Task XI
Time of Use Pricing and Energy Use for Demand Management Delivery

Demand Response Workshop
Helsinki - April 2005

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What is DSB/DR/Demand Elasticity?

- Some customer demand non-essential
- Some demand will not be taken if rewarded
- Saves generation capacity, spinning reserve and increases supply security
- Many issues:
  - Large customer demand
  - Small customer demand
  - Work through suppliers/ESCO
  - How to motivate DR by customers
  - How to deliver DR for Supplier/SO
  - How to validate DR for settlements/payment

Difficulties for smaller customer market participation

- Energy not of much interest to smaller customers
- Customers don’t like inconvenience
- Profile settlements
- Demand side validation

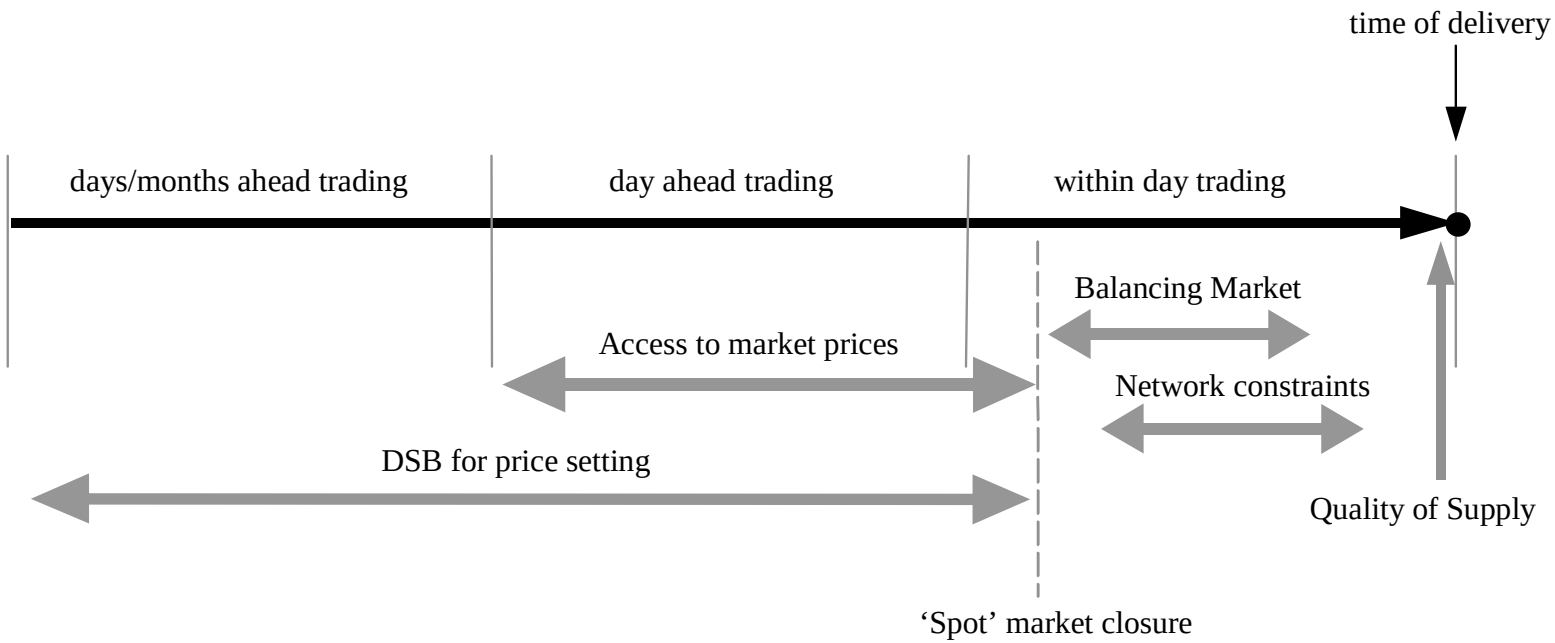
Definition of Smaller Customer

- Smaller customers use “profiles” for settlements or residential and small businesses

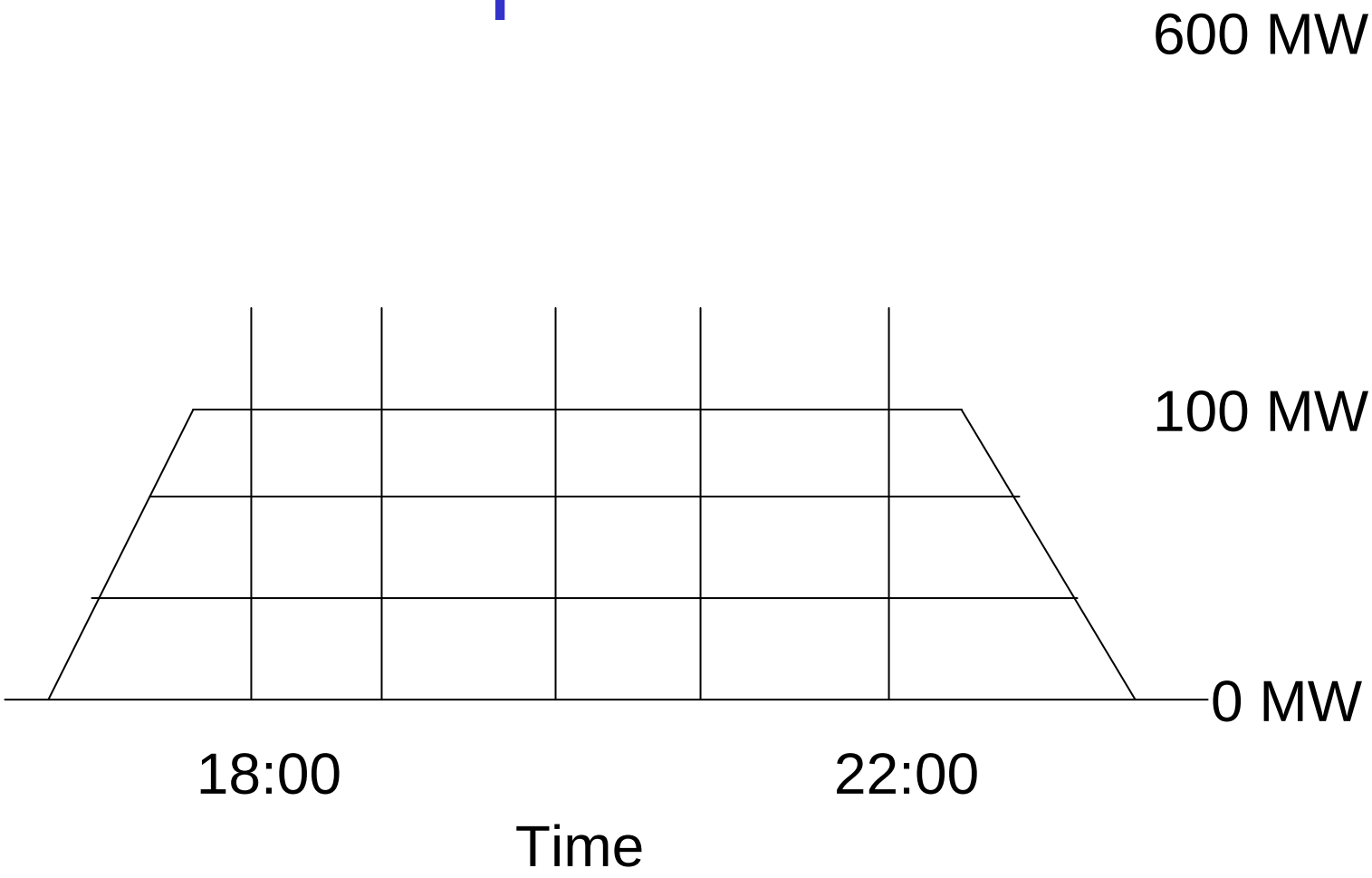
Critical issues from System Operator perspective

