

TOMA DE DECISIONES BAJO INCERTIDUMBRE EN MERCADOS ELÉCTRICOS

CLASE 2: “INTRODUCCIÓN A LOS MERCADOS ELÉCTRICOS”

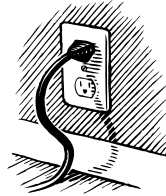
JUAN MIGUEL MORALES
SALVADOR PINEDA



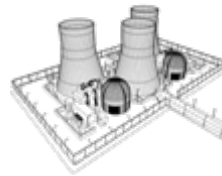
DTU Electrical Engineering
Department of Electrical Engineering

WHAT IS A MARKET?

- PEOPLE NEED CERTAIN PRODUCTS



- PEOPLE CAN PRODUCE SUCH PRODUCTS



- PLACE TO TRADE THE PRODUCTS



?

WHY IS PACO LATE?

- Because he went to **Mercadona** to buy **1 kilo of rice (from Italy)**. He is planning to cook a delicious risotto on his electric cooktop

WHY IS PACO LATE?

- Because he went to **Mercadona** to buy **1 kilo of rice (from Italy)**. He is planning to cook a delicious risotto on his electric cooktop
- Because he went to the **electricity market** to buy **1 kW of electricity (from green energy)**. He is planning to cook a delicious risotto on his electric cooktop

MORE THAN A LAME EXCUSE...

- He went to the **electricity market**...
 - Where is it? Is there such a “physical” place?



Electricity **cannot be**
confined or **stored**
(in large quantities)

- Production and consumption equal at any time!

MORE THAN A LAME EXCUSE...

- ...to buy **1 KW of electricity** (as opposed to “buy 1 kilo of rice”)

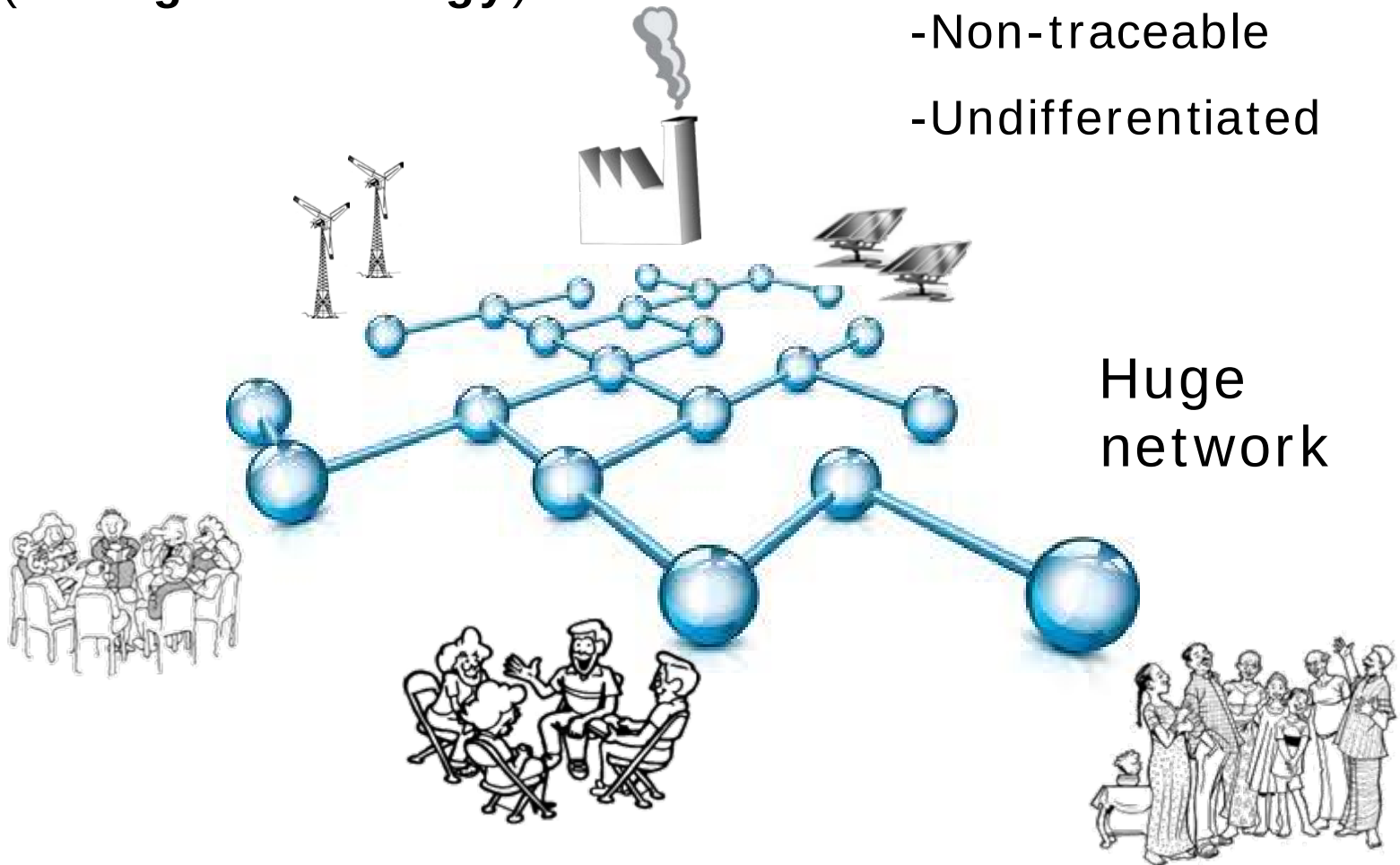


Many very basic needs:
electricity demand is
inelastic and not easy
to estimate

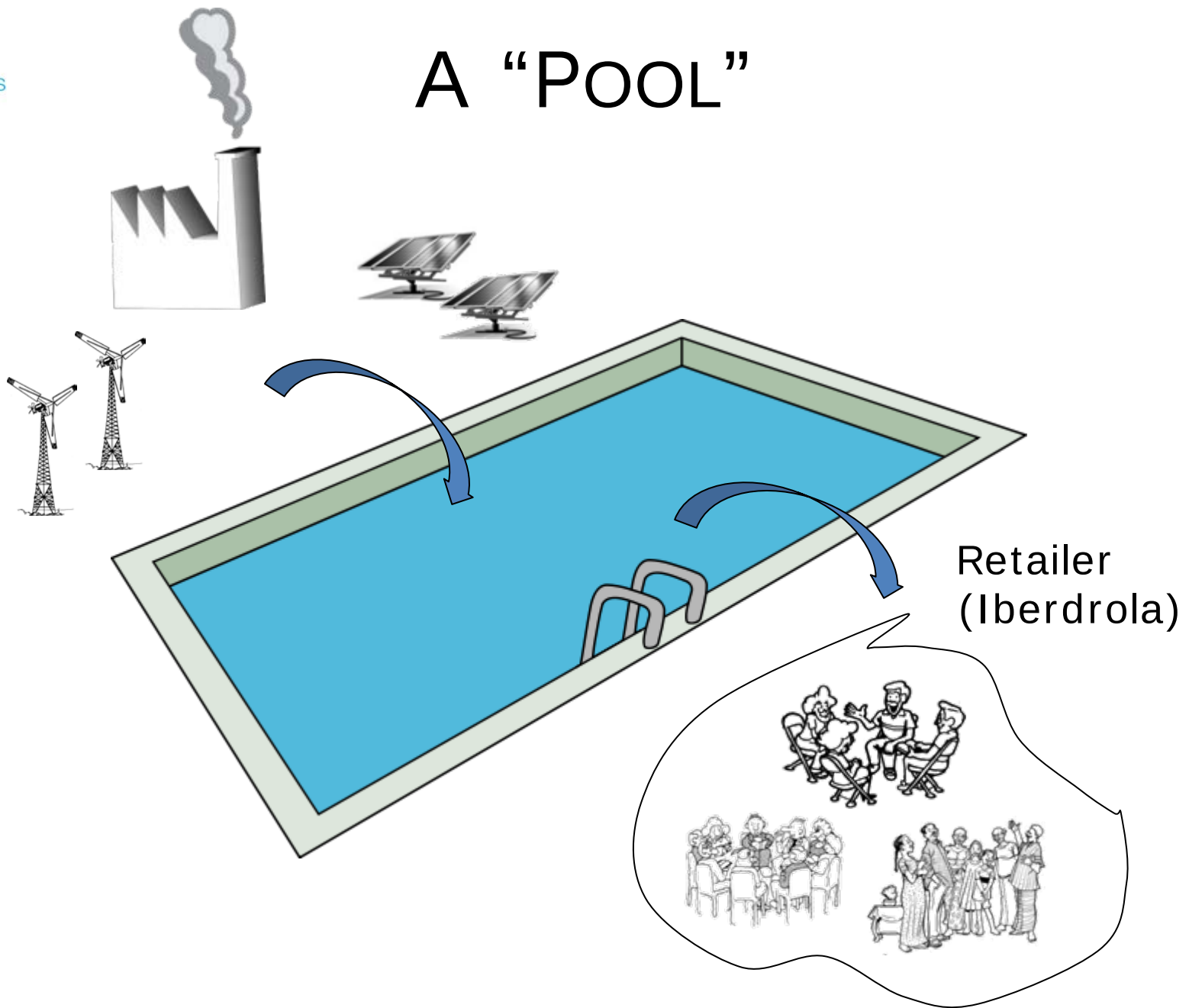
MORE THAN A LAME EXCUSE...

