

Flexible Industrial Electricity Demand Workshop
London, 30th June 2017

Value of Industrial Demand Response for the European Power System

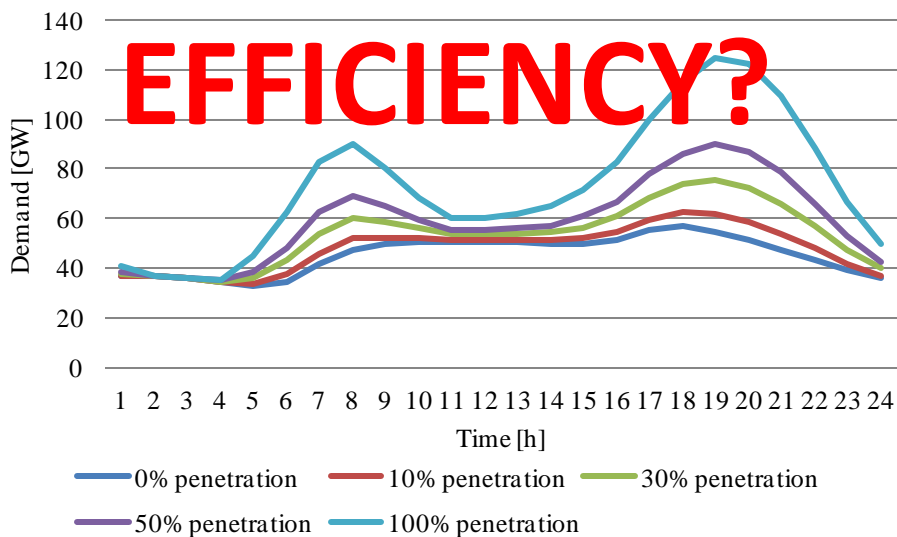
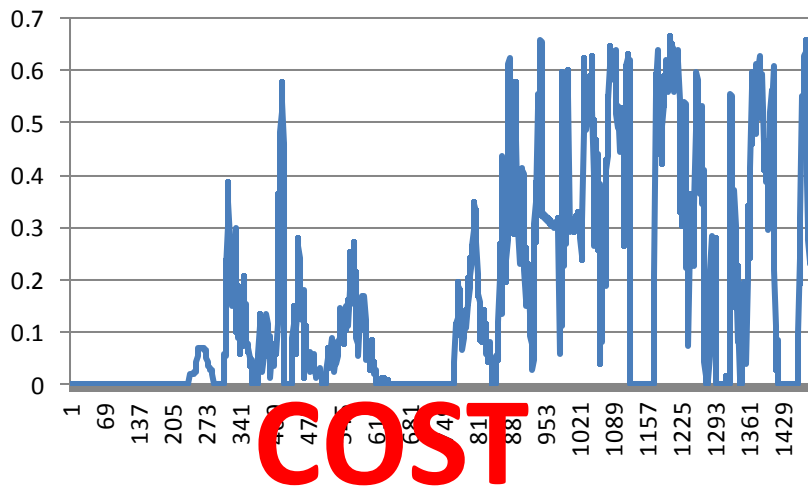
**Dimitrios Papadaskalopoulos, Roberto Moreira, Goran Strbac,
Danny Pudjianto, Predrag Djapic, Fei Teng**
Imperial College London



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Challenges for European power system



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

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



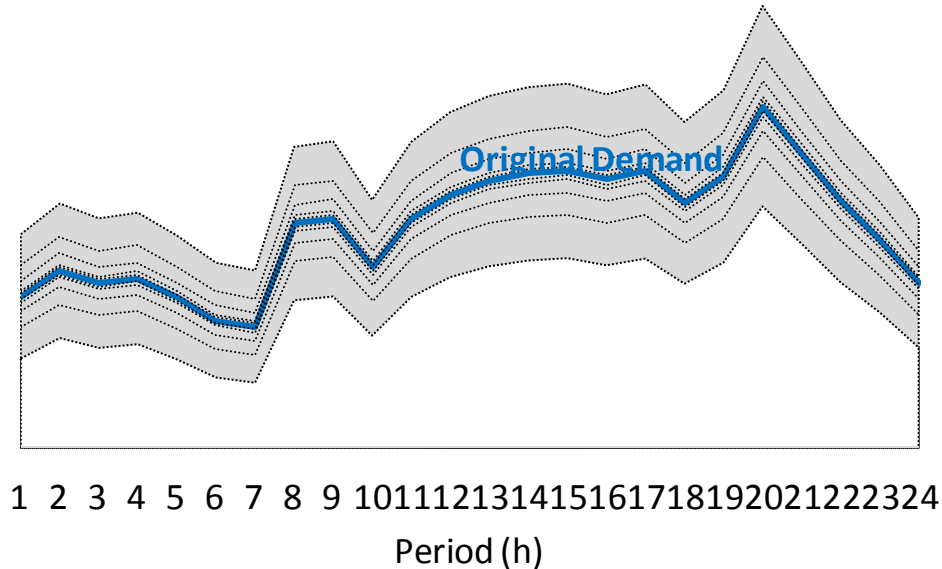
Role of industrial demand flexibility

- Industrial demand flexibility:
 - ability of industrial consumers to modify their electricity consumption patterns
- Suitable coordination of such industrial demand flexibility has the potential to:
 - Support system balancing and therefore reduce the curtailment of renewable generation and the efficiency losses of conventional generation, and
 - Limit peak demand levels and therefore avoid capital intensive investments in under-utilized generation and network assets.



Modelling industrial demand flexibility

- Not reduction / increase of overall consumption, but rather shift / redistribution of demand across time

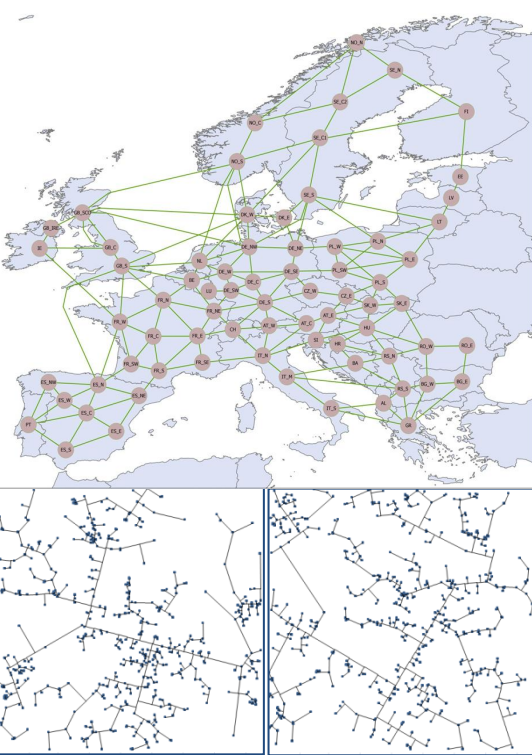


- Generic, process-agnostic model for the representation of industrial demand flexibility is employed in WP5
- Industrial demand at each hour can be reduced / increased within a proportional limit α , as long as the total size of demand reductions is equal to the total size of demand increases within the horizon of a day

