



## Demand response

**Possible role, potential and barriers  
in the EU electricity system**





# The world is changing

## Europe:



40%

LESS CO<sub>2</sub> EMISSIONS  
vs. 1990



27%

MORE RENEWABLE  
ENERGY USE



LESS PRIMARY  
ENERGY USE vs. BAU\*

By the year

2030

\*Business As Usual



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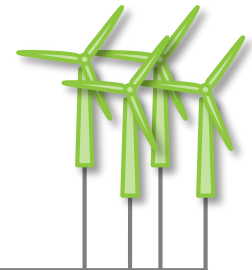
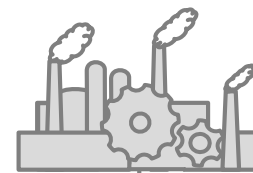
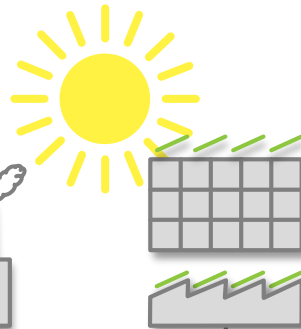
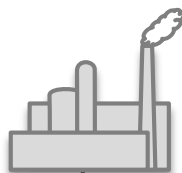
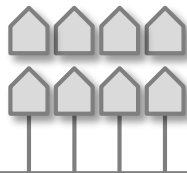
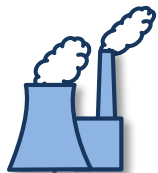


