RED ELÉCTRICA DE ESPAÑA

Converting Demand Side Operation in an accurate tool for the Transmission System Operator

REE Research and Results

II Madrid forum on Demand Side Operation, DSO

Oct 19 2005

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1 ¿What will be DSM and DSO?

2 Fixing overhead objectives

3 Prospecting

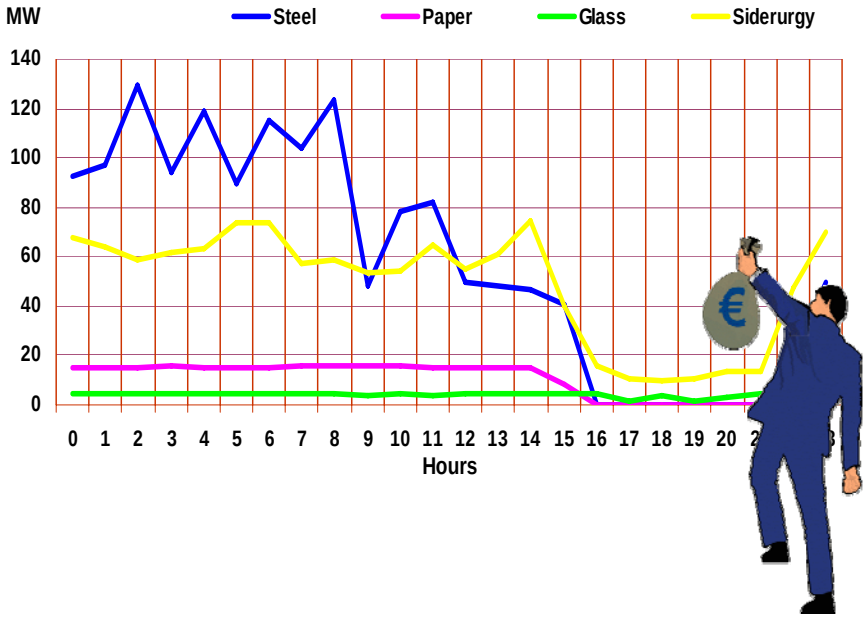
4 Evaluation of DSO resources

5 Implementing infrastructure

1. ¿What will be DSM and DSO?

TRIGERS

THP tariff , dissuading price industrial consumer's response



TRIGERS

5. ¿What will be DSM and DSO?

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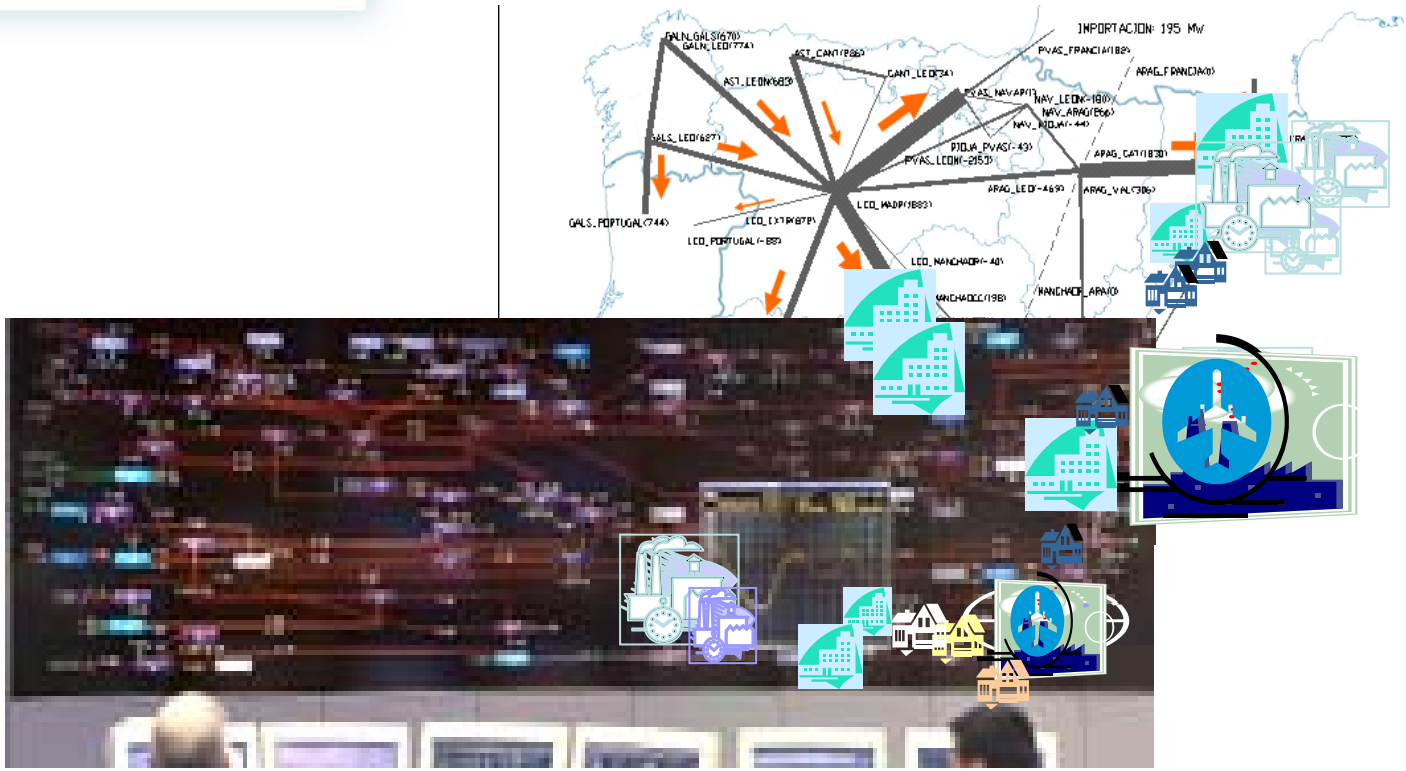


Converting Demand Side Operation in an accurate tool for the Transmission System Operator

- **DSO is been considered by REE as an alternative resource to provide system margin scarcity, bottleneck solutions and other system services as technical balance.**

  It has important advantages

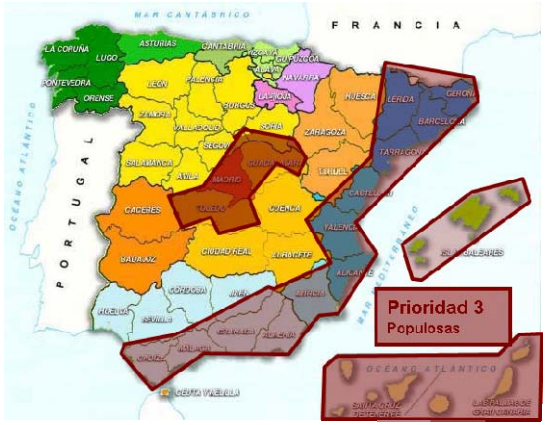
  - **Positive environmental effect**
  - **Minor energetic cost**
  - **Reduced electric cost for the provider costumer**

Nevertheless,

- **there is a lot of work to do inside and outside the company in order to get accurate tools that**
  - **can be operated in the control room and**
  - **considered in the network planning.**

