SmartNet

Smart TSO-DSO interaction schemes, market architectures and ICT Solutions for the integration of ancillary services from demand side management and distributed generation

SmartNet lessons for an aggregator on broadcasting demand response signals

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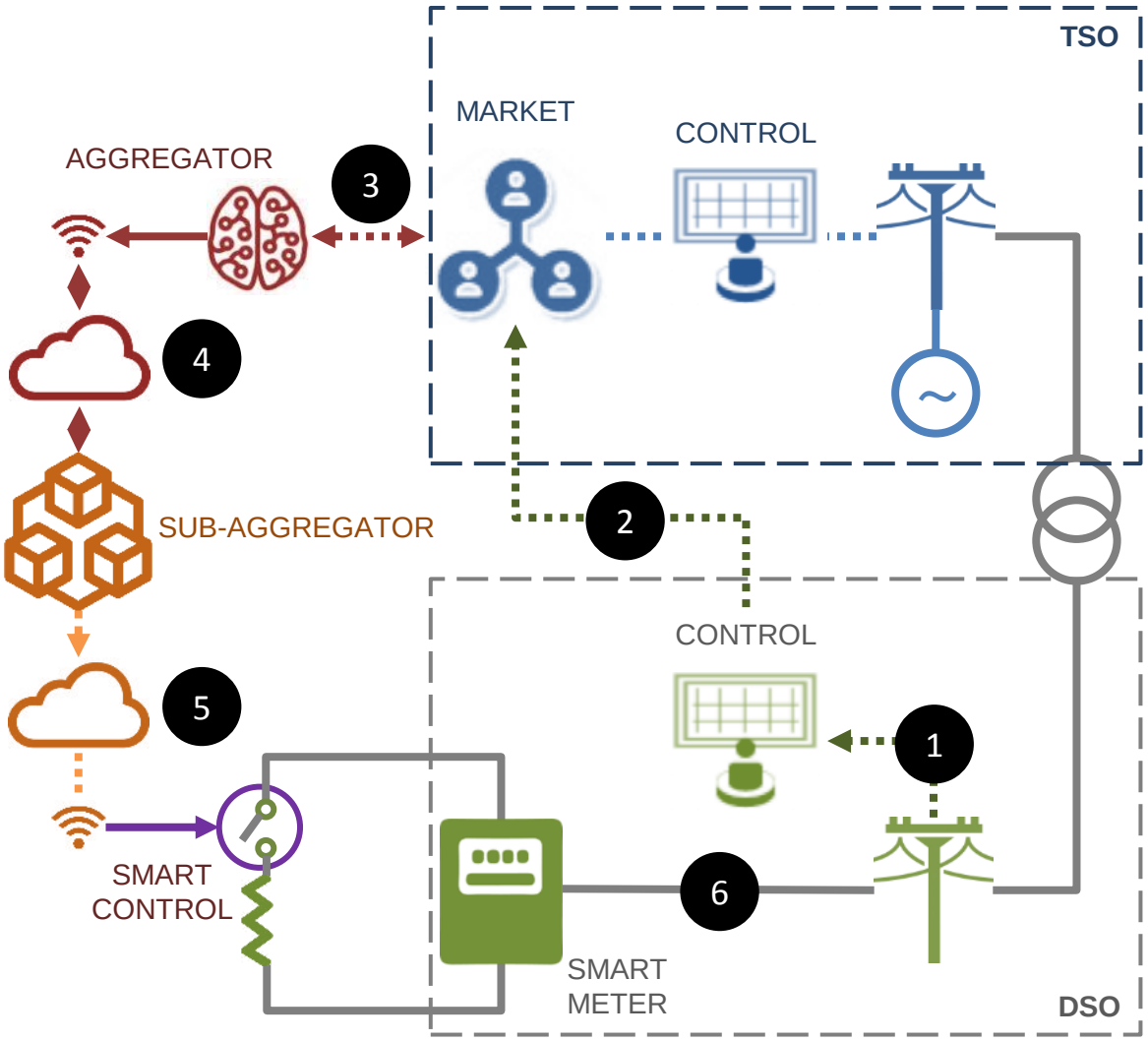
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691405