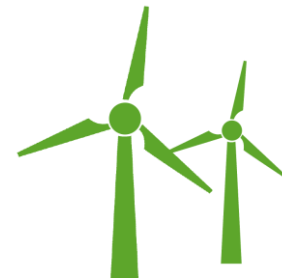
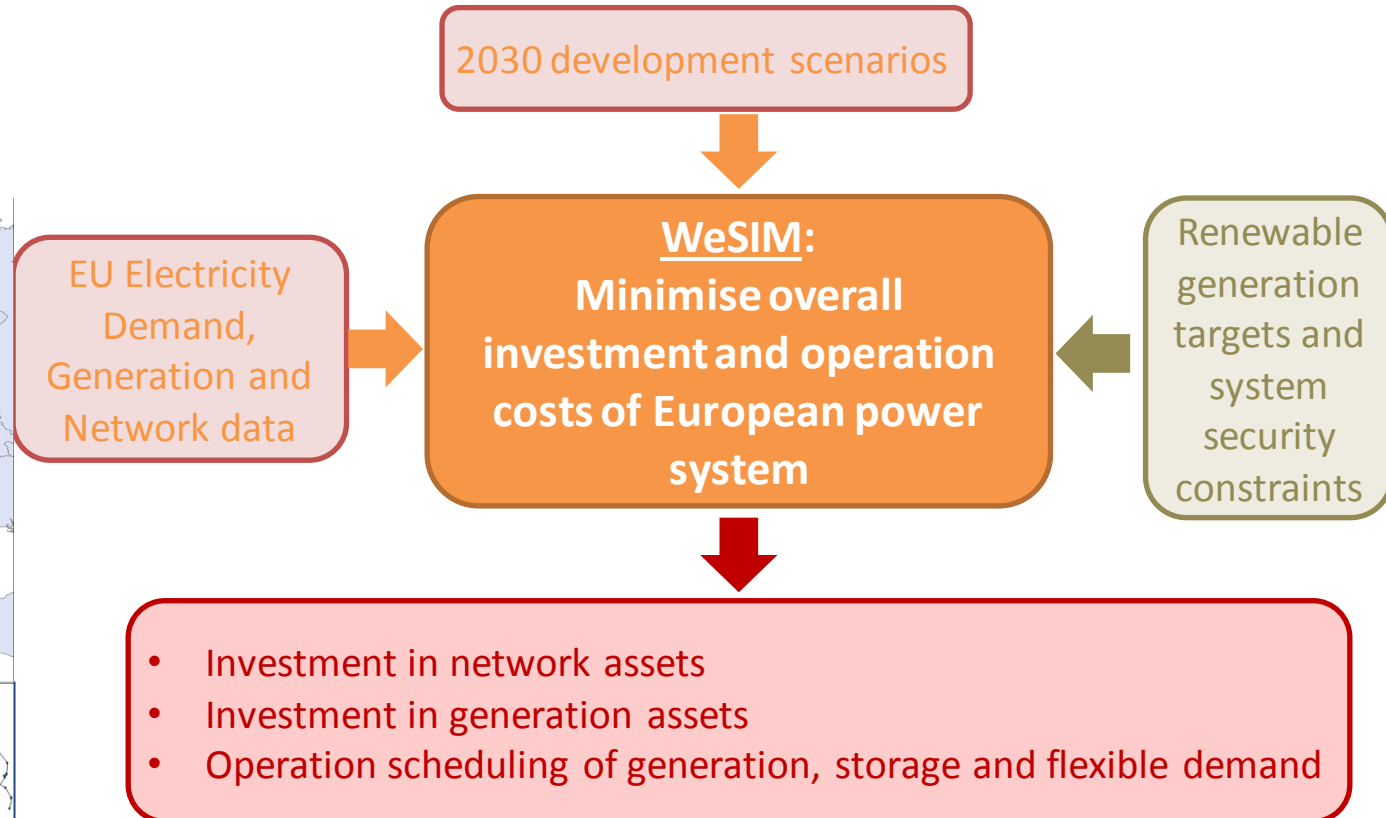


Whole electricity system model (WeSIM)

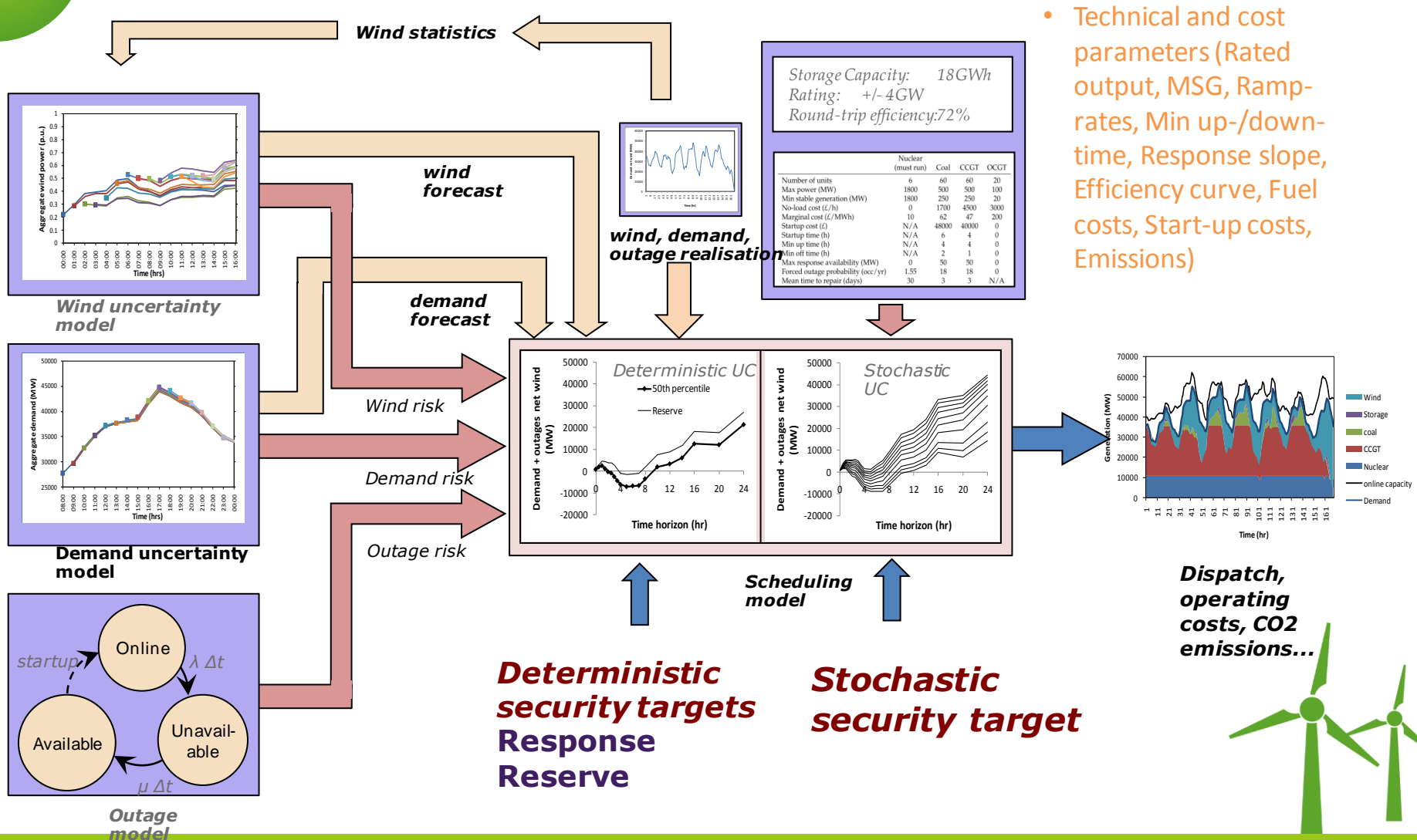
Interconnected EU system



Representative distribution networks in different countries



Stochastic unit commitment model (SUCM)