LESS PRIMARY  
ENERGY USE vs. BAU\*

By the year

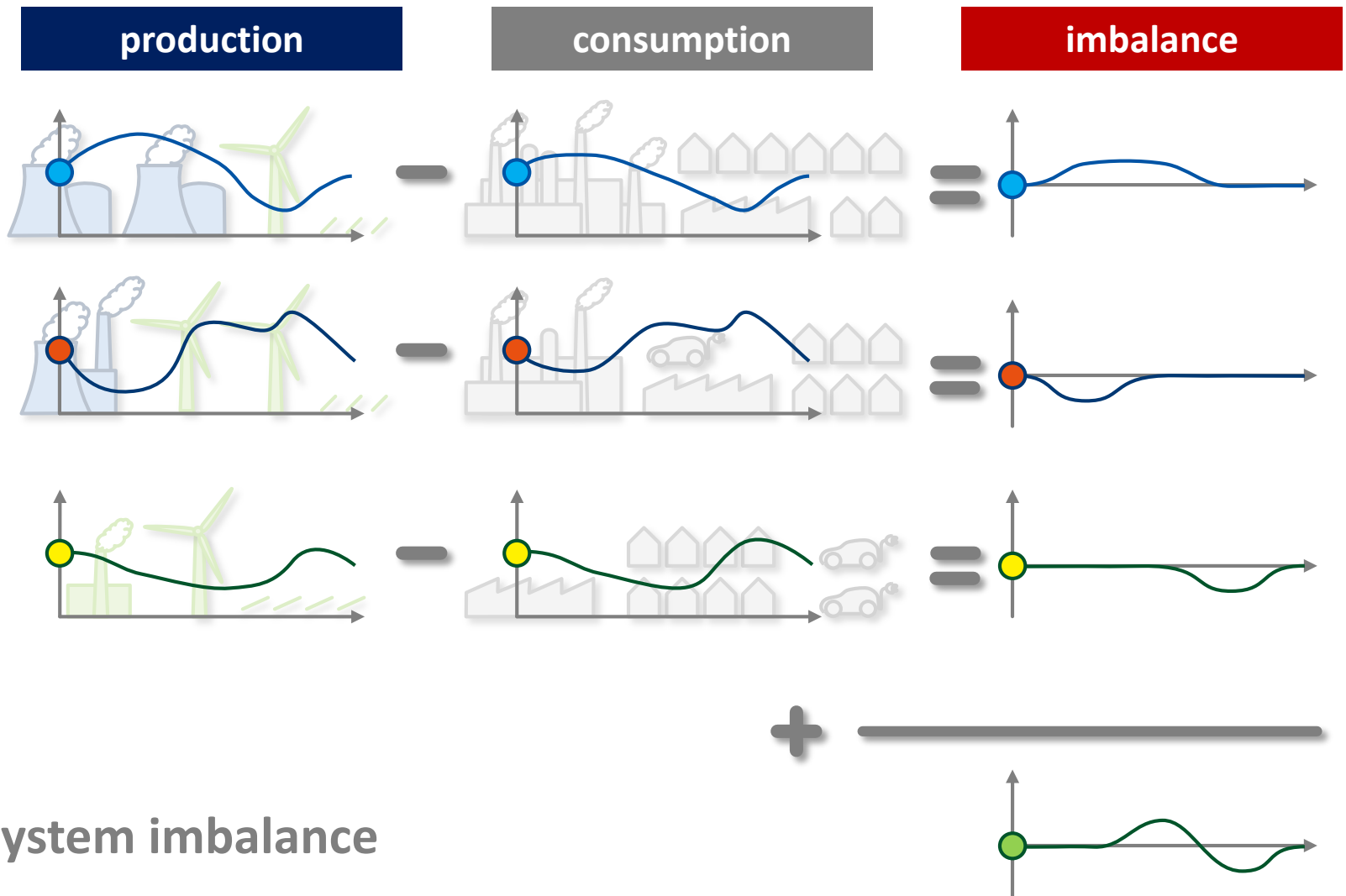
2030

\*Business As Usual



1/06/2017

# System with limited flexibility options



Total system imbalance

# Demand Respond

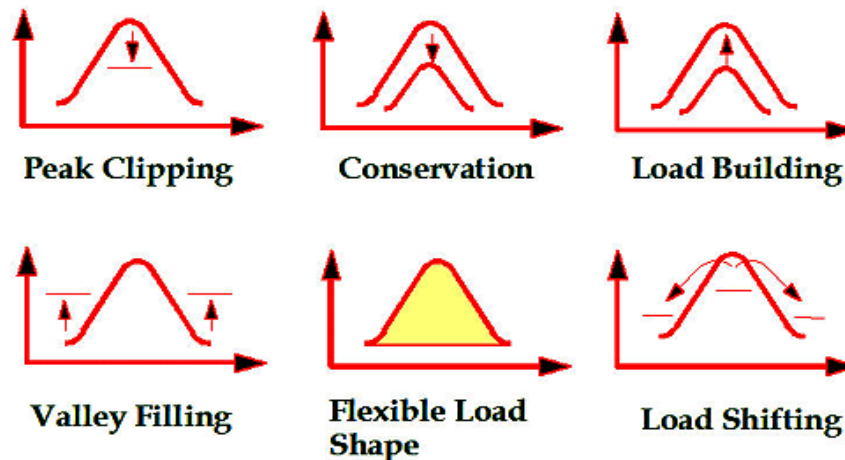
## A characterization

From a high-level perspective,

✦ DR could be understood as the ***change in electric usage patterns*** of end-users by means of ***price signals or incentive payments***

From a high-level perspective, DR could optimize the use of the power system

✦ It is more than “just load reduction”



# Demand Respond

## A characterization

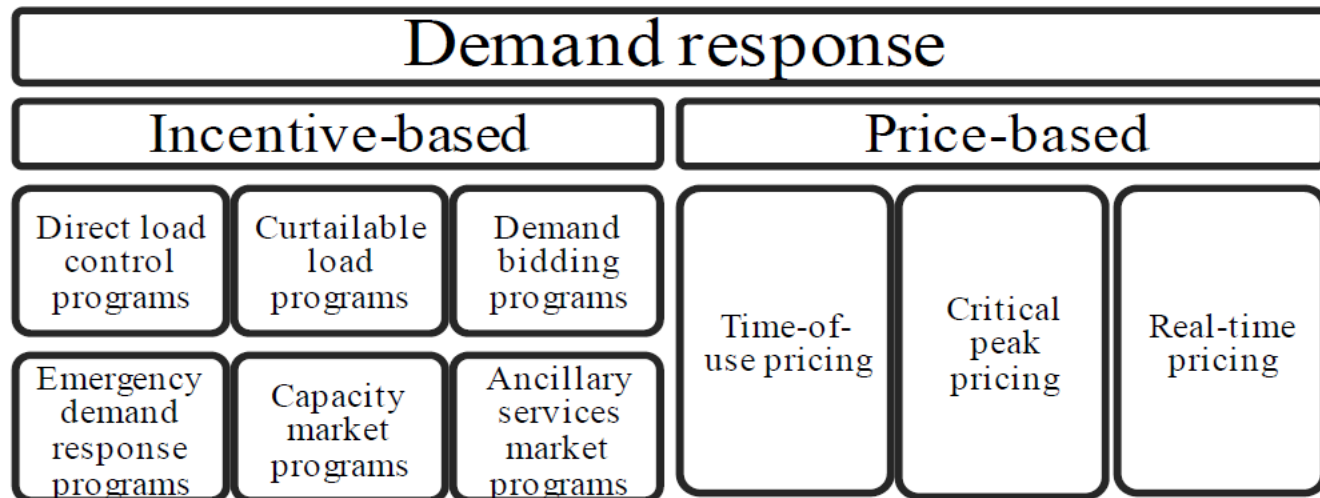
### Readily available flexibility

- ✦ Each consumption device (e.g. home appliance) is a (potential) source of flexibility

### Fast acting and scalable

- ✦ Immediate way to increase flexibility
  - 🏠 For system operators
  - 🏠 For commercial players

### Groups








Dupont, 2015







# Demand Response

## Possible role

### In the flexibility realm

-  Resource provider - Enhancing system reliability and adequacy
  -  Energy
  -  Capacity
  -  Ancillary services
-  Facilitator of a decarbonized power system

### In the technological realm

-  Innovation catalyzer
  -  Metering / Automation (control) / Communication
  -  Storage
  -  Consumption behaviors (new ways to consume)