Agenda

- Schematics
- Infrastructure
- Aggregation
- Paradox
- Conclusions

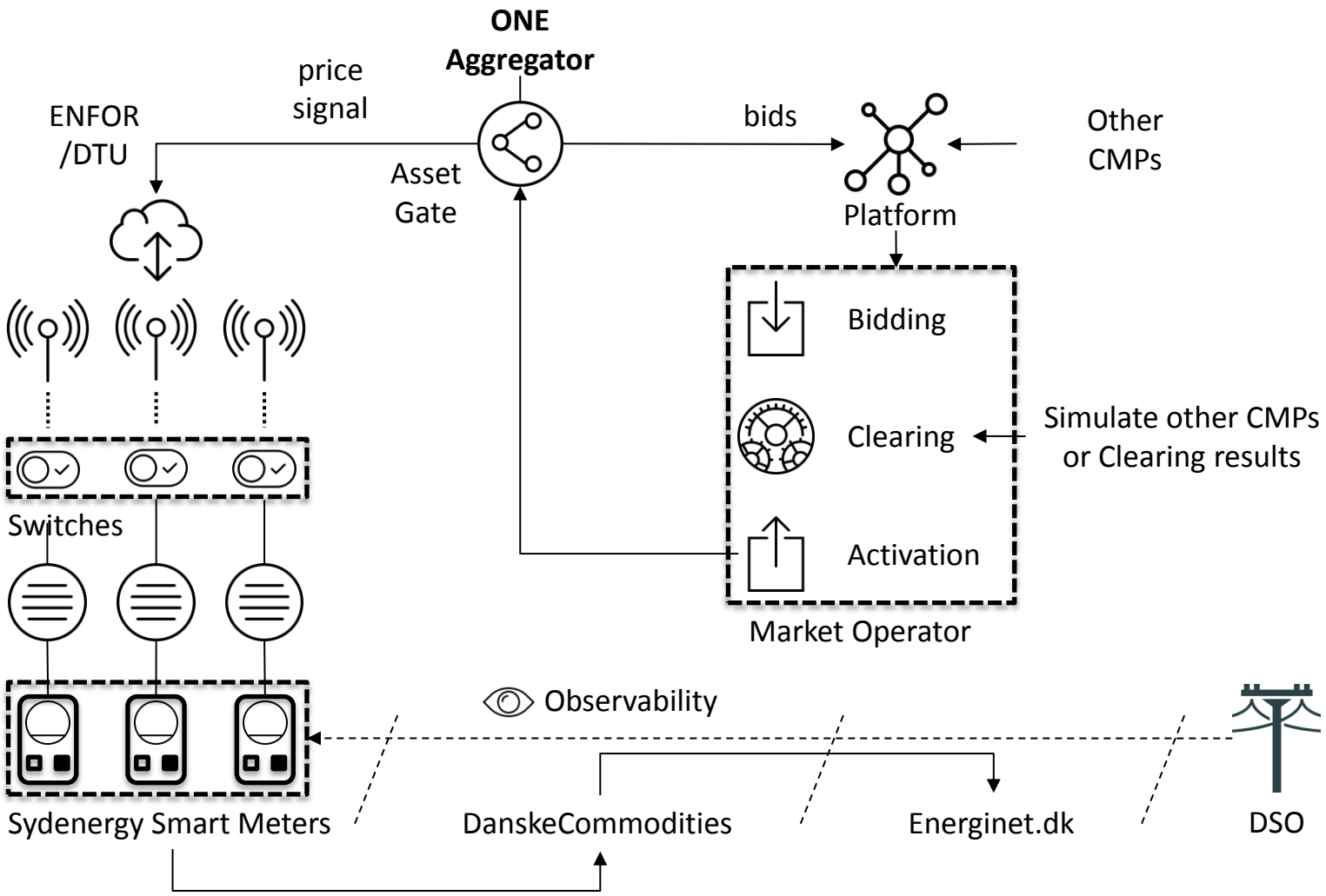
Schematics: Set-up



Sequence of events:

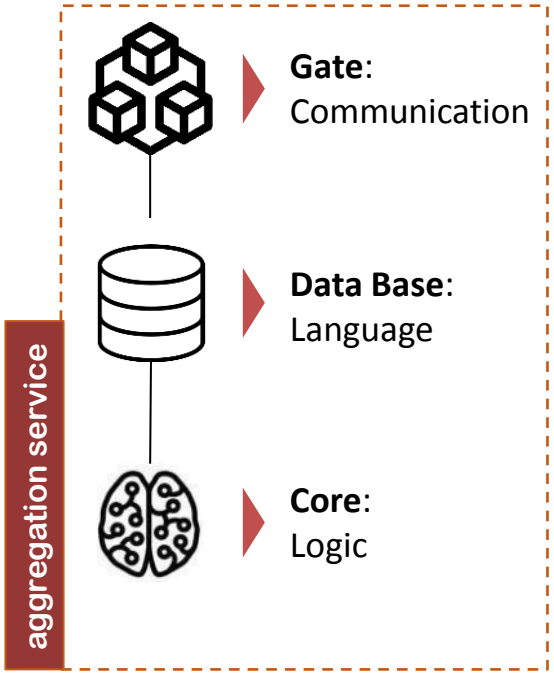
1. Issue
2. Auction resolution
3. Offer resolution
4. Price signal
5. Signal reaction
6. Observability

Schematics: Aggregator

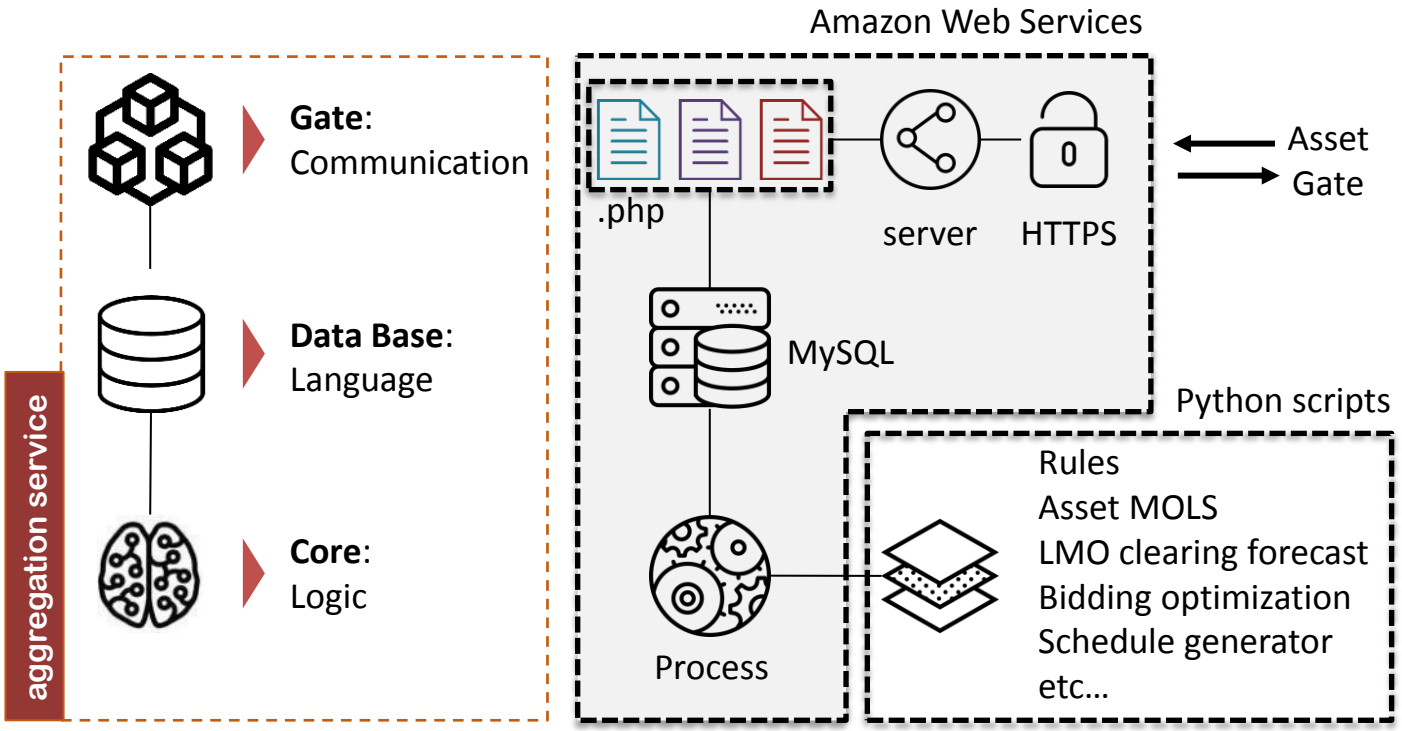


Schematics: Aggregator

- The aggregator 'translates' and takes risks between the transactional market space and the 'soft' unidirectional signals.
- The gate (to market and DERs) was designed to be flexible and easily adaptable to the everchanging requirements from actors.
- We have identified a number of applications of artificial intelligence and deep learning for whose data capturing and structuring is a requisite.
- In the following we Will use as convention that our DER is a consumption asset.



