

# **BLOWING IN THE WIND**

## **RENEWABLES – FOSSILS - TRADING**

Dipl.-Ing. Alois Tost

[tost@alois-tost.de](mailto:tost@alois-tost.de)

25.06.2012

-

- Principles of power trading
- Simulation game
- Sustainable energy / discussion

## ELECTRICITY AS A GOOD

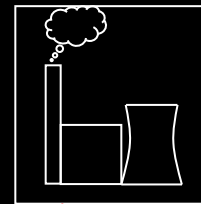
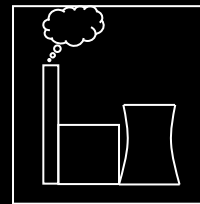
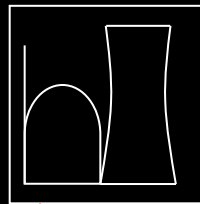
- commodity
- without transfer limitations
- no possibility for storage



# PRICE FORMATION OF ELEKTRICITY

hourly production: 1500 MWh 1200 MWh 1000 MWh

variable cost: 6 €/MWh 20 €/MWh 40 €/MWh



hourly demand: 1000 MWh 1000 MWh 1000 MWh

# DISTRIBUTION OF COMMODITIES

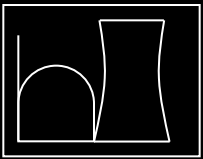
## ➤ dilemma of division

- everybody wants to buy from the cheapest supplier
- the cheapest supplier cannot satisfy the entire demand

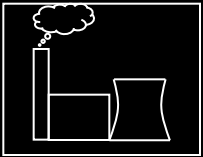
## ➤ two solutions

1. Every consumer pays the price of the most expensive supplier, who is still necessary to satisfy the demand  
→ (marginal price principle)
2. Every supplier is paid by his price - electricity is sold at average price  
→ (pay-as-bid principle)

