# Modelling Electricity Auctions

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Starting from England and Wales, competitive electricity markets have been created in most OECD countries. The Italian power exchange IPEX started on 2004.

**Key features of new electricity markets**

- privatisation and industry reorganisation & restructuring of former vertically integrated, monopoly suppliers
- introduction of a ***competitive*** wholesale spot market or ***wholesale electricity auction***
- introduction of retail competition
- transmission/distribution pricing and regulation (natural monopolies)

I.e. Separation of potentially competitive from natural monopoly elements

# Key Issues in Reforming Wholesale Markets

## A. Market Structure & Market Power in Generation

| YEAR 2004 | 86% NATIONAL GENERATION<br><br>81.4% THERMAL<br>16.2% HYDRO<br>2.4% OTHER TECN. | 14% IMPORT |
|---|---|---|
| MARKET SHARES AND COMPOSITION OF THE GENERATION | | |
| ENEL | 50% | MID-MERIT: 51.4%<br>PEAK-LOAD: 15.2% |
| ENDESA | 7.5% | MID-MERIT<br>PEAK-LOAD |
| EDIPOWER | 7.6% | MID-MERIT<br>BASE-LOAD |
| TIRRENO POWER | 2.3% | BASE-LOAD |
| EDISON | 12.3% | BASE-LOAD |
| ENIPOWER | 2% | MID-MERIT<br>BASE-LOAD |

## B. Market "Architecture" and "Auction Design" Issues

- market "architecture" refers to structure of wholesale market, i.e. a single auction or series of forward and spot markets.
- market "design" refers to detailed design of electricity auctions

**Key Lesson from Experience** – getting A right makes B much less important

## Market Architecture: "Centralised" Versus "Decentralised" Markets

A **pool** = a *centralised* spot market for the wholesale exchange of electricity:

- all supply and demand must go through the pool (no bilateral trades)
- exchange (i.e. price determination) occurs hourly or half-hourly
- bids typically daily or hourly

Pools overcome classic *co-ordination* problem between generation and transmission:

- grid must match supply and demand continuously
- electricity is traded *anonymously*, i.e. no direct physical trade (bilateral contracts are fictional/financial)

Pool *optimisation problem* is to *minimise* total cost of meeting demand subject to:

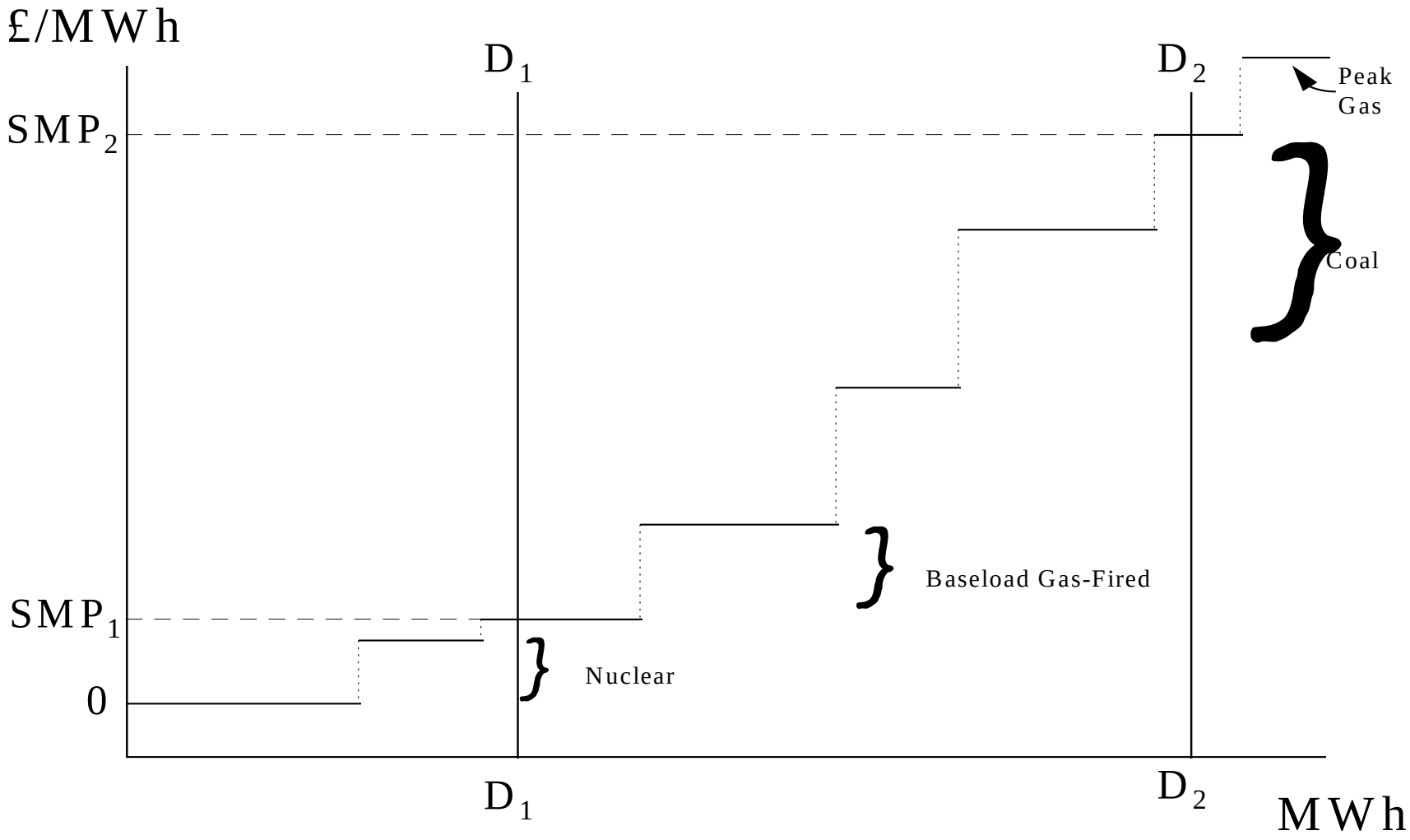
- generation costs of different technologies
- transmission constraints and losses

