
Transformation to High Shares of Renewable Energies – A Case Study for Berlin-Brandenburg

Caroline Möller, Berit Müller, Markus Hlusiak,
Jochen Twele

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One research focus:

- **Integrated energy systems**

- Optimization of energy systems
- Energy transition processes
- Off-grid energy systems

→ study for the Berlin-Brandenburg region in Germany
on the transformation of its energy system



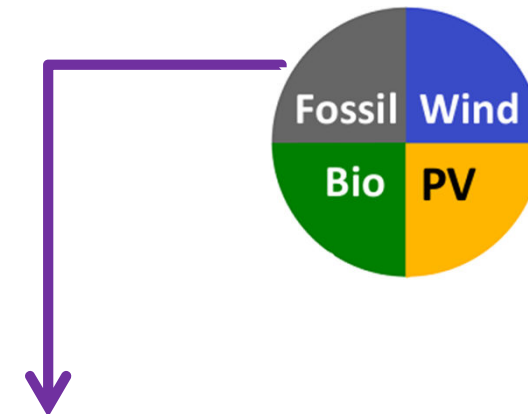
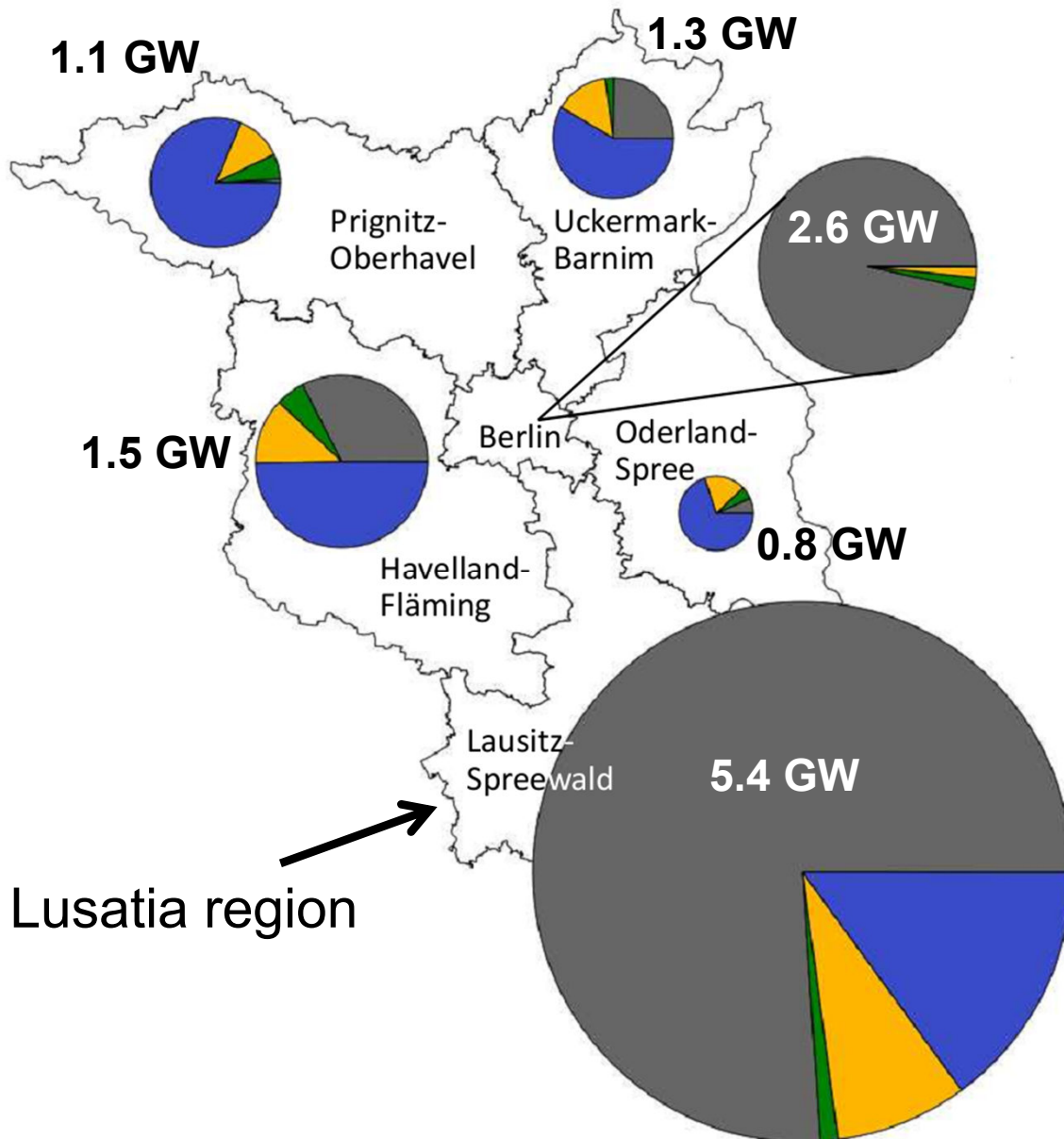
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Founder of the Reiner Lemoine-Foundation

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- **Research Object**
 - **Energy Model**
 - **Simulation Results**
 - **Conclusion**
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- **Berlin: little open spaces**
- **Brandenburg: more open spaces and already a high share of renewable electricity generation**

