DR Research in Spain

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tecnalia energía

INDEX

1. Presentation of Tecnalia-Energia
2. Description of the Spanish power system and existing load control tools
3. Main challenges
4. Demand response research efforts

About us

Tecnalia Energía:

- We are the Energy Unit of Tecnalia Corporation, which is the fifth Private Research Organisation in Europe (95 M€ turnover)
- We are the largest private Research Organisation in Spain in the Energy field:
  - in terms of workers in Research (113)
  - and also in terms of turnover (10 M€)

We work in emerging fields, innovation, research, development and strategic challenges of the future

And always with the scientific and technical rigour, and the objectivity that our independent position gives us

Our R&D activity (I / III)

Active Energy Distribution

- Power Systems advanced architectures : design of microgrids management systems. Aggregation of Distributed Energy Resources.
- Demand Response and Demand Side Management.
- Communication protocols for Power Systems

Wind Power

- Conventional, multilevel and matrix power converters
- Hardware and control algorithms.
- Communication protocols for wind farms.
- Structural materials, blades

Our R&D activity (II/III)

Solar energy

- Distributed architectures. Novel power converters. Communications. MPPT algorithms. Monitoring and predictive maintenance.
- Hybrid and organic cells, DSSC. Thin film cells. Flexible systems.
- PV building integration.
- Materials, covers and joints for solar thermoelectric systems

Wave energy

- New concepts for wave energy systems.
- Energy conversion and interconnection to the grid.
- Forecasting and localization. Infrastructures. Environmental impact.
- System evaluation.

Our R&D activity (III/III)

Biomass:

- Raw material and high organic waste treatment
- Thermal processes for liquid and gas biofuel obtaining.

Hydrogen and fuel cells:

- Hydrogen production: renewables, biomass and hydrocarbons.
- Hydrogen storage.
- Materials security and behavior.
- Materials and components for electrolyzers.
- Materials and components for PEMFC and SOFC.
- Balance of system. Hydrogen for renewable power storage.
- Fuel cell mobile and stationary applications

Our laboratory activities

Electrical equipment testing

- The highest capacity Power Laboratory in Spain
- Conformity assessment according to standards
- Testing to support product design
- Substations and Power Plants equipment diagnosis.
- High voltage underground cables testing
- Technical assessment and suppliers quality control.

Accreditation and Recognitions:

ENAC Accreditation.

Competent body for the Low Voltage Directive

Competent body for the EMC Directive

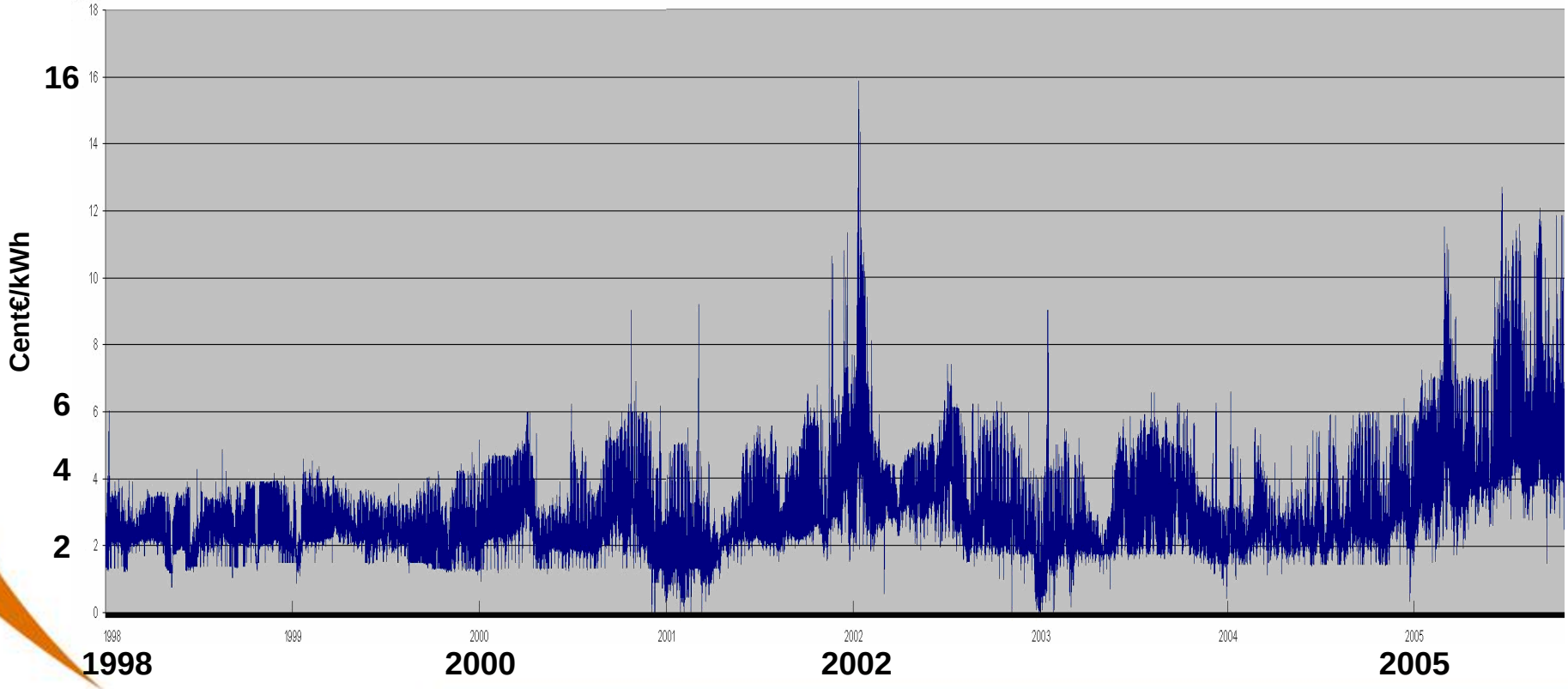
Recognition by LOVAG

Description of the Spanish Power System (1)

- Interconnected to France, Portugal and Morocco
- REE: Transmission system operator
- Two big investor owned utilities:
  - Iberdrola (starting business in the USA, wind generation)
  - Endesa (big customer base in South-America)
- Vertically integrated utilities in the past
- Electricity market open to competition in 1998

