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# **The Detailed Market Rules**

## **Purpose and Content**

**8 and 9 February 2006**

### **Workshop 2: The Regulatory Annexes**

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# Agenda

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- **Introduction**
  - Scope
  - Ownership
- **The Market Price Simulation Model**
  - Theory
  - Sources of data
  - The model and results
- **Simulated Bid and Offer Prices**
  - Theory – consistency with the Market Price
- **Capacity Availability Certificates**
  - Theory and assumptions
  - The model and results

# Purpose of the Annexes

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- **Market Rules are a long-term trading environment**
- **Prices are derived from market activity – the Rules do not set the price per se**
- **Without a traded market there is no means of setting a realistic price**
  - **Even though KEK can use the Market Rules to arrive at balancing energy volumes, the prices it offers will not be correct in the absence of competition**
- **The Annexes are how regulated prices are put into the market**

# Scope – Annexes 1 and 2

- **The Annexes cover all wholesale prices that are subject to the price review**
  - **The transfer prices between KEK Generation and Supply**
  - **The prices at which Ujmani sells to the Public Supplier**
  - **The prices at which regulated generators must post bids and offers into the Balancing Mechanism**
  - **The prices at which reserve contracts will be posted into the Balancing Mechanism**
- **The Annexes include schedules for all these prices**

# Scope Annex 3

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- **This calculates a maximum penalty price for a shortfall in Capacity Availability Certificates**
- **This also sets rules limiting the scale of the Security of Supply Obligation in the earlier years of the scheme**

# Ownership of the Annexes

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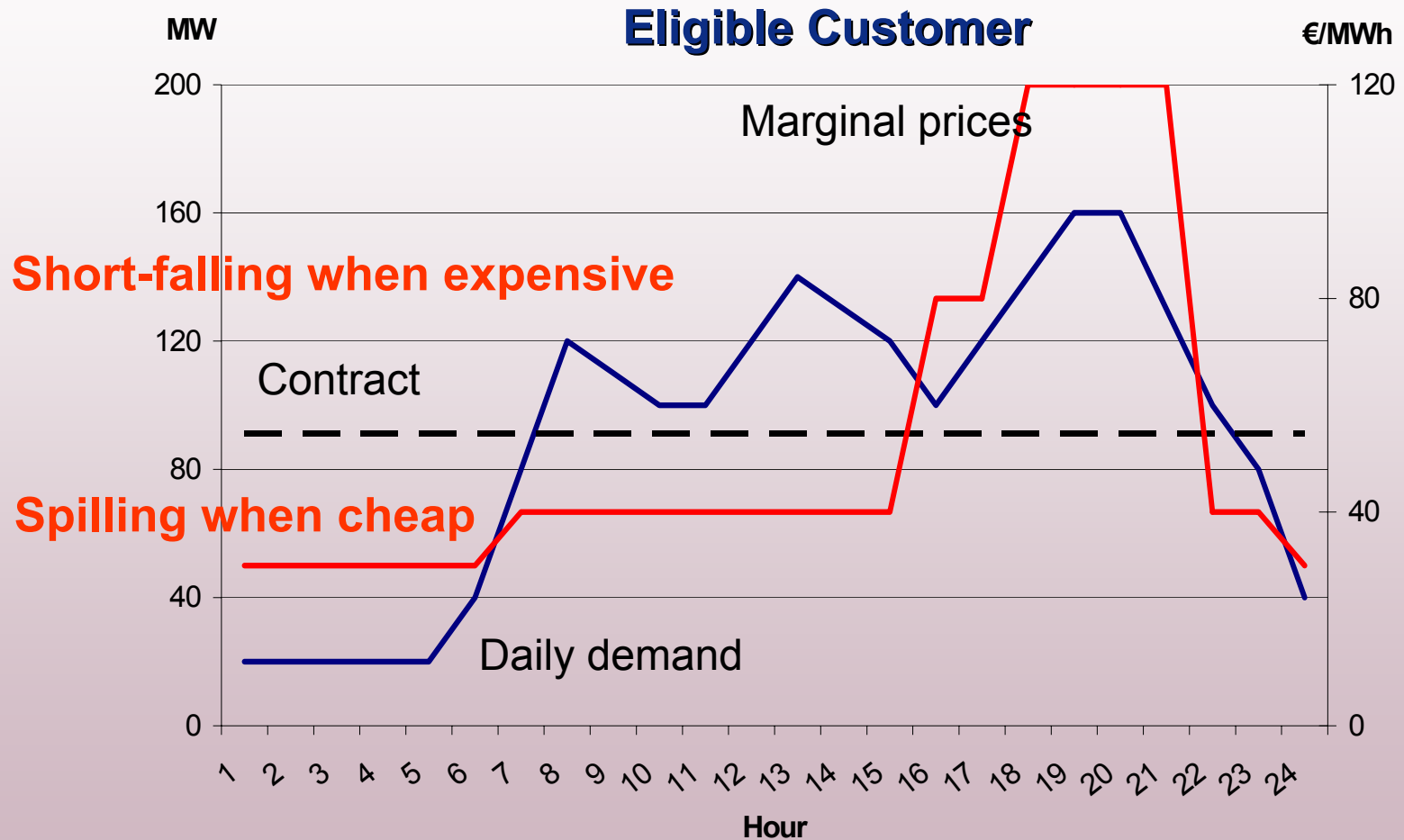
- **ERO owns and will update the annexes**
- **They are in the Market Rules for visibility and transparency**
- **Responsibility of the Market Operator to ensure they remain up to date**