- Is demand available for reduction at right time and place?
- Will demand reduce when price increases?
- Will demand return when price reduces?
- Is reliability and predictability of process acceptably high?

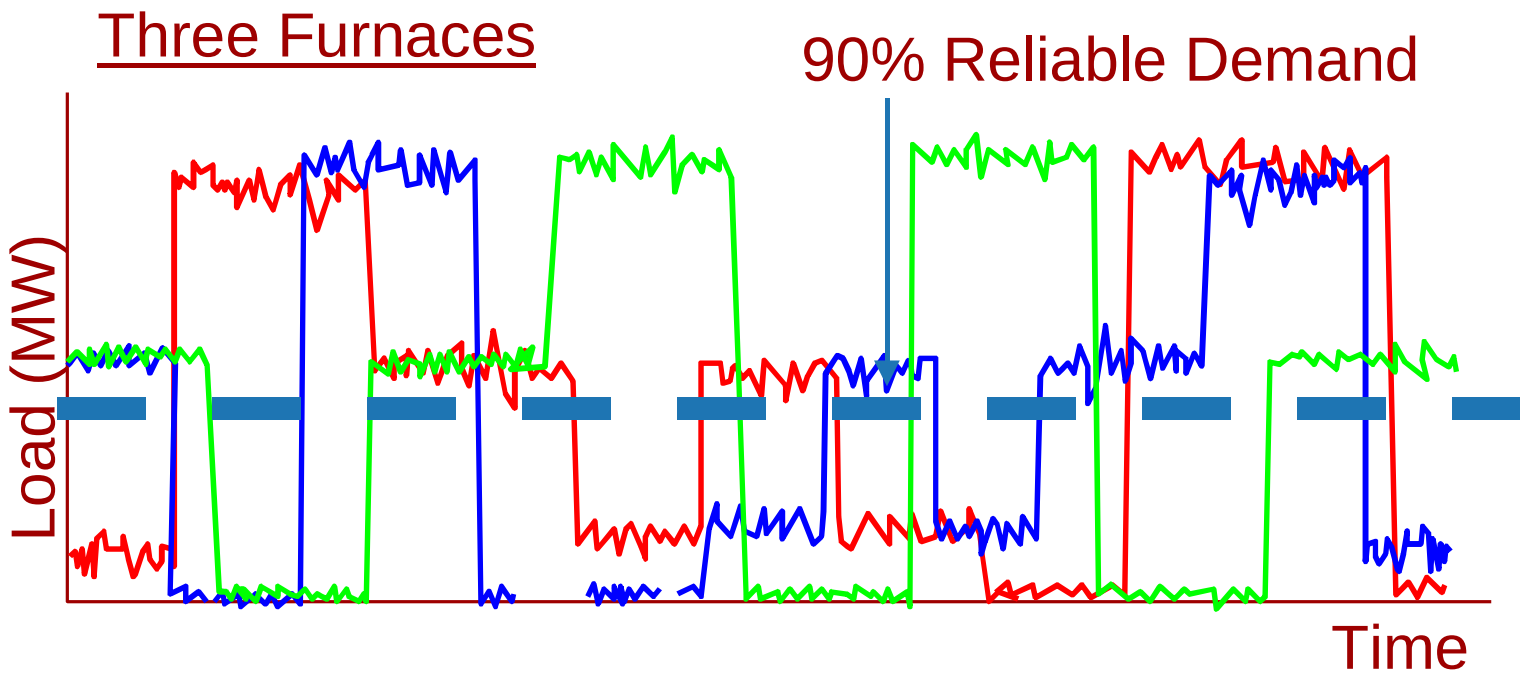
Time-frame for different DSB categories



Aggregated DSB, BMU in position



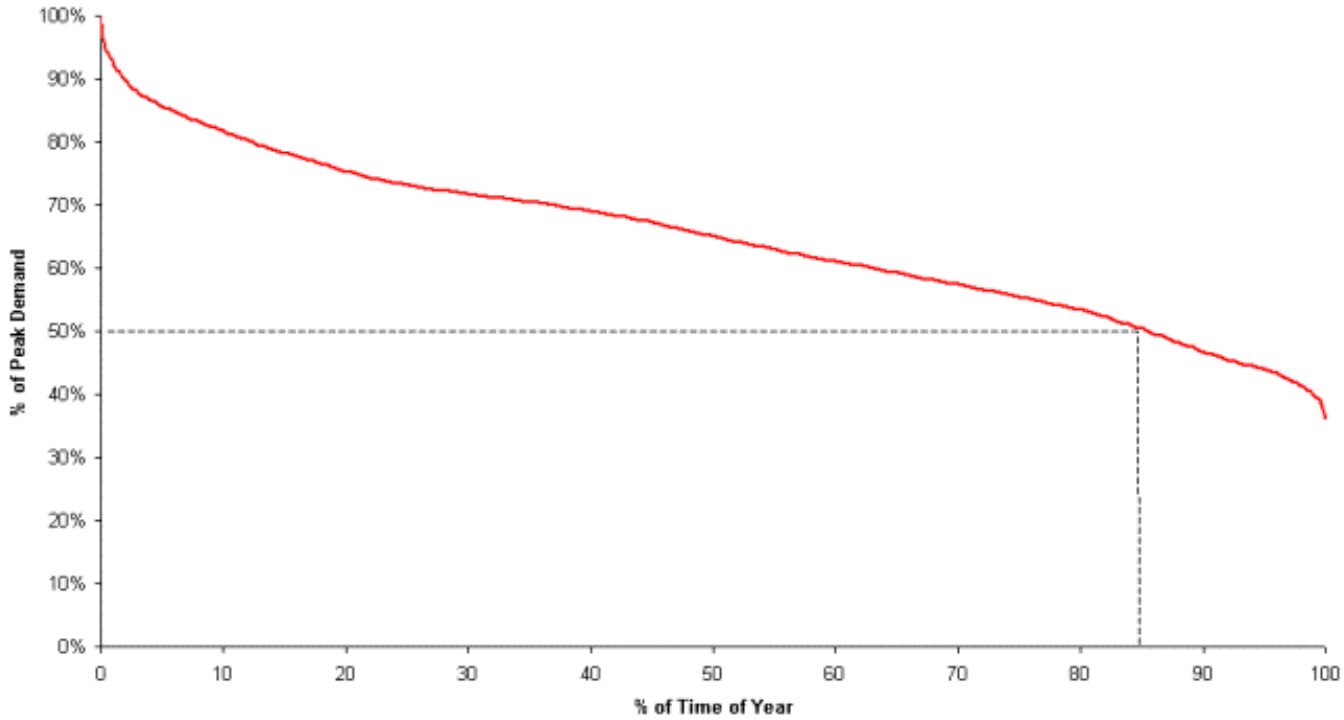