- ... (from **green energy**).

-Non-traceable
-Undifferentiated



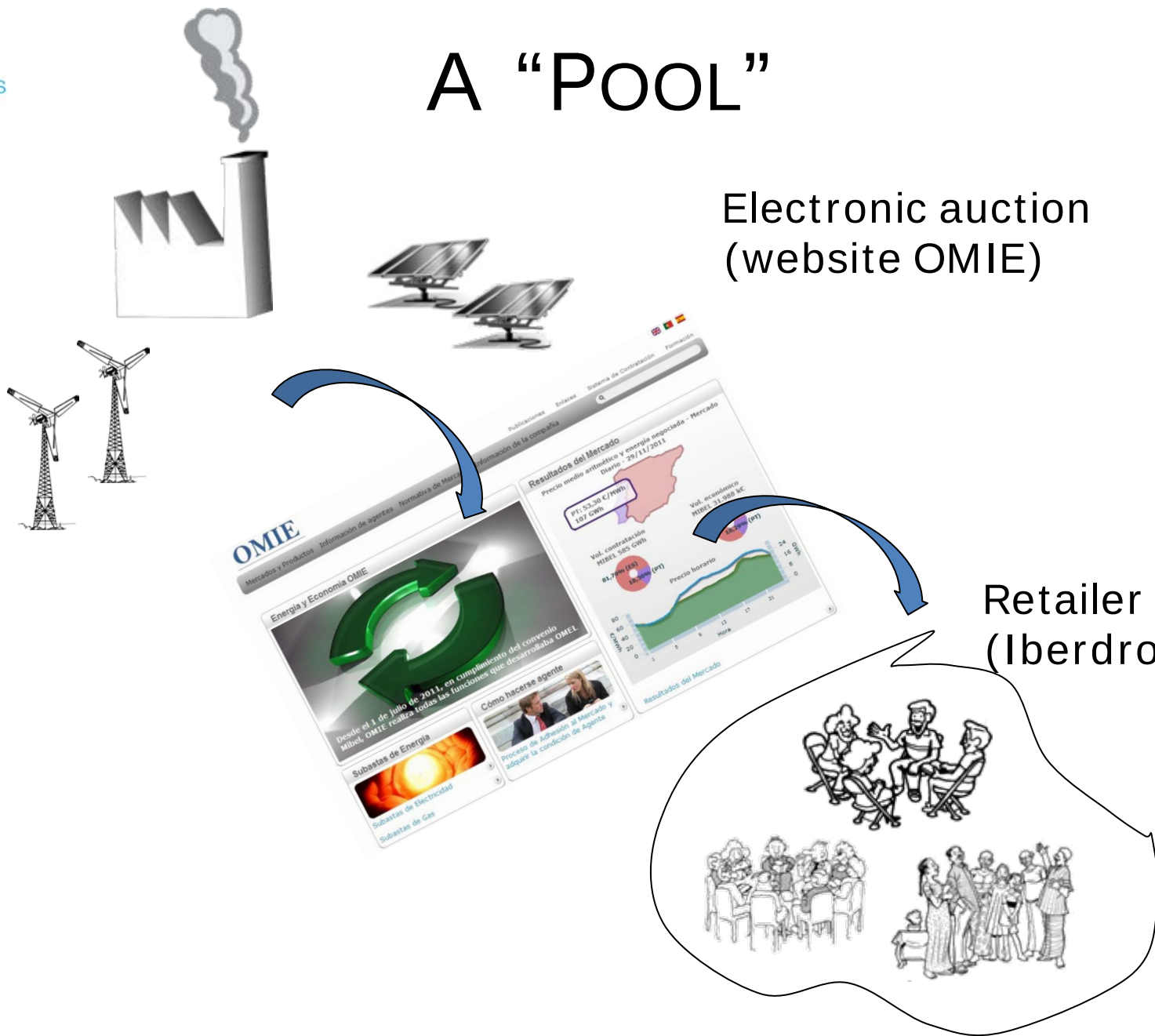
A "POOL"



A "POOL"

Electronic auction
(website OMIE)

Retailer
(Iberdrola)



REWORD PACO'S EXCUSE

- Because he surfed on **OMIE** to buy **1 MW of electricity** for his customers. He works for Iberdrola

KEY CONCEPTS

- An electricity market is an organizational structure that allows buyers and sellers to exchange electricity for money

KEY CONCEPTS

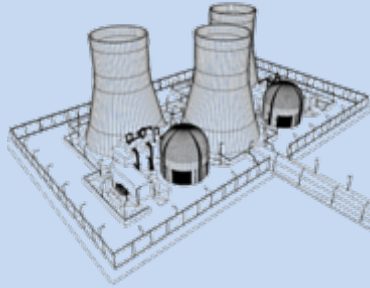
- Characteristics of the product:
 - Electricity **cannot be stored** (consumption and production equal at any time)
 - Electricity flows on the grid are governed by **Kirchhoff's Laws**
 - Electricity demand is highly **inelastic**

KEY CONCEPTS

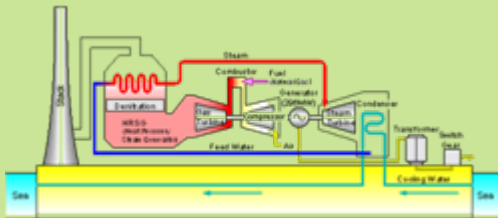
- An electricity market is an organizational structure that allows buyers and sellers to exchange **electricity** for money.
- Market participants consist of all the **buyers** and **sellers** of electricity.

KEY CONCEPTS

- Characteristics of the players:



- Large fuel-based units (economy of scale)
- Technical constraints (required a schedule)
- Far from consumption centers (transmission)
- Inflexible, but often cheap



- Medium-size gas-based units (low capital costs)
- Not necessarily far from big load pockets
- Flexible, but usually expensive

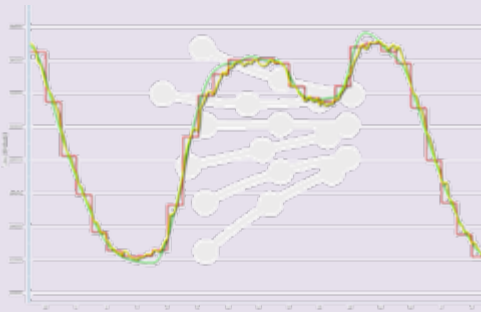
KEY CONCEPTS

- Characteristics of the players:

<http://www.greenrhinoenergy.com/renewable/context/economics.php>



- “Fossil-free” generation technologies
- Non-dispatchable and limited predictability
- Distributed generation



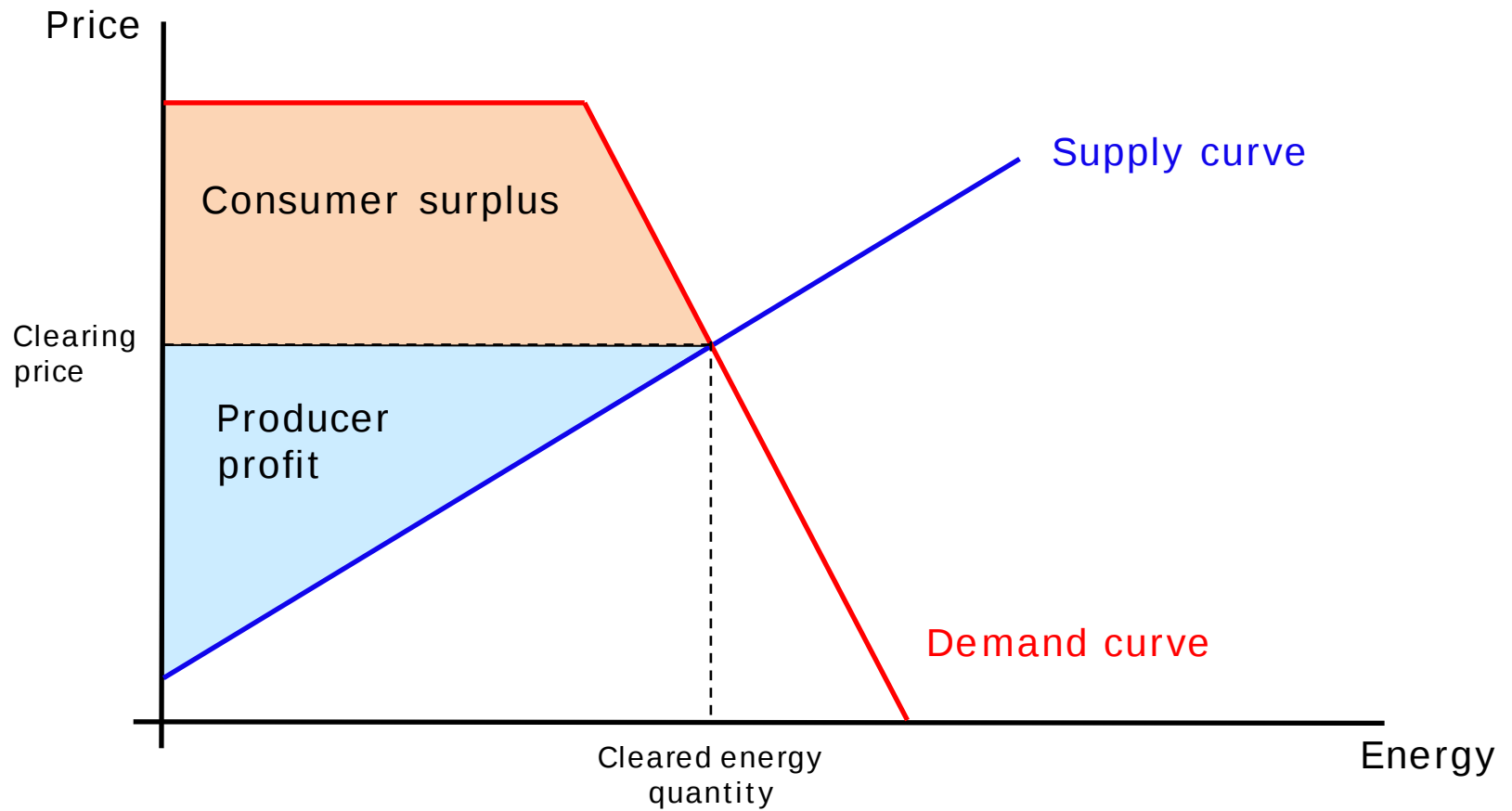
- Total demand is highly predictable
- Known daily, weekly, and yearly patterns
- Industrial consumers (partially flexible)
- Residential consumers (represented by retailers)
- Overall highly inelastic (Smart grids revolution?)