# Why simulate the price?

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- **One integrated generation and supply business**
  - Indifferent about price of generation
- **Ability to manipulate prices**
  - Low transfer prices could deter a new generator or importers
  - High transfer prices could deter competitive supply
- **Wrong transfer price gives wrong signals of cost to eligible customers**

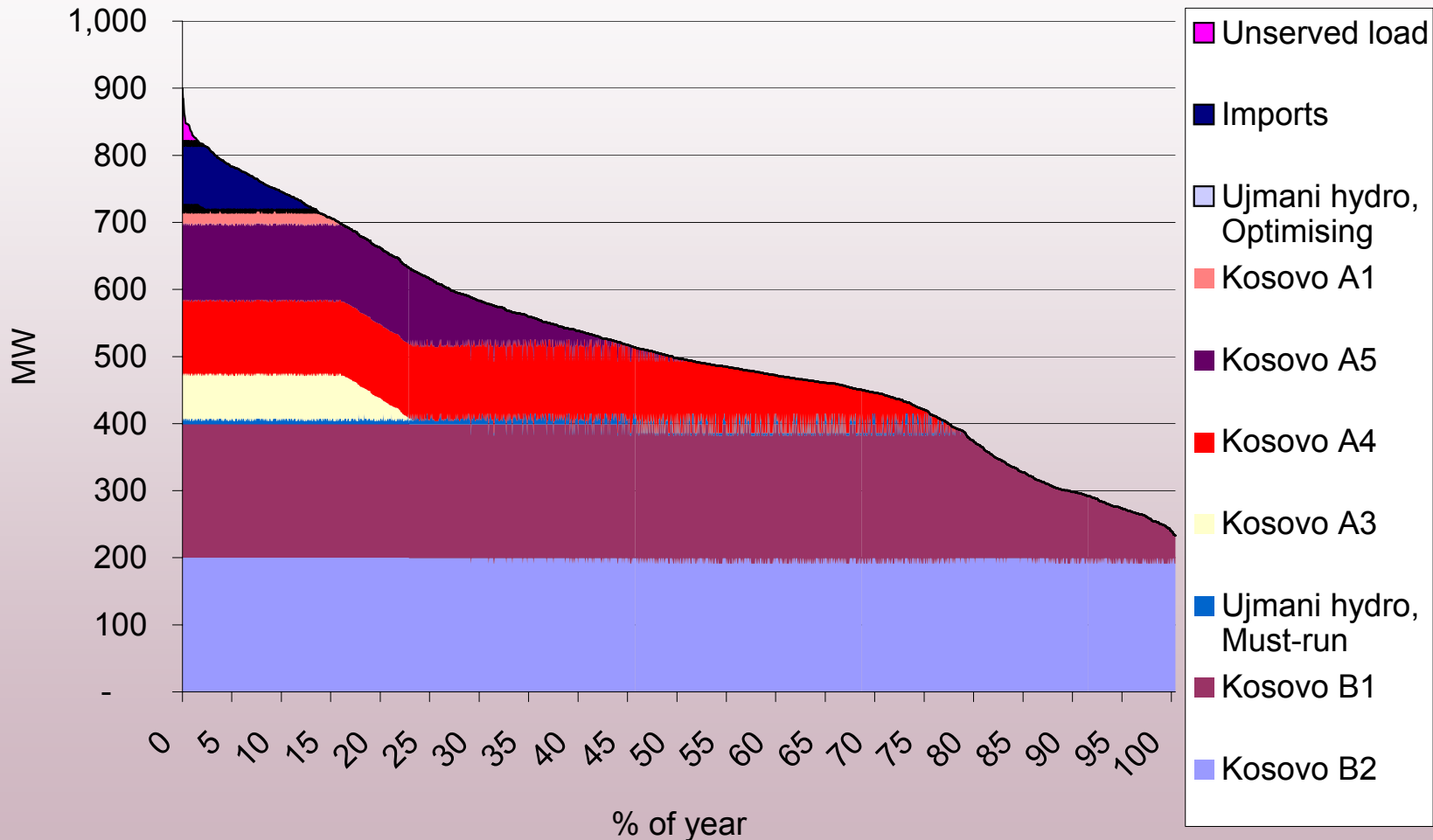
# Price shape is also important



# Basic theory of the SiMP – merit order

- **A simulation of a competitive market**
- **Merit order dispatch principles**
  - Base load capacity with lowest variable costs
  - Peaking capacity has limited run time
- **Simulation of full market**
  - KEK Generation
  - Ujmani
  - Net imports
- **Simple modeling of hydro dispatch included**
  - Some capacity at Must Run
  - Remaining capacity will seek to optimise value of available energy