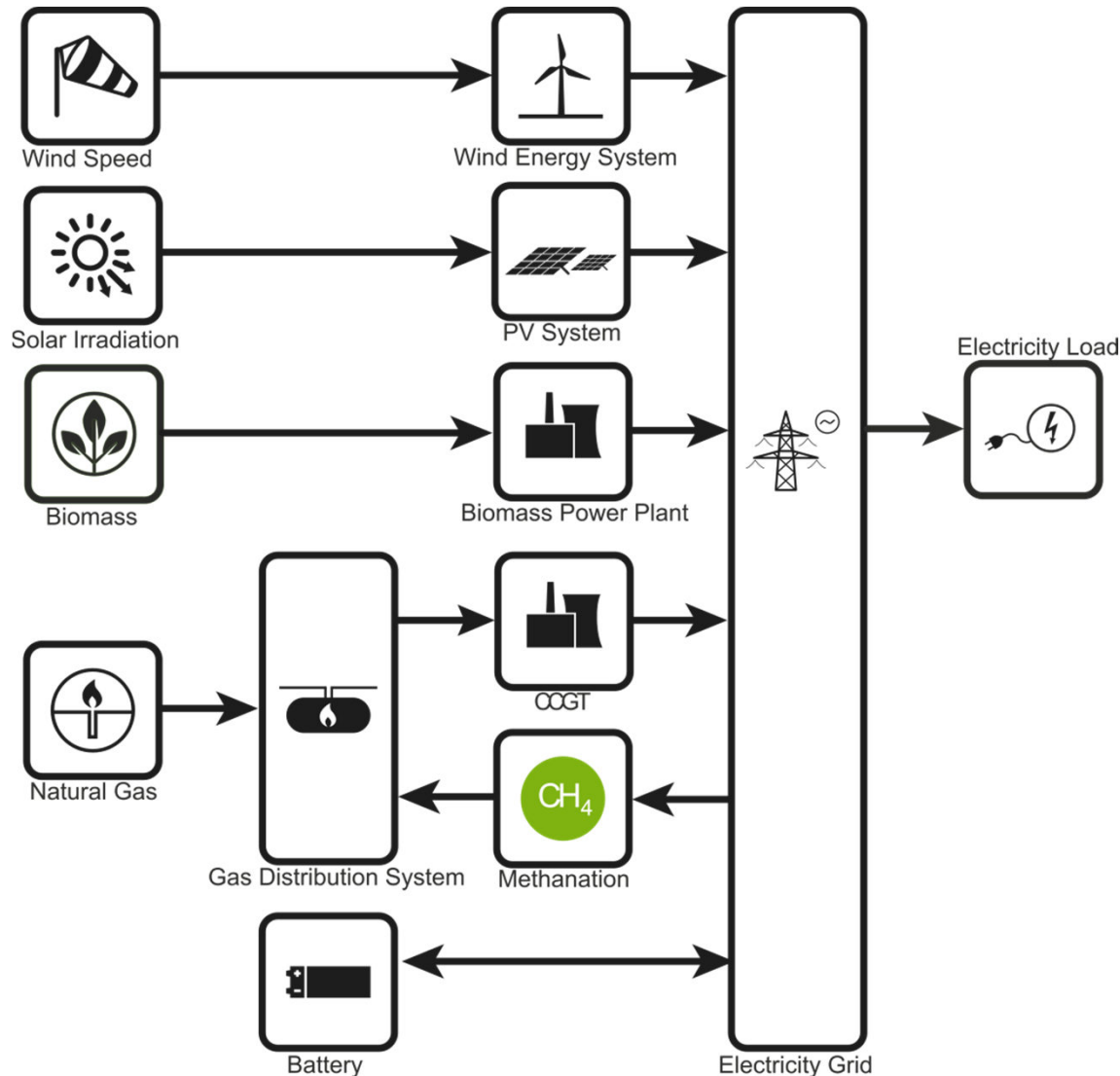
Electricity Supply – Installed Capacities



Brandenburg:
lignite coal (80 % of fossil power plants)

Berlin:
natural gas (50 %)
hard coal (30 %)