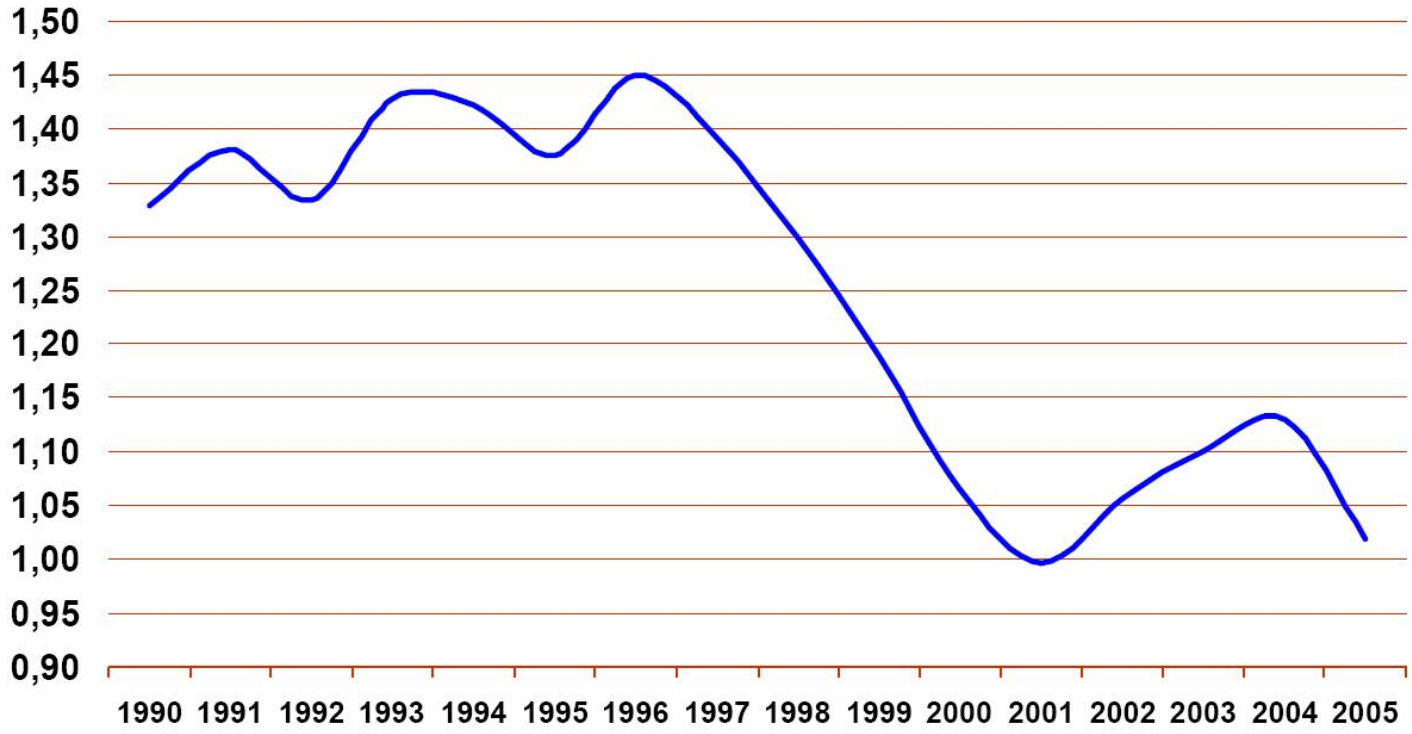
Description of the Spanish Power System (2)

- Not much market competition
- Historic day-ahead market price (marginal price):



