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Realizing the Flexibility Potential of Industrial Electricity Demand: Overview of the H2020 Project IndustRE

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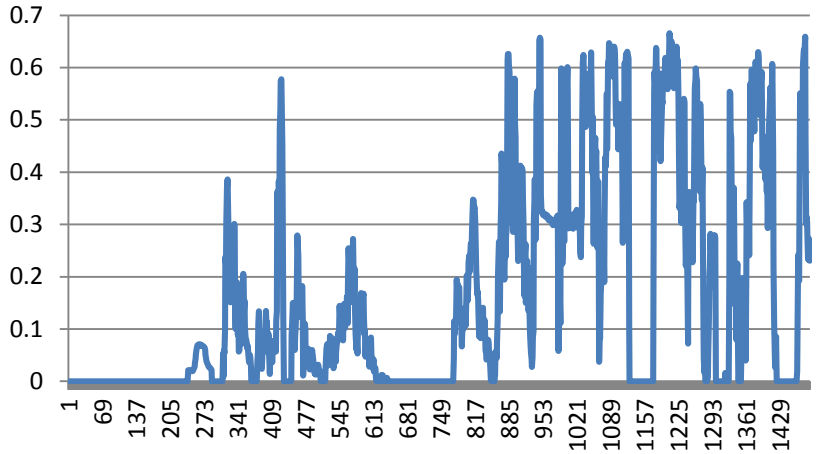
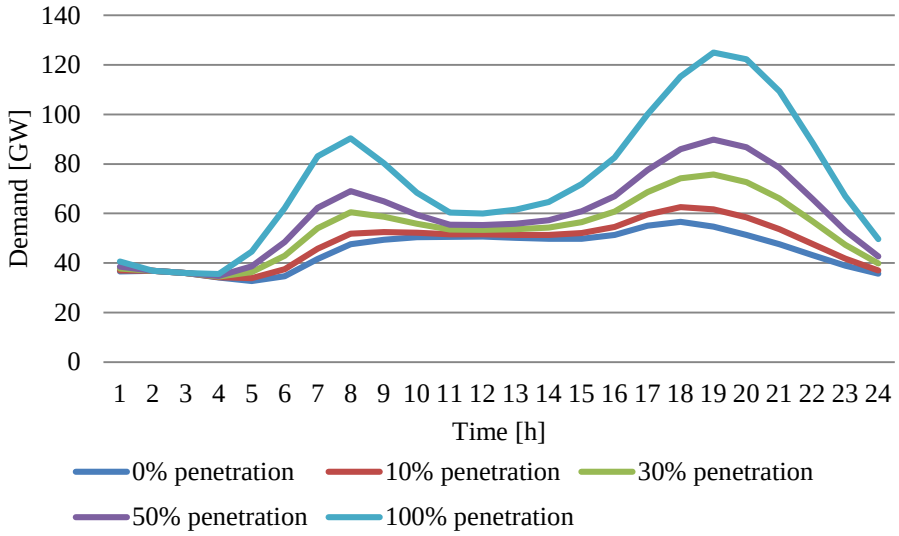
Challenges for European power system



- 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

Motivation

The cost-effective transition to a low-carbon European power system

The rising cost of electricity and its effects on the competitiveness of the European Industry

the **IndustRE** project sees the **industrial electricity demand flexibility** as an opportunity to deal with both challenges at the same time

Objectives

The project brings together the large industry with the renewable energy community in order find common ground and create win-win situations.

- Formulate business models
- Develop tools to facilitate their adoption
- Quantify the potential benefits for the power system and industrial consumers
- Formulate regulatory and policy recommendations

Project Focus & Geographical Coverage

The project will be relevant to all industries in Europe, but the key focus is:

Chemicals | Non-ferrous metals | Steel | Cold storage | Water treatment

These five sectors - with 302 TWh/year - represent around **10%** of Europe's total electricity consumption.

The project will apply to all European countries, with particular focus in Belgium, France, Germany, Italy, Spain and the UK. These six countries represent more than **65%** of the EU population and almost **80%** of Europe's installed wind and PV capacity.

Business Models

Available tools

		Flexible demand only	+ contract with offsite VRE	+ contract with onsite VRE
Savings	Energy costs	1 Supplier price response Market price response	3 Long-term electricity supply	5 Long-term electricity supply
	Network and other regulated costs	ToU network tariff		Volumetric tariff response
Revenues	System services	2 Balancing provision and other services	4 Bilateral balancing provision	

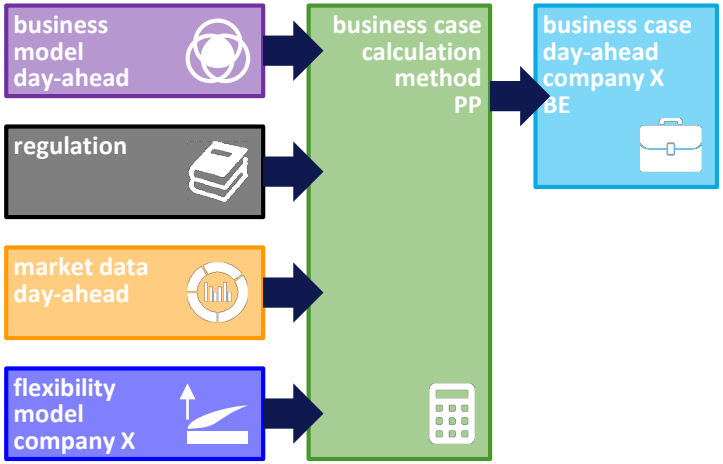
Demand flexibility audits

Demand flexibility audit execution in 3 major steps:

Identification: *"Which industrial processes or equipment of the facility contain demand side flexibility?"*

