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Energy systems modelling

Tutorial 3

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Assume there is a slightly more complex situation:

- 3 countries
  (Germany, France, Netherlands)
- Different generation technologies
  (Nuclear, Lignite, CCGT, OCGT and Wind)
- Time dimension
  (Hourly generation and dispatch)

Slightly more complex situation

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- There is a set of power plants [P] in 3 different countries [N]

Power plants	Countries	Technology	Capacity [MW]	VC [$/MWh]
P1	FR	Nuclear	700	20
P2	FR	OCGT	250	55
P3	GER	Lignite	750	30
P4	GER	CCGT	250	40
P5	GER	Wind	300	0
P6	NL	CCGT	400	40
P7	NL	OCGT	200	55
P8	NL	Wind	200	0

Slightly more complex situation

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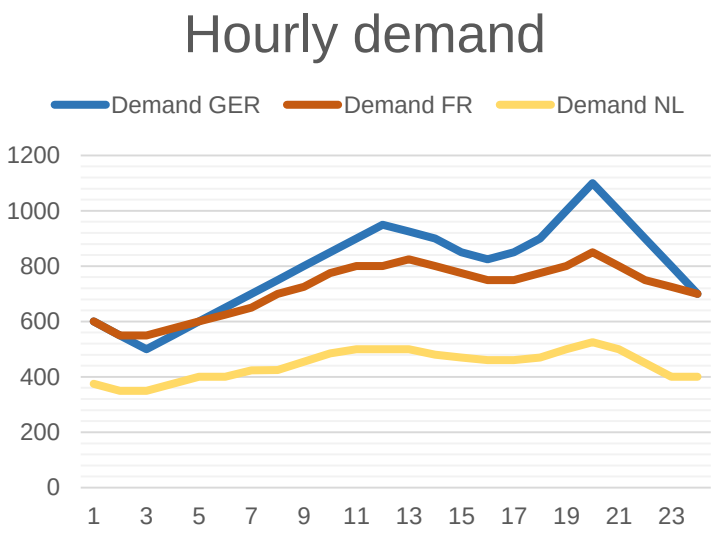
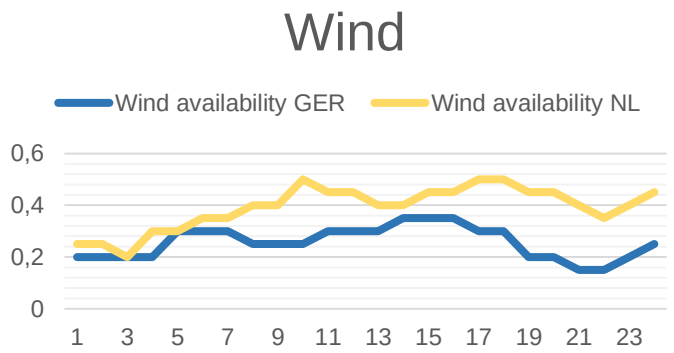
- Time series data is as follows:

Hours	Demand [MW]			Wind availability factor	
	GER	FR	NL	GER	NL
1	600	600	375	0.2	0.25
2	550	550	350	0.2	0.25
-	-	-	-	-	-
-	-	-	-	-	-
23	800	725	400	0.2	0.4
24	700	700	400	0.25	0.45
Max	1100	850	525	0.35	0.5
Min	500	550	350	0.15	0.2
Capacity all	1300	950	800		
Capacity conv	1000	950	600		





Objective function and demand constraint

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- Minimize the total cost function

$$\min_{G_{p,n,t}} COSTS = \sum_{p,n,t} G_{p,n,t} * vc_p$$

- The demand has to be covered *in each* country *at every* hour

$$demand_{n,t} = \sum_{p} G_{p,n,t}$$

If $G_{p,n,t}$ is a generation of power plant ***p*** in a country ***n*** at time ***t***

Generation constrains

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- The electricity generation is constrained by the installed capacity
  - For conventional generation ($G_{c,n,t}$):

$$G_{c,n,t} \leq cap_c \qquad \forall\, c, t$$

  - For renewables ($G_{r,t}$):

$$G_{r,n,t} \leq cap_r * afWind_{n,t} \qquad \forall\, n, t$$

$afWind_{n,t}$ is the hourly wind availability factor

See you next class!