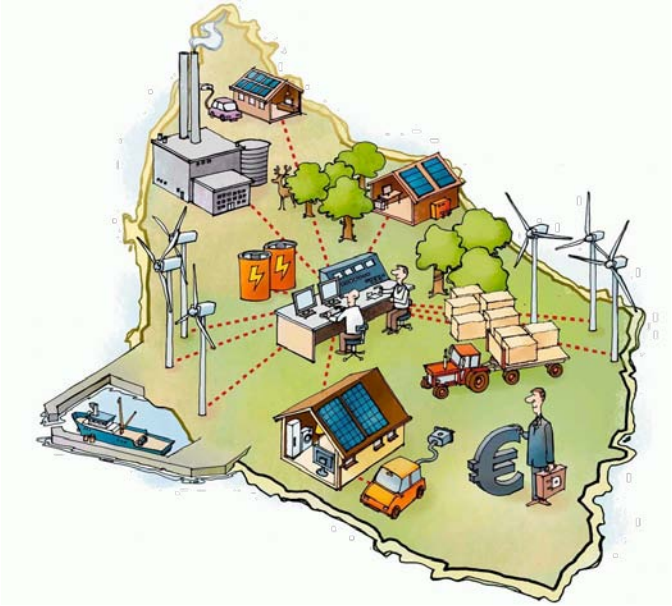
EcoGrid EU: a real-time market demonstration Project to facilitate the integration of renewables



Presentation at: Jornada Renovables

Presentation by: Salvador Pineda

CENTER FOR ELECTRIC POWER AND ENERGY

- CEE established 15 August 2012 as a merger of existing units:
  - Center for Electric Technology, DTU Electrical Engineering
  - Intelligent Energy Systems, Risø National Laboratory for Sustainable Energy
- Main competences
  - Electric Power Engineering
  - Automation and control
  - Information and Communication Technology
  - Electricity markets
- A strong university centers within its field
  - Staff: 85 persons incl. PhD-students
  - Covers discipline oriented research as well as national lab type application-driven research and proof-of-concept
- Strategic partnerships

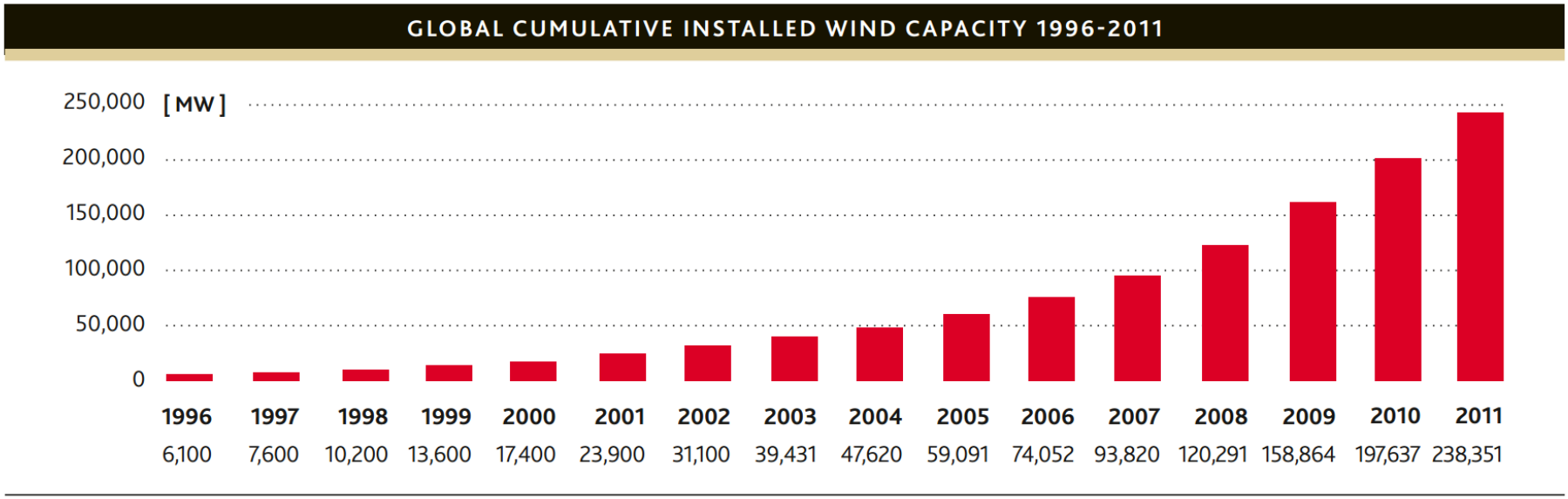
ENERGINET.DK DONG energy SIEMENS

Content

- The Challenges of Tomorrow
- EcoGrid: A Real-time Market Solution
- Bornholm: A Unique Demonstration Site