2. Fixing overhead objectives

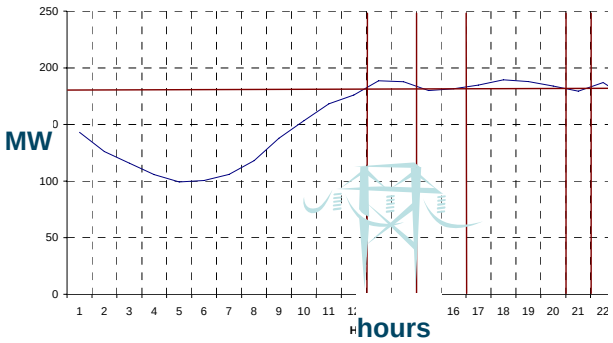
Priorities



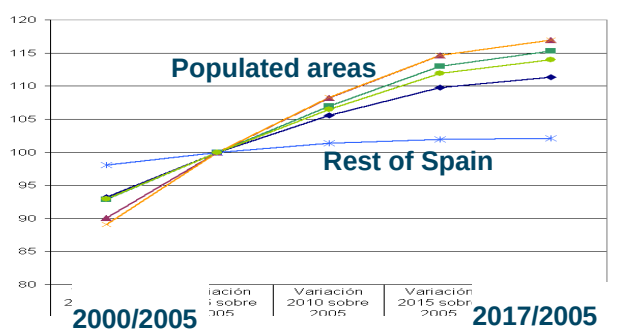
Quick population and economic growth

1. **Provide local system margin, at least until new network or plants are in place**
2. **Energy saving at day time demand**

Southern line saturation in a average summer labour day



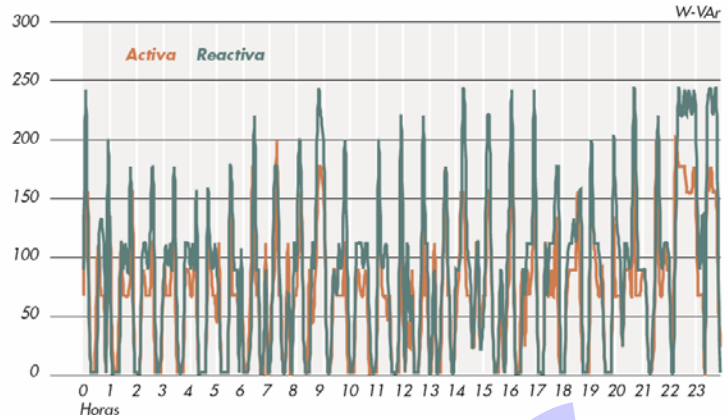
Number of household growth index number



Source: INE

Priorities

Active and reactive energy hourly consumed on a domestic fridge



hours

High increase on reactive power consumption on cooling, fridge and freezers

3. **Provide distributed compensation management capacity**
4. **Reduce reactive power consumption on the appliances.**

2. Prospecting

Prospecting

Following up of international experiences

- **DSM AIE agreement Spain participation representative**

  Projects with REE active participation

  - **Annex XI Residential automatic response and modulation,**

    Leader: Richard Fomby, EA technology, UK

  - **Annex XIII Market pace for DSM and DSO,**

    Leader: PLMA, USA

  - **Annex XV Network driven DSM, DSO**

    Leader: David Crosby, Utilities Association, Australia

- **Madrid Forums on Demand Side Operability, REE and DSM AIE cooperation**

Prospecting, **In deep consults to GYMCO**

To analyse the possibility of converting demand management into a control tool associated with the System's operation.

- **GYMCO SEGMENTS**
  - **Water and desaltation**
  - **Irrigation**
  - **Hospital**
  - **Airports**
  - **Hotels**
  - **Ceramic**
  - **Large commercial and malls**
  - **Frizz storage**
  - **Already interruptible segments**

- **GYMCO SEGMENT**
  - **Large and medium consumers, power level in critical periods**
  - **In Populated areas**
  - **DSO capability expected**

- **Sample 30 consumers**

EMERGÍE

PRICEWATERHOUSECOOPERS

Prospecting, **In deep consults to GYMCO**

GYMCO Project within the Framework of the EMERGÍE Project

1 Areas and economic sectors

- Analysis of areas of interest (areas with smallest oversizing).
- Analysis of hourly periods during which summer and winter peaks are produced.
- Analysis of predominant economic sectors in each province to be analysed.

2 Sample of clients to be interviewed

- Initial selection of client sample (sector, consumption, cogeneration capacity, emergency systems, international experience…)
- Analysis of load curves.
- Final selection of the sample of clients to be interviewed.

3 Interviews with consumers. Elaboration of documentation and plan for future actions

- Demand management analysis of the sectors/ consumers interviewed.
- Extrapolation of results to national and international level.
- Publication of results and presentations to the Organizations and Agents involved in the Spanish Electrical System.

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Prospecting, **In deep consults to GYMCO**

Examples of preliminary findings

Analysis of the demand management capacity in other analyzed sectors.

Sector	Demand management Capacity	Reason	Actions need to management	Facility of interest
Integral cycle of water		**· Depuration** **· Desalination**	**Investment in tanks of storage (desalination).**	**Yes**
CHP		**· Autonomous generation**	**The CHP capacity make them autonomous and with interruption capacity.** **Low additional investment.**	**Yes**
Beer Sector		**· Flexible production** **· Maintenance**	**Capacity of DSR in winter.**	**Yes**
Cement Sector		**· Flexible production** **· Maintenance**	**Capacity of DSR in winter.**	**Yes**

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Prospecting, **Short consults consults to GYMCO**

- **GYMCO, Inventory of distributed resources**
  - **Quick response capability**
  - **Security generation plants**
  - **Reactive compensation capability**
  - **Cogeneration**
  - **Energy control systems on that facilities**
- **Sample 200 consumers**
- **Phone media**

Prospecting, **Residential survey and metering**

RESCO

- Sample 2.000 households
- National representativnes
  - Actualise information on appliances possession, time of use, programmable, controllable ones and stably controlled
  - Infrastructures for control and bidirectional communication, domotica, security, internet, others
  - Preferences on remote control in short periods and override
- Nielsen permanent panels

EMERGÍE Nielsen

Prospecting, **Residential survey and metering**

As one of the main targets of the study, a concept test will be carried out. The DSO concepts to be tested are the following:

DSO CONCEPT A:

“Installation of “intelligent” plugs with override option ”. These plugs will be able to receive interruption commands from REE, but the consumer could choose wether interrrupting the service or reactivate it.

“Installation of “intelligent” plugs without override option”. These plugs will be able to receive interruption commands from REE, but in this case the consumer will not be able to reactivate the service.

DSO CONCEPT B:

“Capability to change consuming behaviour to those time brackets which have cheaper tariffs. For this purpose special devices would be previously installed in every domestic appliance”.

