Modelling of a French Energy System

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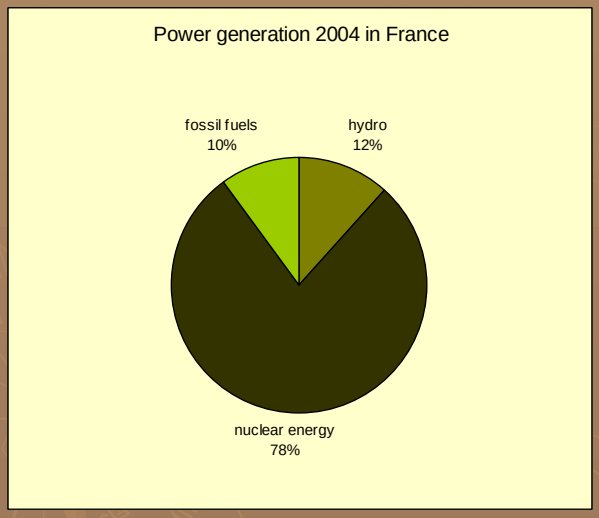
Structure

- Introduction
- Software New-Urbs
  - Model in general
  - Input/Output/Operation
- Input Data
  - Consumption Centers
  - Transmission Lines
  - Demand
  - Wind
  - Costs
- Results of German Model

Introduction
Energy Production in France



Source:UCTE

- Based on nuclear and hydro power
- Policy objective: divide by 4 CO2-Emission by 2050
- Major obstacle for Nuclear
  - Radioactive waste
  - Resource limits and
  - Proliferation issues

Introduction
Energy Production in France

- On long term even fission needs replacement:
  - Renewable energies
  - Nuclear concepts like Generation IV

Introduction
Goal of the Model

- Description of a future french electricity system
- 10-20% of electricity is supplied by wind
- Analyse integration of wind power:
  - Changes in existing system
  - Increase of costs
  - Decrease of CO2-Emission

Software New-Urbs
Model

Technical Model

Economical Model

DigSilent GmbH provides Software PowerFactory

Simulation Model

=> Guarantees technical feasibility of economical solution

Linear Optimasation Model

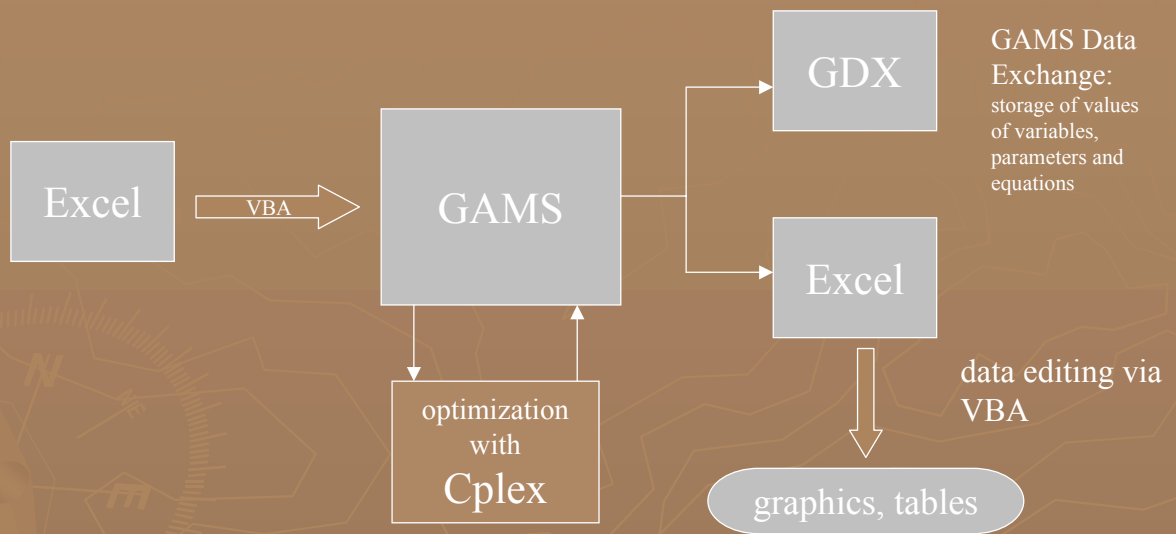
Calculates electricity flows (static basis)