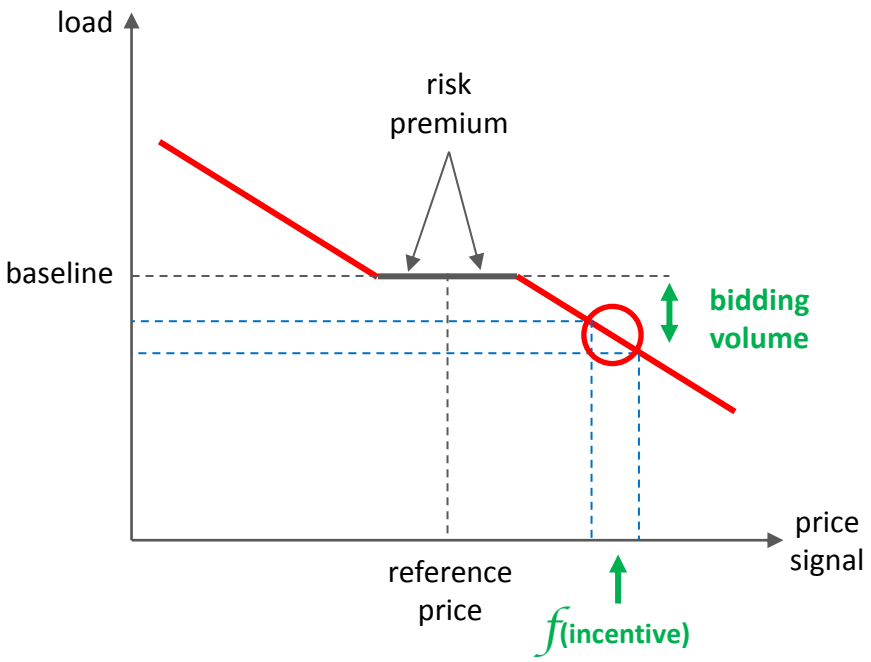
Infrastructure



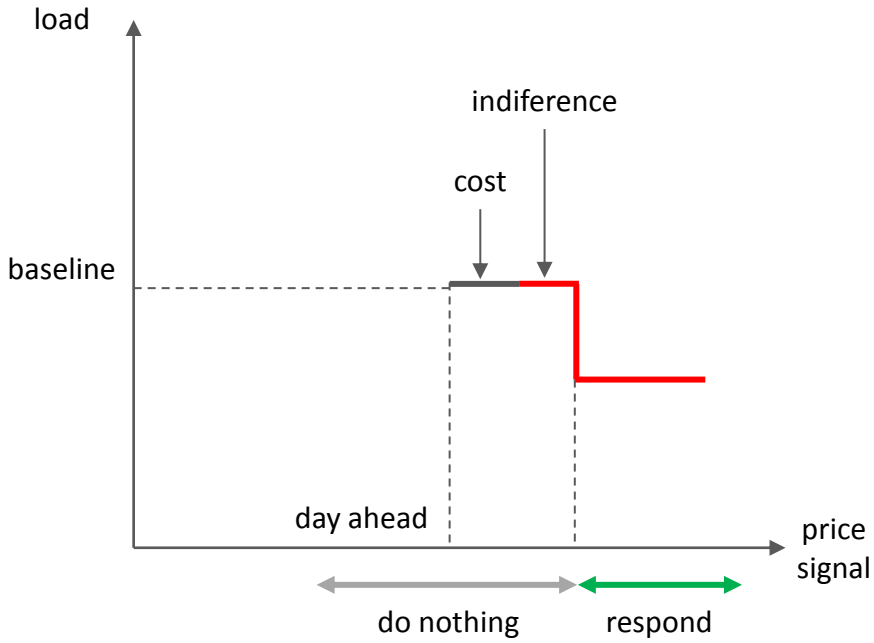
The whole system has been structured around a LAMP server hosted in Amazon Web Services, proving the capacity of such lean infrastructure to deal with the process.