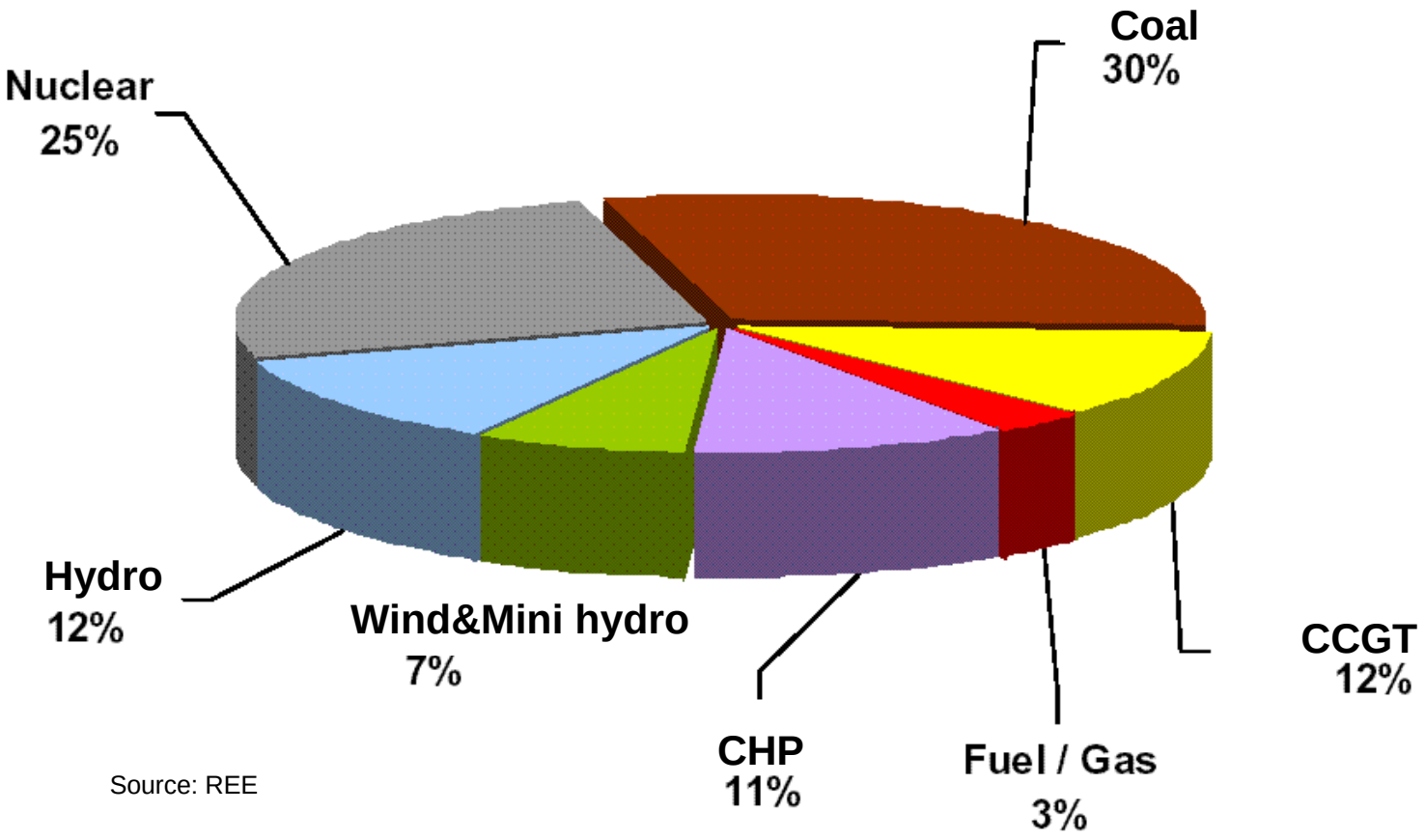
Source: OMEL

- Demand coverage index:
  - Ratio between the installed dispatchable generation and peak demand.



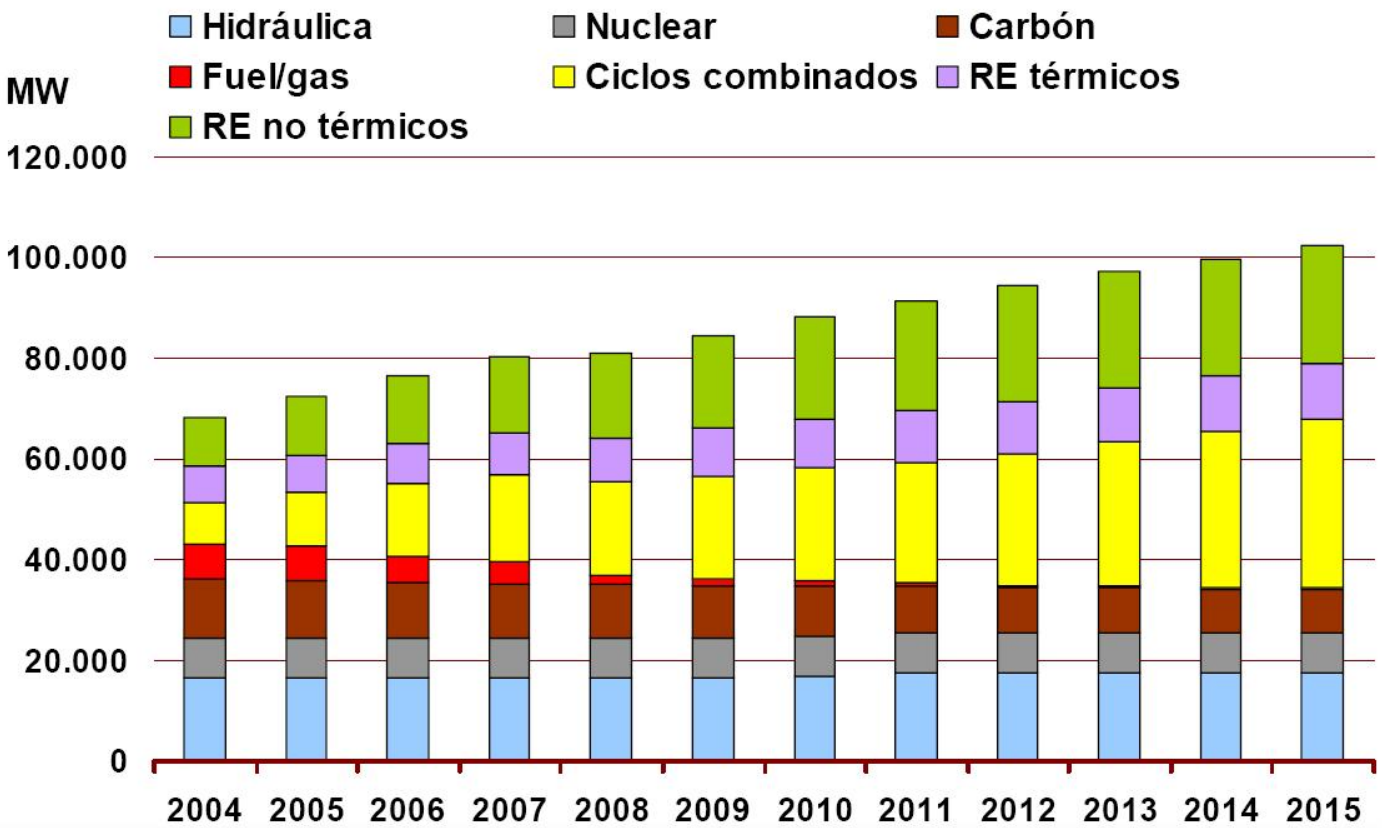
Source: REE

- Yearly energy demand coverage by generation technology:



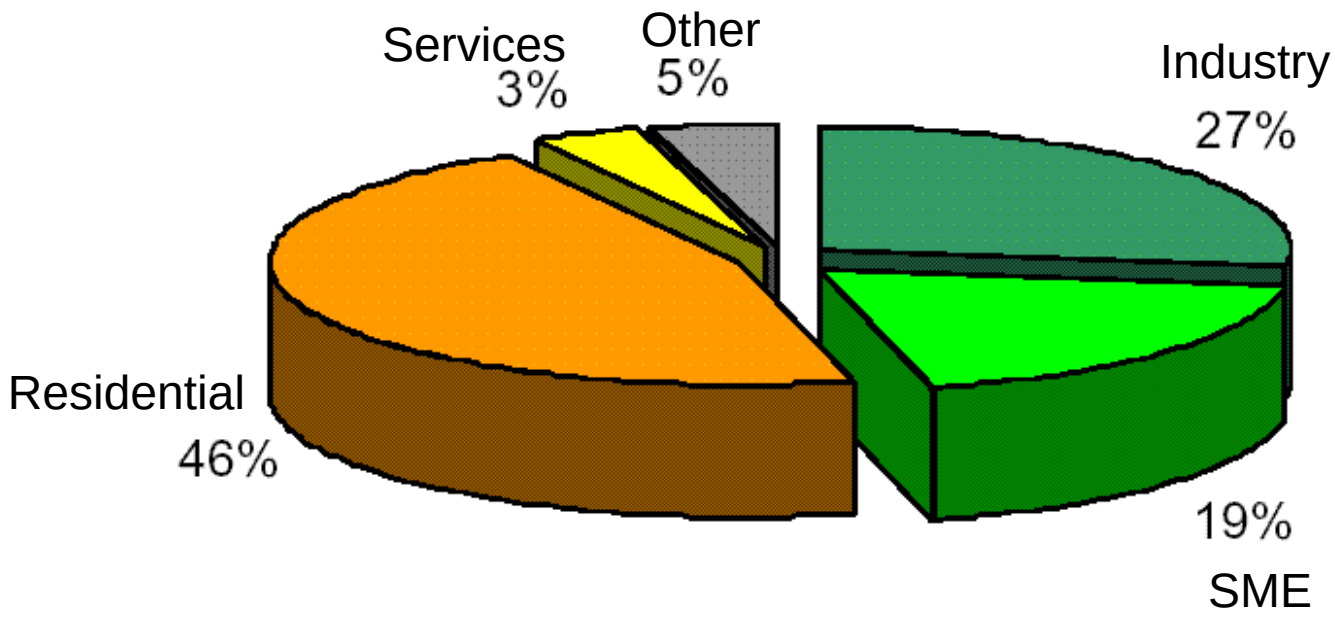
Source: REE

- Installed and forecasted generation capacity by technology:
  - Incentives for renewables and CHP



Source: REE

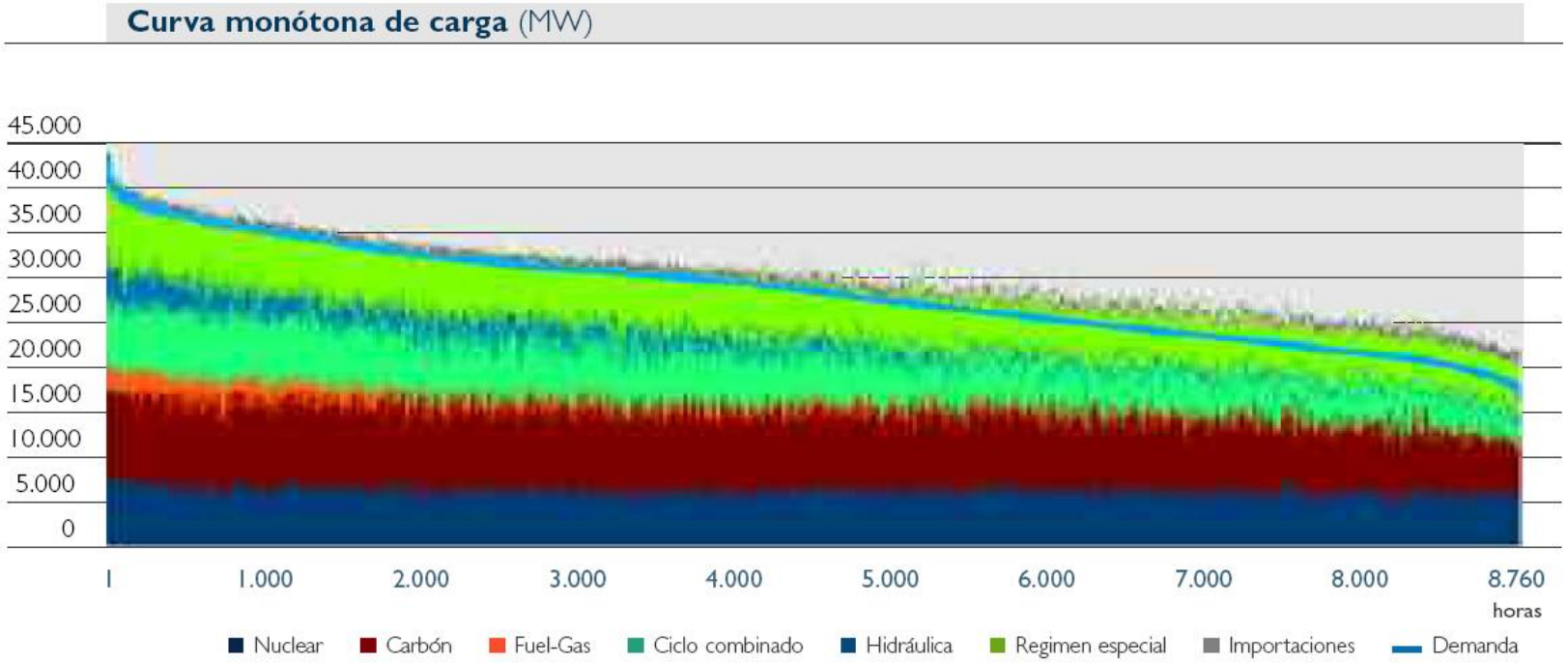
- Electrical energy usage by sector:



Source: CNE

Demand (2)

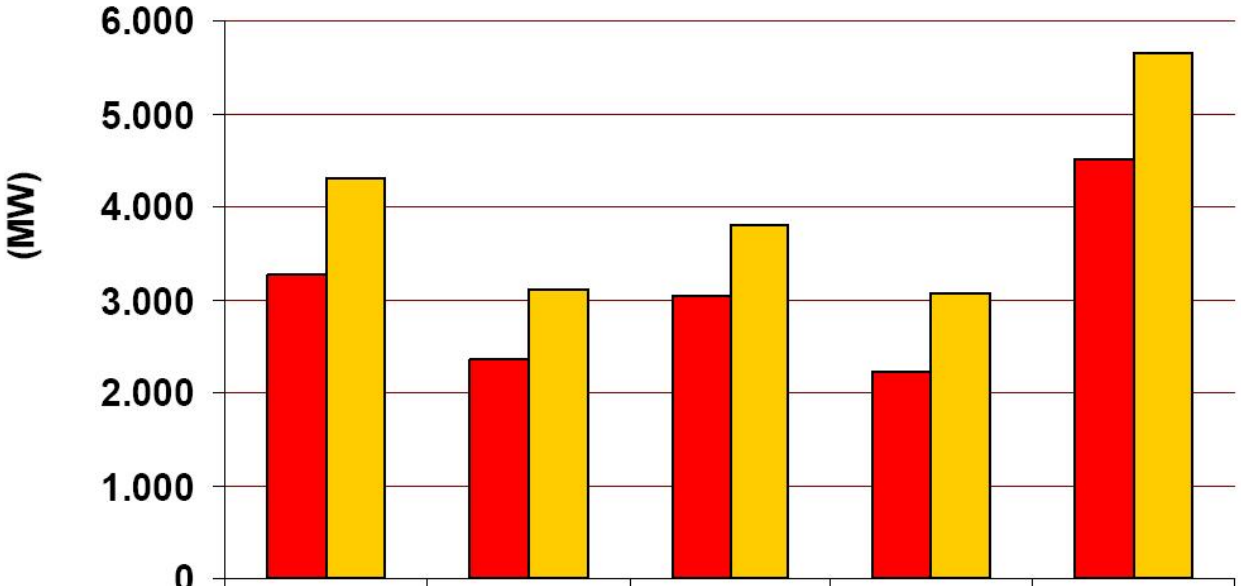
- Load Duration Curve 2005:



Source: REE

Demand (3)

- Left part of the LDC:



	2001	2002	2003	2004	2005
Power used < 100h	3.269	2.358	3.048	2.222	4.518
Power used < 200h	4.297	3.120	3.799	3.063	5.639

Source: REE

Existing load control tools

- Residential customers:
  - Most customers supplied through a flat regulated tariff
  - Night-tariff (6% penetration)
  - No economic incentive for most customers to “improve” their energy usage.
  - Charges:
    - Energy charge
    - Peak demand charge: demand limiters
  - No load control initiatives

Existing load control tools

- Commercial customers:
  - Customers with peak consumption above 50kW, are subjected to TOU charges.
  - Charges:
    - Energy charge
    - Peak demand charge: Maximeters

Existing load control tools

- Industrial customers:
  - REE runs an interruptible load program
  - Minimum of 5MW reduction required
  - The payment is based on reduction capacity: it is an specific regulated tariff
  - Severe economic penalties in case of bad performance
  - Few events, just used in case of extreme emergency
  - Manual execution of the actions
  - Specific communication protocol for real time verification of the consumption

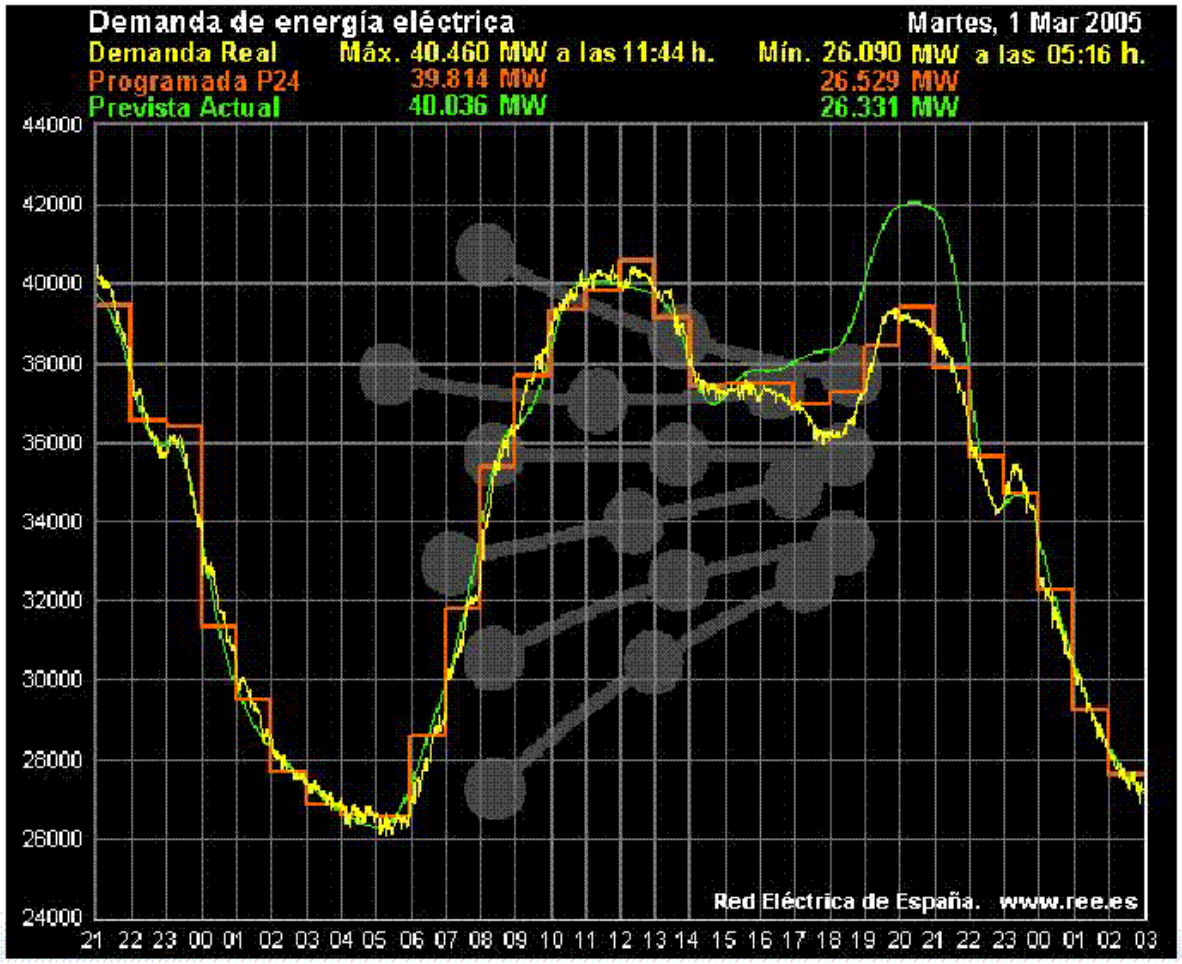
Existing load control tools

- Industrial customers:
  - 200 participating customers
  - 3500 MW reduction capacity
  - Possibilities:

	Time between the request and the execution	*Maximum duration of the control*
Type A	From 2 to 16 hours	12 hours
Type B	From 2 to 6 hours	6 hours
Type C	1 hour	3 hours
Type D	30 minutes	45 minutes