DEREC projection of households response

- **Projection of the Demand response Portfolio for Residential Consumers in Spain.**
  - **FORECAST PERIOD: 2010, 2015 y 2020**
- **Desegregation level:**
  - **By end-use equipment:** lighting, fridge, freezer, laundry machine, tumble dryer, dishwasher, heat pumps, stand-by appliances, space heater, air conditioner, water heater, sauna, water filters, etc.
  - **By time of use and season-type day.**

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DEREC projection of households response

- **EXAMPLE: Total consumption estimation for one-door fridges by priority zones on an average season-type day.**

FRIDGE (one door)	
Average winter day	
Power	0,02 KW
Dayly hours of use	24,0
Dayly comsumption by equipment	0,48 KWh

	% OF HOUSEHOLDS WITH FRIDGE (one door)	HOUSEHOLDS (Number)	NUMBER OF FRIDGE (one door)	ELECTRICITY CONSUMPTION (KWh) FRIDGE (one door)
PRIORITY ZONE 1	6,72	2.008.619	134.912	64.758
Málaga	5,90	434.766	25.651	12.313
Almeria	6,40	176.170	11.275	5.412
Cádiz	8,40	347.038	29.151	13.993
Granada	6,30	281.557	17.738	8.514
Sevilla	4,10	555.605	22.780	10.934
Gerona	9,20	213.483	19.640	9.427
PRIORITY ZONE 2	8,56	4.400.626	376.694	180.813
Insular	12,20	555.605	67.784	32.536
Comunidad Valenciana	7,30	1.492.792	108.974	52.307
Murcia	10,60	378.252	40.095	19.245
Barcelona	7,00	1.754.332	122.803	58.946
Tarragona	5,70	219.645	12.520	6.009
PRIORITY ZONE 3	5,73	2.124.350	121.796	58.462
Guadalajara	5,80	64.741	3.755	1.802
Toledo	4,70	185.817	8.733	4.192
Comunidad de Madrid	6,70	1.873.792	125.544	60.261

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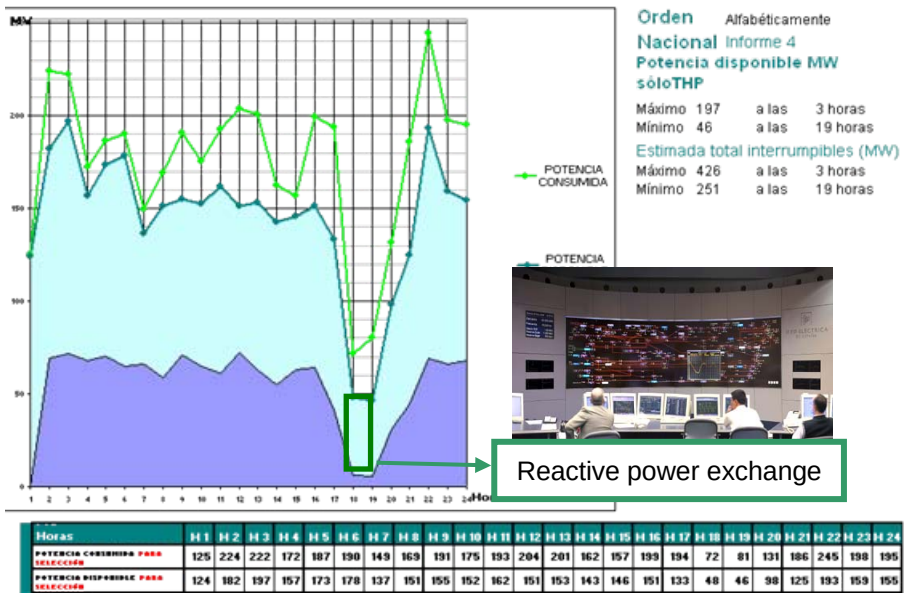
4. Methodologies PUVS for evaluation of a disperse and probabilistic consumer response

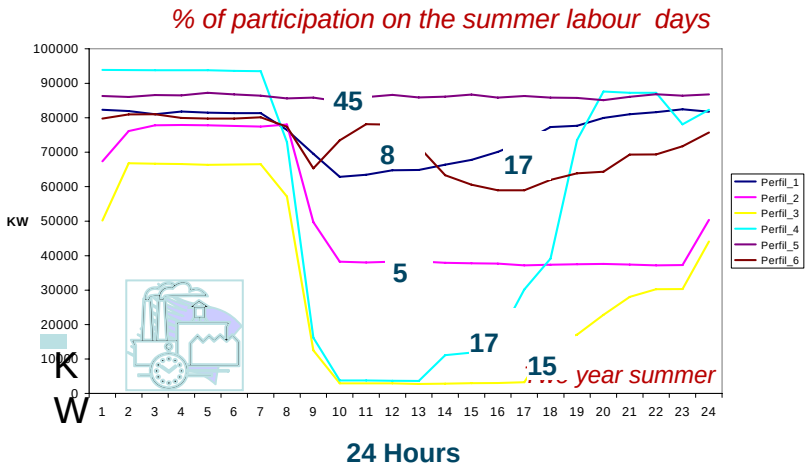
Prospecting, **Methodologies PUVS for evaluation**

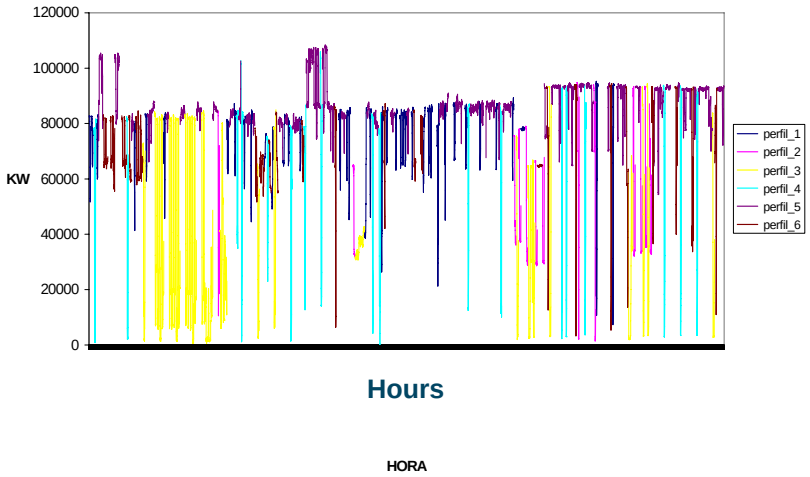
- **Statistic Methodologies PUVS for evaluation of a disperse and probabilistic consumer response;**
  - **on**
    - **Predictability,**
    - **Uncertainty**
    - **Variability**
    - **Sensibility on the network**
  - **For assignment**
    - **Capability contracts**
    - **Optimise operational orders**

Consumers operation aid prototype OPCO



PUVS Variability



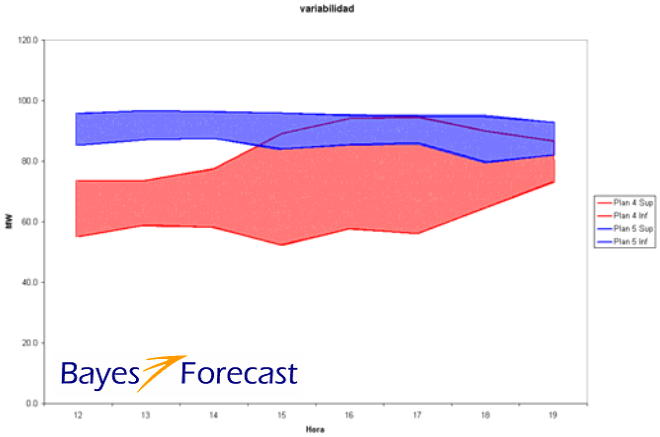


- **Classifying the Type Days of an industrial consumer In order to establish the impact of:**
  - **Load reduction capabilities in the contracts**
  - **And**
  - **Load reduction when reductions activation has to be to be assigned, OPCO**

Developed by

PUVS uncertainty

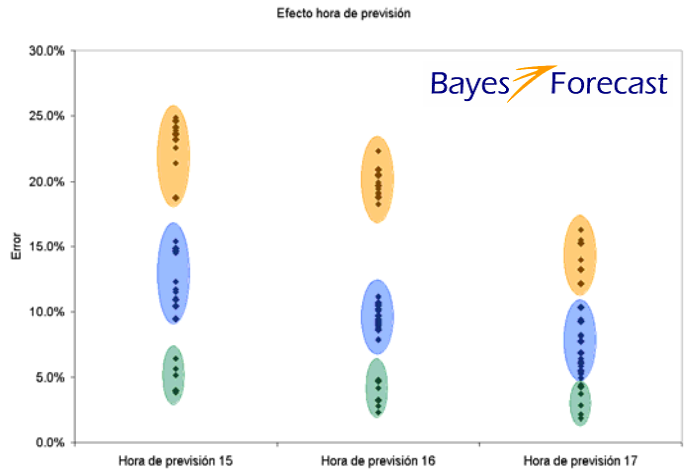
El nivel, la incertidumbre y la variabilidad es muy dependiente del plan de producción. La composición de dichos planes de producción es fundamental para la valoración de la respuesta esperada del consumidor.



