

# Gas-to-power in electricity grid development

## The German NEP as an example

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# Some characteristics of electricity

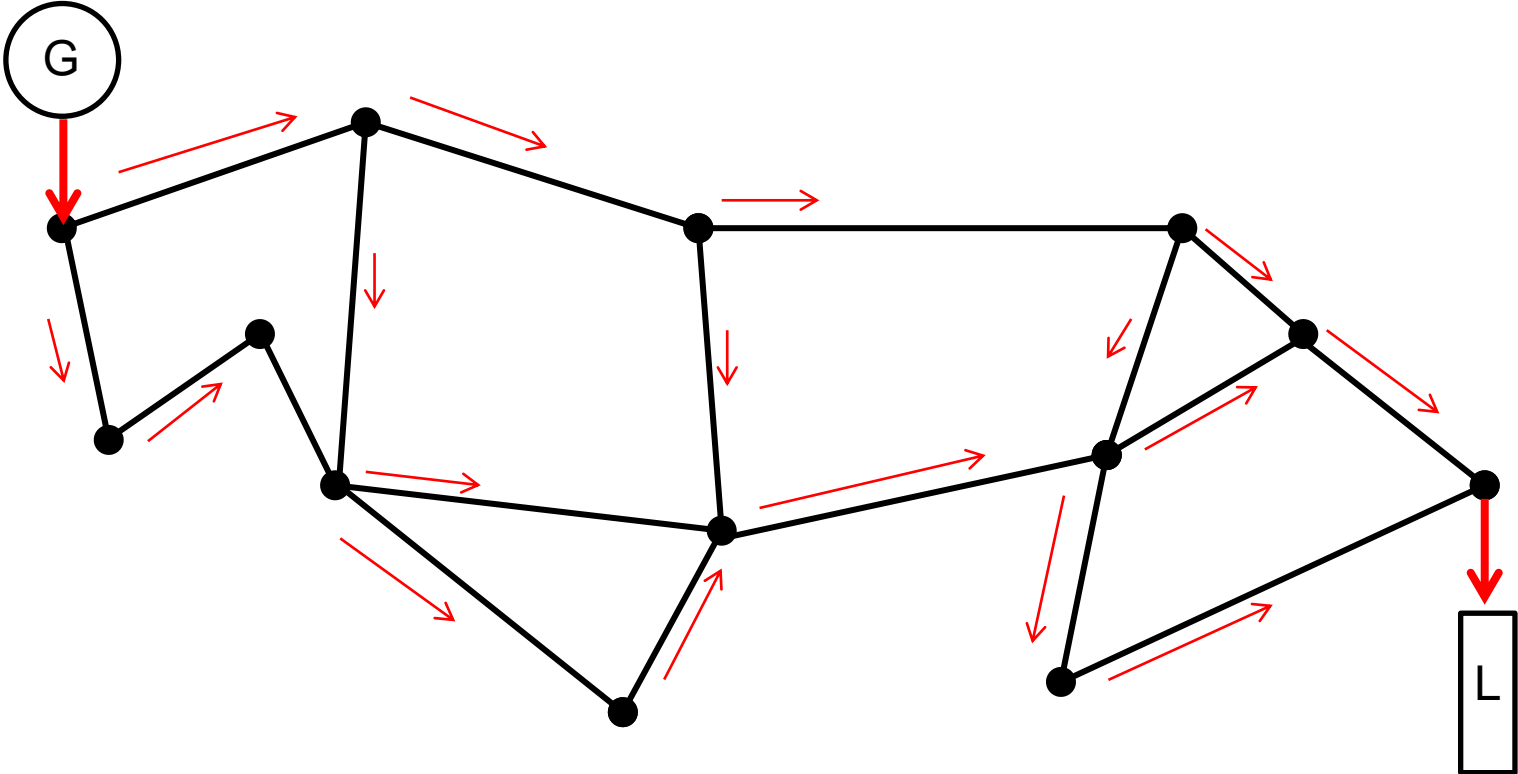
- The sum of all infeeds and losses equals the sum of all outtakes of the electricity system at all times
- The flow on each branch of the grid is related to all infeeds and outtakes (Superposition principle)
- Voltage, current, and other electrical variables define the flow on each branch