# Electricity Pools

Electricity pools are ***uniform, first-price, multi-unit auctions***:

- generators submit bids for each generating unit
- price/capacity bids are used to construct a 'merit order' of generating units, i.e. a market supply curve (subject to transmission costs/constraints)
- the intersection of the market supply curve with estimated demand determines *'system marginal price'* (SMP) for each hour
- each 'successful' supplier is paid bid price of marginal 'successful' bid for each unit sold
- price bids typically fixed for entire day or week

# Stylised Merit Order & SMP Determination



## "Decentralised" Electricity Markets

**California, NETA (England)**

- a series of voluntary forward markets and spot markets
- bilateral trading permitted
- spot or balancing market mandatory for "out of balance" suppliers (i.e. to coordinate supply and demand)

Advocates of "decentralised" design (e.g. Wilson, 2002) argue that:

- optimisation in pools is illusory as bids do not reveal costs
- sequence of markets increases competition/mitigates market power

Opponents say it is more opaque, creates greater opportunities for strategic behaviour, and more likely to result in productive inefficiency

**Conclusion: The jury is still out on this issue**

# Design Issues: Auction Format

**Standard auctions (e.g. paintings, tulips, treasury bills)**

- buyers bid fixed prices or demand curves for one or many units of objects been sold . We can have sealed bids or ascending bids.
- winning bidders' payments determined by ***auction rules***, e.g.

***Discriminatory Auction***: each purchaser pays his own bid price

***Uniform First Price Auction***: each purchaser pays bid which just clears the market (i.e. price of marginal successful bidder)

***2nd Price (Vickrey) Auction***: each purchaser pays bid prices of unsuccessful bids replaced, or market-clearing price ignoring that bidder's own bids.

# Electricity Auctions

**Properties of standard - e.g. uniform, discriminatory - auctions:**

- a seller's bid determines the price received with some probability, hence they have an incentive to increase bids above cost
- units may not be sold by cheapest suppliers - so inefficient allocation of resources results
- hence we would expect **above-cost bidding** and **inefficient despatch** whenever generators have market power
- in uniform auction, large suppliers have incentives to increase their bid as marginal bid determines price paid on submarginal
- in discriminatory auction, each trader tries to guess market-clearing price
- **Conclusion: No general results on whether uniform preferred to discriminatory**