Fast acting frequency response - probabilistic



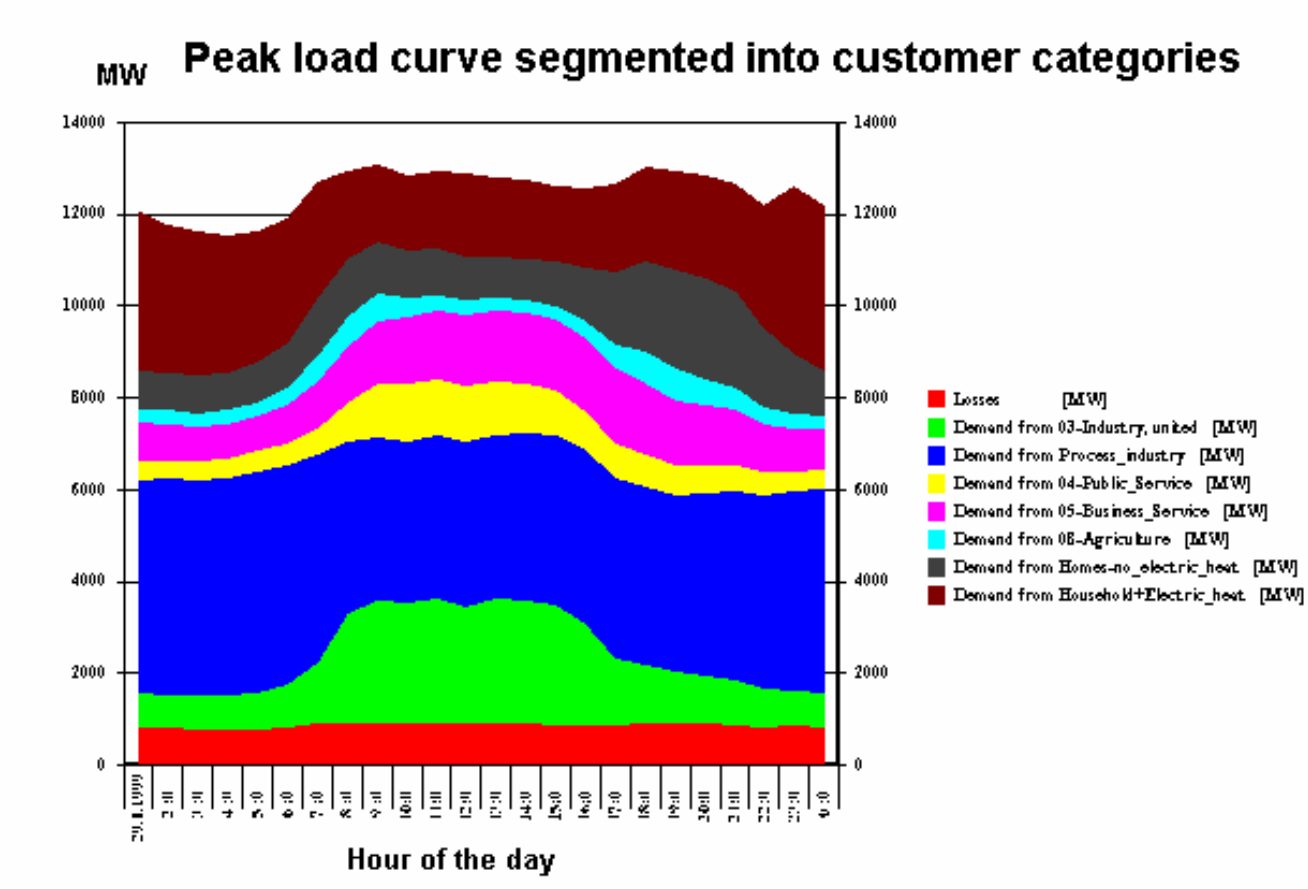
DSB service payments

- Demand availability fee:
  - Euro 15,000 (whole month)
- Demand position fee:
  - 4 hours @ Euro 150/hr = Euro 600
- Window initiation fee:
  - 1 hour @ Euro 200/hr = Euro 200
- Despatch of Fast Reserve paid at Offer price