Quantification: *"How much flexibility is available in the identified parts?"*

Valorization: *"How much money can be made with the quantified flexibility?"*

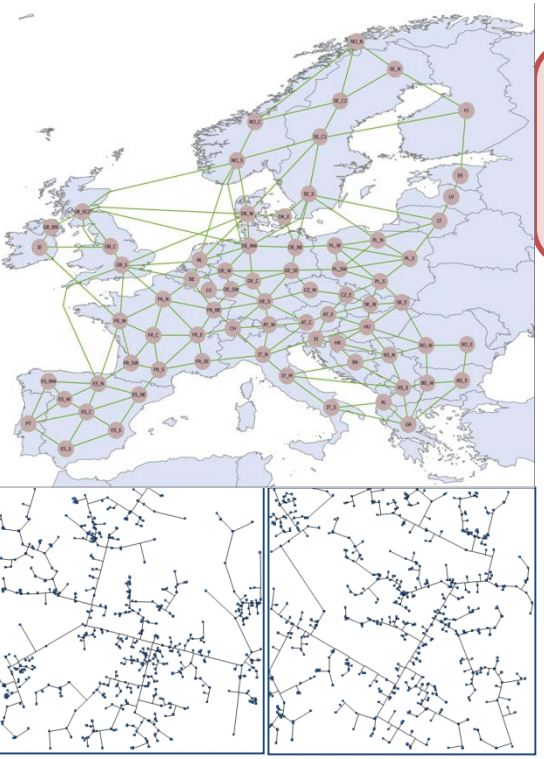


Case studies

Sector	Country	Flexibility	Business model
Paper	Belgium	Overcapacity of pulp factory	Bilateral balancing provision
Steel foundry	Italy	Thermal buffer in induction furnace	Day-ahead market
Distribution centre	United Kingdom	Thermal buffer in cold storage, emergency generators, battery storage of fork lifts	Day-ahead market, reserves market
Water treatment	Germany	Switching between electricity and gas	On-site VRE, Day-ahead market
Cold storage	France	Thermal buffer	Day-ahead market, reserves market
Gas refinery	Germany	Overcapacity of liquefaction process	Day-ahead market
Non-ferrous metals	Germany	Thermal buffer in induction furnace	Day-ahead market

Whole electricity system model (WeSIM)

Interconnected EU system



Representative distribution networks in different countries

2030 development scenarios

EU Electricity Demand, Generation and Network data

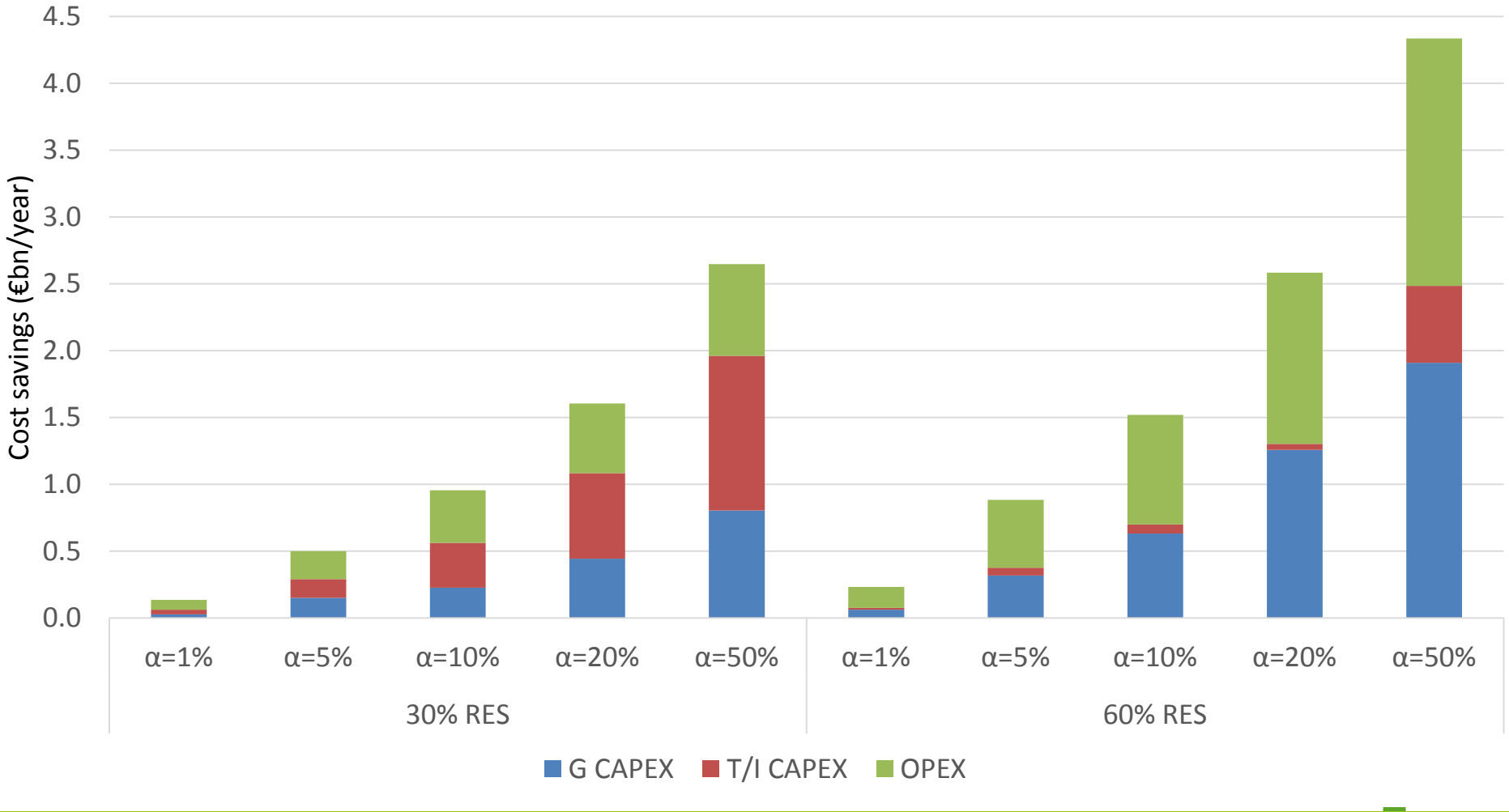
<u>WeSIM</u>: Minimise overall investment and operation costs of European power system