# Simulated merit-order dispatch, 2007



# The SiMP – Price setting theory

- **In full competition, generators can only recover variable cost**
- **Need to recover fixed costs means:**
  - **Part of year will be oligopoly when demand is higher**
  - **Marginal plant can set price above variable cost**
  - **Fixed cost recovery is related to demand when there is less capacity competing for the marginal MW**

# The SiMP Model

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- **Input cost and availability data**
- **Sort demand in descending order**
- **Create merit order dispatch**
- **Apply fixed cost algorithm such that marginal plant recovers fixed cost as the lower of:**
  - **Variable cost of next generator in stack, and**
  - **Residual share of fixed cost to be recovered in the Settlement Period**
- **Prices can be reset for each season**

# The SiMP Equation

In any **Settlement Period** “*j*”, the **Simulated Market Price** ( $MP_{sj}$ ) is derived from the formula:

$$MP_{sj} = VC_{Ms} + RR_{Msj} * \frac{(DD_{Msj})^2}{CC_{Msj}} * k_M$$

where:

“*s*” is the season in which **Settlement Period** “*j*” falls;

“*M*” is the **Marginal Plant** in the merit-order dispatch in **Settlement Period** “*j*”;

$VC_{Ms}$  is the variable costs of the **Marginal Plant** “*M*” in the season “*s*”;

$DD_{Msj}$  is the modelled dispatch of the **Marginal Plant** “*M*” in the **Settlement Period** (in MWh);

$CC_{Msj}$  is the available capacity of the **Marginal Plant** “*M*” in the **Settlement Period** (in MW);

$RR_{Msj}$  is residual **Required Revenue** (in €) for the remainder of the year of the **Marginal Plant** “*M*” in the **Settlement Period** derived from the formula:

$$RR_{Msj} = RR_{Msj-1} - (MP_{sj-1} - VC_{Ms}) * DD_{Msj-1} ;$$

$k_M$  is a scaling factor designed to scale back the contribution to **Required Revenue** of the **Marginal Plant** “*M*” in each **Settlement Period** to that of total annual revenue requirement that is derived from the formula:

$$k_M = \sum_{n=1}^{n=8760} \frac{(DD_{Msj})^2}{CC_{Msj}}$$

with “*n*” as each **Settlement Period** in the year to which **Required Revenue** applies;

and “*j*” is derived from and ordering of **Settlement Periods** derived from the **Load Duration Curve** for the year such that:

$$\sum_{a=1} DD_{aj-1} \geq \sum_{a=1} DD_{aj}$$

with  $DD_{aj}$  as the modelled dispatch of the **Balancing Unit** “*a*” in the **Settlement Period** (in MWh);

with the constraints:

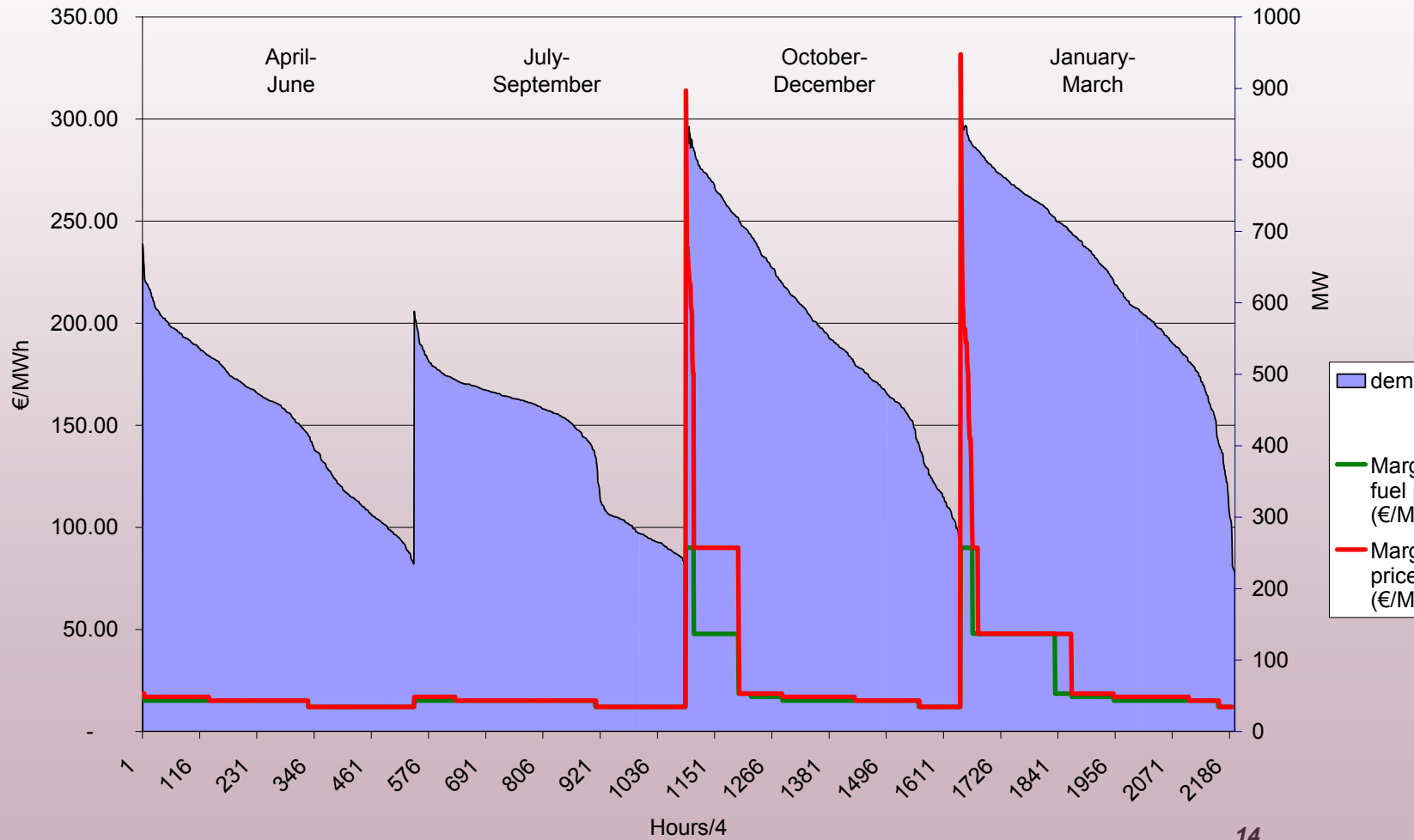
$$MP_{sj} \leq MP_{sj-1}$$

but only where the season “*s*” is the same in both **Settlement Period** “*j*” and **Settlement Period** “*j-1*”; and

$$MP_{sj} \leq VC_{M+1s}$$

where “*M+1*” is the next plant in the merit order stack in ascending order of variable cost.

# The price curve



# The Simulated Market Price schedule

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- Issued annually
- Separate schedule for each season
- Price on the day determined by the System Operator day ahead forecast of demand level
- Price at which Public Supplier buys energy from KEK Generation

# Sources of data

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- **Consistency with price control**
- **Current assumptions based on GIS and other sources – new prices will be set for 2007 (but these will be a reasonable approximation)**
- **Assumptions required on:**
  - **Generator availability in the coming year**
  - **Import prices**
    - **Peaking and base load**
  - **Value of lost load**
    - **Stand-by generation and diesel costs**

# Main current assumptions

- **Costs of a new generator (from GIS):**
  - €1,013 per kW
  - €10.2 per 300 MW fixed O&M
  - €1.3/MWh variable O&M
- **Each generating unit depreciated over 40 years to give residual asset value**
- **Regulated rate of return on historic assets = 12%**
- **New investments (Kosovo A rehabilitation study) amortised over life of project**

# Other KEK data assumptions

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- **Conversion rates of lignite into generation**
- **Exported energy as against generated energy**
- **Plant outage rates in each season**
- **Cost of lignite (based on the Vattenfall/DMT study for Sibovc)**
- **Cost of masut and usage at different output levels**
- **All these assumptions are subject to confirmation**

# Other assumptions needed

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- **Value of lost load**
  - **Cost of standby generation per kW**
  - **Total standby generation capacity**
  - **Amortisation years**
  - **Cost of diesel**
- **Price of imports**
- **Ujmani hydro availability rates by season**

# Ujmani hydro modelling

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- **Need to set fair price**
- **2 products modelled independently**
  - **Must-run**
  - **Peaking**
- **Must-run is still a daytime product**
- **Peaking capacity is for remaining energy in the system**
- **Trial and error running of the model to simulate appropriate dispatch profile using reserve prices to avoid over-generation**