Simulates dynamic behaviour of grid and power plants

Software
Economical Model

- French energy production and transmission system
- in consideration of:
  - wind fluctuation
  - variable demand
- output:
  - optimal manner of operation of power plants
  - capacities for power plants and transmission lines

Software
Model Operation

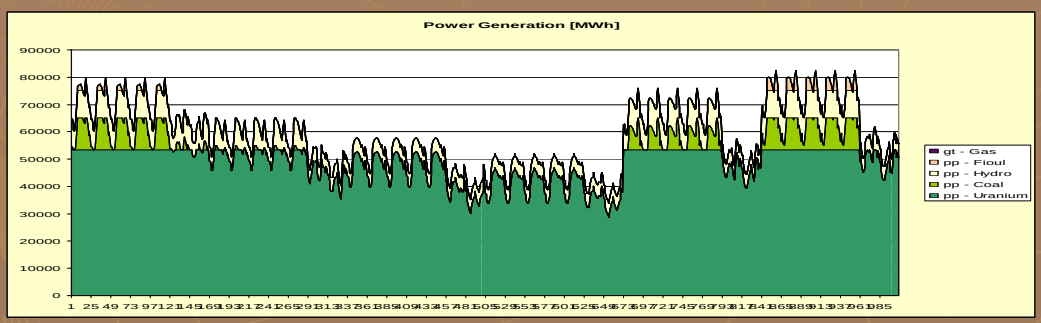


Software
Model Input

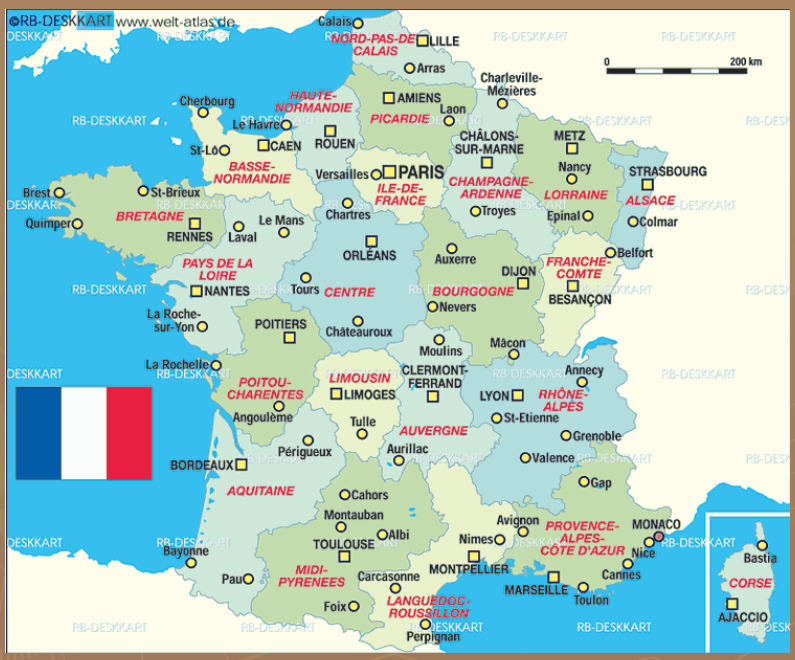
- Data of power plants (type, capacity boundaries, efficiency, etc.)
- Data of transmission lines (maximal capacity of power flows, etc.)
- Supply of wind (time series, hourly resolution)
- Energy demand (time series, hourly resolution)

Software
Model Output

- Optimal manner of operation
- Power flows
- Optimal capacities
- Costs
- Marginal Costs (dual solution)
- CO_2-Emission