	Forecast's Hour	Winter (16 a 22) 16			Summer (12 a 19) 9		
		Participation	Level (MW)	Error (%)	Participation	Level (MW)	Error (%)
Plan	1	18	24	64	14	31	41
	2	19	30	16	26	82	4
	3	12	77	6	8	36	29
	4	27	80	2	16	72	11
	5	17	52	8	24	90	4
	6	7	76	8	11	69	14
	Average	19	57	16	19	70	13

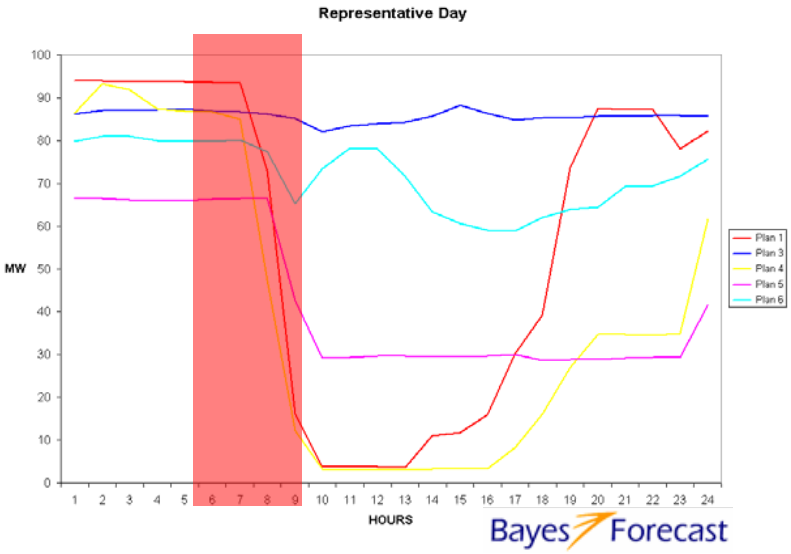
Bayes Forecast

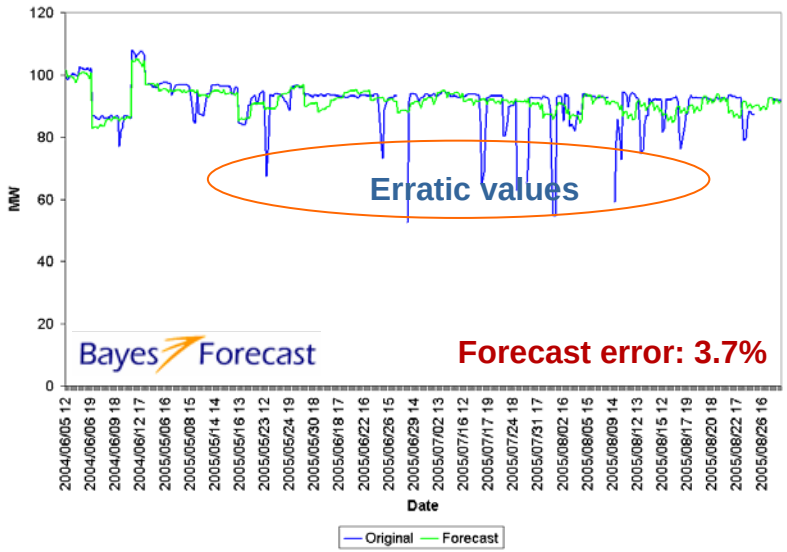
El error previsión es menor a medida que la hora de realización de la previsión está más cercana a las horas a prever



PUVS predictability

El sistema de previsión identifica los planes de producción en un periodo inicial del día.
(En este caso de 6 a 9 de la mañana)

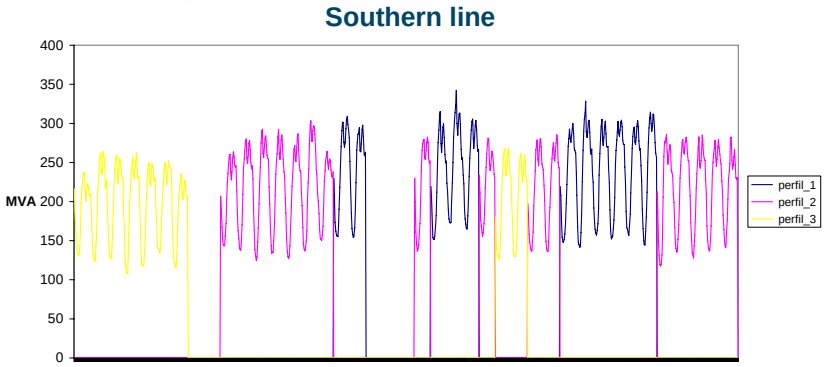




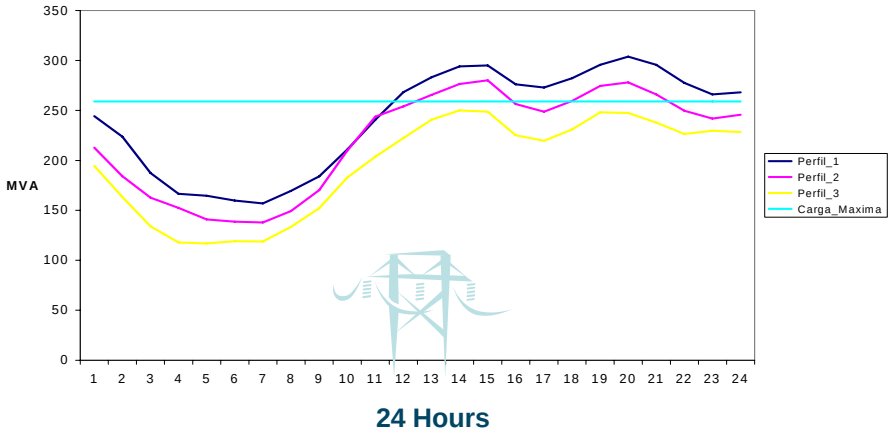
Se realiza el modelo de previsión sobre el plan de producción teniendo en cuenta el comportamiento histórico y la información del periodo inicial.
La línea verde muestra la previsión a las 9 de la mañana de cada día.