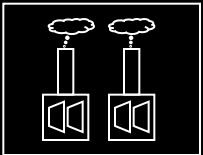
# CONVENTIONAL POWER PLANTS



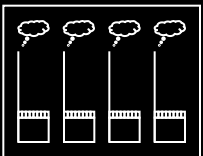
**NUCLEAR**



**COAL**



**COMBINED CYCLE**



**GAS ENGINE**

# MERIT ORDER: PRINCIPLE

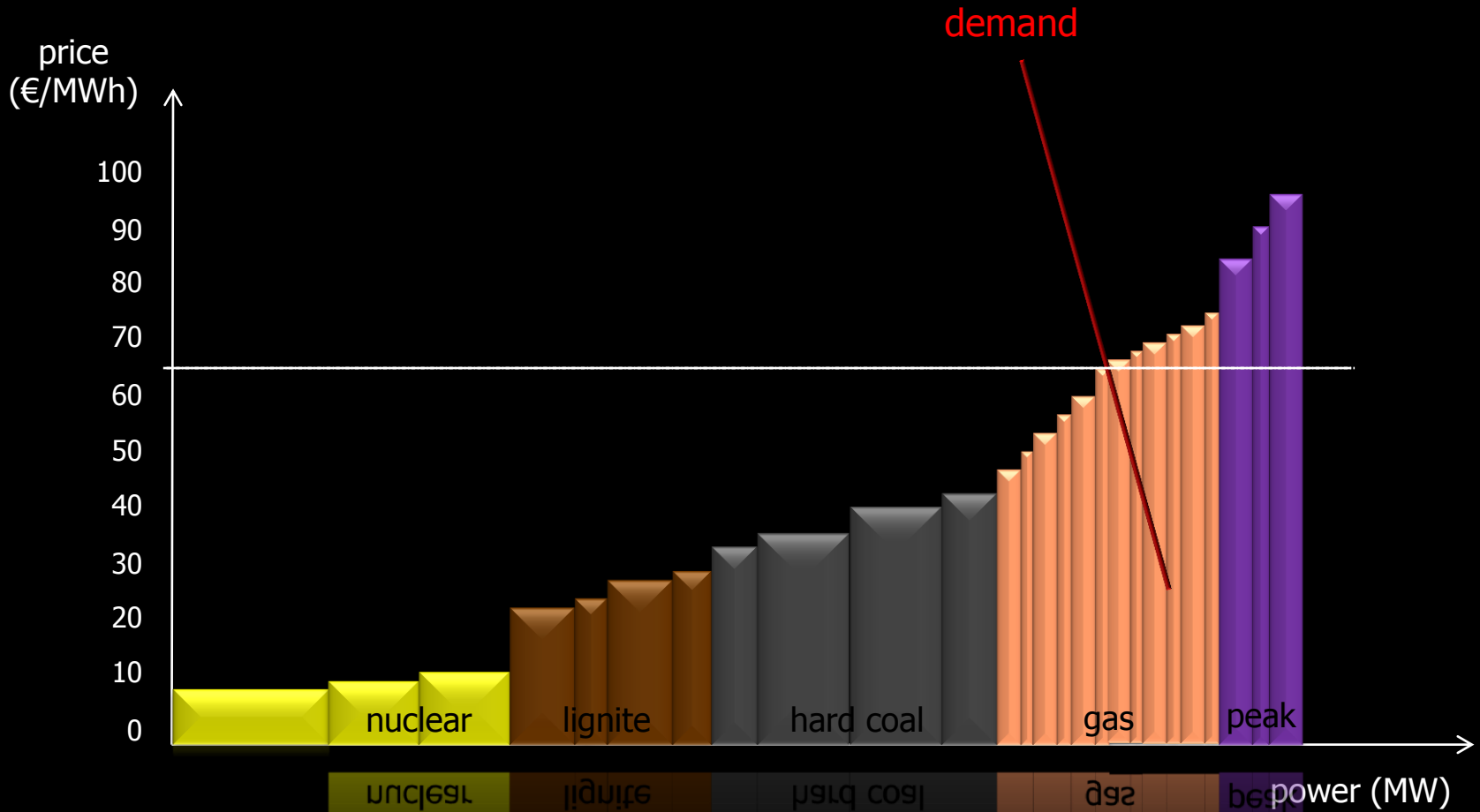


# MERIT ORDER: COAL INSTEAD OF NUCLEAR