### In the market realm

-  Competition enhancer
-  Facilitator for better price formation

# Demand Response

## Possible role



### Provider of flexibility-based solutions

⚡ Across wholesale and balancing markets

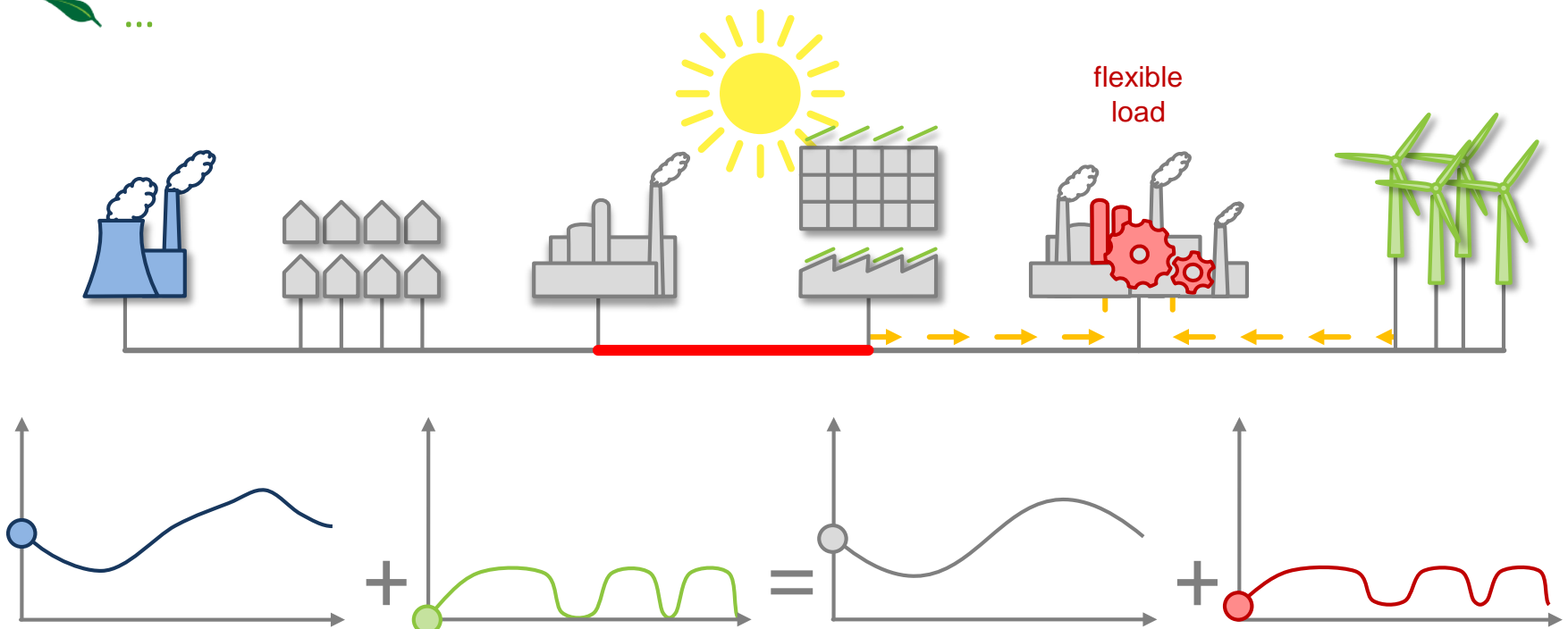
### Innovation catalyzer

### Promoter of competition

...

Art. 15 from the European Commission Energy Efficiency Directive (2012/27/EU):

- Encourage DR participation in wholesale and retail markets
- Promote access and participation of DR in system services markets
- No discrimination to DR providers (aggr.) by system operators



# Demand Response

## Possible sources

*“Flexibility can be found in a broad range of appliances and different kinds of customers.”*

### residential

- hot tap water boiler
- washing machine
- tumble dryer
- dish washer
- air-conditioning
- heat pump
- charging EV

### SME & buildings

- air-conditioning
- ventilation
- heat pump
- cold storage
- compressors
- pumps
- ...

