Value of Industrial Demand Flexibility for the European Power System and the Industrial Electricity Consumers

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Enabling PV integration by delivering flexibility to the energy market
Amsterdam, 26th September 2017

This project has received funding from the European Union’s Horizon2020 research and Innovation programme under grant agreement No 646191 - The sole responsibility for the content of this presentation lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither INEA nor the European Commission are responsible for any use that may be made of the information contained therein
Challenges for European power system

- Under-utilized, inefficient generation units required to balance renewables’ variability...or significant renewable power curtailment

- Significant amount of under-utilized generation and network capacity required to cover demand peaks
Role of industrial demand flexibility

Industrial demand flexibility:

- ability of industrial consumers to modify their electricity consumption patterns
- not reduction / increase of overall consumption, but rather shift / redistribution of demand across
- generic model: demand at each hour can be reduced / increased within a proportional limit $\alpha$, as long as the daily consumption does not change

Suitable coordination of industrial demand flexibility can:

- Support system balancing
- Limit peak demand levels
- Enable cost-effective transition to low-carbon future
Whole electricity system model (WeSIM)

WeSIM:
Minimise overall investment and operation costs of European power system

- Investment in network assets
- Investment in generation assets
- Operation scheduling of generation, storage and flexible demand
Benefits for European generation / transmission system

ENTSO-E 10 year network development plan: 7 €bn/year for network investments
Impact on utilisation of energy sources (60% RES scenario)

- Increased utilisation of renewable generation
- Reduced utilisation of peaking units and storage

**α=1%**

**α=5%**

**α=10%**

**α=20%**

**α=50%**

- Wind
- Solar
- Storage
- OCGT
- Oil
Utilisation of industrial demand flexibility ($\alpha=20\%, 60\%$ RES scenario)
Flexible industrial consumer market model

Quantification of system benefits

Objective function:
Minimise overall electricity cost of flexible industrial consumer

Operational constraints of flexible industrial consumer

Prices of energy, balancing and capacity services

- Energy procured by the consumer in the energy market
- Volume of balancing services offered by the consumer
- Peak demand of consumer in the examined horizon

Case study: Steel plant with actual yearly demand profile
Benefits for flexible industrial consumer ($\alpha=10\%$ scenario)
Impact of higher individual flexibility

Cost savings (%)

- Countries: Belgium, France, Germany, Italy, Spain, UK
- RES targets: 30%, 60%
- Parameter: $\alpha_c$ (1%, 5%, 10%, 20%, 50%)

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Impact of higher system flexibility

Cost savings (%)

α_s=1%  α_s=5%  α_s=10%  α_s=20%  α_s=50%

Belgium  France  Germany  Italy  Spain  UK
30% RES

Belgium  France  Germany  Italy  Spain  UK
60% RES

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Main findings

• Numerous value streams of industrial demand flexibility:
  ➢ Reduction of system operation costs by enabling higher utilisation of renewable and cheaper energy sources and providing balancing services (reserves, frequency response)
  ➢ Reduction of generation and network investments by limiting peak demand levels and limiting the required generation flexibility

• Synergy between renewable generation and industrial demand flexibility:
  ➢ Industrial demand flexibility increases the utilisation of renewable generation
  ➢ System cost and industrial consumers’ cost savings are more significant under higher renewable generation levels
Relevant deliverable report (5.1)

http://www.industre.eu/downloads/category/project-results
Stochastic unit commitment model (SUCM)

- Technical and cost parameters (Rated output, MSG, Ramp-rates, Min up-/down-time, Response slope, Efficiency curve, Fuel costs, Start-up costs, Emissions)
Overall modelling approach

Future scenarios
2030 horizon

Generation, Transmission and Distribution Investment Optimisation

G+T+D infrastructure assessment

Op assessment

Flexible Industrial demand

System benefits of industrial demand response

Inflexible Industrial Demand

Sensitivity studies
Share of industrial demand per country

Share of industrial electricity consumption
Benefits for European distribution networks

Greatest share of industrial load and low demand growth

Lowest share of industrial load and high demand growth

Country: Belgium, France, Germany, Italy, Spain, UK

Cost savings (%)

- $\alpha=1\%$
- $\alpha=5\%$
- $\alpha=10\%$
- $\alpha=20\%$
- $\alpha=50\%$

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