# International Conference on Energy Systems Integration

## *Flexible Industrial Demand Supporting Cost Effective Integration of Renewables*

**Goran Strbac**

**Imperial College London**

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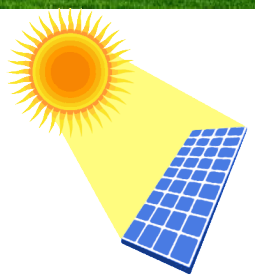
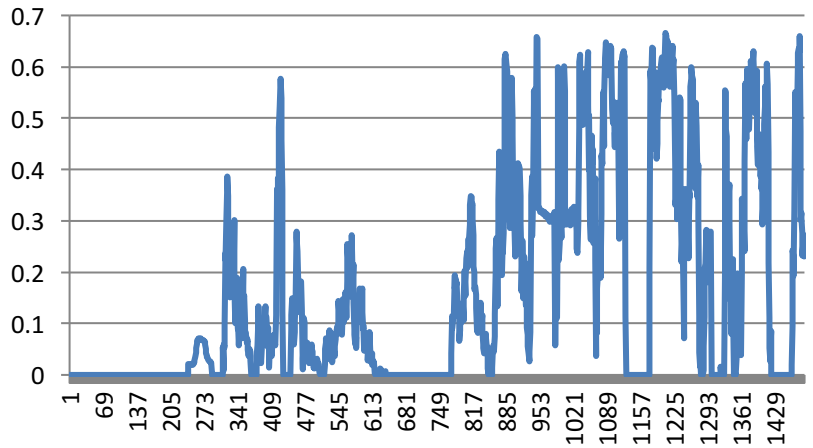
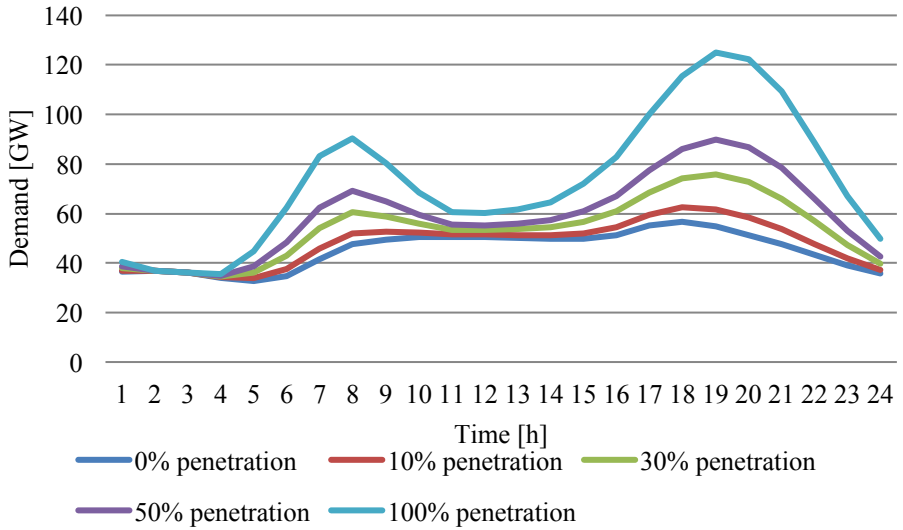
# Challenges of decarbonisation of European power system






- Degradation in utilization of generation and network infrastructure
- Limited ability to integrate renewable generation

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# Key objectives

Cost-effective transition to a low-carbon European power system

Rising cost of electricity – impact on competitiveness of the European Industry

**Bring together the EU industrial and renewable energy community - create win-win context**

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

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# Case Studies

**IndustRE – targeted 6 countries in Europe:**

- **Belgium – France – Germany - Italy – Spain - UK**
- **Combined these represent:**
  - **>60% EU population**
  - **80% of EU wind and PV capacity**
- **Industrial sectors targeted in IndustRE**