**Assume that the order of bids is given by:**

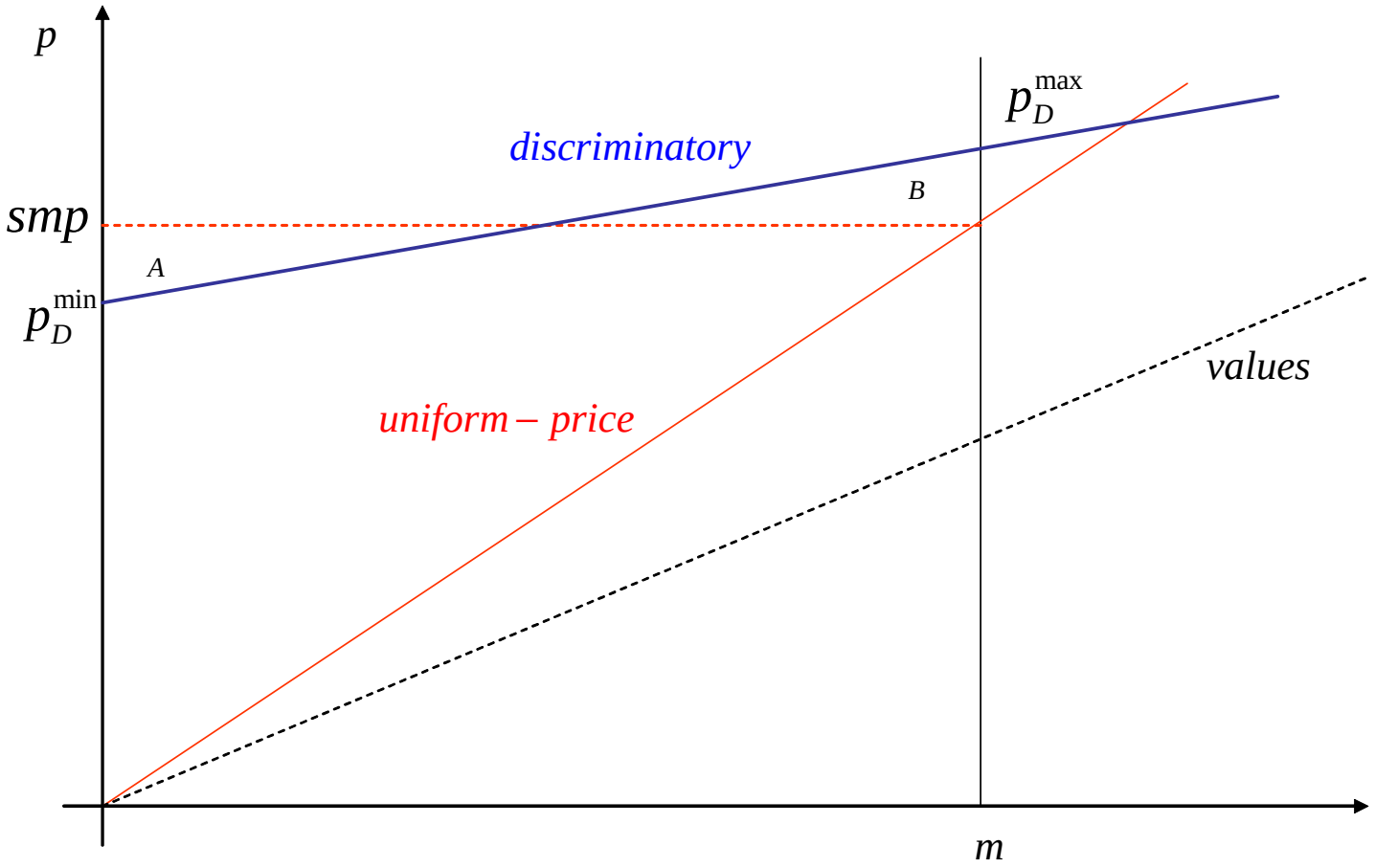
$$b_{(1)} \le b_{(2)} \le \ldots \le b_{(m)} \le b_{(m+1)} \le \ldots \le b_{(n)}$$

**Uniform auction:**
All suppliers are paid the highest accepted bid (= system marginal price):

$$\Pi_i = \left\{ \left( SMP - c_i \right) \sum_{k=1}^{i} q_k \middle| b_i \le b_{(m)} = SMP \right\}$$
$$= 0 \text{ otherwise}$$