Existing load control tools

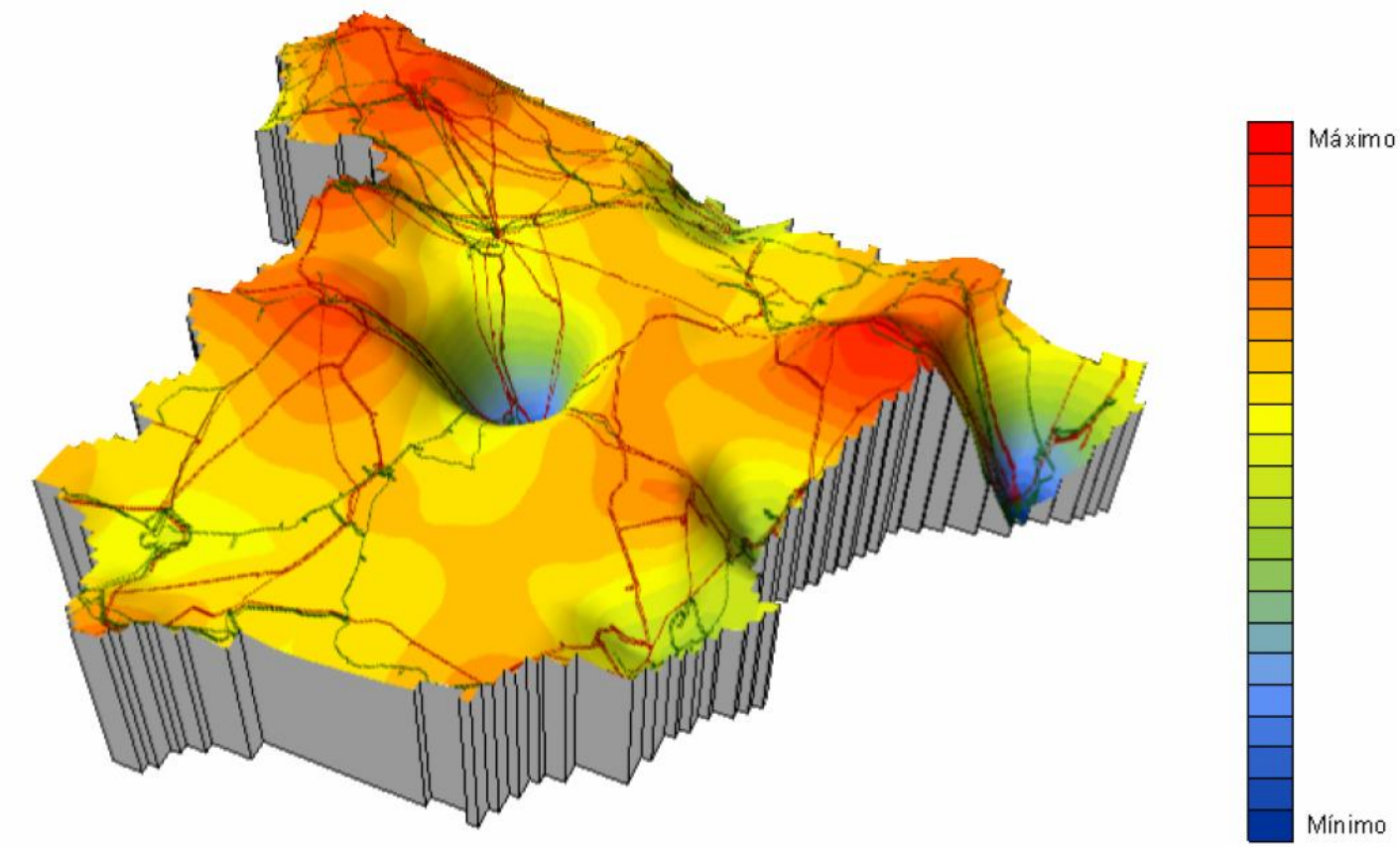
- Effect of the application of one action :



Source: REE

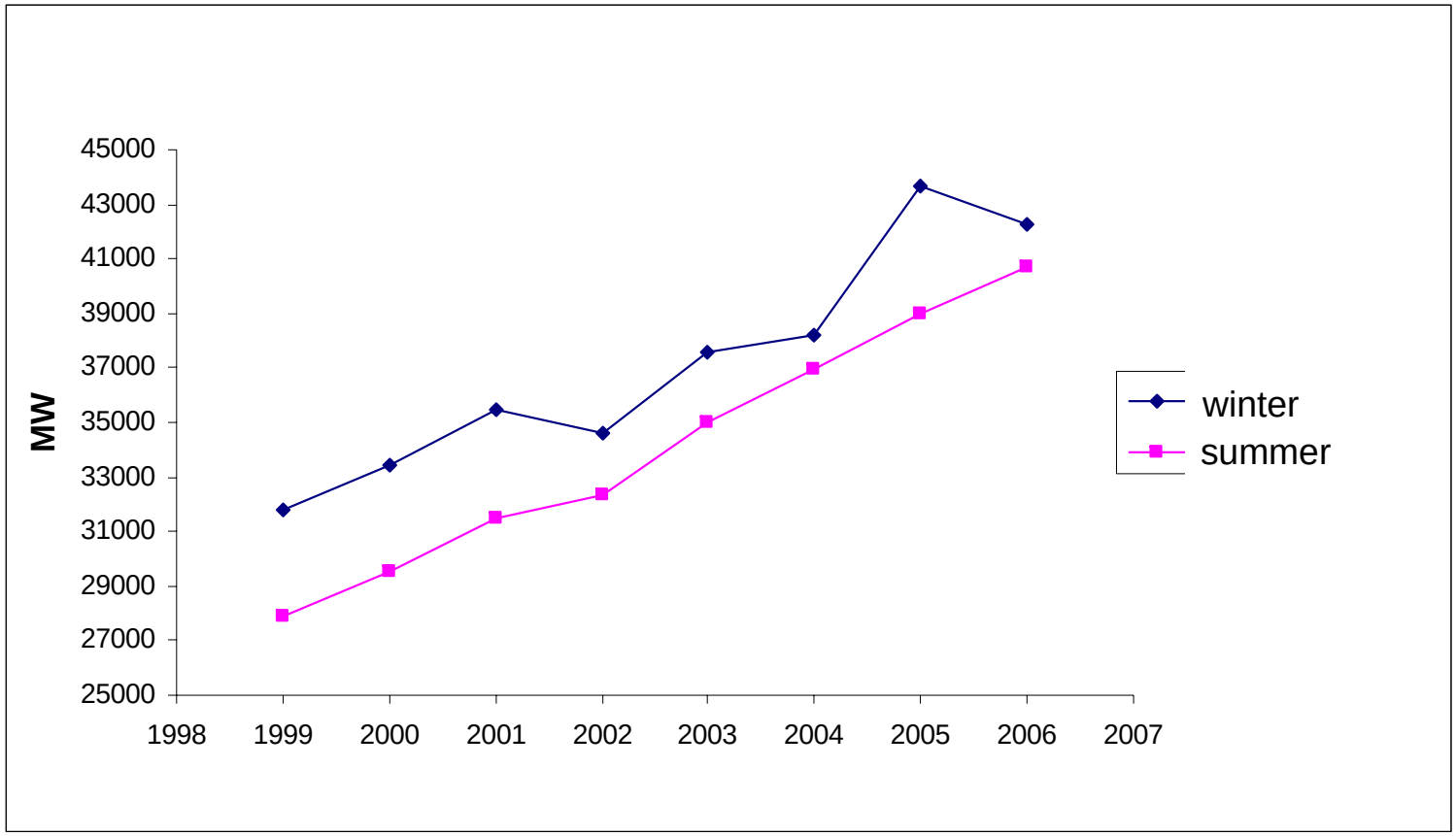
- Major challenges and concerns:
  - Construction of new Transmission & Distribution infrastructure
  - Growth of peak demand (specially summer peak)
  - Growth concentrated in particular areas
  - Problems both in summer and winter
  - Operation of the network with high wind penetration (10GW today)
  - Greenhouse gas emission reduction