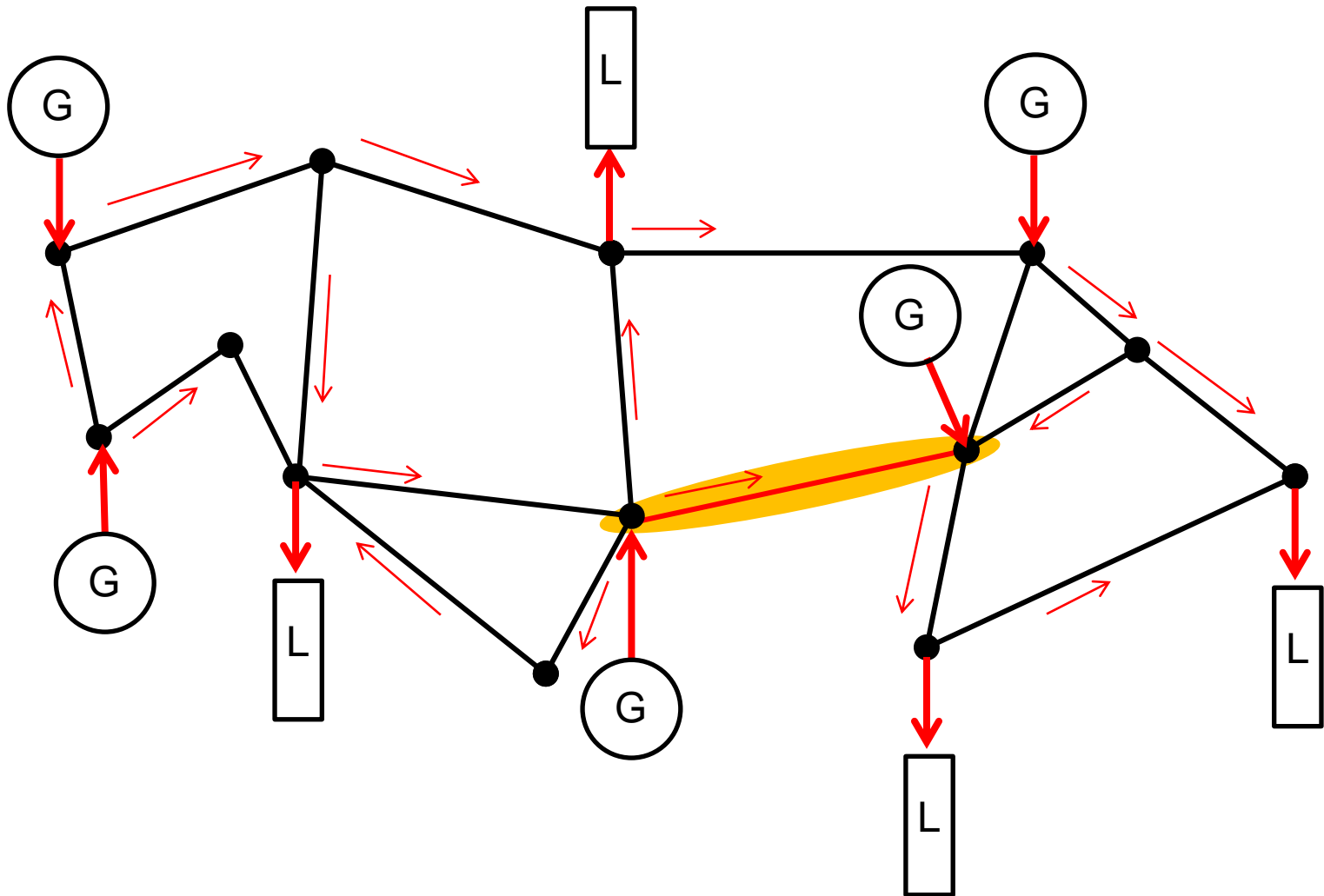
# Main drivers for grid development

- increasing transport moments (distance x volume)
  - reducing impedances along transit axes
  - installation of phase shifting transformers
  - redispatch of power plants
  - reserve contracts with power plants
- increasing needs for volatile provision of reactive power
  - installation of reactive power devices and VSC-HVDC
  - reactive power provision by DSOs and generators
- decreasing amount of locally available short circuit power
  - increase of meshing
  - installation of rotating phase shifters
  - contracts with power plants