Renewable generation targets and system security constraints

- Investment in network assets
- Investment in generation assets
- Operation scheduling of generation, storage and flexible demand

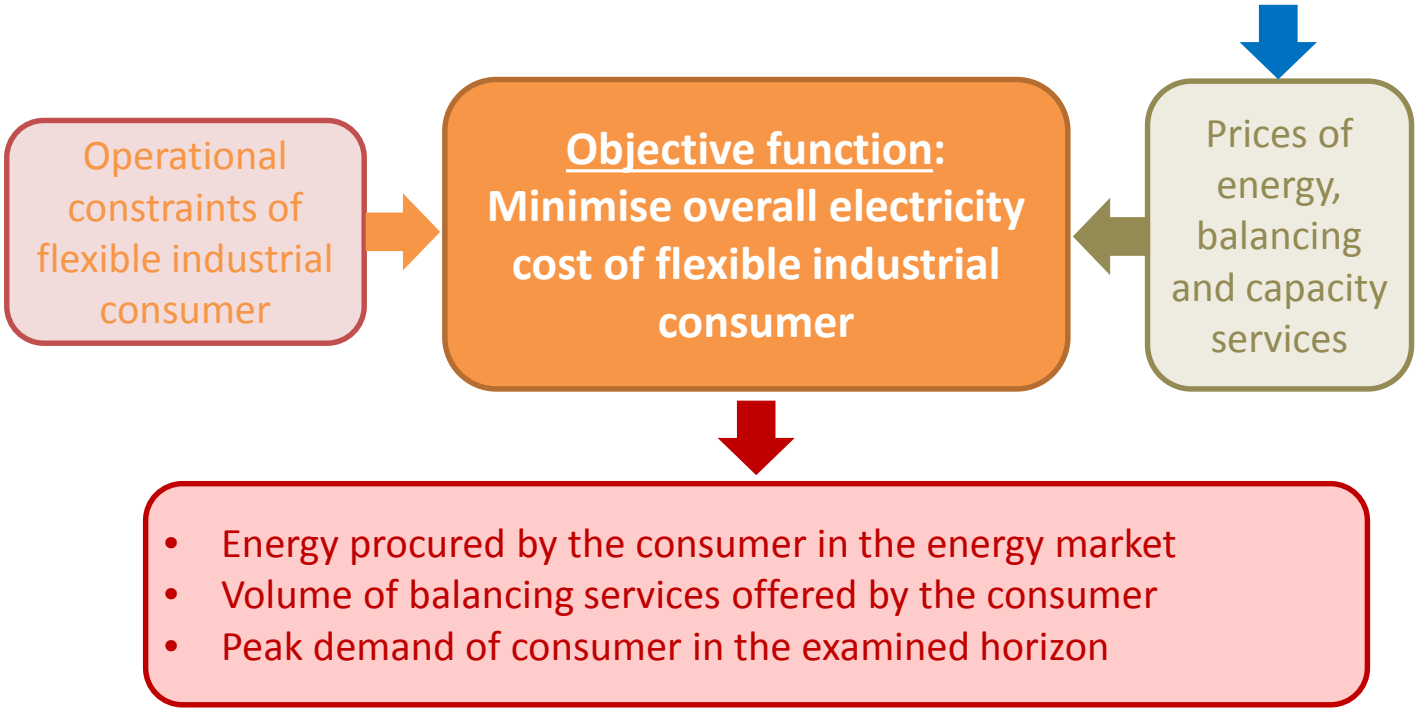
Generic model of demand flexibility: demand at each hour can be reduced / increased within a proportional limit **α**, as long as the daily consumption does not change