- Unbalance between generation and demand:



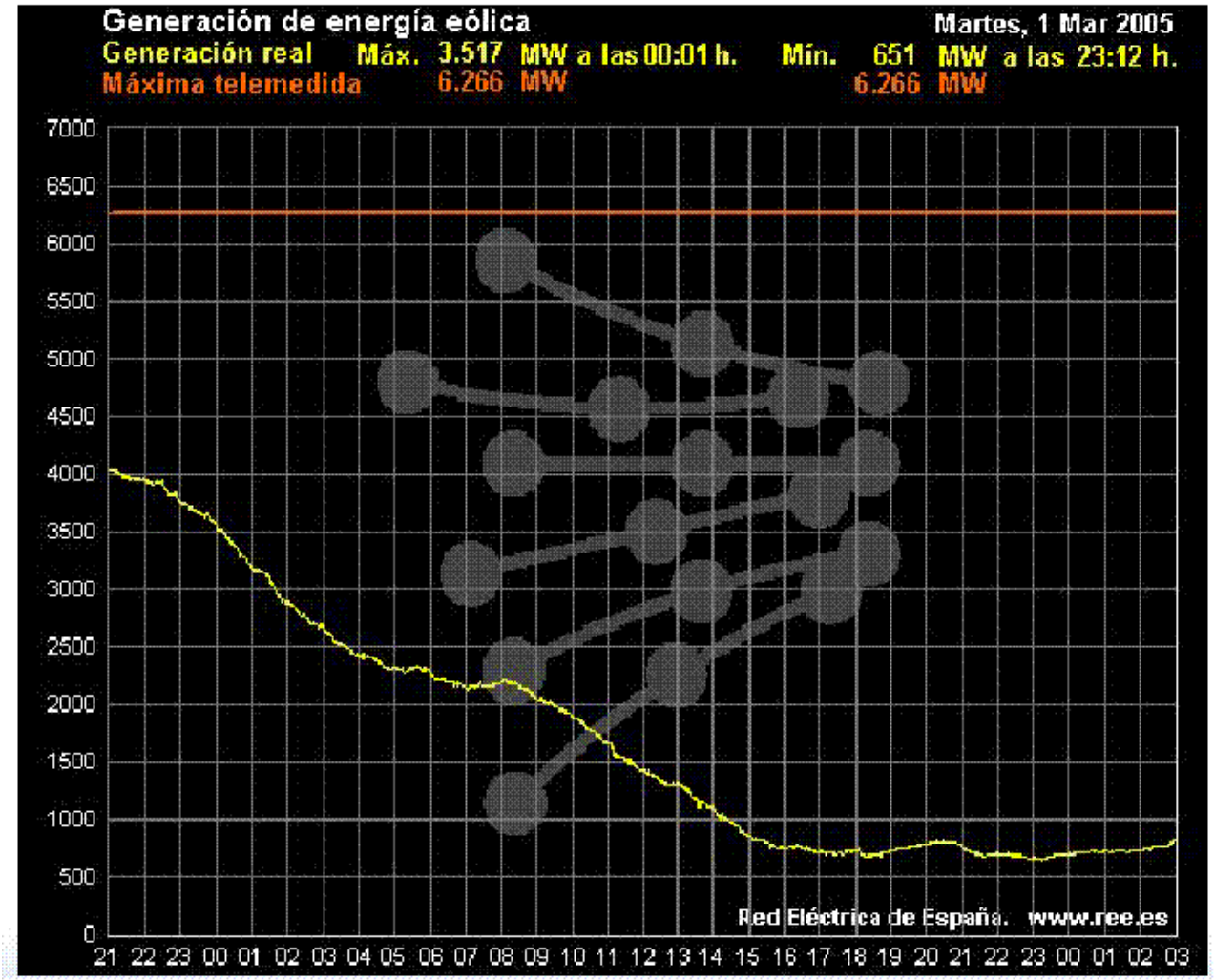
Source: REE

- Evolution of winter and summer peak demands:



Operability of the network with high wind penetration

- Contribution from wind generation on the day that the previously shown interruption took place:



Source: REE

REE: Transmission system operator (1)

- REE has the biggest concerns
- Plans to develop demonstration projects targeting most customer types
- Research:
  - Establish customer behaviour trends
  - Analyse demand side operation potential
  - Pilot programs
  - DR and energy efficiency
  - Provide recommendations to regulators

REE: Transmission system operator (2)

- Industry and commercial customers, coming future:
  - Reduce the participation requirements to 1MW
  - Include frequency relays in some loads: no advance notification
  - Allow the participation of aggregators:
    - Define the functions of the aggregators: pilots
  - Automatic connection of back-up generators: pilots
  - Payment for both participation and actual response

REE: Transmission system operator (3)

