Electricity Market Game

Introduction and instructions

Goal of the game

To learn:

- The basic functioning of an electricity market
- How to bid in a spot market
- How to make investment decisions in an uncertain environment

  → implications for the energy transition!

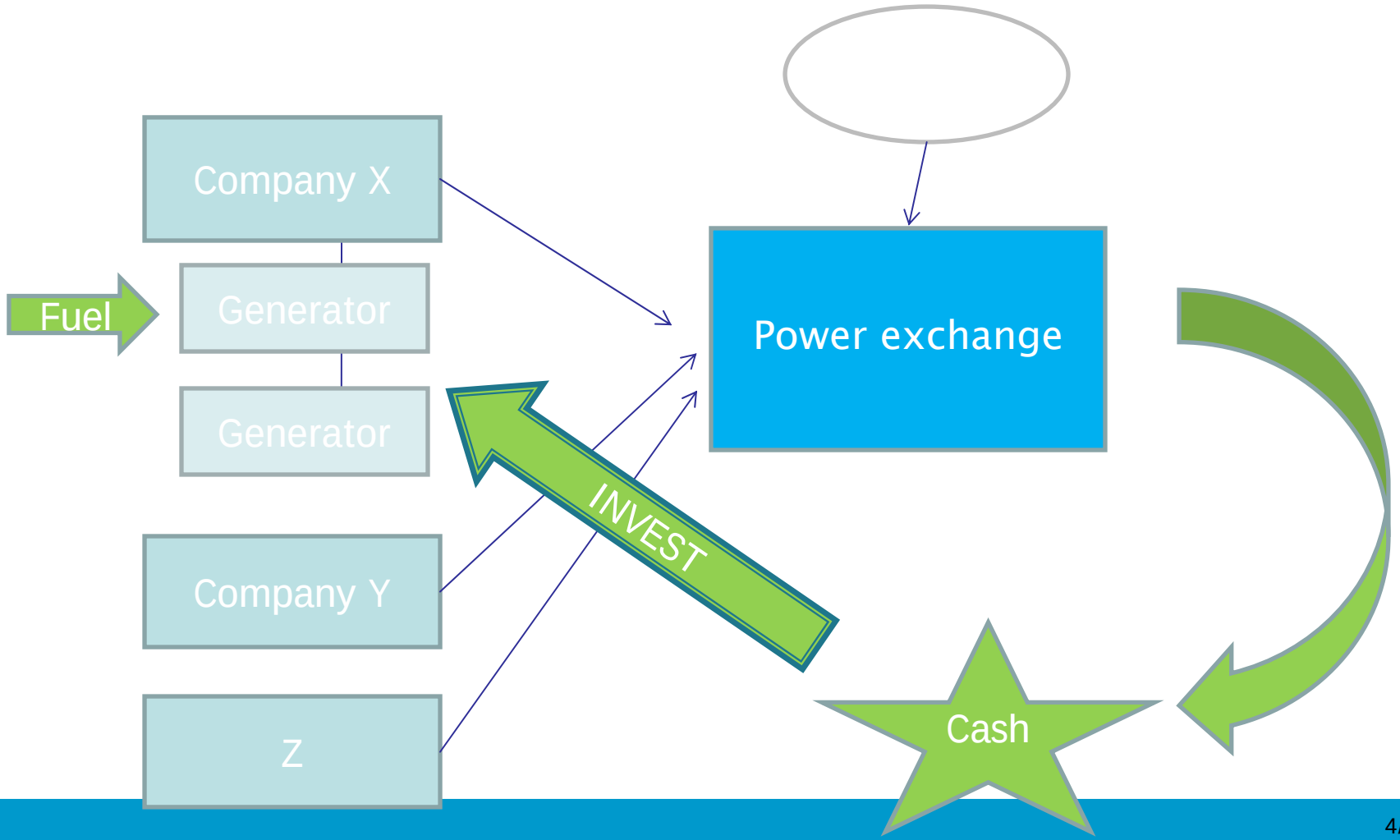
Winning criterion

- The objective is to maximize the company's net value by the end of the game.
- In principle:

  Company value = bank balance + asset value – loans
- We assume: depreciated asset value = loan principal

→ SCORE = Bank balance

Basic structure of the game



NEXT GENERATION INFRASTRUCTURES FOUNDATION

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Main characteristics

- Players have power plants, know current energy prices
- Bid their capacity into a power exchange
- Each round is one year
- Three sub rounds: base (5000 h/y), shoulder (3500 h/y) and peak (160 h/y)
- Power plants are run in order to produce sold electricity
- Operating profit = power exchange revenues – fuel cost
- Net profit = operating profit – capital cost – fixed O&M cost
- Demand grows, power plants age: need to invest
- New plants: construction time

Your website

- Media: public information
  - energy news
  - company performances
  - (dis)investments by competitors
- Power exchange
  - bid form
  - market results
- Balancing market

Your website (2)

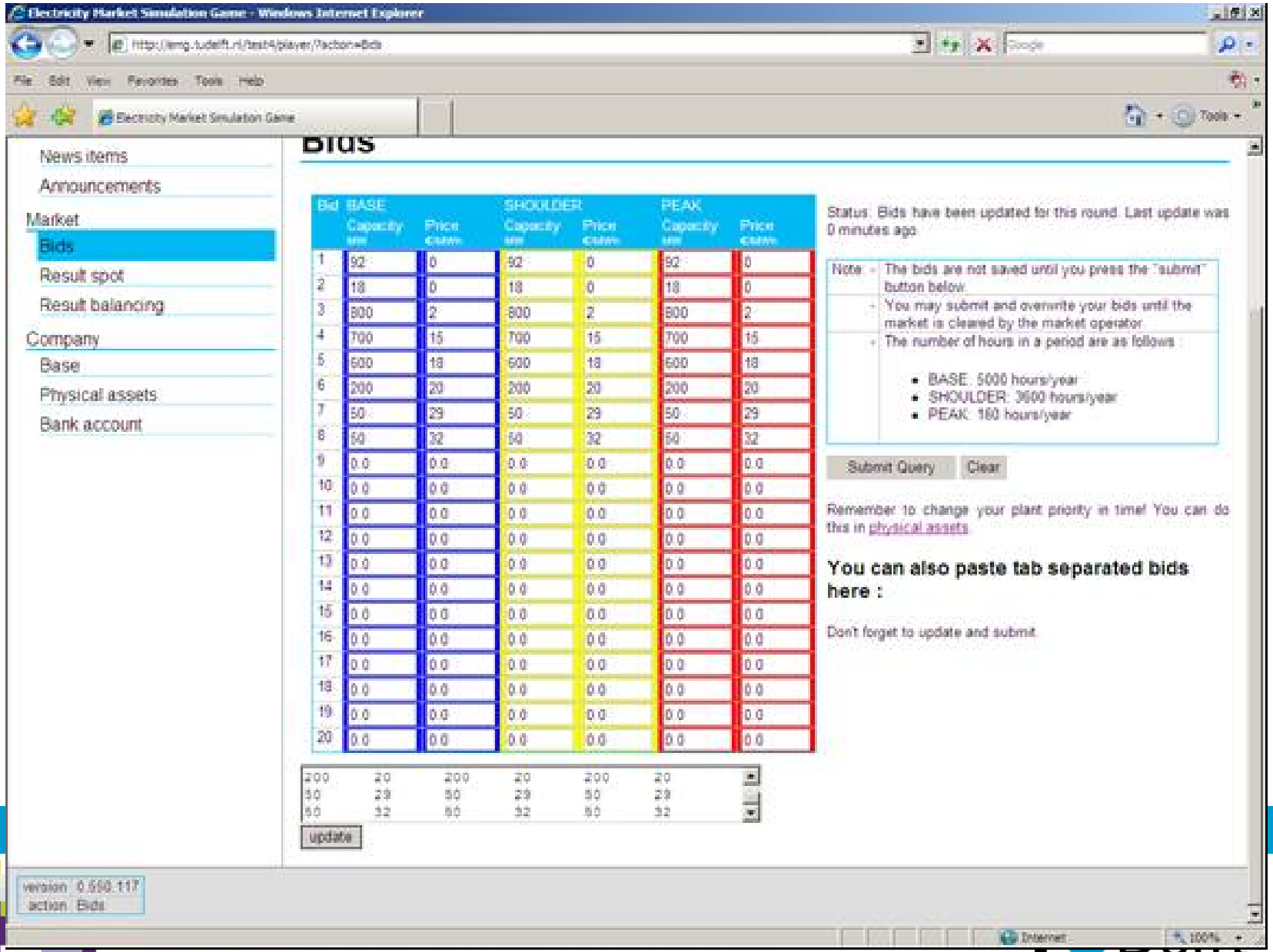
Private company data:

- Physical data:
  - Power production per round
  - Overview of power plants (capacity, reliability, efficiency, remaining loan, fixed O&M costs, operational status, age, dispatch priority)
  - Forms for (dis)investing
- Financial data
  - Bank account, with all costs and revenues
  - Overviews of cash flow and financial history

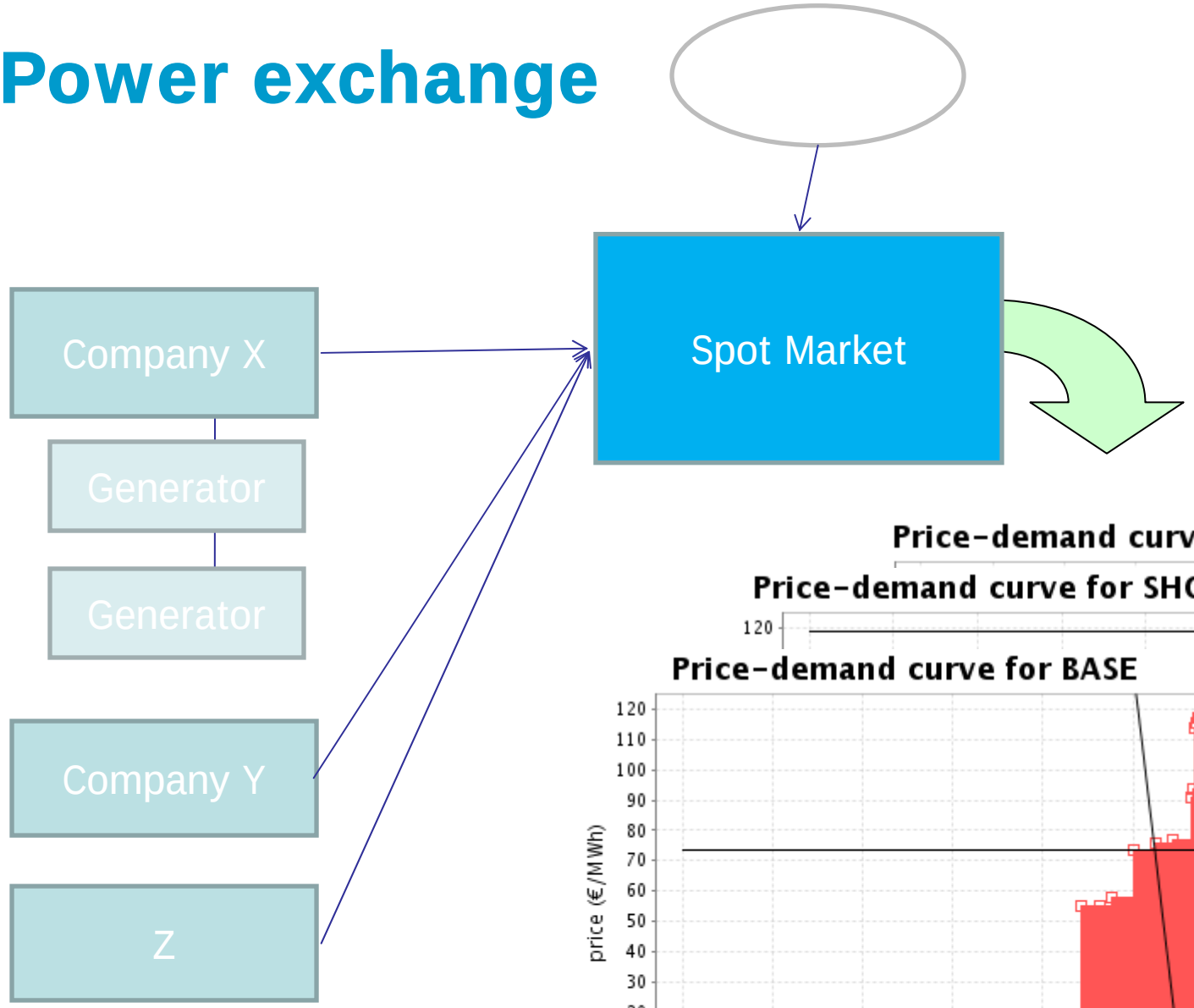
How to bid

- Calculate available capacity
  - correct for wind factor and power plant outages
- Check fuel prices to calculate your costs
- Bid MW not MWh!
  - the capacity of your bids is multiplied by the hours of the time period for which you bid
- If you sell more than you can produce, you will be charged for an imbalance!
  - In this case, companies with excess capacity will sell to the balancing market