KEY CONCEPTS

- An electricity market is an organizational structure that allows buyers and sellers to exchange **electricity** for money.
- Market participants consist of all the **buyers** and **sellers** of electricity.
- The market **allocates** electricity among players and allows it to be **priced**.

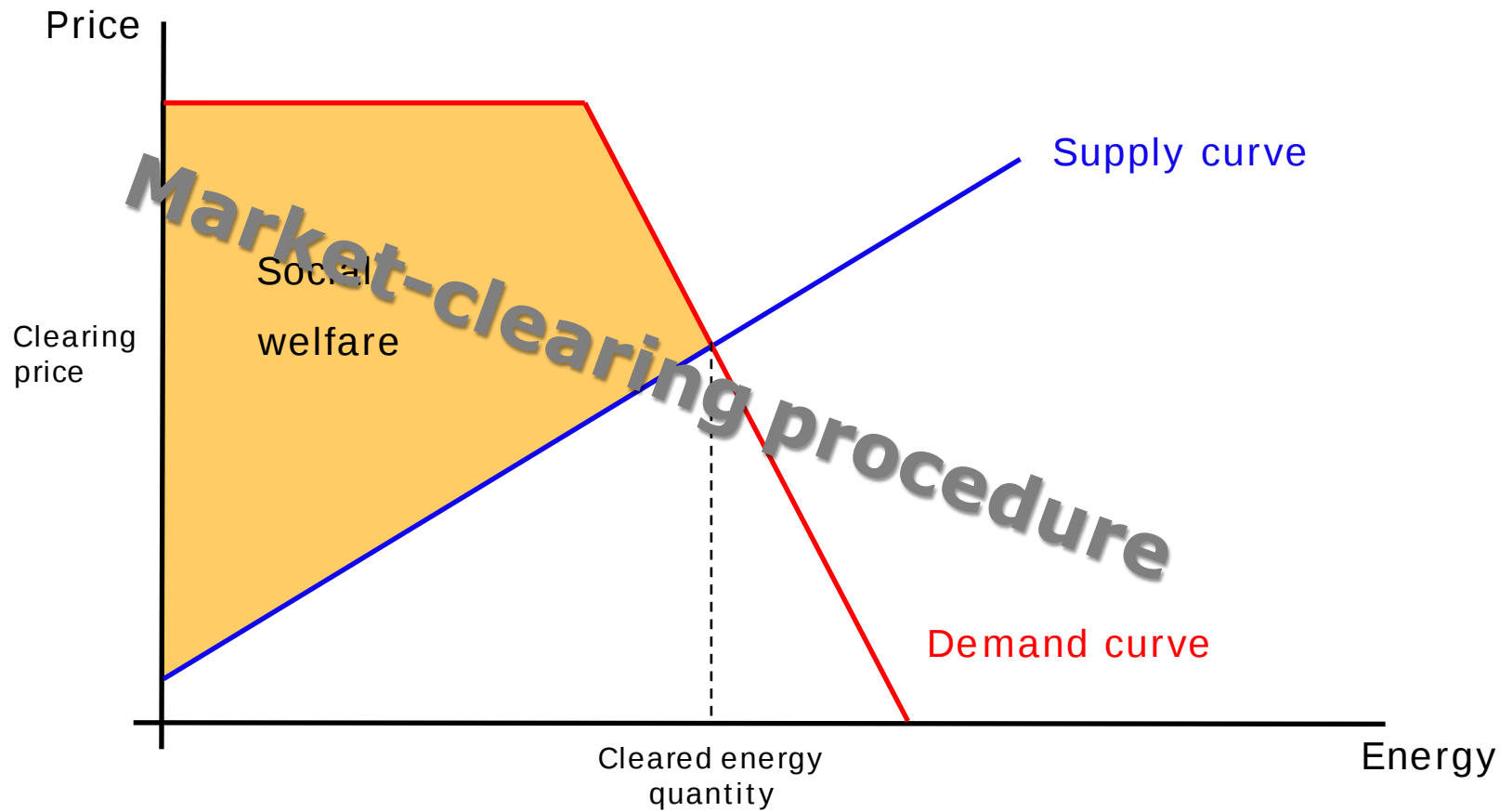
KEY CONCEPTS

- Social welfare:



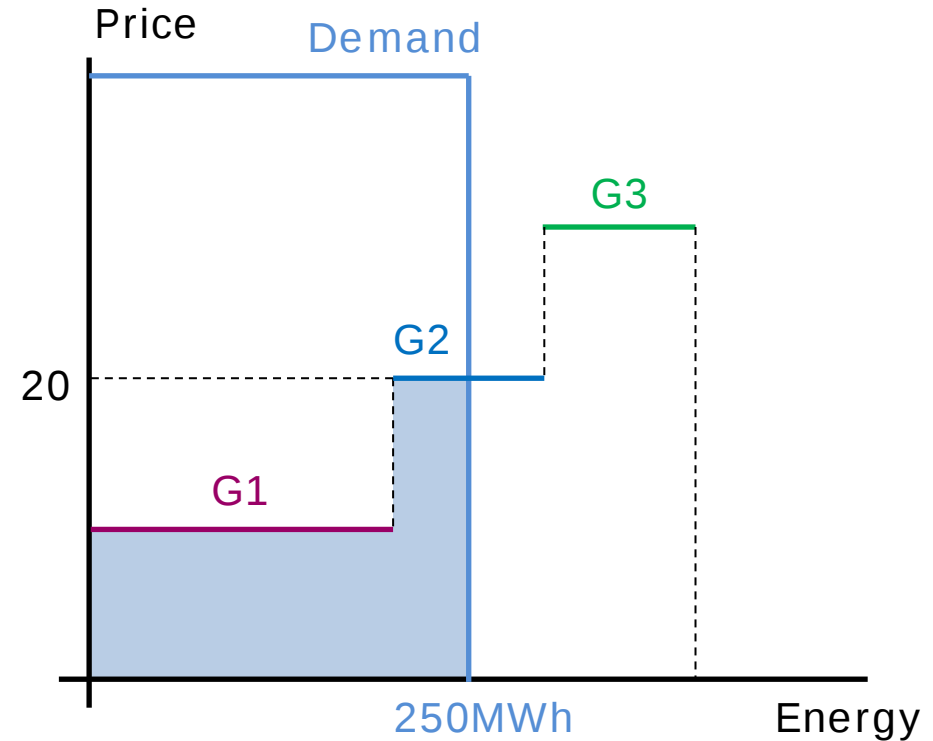
KEY CONCEPTS

- Social welfare:



MARKET-CLEARING PROCEDURE

TIME t			
UNIT	COST (€/MWh)	OFFERS (MWh@€/MWh)	DEMAND (MWh)
G1	5	200@10	250
G2	15	100@20	
G3	25	100@30	



MARKET-CLEARING PROCEDURE

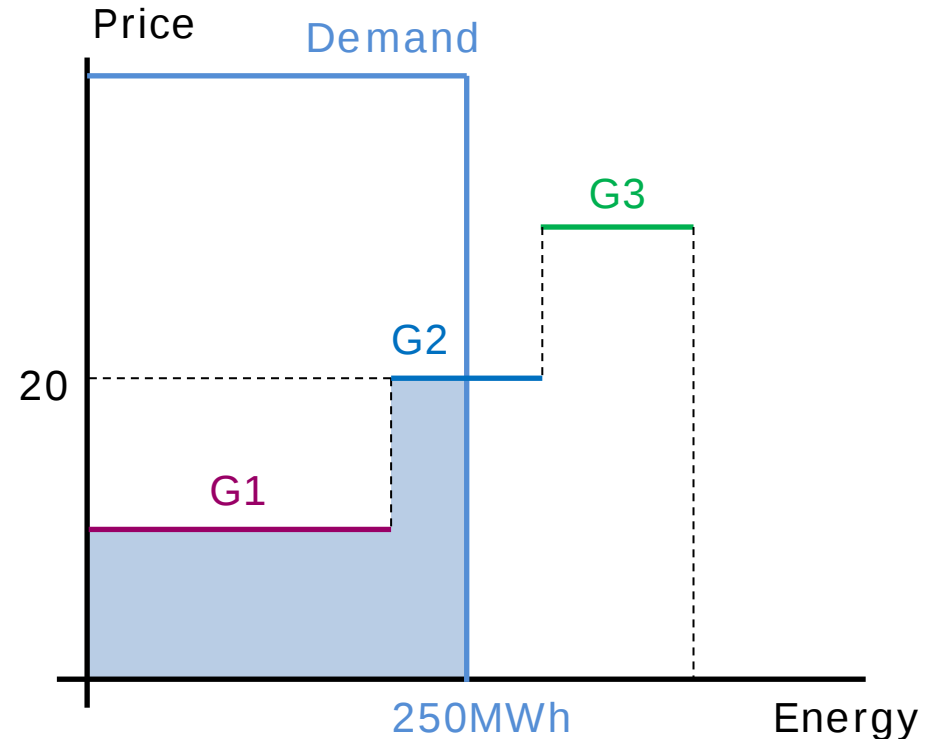
$$\text{DEMAND} = 250 \times 20 = 5000$$

$$G1 = 20 \times 200 = 4000$$

$$G2 = 20 \times 50 = 1000$$

THIS IS CALLED **MARGINAL PRICING**

IS “FAIR” THAT G1 IS PAID AT THE MARGINAL PRICE?



MARKET-CLEARING PROCEDURE

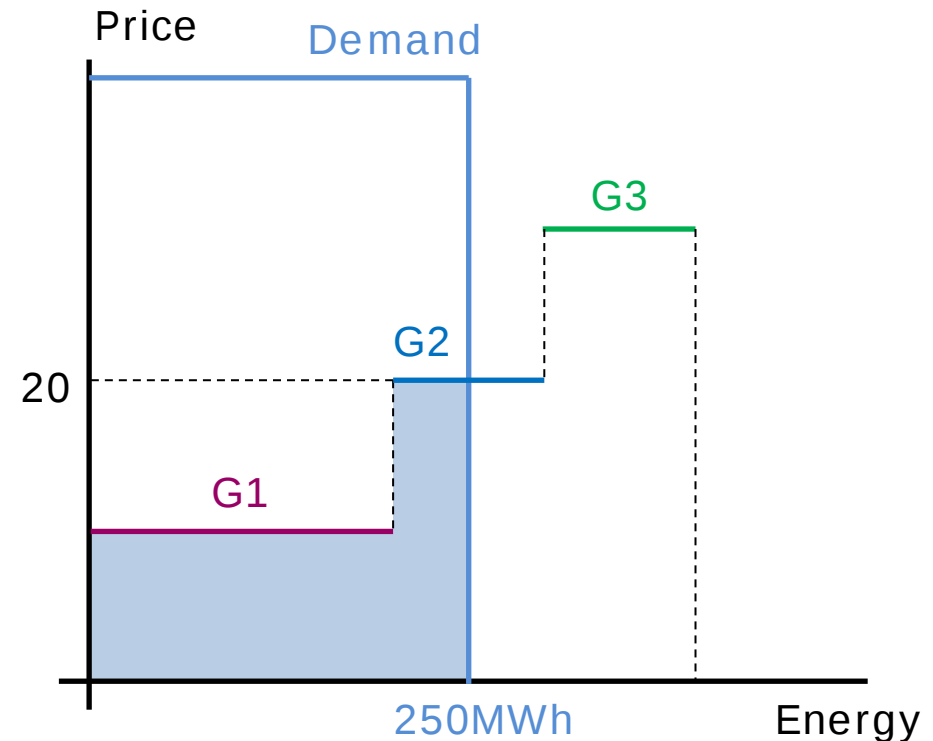
WHAT IF ACCEPTED OFFERS ARE
PAID-AS-BID?

$$\text{DEMAND} = 250 \times 20 = 5000$$

$$G1 = 10 \times 200 = 3000$$

$$G2 = 20 \times 50 = 1000$$

THE SYSTEM COLLECTS EXTRA MONEY

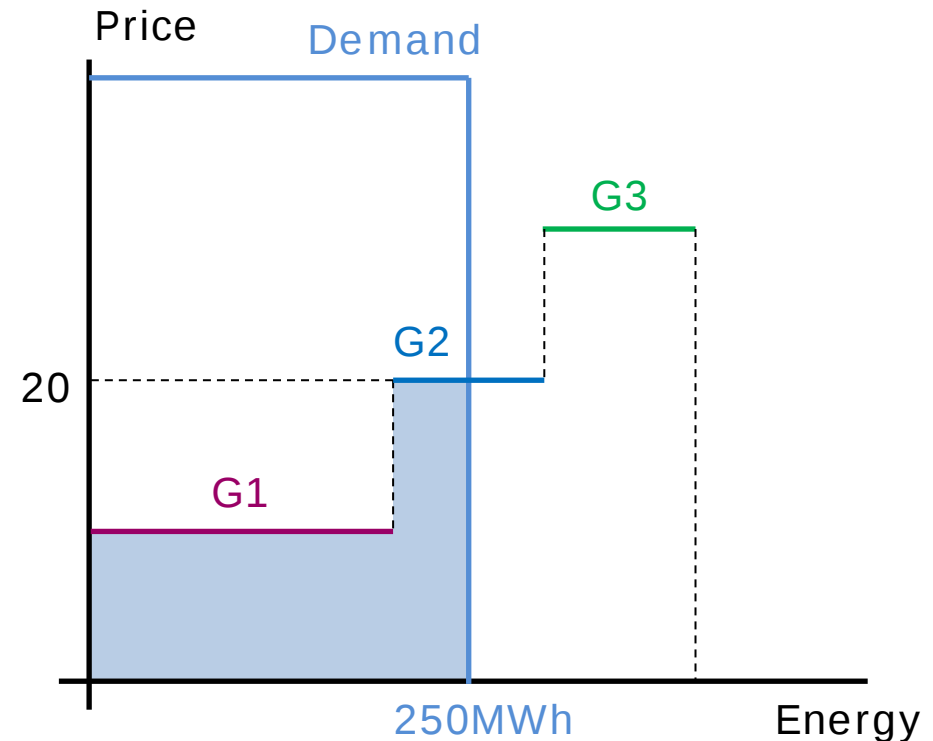


MARKET-CLEARING PROCEDURE

WHAT WOULD G1 DO?

G1 WOULD INCREASE ITS OFFER PRICE TO
MAKE MORE MONEY

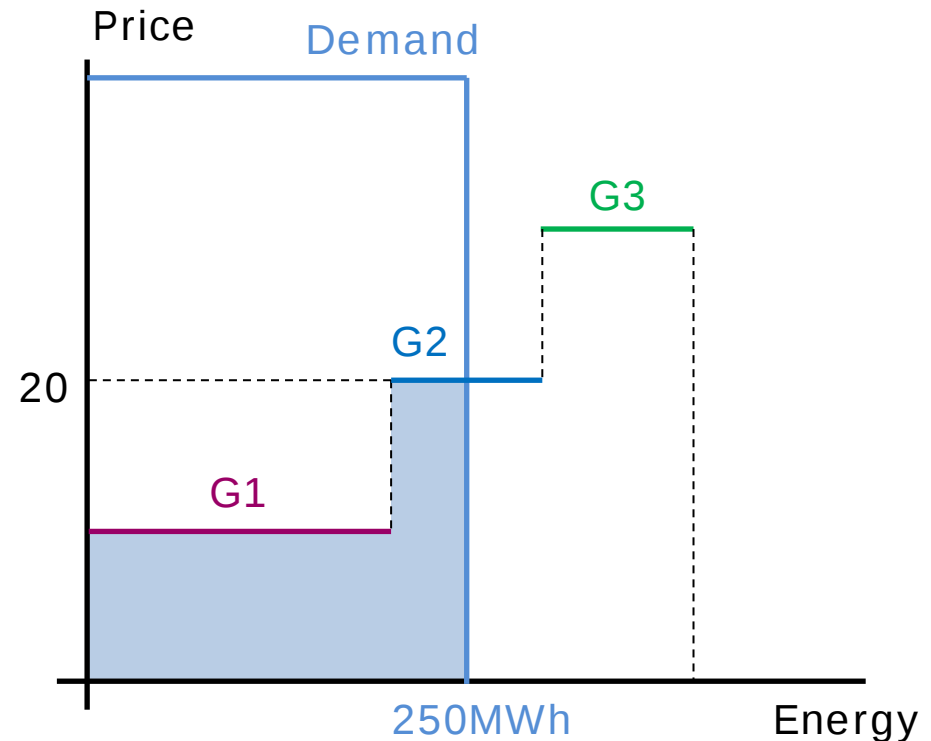
PLAYERS ARE ENCOURAGED TO **MARK-UP**
THEIR OFFER PRICES