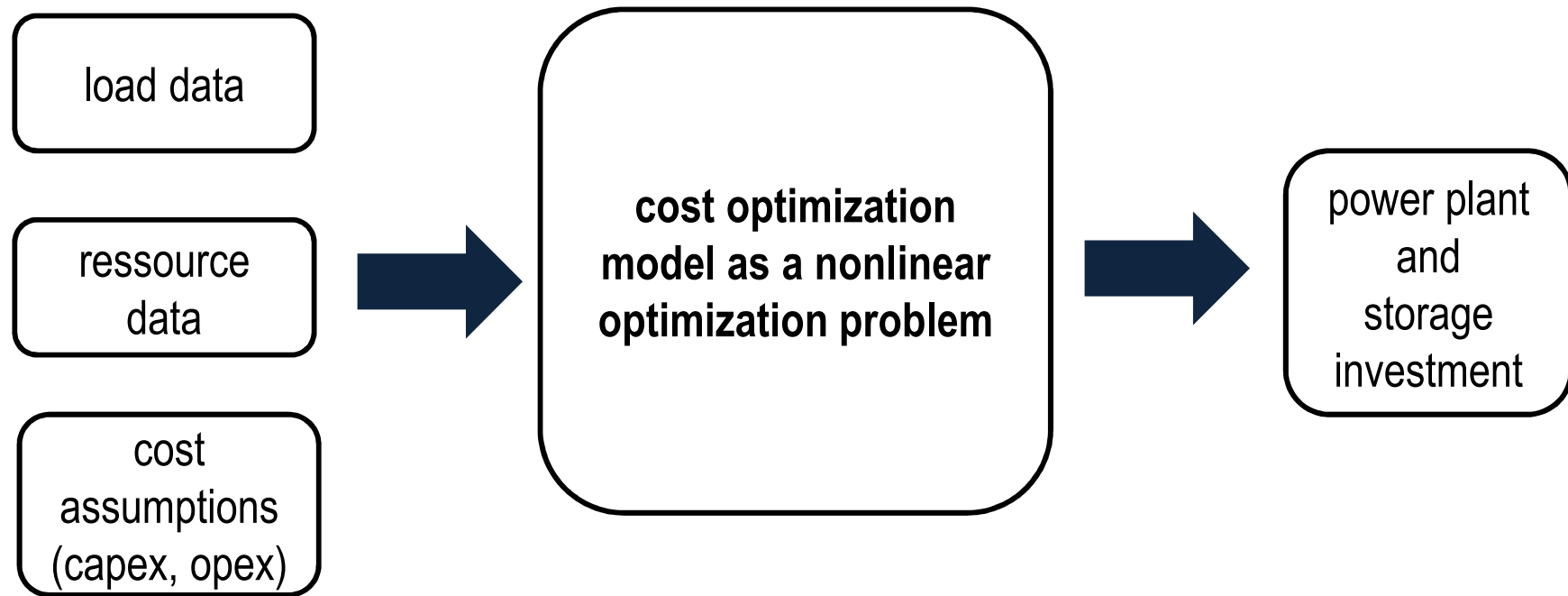
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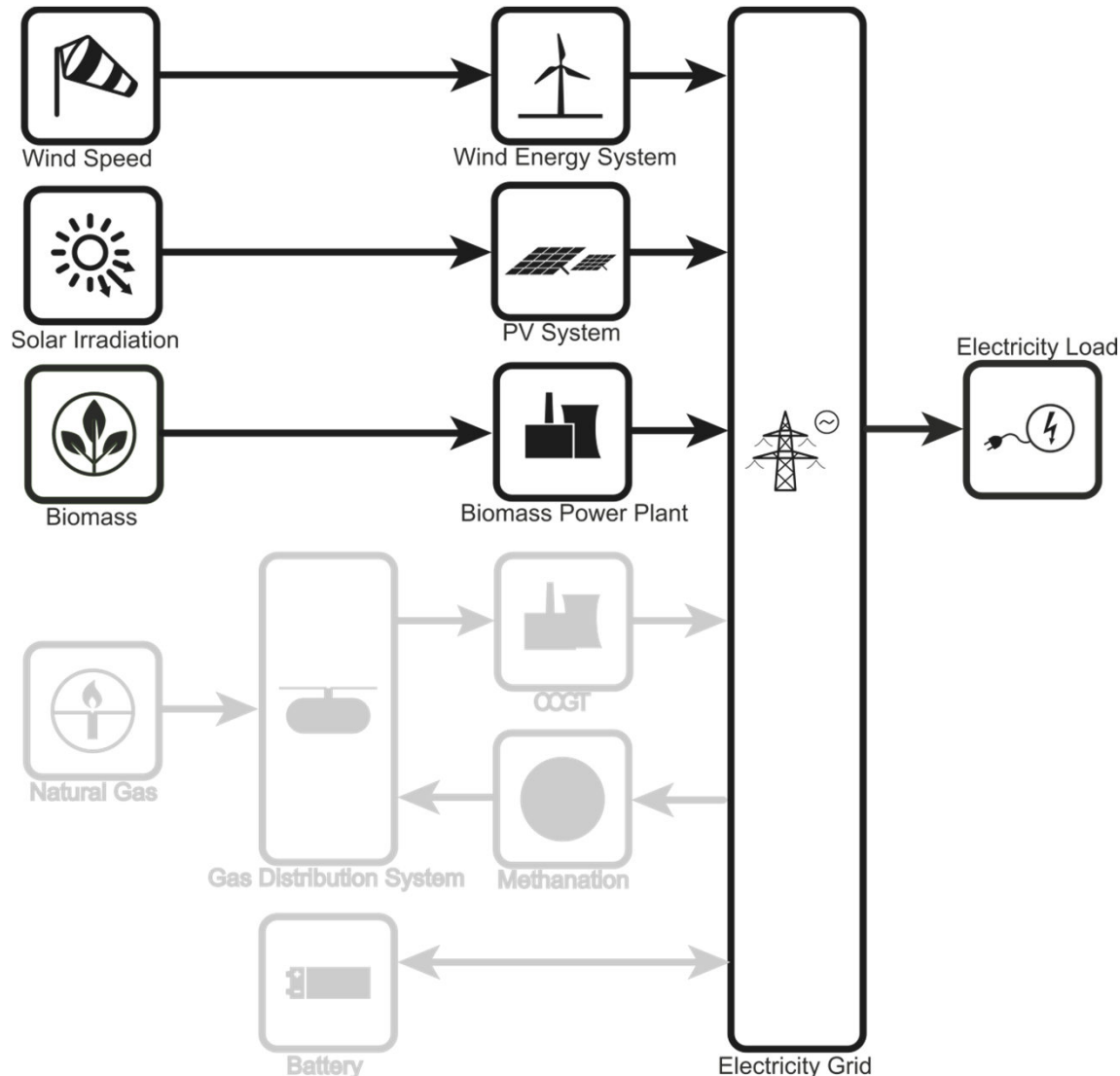