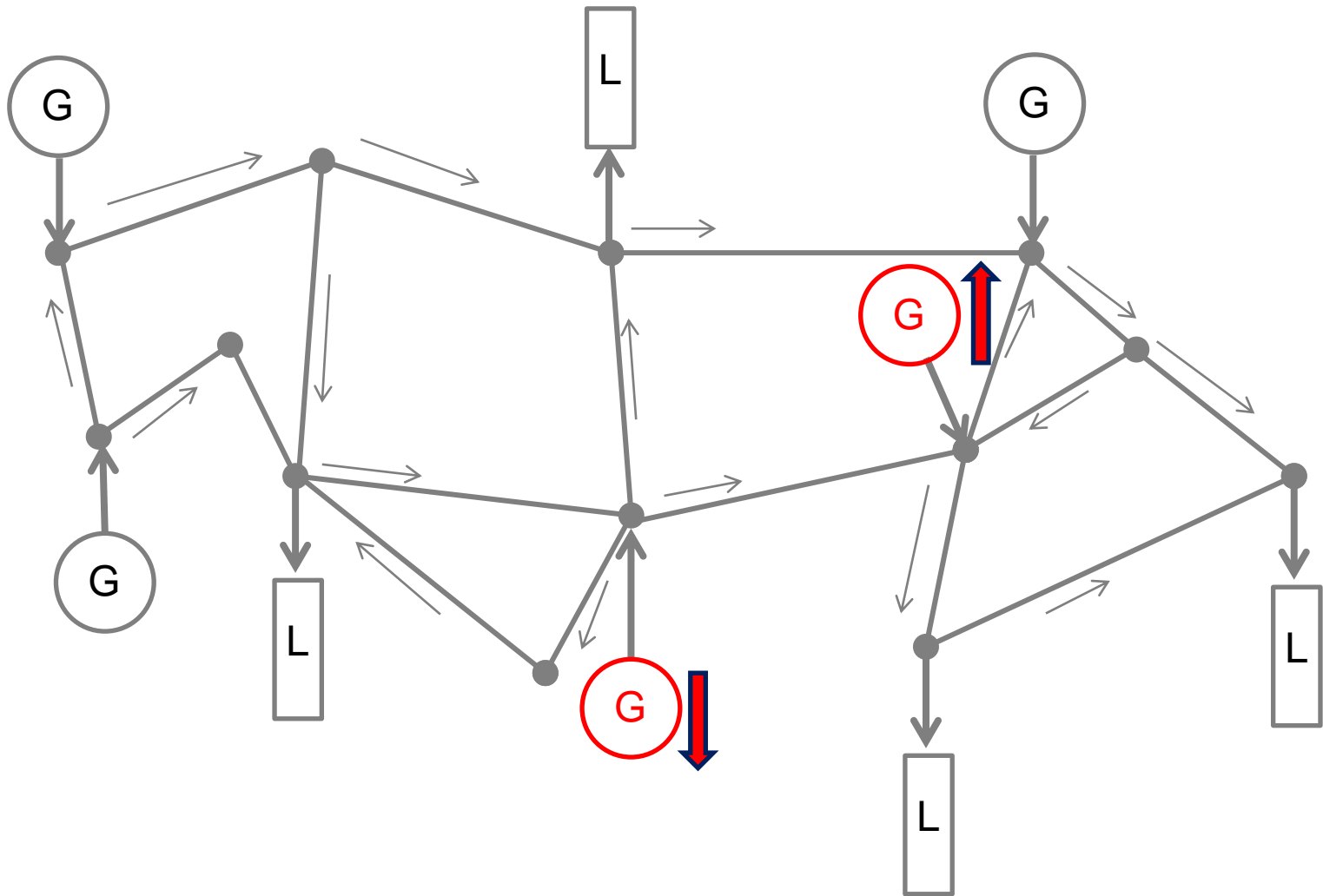
# Operation of the meshed electricity grid