Software: Input
Consumption Centers



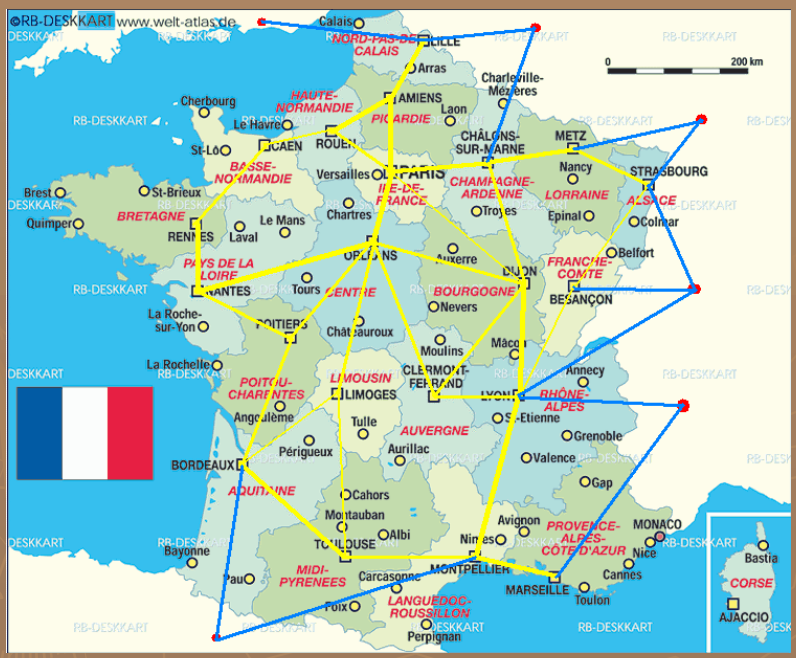
-21 nodes (Regions):