THE CHALLENGES OF TOMORROW

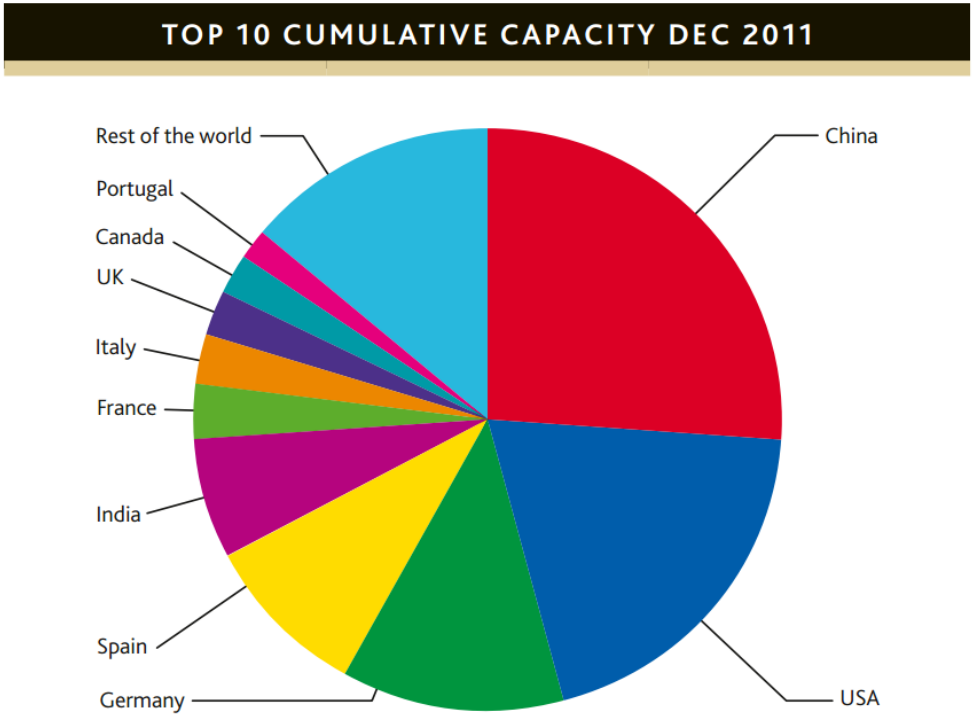
- INCREASE OF WIND INSTALLED CAPACITY WORLDWIDE



Source: Global Wind Energy Council (2011)

THE CHALLENGES OF TOMORROW

- SPAIN: LEADING COUNTRY ON WIND INTEGRATION

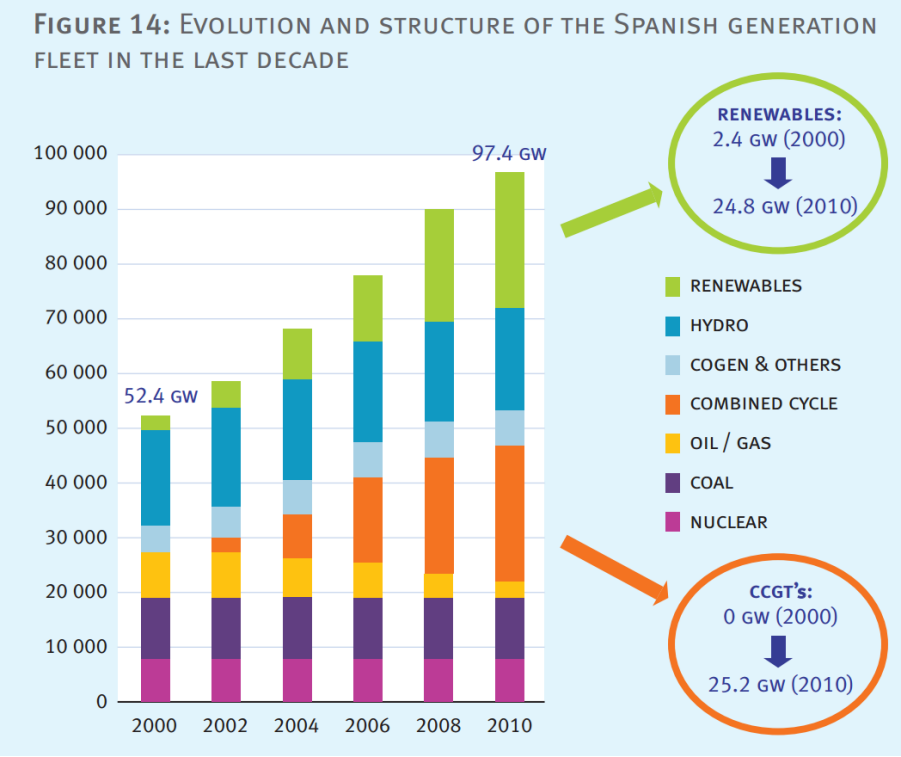


Country	MW	% SHARE
China**	62,733	26.3
USA	46,919	19.7
Germany	29,060	12.2
Spain	21,674	9.1
India	16,084	6.7
France**	6,800	2.9
Italy	6,747	2.8

Source: Global Wind Energy Council (2011)