Aggregation: #1

Transactional

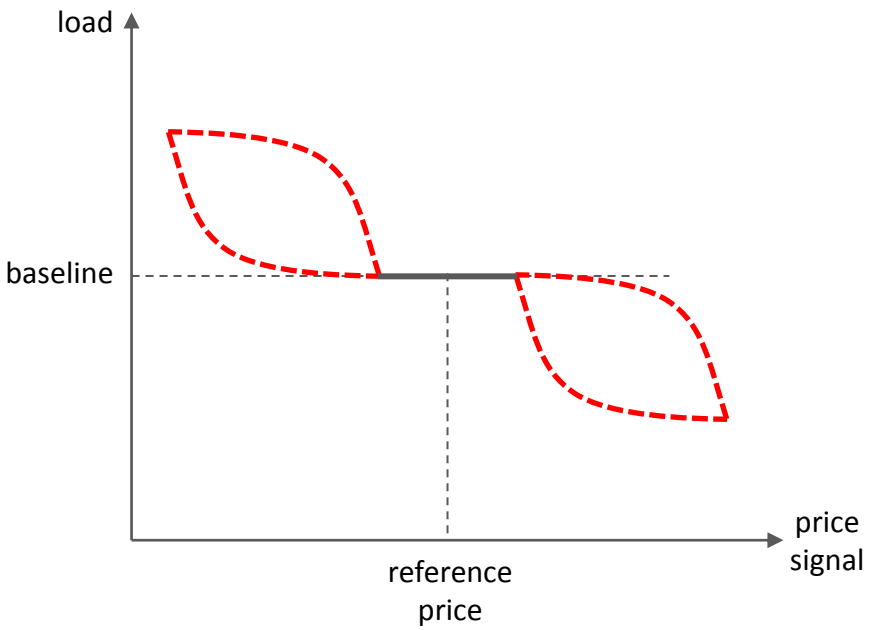


Signals

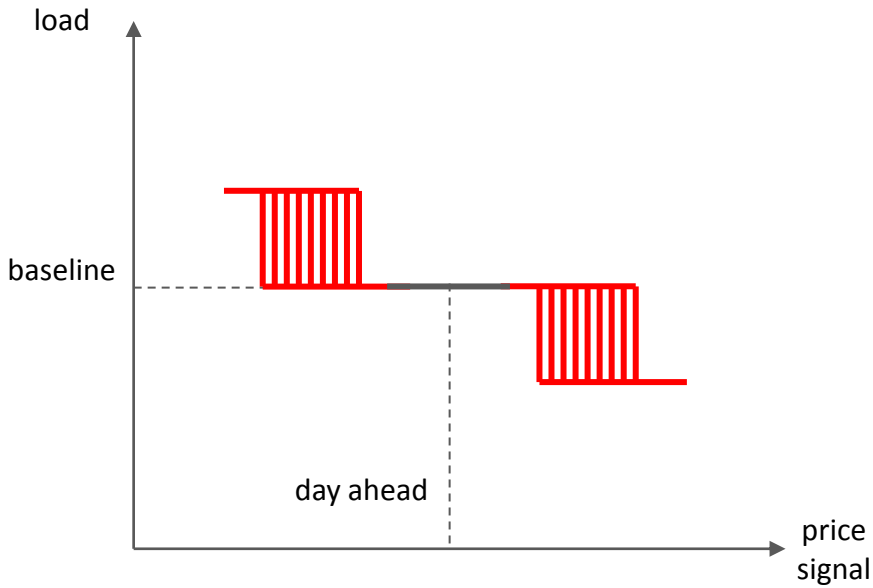


Aggregation: #2

Transactional



Signals

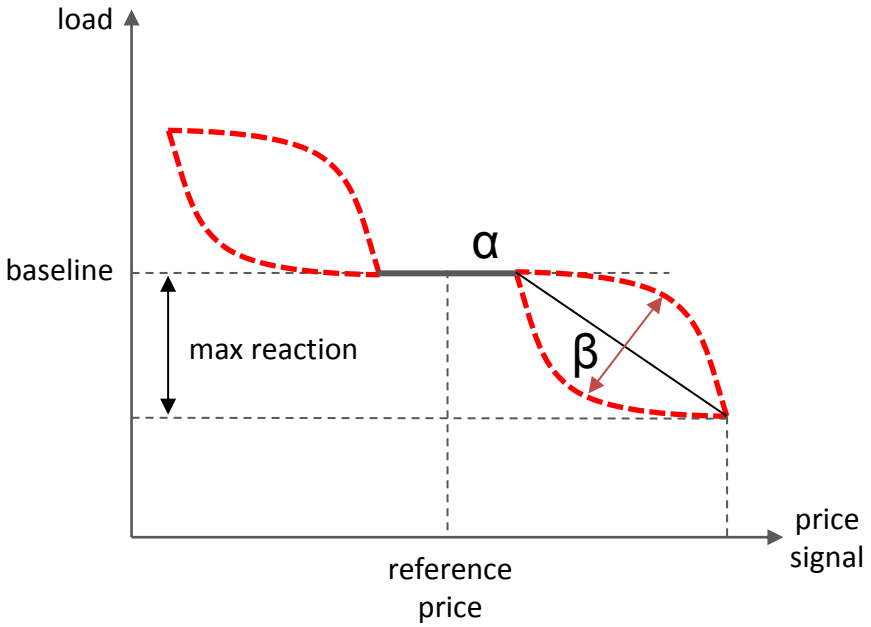


We can encounter differences in activation costs, indifference, symmetry and reaction response amongst many others.

We must transpose those into the transactional space via parametrisation.

Aggregation: #3

Transactional



- Reference price:
  - Day-ahead and last intraday
  - Statistical
- Max reaction (up & down)
  - DERs statistics
  - Date and time
- Activation cost (α)
  - DERs statistics (e.g. rebounds)
  - Date and time
  - Risk premium
- Price elasticity (β)
  - DER statistics (e.g. rebounds)
  - Date and time
  - Risk premium

Paradox:

- A DER has a baseline in a given hour H, 'bought' on spot auction at P
- Aggregator intends to 'modulate' his load via price signal P*:
  - P*>P would incentivise DER to reduce consumption load
  - P*<P would incentivise DER to increase consumption load
- Aggregator weights to auction DER's flexibility; let's assume that:
  - upregulation Price is Pu > P and
  - downregulation Price is Pd < P

- Reminder: The supplier (or aggregator) baseline price for the non-response of the asset is the baseline Price above P

Paradox:

P*>P ⟶ DER 'upregulates'

P*<P ⟶ DER 'downregulates'

upregulation Price is Pu > P

downregulation Price is Pd < P

- If Aggregator bids for downregulation and receives activation, he effectively 'buys' cheap energy (since Pd < P) for the DERs.
- Pd is diluted into P* (P* ≈ Pd x (1-k) + P x k), hence P* < P
- As consequence, there is a true incentive for DER from the 'cheap' energy signal broadcasted; P* < P incentivise extra consumption.