-Different types of power plants

- variable demand

- wind supply

Software: Input
Transmission Lines

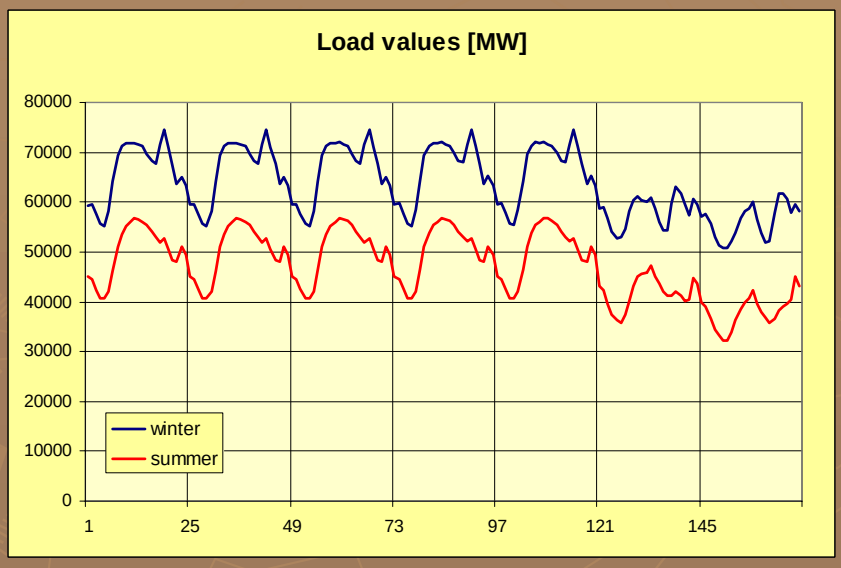


- Basis 400kV Network

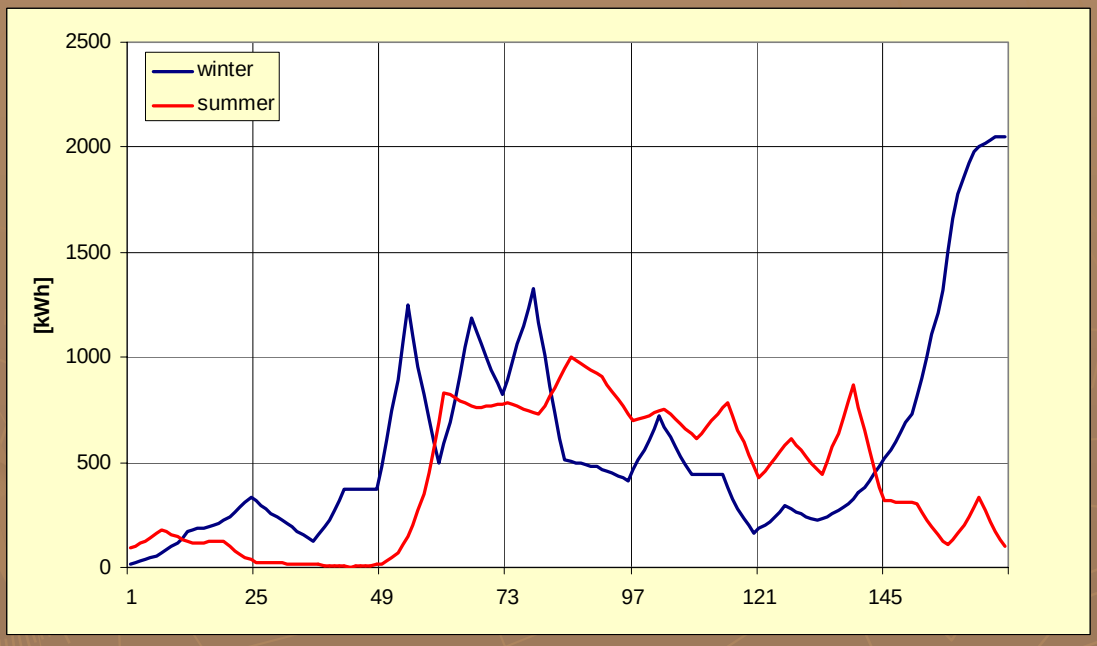
- Capacity 1650 MW

- 34 transmission lines in France

Software: Input
Energy Consumption



Software: Input
wind supply



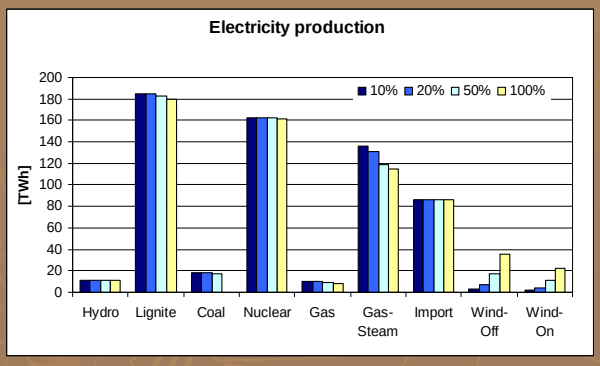
Software: Input
Costs

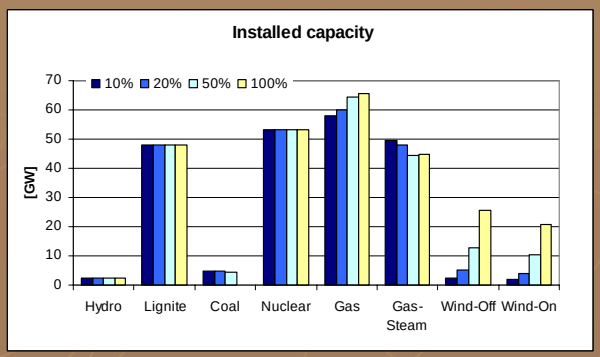
- Investment Cost for new Construction of Power plants, Transmission lines
- Fixcosts for Production, Storage and Transmission
- Variable Cost for Production, Storage and Transmission

		Uran	Gas	Coal	Oil	Wind-Onshore	Wind-Offshore
Investment costs	[/kW]	1496	325	1328	323	878	1517
Fixcosts	[/kW]	29	14	30	14	0	0
variable costs	[ct/kWh]	1.46	7.14	2.18	5.58	0.36	0.47