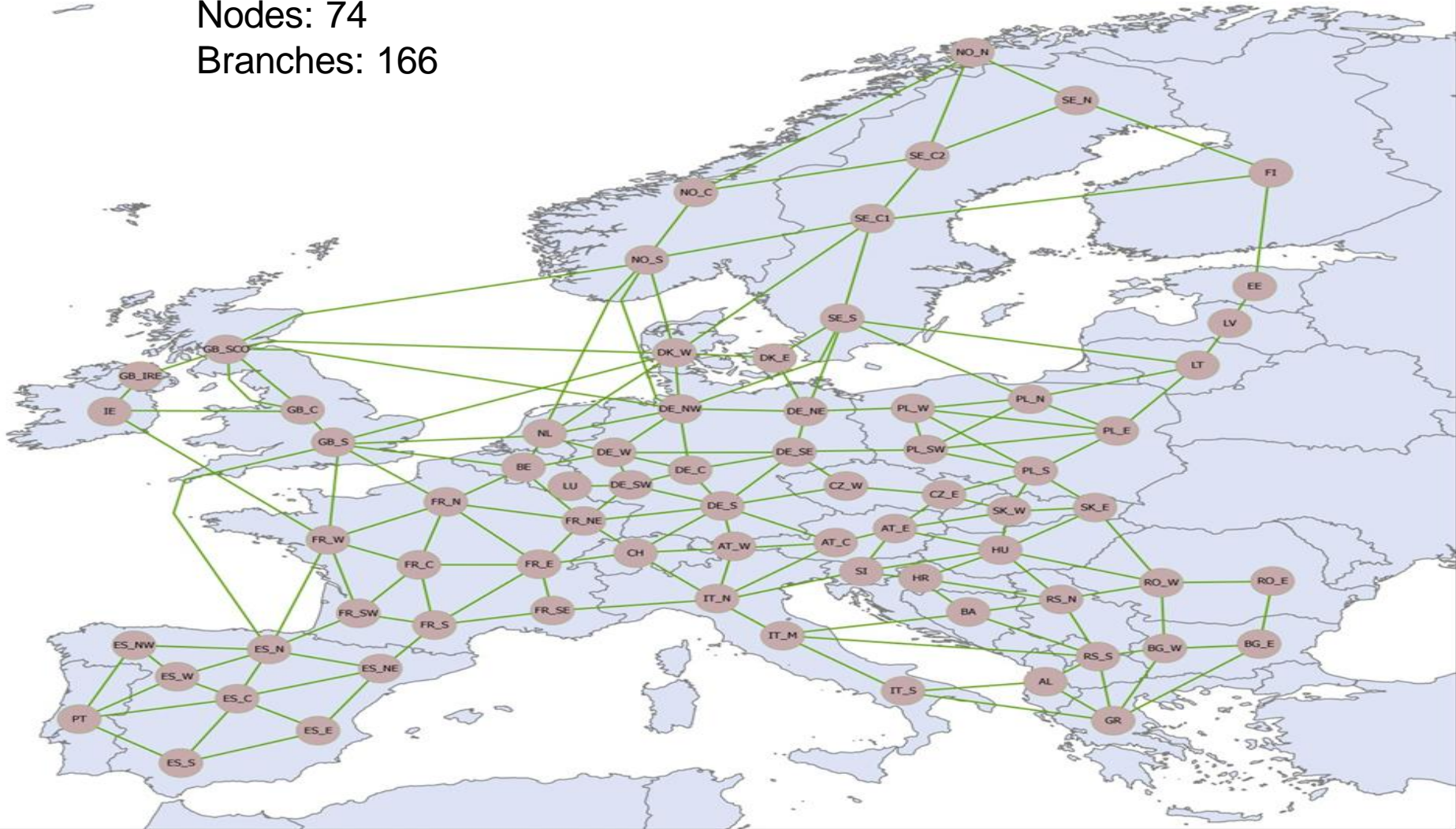


- Technical and cost parameters (Rated output, MSG, Ramp-rates, Min up-/down-time, Response slope, Efficiency curve, Fuel costs, Start-up costs, Emissions)

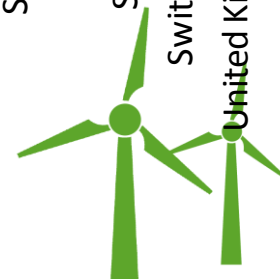
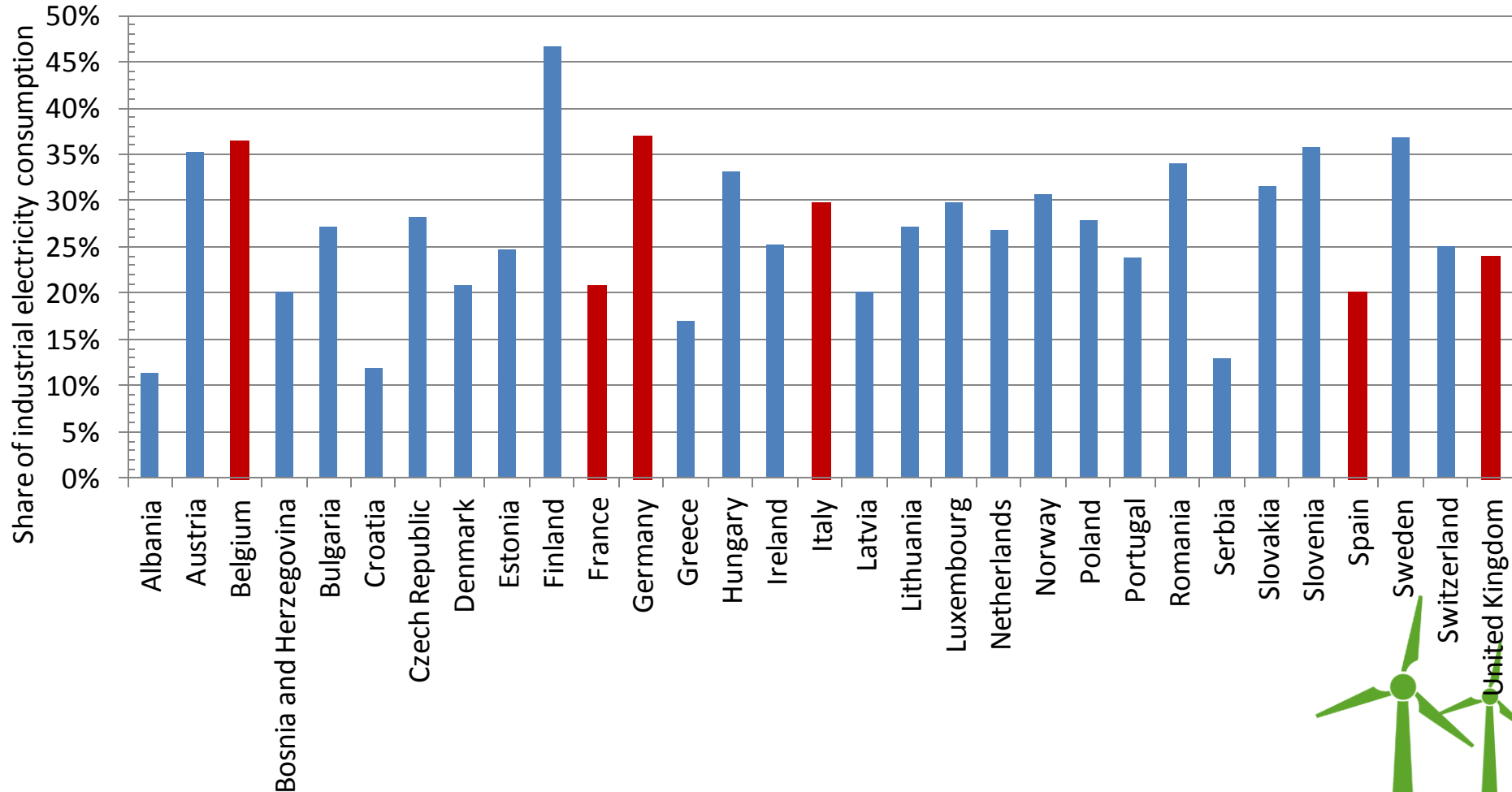