# Simulated Bid Price theory

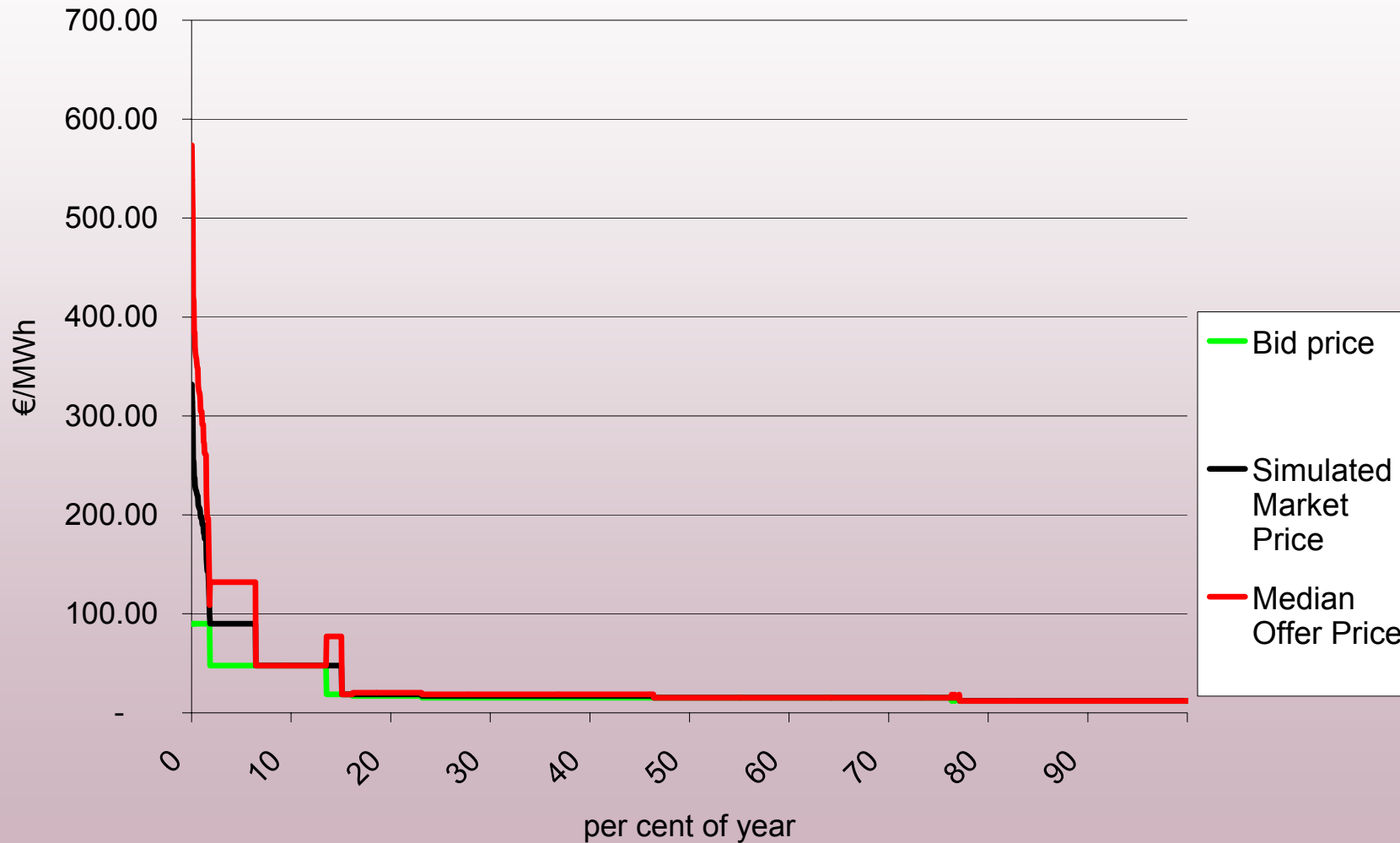
- **Consistency with the Simulated Market Price**
- **Bid prices around avoided costs**
  - **Liquid market in de-loading plant**
  - **Bid prices just below plant variable cost for small reduction in output**
  - **Prices for reduction below level where supplemental fuel needed will be lower**
  - **Price to reduce below Minimum Stable Generation to include cost of minimum off time**
    - **Price can go negative**

# Simulated Offer Price theory

- **Generator has choice**
  - **Sell at market price, or**
  - **Withhold same capacity for Balancing Mechanism**
- **Withheld capacity has risk of non-use**
  - **Need for compensation for risk of no contribution to fixed costs**
  - **If 50% probability of not being accepted in BM then mark-up price is:**

**Market Price plus (Market Price minus Variable Cost)**

# Price duration curves



# Offer prices at lower output levels

- **Start-up from zero must cover start-up costs as well**
  - Unlikely to be needed unless large volume of energy needed for some time
  - Lack of firm data so initial assumption of three times variable cost to cover this
- **Ramp-up from Minimum Stable Generation**
  - Increased output is cheaper because less masut needed
  - Price is therefore no higher than normal Offer Price

# Simulated Bid and Offer Price Schedules

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- **Schedule for each Regulated Generator**
- **Schedule for each season**
- **Bid and Offer Prices to be submitted are based on day ahead demand forecast for each hour**
- **Interconnectors and other parties free to offer at unregulated prices**