MARKET-CLEARING PROCEDURE

TIME t			
UNIT	COST (€/MWh)	OFFERS (MWh@€/MWh)	DEMAND (MWh)
G1	5	200@10	250
G2	15	100@20	
G3	25	100@30	

MARGINAL PRICING ENCOURAGES PLAYERS
TO DECLARE THEIR MARGINAL COSTS

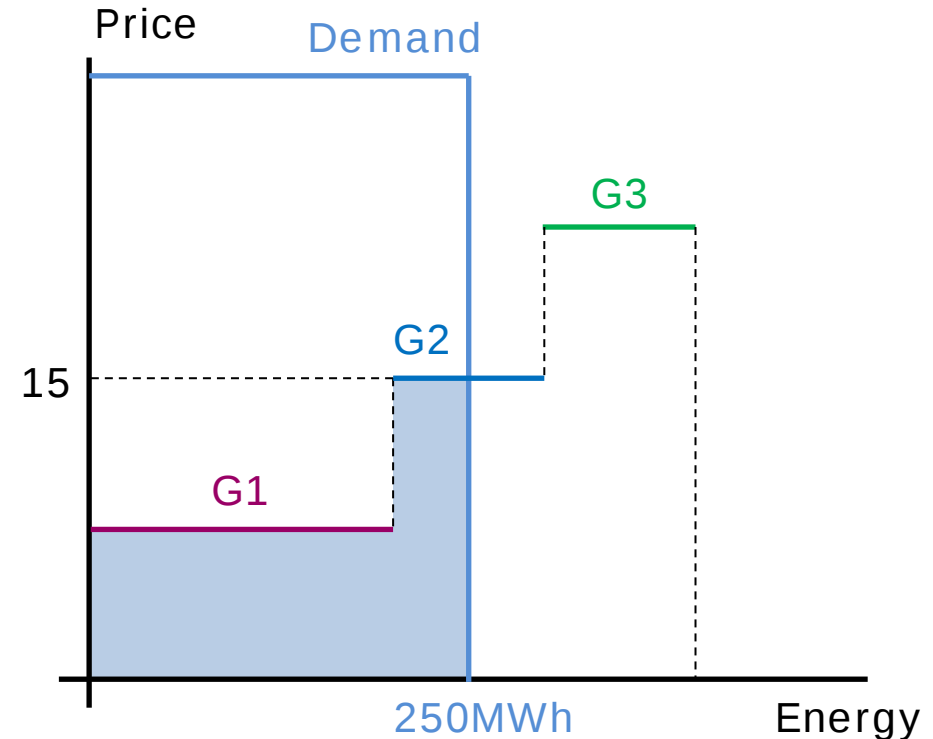


MARKET-CLEARING PROCEDURE

TIME t			
UNIT	COST (€/MWH)	OFFERS (MWH@€/MWH)	DEMAND (MWH)
G1	5	200@5	250
G2	15	100@15	
G3	25	100@25	

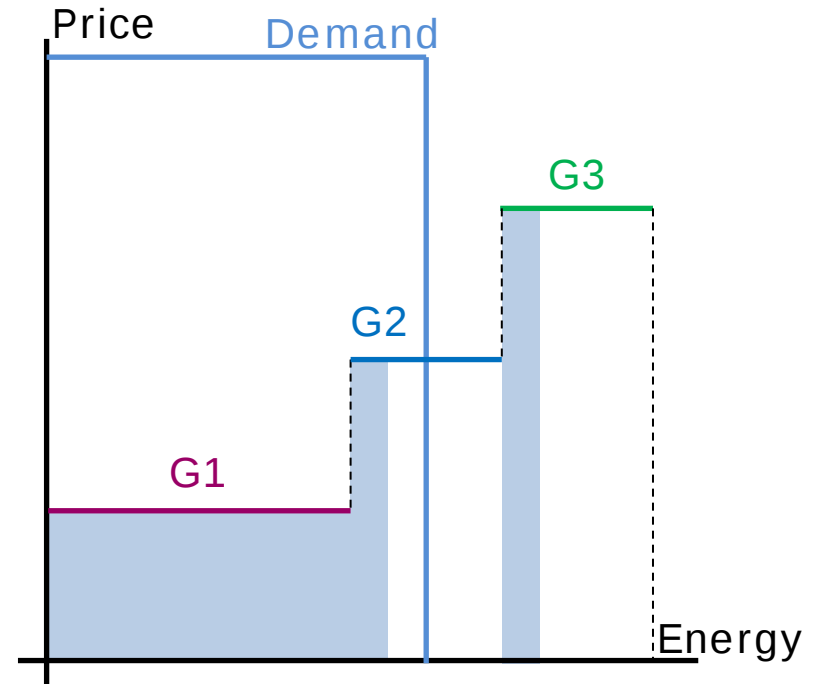
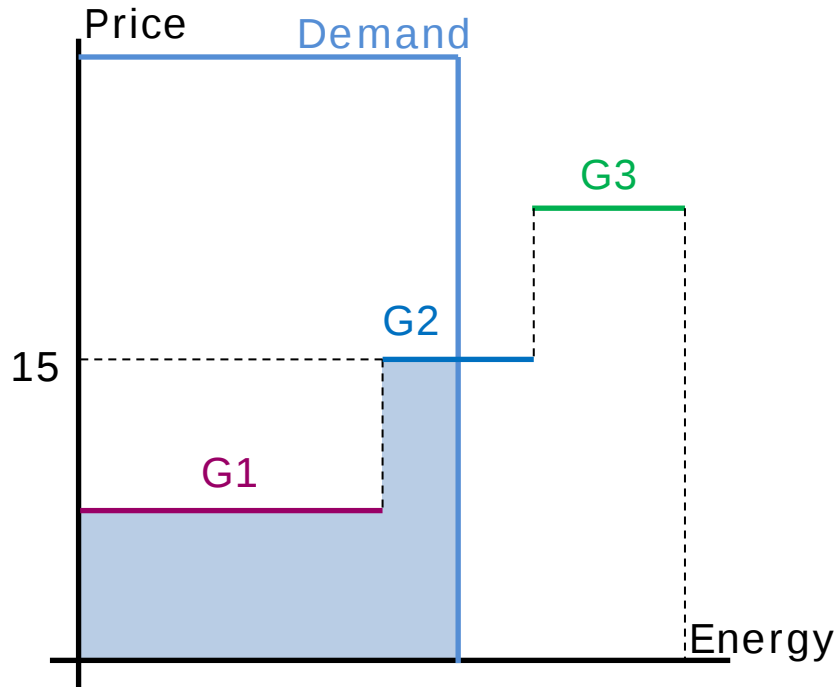
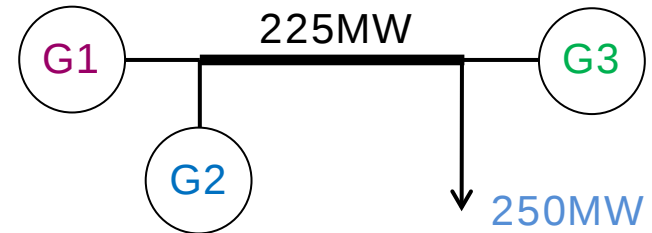
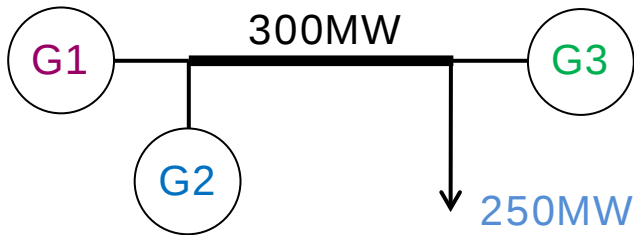
MARGINAL PRICING ENCOURAGES PLAYERS
TO DECLARE THEIR MARGINAL COSTS

DOES PAY-AS-BID INCREASE THE ELECTRICITY PRICE? NOT NECESSARILY, BUT IT MAY
JEOPARDIZE SYSTEM EFFICIENCY



MARKET-CLEARING PROCEDURE

- WHAT ABOUT THE NETWORK?



MARKET-CLEARING PROCEDURE

• WHAT ABOUT THE NETWORK?

WHAT SHOULD BE THE PRICE?