Model of European transmission network

Countries: 31
Nodes: 74
Branches: 166

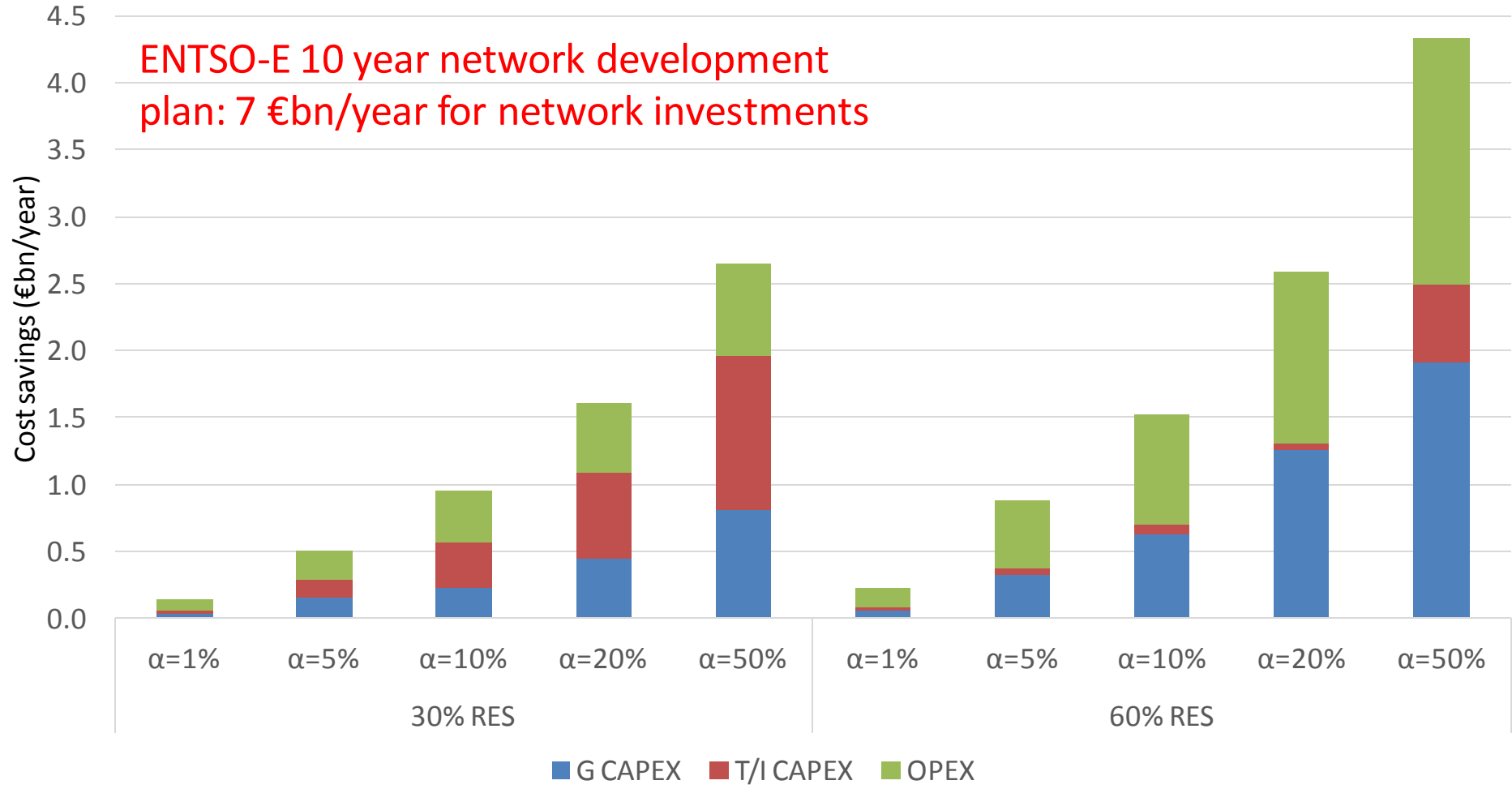


Share of industrial demand per country

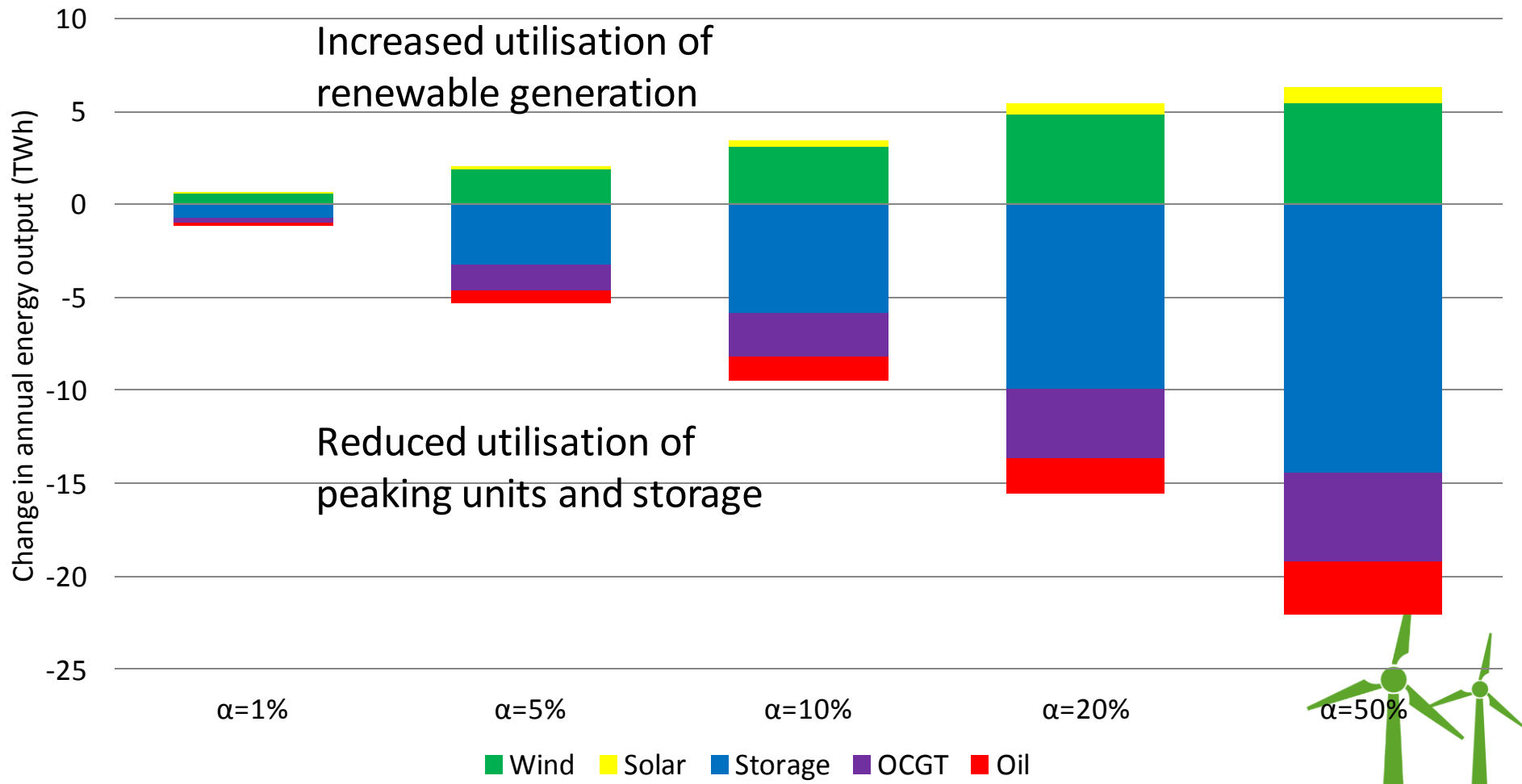


Benefits for European generation / transmission system

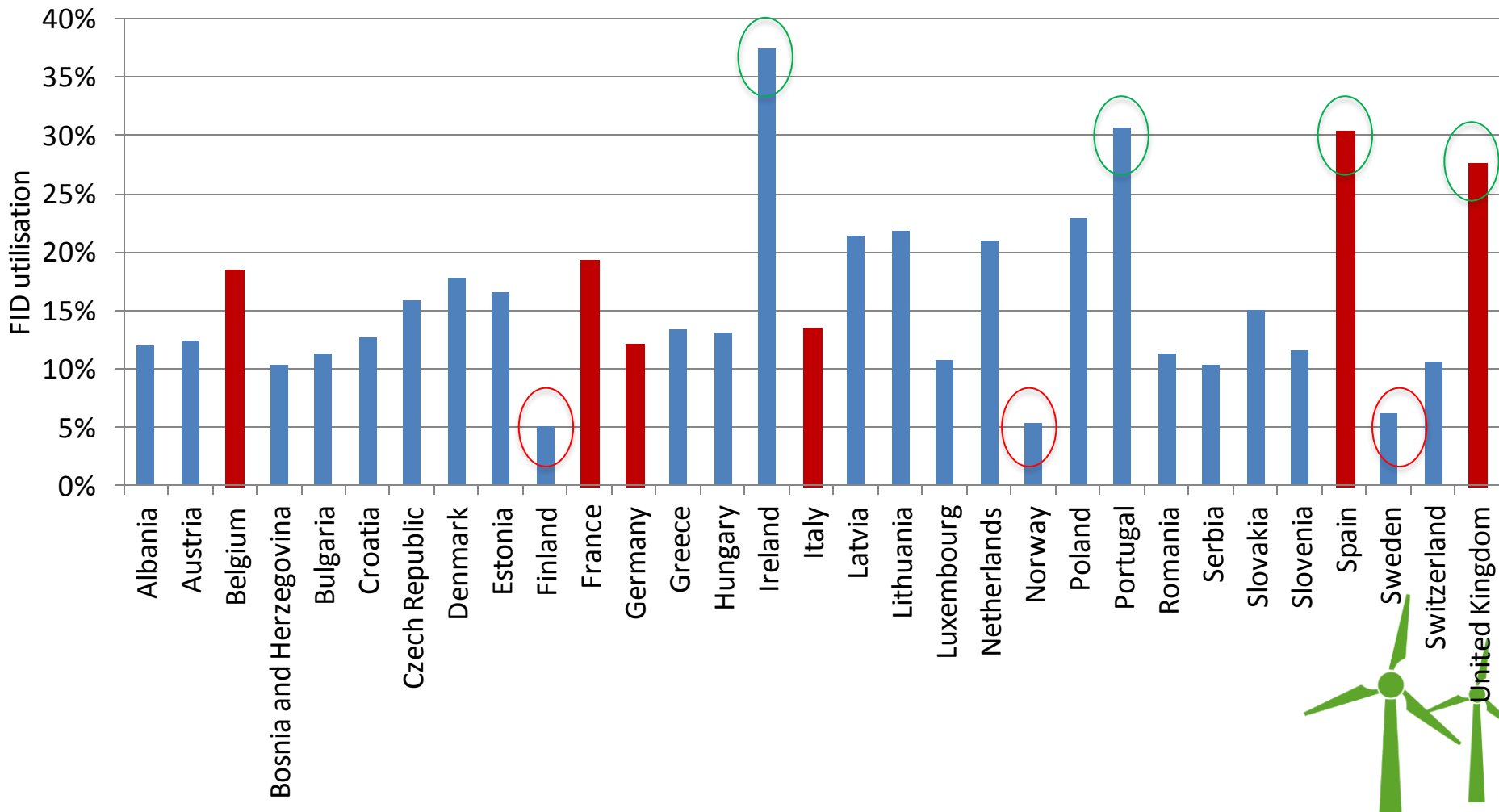