THE CHALLENGES OF TOMORROW

- SPAIN: LEADING COUNTRY ON WIND INTEGRATION



Source: Red Eléctrica de España

THE CHALLENGES OF TOMORROW

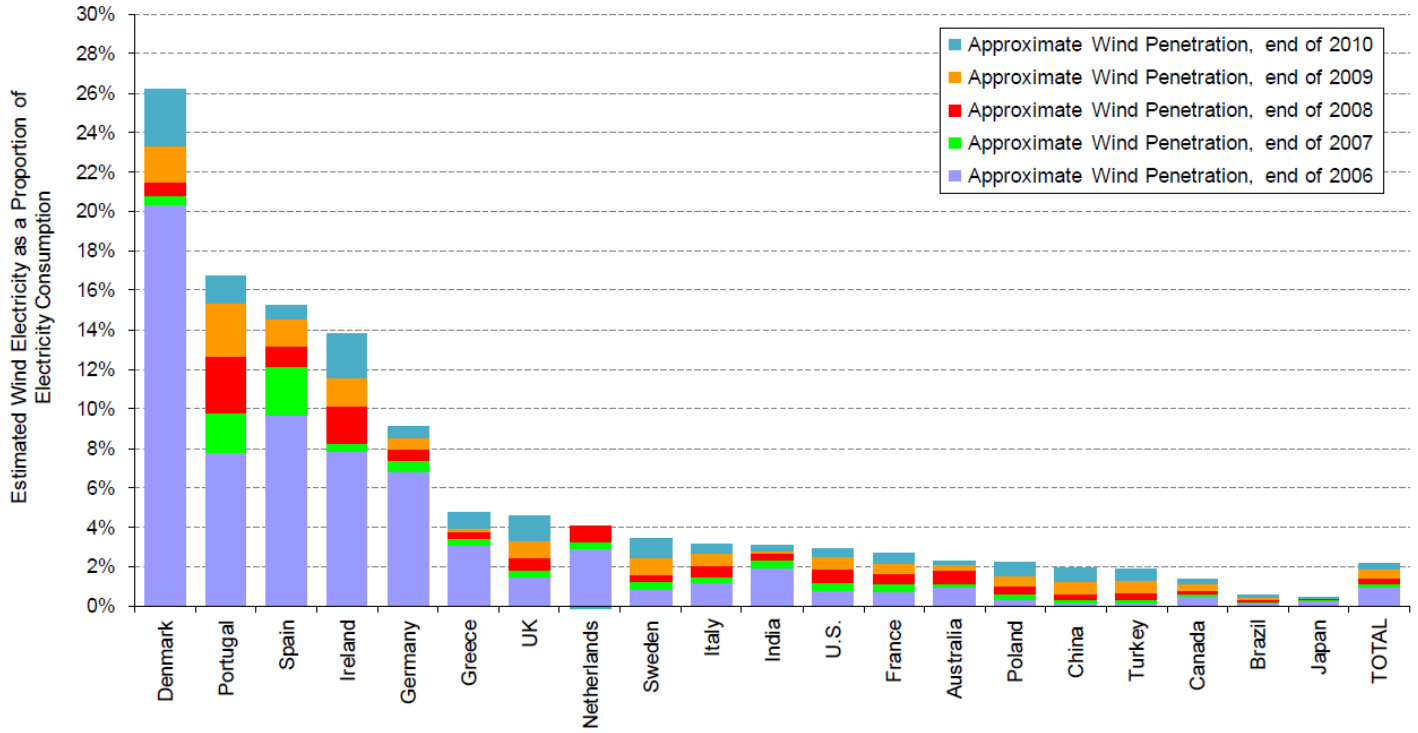
- SPAIN: LEADING COUNTRY ON WIND INTEGRATION

16/04/12

Source: Red Eléctrica de España

THE CHALLENGES OF TOMORROW

- DENMARK: LEADING COUNTRY ON WIND INTEGRATION

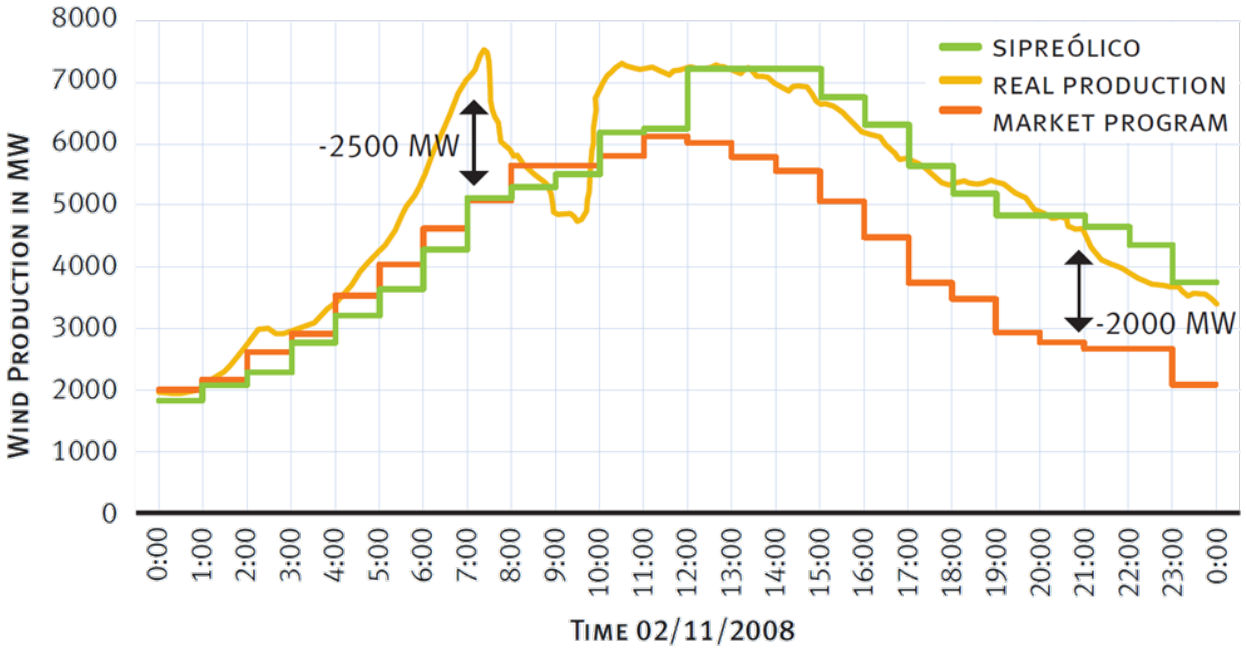


Source: US Department of Energy

THE CHALLENGES OF TOMORROW

- SIGNIFICANT WIND PRODUCTION FORECAST ERROR

FIGURE 16: WIND FORECAST ERROR IN SPAIN



Source: Red Eléctrica de España

The Challenges of Tomorrow

- Imperative need for additional balancing power

Transmission capacity

Flexible generation

Storage

Flexible demand

EcoGrid: A Real-time Market Solution

- **EcoGrid objective**: to use flexible demand response of end-customers to reduce the impact of the variability and uncertainty of the renewable production on the operation of the power system