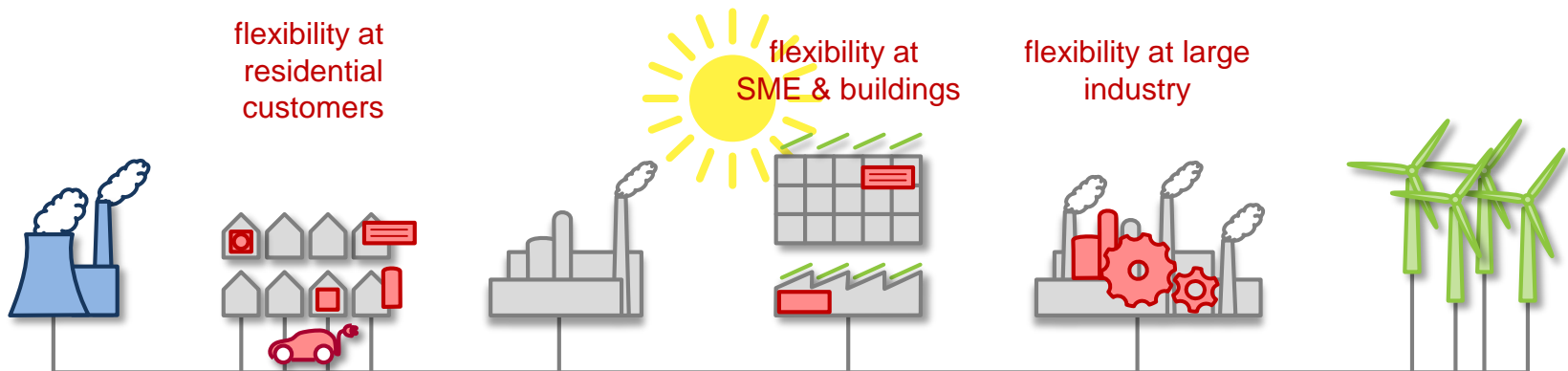
### large industry

- steel industry
- electrolysis
- compressors
- pumps
- paper industry
- ...