PUVS Evaluation, Sensibility on the network

Marginal line criteria



	Grupo 1	Grupo 2	Grupo 3
NDias	11	16	10
Participación	29.7%	43.2%	27.0%
Error	3.5%	3.6%	4.4%



- **Classifying the days profile of a marginal line the one that first gets into over- load risk**

  In order to establish the impact of

  - **Load reduction capabilities on the contracts**

    And

  - **Load reduction when reductions activation has to be to be assigned, OPCO**

Developed by

PUVS Evaluation, Sensibility on the network

Estate 1: ***26.8% of total hours***

Estate 2: ***14.4% of total hours***

Transmission system states criteria

Andalucía. Jul–Dec Period. 2005

1 **multivariate cluster analysis to find groups of hours as homogeneous on level and direction on transmission lines**

and

2 discriminating analysis to chose a subset of lines that detect the states

Estate 3: ***28.4% of total hours***

Estate 4: ***11.2% of total hours***

Developed by

EMERGÉ BayesForecast

PUVS Evaluation, Sensibility on the network

Clasificación de las horas de la primavera según estados del sistema

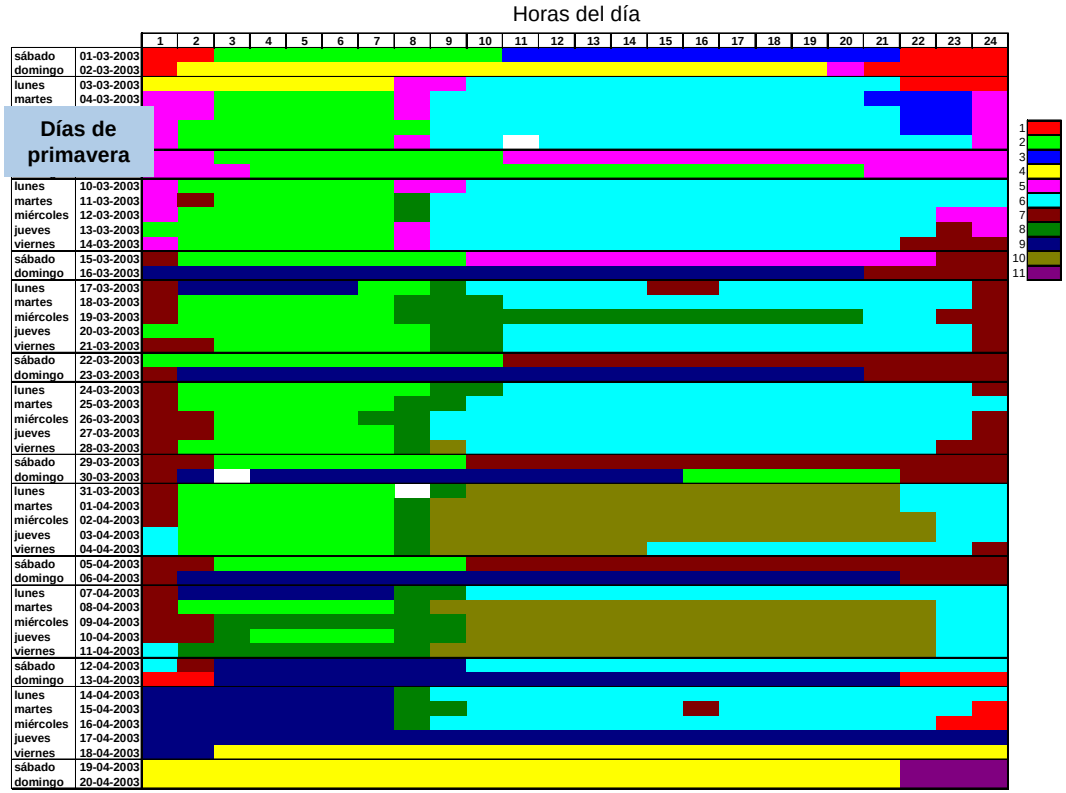
Cada color supone un grupo de horas homogéneo

Transmission system states criteria

Espain **Jul–Dec Period. 2005**

Multivariate cluster on Transmition between electric operational zones on spring

Each color means an homogeneous group



Fuente REE, Proyecto EMERGÍE, Clasificación de los estados del sistema mediante un una clusterización multivariante sobre los flujos netos entre zonas de operación.

PUVS Evaluation, Sensibility on the network

Transmission system states criteria

Spain **Jul–Dec Period. 2005**

ESTATE 10 SPRINT LABOUR DAY EXPORTING TO NEIVERS. High hydro and wind production

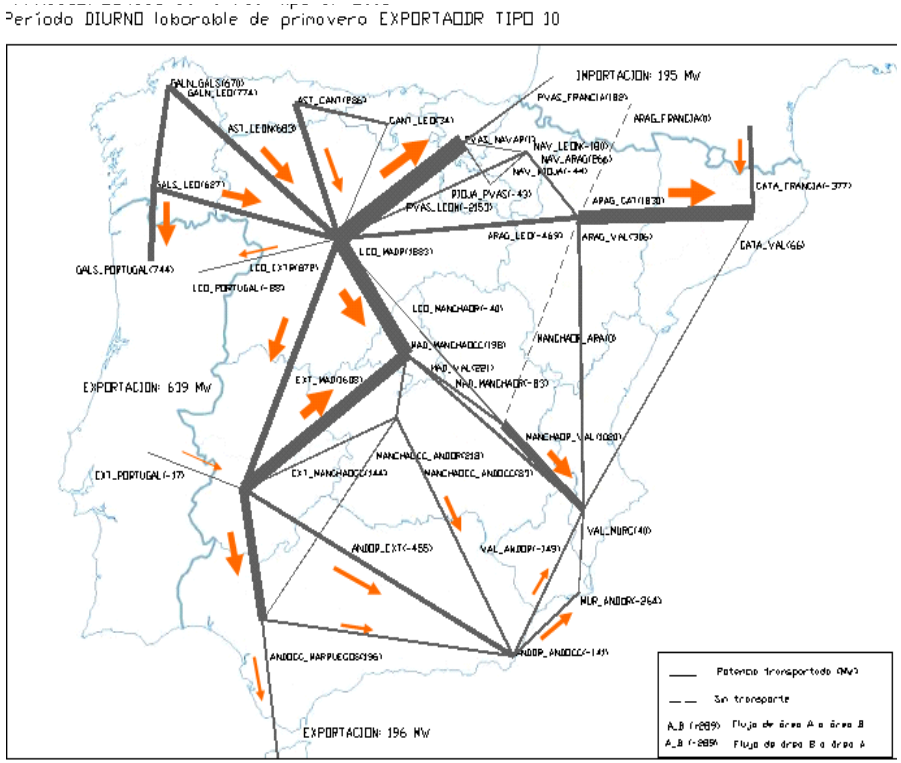


Ilustración 1: Estado de la red tipo 10 - Diurno laborable de primavera exportador

Fuente REE, Proyecto EMERGÍE, Clasificación de los estados del sistema mediante un una clusterización multivariante sobre los flujos netos entre zonas de operación.