EcoGrid: A Real-time Market Solution

Other solutions

End-customers can provide balancing power

Retailers sells the balancing power of the customers to TSO

TSO buys balancing power to the retailers to balance wind

EcoGrid: A Real-time Market Solution

Other solutions

EcoGrid eu www.eu-ecogrid.net solution

EcoGrid: A Real-time Market Solution

Other solutions

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EcoGrid eu solution

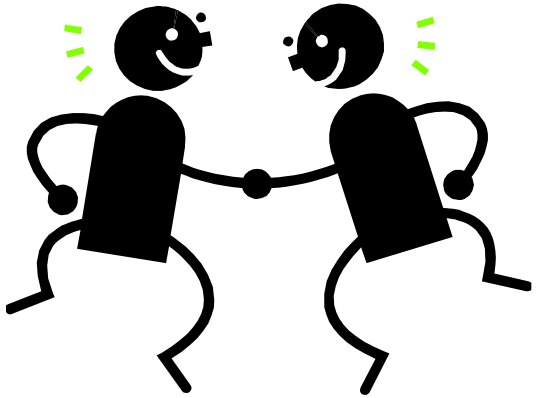
End-customers can provide balancing power

TSO buys balancing power to the customers to balance wind

EcoGrid: A Real-time Market Solution

- **WHY?**

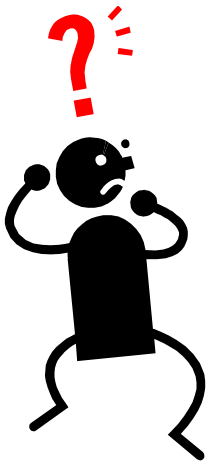
  To offer flexible end-customers a transparent and clear product to trade their flexibility with the system



EcoGrid: A Real-time Market Solution

- **CHALLENGE**

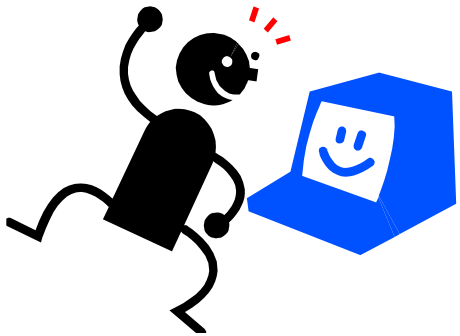
  End-customers cannot submit bids to buy electricity. It is difficult to determine numerically the utility function of a household.



EcoGrid: A Real-time Market Solution

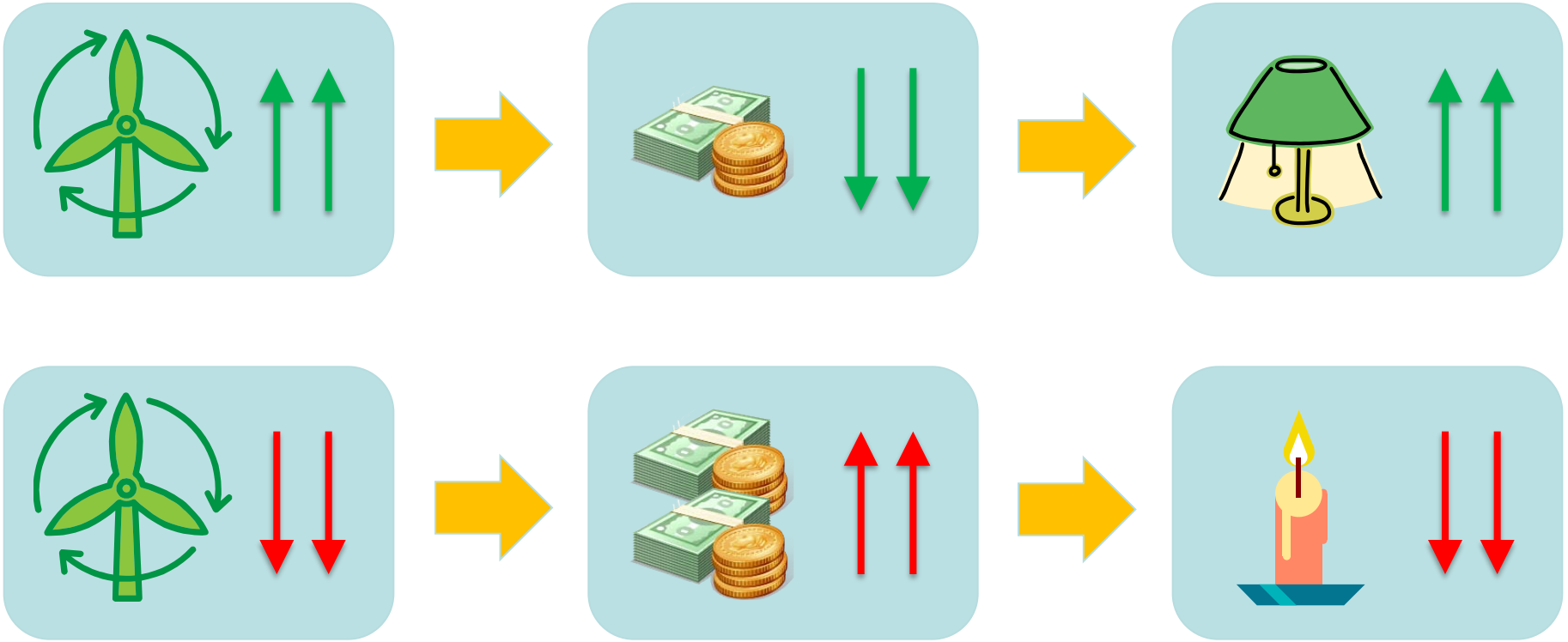
- **SOLUTION**

  End-customers will continuously receive the electricity price at which they will be charged beforehand.