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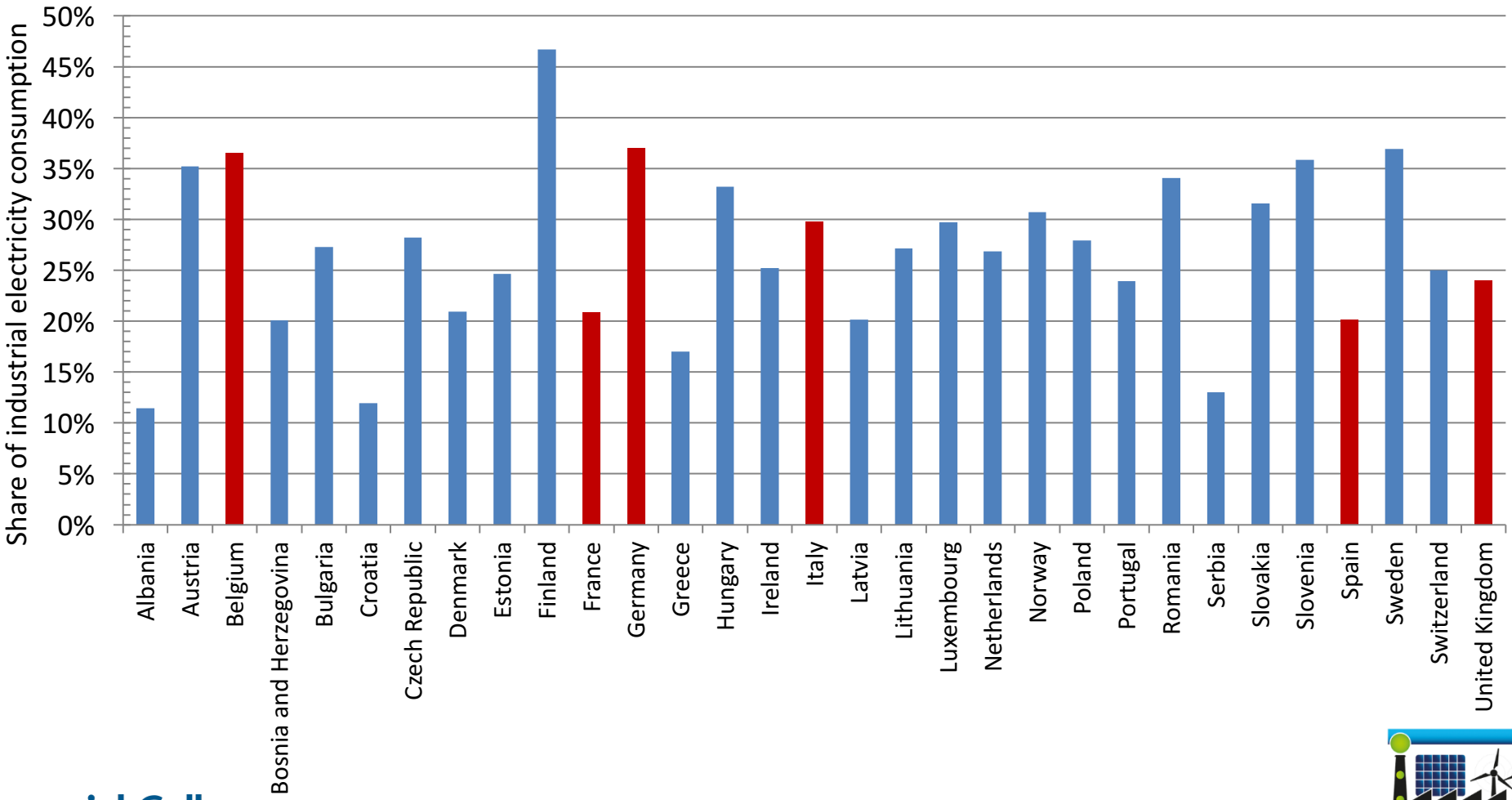
# Share of EU industrial demand per country

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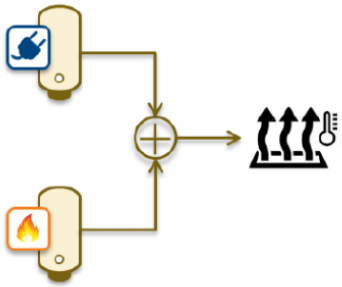
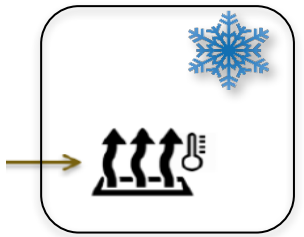
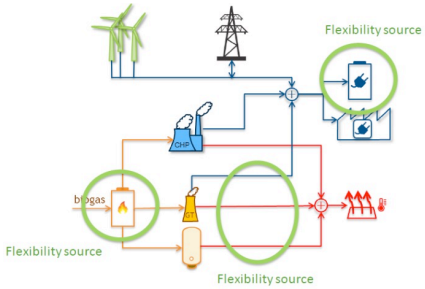
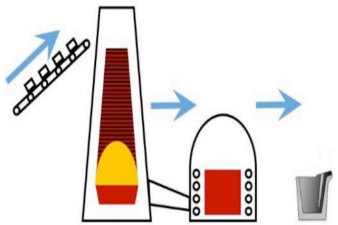
# Case Studies