ENTSO-E 10 year network development plan: 7 €bn/year for network investments



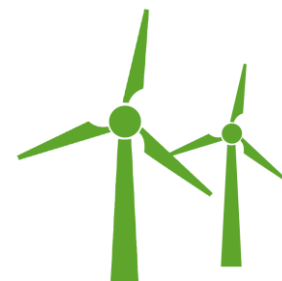
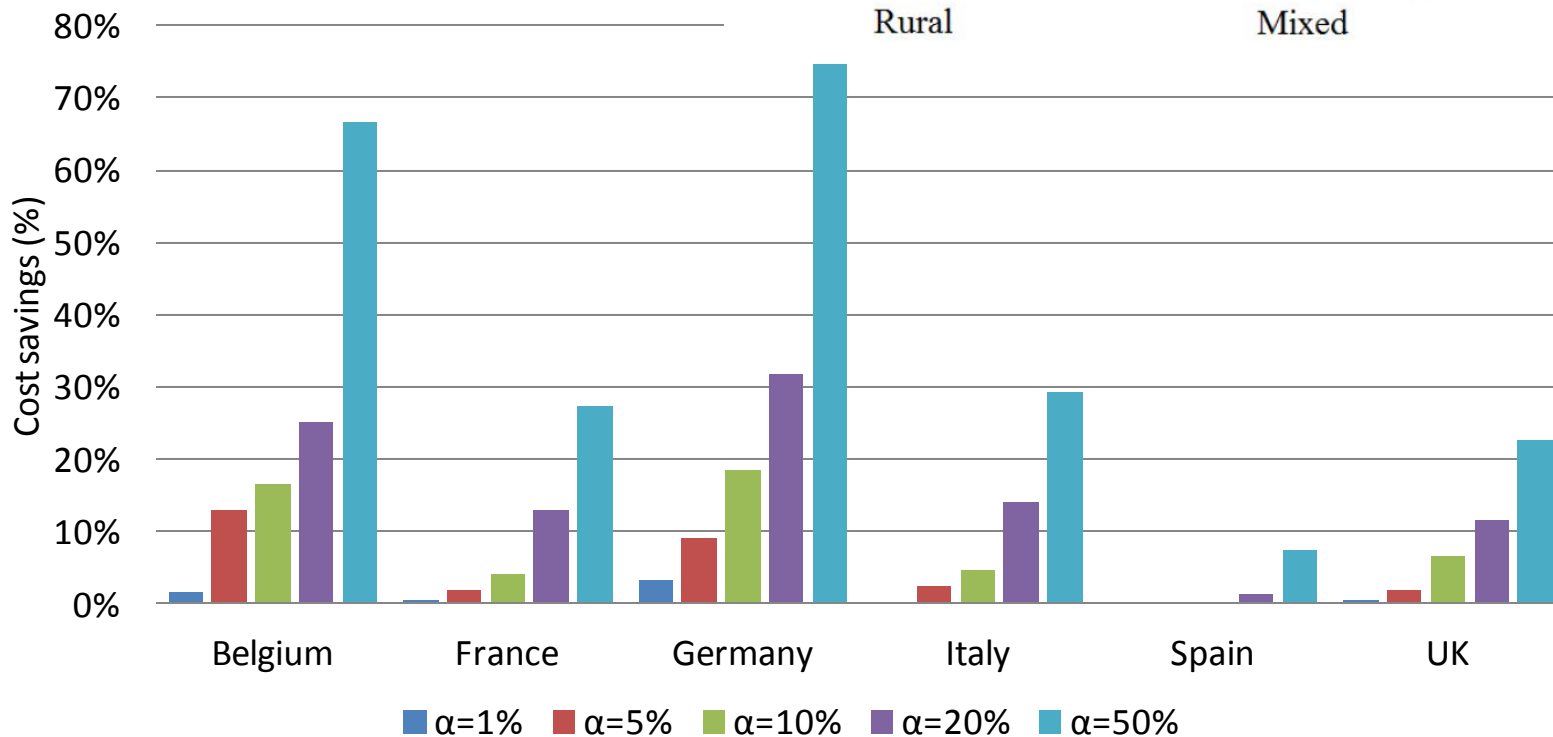
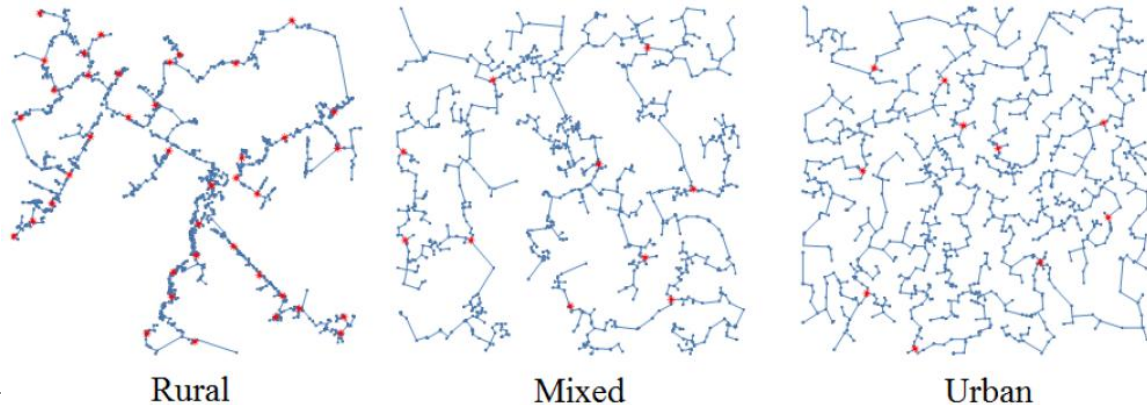
Impact on utilisation of energy sources (60% RES scenario)