flexibility at  
residential  
customers

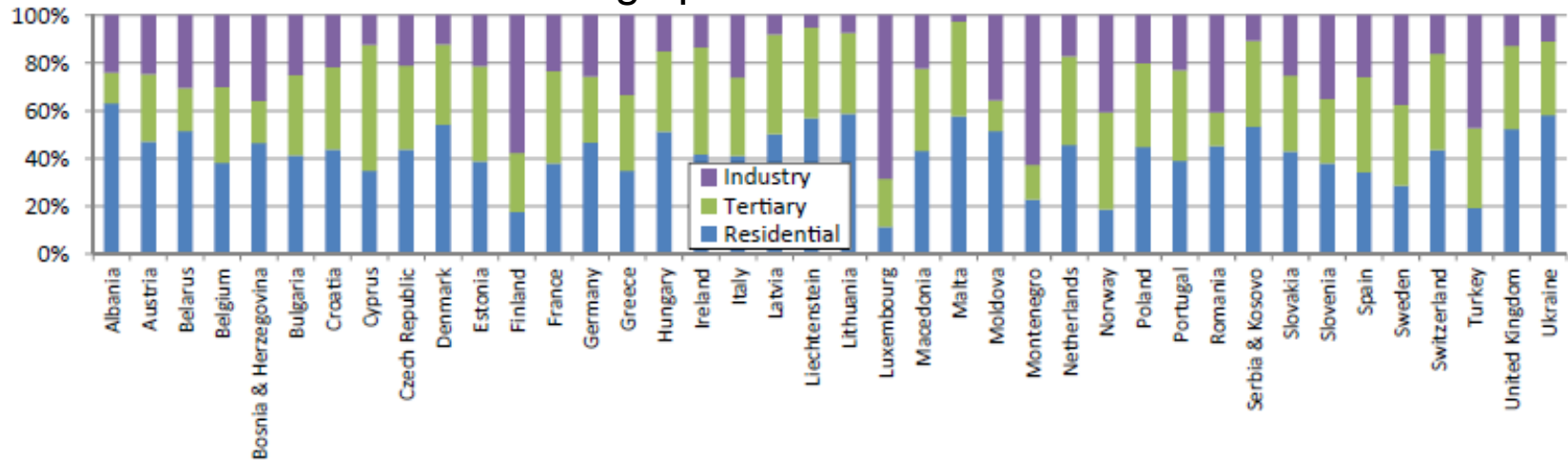
flexibility at  
SME & buildings

flexibility at large  
industry

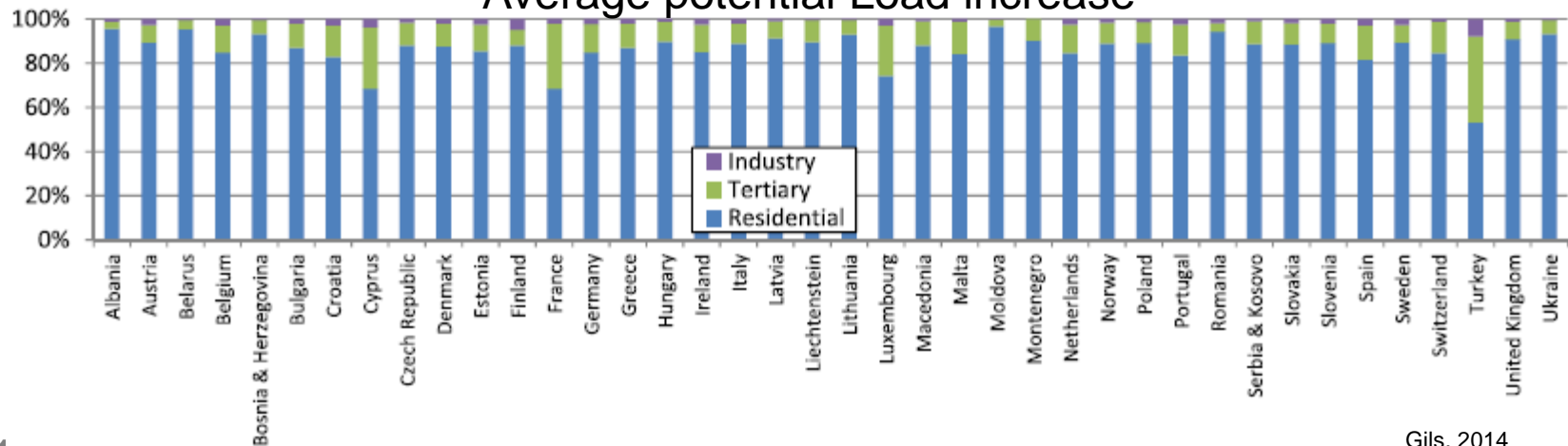


# Demand Response Potential

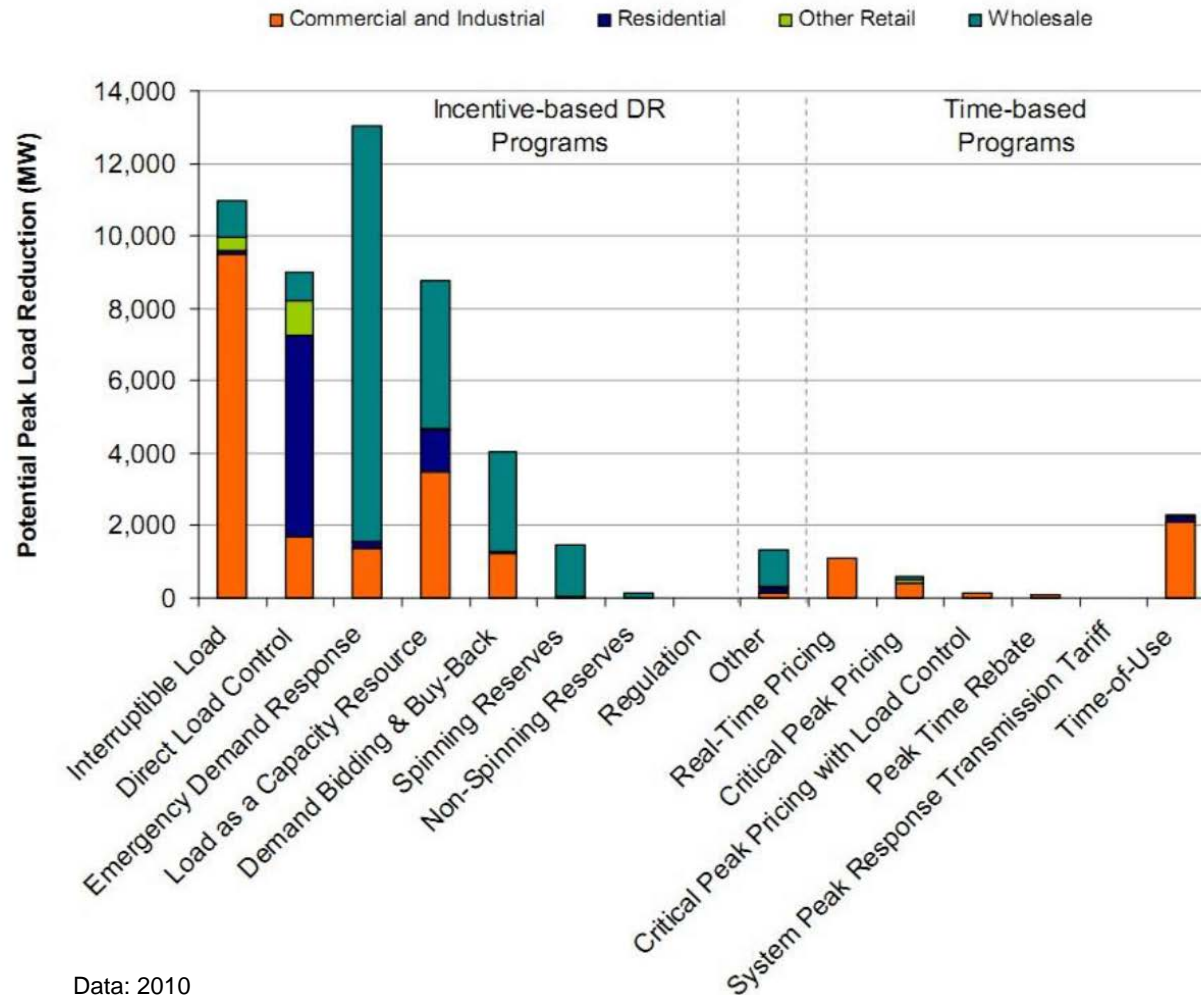
Average potential Load reduction