PUVS Evaluation, Sensibility on the network

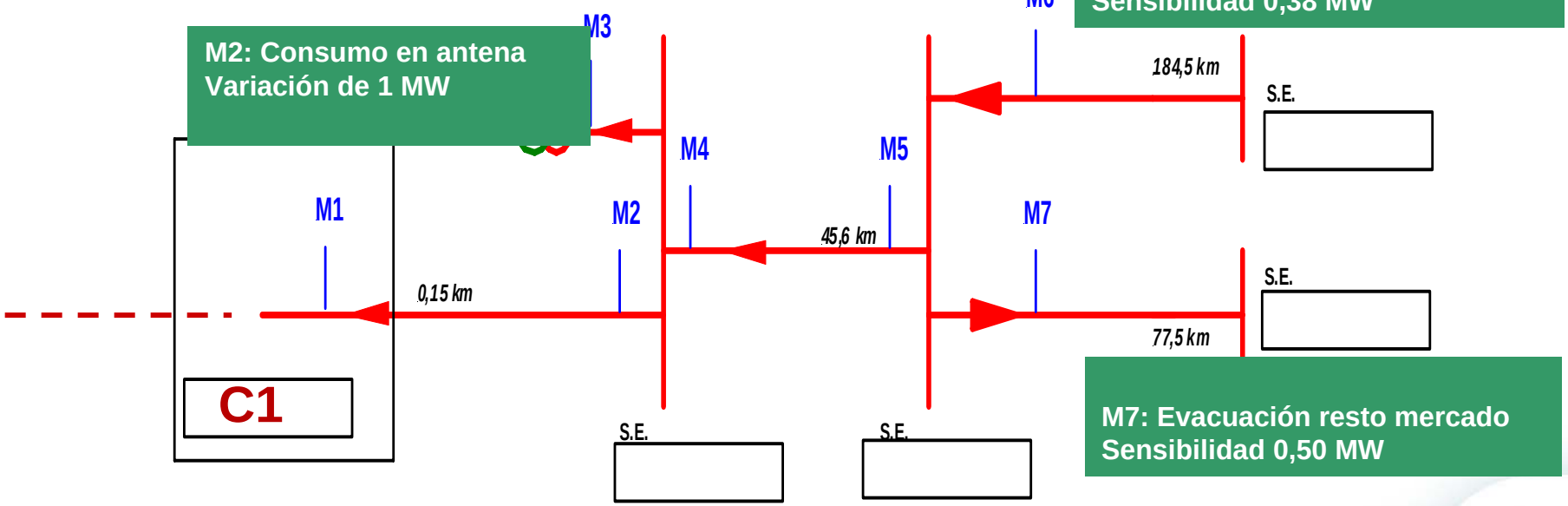
Consumo en la red de distribución

Conexión con transporte
M4 (lectura salida): Sensibilidad 0,87 MW
M5 (lectura entrada): Sensibilidad 0,86 MW

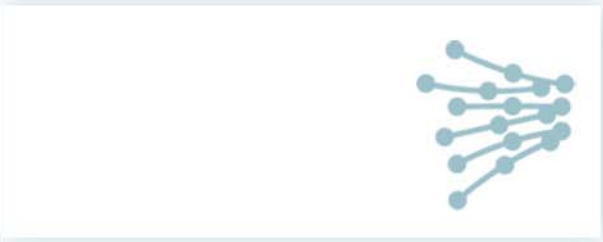
M3: Evacuación distribución local
Sensibilidad 0,12 MW

M6: Alimentación desde nuclear
Sensibilidad 0,38 MW

M2: Consumo en antena
Variación de 1 MW



M7: Evacuación resto mercado
Sensibilidad 0,50 MW



4. Implementing infrastructure

GFI flexible interruption system

Gestión flexible de la interrumpibilidad, GFI

- **Los consumidores envían a REE información de consumo en tiempo real,** Real time consumption (active and reactive) information to TSO: 1 minute period from the 3,000 MW larger consumers.
- **Previsiones de consumo,** Continuous consumption programs information to Red Eléctrica.

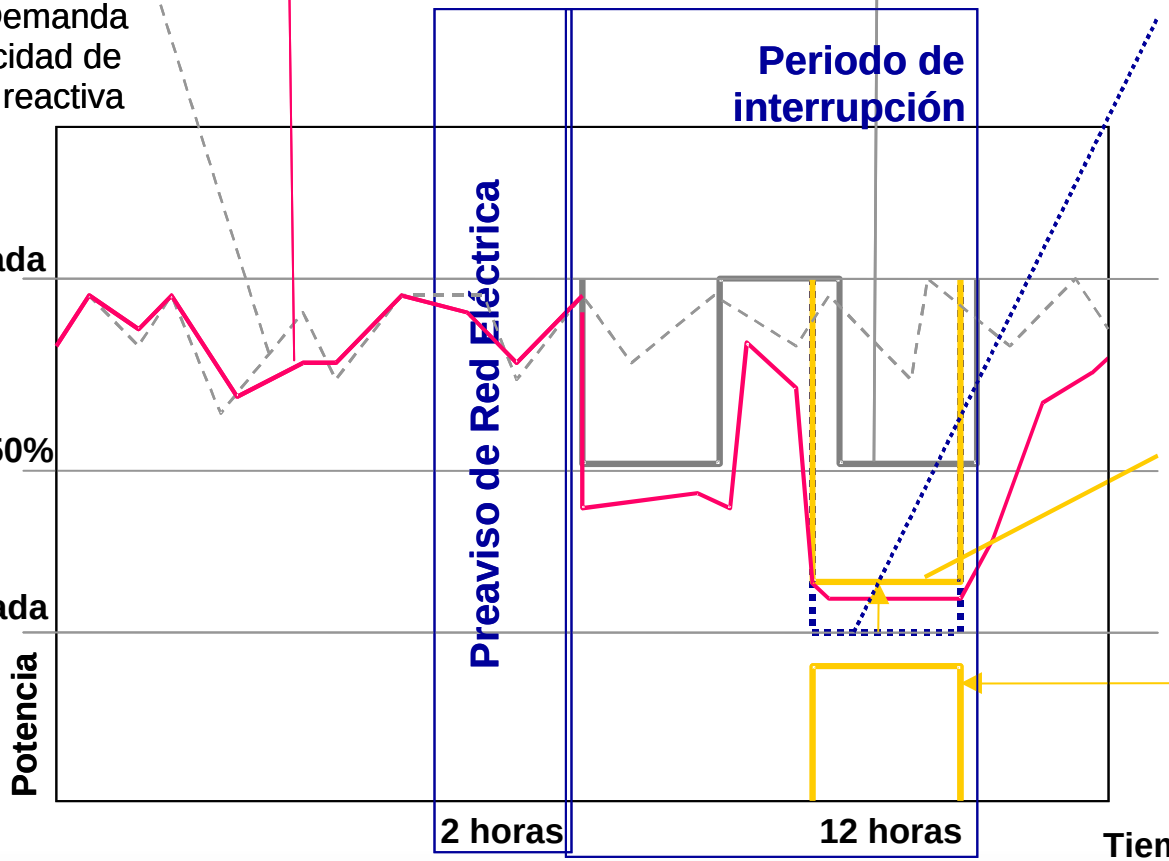
Centro de Control Eléctrico de Red Eléctrica (CECOEL)

GFI flexible interruption system

1 El consumidor envía permanentemente a Red Eléctrica su Demanda real

2 El consumidor envía permanentemente su Demanda prevista y capacidad de compensación de reactiva

3 **Ejemplo de**Máximo perfil de consumo permitido en la orden inicial por Red Eléctrica