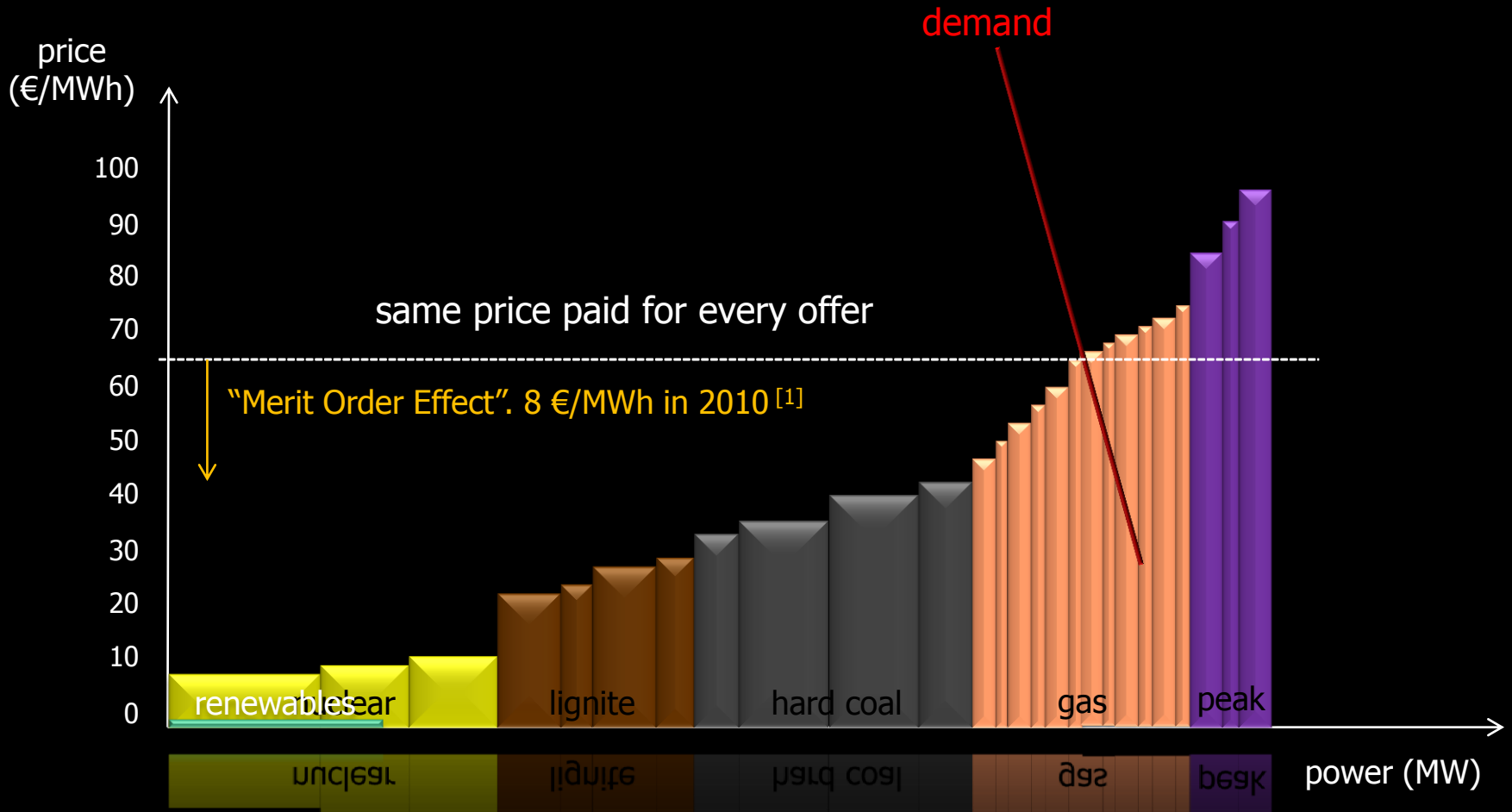




# MERIT ORDER: CAPACITY NOT REPLACED

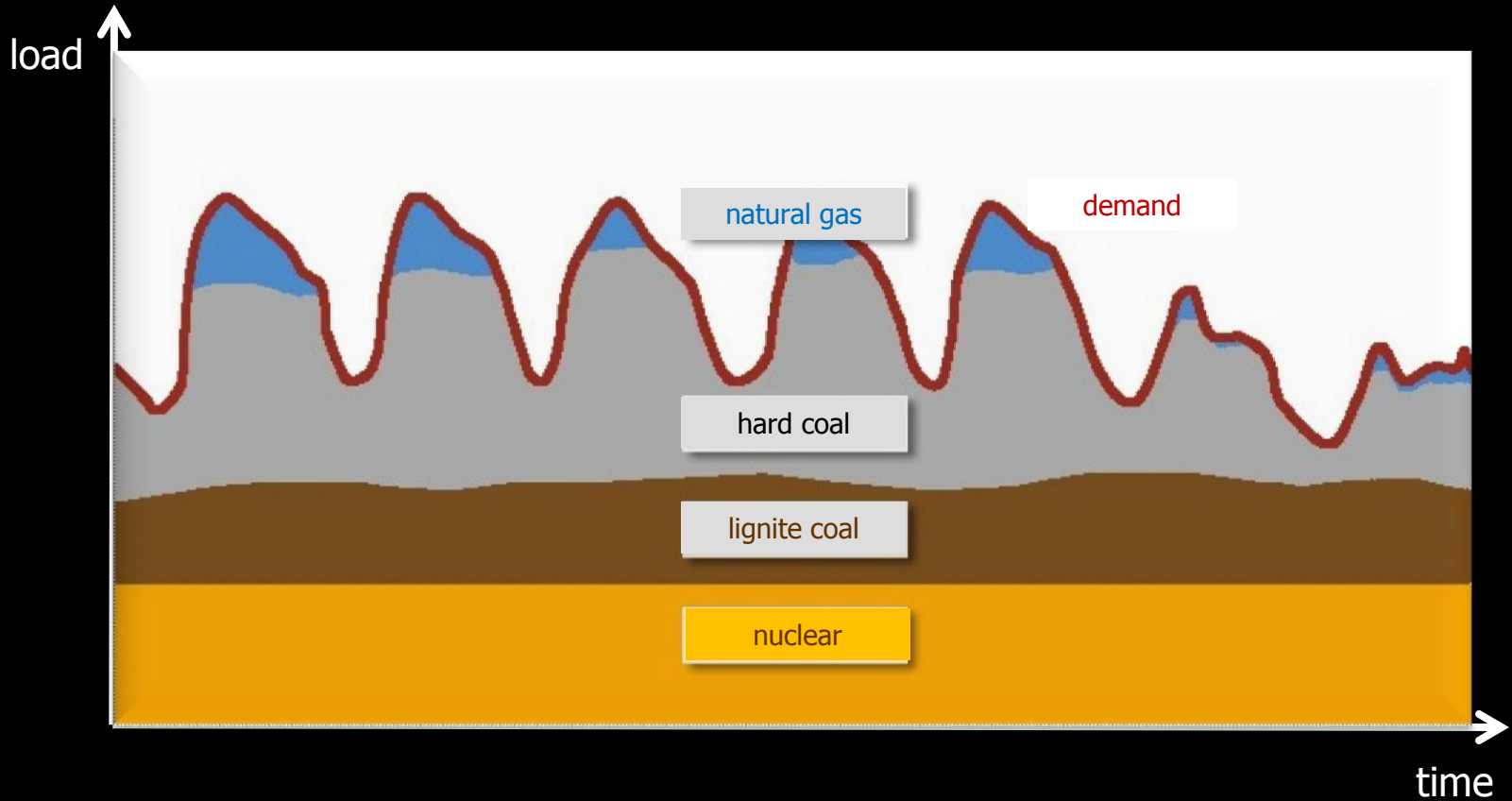