Average potential Load increase



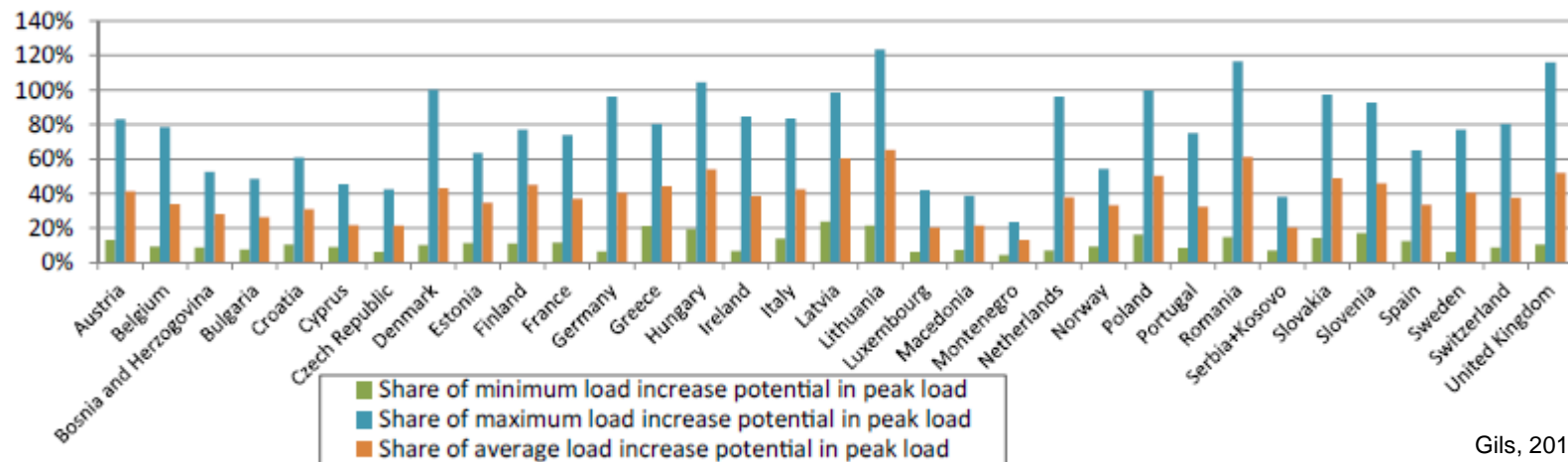
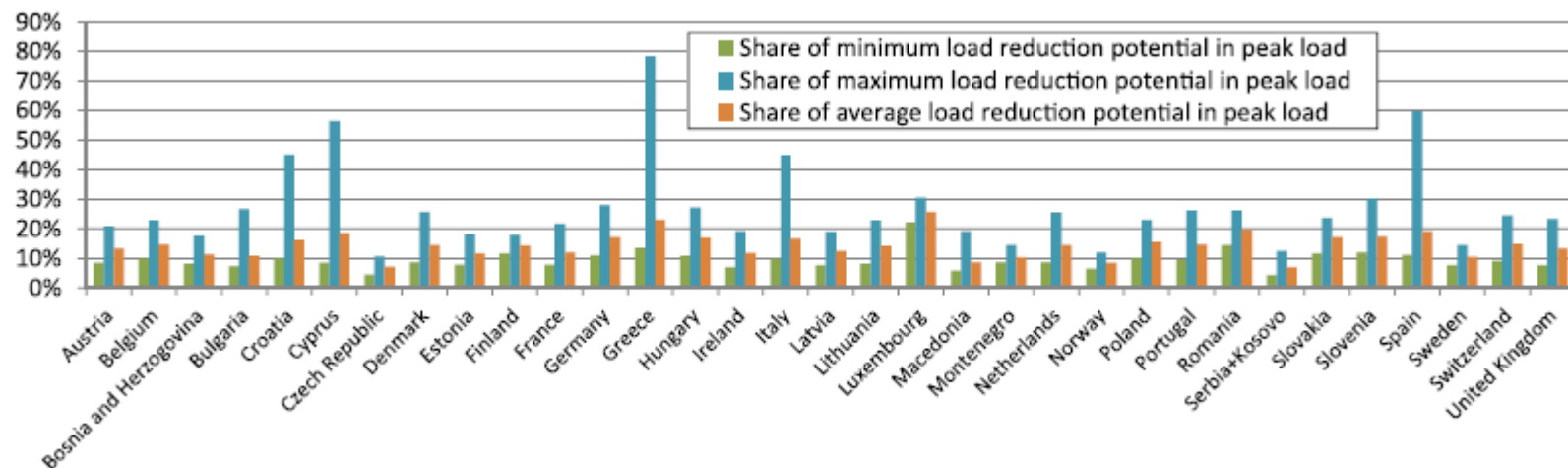
# Demand Response Potential



Data: 2010

Dupont, 2015

# Demand Response Potential



# Demand Response Potential

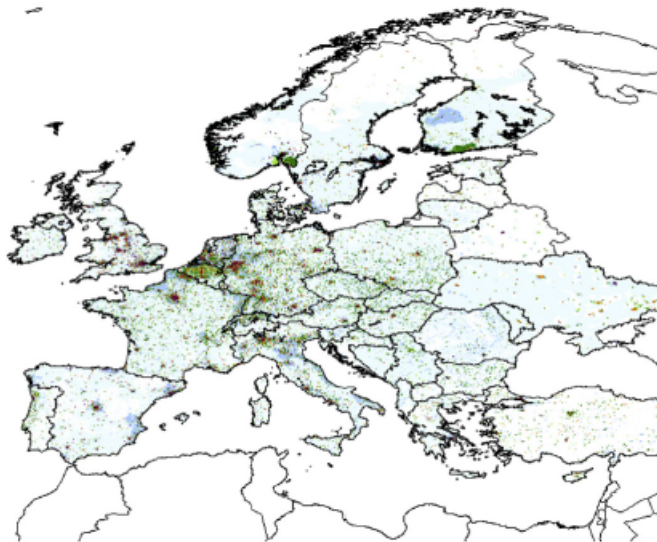
Values of more than 900 kW/Km<sup>2</sup>