Bid forms

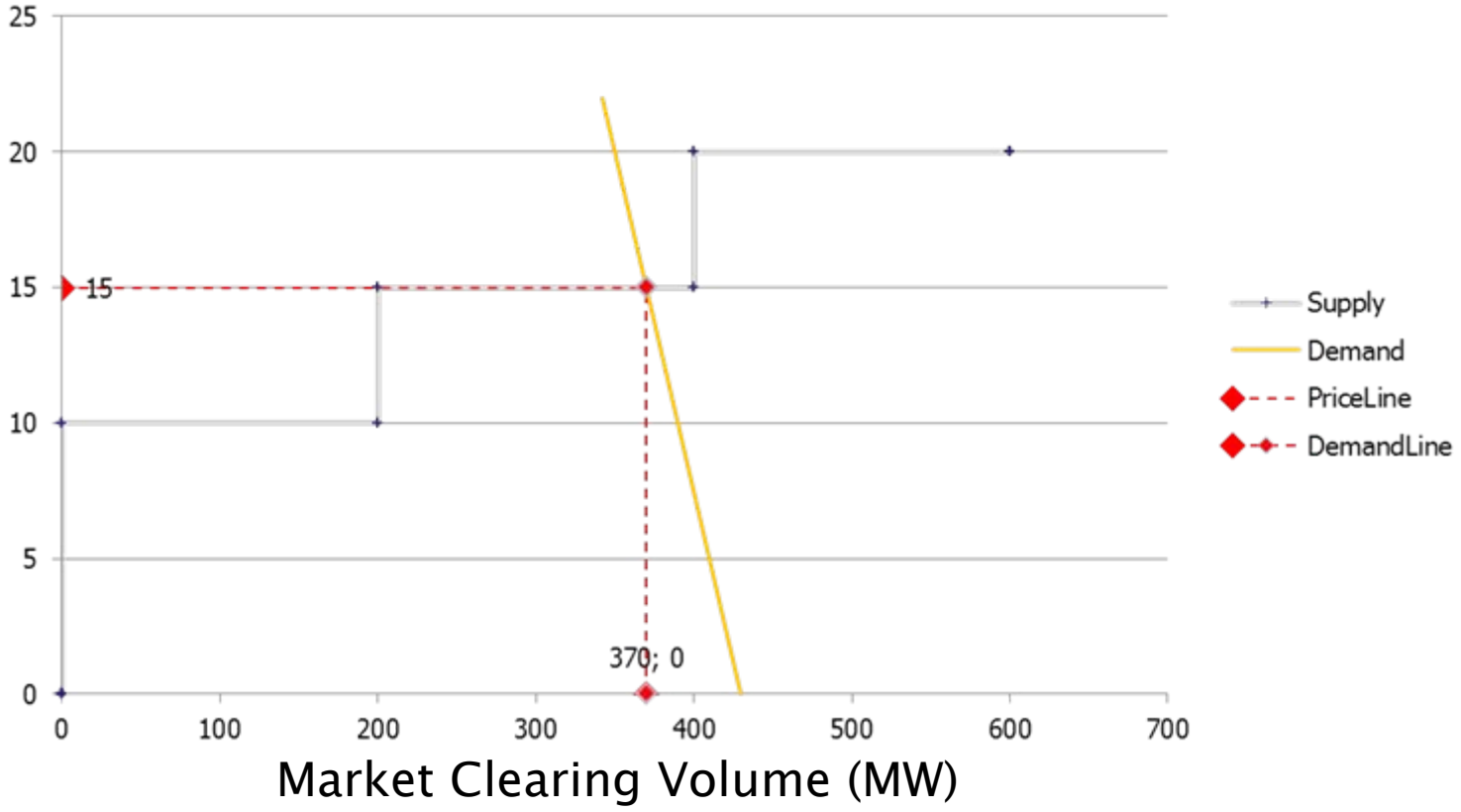

Electricity Market Simulation Game - Windows Internet Explorer
Electricity Market Simulation Game
News items
Announcements
Market
Bids
Result spot
Result balancing
Company
Base
Physical assets
Bank account
Bids
Bid
BASE
SHOULDER
PEAK
Capacity
Price
Status: Bids have been updated for this round. Last update was 0 minutes ago
Note:
The bids are not saved until you press the "submit" button below.
You may submit and overwrite your bids until the market is cleared by the market operator.
The number of hours in a period are as follows:
BASE: 5000 hours/year
SHOULDER: 3600 hours/year
PEAK: 160 hours/year
Submit Query
Clear
Remember to change your plant priority in time! You can do this in physical assets
You can also paste tab separated bids here :
Don't forget to update and submit
update
version 0.550.117
action Bids

Power exchange



Market clearing

Market Clearing Price (€/MWh)