- Residential customers, research:
  - Create demand response programs that allow the participation of residential customers, through aggregators.
  - Minimum 1MW aggregated reduction
  - Automatic control over appliances
  - Action override possibility?
  - Associated to particular network areas
  - Duration, notification periods and payments to be decided.
  - Pilots

REE: Transmission system operator (4)

- REE is the Spanish representative in the International Energy Agency IEA/DSM agreement
- Labein-Tecnalia participates with REE in the task related to residential load control

Iberdrola-GAD Project (1)

- Funded by the Government under the CENIT program: €10million
- Just started, duration 4 years
- Objective:
  - ***Create the knowledge required to optimise the consumption of small customers***
  - Wide optimisation objectives:
    - Peak reduction (demand shifting)
    - Energy efficiency
    - Demand response
    - Reduce environmental impact

- Explore interaction strategies and develop tools
- Possibilities of Real Time Pricing
- Based on in-house intelligence

Iberdrola-GAD Project (2)

- Big consortium including:
  - 15 companies
    - Iberdrola (leader)
    - REE
    - Union Fenosa
    - Metering and communication system manufacturers
    - Appliance manufacturers
    - House automation system manufacturers
  - 14 research organisations

- No pilot tests

Government plans for advanced meters (1)

- Very small penetration of advanced meters in the residential sector
- Metering performed by the distribution companies:
  - They own the metering and communication infrastructure

Government plans for advanced meters (2)

- Starting from “now” every new residential supply point has to be fitted with an advanced meter.
- Specifications under discussion:
  - Hourly metering
  - Remote reading
  - Load control capabilities: dynamic demand limiter
  - Interface: customer feedback
- Plans to replace all existing meters. Date is not fixed yet

ENDESA-Optiges project

- Project with Labein-Tecnalia: research prize
- Budget: €500,000
- Actual start this year, duration 3 years
- Explore the control possibilities over commercial facilities
- Focus on the customers
- Pilot tests will be executed
- Endesa faces distribution problems in the south and mediterranean coast
- Considers Demand Response as a possible solution to supply problems

Other Demand Response Research Efforts by Labein-Tecnalia

- *Leading the demand response tasks in 3 EU funded projects:*
  - MICROGRIDS project:
    - Development and simulation of direct load control algorithms over residential customers, based on the existence of bi-directional communications.
    - Applicability of the algorithms in microgrids with high penetration from renewables.
    - Modify the load shape of a group of customers over a time period, making it as close as possible to a pre-defined optimal curve.
    - Calculation of optimal appliance shifting and curtailment actions
  - SOLID-DER project:
    - Demand side management: State of the art and general definition and classification of programs and initiatives.
    - Development of a methodology that allows the assessment of the demand control potential in new EU member countries

– FENIX project:

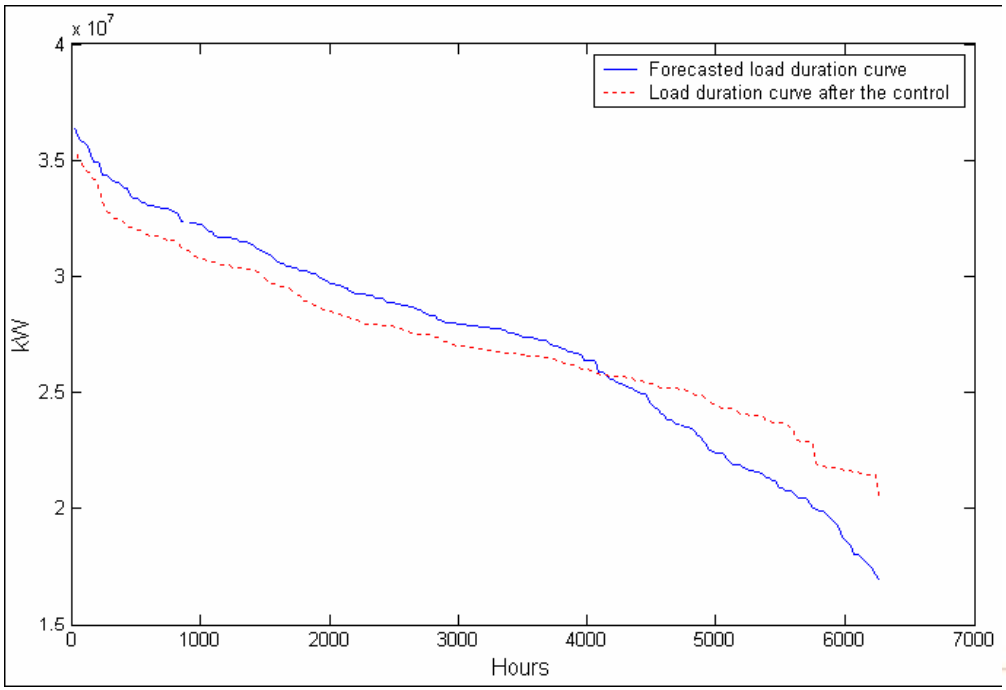
- Main project objective: Study the possibilities of Distributed generation and DR to provide ancillary services. Focus is laid on generation
- Improve the existing curtailment algorithm
- Include the load recovery effect:
  - Use of energyplus simulations for simple building models
- An aggregator can optimise the load shape of a group of customers and submit demand response bids to network operators.
- Optimisation criteria:
  - Flexible load shape
  - Cost optimisation
- Duration of the control period flexible
- Simulate the bid selection process

fenix
'… a step towards the future of electricity networks'

- PhD thesis:
  - Effect of the application of a Nationwide residential appliance shifting algorithm (20M customers)
  - Cost optimisation: use of market prices
  - Model the price-load relationship in the market: if load is significantly modified at peak, it will affect prices
  - Year 2003 simulated

Other Demand Response Research Efforts by Labein-Tecnalia

- Small daily price variability in the market
- 1GW of control margin at winter peak
- 1.5GW of control margin at summer peak
- Very small savings per customer per year: less than €10
- Simulation of more extreme price situations



- Divulgative publication for the region of Madrid:
  - Demand response overview and potential benefits for the region
- Participation on:
  - CIGRE WG on Demand Side Response
  - FUTURED, Demand Side Management WG

CONCLUSION

- Key moment for demand response in Spain
- Stakeholders face challenges and see demand response as a solution worth considering

- Research centres to support DR development