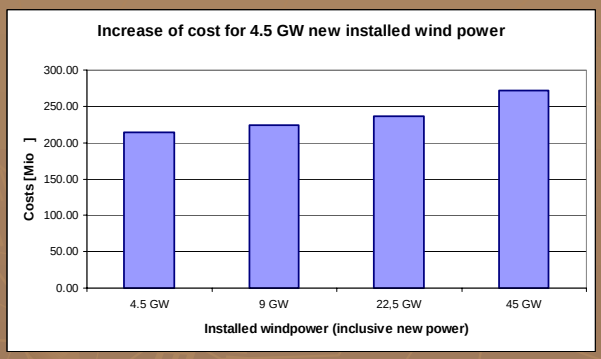
Source: Ministère de l´economie des finances et de l´industire

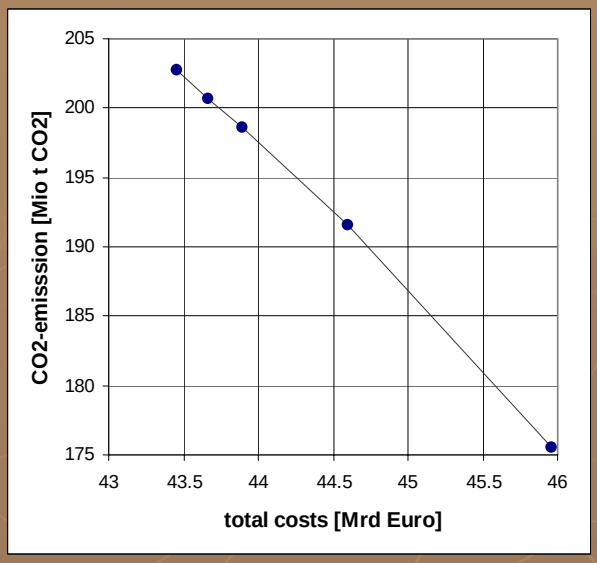
Results of German Model
Installation of Wind power



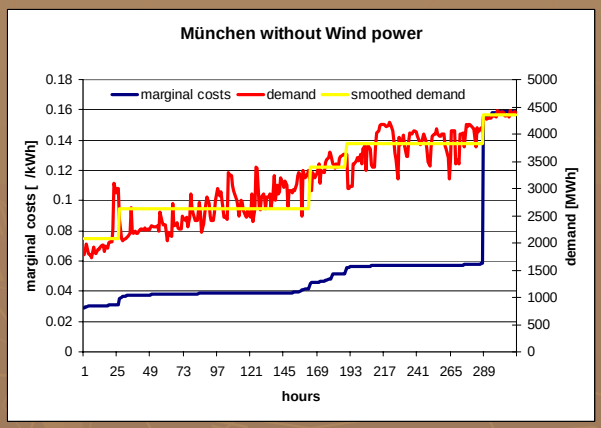


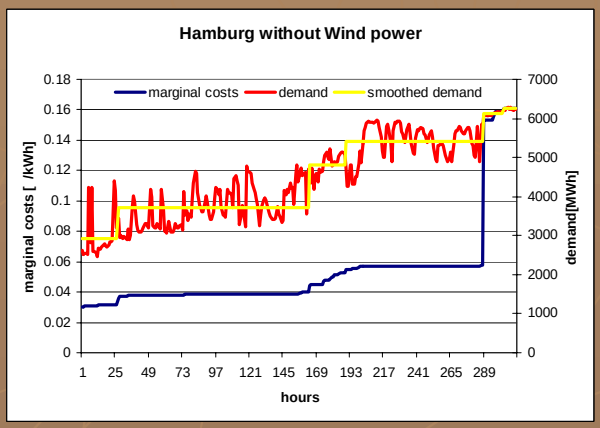
Results of German Model
Costs of Wind power