Load duration curve for England and Wales in 2003



Finland


Peak load curve segmented into customer categories
MW
14000
12000
10000
8000
6000
4000
2000
0
Hour of the day
Losses [MW]
Demand from 03-Industry, united [MW]
Demand from Process_industry [MW]
Demand from 04-Public_Service [MW]
Demand from 05-Business_Service [MW]
Demand from 06-Agriculture [MW]
Demand from Homes-no_electric_heat [MW]
Demand from Household+Electric_heat [MW]

IEA Project (Task XI)

- Started April 04
- 7 countries participating
  - Denmark
  - Finland
  - Greece
  - Netherlands
  - Spain
  - Sweden
  - UK

Objective of Task XI

- Save energy/CO2 and increase security by identifying and quantifying methodologies for smaller customers to reduce demand and participate in markets using their demand/generation elasticity.

Subtasks 1,2,3

- Subtask 1 - Quantify demand disaggregation/ feedback methods, benefits and viability
- Subtask 2 - Quantify impact of time of use pricing for smaller customers
- Subtask 3 - Quantify bidding, validation and control mechanisms for smaller customer DSB

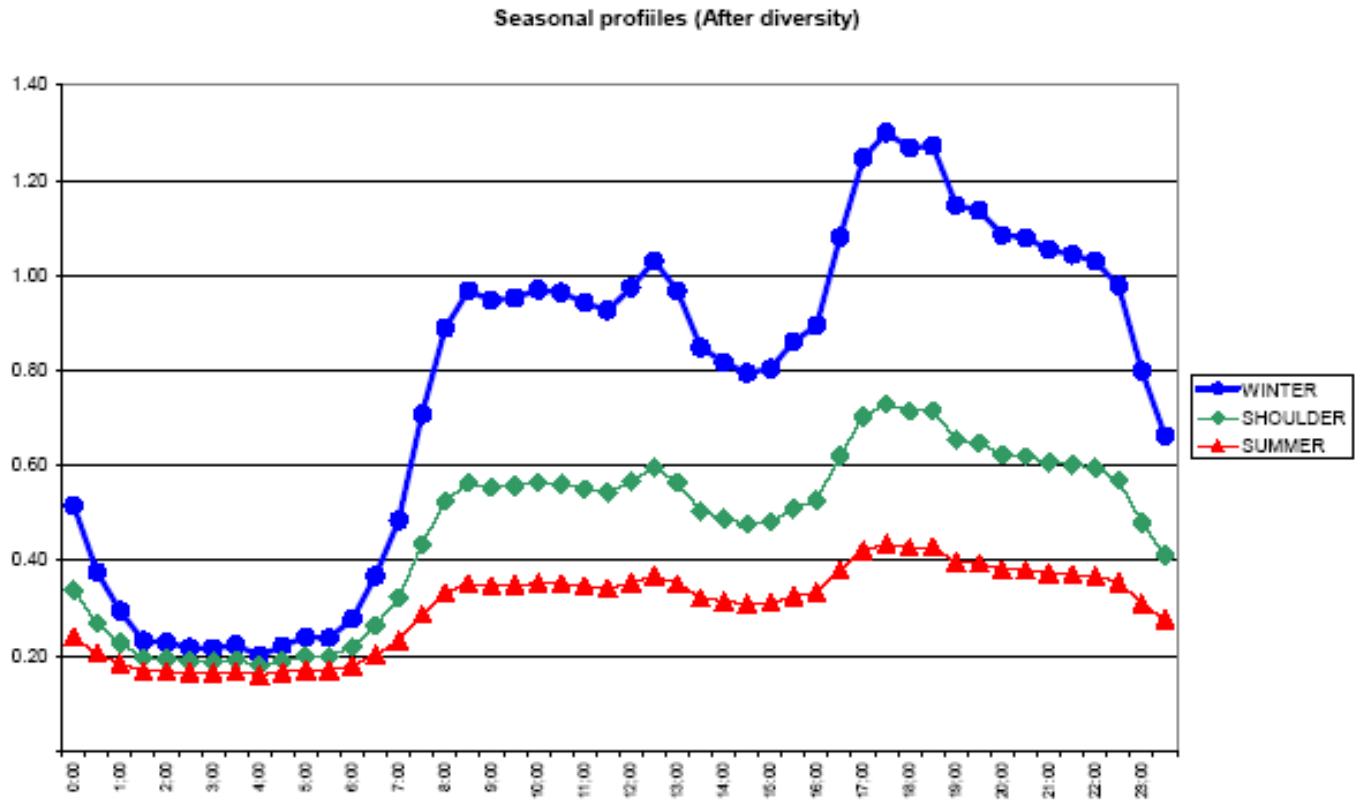
Customer Perspective

- Subtask 1 EUMF
  - Requires general policy to reduce use of most expensive energy items
- Subtask 2 TOU/RTP
  - Requires customer to make conscious decisions to move optional or controlled demand to low price periods
  - Day ahead prices?
  - Tariff
- Subtask 3 DSB
  - Requires customer to plan and bid optional demand and be prepared to move demand at relatively short notice (hours)

