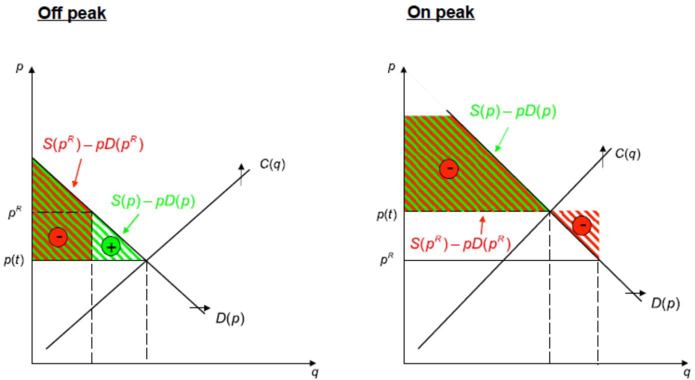
Optimal investment, prices, and rationing

1. Rationing price reactive customers never optimal
2. Constant price customers are rationed if and only if their Value of Lost Load $(VoLL)$ is equal to (or lower than) $p(t)$, the wholesale spot price in state t
3. The optimal retail price is the weighted average wholesale price, where the weights are the marginal "rationed demand"
4. Total installed capacity determined by (r_N, c_N) and demand. Installed capacity for technology $n < N$, determined by (r_n, c_n) and (r_{n+1}, c_{n+1})
5. Expected price independant of α:

$$\mathbb{E}[p(t)] = c_1 + r_1$$

Increasing the share of price reactive customers increases net surplus

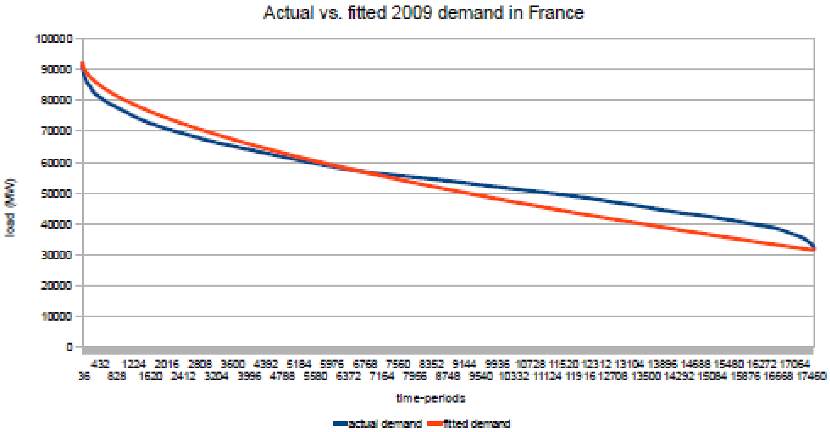
- A marginal increase in α transforms customers facing a constant price into customers facing the marginal cost of production in every state of the world



A specific case

- Linear inverse demand: $P(q,t) = a_0 - a_1 e^{-\lambda_2 t} - bq$
- Exponential distribution of the states of the world: $f(t) = \lambda_1 e^{-\lambda_1 t}$
- $\left(a_0, a_1, \lambda = \frac{\lambda_1}{\lambda_2}, b\right)$ calibrated using the average elasticity of demand η for a given price δ, and the 2009 French load duration curve
- Provides (almost) closed form expressions for optimal investment, prices, and marginal surplus $W'(\alpha)$
- Base case $\eta = -0.05$ at price $\delta = 100$ €$/MWh$, from Lijesen (2007). Upper estimate from Patrick and Wolak (1997) using UK data, and much higher than Lijesen (2007) own estimate on Dutch data, consistent with estimates from California experiment (Faruqui (2006)). Robustness check with $\eta = -0.1$.

Actual vs. fitted demand



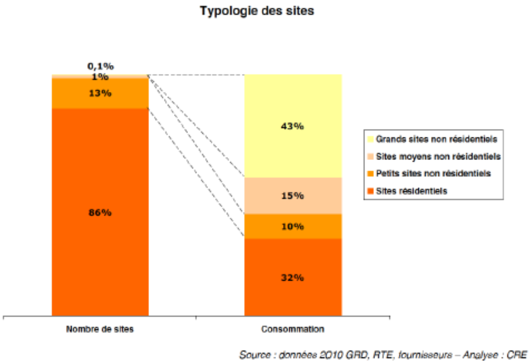
Technologies and production costs

- Two technologies: nuclear plants $(n = 1)$ and gas turbines $(n = 2)$
- Cost provided by IAE (2010)

	1	2
c_n	10.99	71.56
r_n	34.16	6.00

Number of sites and demand share data by customers class

Customers broken down in 4 classes, following the Commission de Régulation de l'Energie (CRE)



Marginal share increase per customer decreases rapidly

- Assume customer size (in *MWh*) constant within each class

α (%)	$(0, 43)$	$(43, 58)$	$(58, 68)$	$(68, 100)$
$\delta\alpha$ (%/*user*)	1.24×10^{-5}	4.31×10^{-7}	2.21×10^{-8}	1.07×10

- Marginal surplus per customer is $\delta W(\alpha) = W'(\alpha)\,\delta\alpha$. Discontinous at the boundaries between classes. Define $\delta W^{-}(\alpha) = W'(\alpha)\,\delta\alpha$ for $\delta\alpha < 0$ and $\delta W^{+}(\alpha) = W'(\alpha)\,\delta\alpha$ for $\delta\alpha > 0$

Marginal benefits from switching for base elasticity estimate...

α (%)	15	43	58	68	100
K_1 / Q^{∞} (%)	59.3	59.3	59.3	59.3	59.4
K_2 / Q^{∞} (%)	95.7	92.7	91.6	90.9	89.1
$W'(\alpha)$ (€ millions/year)	688	436	389	366	324
δW^{-} (€ /user/year)	8512	5386	168	8	3
δW^{+} (€ /user/year)	8512	188	9	4	n/a

... and for high elasticity estimate

α (%)	16	43	58	68	100
K_1/Q^∞ (%)	61.1	61.2	61.2	61.3	61.4
K_2/Q^∞ (%)	95.6	91.7	90.2	89.2	86.7
$W'(\alpha)$ (€ millions/year)	981	681	620	592	533
δW^- (€ /user/year)	12 129	8 419	268	13	6
δW^+ (€ /user/year)	12 129	294	14	6	*n/a*

Comparison point: cost of real time meters

- Cost of a real time meter estimated at €250, assumed independent of the characteristics of the site where the meter is installed, in particular peak-demand.
- Assuming a cost of capital at 10%, the annualized cost of each meter is 25 €/meter/year.

Conclusion and next steps

- Preliminary analysis suggests switching to real time pricing generates net surplus from consumption estimated around 10 €/customer/year for small customers. If confirmed, this finding would challenge the smart meters business case for these customers.
- Additional analysis is required, that will:
  - develop and test other specifications for demand and uncertainty
  - apply to other markets
  - incorporate market power (Allcott (2010))