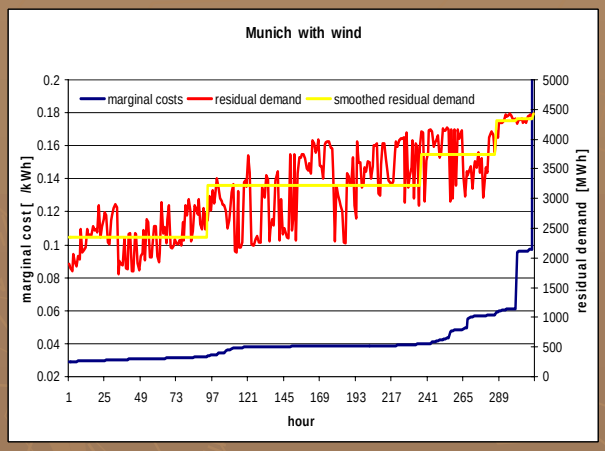


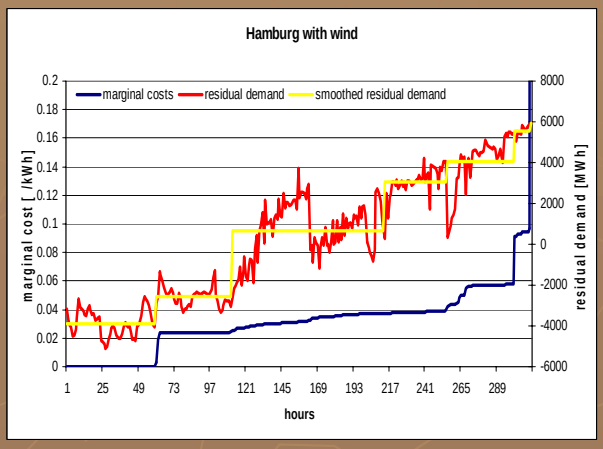
Results of German Model
Marginal Costs



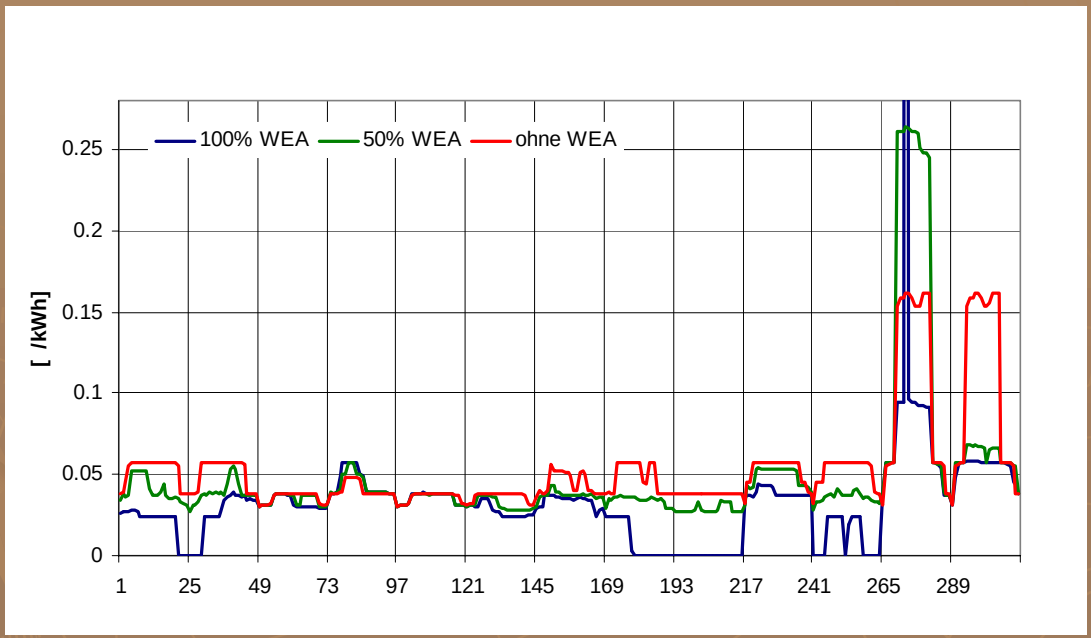


Results of German Model
Marginal Costs

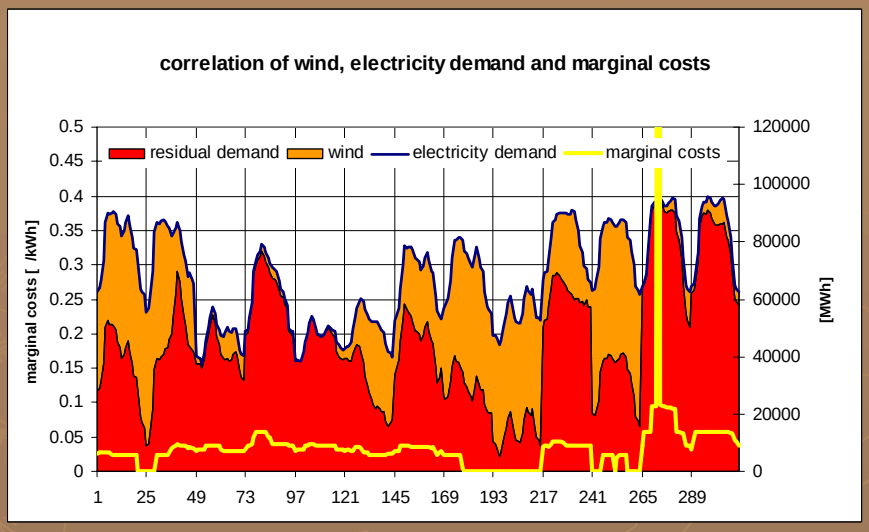




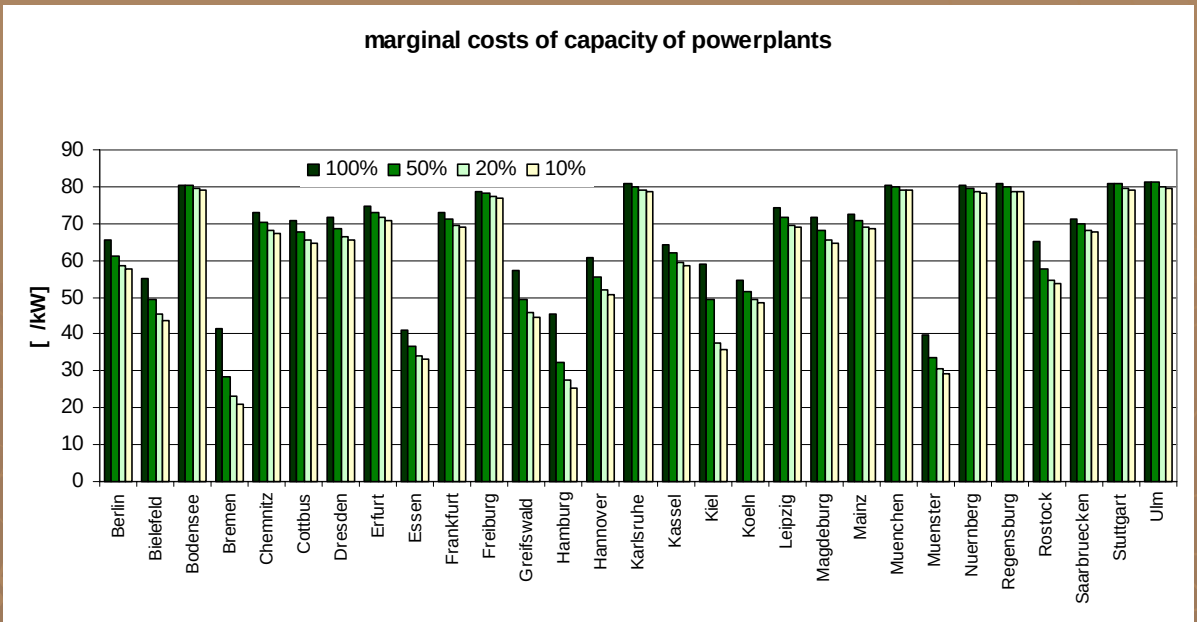
Results of German Model
Electricity Tariff Development



Results of German Model
Marginal Costs



Results of German Model
Marginal Cost of Capacity



Conclusion

- Steady increase of electricity demand
- Necessity of reorganisation of power plant mix
- And integration of renewable Energies
- Choice of location for wind power is very important
- Cost for wind energy are highly dependent on installed wind turbines
- And on the wind supply itself