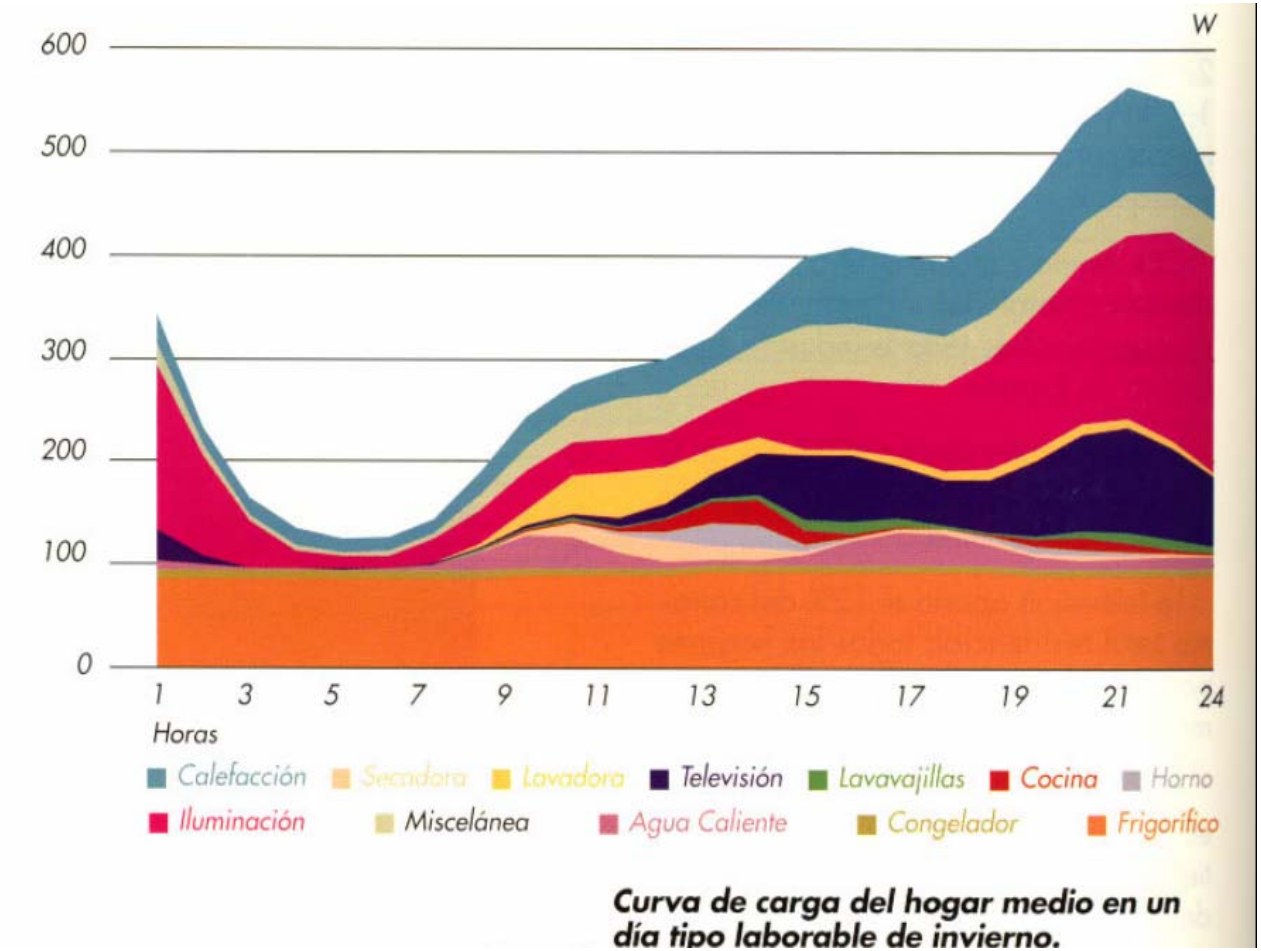
Subtask 2 “TOU Pricing and Demand Management Delivery”

- What has been done:
  - Analysis of TOU method (Tariff, Dynamic, Real Time)
  - Availability of customer end use demands (obtrusive/non obtrusive)
  - Linking of TOU methods to each end use demand (customer categories)
  - Impact on profile settlements (dynamic profiles)
  - Costs of implementing EU management
  - Value of implementing EU management
  - National generation peak %
  - Dynamic demand changes with single rate metering?
  - Customer override option/metering

After diversity Demand of Typical UK Household



Individual End Use Contribution to Peak Demand



Curva de carga del hogar medio en un día tipo laborable de invierno.

TOU Pricing Mechanisms

- Tariff TOU pricing - fixed times
- Dynamic TOU pricing - variable times
- Real Time TOU pricing - notice time
- Variable durations
- No notice times
- Customer override option
- TOU Metering?

Applications and Technologies for TOU Pricing

- Potential loads are:
  - Storage heating, cooling and water heating (switch energy “in”/”out”)
  - Direct space heating (modify thermostat settings)
  - Direct water heating (modify thermostat settings)
  - Direct space cooling (modify thermostat settings)
  - Embedded generation (start out of heat led regime)
  - Fridges and freezers (switch off for short period)
  - Washing machines (disable for period, change time schedule
  - Cooker (disable for period)
  - Sauna, car heaters (disable for period)
  - Direct electric showers (disable for period)

Override Inhibits

- Providing customer with override options to automatic demand switching needs careful consideration
- Providing the number of times demand is switched with no override option is small, it may be accepted by customers

Summary of Tariff, Dynamic, Real Time Pricing and Switching

- All customers can move some appliance and lighting from peak to off peak (1-2 kW)
- Direct space and water heating, air conditioning controlled by reducing thermostats or heating in selected rooms
- Dynamic pricing can be applied to all demand by providing 24 hour notice of price changes
- Direct space, water heating and air conditioning can respond automatically to real time pricing signals

Summary of Tariff, Dynamic, Real Time Pricing and Switching

- Microgeneration can respond to real time prices and generate outside normal heat led times
- Appliances and lighting controlled by inhibits
- Complex control algorithms implemented successfully in trials.
- Systems cannot be switched on by customers at high price times/single rate metering is used
- If no override option, then single rate metering possible

Summary of Tariff, Dynamic, Real Time Pricing and Switching

- Dynamic pricing/switching deals with unscheduled and scheduled peaks
- Direct electric space and water heating, air conditioning, lighting and appliances reduce peak demand by a few kW per customer
- Real time pricing sends right messages to demand by SO (similar to generation)

Costs and Benefits of TOU Pricing

- Capital cost of 2000MW of generation/ transmission/distribution, Euro 2000 million
- Capital cost of removing 2000 MW of demand using demand management is Euros 435 million
- Are savings sufficient to motivate 2kW of demand reduction for 9 hours per year?