| Sector | Country | Flexibility |
|---|---|---|
| Paper | Belgium | Electric / gas boiler identified as main source of flexibility<br>Overcapacity of pulpmill factory |
| Steel | Italy | Thermal buffer in induction furnace |
| Cold Storage | UK | Thermal buffer in cold storage, emergency generators |
| Water treatment | Germany | Switching between electricity and gas with multiple sources of flexibility |
| Cold storage | France | Thermal buffer |
| Chemicals | Germany | Overcapacity of liquefaction process |
| Non-ferrous metals | Germany | Thermal buffer in induction furnace |







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# Quantification of whole system value of industrial demand flexibility

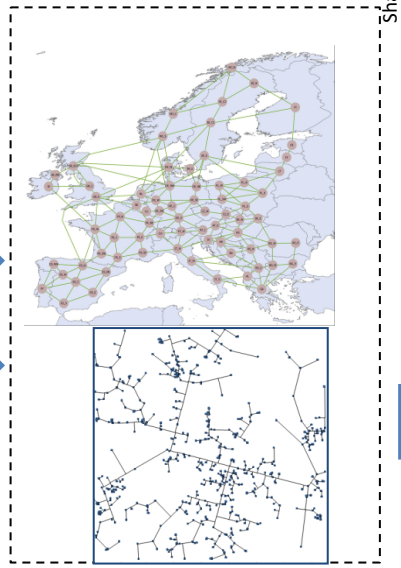
- **Benefits across multiple system sectors**:
  - Generation system (incl. conventional and renewable generation)
  - Transmission network
  - Distribution network
- **Benefits across multiple timescales**:
  - Long-term investment planning
  - Short term scheduling
  - Real-time balancing