# MERIT ORDER: RENEWABLES

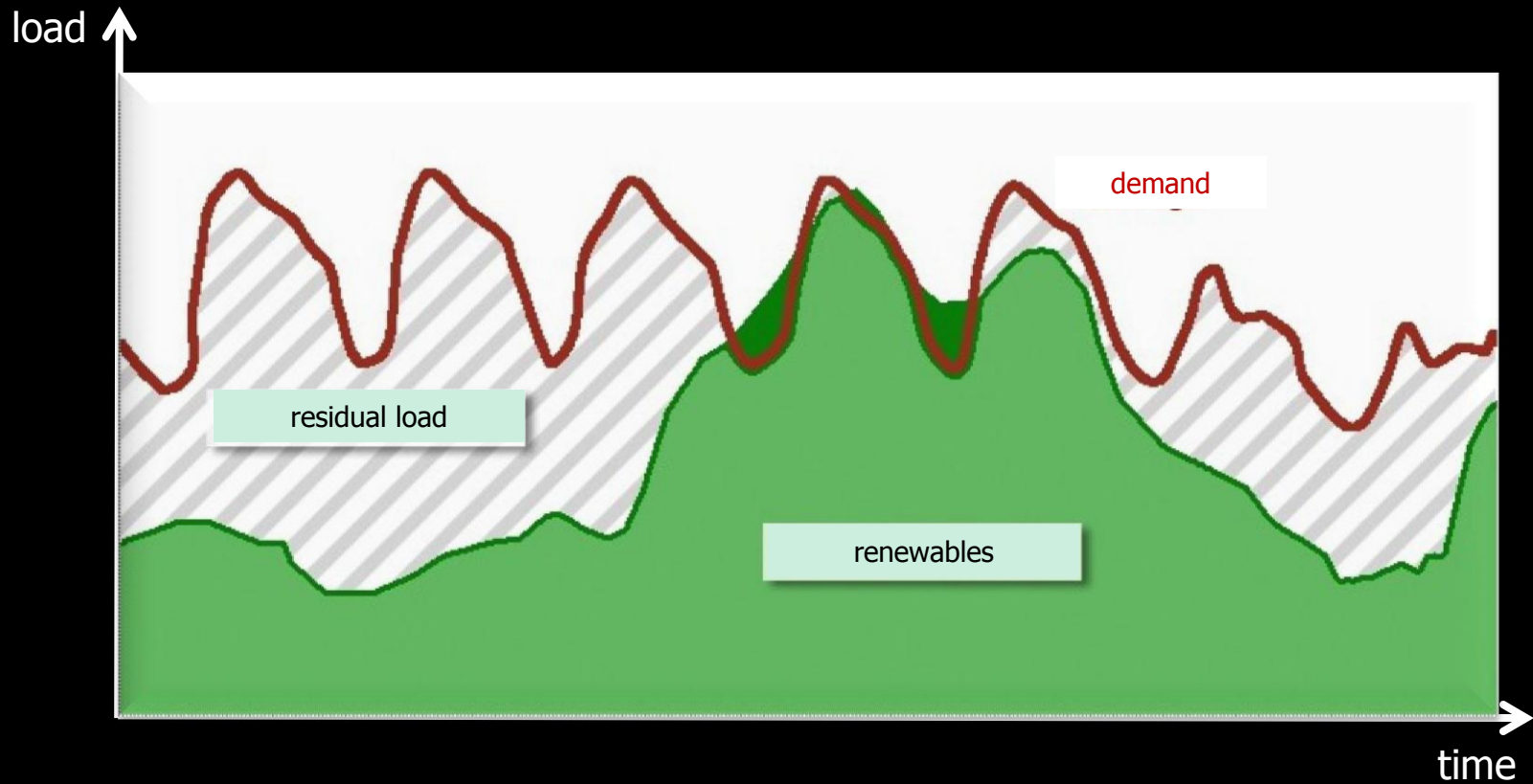


[1] Georg Erdmann (TU Berlin): Kosten des Ausbaus der erneuerbaren Energien, München, 2011