Conclusions

- Tariff, Dynamic and Real Time TOU pricing viable for direct space, water heating thermostat control
- May be viable for central air conditioning, microgeneration, saunas and direct electric showers
- Local balancing of renewables
- May be possible to inhibit demand for short times for each customer but apply to larger population in sequence

Conclusions

- Dynamic and Real Time TOU demand switching can replace scheduled generation
- Communication not major technical constraint
- Difference between TOU methods unclear if no override option is allowed and single rate metering

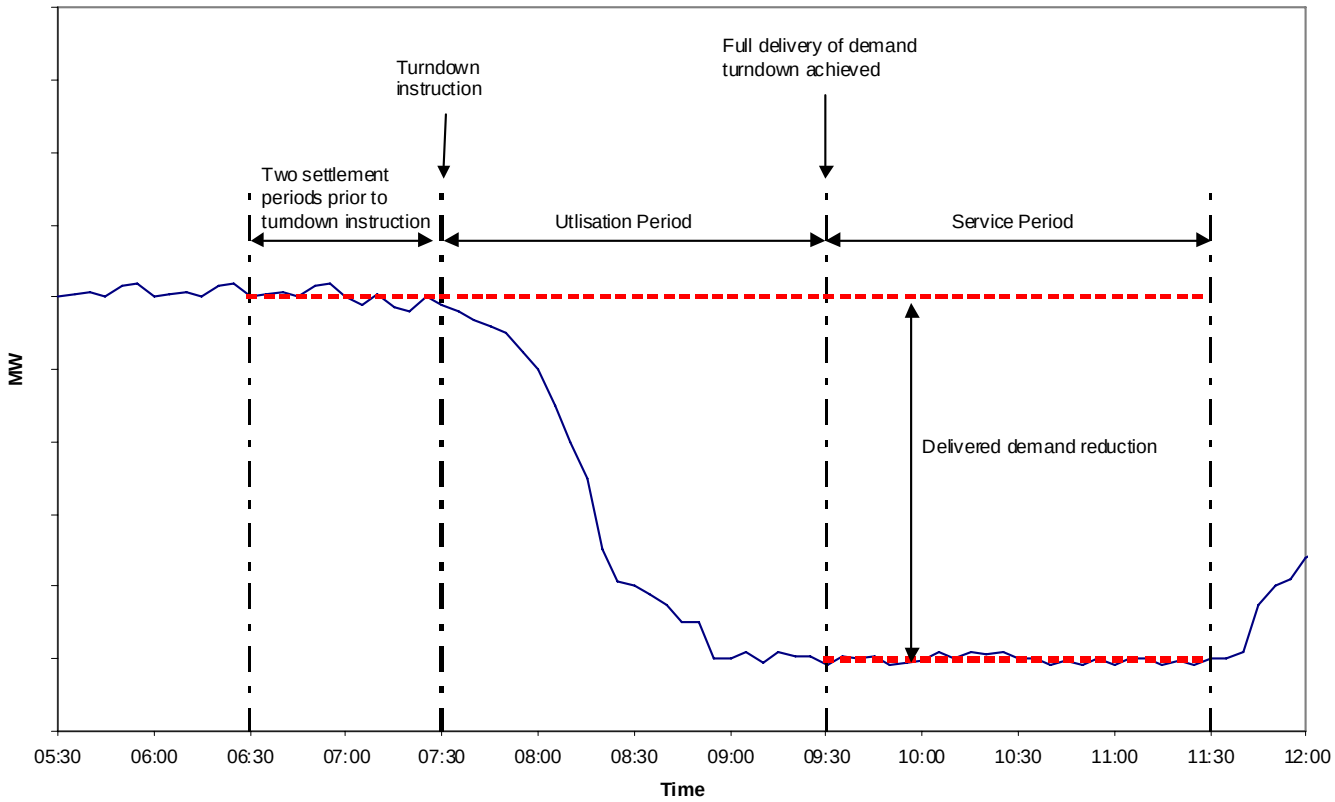
Subtask 3
Demand Side Bidding

- Bidding aggregated demand in market (shift)
- Moving demand for payment
- Existing for larger customers
- Metering and energy contracts to validate
- How can it work for smaller customers?
  - Aggregation
  - Bidding
  - Validation