# Overall modelling approach

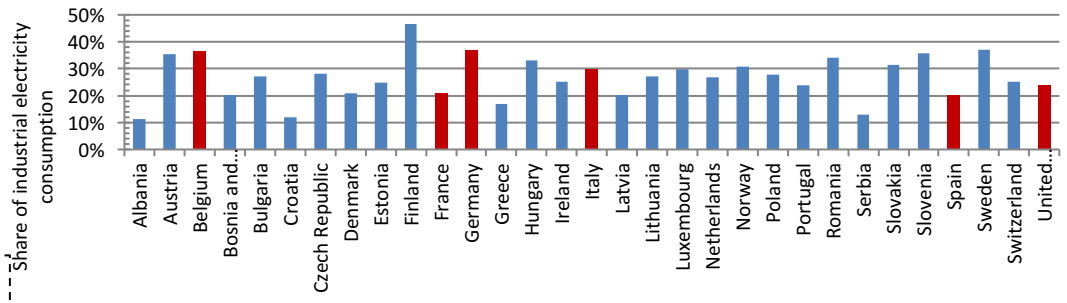
*Future scenarios*
2030 horizon

*Sensitivity studies*

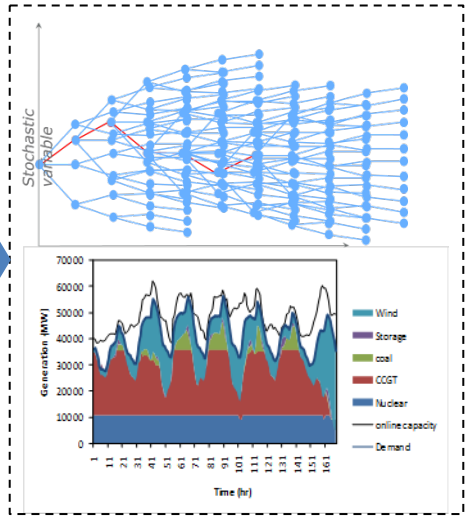
G+T+D infrastructure assessment



**Generation, Transmission and Distribution Investment Optimisation**




Operational assessment




**Stochastic Optimisation**

Flexible Industrial demand

Inflexible Industrial Demand

**System benefits of industrial demand flexibility**

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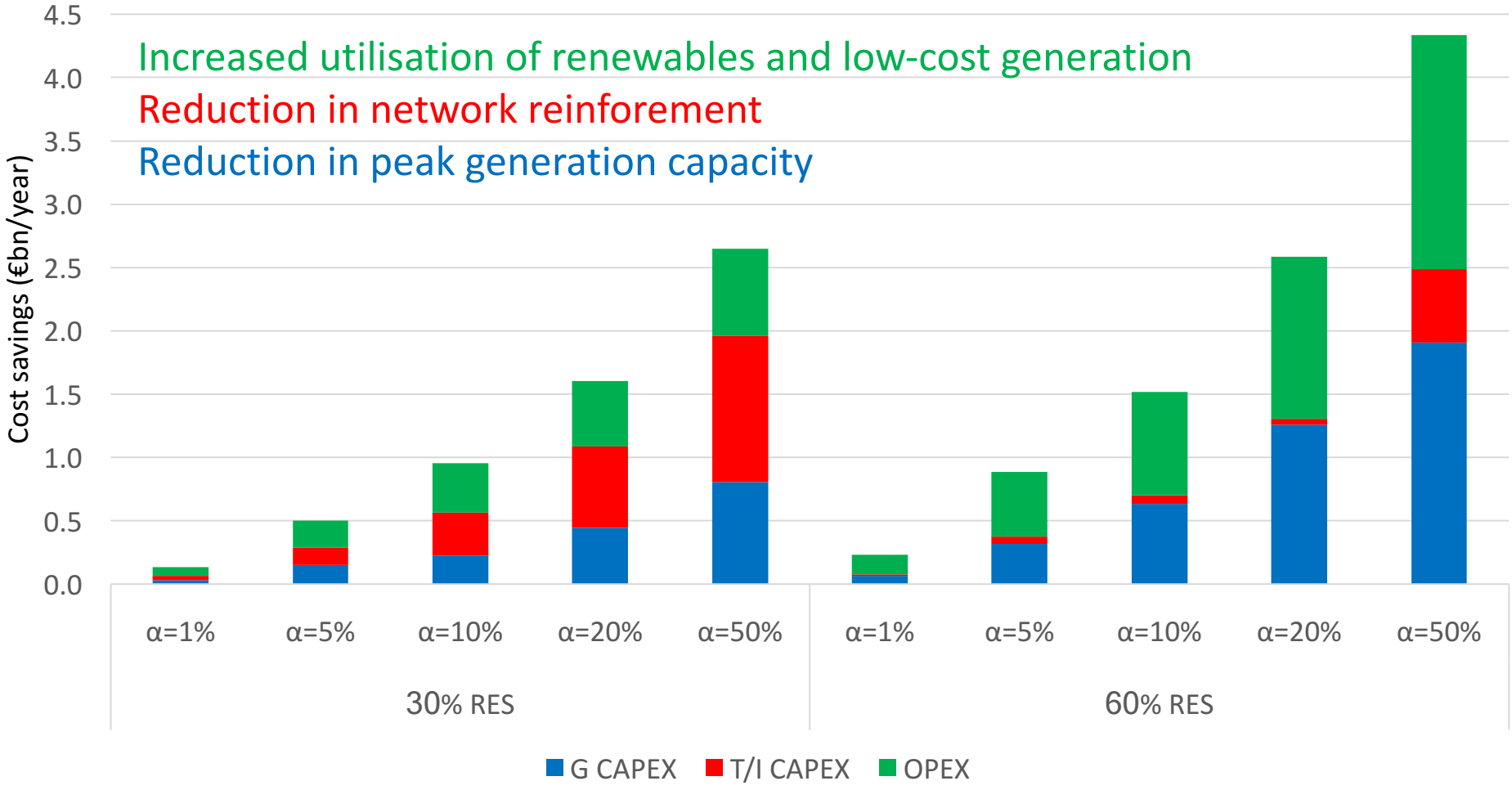
# Benefits for European power system