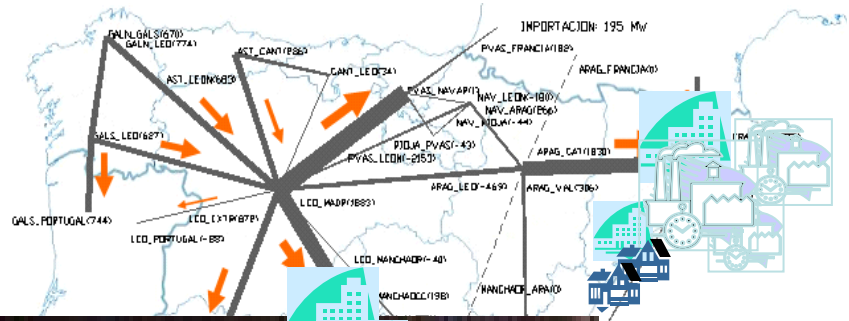


4 Ejemplo de Máximo de consumo permitido en una orden modificada, al menos con una hora de antelación por REE

5 Máximo de consumo permitido en la orden con sustitución por entrega de reactiva

SCECI Communication and control REE-Consumers

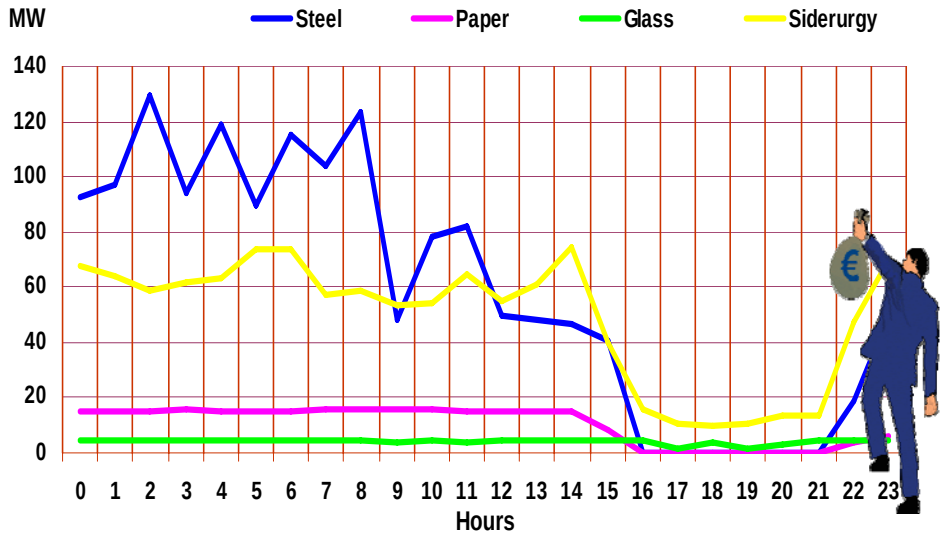
- Private virtual internet network
- Star topology, Fixt IP
- Permanent communication, automatic information on the communication failure
- ADSL RSI access trough ETHERNT interface
- Minimum access speed
  - Consumer REE 256 Kbps
  - REE Consumer 512 Kbps.



OPCO consumers operation aid prototype

- The response used to be 80% than expected
- The procedure was unnecessarily harmful for industrial processes
- Instructions communication system failure

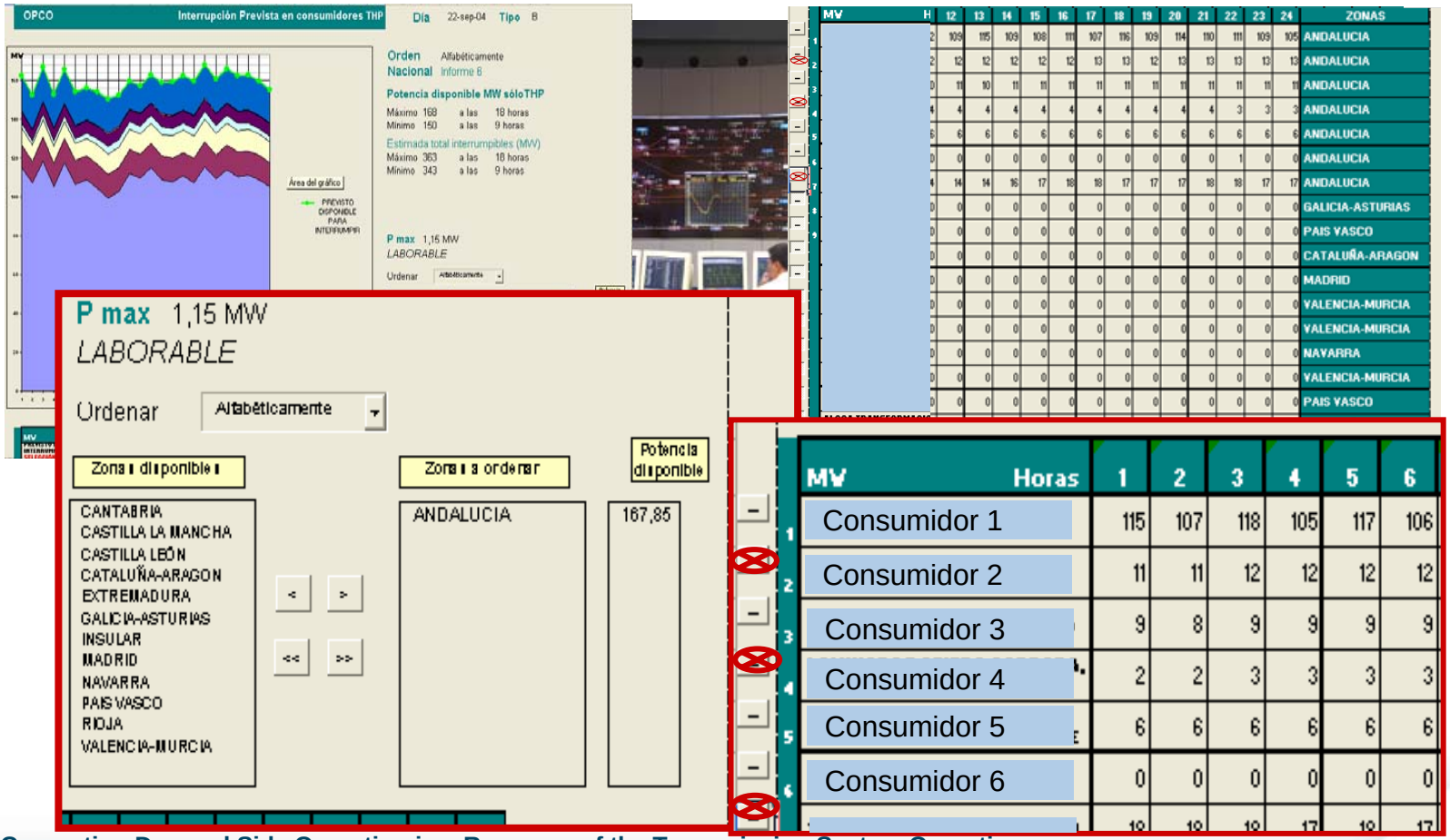
THP consumer's response



- Respuesta de los consumidores interrumpible con tarifa THP a una orden de interrupción el xxx

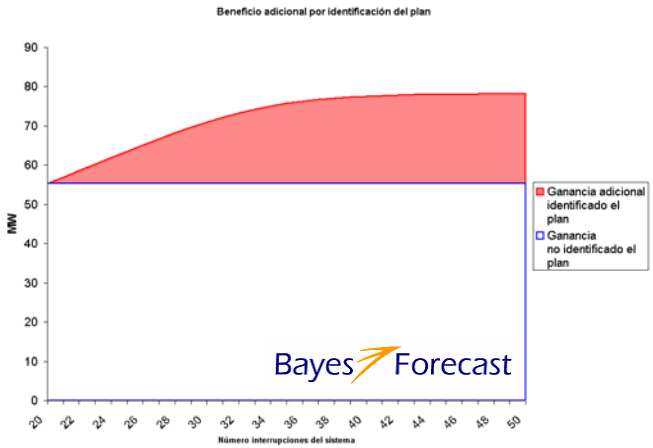
Fuente REE, Proyecto EMERGÍE, OPCO Prototipo de ayuda a la OPeración de COnsumos.