Benefits for European generation / transmission system



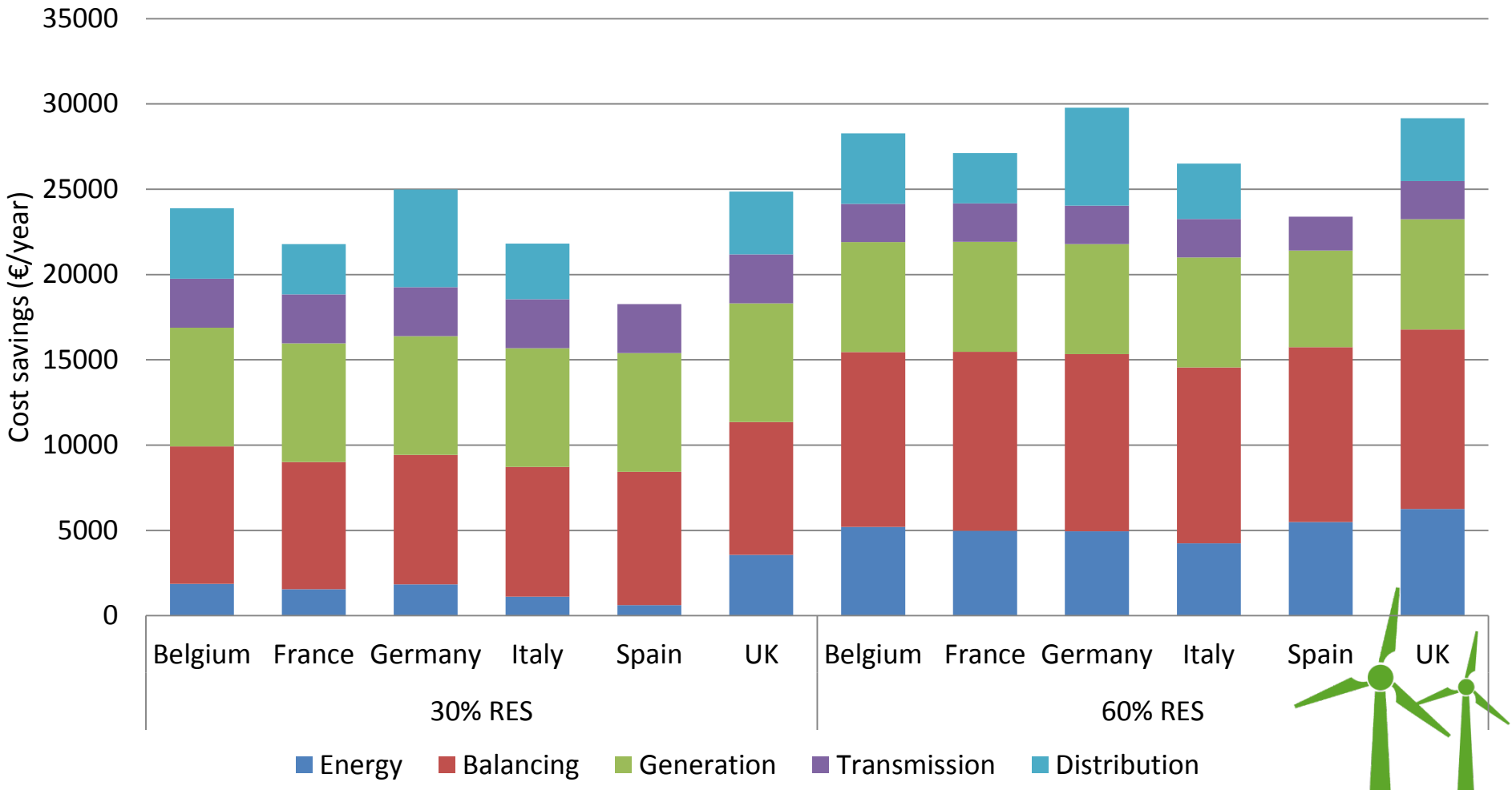
Flexible industrial consumer market model

Quantification of system benefits



Case study: Steel foundry with actual yearly demand profile

Benefits for flexible industrial consumer (α=10% scenario)



Regulatory barriers

Business models

Available tools

Savings / Revenues	Flexible demand only	+ contract with offsite VRE	+ contract with onsite VRE
Energy costs	1 Supplier price response Market price response	3 Long-term electricity supply	5 Long-term electricity supply
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Regulatory barriers

Business model	BE	FR	DE	IT	ES	UK
model I						
model II						
model III						
model IV						
model V						

	business case is viable in existing regulatory framework
	business case limited viability/restricted in current regulatory framework
	business case impossible in existing regulatory framework

http://www.industre.eu/downloads/category/project-results

WIP

Universidad Pontificia ICAI ICADE Comillas Madrid
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vito Energy Ville