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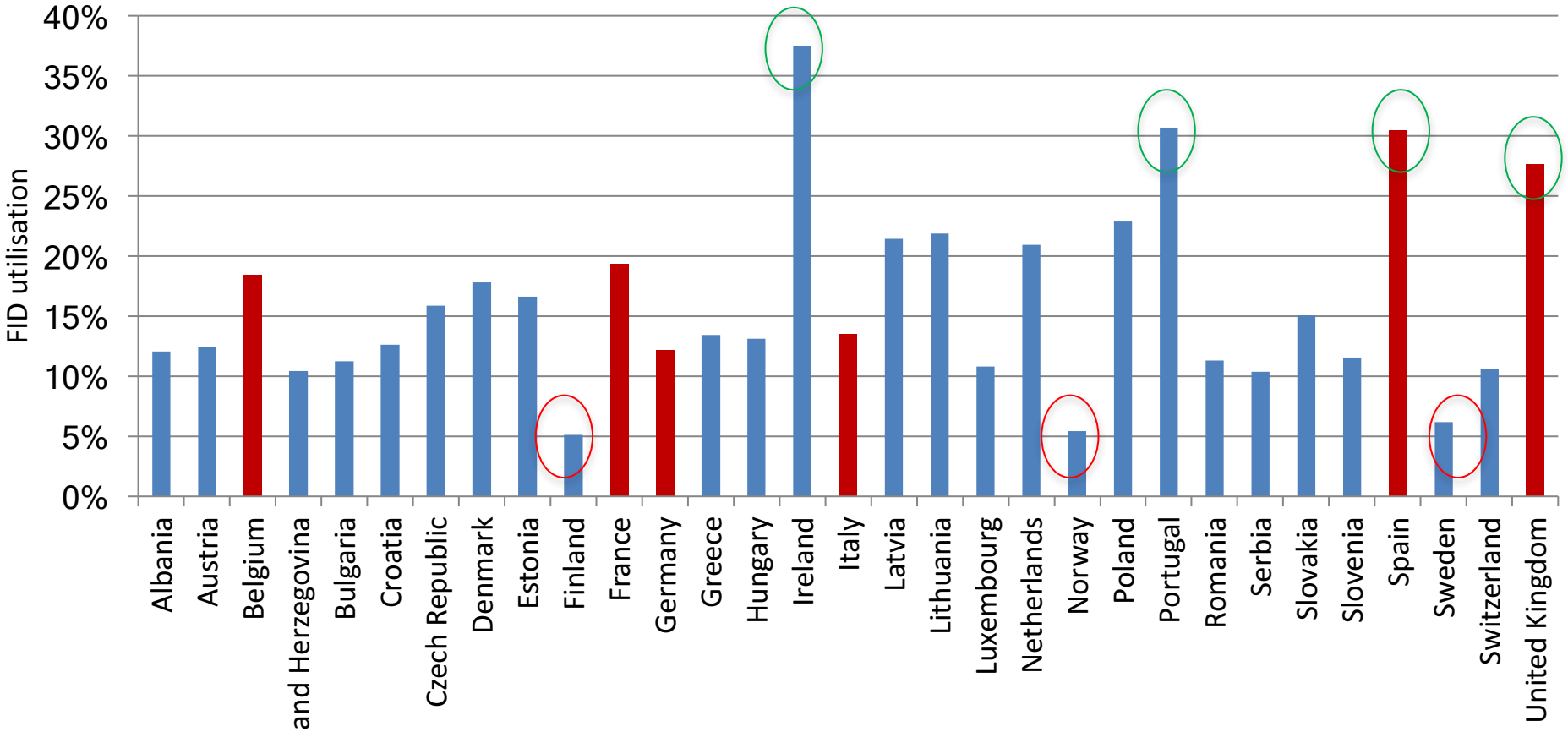
# Utilisation of industrial demand flexibility