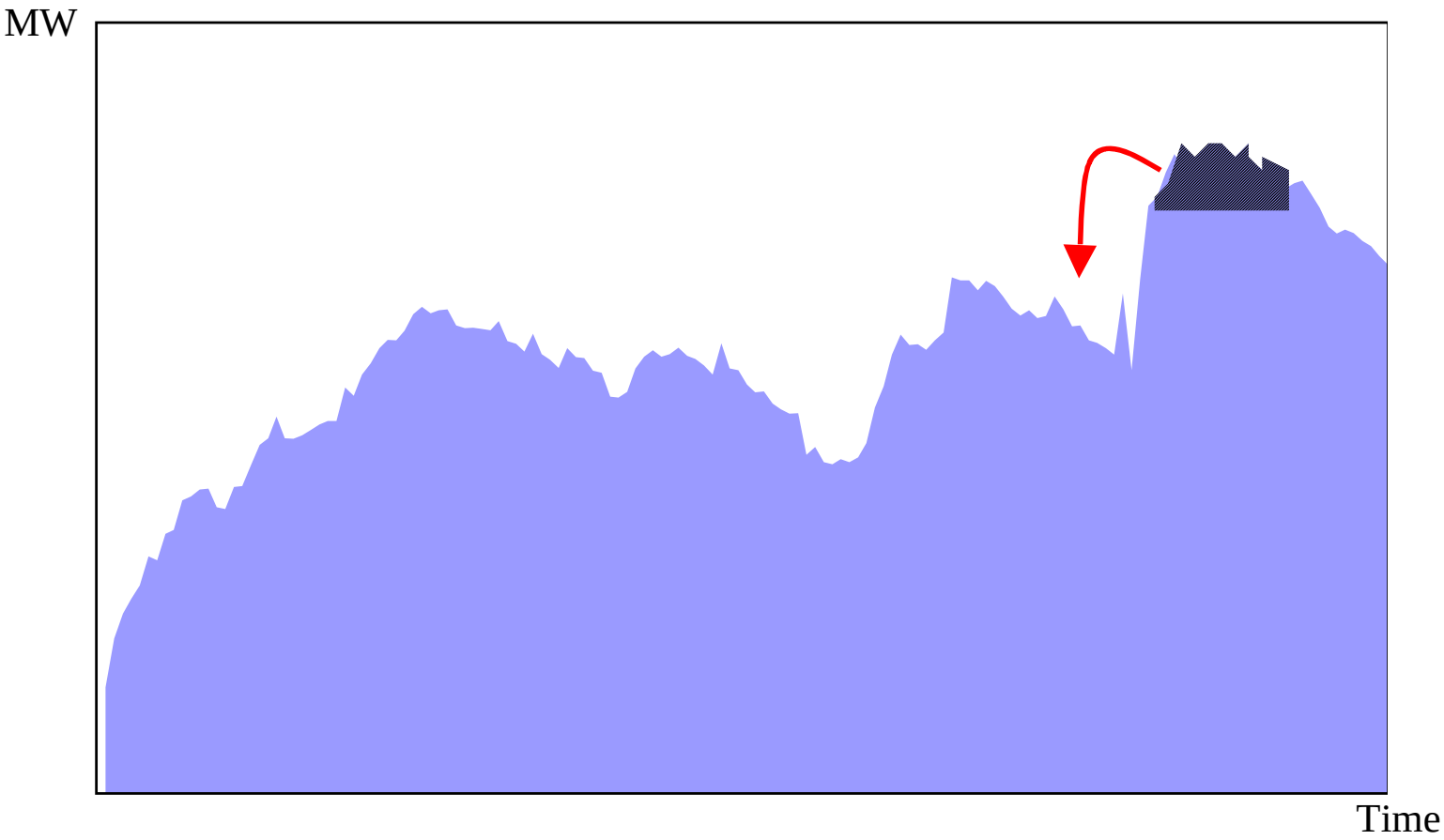
Smaller Customer Demand Bidding

- Remote switched domestic storage demand now bid by suppliers
  - Grid metering and command validation used
  - Payment to suppliers and ESCOs
  - Demand bidding of other loads?
  - Remote disable of end uses? (communication)
  - Frequency relays on end uses?
  - Remote enabling of generation
  - Metering?

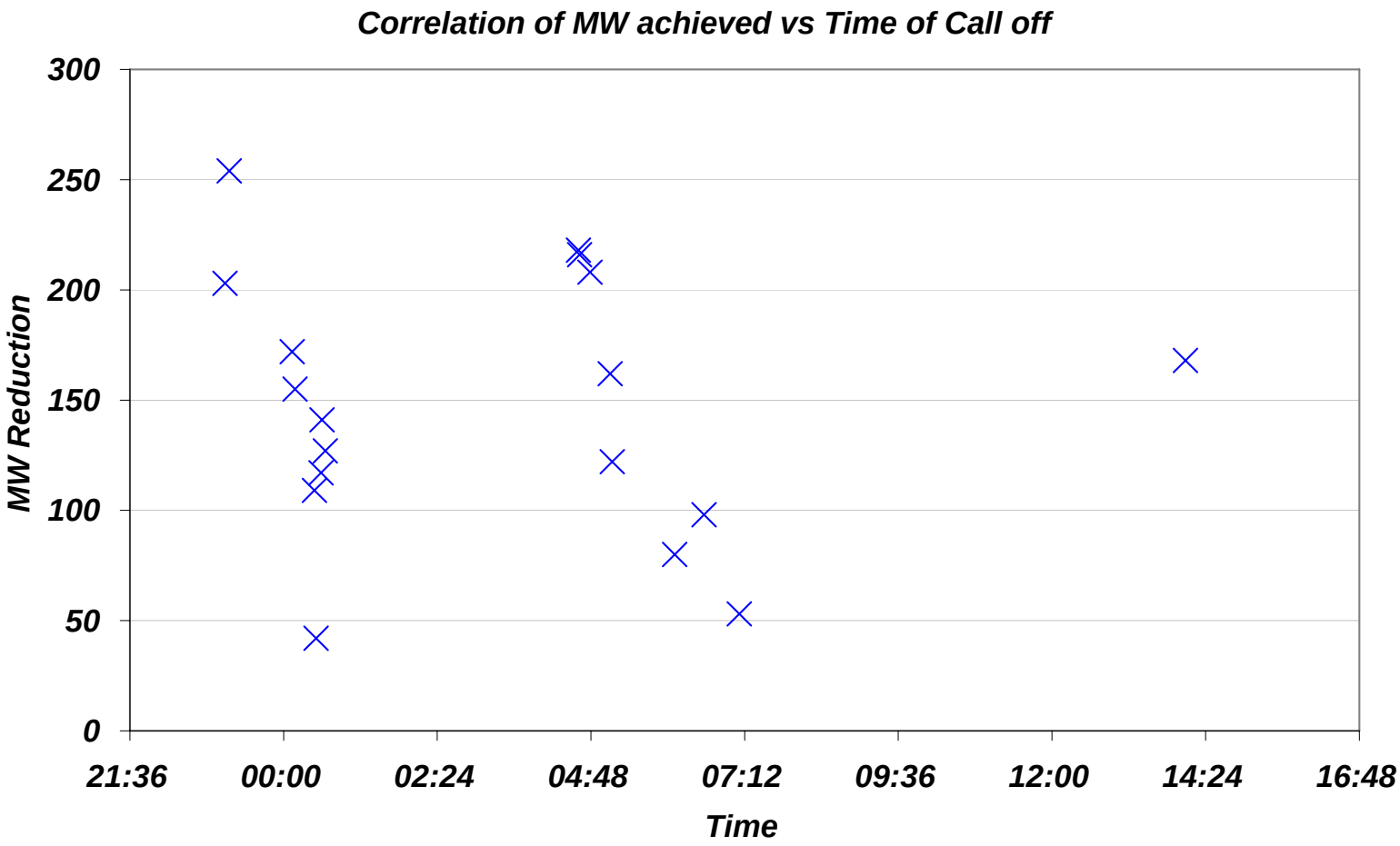
Metering demand reduction delivered in the Demand Turndown Trial



