

Nobel Grid Demand-side Flexibility Profiles: the Case for Price Elasticity of Demand



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The Nobel Grid Flexibility Profiling Engine





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The Price-based Flexibility Profiling component

- The Price Based Flexibility Profiling component produces a profile for each customer for peak and off-peak periods, reflecting real-time demand flexibility as a function of:
 - energy retail prices periods
 - environmental context/ conditions, and
 - customer preferences.



 \mathcal{E}_{i}



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An example

- Setting:
 - Customers pay according to a dynamic pricing scheme
 - During peak periods the price is
 - either 0.12 €/KWh
 - or 0.20 €/KWh
 - During off-peak the price is 0.12 €/KWh
 - Outside temperature ranges from -10°C to 40°C
- Key observations:
 - Customers' load is sensitive to both prices and extreme weather conditions
 - Load is expected to be shifted in periods of lower price





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The Profile

Average (own-price) elasticity of demand:

Measures the reduction of the customer's demand in a certain period due to the increase in the price of that period



Cooling or Heating needs due to weather conditions and prices

Average elasticity of substitution:

Measures the load shifting that takes place after a change in price during the previous period(s)





Estimating the new consumption at peak period after a price increase

• The consumption of endpoint i during peak period d and for a new price \mathbf{p}_d is:



Based on AUGMENTED CES MODEL of Ton et al. "Tool for determining price elasticity of electricity demand and designing dynamic price program." Innovative Smart Grid Technologies (ISGT), *IEEE PES*, 2013.



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Estimating the consumption of the next period

• The load of endpoint *i* in the next period is:



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Further usage of price-based profiles

- These profiles can be further processed in order to:
 - come up with the details of a manual DR event for obtaining the desired flexibility level:
 - the new retail price, in case of dynamic pricing schemes
 - otherwise, the quantity that should be curtailed by each endpoint together with the incentive for motivating consumers to adjust their consumption during a certain period
 - calculate the minimum remuneration that an Aggregator would be willing to accept from a DSO/Retailer



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Conclusions & Future work

- The Flexibility Profiling Engine supports all major providers
- The Price Based Flexibility Profiling component
 - relies on the correlation between consumption, prices and environmental conditions.
 - can be used for key operational decisions of Aggregators and Retailers related to Manual DR schemes
- We will use the Price Based Flexibility Profiling component in real-world scenarios in order to:
 - Evaluate its ability to predict the actual flexibility obtained in a real-world setting
 - Test whether/what dynamic pricing schemes can affect consumption at desired level



Thank You!



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