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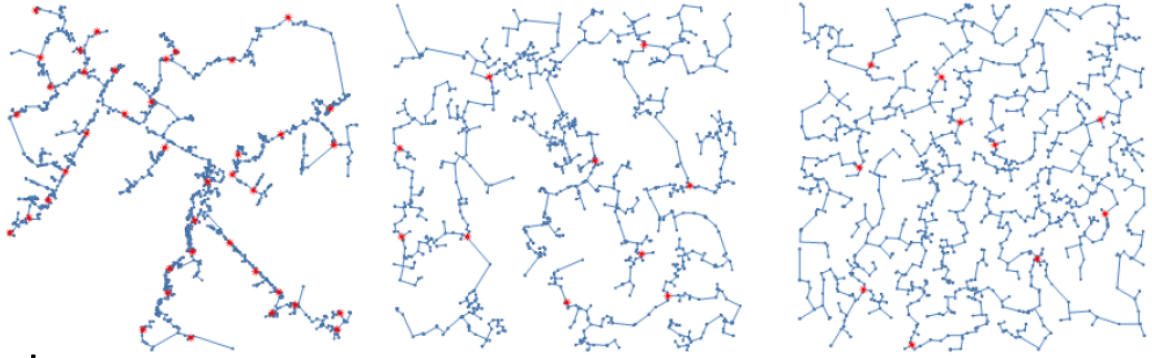
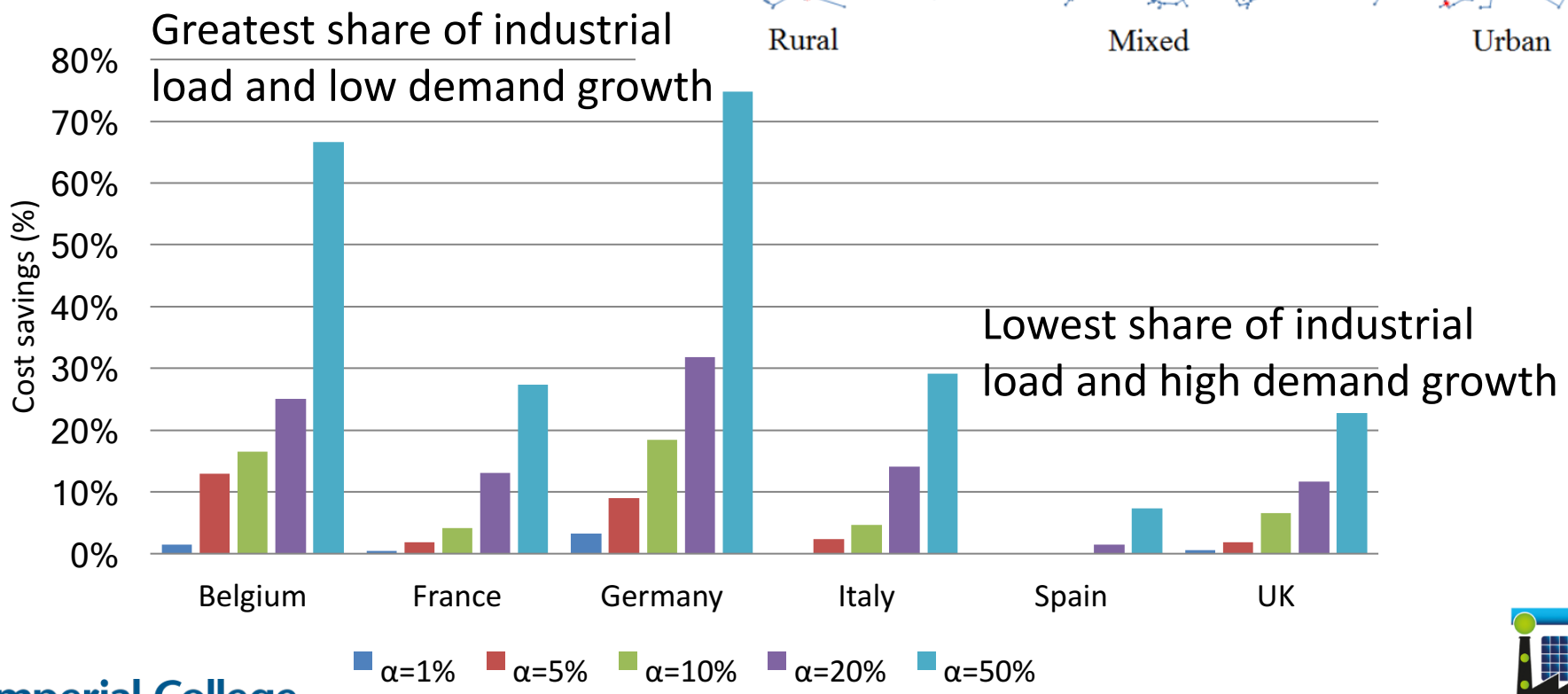
# Benefits for European distribution networks

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# Flexible industrial consumer market model

*Quantification of system benefits*

**Operational constraints of flexible industrial consumer**

**Objective function:** Minimise overall electricity cost for flexible industrial consumer

**Prices of energy, balancing and capacity services**

- Energy procured by industrial consumer in the energy market
- Volume of balancing services offered by industrial consumer
- Reduction of peak demand of industrial consumer


Chemicals


Non-ferrous metals


Steel


Cold storage


Water treatment

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*Case studies with actual demand profile and flex capacity*