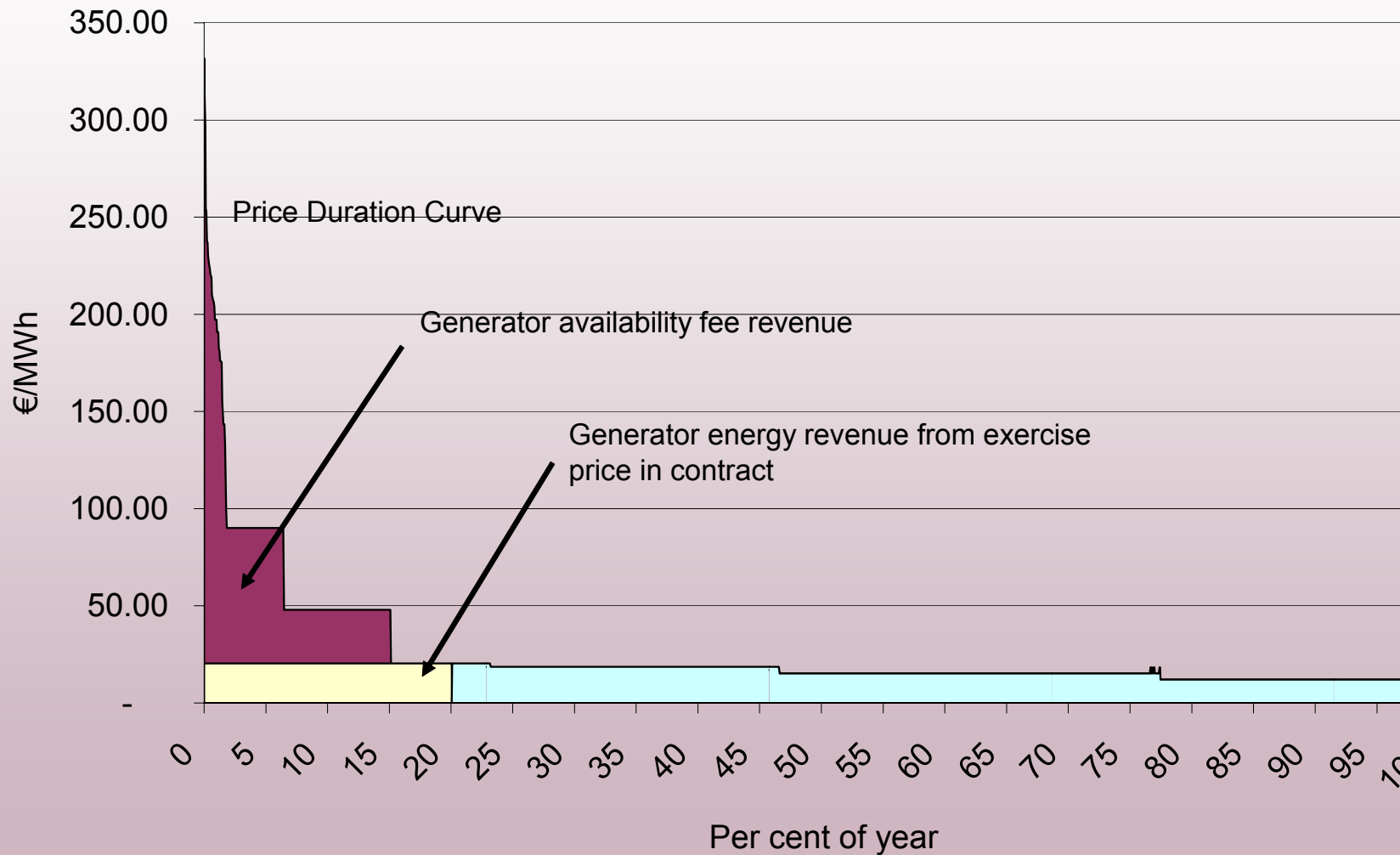
# Interrupted supply

- **Public supplier has requirement to request TSO interrupt if it cannot afford imports**
  - **Otherwise, TSO must accept Offers in the Balancing Mechanism with Public Supplier facing imbalance**
- **Interruption could interrupt distribution-connected Eligible Customer**
  - **ERO must set a regulated price for this interruption in the form of a deemed Offer from the relevant supplier**
- **Deemed Offer from Public Supplier (at zero price) to avoid appearance of imbalance**

# Secondary and tertiary reserve contracts

- **Form of contract is:**
  - **An availability fee covering some of fixed costs**
  - **An exercise price covering variable cost and remaining fixed cost**
  - **Exercise price paid when generator used via an Offer Acceptance**
- **Availability fee to be recovered partly in the market as a mark-up over the exercise price**
  - **This avoids over-use of reserve**
  - **Price of reserve should be based on a median (i.e. 50% acceptance probability) mark-up over Simulated Market Price**

# Reserve valuation example



# Capacity Availability Certificates – required security margin

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- UCTE standards – suggests 300 MW
- Most markets want 20%-25%
- Path to reach that margin
  - 2.5% growth per year starting at 2006 peak demand level

# CACs – value of peak capacity

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- **Based on fixed costs of maintaining the marginal capacity required**
  - **Units of Kosovo A**
- **Simulation of a marginal price for the last MW using a formula related to the square of capacity above normal peak capacity relative to the sum of squared dispatch through the year**