Several electricity sources and storages supply one load

Combined simulations in two energy models

- **cost optimization**
- **distribution model**





Renewable Ressources

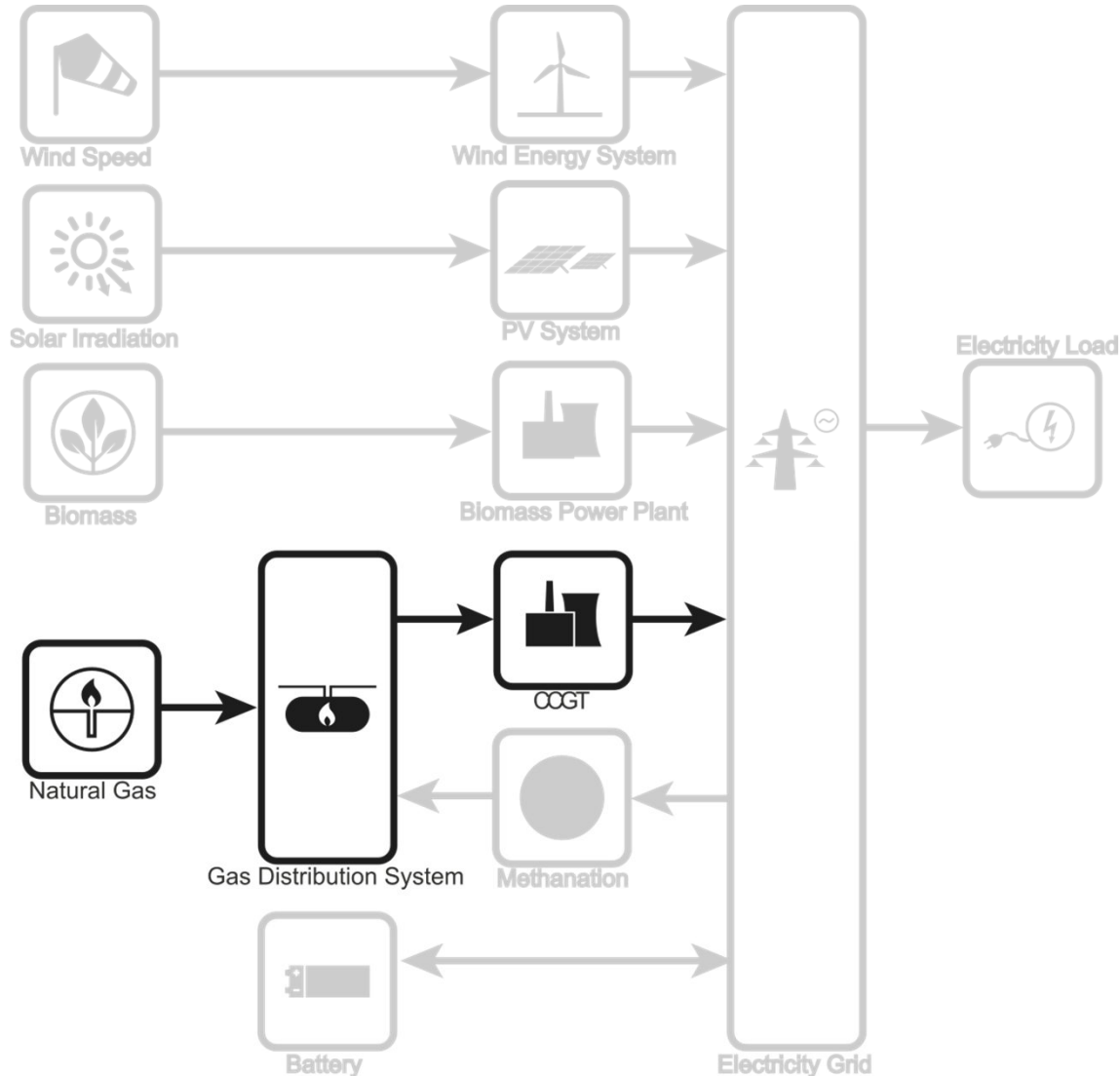
- Wind, PV: hourly data from a global model
- Biomass: present level

