



POTSDAM INSTITUTE FOR  
CLIMATE IMPACT RESEARCH

**undendlich viele Lösungen...**

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# LIMES-EU *Long-term investment model of the electricity sector*

## Objective

- minimizing cumulated costs for electricity provision
- optimal investment and dispatch decisions for generation, storage and transmission capacities

## Linear optimization model

- GAMS / CPLEX Solver

## Technologies

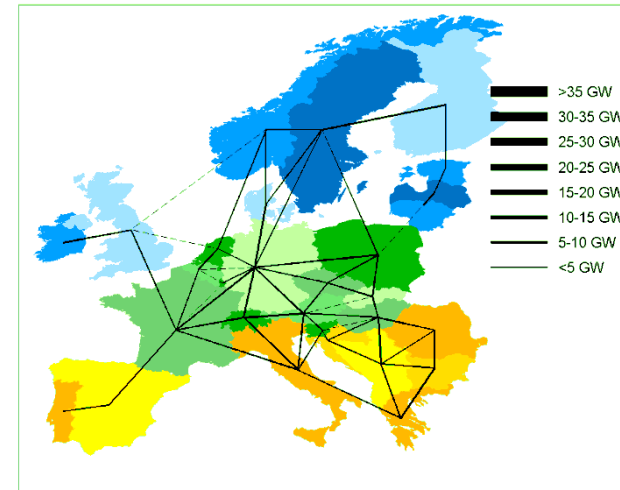
- generation [*nuclear, hard coal (+ccs), lignite (+ccs), natural gas cc/gt, hydro, wind on-/offshore, solar pv/csp, biomass*]
- storage [*diurnal, seasonal*]
- transmission [*net transfer capacities between regions*]

## Geographical scope & resolution

- EU28 countries w/o Malta & Cyprus
- plus Norway & Switzerland & Balkan

## Temporal scope & resolution

- 5 year steps 2010 – 2050
- representative days per year
- perfect foresight



Net transfer capacities in 2050

## Policy equations

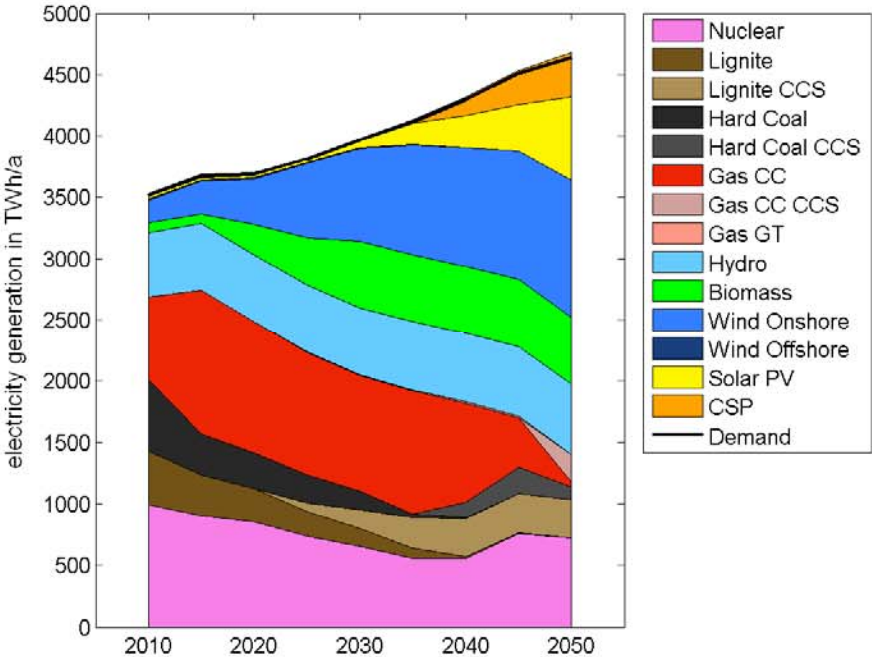
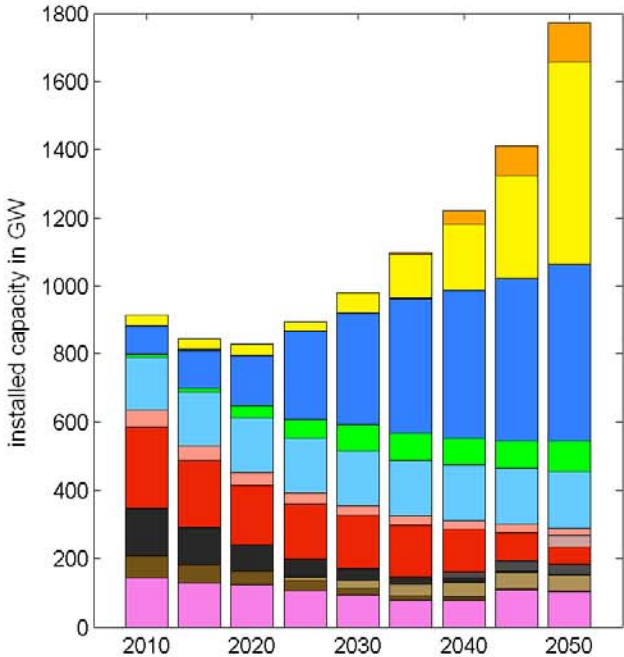
- CO<sub>2</sub> targets / RES targets
- EU or Member State level

## Exogenous parameters

- electricity demand per region
- nuclear / ccs policies
- investment costs
- fuel costs
- ...

based on Haller et al. (2012)