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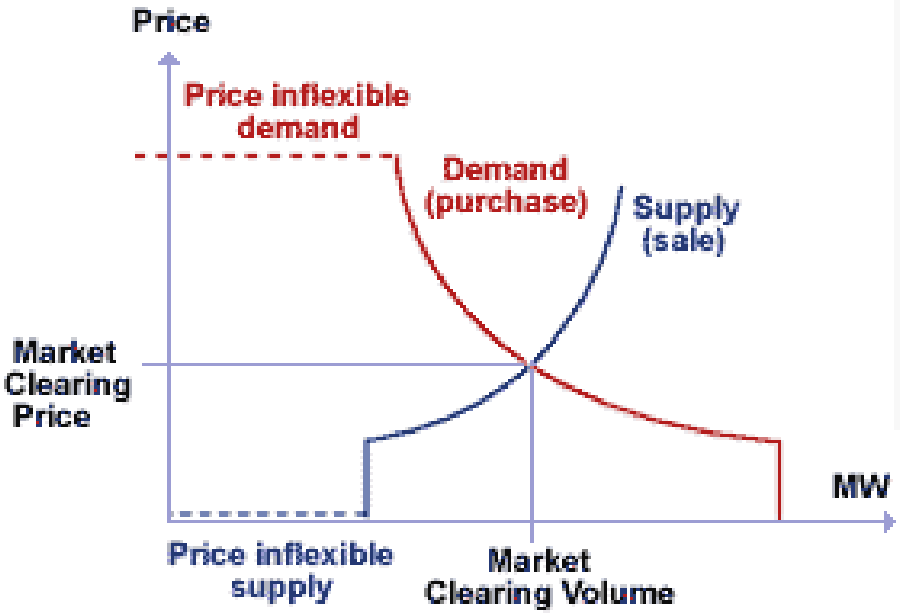
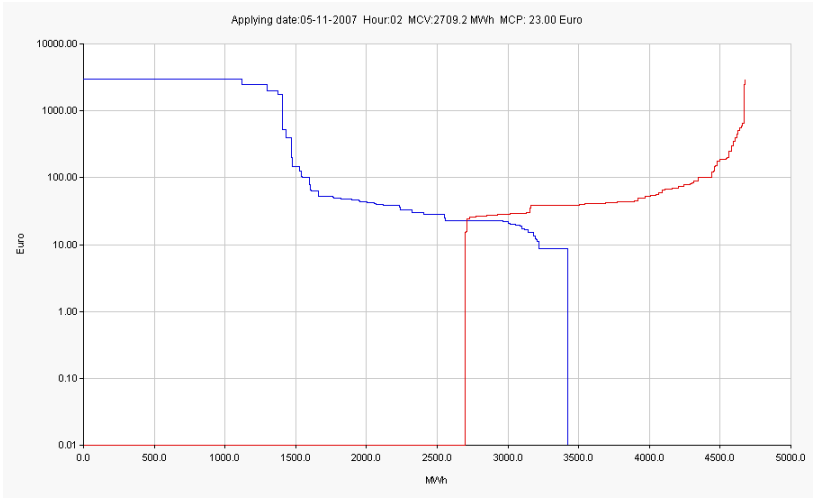
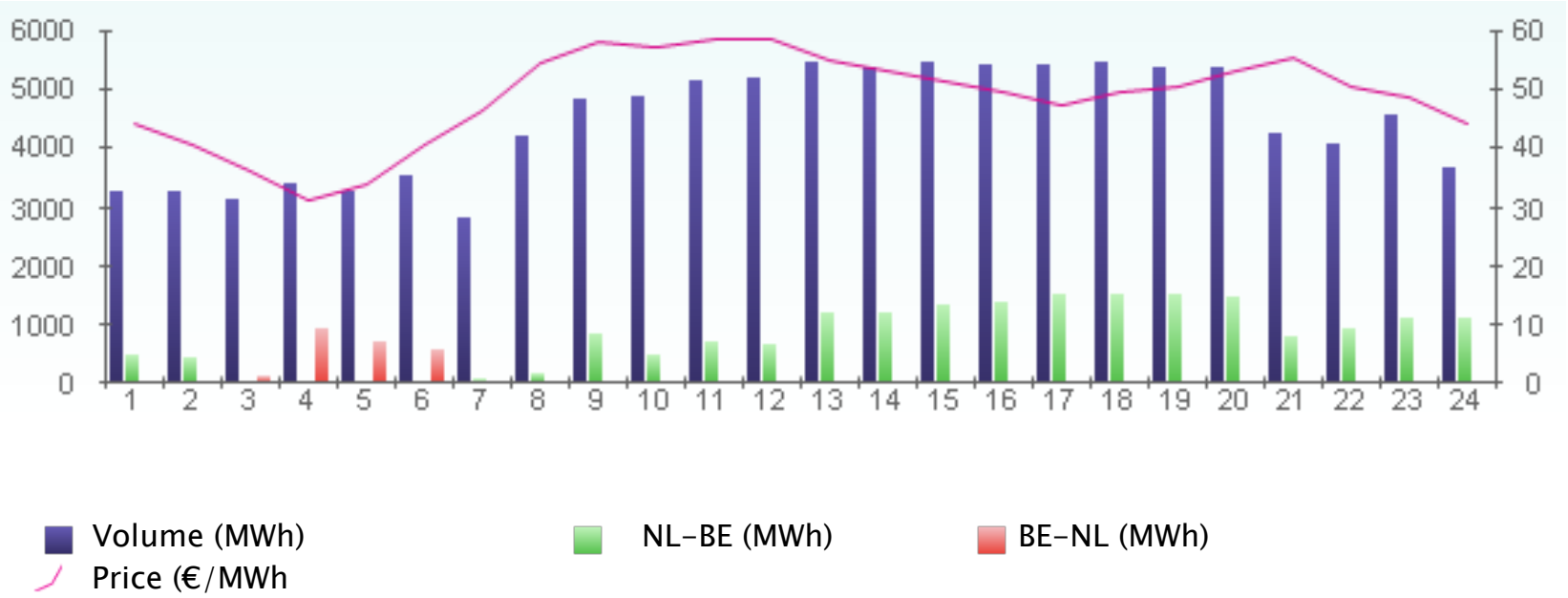
The spot market – modeled on the APX





Bron: APX.nl

APX results a few weeks ago



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Bid periods

- In reality: bids every half hour.
- Here: three bid periods per round:
  - Peak 160 hours/year
  - Shoulder 3600 h/y,
  - Base 5000 h/y,

→ Each round represents a year

Demand growth varies, but the difference between peak, should and base demand functions remains the same.