Electricity Load

- Hourly data from the TSO
- 50Hertz
- Load reduction 20 % → 23 TWh

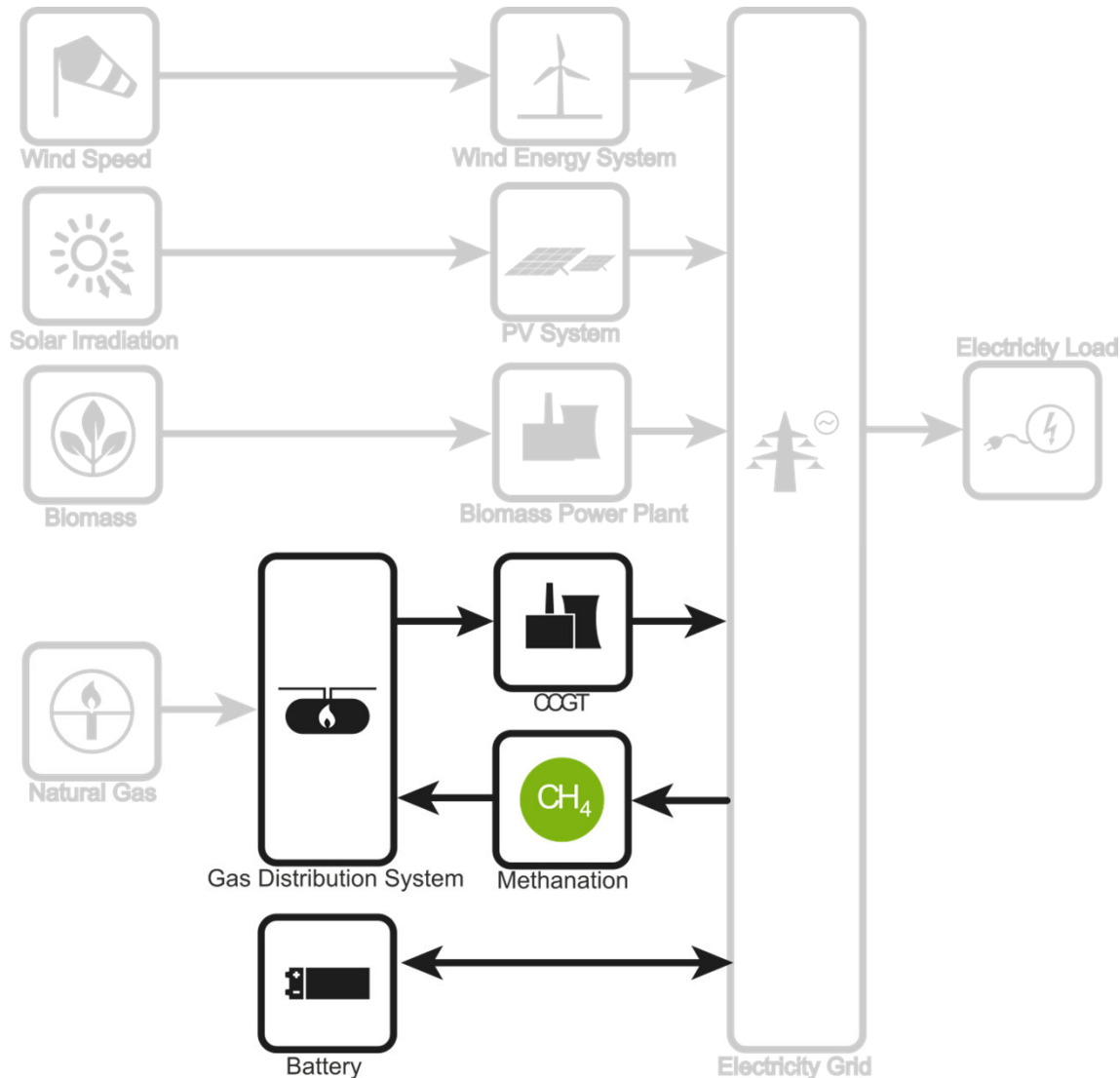
Electricity Grid

- one node
- no losses and bottlenecks



Natural gas path

- natural gas resource
- methane storage
- gas turbine power plant



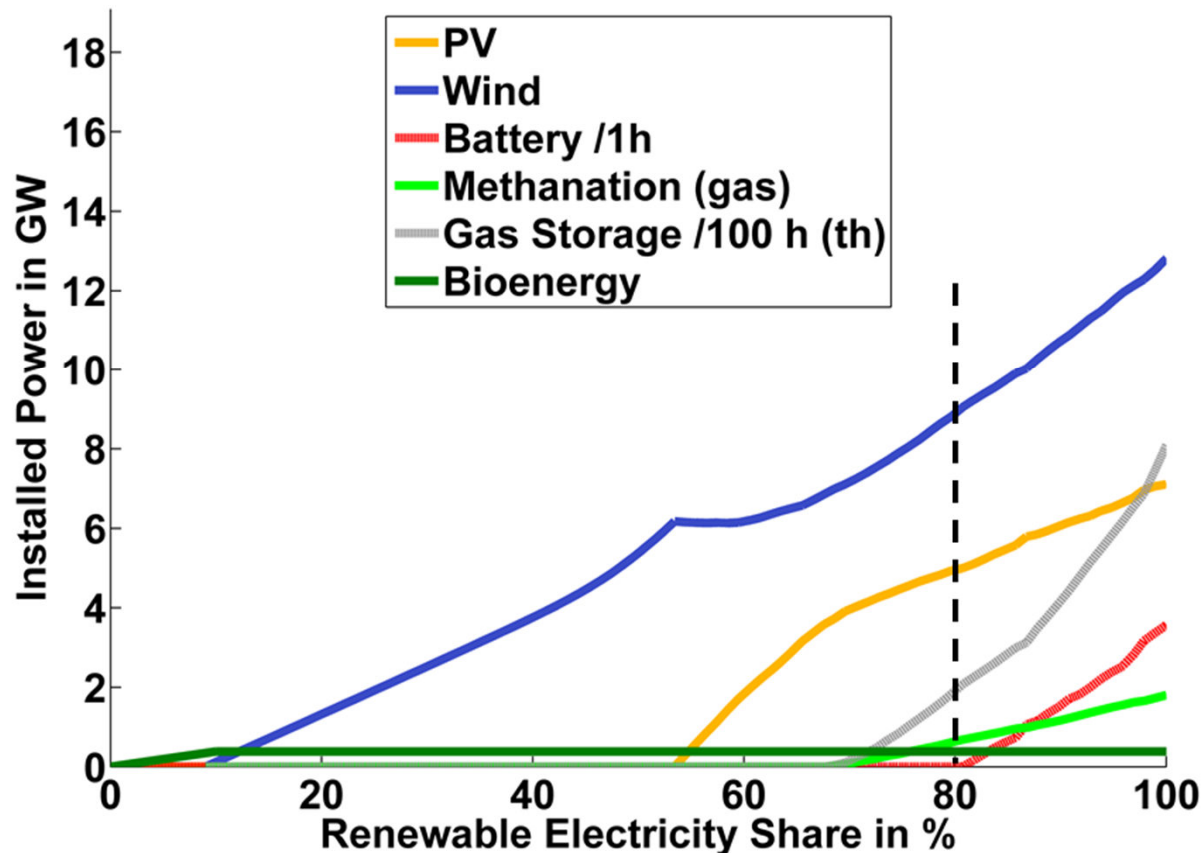
Storages

- Battery: sodium-sulphur (NaS)
- Renewable power methane:
 - methane generation
 - methane storage
 - gas turbine power plant

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cost reference year: 2020

Technologies for an
„80 % scenario“

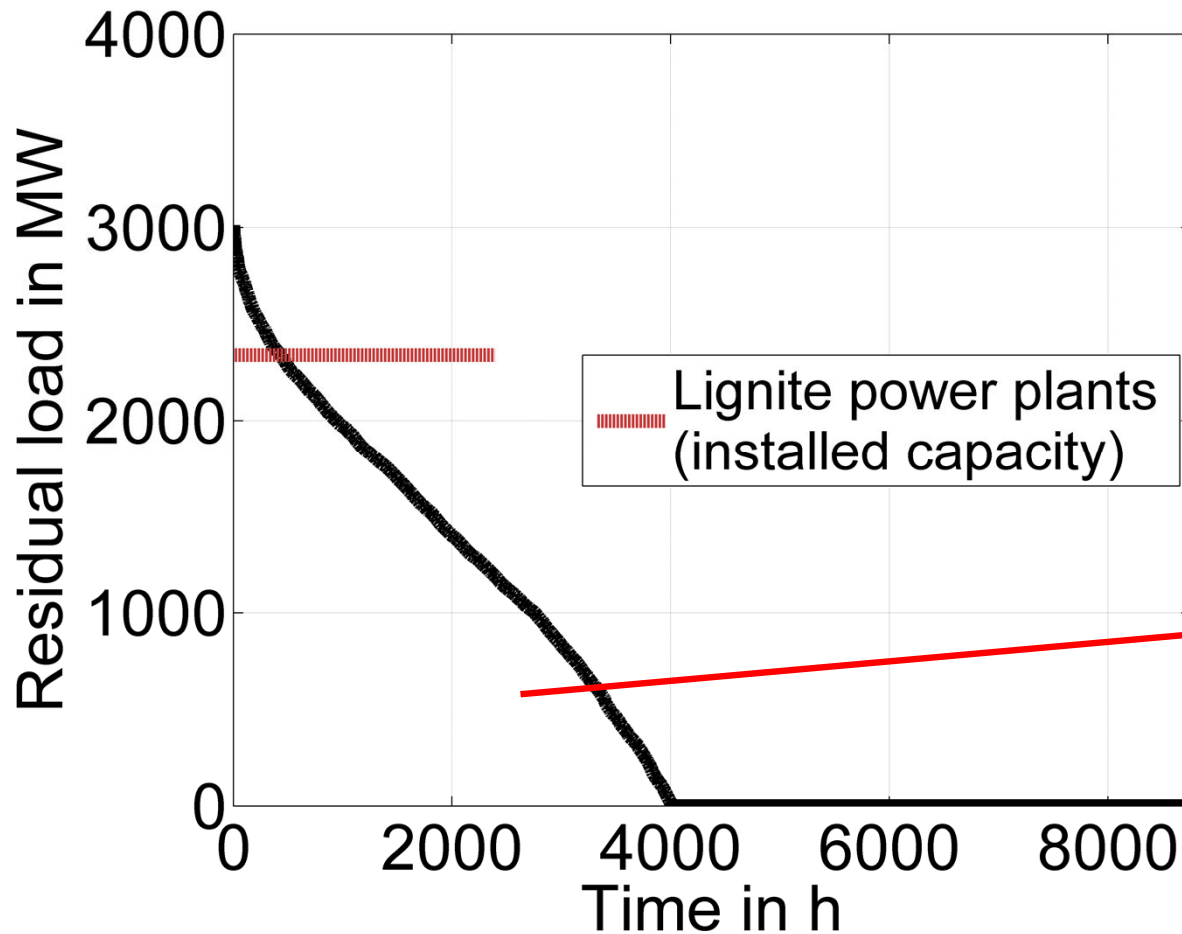


- Wind: 8 820 MW
- PV: 4 840 MW
- Methanation: 620 MW
- Gas Storage: 184 GWh
- Bioenergy: 390 MW

Installed Capacities – Comparison

		present situation	scenario 2020 (80 %)	political target
PV	MW	1 280	4 840	2 940
Wind	MW	4 470	8 820	7 640
Battery	MWh	0	0	0
Methanation	MW	0	620	0
Gas storage	MWh	0	184 400	0
Bioenergy	MW	390	390	390
Electricity demand	TWh	28.4	22.7	25.0

Required Fossil Backup Plants



Lignite power plants

- Schwarze Pumpe: 1 500 MW
- Jänschwalde: 840 MW
- 2 340 MW**

**2 400 full load hours
for lignite power plants**

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Required installed capacities are partially comparable to those planned by the governments.