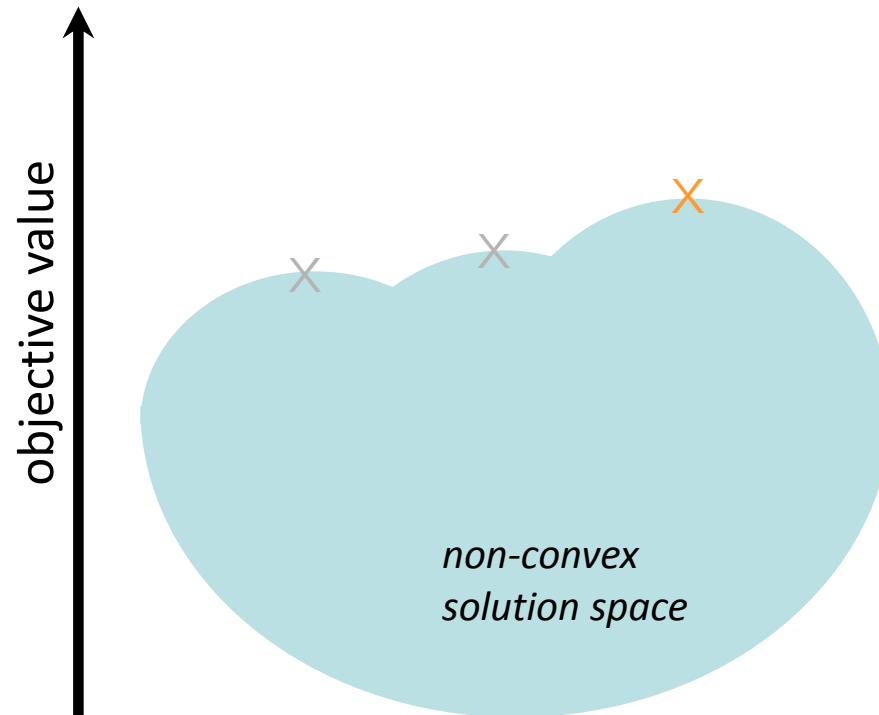
# LIMES-EU *Long-term investment model of the electricity sector*



- Nuclear
- Lignite
- Lignite CCS
- Hard Coal
- Hard Coal CCS
- Gas CC
- Gas CC CCS
- Gas GT
- Hydro
- Biomass
- Wind Onshore
- Wind Offshore
- Solar PV
- CSP
- Demand



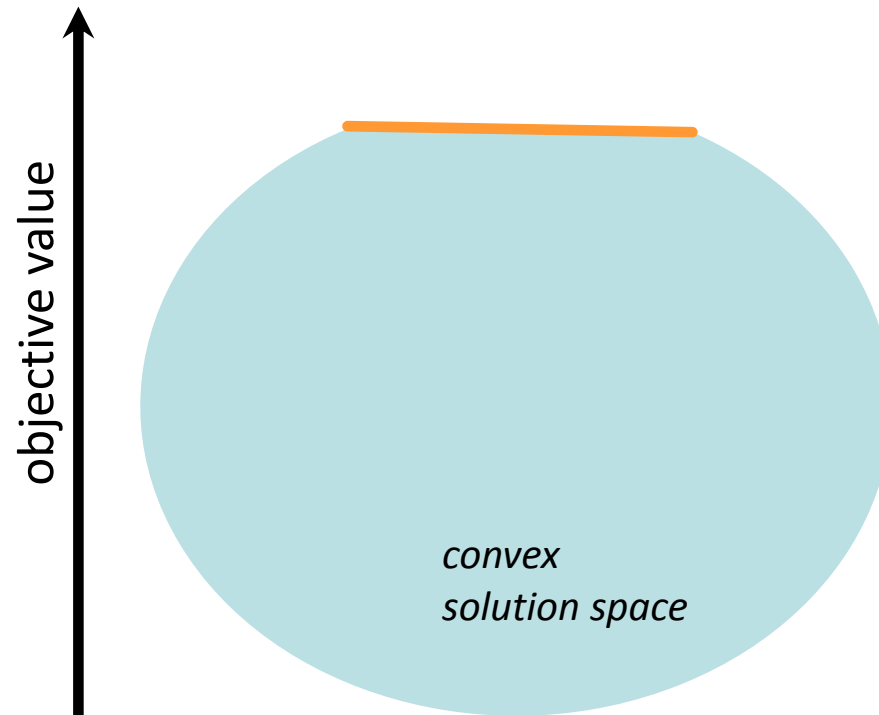
# Multiple optimal solutions for base year



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One optimal solution for the overall European electricity mix

...but different distribution of electricity generation between model regions



# Multiple optimal solutions for base year

One optimal solution for the overall European electricity mix

...but different distribution of electricity generation between model regions.

- multiple regions
- same fuel prices, efficiencies, ...
- excess capacity
- emission cap (not price)

	Demand	Hard Coal / Natural Gas
Region A	8	
Region B	8	
Sum A+B	16	

# Multiple optimal solutions for base year

What is the „right“ solution?

*Diversified national generation portfolio.*

- transmission losses between regions – *still multiple (but less) optimal solutions*
- fuel prices that depend on consumption – *non-linear equation*
- more detail in technology representation – *computation time*
- approximation of historic emissions – *only for base year, still multiple (but less) optimal solutions*

	Demand	Hard Coal / Natural Gas	
		Solution 1	Solution 2
Region A	8	5/3	4/4
Region B	8	4/4	5/3
Sum A+B	16	9/7	9/7