# RUMOR 2: BASE LOAD: YESTERDAY



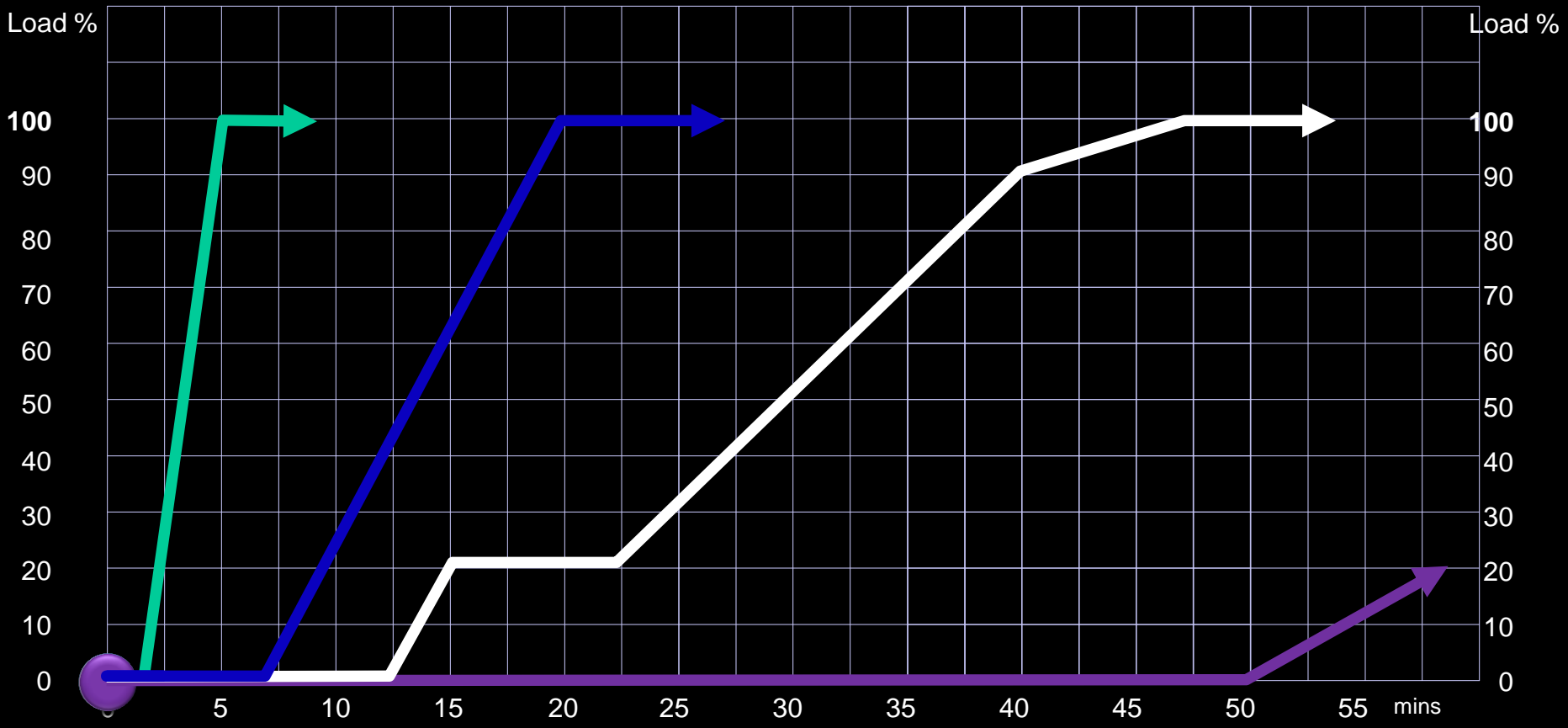
## RUMOR 2: BASE LOAD: TOMORROW



## RUMOR 2: BASE LOAD

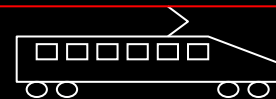
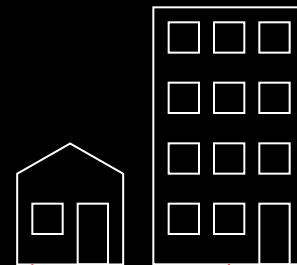
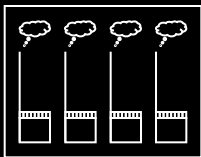
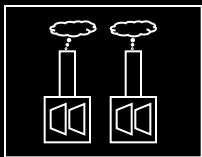
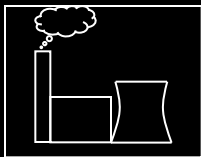
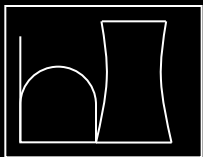
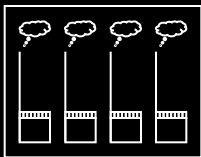
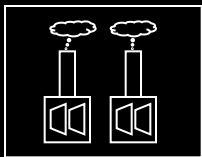
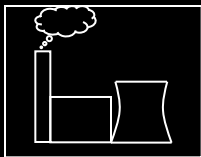
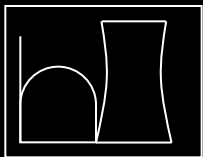
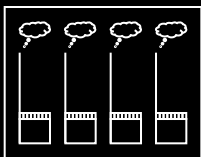
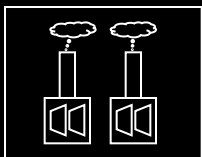
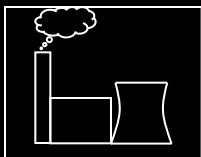
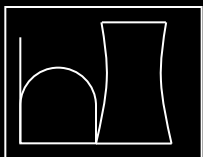
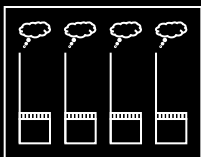
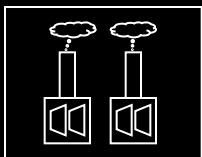
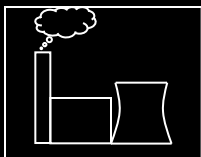
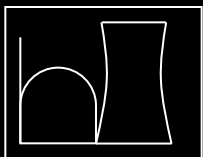
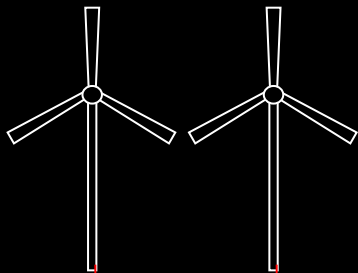
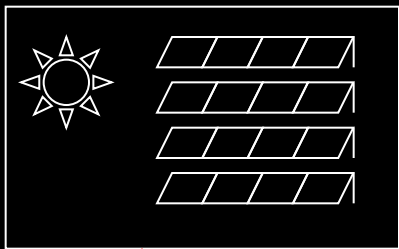
- base load on **demand side**: ok for some industries
  - however: unused potential in demand-side management
- base load on **generation side**: becoming history
  - high share of volatile generation facilities (renewables)
  - conventional power plants: **residual load**, no base load!
- Why claim base load power plants?
- Needed
  - **dynamic & flexible** power plants!
  - demand-side management