# Big assumption

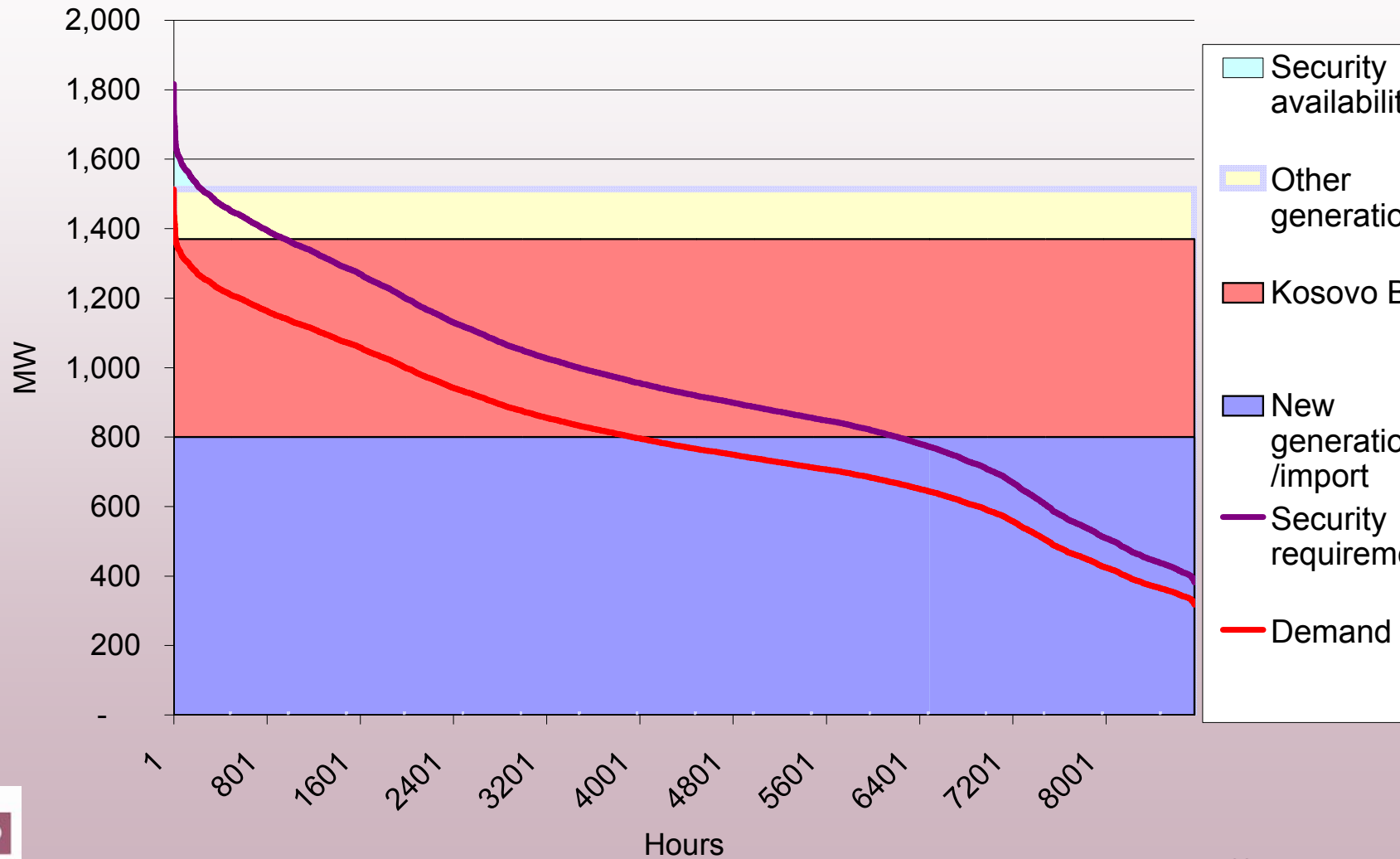
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- **What is normally available capacity level?**
- **Must assume new build (else why would we have CACs at all?)**
- **Must assume sufficient capacity to meet a forecast peak – remainder exported**