- Moreover the DER has, by means of such mechanism, received and effectively settled its participation to the ancillary market via the cheaper Price.
- Invoicing according to Price signal alone has served as settlement for DER's participation to downregulation.

Paradox:

P*>P → DER 'upregulates'

P*<P → DER 'downregulates'

upregulation Price is Pu > P

downregulation Price is Pd < P

- If Aggregator bids for upregulation and receives activation, he effectively 'sells' the committed energy to DERs at expensive Price (since Pu < P).
- Pu is diluted into P* (P* ≈ Pu x (1-k) + P x k), hence P* > P
- As consequence, there is a true incentive for DER from the 'expensive' energy signal broadcasted to DERs; P* > P incentivise load curtailment.
- However, the DER pays P* (> P) for energy that 'belonged' to him at P, facing an extra cost. The revenue from the transaction is actually captured by the Aggregator who 'buys' at P and sells at Pu (> P).
- Invoicing according to Price signal alone does not serve as settlement for DER's participation to upregulation, thereby requiring an additional incentive mechanism.

Conclussions

- As proven by SmartNet, the logical, software and hardware requirements to effectively aggregate DERs is relatively accessible. Flexibility in the input / output functions cannot be overestimated.
- Parametrisation of the DERs response is critical, presenting a large space for big-data applications and use of deep learning techniques.
- Signal broad casting offers a number of interesting advantages, rendering demand response easily accessible to a broad base of assets.
- However, business models are to be thought thoroughly to create a true incentive alignment between DERs and aggregators.

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