

Market Design for a Decarbonized Electricity Market

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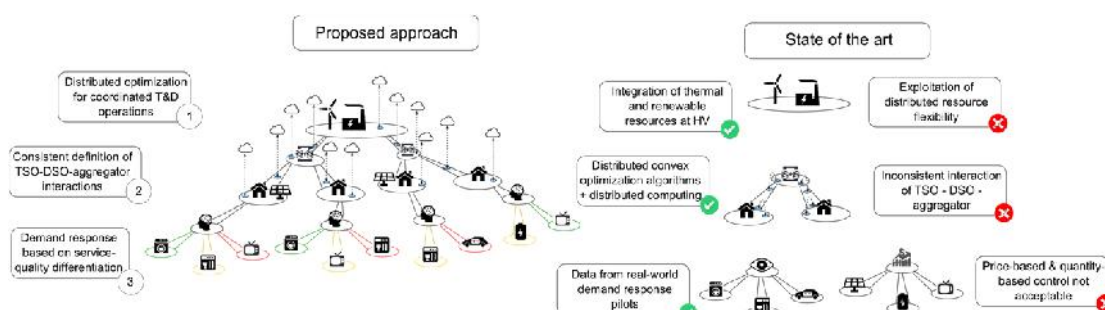
Université Catholique de Louvain

June 7, 2017

Joint EURELECTRIC-Florence School of Regulation event:

Design of the Electricity Market(s) of the Future

A Vision for Future Energy Systems



Zooming in on Scarcity Pricing

- Commission de Régulation de l'électricité et du Gaz (CREG) raised concerns about whether adequate incentives are in place in order to attract investment in **flexible** power generation in Belgium
- Question addressed in first study: *How would electricity prices change if we introduce **scarcity pricing** (Hogan, 2005) in the Belgian market*
- Study results: A. Papavasiliou, Y. Smeers, 'Remuneration of Flexible Capacity under Conditions of Scarcity', forthcoming in the Energy Journal
- Follow-up study:
 - Impact of strategic reserve
 - Impact of VOLL
 - Impact of nuclear capacity restoration
 - Impact of day-ahead (instead of month-ahead) clearing

(Hogan, 2005) W. Hogan, *On an Energy-Only Electricity Market Design for Resource Adequacy*. Center for Business and Government, JFK School of Government, Harvard University, September 2005.

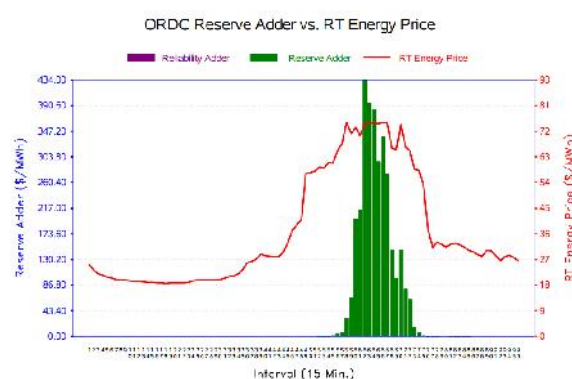
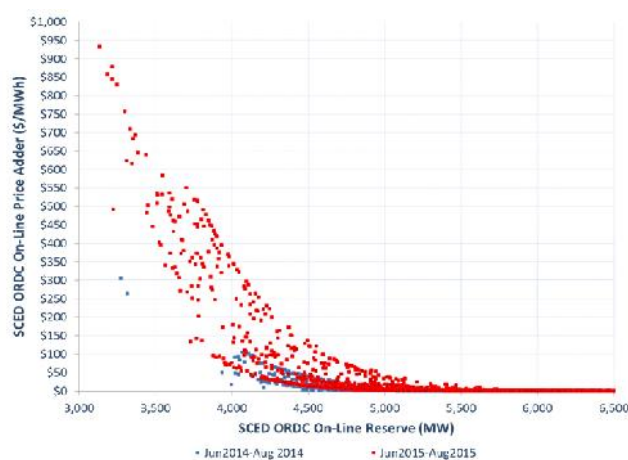
Scarcity Pricing through Operating Reserve Demand Curve (ORDC)