EcoGrid: A Real-time Market Solution

- **SOLUTION**



EcoGrid: A Real-time Market Solution

- **CHALLENGE**

  TSO has to forecast the response of end-customers to prices to maintain the balance in the system. However, this response is:

  - Time variant
  - Uncertain
  - Dynamic

EcoGrid: A Real-time Market Solution

- **SOLUTION**

  To publish one price every 5 minutes in order to take corrective actions when the forecast of the demand response is not accurate enough.

EcoGrid: A Real-time Market Solution

- **QUESTIONS**
  - How much balancing power can we obtain from flexible end-customers?
  - Can we use flexible demand of end-customers to reduce wind power production fluctuations?
  - How much does the system benefit?
  - How much is the flexible customers saving?

BORNHOLM: A UNIQUE DEMONSTRATION SITE

- **SOLUTION**

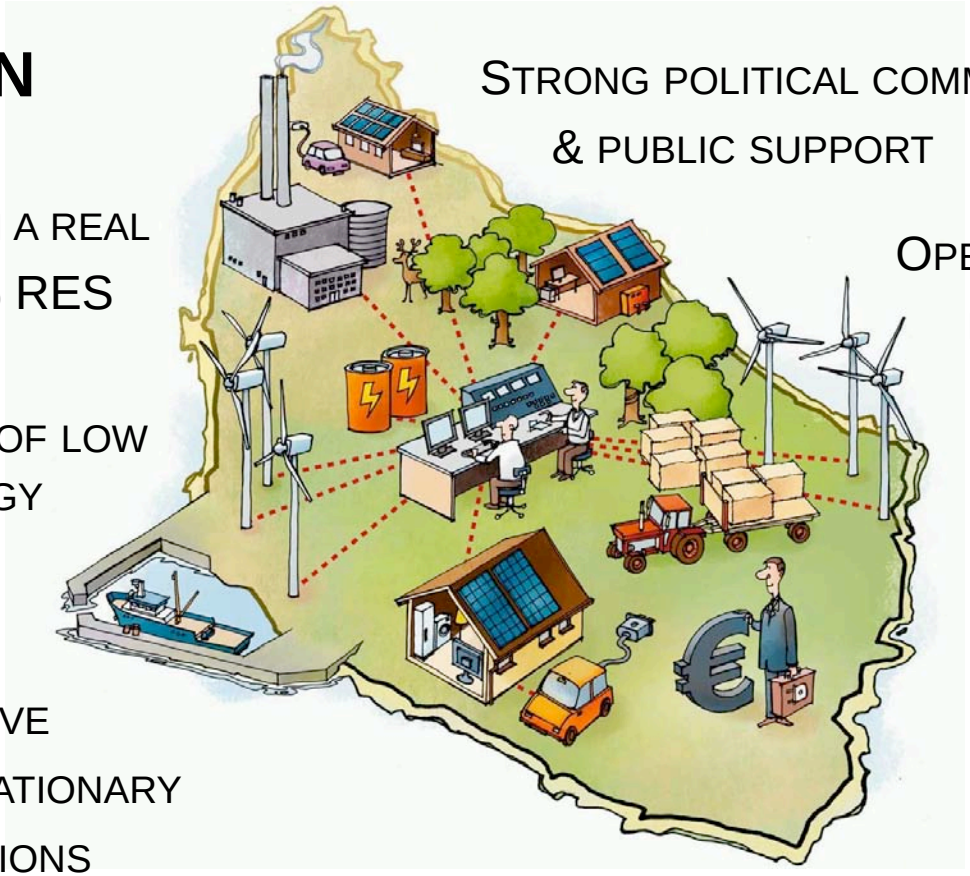
STRONG POLITICAL COMMITMENT & PUBLIC SUPPORT