Paris, Inner London, Ludwigshafen am Rhein

Low densities

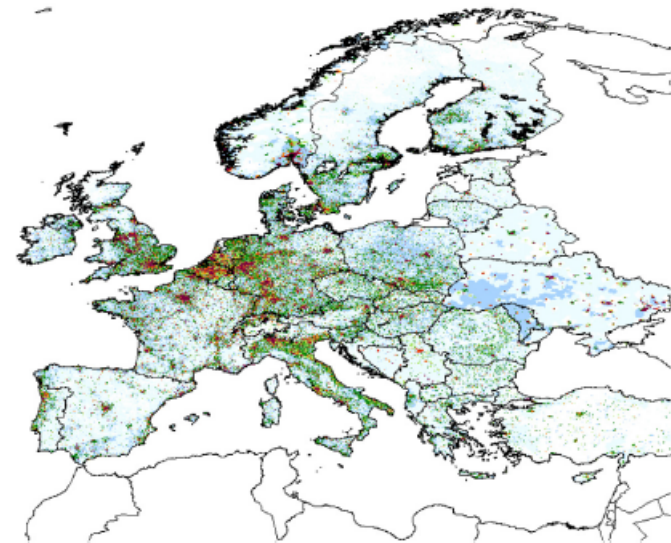
North-eastern Germany, Scotland, northern Finland, ...