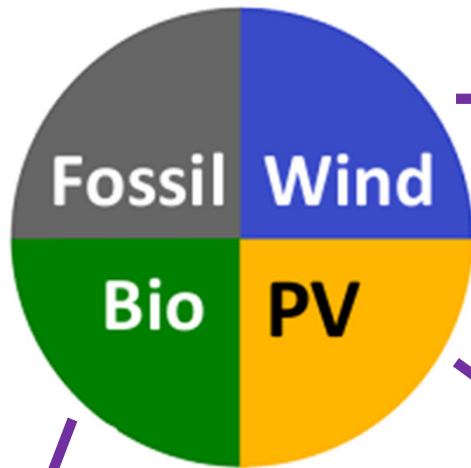
An increase of storage technologies is crucial for a successful transformation.

Lignite power plants are not suitable as a bridging technology.

Thanks for your attention!



Backup: Installed capacities of renewable energies



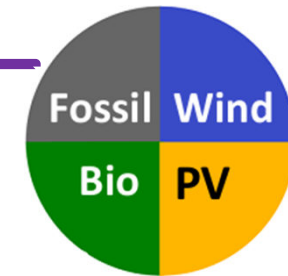
Brandenburg: **4 470 MW**
Berlin: **2 MW**

Brandenburg: **1 240 MW**
Berlin: **40 MW**

Brandenburg: **340 MW**
Berlin: **25 MW**

Coverage of electricity demand through renewable energies (annual balance):
in Brandenburg **around 60 %**,
in Berlin **around 2 %**