Price	G1	G2	G3
15	😊	😊	😞
25	😊	😞	😊
15/25	😊	😊	😊

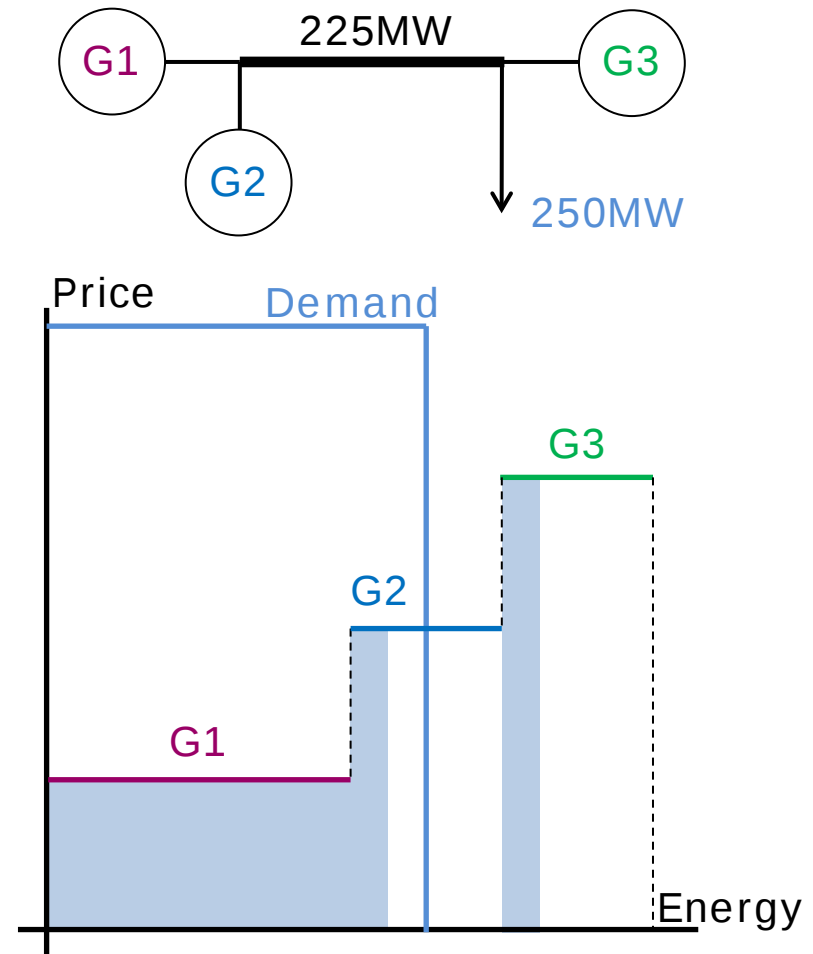
$$\text{Demand} = 250 \times 25 = 6250$$

$$G1 = 15 \times 200 = 3000$$

$$G2 = 15 \times 25 = 375$$

$$G3 = 25 \times 25 = 625$$

2250 extra!!



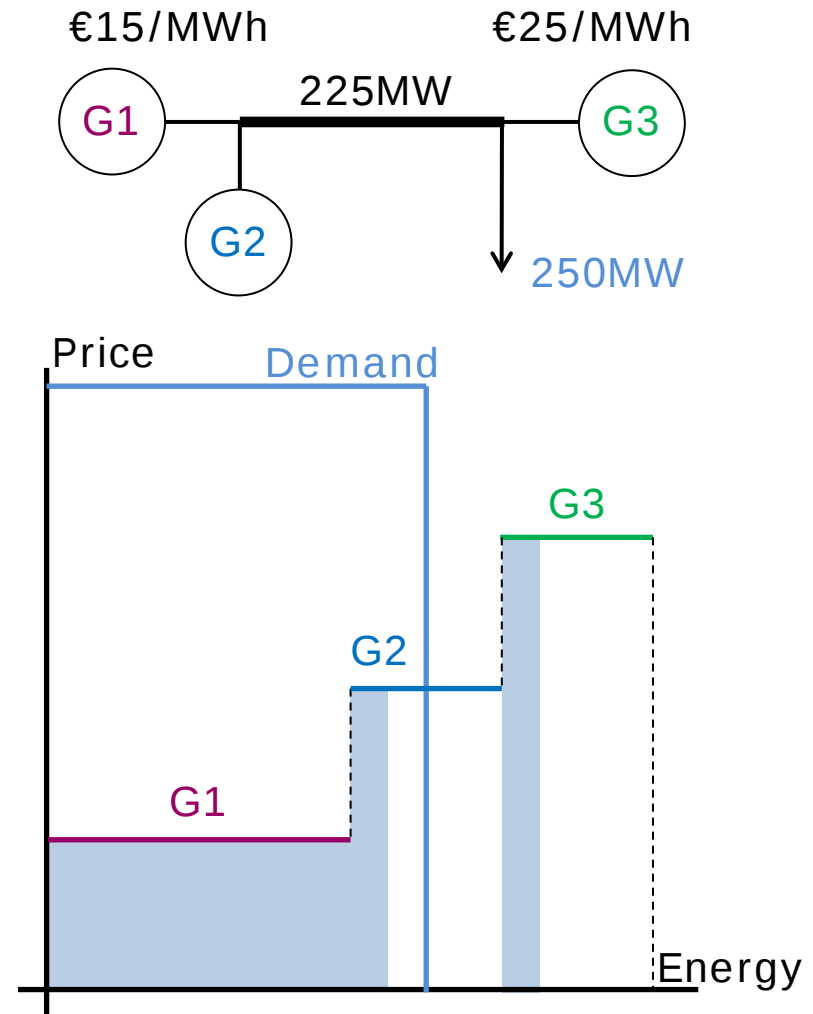
MARKET-CLEARING PROCEDURE

- WHAT ABOUT THE NETWORK?

WHAT SHOULD BE THE PRICE?

Price	G1	G2	G3
15			
25			
15/25			

Locational marginal prices (LMPs)

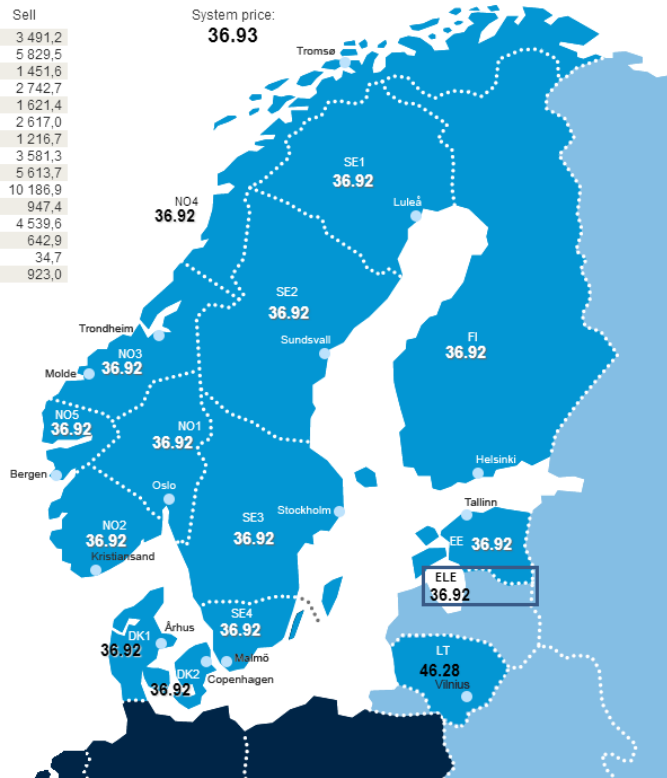


ZONAL PRICES

01-11-2012 Resolution 10 - 11 Currency EUR Capacities Flow Area Prices
ITVC ITVC

Eislot volumes

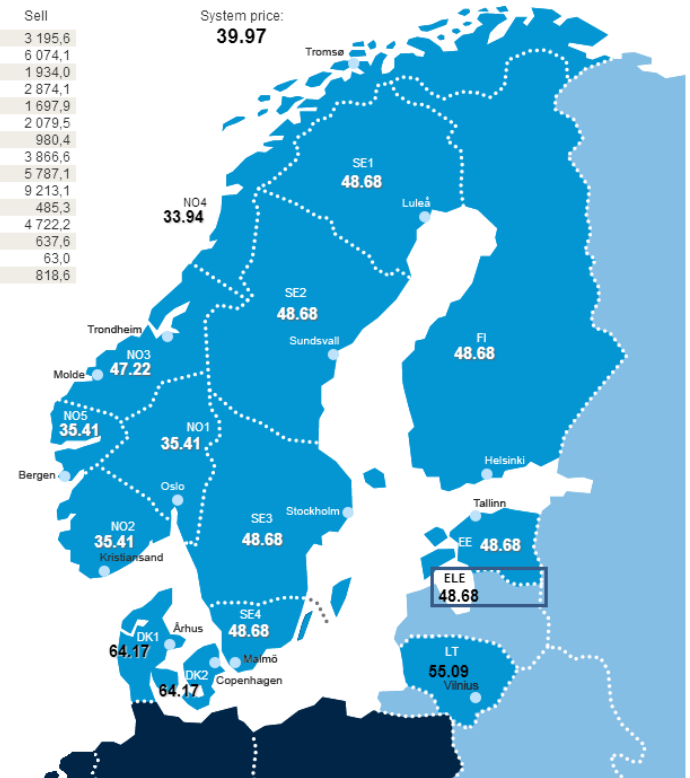
	Buy	Sell
NO1	5 241,4	3 491,2
NO2	4 405,9	5 829,5
NO3	2 430,0	1 451,6
NO4	2 218,5	2 742,7
NO5	1 715,8	1 621,4
DK1	3 083,2	2 617,0
DK2	1 720,9	1 216,7
SE1	1 270,6	3 581,3
SE2	1 675,2	5 613,7
SE3	10 732,2	10 186,9
SE4	3 100,5	947,4
FI	6 112,6	4 539,6
EE	333,4	642,9
ELE	476,4	34,7
LT	923,0	923,0