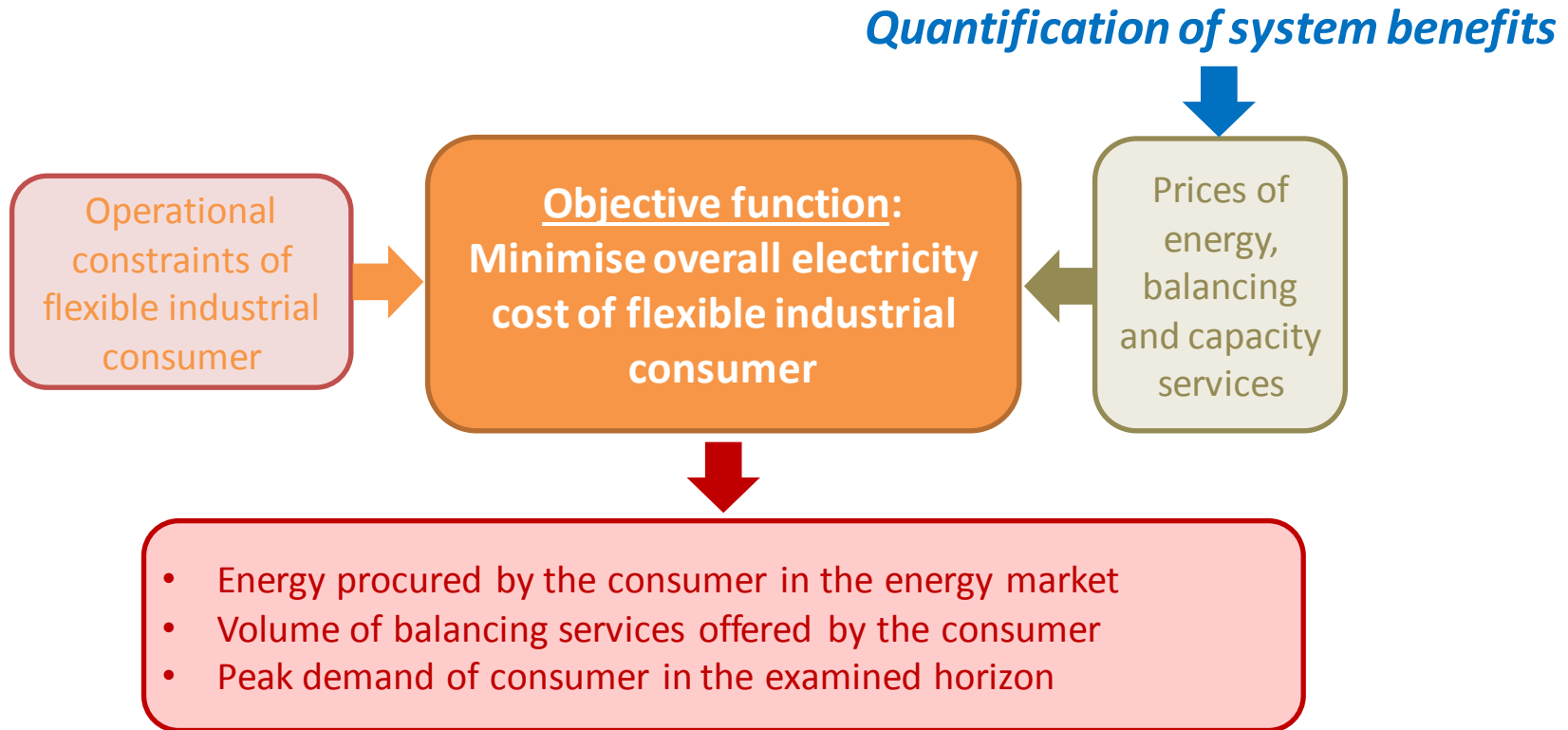
Utilisation of industrial demand response ($\alpha=20\%$, 60% RES scenario)



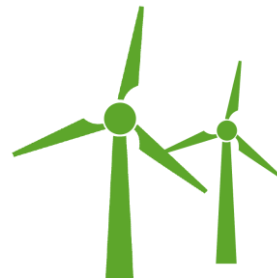
Benefits for European distribution networks