Imperial College London

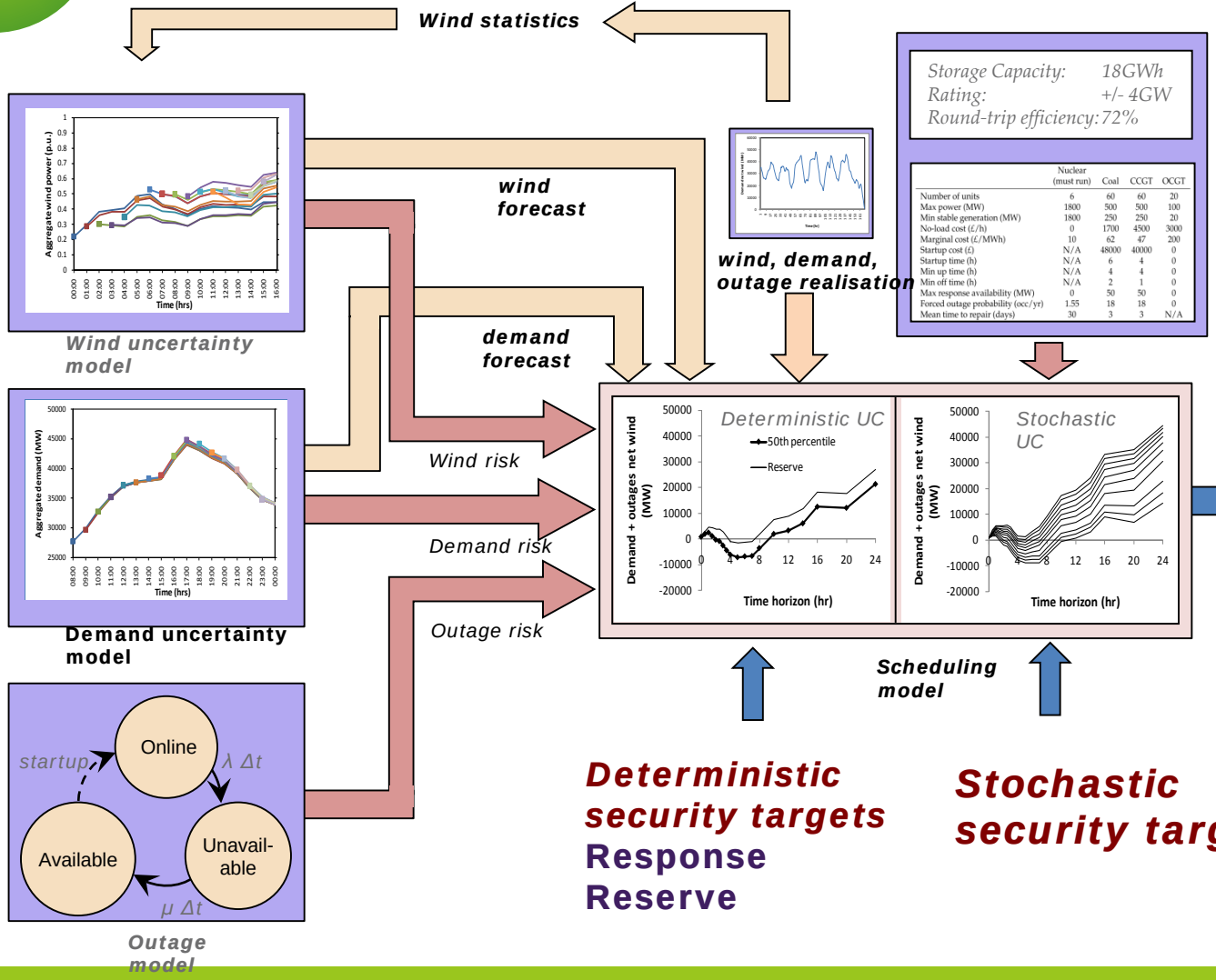
bbh Becker Büttner Held

Cu European Copper Institute Copper Alliance

scmgroup

SER

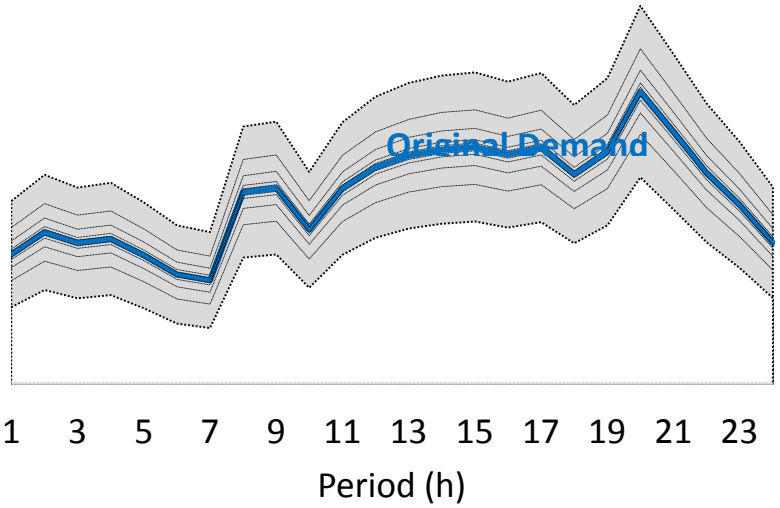
Stochastic unit commitment model (SUCM)



	Nuclear (must run)	Coal	CCGT	OCGT
Number of units	6	60	60	20
Max power (MW)	1800	500	500	100
Min stable generation (MW)	1800	250	250	20
No-load cost (£/h)	0	1700	4500	3000
Marginal cost (£/MWh)	10	62	47	200
Startup cost (£)	N/A	48000	40000	0
Startup time (h)	N/A	6	4	0
Min up time (h)	N/A	4	4	0
Min off time (h)	N/A	2	1	0
Max response availability (MW)	0	50	50	0
Forced outage probability (occ/yr)	1.55	18	18	0
Mean time to repair (days)	30	3	3	N/A