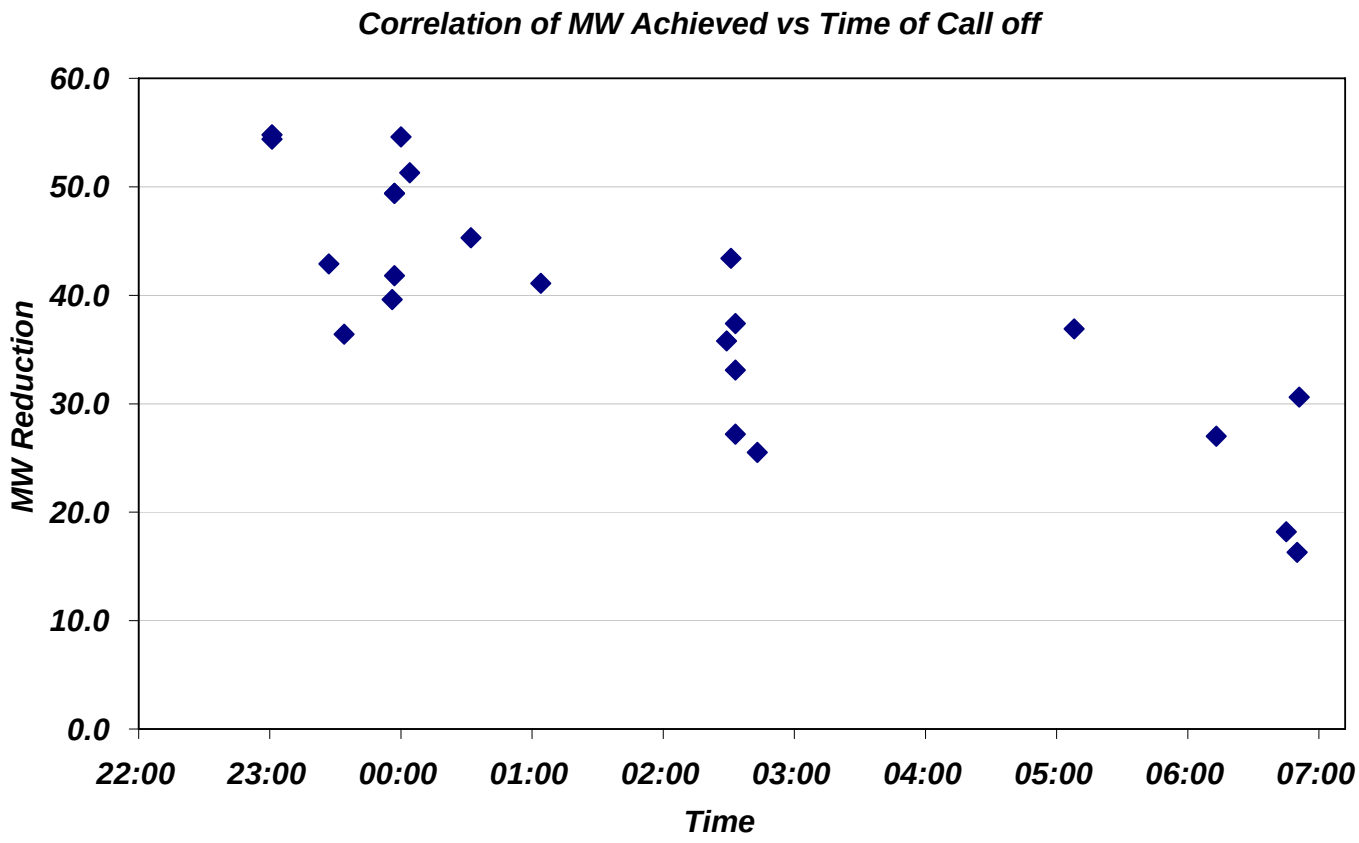
Schematic of the demand profiling trial



Results of NGC Radio Teleswitch Trial



NGC Cyclo-Control Trial Results



DSM Delivery by TOU and DSB

- Dynamic TOU pricing
  - Modifies demand manually/automatically in response to price
  - TOU metering if override option
  - Single rate metering if automatic and no override option
  - Statistical delivery of demand change
  - Result is uncertain demand change in response to SO/Supplier request
  - Payment via tariff
  - “Profile” settlements issues

DSM Delivery by TOU and DSB

- Formalises TOU pricing/switching methodology
- Aggregator contracts for delivery of demand block
- Provides SO with guaranteed demand/equivalent generator
- Remote switching required
- “Validation” needed to meet contract
- Payments by SO for delivery

DSM Delivery by TOU and DSB

- Aggregator contracts with SO for statistical demand shift
- Aggregator has portfolio of statistical demand delivery blocks
- Customer paid through tariff (single rate metering)
- Aggregator paid via GSP validation
- Dynamic “Profiles”

Task XI Status and Direction

- Studies and Reports delivered
- New Proposals for developing implementation routes
- Subtasks 4 & 5, “Smaller Customer Participation in Dynamic Demand Shifting”