- Reserve is procured by the system operator from generators in order to ensure reliability, which is a public good
- Demand for reserve can be driven by its value for dealing with uncertainty, based on engineering principles:
 - Above a max threshold ($Q_{\max}$), extra reserve offers no additional protection $\Rightarrow (P, Q) = (0, Q_{\max})$
 - Below a min threshold ($Q_{\min}$), operator is willing to curtail demand involuntarily $\Rightarrow (P, Q) = (VOLL, Q_{\min})$, where VOLL is value of lost load
 - At $Q_{\min} < Q_i < Q_{\max}$, extra reserve increases probability of preventing load curtailment $\Rightarrow (P, Q) = (L \cdot \frac{Q_i - Q_{\min}}{Q_{\max} - Q_{\min}}, Q_i)$, where LOLP is loss of load probability

ORDC Price Adders

- Price adder: $\Delta P = (C_m - C_{min}) \cdot \frac{(R - R_{min})}{(R_{max} - R_{min})}$, where C_m is the marginal cost of the marginal producer, C_{min} is the available reserve, and R_{min} is the minimum threshold of reserve
- This adder would ensure that a price taking agent that offers energy and reserve capacity would, in equilibrium, dispatch its unit according to the optimal schedule
- More frequent, lower amplitude price spikes
- Price spikes can occur even if regulator mitigates bids of suppliers in order to mitigate market power

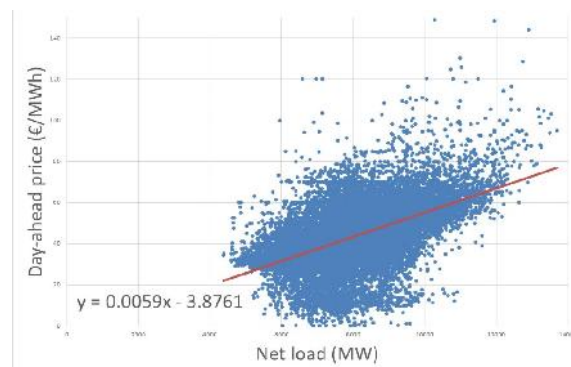
Illustration from Texas: July 30, 2015



Understanding the Belgian Market

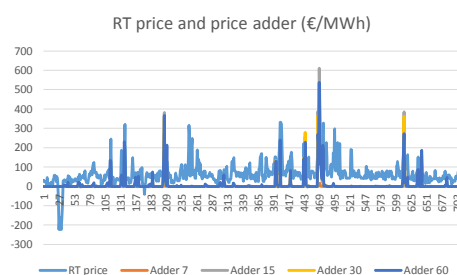
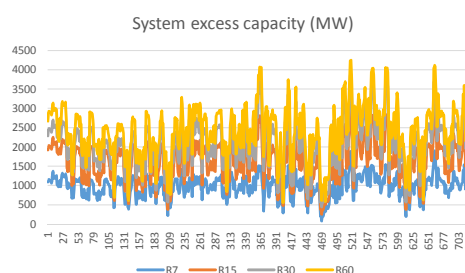
- Possible causes for variability of supply function

- Outages
- Unit commitment
- Imports/exports
- Reserves
- Distributed renewables (not measured)
- Pumped storage
- Combined heat & power, must-take resources
- Fuel price fluctuations
- Market power
- ~~Forward/bilateral commitments~~
- ~~Demand side bidding~~



Price Adders, January 2013

- A deeper time horizon implies more reserves are available...
- ... but conditions are also more uncertain



CCGT Profits and Adder Benefits

	Price (€/MWh), no adder	Price (€/MWh), with adder	Adder benefit (€/MWh)
CCGT1	3.6	10.6	8.5
CCGT2	1.3	3.6	11.6
CCGT3	1.1	10.0	7.7
CCGT4	3.8	11.1	10.0
CCGT5	0.9	6.4	7.5
CCGT6	3.9	8.3	6.8
CCGT7	1.0	3.2	6.8
CCGT8	1.1	8.0	8.0
CCGT9	2.3	11.1	10.1
CCGT10	1.7	7.4	14.9
CCGT11	1.7	4.3	8.6

Remarks

- CCGT seems not to be viable given the market prices of the study (confirming what we have already heard in the policy debate)
- Adders, as computed in the study, could potentially change this for the majority of CCGT units (although there are still three CCGTs that are not profitable after the intro of the adders)
- The average adder for the duration of the study is 6.06 €/MWh, but the adder is effectively much higher for CCGT units (e.g. up to 20 €/MWh for some months)
 - ORDC mechanism rewards flexibility
 - Result of positive correlation of CCGT production with adders/conditions of scarcity

Thank you

For more information

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