DEMONSTRATION IN A REAL SYSTEM WITH 50 % RES

OPERATED BY THE LOCAL MUNICIPAL OWNED DSO, ØSTKRAFT

HIGH VARIETY OF LOW CARBON ENERGY SOURCES

ELIGIBLE RD&D INFRASTRUCTURE & FULL SCALE TEST LABORATORY



SEVERAL ACTIVE DEMAND & STATIONARY STORAGE OPTIONS

INTERCONNECTED WITH THE NORDIC POWER MARKET

BRIGHT GREEN ISLAND
BORNHOLM

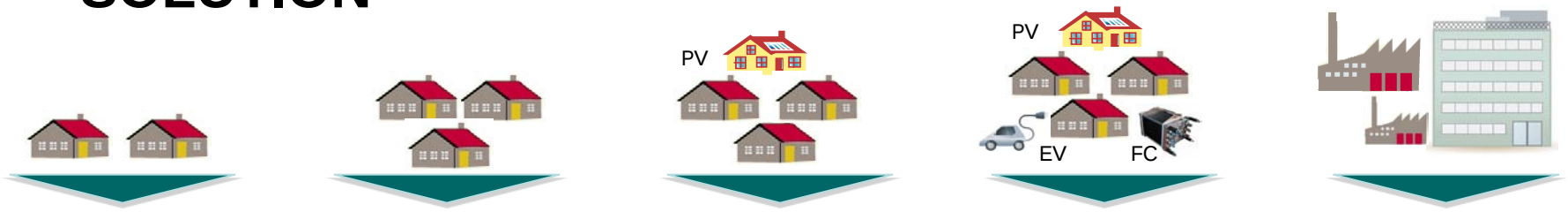
BORNHOLM: A UNIQUE DEMONSTRATION SITE

- **SOLUTION**

Property	Value
Customers	
Number of customers	~28.000
Number of customers (> 100.000 kWh/year)	~300
Total energy consumed	268 GWh
Peak load	55 MW
Low-carbon energy resources	
Wind power plants	30 MW
CHP/biomass	16 MW
PV (roll-out under project)	2.0 MW
Biogas plant	2.0 MW
Electric vehicles (under roll-out)	
Grid	
60 kV grid	131 km
Number of 60/10 kV substations	16
10 kV grid	914 km
Number of 10/0.4 kV substations	1006
0.4 grid	1.887 km
Communication	
Fiber network between 60/10 kV substations	131 km
District heating	
Number of district heating systems	5
Total heat demand (in 2007)	560 GWh
Operation	
Normal operation mode	Interconnected Nordel
Island operation capability	Continuous

BORNHOLM: A UNIQUE DEMONSTRATION SITE

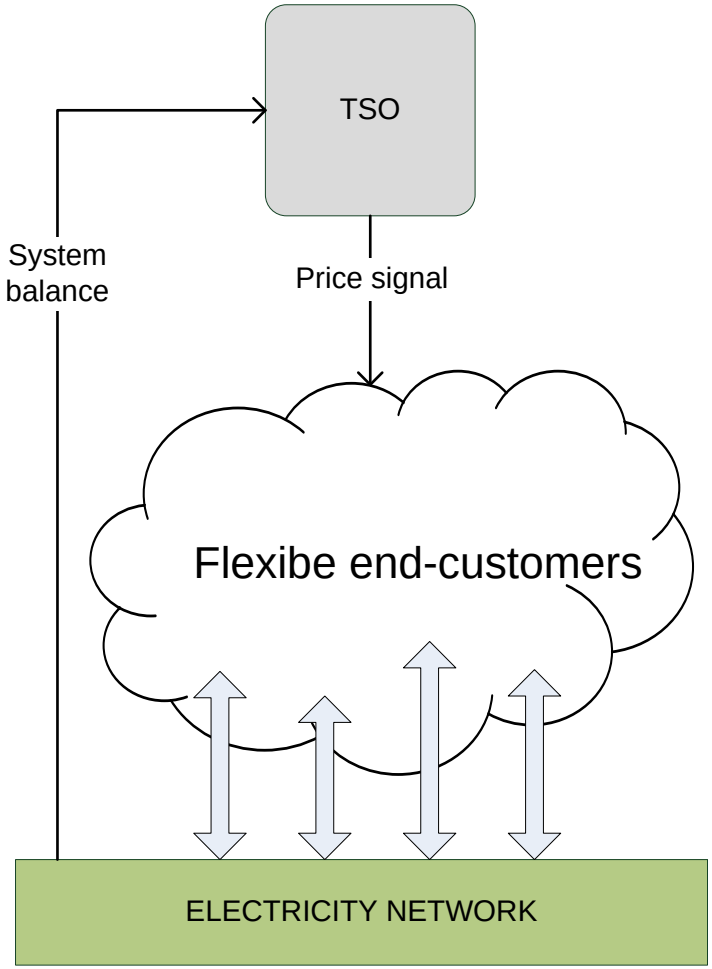
- **SOLUTION**



Reference group	Manual houses	Automatic houses	Aggregator	Smart businesses
200 households	400-500 households	700 households	500 households	100 commercial/public customers
No access to specific information or smart equipment	Receiving market price information/prognosis	Installation of appliances responding to market price signals/prognosis (heat pumps or electric heating)	Installation of multiple connected appliances responsive to price signals	Smart meter and appliances
No response	Manual response to price changes	Automatic response	Direct control by aggregator	Automatic/manual response