**Discriminatory auction:**
Suppliers are paid their own bid:

$$\Pi_i = \left\{ \left( b_i - c_i \right) q^k{}_i \middle| b_i \le b_{(m)} = SMP \right\}$$
$$= 0 \text{ otherwise}$$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smp
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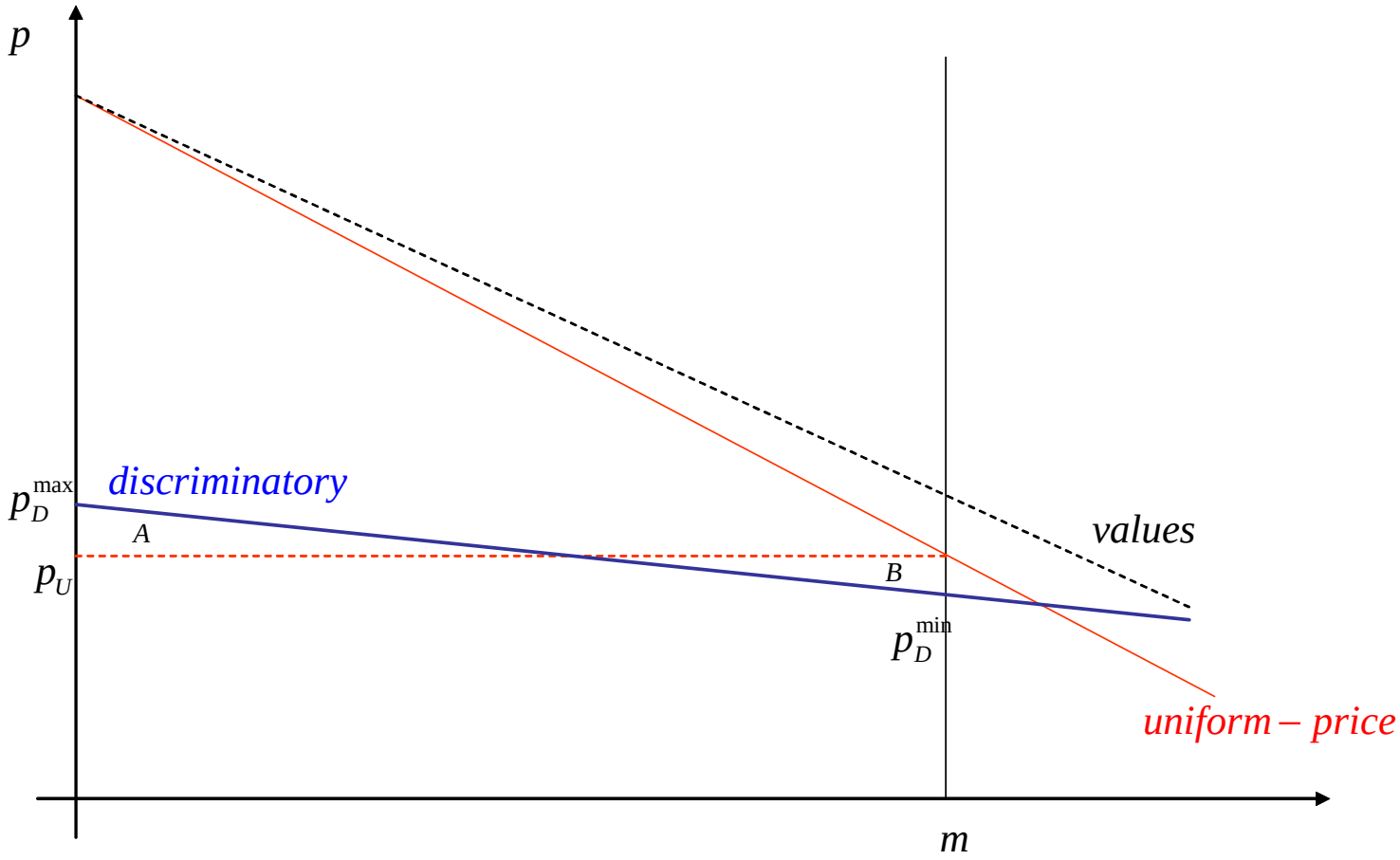
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**Conclusions:**

- **Electricity auctions with SMP rule may not result in an efficient allocation of production rights**
- **Notwithstanding the former point, SMP rule is popular in electricity auctions**
- **More generally electricity auctions are influenced by the market structure**
- **Market concentration appears to be relevant especially among mid-merit and peak plants which are more likely to set the SMP.**
- **The pricing rule that minimises the expected total cost of purchasing electricity cannot be decided on general grounds**