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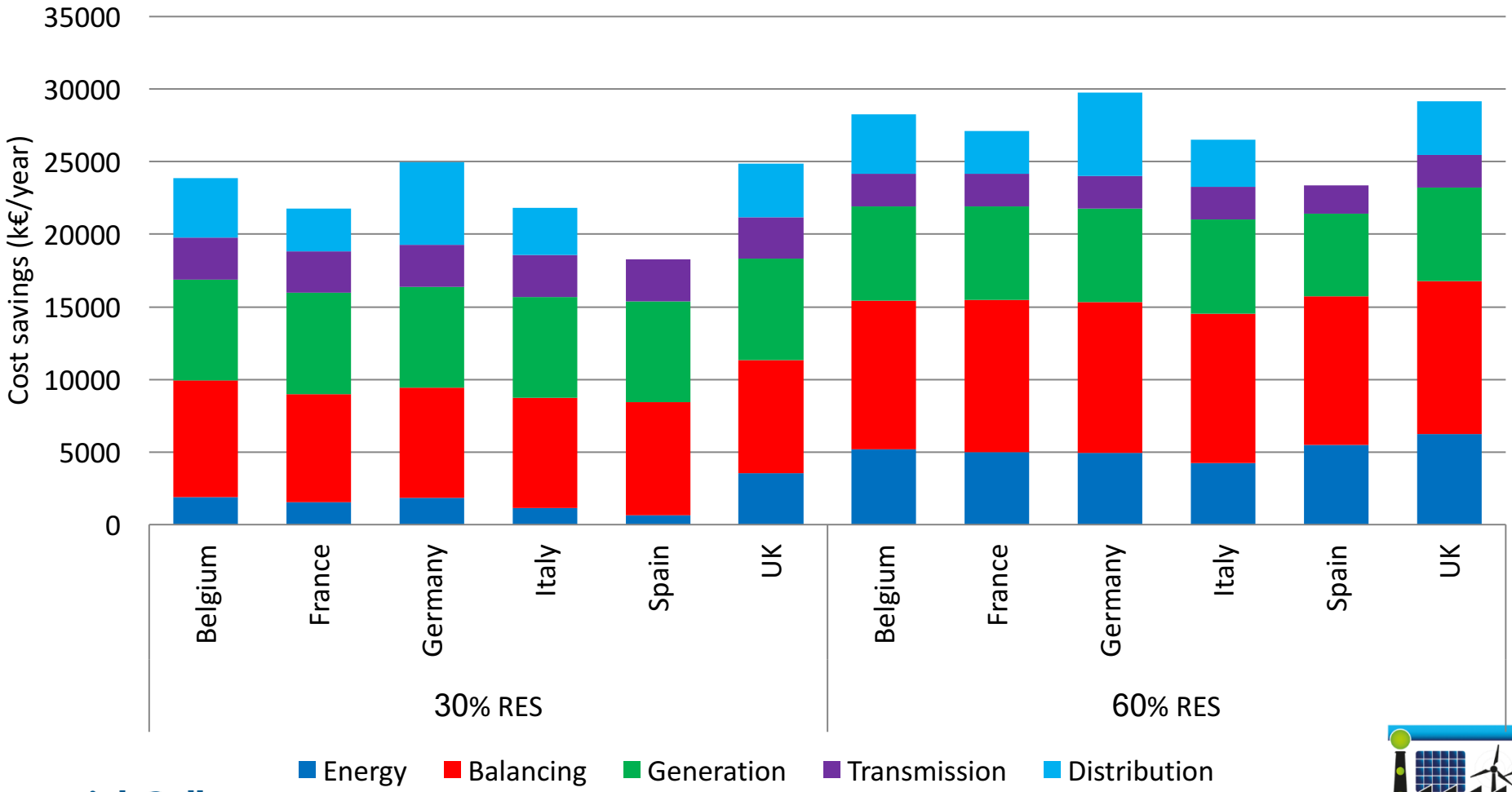
# Benefits for flexible industrial consumer