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

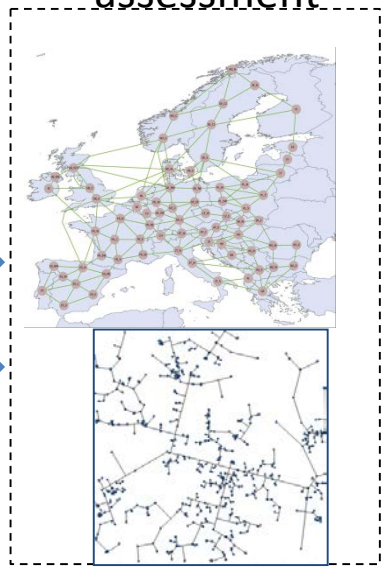
Overall modelling app



Future scenarios
2030 horizon

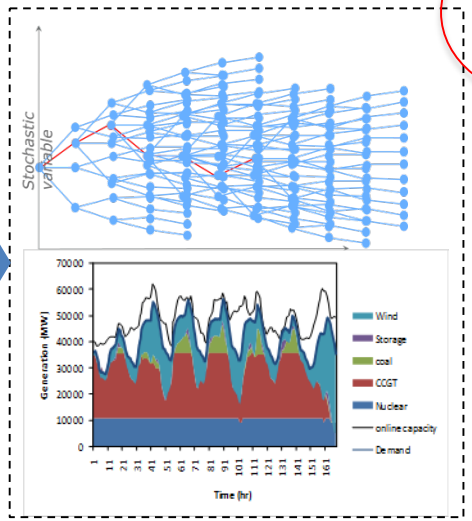
Sensitivity studies

G+T+D infrastructure assessment



Generation, Transmission and Distribution Investment Optimisation

Op… assessment



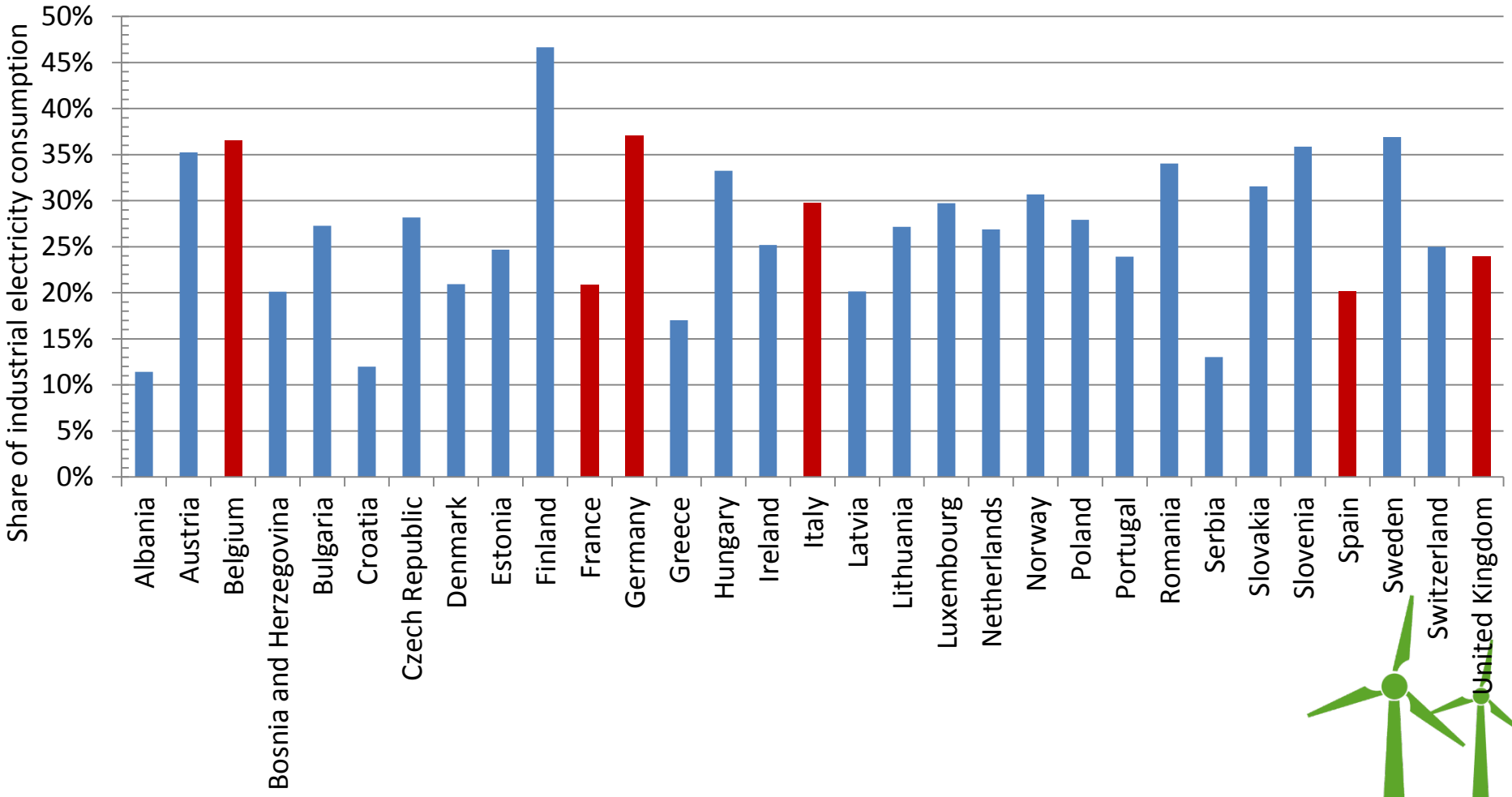
Stochastic Optimisation

Flexible Industrial demand

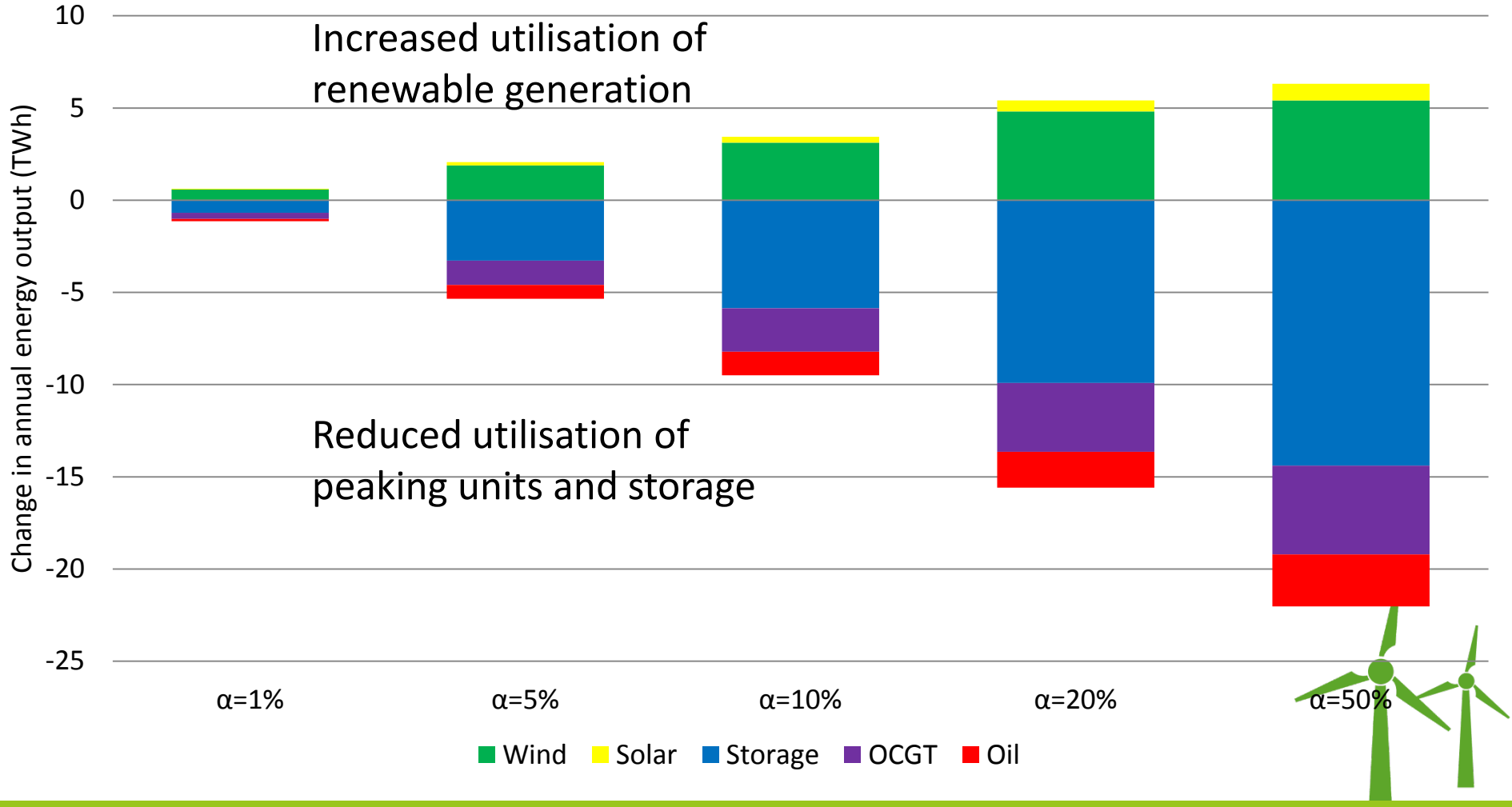
Inflexible Industrial Demand

System benefits of industrial demand response

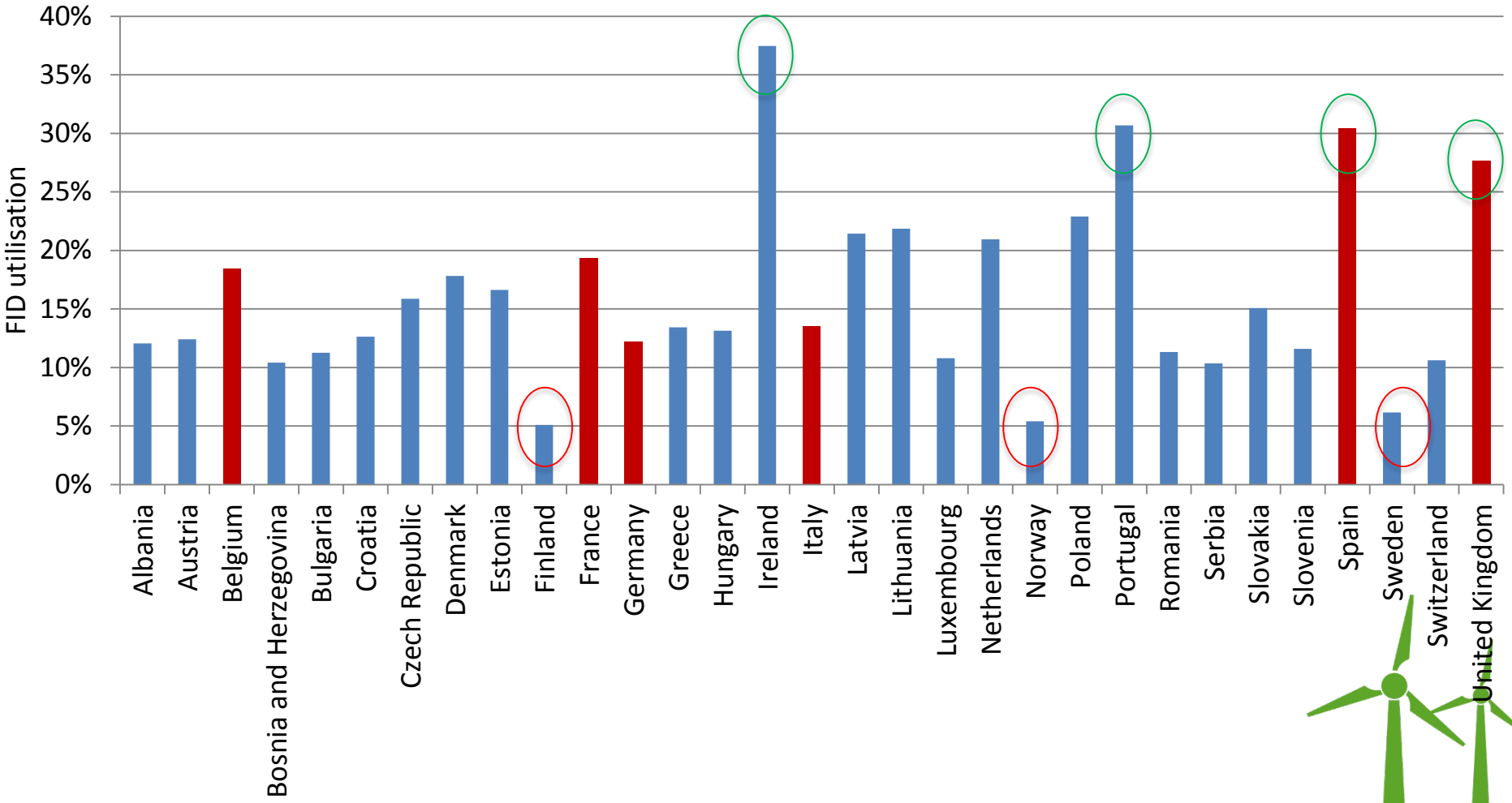