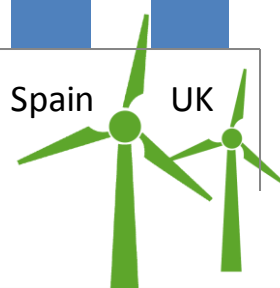
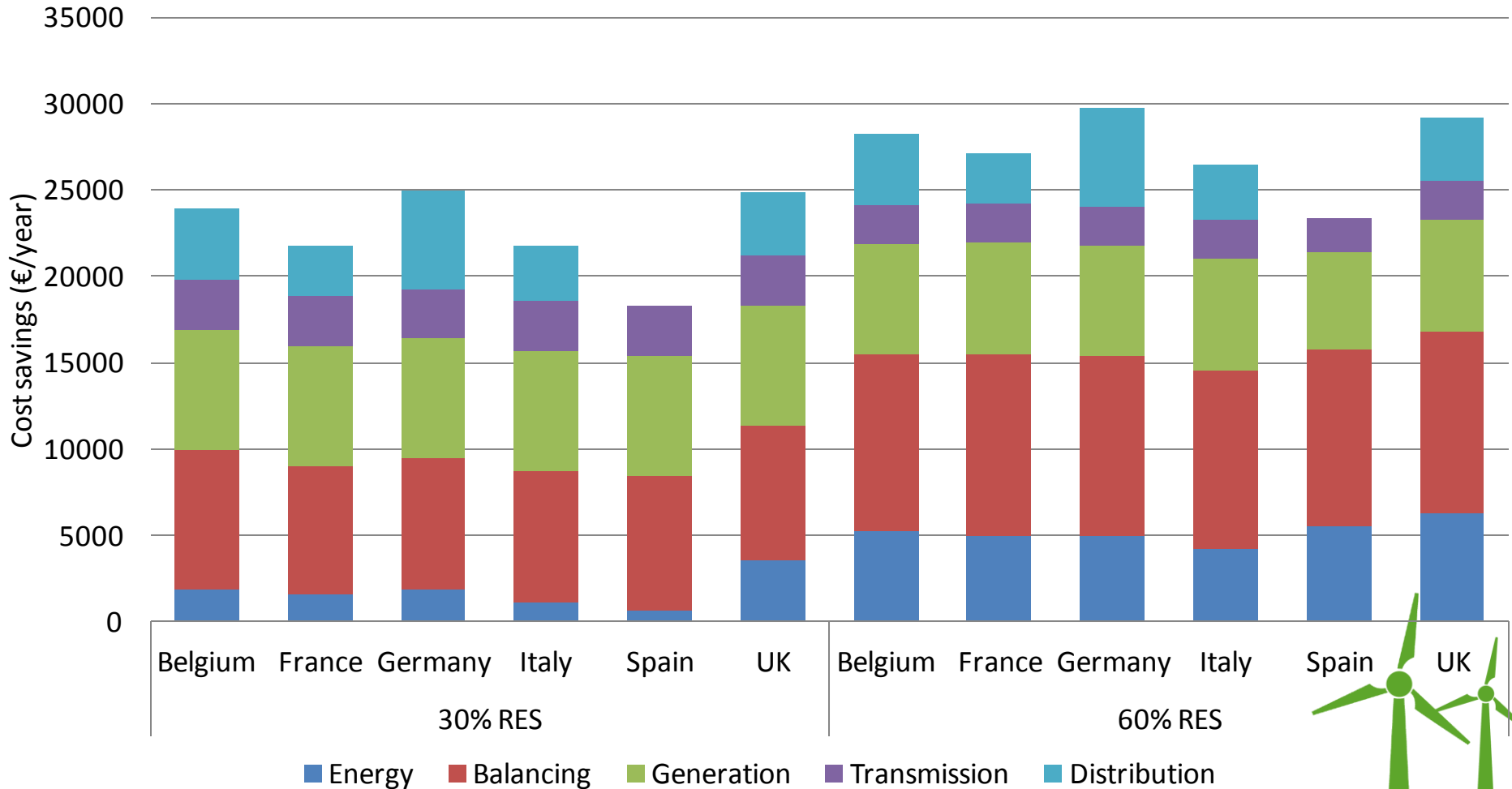
Bottom-up quantification of benefits



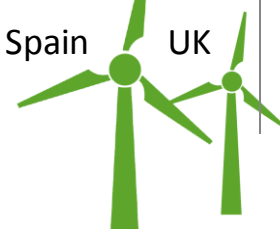
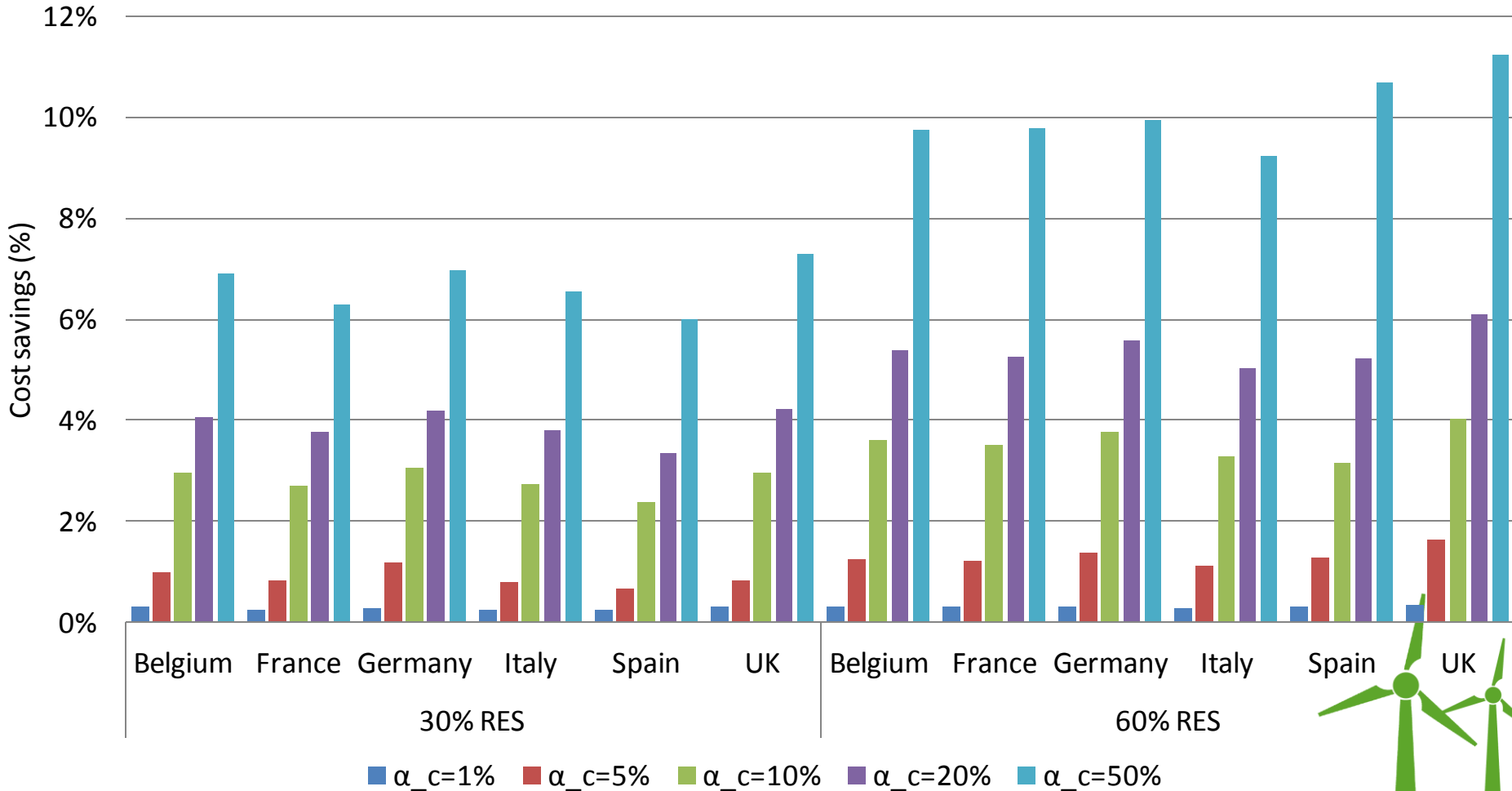
Case study: Steel plant with actual yearly demand profile