# FLEXIBILITY OF POWER PLANTS



- Coal Fired power plant
- Combined Cycle power plant (GTCC)
- Industrial GT power plant (GTSC)
- Combustion Engine power plant (20V34SG)

Start up from WARM condition



# SIMULATION GAME

	group		1	1	1	1	prognosis	
			nuclear	coal	GTCC	engine	demand	renewables
	plant							
	capacity		950	830	800	500		10500
10:00 - 11:00	Bid: Power	MW	700	830	550	500	11200	5250
	Bid: Price	€/MWh	-10	38	50	84	de facto:	
	order: Power	MW	700	830	550	0	10090	5000
	Price after auction	€/MWh	50					
	sold electricity	€	104.000					
	Fuel cost	€	4900	48970	38500	0		
	Maintenance Cost	€	0	0	0	0		
	Profit margin	€	11.630				sum	11.630



# SIMULATION GAME

You are a utility company and operate four power plants.

You'll sell the whole electricity on the energy stock market and operate your power plants accordingly.

You'll bid with a price and a load for every power plant

Give bids everytime only for the following hour (not for further hours).

After you'll have given your bids into the auction, you'll receive a table with the results

- which bids have been accepted and which not?
- at which load will your power plants operate for the bidded hour?
- what are your fuel and emission costs?
- will you have to start or stop a power plant?
- how much will you have to pay for additional maintenance for load changes or starts/stops?

All the above mentioned calculations are done by the game leader.

During the game you are not allowed to..

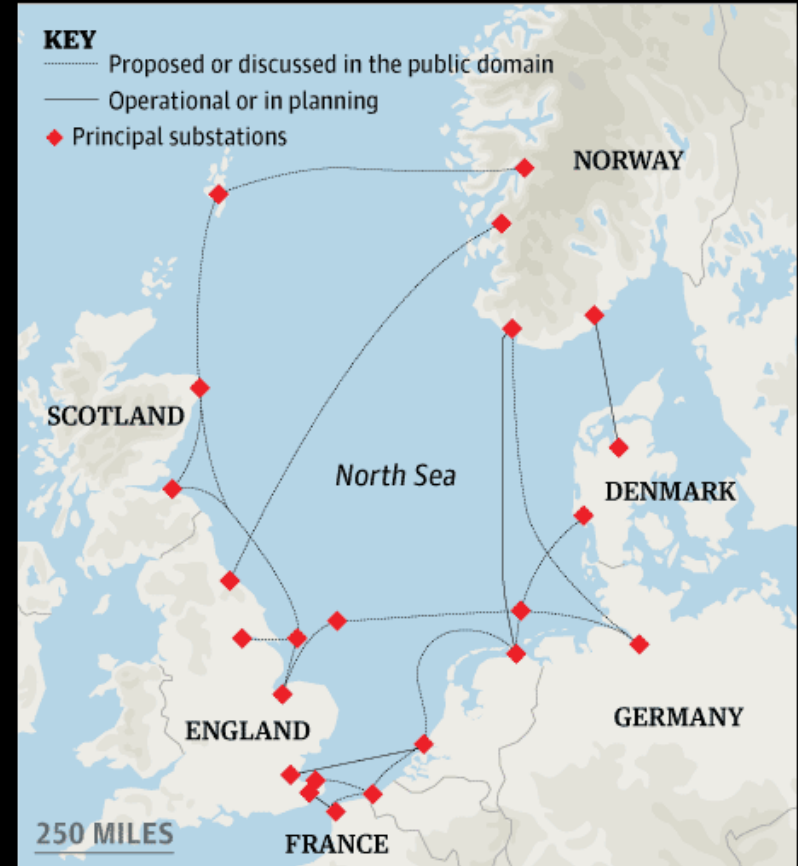
- talk to the other groups
- see the bids of the other groups
- get information about the results and operation of the other groups

The group with the highest profit after the game is the winner!

# INTERNATIONAL COOPERATION: DESERTEC / NORTH SEA GRID

- Combination of renewable sources from many different regions
- Hydropower for balancing

## High voltage grid



# IDEAS FOR DISCUSSION