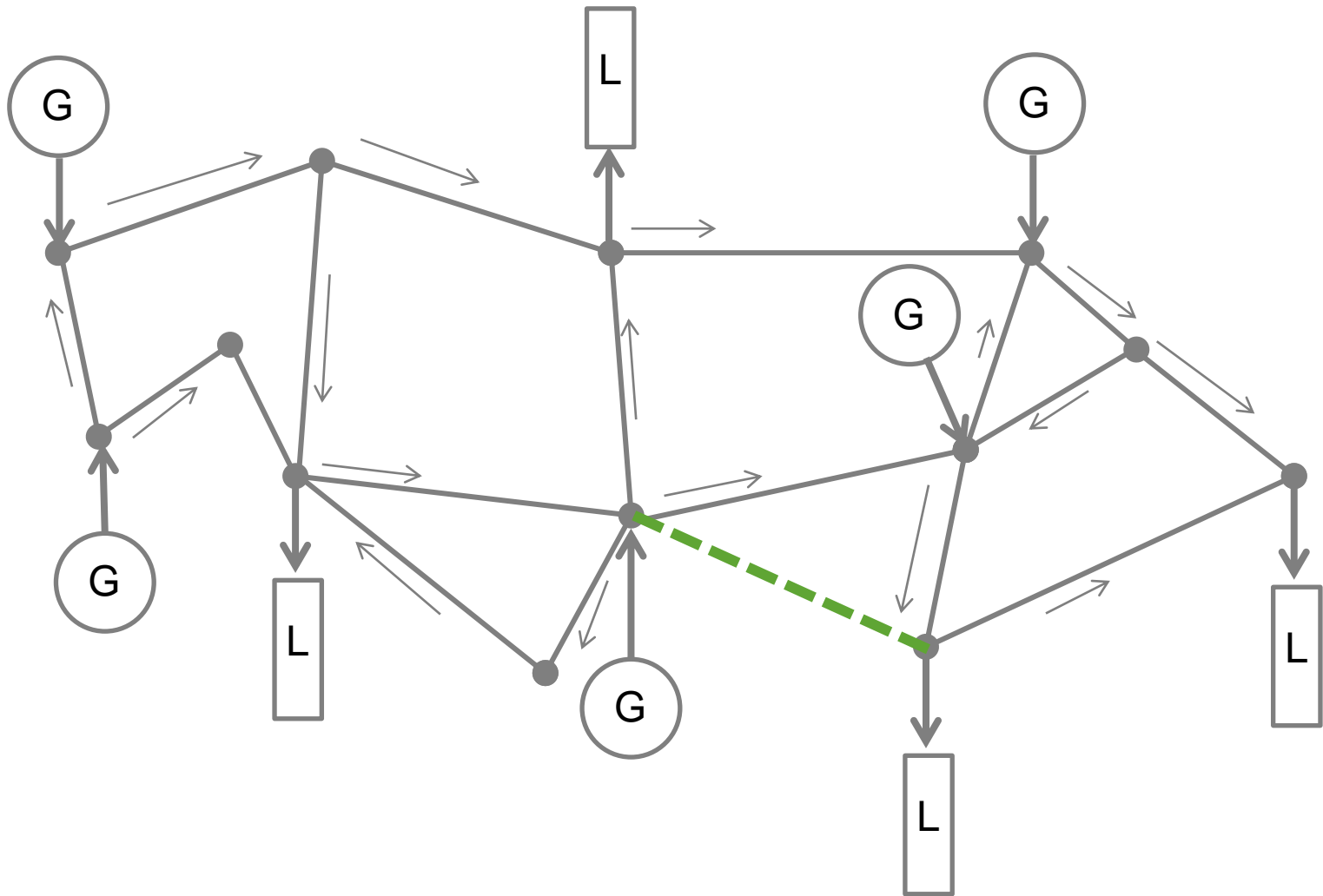
# Transport congestion (thermal N-1)



# Role of power plants in solving congestion



# The „grid solution“



# The Netzentwicklungsplan (2012)

- Is prepared yearly by all four German TSOs together
- Contains the outlook for 10 and 20 years in three scenarios
- TenneT connects the largest part of the RES in Germany:
  - 42% Onshore wind
  - 81% Offshore wind
  - 41% Photovoltaics

[www.netzentwicklungsplan.de](http://www.netzentwicklungsplan.de)