OPCO consumers operation aid prototype



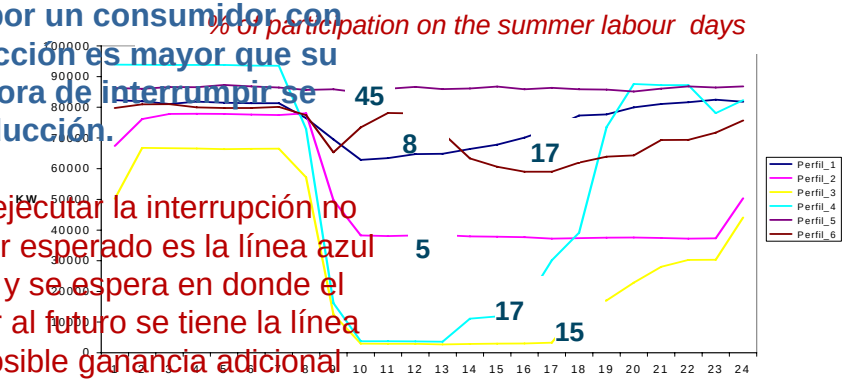
OPCO assignment process and algorithms

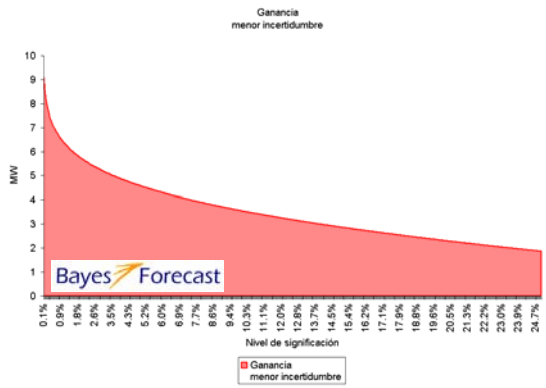
- The Contribution of each consumer in the portfolio is evaluated by a benefit function



El beneficio generado por un consumidor con varios planes de producción es mayor que su valor esperado si a la hora de interrumpir se conoce su plan de producción.

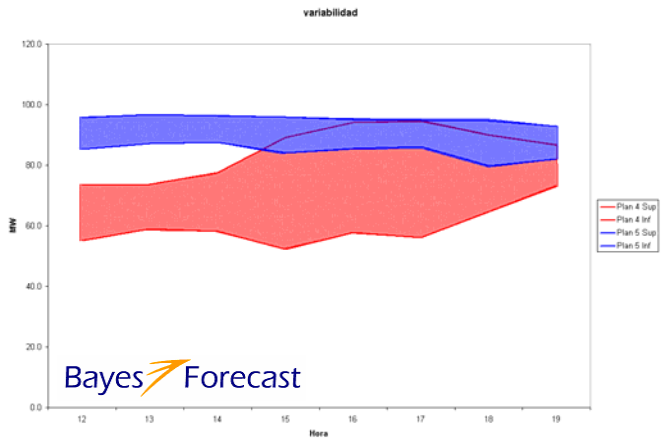
Ejemplo: Si a la hora de ejecutar la interrupción no se conoce el plan el valor esperado es la línea azul pero si se conoce el plan y se espera en donde el valor presente sea mayor al futuro se tiene la línea roja que tiene una una posible ganancia adicional superior a 20MW.





El beneficio generado por el plan con menos incertidumbre es mayor a medida que se quiere estar más seguro del aportación al sistema

Ejemplo: La ganancia de interrumpir el plan menos incierto frente al incierto es mayor a medida que el coste de caída del sistema es mayor. La ganancia es la zona sombreada.



OPCO consumers operation aid prototype

OPCO assignment process and algorithms

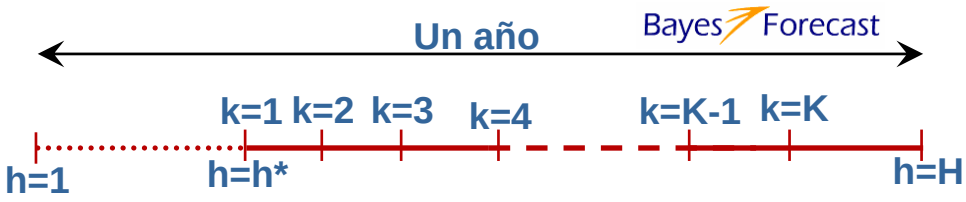
The Contribution of each consumer in the portfolio is evaluated by

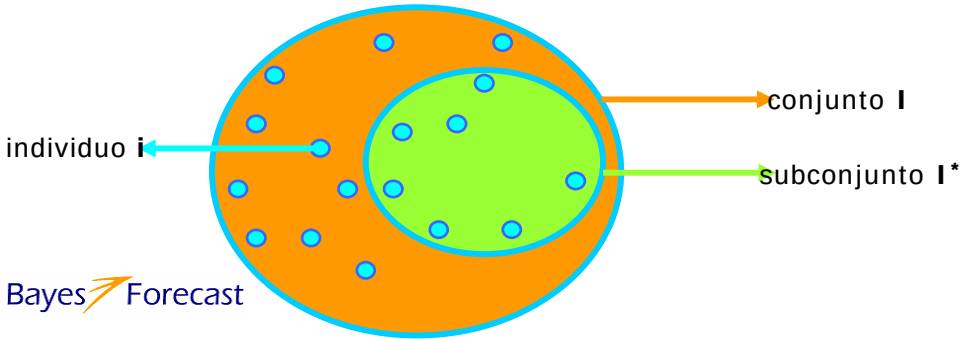
- its average level of expected response on each production plan
- Uncertainty
- Location in relation on the network sensibility
- Functional form on the lose function
- Scarcity of available DSO resources

Bayes Forecast

OPCO assignment process and algorithms

Objetivo: Asignar a un conjunto de consumidores unos niveles de interrupción, optimizando los contratos con criterios a largo y corto plazo





En la hora h* se debe hacer frente a una interrupción con unas necesidades de potencia L1 con una tipología T1.

Después de la hora h* se tiene que hacer frente a K-1 interrupciones con unas necesidades de potencia Lk y con una tipología Tk.

Se tiene I individuos con nhi horas de interrupción cada uno

Cada hora de interrupción tiene una ganancia gi que es función de la potencia consumida natural (PCN), del PMax y de la tipología de la interrupción.

OPCO assignment process and algorithms

Loss functions

- Direct loss
  When the DSO contributions are lower than the needs
- Indirect loss
  When the DSO contributions became scarce than the needs

Objective

Assign the group of DSO response that minimize direct and indirect losses

Bayes Forecast

Converting Demand Side Operation in an accurate tool for the Transmission System Operator

Electric market participants contribution on the electric system efficiency

On the R & D project EMERGÍE, REE is developing

- DSO priorities,
- Evaluation methodologies,
- technical tools prototypes and feasibility analysis

The scope of EMERGÍE

1. Develop DSO offer opportunities and tools
2. Evaluate alternative for DSO trade
3. DSO insertion on the system planning

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Bilateral collaboration

- REE valuate highly the exchange of ideas with operators, participants in the market, researchers, ESCOS and regulators

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Tank you