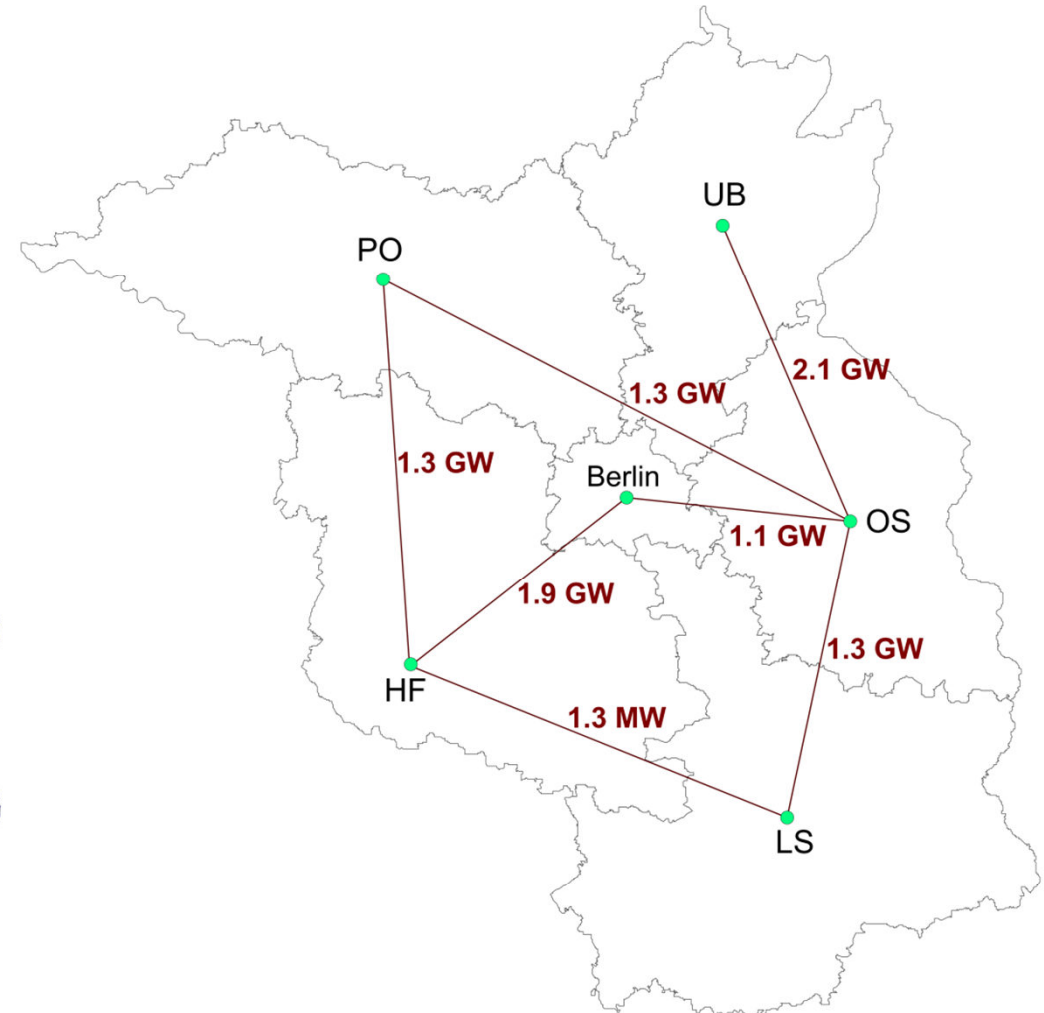
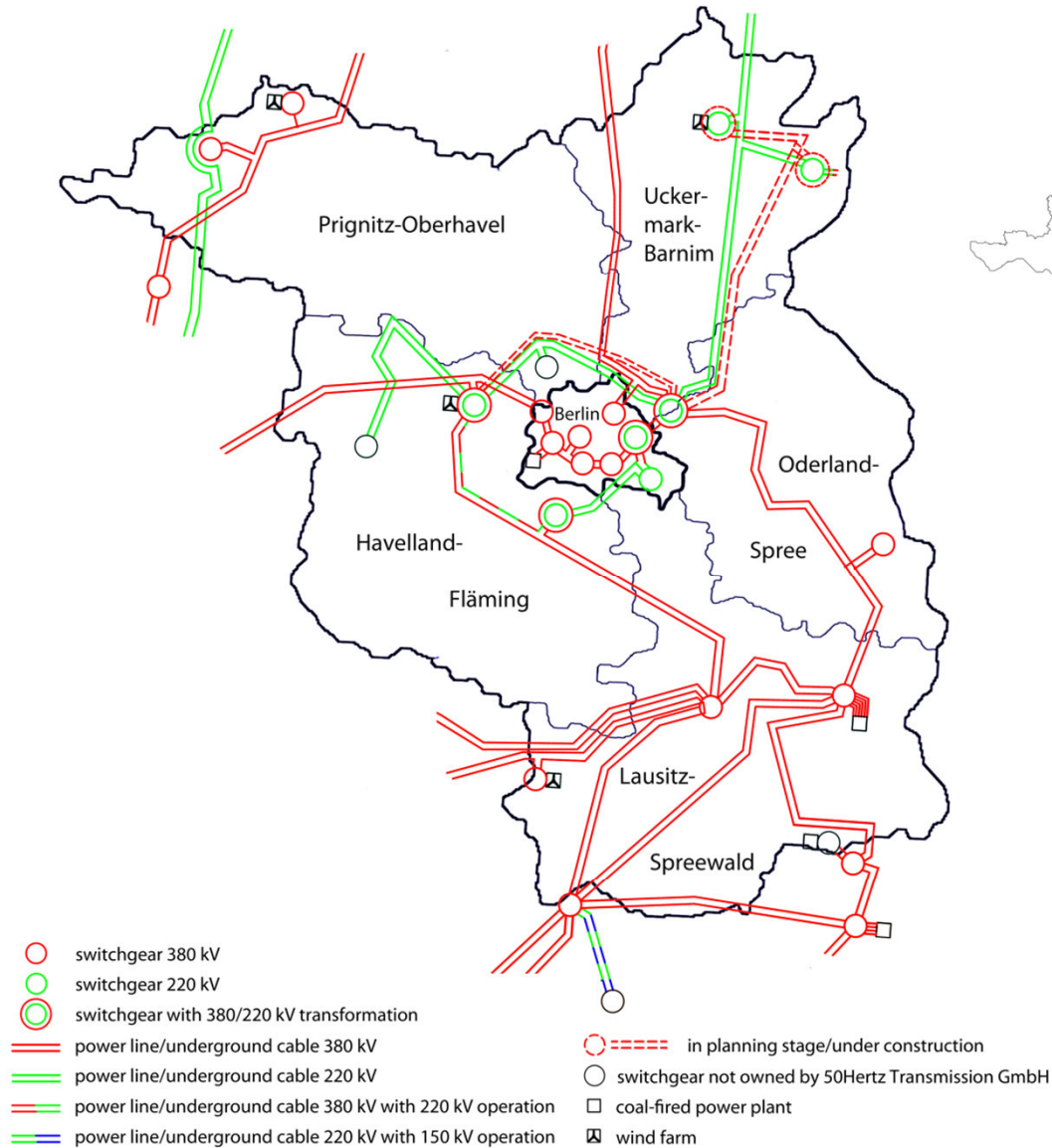
Backup: Installed capacities of fossil power plants



installed capacity natural gas:
currently: **around 2.000 MW**
additionally required: **1.000 MW**

	Brandenburg	Berlin
lignite coal	4 500	160
hard coal	0	650
natural gas	870	1 150
oil	190	280
other	120	120
total	5 680	2 360

Backup: distribution model



Invest PV	1 000 €/kW_p
Invest Wind	1 000 €/kW_{nom}
Invest Gas Turbine Power Plant	750 €/kW_{el}
Invest Battery	175 €/kWh_{cap}
Invest Methane Storage	1 €/kW_{cap,th}
Invest Methanation	1 880 €/kW_{th}
Natural gas price	50 €/MWh_{th}
Interest rate (WACC)	6.4 % p.a.
Lifetime battery	10 years
Lifetime other power plants	≥ 20 years
Efficiency Gas Turbine Power Plant	58 %
Efficiency Methanation (Power to Gas)	50 %
Efficiency Battery (Power to Power)	85 %