# The assumptions used

	Unit	2007	2008	2009	2013	2015	2017
<b>Generator Declared Capacity</b> ( $GDC_a$ )							
Kosovo A1	MW	35	35	35	0	0	0
Kosovo A3	MW	110	110	110	110	110	110
Kosovo A4	MW	150	150	150	150	150	150
Kosovo A5	MW	155	155	155	155	155	155
Kosovo B1	MW	285	285	285	285	285	285
Kosovo B2	MW	285	285	285	285	285	285
Ujmani	MW	32	32	32	32	32	32
Kosovo C/Net Imports	MW	0	0	0	560	690	800
<b>Total</b>	<b>MW</b>	<b>1,052</b>	<b>1,052</b>	<b>1,052</b>	<b>1,577</b>	<b>1,707</b>	<b>1,817</b>
<b>Maximum-sized generation unit</b>		285	285	285	285	285	285
Maximum Available to Competitive Market	MW	0	0	0	560	690	800
maximum for calculation	( $GDC_{MAX}$ ) MW	0	0	0	285	285	285
<b>Maximum Capacity Margin Requirement</b>		1.200	1.200	1.200	1.215	1.201	1.200
Capacity Margin Requirement limited by uplift	( $ATMN$ )	1.025	1.051	1.077	1.189	1.201	1.200
Capacity Peak Demand	( $ATD$ ) MW	1,083	1,120	1,158	1,324	1,416	1,514
Capacity Requirement at peak	( $ATREQ_{PEAK}$ ) MW	1,110	1,177	1,247	1,574	1,701	1,816
<b>Capacity to be financed</b>		58	125	195	412	409	414
Units to be held available							
Kosovo A1	MW	35	35	35	0	0	0
Kosovo A3	MW	23	90	110	110	110	110
Kosovo A4	MW	0	0	50	150	150	150
Kosovo A5	MW	0	0	0	152	149	154
Fixed costs of units to be financed							
Kosovo A1	€m	2.2	2.2	2.2	0.0	0.0	0.0
Kosovo A3	€m	2.8	10.6	12.9	12.9	12.9	12.9
Kosovo A4	€m	0.0	0.0	6.1	18.2	18.2	18.2
Kosovo A5	€m	0.0	0.0	0.0	21.6	21.1	21.9
<b>Total</b>	( $CYTOT$ ) €m		12.8	21.3	52.7	52.2	53.0
<b>Derived variables</b>							
Normal Dispatched Capacity	( $NDC$ ) MW	907	907	757	1,162	1,292	1,402
Megawatts Security Capacity at peak	( $MWSEC_{PEAK}$ ) MW	203	270	490	412	409	414
<b>Capacity Scaling Factor</b>	( $ATSCALAR$ )				<b>0.06898</b>	<b>0.06898</b>	<b>0.06898</b>
<b>Capacity Penalty Reference Price</b>	( $PCMAX$ ) €/MW				<b>4394.92</b>	<b>4074.43</b>	<b>3869.04</b>

# Example forecast year



# Model results

- **Modelled for projections of 2013, 2015 and 2017**
- **Peak penalty prices are:**
  - **€4,395    €4,074    €3,869**
  - **Averaged as €4,113/MW/hour**
- **Based on costs used in Simulated Market Price and so provisional**
- **But long-term security price so single price to be used for five years or so**

# CAC Penalty payments formula

If the **Capacity Imbalance Total** is less than or equal to zero in **Settlement Period “j”** then the **Capacity Penalty ( $PC_j$ )** will be derived from the formula:

$$PC_j = ATSCALAR * PCMAX * (ATREQ_j - ATD)^2$$

where:

the **Capacity Penalty Reference Price ( $PCMAX$ )** which is expressed in €/MW/hour and is recorded in the Schedule to **Regulatory Annex 3**;

**Capacity Peak Demand ( $ATD$ )**, which is the predicted highest level of offtake (adjusted for losses) in MW and is recorded in the Schedule to **Regulatory Annex 3**;

the **Capacity Scaling Factor ( $ATSCALAR$ )**, which is a calculated factor to be applied to any calculation of **Capacity Penalty** in order seek to recover the assessed value of security of supply and is recorded in the Schedule to **Regulatory Annex 3**; and

the **Capacity Requirement ( $ATREQ_j$ )** which is derived from:

$$ATREQ_j = ATMN * \sum_{z=1} \sum_{a=1} QESU_{zaj} / TLF_j$$

where:

$ATMN$  is the **Capacity Margin Requirement**, which is defined by the **Regulator** and recorded in the Schedule to **Regulatory Annex 3**;

$QESU_{zaj}$  is **Supply Unit Metered Energy**;

“z” is any **Distribution Zone** that is not an **Interconnector** (being used as a deemed **Distribution Zone** for **Settlement** purposes);

“a” is any demand-side **Metering System** that is not an **Interconnector** and is not an **Embedded Generator** or an **Auto-producer** with **Generator Declared Capacity** in the **Capacity Register**; and

$TLF_j$  is the **Transmission Loss Factor (TLF)** applying in the **Settlement Period**.

# Purpose of CAC

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- **CACs will stimulate Security of Supply**
  - It pays fixed costs of oldest generating units
  - It guarantees an income to refurbished Kosovo A units
- **Modelling suggests about €50m per year will be spent on CACs**
- **Contribution to finance of new build**
  - Not sufficient by itself
  - Reliance on operation at base load with lower variable costs

# Concluding remarks

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- **Need to stress link to information received from price review**
  - **These prices will change over the course of 2006 but will then be stable**
- **These Annexes are transitional**
  - **When competition is sufficient, prices will be set in a competitive market**
- **Annexes are there to start the market because prices are so important**