## Need for fundamental reform of market and regulatory framework

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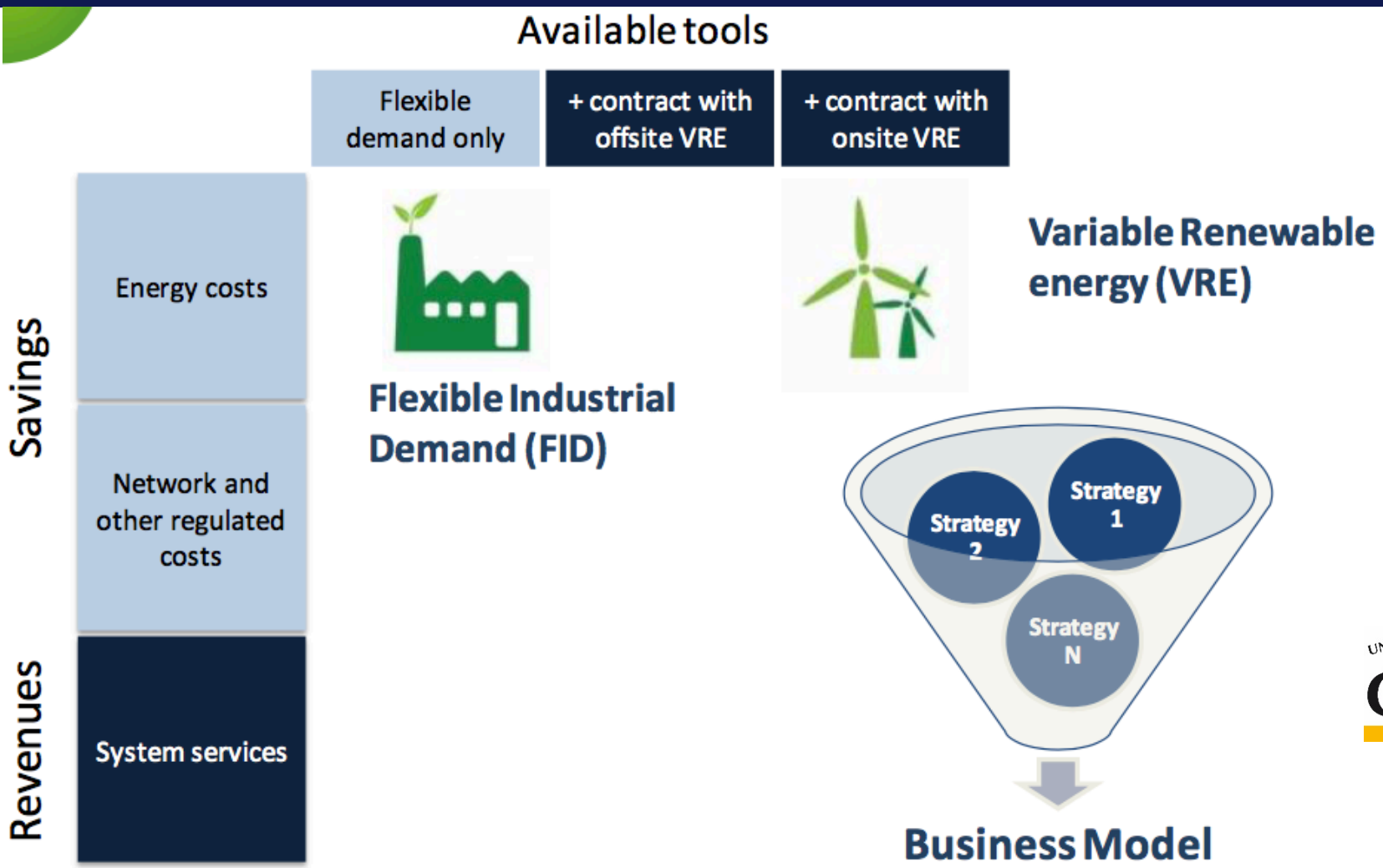
# Main findings: System perspective

- Multiple value streams of industrial demand flexibility for the European power system:
  - Reduction in system operation costs by providing balancing services (reserves, frequency response) and enabling higher utilisation of renewable and cheaper energy sources and
  - Reduction in generation and network investments by limiting peak demand levels and limiting the required generation flexibility
- System cost savings become more significant under higher renewable generation levels
- Value of industrial demand flexibility varies across different European countries

# Main findings: Industry perspective

- Multiple revenue streams for demand flexibility for the European industrial consumers:
  - Energy cost savings by adjusting electricity consumption patterns to the temporal variation of energy prices
  - Revenues from provision of balancing services (reserves, frequency response)
  - Revenues from provision of capacity services (generation, transmission and distribution level)
- Total cost savings and revenues become more significant under higher renewable generation levels
- Need for fundamental reform of market and regulatory framework to remunerate the multiple provided services in a cost-reflective way

# Business Models identified for FID /1





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# Business Models identified for FID

Available tools

| Savings | 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 |
| Network and other regulated costs | ToU network tariff | | Volumetric tariff response |
| **Revenues** | | | |
| System services | 2 Balancing provision and other services | 4 Bilateral balancing provision | |

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# Key Market/Policy Recommendations

- **Harmonize flexibility mechanism and products across EU markets**
  - Level playing field – trading of flexibility cross-border
- **Energy and Capacity Market access**
  - Improve access and participation of small and large industries in wholesale electricity markets (day-ahead and intraday markets)
  - Ensure level playing field for flexible industrial demand into these markets
- **Ancillary services**
  - Promote active network access / management by DSOs
  - Apply marginal pricing contracting balancing energy instead of pay-as-bid (also supported by National Grid); Reduce procurement horizons to closer to real time
- **Tariff design**
  - Establish cost-reflective network tariffs
- **Carbon benefits of flexibility**
- **Option value of flexibility**


**Detailed project results:**
**www.industre.eu/downloads/category/project-results**

# International Conference on Energy Systems Integration

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