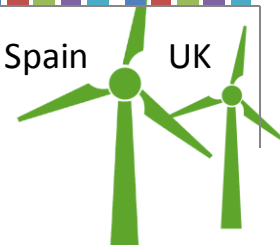
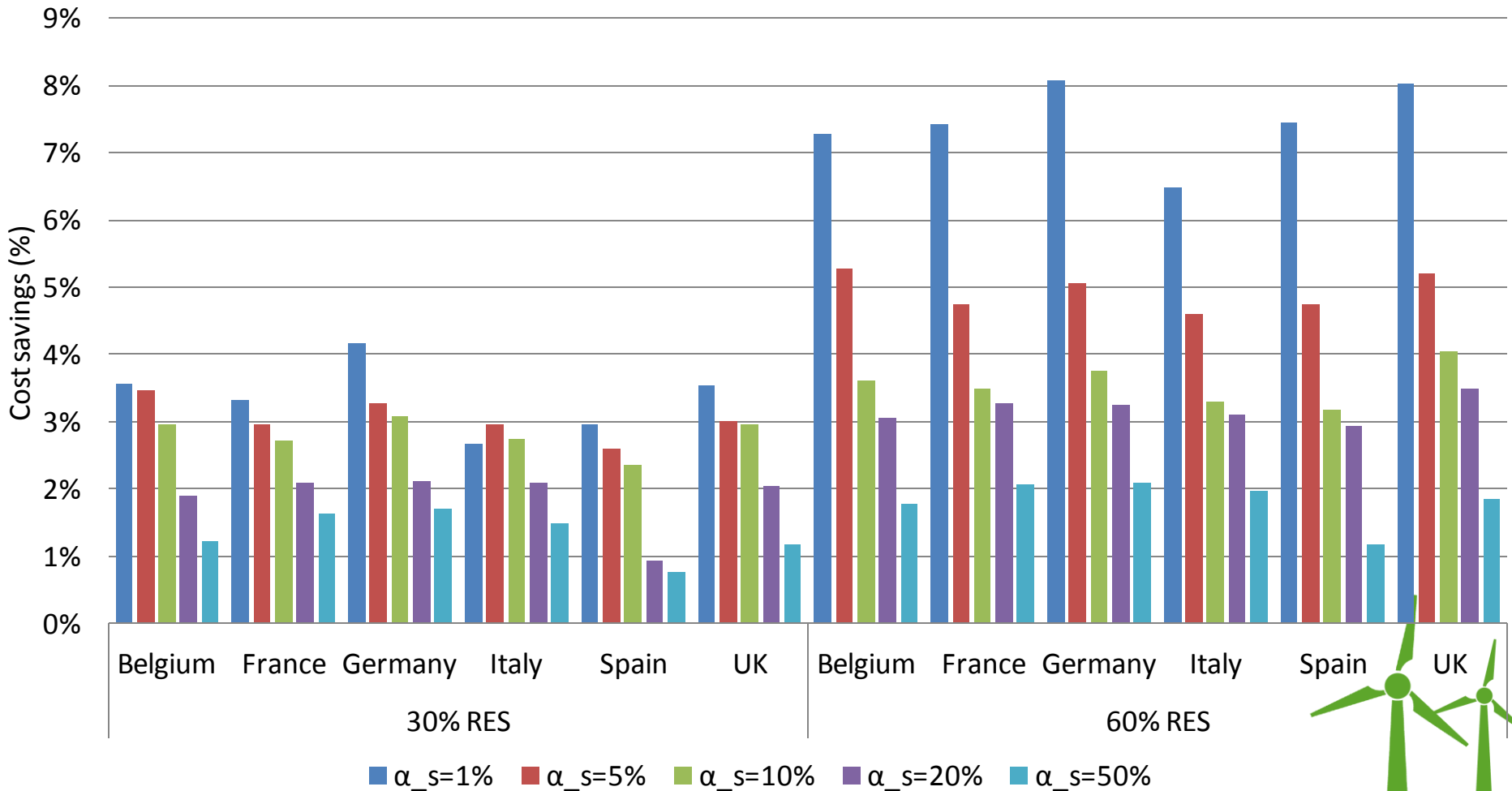
Benefits for flexible industrial consumer



Impact of higher individual flexibility



Impact of higher system flexibility



Conclusions

- 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 limits the curtailment of renewable generation
 - System cost savings are more significant under higher renewable generation levels



Relevant deliverable report (5.1)



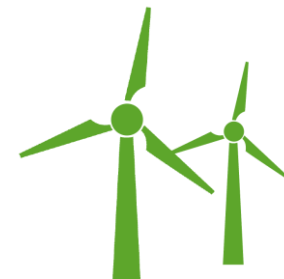
"Innovative Business Models for Market Uptake of Renewable Electricity
unlocking the potential for flexibility in the Industrial Electricity Use"

Quantifying the Economic Benefits of Flexible Industrial Demand

Deliverable 5.1
May 2017



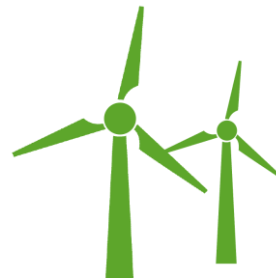
IndustRE



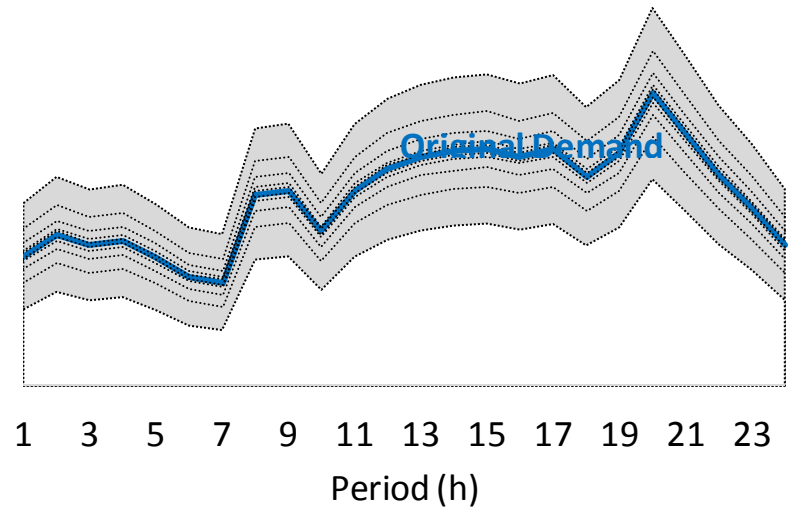
www.IndustRE.eu



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London

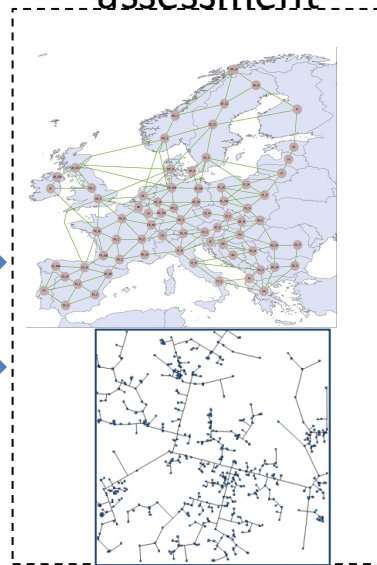


Overall modelling approach



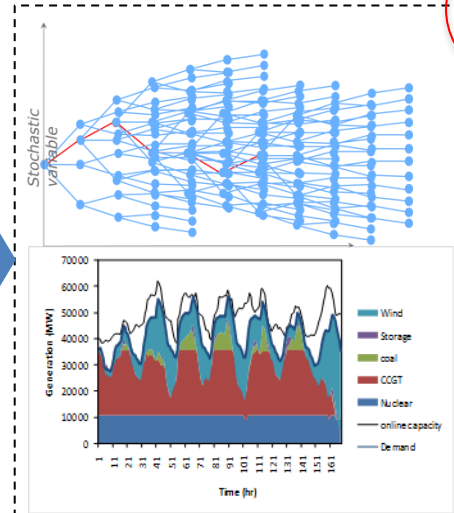
Future scenarios
2030 horizon

G+T+D
infrastructure
assessment



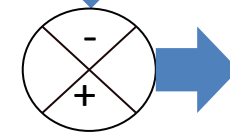
Generation, Transmission and
Distribution Investment
Optimisation

Op
assessment



Stochastic
Optimisation

Flexible
Industrial
demand



Inflexible
Industrial
Demand

System
benefits of
industrial
demand
response

Sensitivity
studies