10-10-2012 Resolution 18 - 19 Currency EUR Capacities Flow Area Prices
ITVC ITVC

Eislot volumes

	Buy	Sell
NO1	4 141,1	3 195,6
NO2	3 876,6	6 074,1
NO3	2 134,0	1 934,0
NO4	1 824,1	2 874,1
NO5	1 419,9	1 697,9
DK1	3 439,5	2 079,5
DK2	2 280,4	980,4
SE1	1 206,4	3 866,6
SE2	1 709,4	5 787,1
SE3	10 524,0	9 213,1
SE4	3 968,4	485,3
FI	6 436,9	4 722,2
EE	315,7	637,6
ELE	334,1	63,0
LT	818,6	818,6



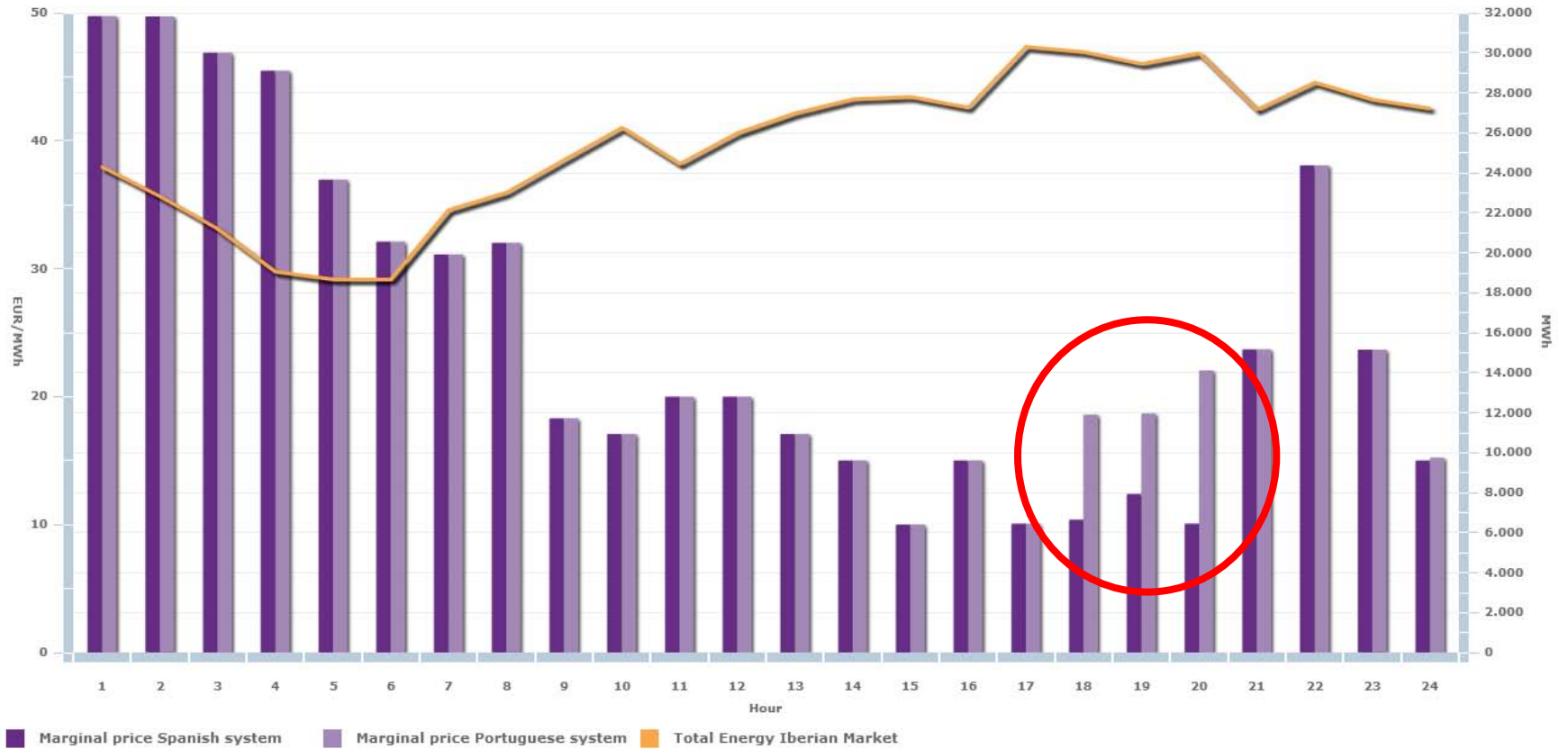
ZONAL PRICES

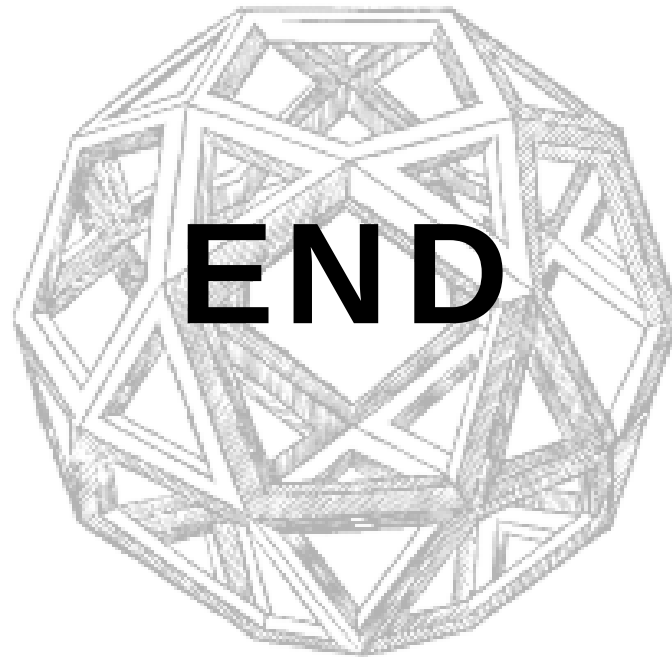
09/11/2012 - Daily market hourly price



ZONAL PRICES

27/10/2012 - Daily market hourly price





SPOT MARKETS

Day d-1

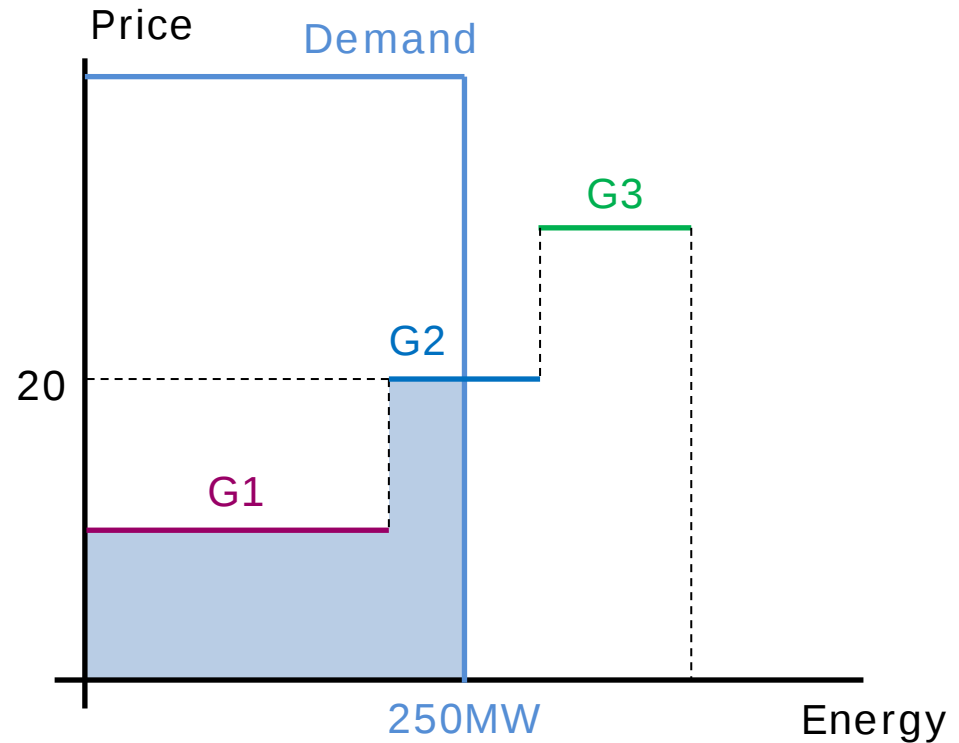
Day d



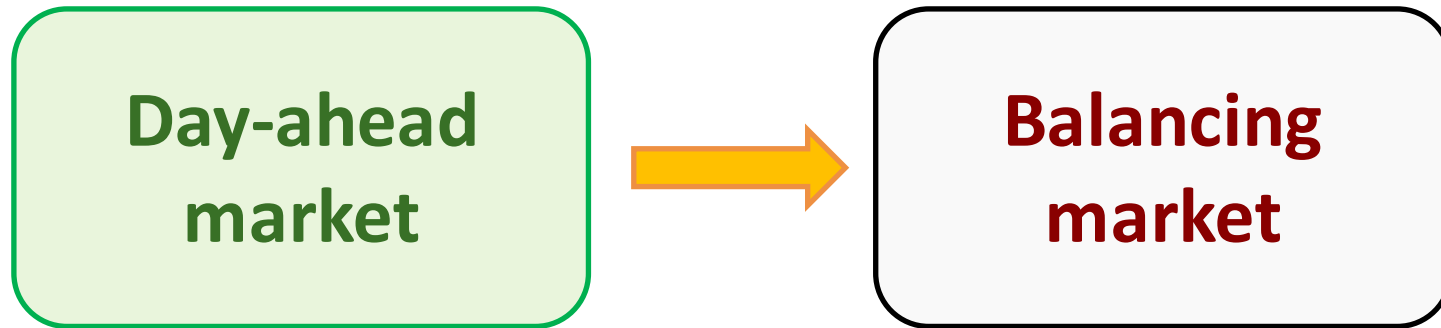
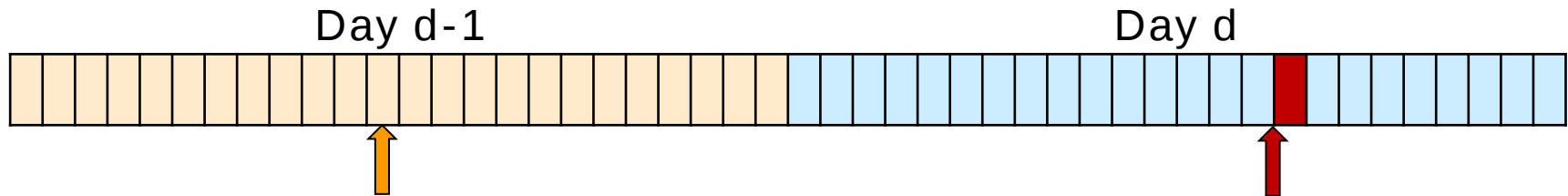
12 a.m.

4-5 P.M.

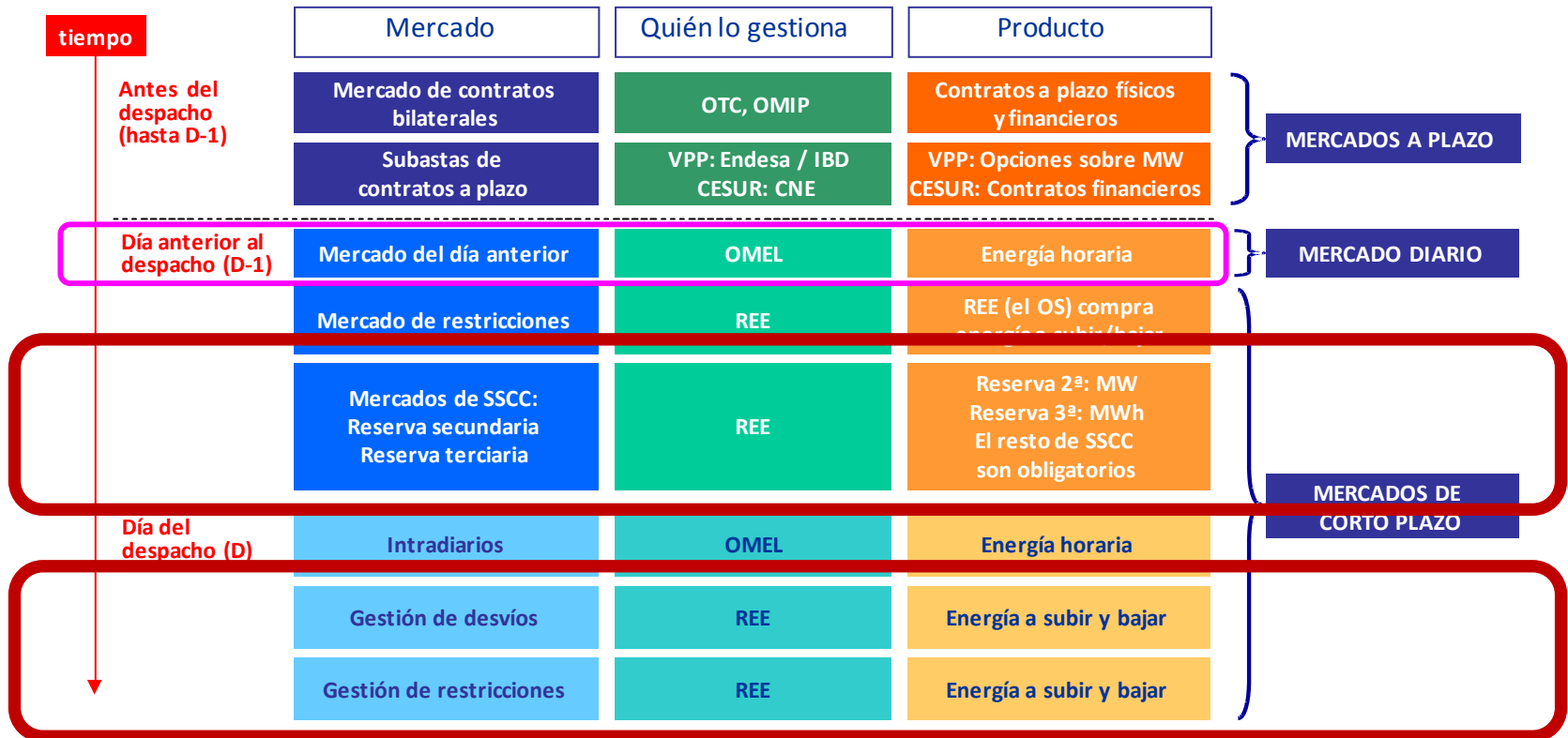
UNIT	COST	OFFERS	DEMAND
G1	5	200@10	250 MW
G2	15	100@20	
G3	25	100@30	



SPOT MARKETS

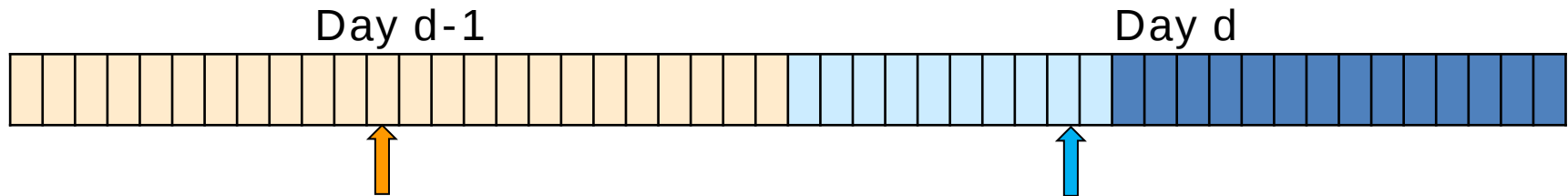


SPOT MARKETS



Balancing markets

SPOT MARKETS



**Day-ahead
market**



**Balancing
market**

Adjustment markets



SPOT MARKETS

tiempo	Mercado	Quién lo gestiona	Producto	
Antes del despacho (hasta D-1)	Mercado de contratos bilaterales	OTC, OMIP	Contratos a plazo físicos y financieros	MERCADOS A PLAZO
	Subastas de contratos a plazo	VPP: Endesa / IBD CESUR: CNE	VPP: Opciones sobre MW CESUR: Contratos financieros	
Día anterior al despacho (D-1)	Mercado del día anterior	OMEL	Energía horaria	MERCADO DIARIO
	Mercado de restricciones	REE	REE (el OS) compra energía a subir/bajar	MERCADOS DE CORTO PLAZO
	Mercados de SSCC: Reserva secundaria Reserva terciaria	REE	Reserva 2ª: MW Reserva 3ª: MWh El resto de SSCC son obligatorios	
Día del despacho (D)	Intradiarios	OMEL	Energía horaria	MERCADOS DE CORTO PLAZO
	Gestión de desvíos	REE	Energía a subir y bajar	
	Gestión de restricciones	REE	Energía a subir y bajar	

Adjustment (Intra-day) markets