Share of industrial demand per country



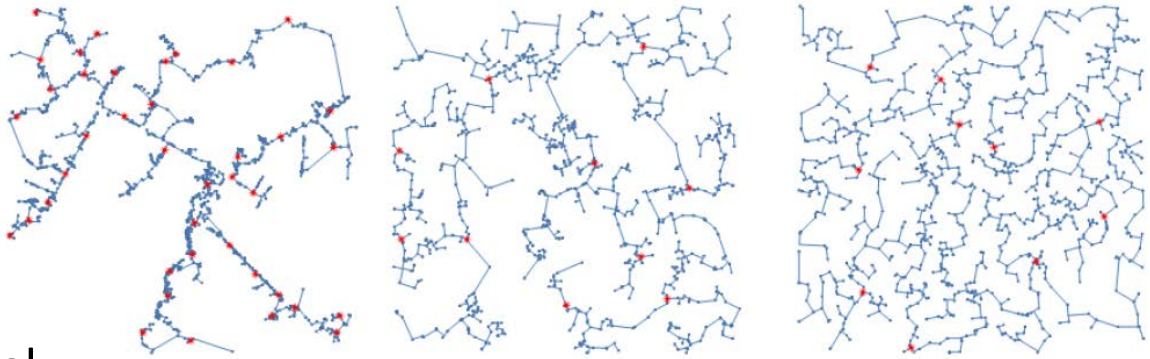
Impact on utilisation of energy sources (60% RES scenario)



Utilisation of industrial demand flexibility (α=20%, 60% RES scenario)

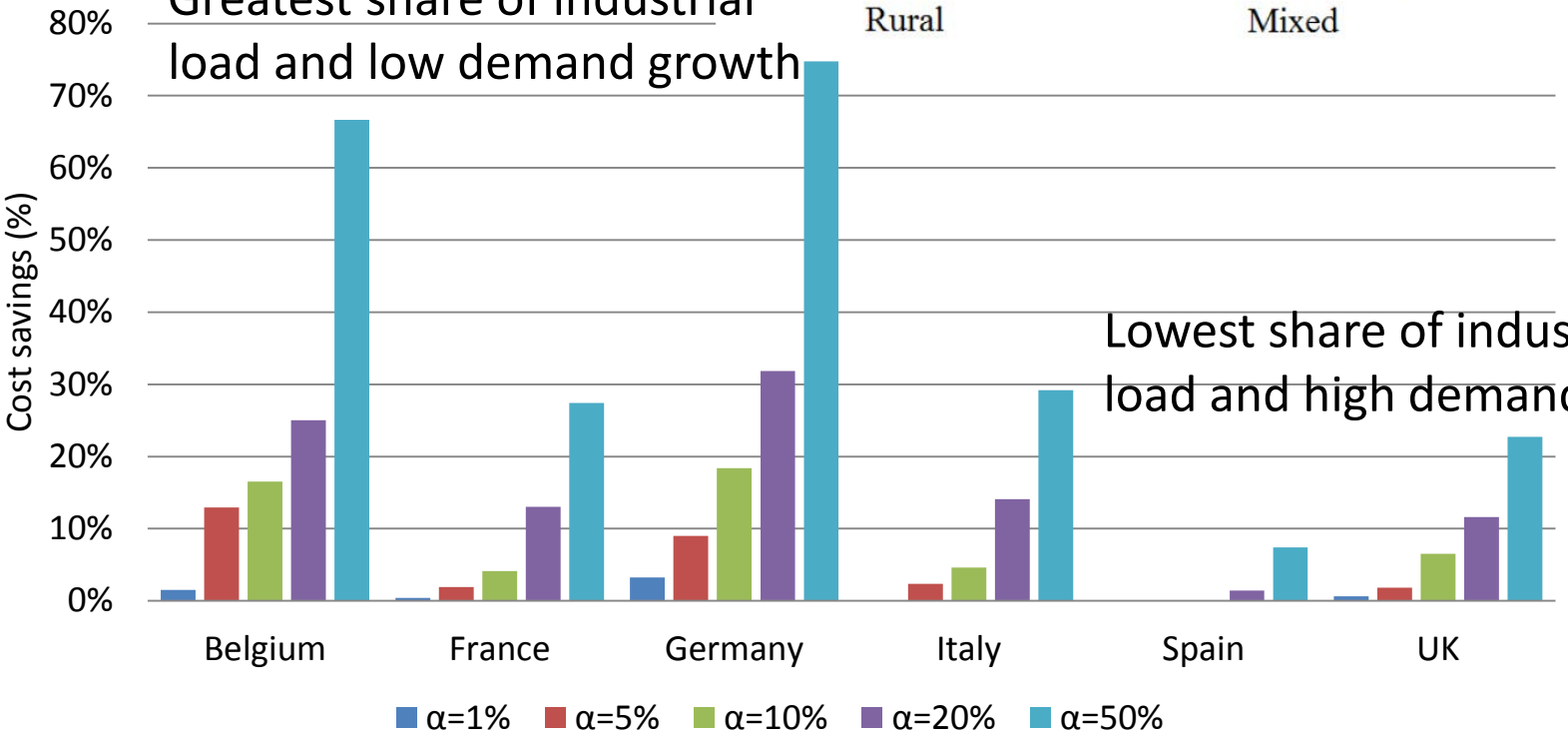


Benefits for European distribution networks



Greatest share of industrial load and low demand growth

Lowest share of industrial load and high demand growth



Policy recommendations by country

Countries	BE	FR	DE	IT	ES	UK	Winter Package
Market access							
Aggregation fully allowed							MARKET prop new dir. - Art 13
Direct access intraday/day-ahead markets							MARKET prop new dir. - Art 15,17
Reserves open for DR							
Ancillary services							
Procurement to real-time							
Symmetric Products							
Minimum-bid size							
Distribution connected demand can participate							MARKET prop new dir. - Art 32
Load-interruptibility competitive							
Tariffs							
Regulated charges in kWh							
Peak-coincident capacity component							
Extra charge for self-generation							RES prop new dir. - Art. 21
Balancing							
Single or Double pricing	S	S	S	S/D	D	S	
VRE balancing responsible party							
On-site generation							
Abandon net-metering							