Load reduction potential



Density in kW/Km<sup>2</sup>

Load increase potential

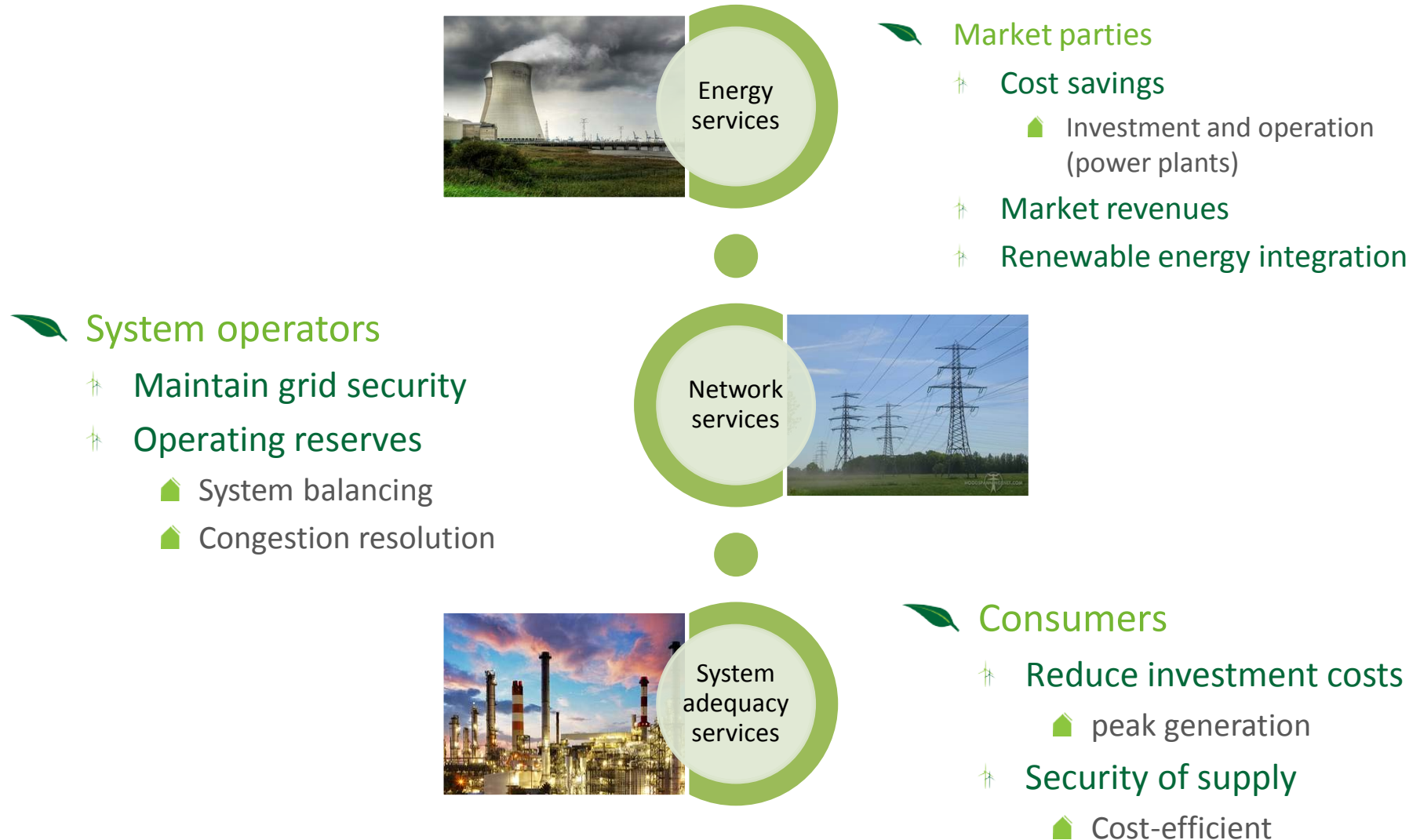


Density in kW/Km<sup>2</sup>



Gils, 2014

# Demand Response Potential



# Demand Response Potential

## Potential business models for DR in 6 Member States

Business model		BE	FR	DE	IT	ES	UK
Standard contract optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Day-ahead optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Reserve capacity	FC reserve	●	●	●	●	●	●
	FR reserve	●	●	●	●	●	●
	R reserve	●	●	●	●	●	●
Imbalance optimization		●	●	●	●	●	●
On-site VRE optimization		●	●	●	●	●	●

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

IndustRE, 2016




# Demand Response Potential

Potential to **optimize the use of the power system**  
Maintaining the balance between demand and supply

## (peak) demand reduction


 In a 2011 study ordered by the FERC (USA)

 The vast majority of peak reduction potential will come from incentive-based demand respond (92%)

 However, in the long run the introduction of “smart” technologies may tilt the balance towards price-based DR

## Better wholesale market price formation


 Increases market efficiency

 Flexible enough to substitute or complement services provided by other technologies (e.g. pumped storage)

## Improved supply of system services


 Enhances system reliability

 Fast enough to cope with sudden imbalances (short-term)

 May reduce the need of investments on new (peak) generation capacity (long-term)

## Lower investment in capacity

 Cheapest flexibility option

 In comparison with other capital intensive options (flexible generation, storage, enhanced interconnections)

# Demand Response Challenges

## Adequate remuneration

- ✂ Need of price spreads in the market that makes DR profitable
  - 🏠 Rather than occasional price spreads that do not allow for building a flexible tariff optimization model
- ✂ Need of adequate peak pricing and/or rebate program
  - 🏠 Peak periods: suitable announcement lead time and duration

## Requirements for participation

- ✂ E.g. frequency of procurement, resource availability, event duration, ...

## Measurement and verification protocols to ensure a fair payment for DR services

- ✂ E.g. standardized baseline mechanism

## Clarification of relationships

- ✂ E.g. between BRP and aggregator



# Demand Response Challenges



# Demand Response

## Challenges in practice

### Participation in balancing reserves

#### Product

- Originating from the design of regulatory framework, market, product which focus on the characteristics of generators
  - Bid (minimum) size
  - Timing requirements: product duration & minimum run/down times
  - Symmetry

#### Economic

- Financial (dis)incentives
  - Incentives are too low or not existing
  - Fear to increase in bill due to high peak demand usage
  - High penalties for non-compliance

#### Technical

- Special requirements for the system or consumers (focus on generation specifics)
  - Lack of infrastructure: no smart meter = no time-varying prices
  - Network and scheduling constraints

#### Consumer

- Lack of awareness and policy restrictions
  - Low awareness and understanding of DR programs
  - Low willingness to react to signals (prices or incentives) due to inelasticity of demand
  - No freedom to design rates (retail)
  - Wholesale prices are more variable than retail market prices



# Demand response

## The take away

- ✦ DR may play a central role in the evolution of the power system
  - ✦ As resource provider
  - ✦ As innovation catalyzer
  - ✦ As competition enhancer
- ✦ DR has the potential to reshape the electricity business
  - ✦ especially at distribution system level
    - 🏠 However, the value of this source of flexibility should be reflected by the financial incentives and price signals delivered to the consumer
- ✦ Participation of DR
  - ✦ System adequacy and balancing seems to be more interesting for DR
  - ✦ Wholesale has still low participation
- ✦ Main source of barriers for the deployment of DR
  - ✦ Design of the regulatory framework, markets and products
    - 🏠 It is important to take into account these barriers when deciding on the scope and characteristics of any reform (e.g. IEM – market harmonization)



# Demand response

## The take away

🍃 To continue the deployment of DR it is needed to

✂ Promote a “flexibility friendly” legislation

🏠 E.g. Providing consumers with access to infrastructure (smart meters) and schemes (dynamic pricing)

✂ Support an standardized framework

✂ Give guidelines to assess system flexibility needs and DR flexibility value

🏠 E.g. Promoting robust CBAs

🏠 E.g. Taking into account expected potential and related cost (e.g. methods, incentives and technologies to measure and promote changes in consumer’s behavior)

✂ Increase consumer’s awareness

🏠 E.g. Simplifying the message and enhancing the protection

✂ Mitigate market and regulatory distortions

🏠 E.g. Considering solutions for DR barriers in the design of the regulatory framework, markets and products



# EnergyVille

## Questions?

[ronnie.belmans@energyville.be](mailto:ronnie.belmans@energyville.be)

[Daan.six@energyville.be](mailto:Daan.six@energyville.be)

[enrique.riveropuente@energyville.be](mailto:enrique.riveropuente@energyville.be)