1	2535.8	2435.0	0.0	2435.0	0.0	2535.0	0.0
0	2444.0	1942.0	0.0	2342.0	68.7	2442.0	0.0

Electranel's plants

The table below presents an overview of your plants. Use this table to indicate the dispatch order of your plants. Selecting the same number for several plants will cause those plants to run in random order.

Name	Type	Capacity	Reliability	Efficiency	Remaining loan	Fixed O&M costs	Status	Round active	Priority
E1	Nuclear	800.0 MW	87%	100%	€ 0	€ 19.200.000	OPERATIONAL	-10	1
nuke1	Nuclear	800.0 MW	94%	100%	€ 480.000.000	€ 19.200.000	OPERATIONAL	7	2
E3	Wind	250.0 MW	91%	N/A	€ 0	€ 2.100.000	OPERATIONAL	-1	3
E4	Wind	50.0 MW	88%	N/A	€ 0	€ 420.000	UNAVAILABLE	-8	4
E5	CCGT	600.0 MW	91%	56%	€ 0	€ 4.320.000	OPERATIONAL	-1	5
E7	OpenCycleGasTurbine	50.0 MW	89%	35%	€ 0	€ 180.000	OPERATIONAL	-7	6
E6	CCGT	200.0 MW	87%	53%	€ 0	€ 1.440.000	OPERATIONAL	-9	7
E2	PowderCoal	700.0 MW	88%	42%	€ 0	€ 9.618.000	OPERATIONAL	-8	8
Total		3450.0 MW			€ 0	€ 480.000.000	€ 56.478.000		

Confirm priority

Investment in new power plants

Use the form below to order new power plants. To order a power plant do the following:

1. Give each plant a unique name, for instance the first letter of your company name followed by a number.

2. Indicate the capacity of your new plant in the column "Desired capacity". The range of capacity that you can choose from is limited, as indicated in the column "Available capacity range".

3. Check the box in the last column.

4. Indicate your motivation for buying new plant in the text box below the table.

5. Press the "Buy generators" button.

Generation portfolio

- Your generation portfolio determines
  - your generation capacity available for power production
  - your operating cost → bid strategy
- You need to make a spreadsheet to calculate operating cost
  - Investment decisions are also best supported by an Excel sheet

Power plants

- Power plants can fail
  - Current plant availability is indicated
  - Outages last entire year
  - Reliability decreases over time
- Capital costs: 15 years from start of construction
- Operating costs (only fuel) depend on:
  - fuel efficiency
  - fuel prices vary
- Wind plants: output varies
- Plant value = Loan → net value of assets is zero

Investment

- A long time period is simulated → investment is key to success.
- Power plants are 100% debt financed. Loans are paid off in 15 rounds.
- Other costs:
  - fixed Operating and Maintenance (O&M)
  - fuel cost
- Plants become less reliable as they age.
- Uneconomic plants can be dismantled
  - this terminates their fixed O&M costs
  - but their loans will need to be paid off.

Bank account

- Revenues from selling electricity
  - to the spot market
  - to the balancing market
- Costs
  - plant: loan, fixed O&M and fuel costs
  - balancing market costs/revenues
  - penalties from the Competition Authority (if applicable)
- See the manual for how the transactions are organized

Playing the game

- Each round, you need to...
  - ... analyze output from previous rounds, fuel prices, news etc.
  - ... prepare bids for spot market
  - ... make (disinvestment) decisions
- Between rounds, time stands still

- Gradually, we will play more rounds per hour

→ Prepare a spreadsheet for your bids and investment analysis

  –bids can be copied from a spreadsheet into the game