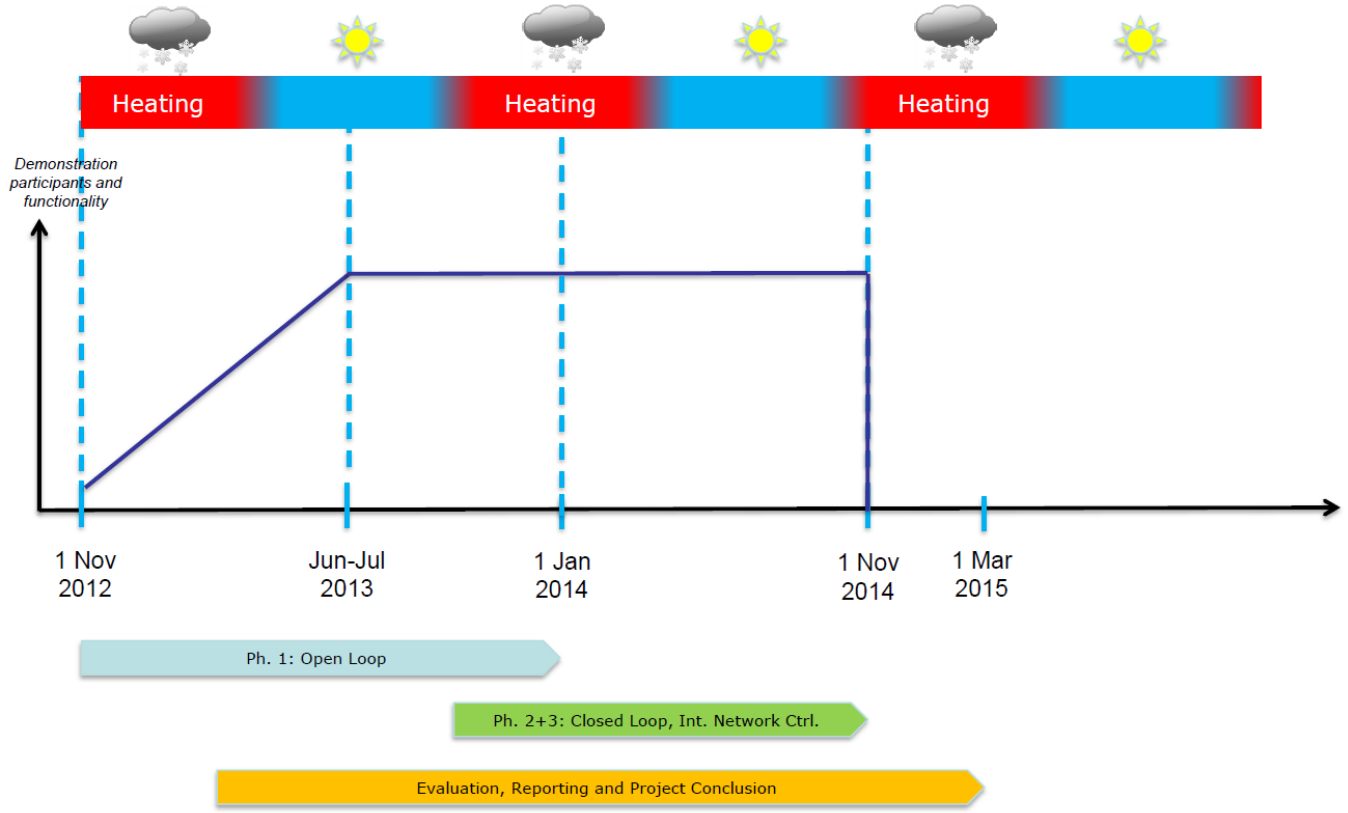
BORNHOLM: A UNIQUE DEMONSTRATION SITE

- **SOLUTION**



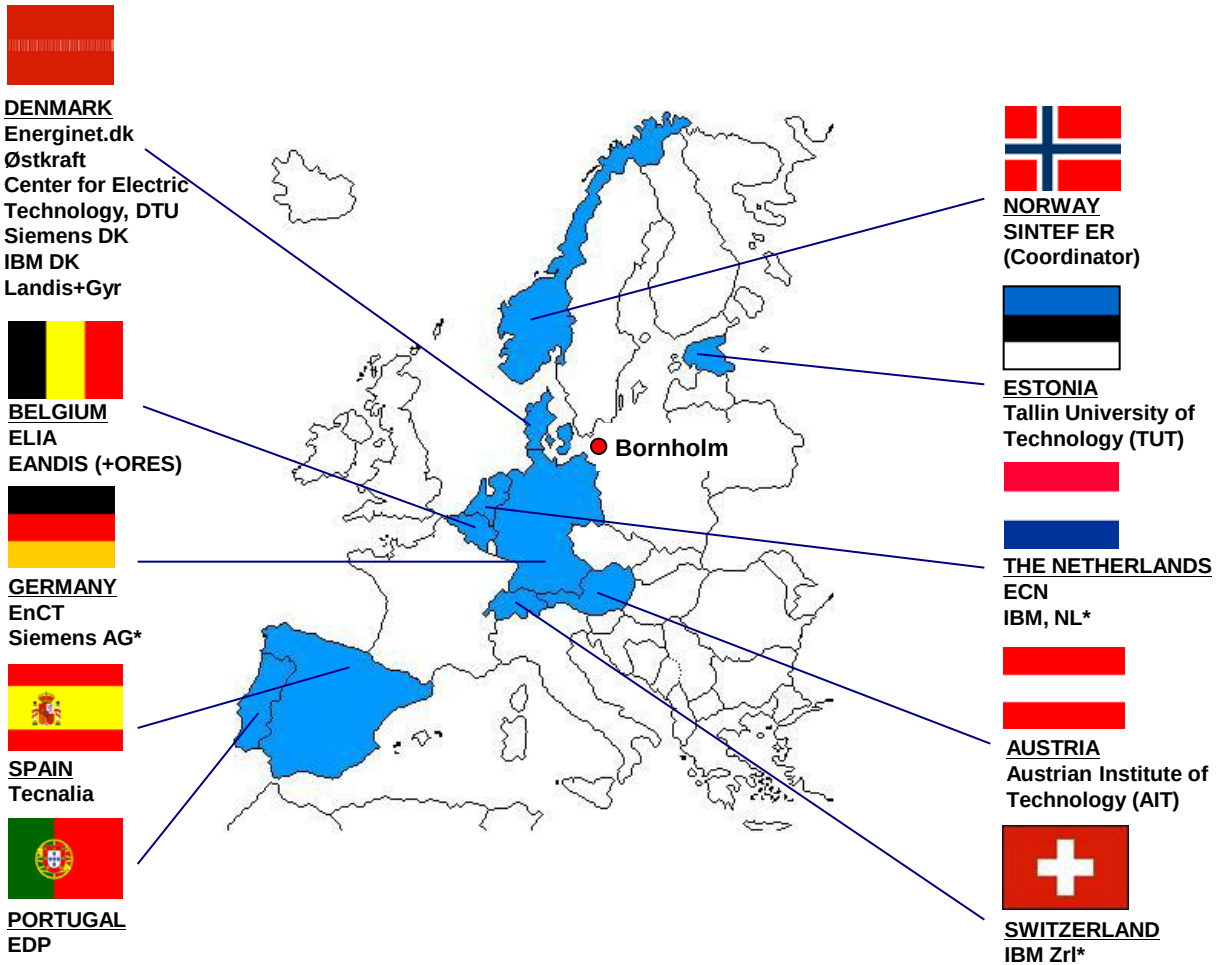
BORNHOLM: A UNIQUE DEMONSTRATION SITE

- **SOLUTION**



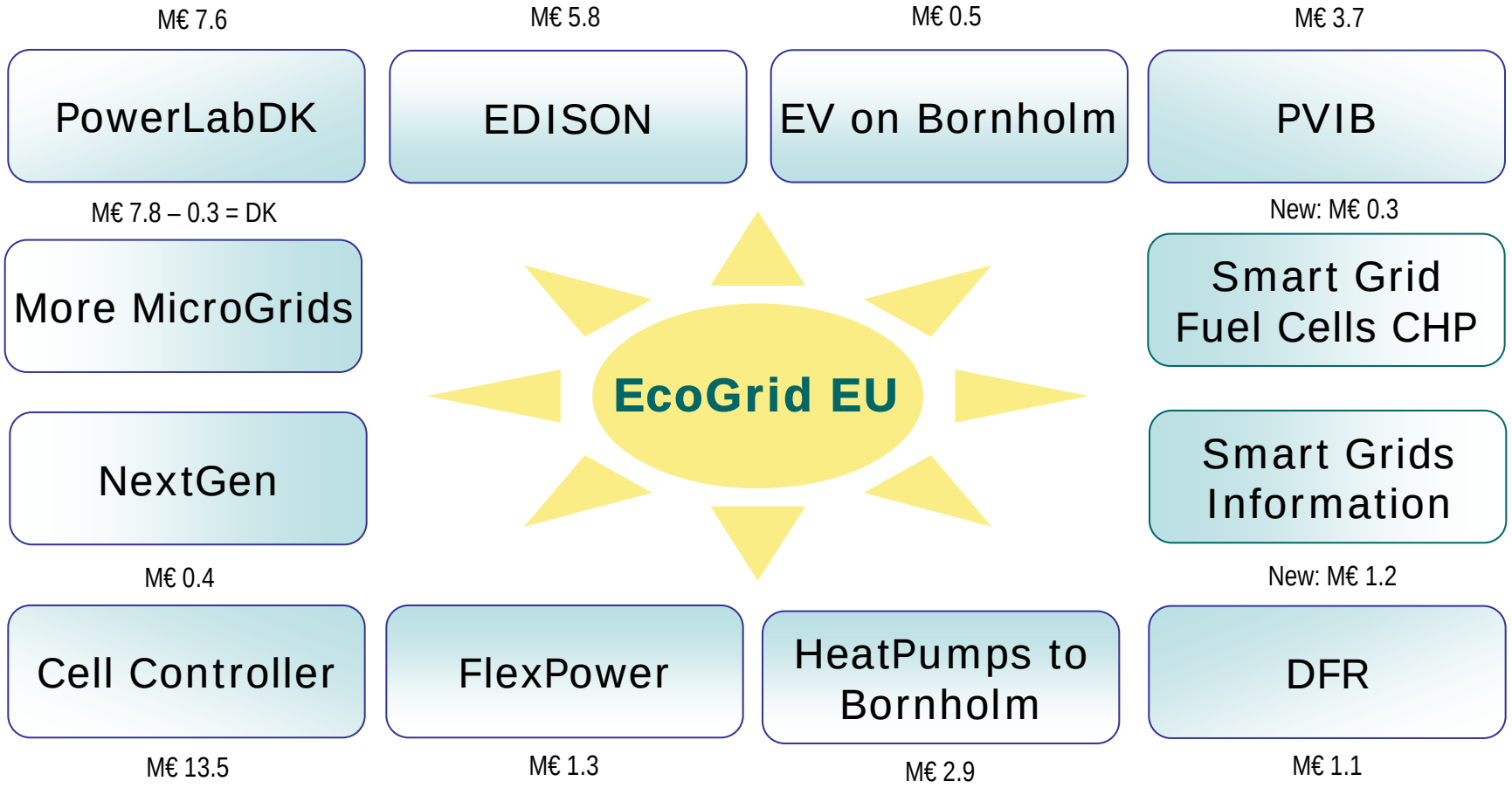
BORNHOLM: A UNIQUE DEMONSTRATION SITE

- **SOLUTION**



* Third party

BORNHOLM: A UNIQUE DEMONSTRATION SITE



- Some M€ 40 National funding to related projects

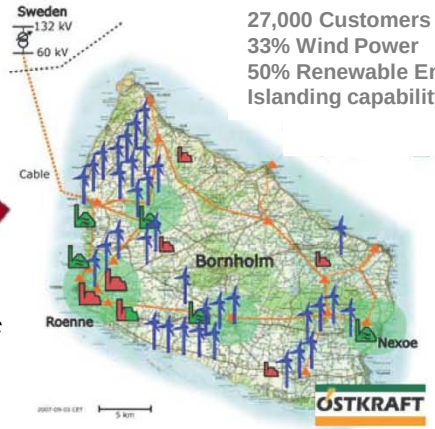
BORNHOLM: A UNIQUE DEMONSTRATION SITE

Flexible multi-purpose laboratories

Lyngby &
Ballerup Campus

Large-scale power system (1:10)

Risø Campus



27,000 Customers
33% Wind Power
50% Renewable Energy
Islanding capability

Full-scale Realistic Power System

Østkraft (Bornholm)

Thanks for your attention!

Questions?