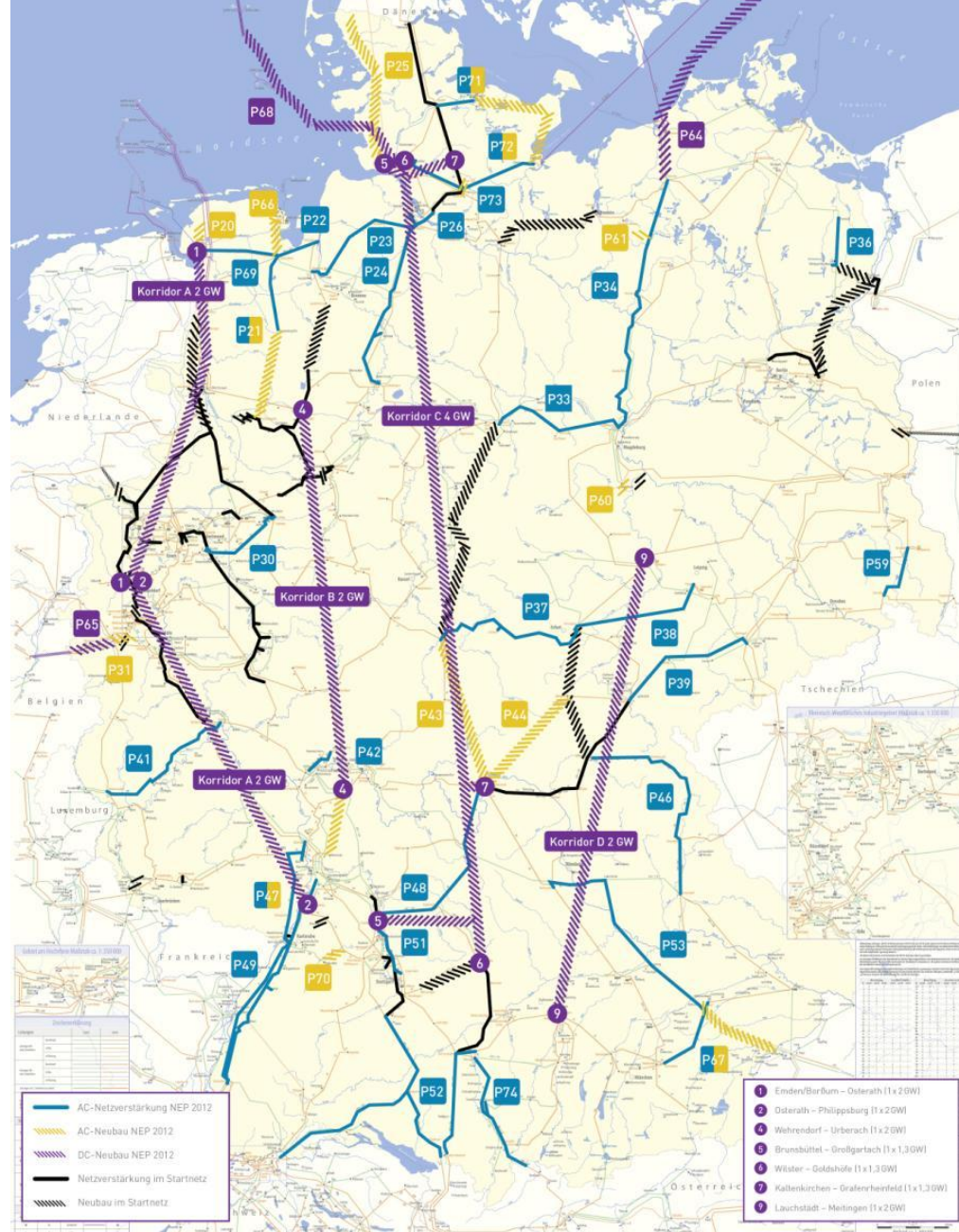


# Scenario Framework 2012

Technologie - ÜNB	Referenz -2010	Szenario A 2022	(Leit-) Szenario B - 2022	Szenario B - 2032	Szenario C 2022
<b>Installierte Erzeugungleistung [GW]</b>					
Kernenergie	20,3	0,0	0,0	0,0	0,0
Braunkohle	20,3	21,3	18,6	13,9	18,6
Steinkohle	25,0	30,6	25,1	21,2	25,1
Erdgas	24,0	25,1	31,3	40,1	31,3
Pumpspeicher	6,3	9,0	9,0	9,0	9,0
Öl	3,0	2,9	2,9	0,5	2,9
Sonstige	3,0	2,3	2,3	2,7	2,3
<b>Summe konv. KW</b>	<b>101,9</b>	<b>91,2</b>	<b>89,2</b>	<b>87,4</b>	<b>89,2</b>
Wasserkraft	4,4	4,5	4,7	4,9	4,3
Wind (onshore)	27,1	43,9	47,5	64,5	70,7
Wind (offshore)	0,1	9,7	13,0	28,0	16,7
Photovoltaik	18,0	48,0	54,0	65,0	48,6
Biomasse	5,0	7,6	8,4	9,4	6,7
andere reg. Erzeugung	1,7	1,9	2,2	2,9	2,0
<b>Summe EE</b>	<b>56,3</b>	<b>115,6</b>	<b>129,8</b>	<b>174,7</b>	<b>149,0</b>
<b>Summe Erzeugung</b>	<b>158,2</b>	<b>206,8</b>	<b>219,0</b>	<b>262,1</b>	<b>238,2</b>

# The Result

- Thousands of market simulations for Europe based on ENTSO-E data
- Hundreds of grid topologies tested
- Thousands of load flow calculations for each (4 model years = 4\*8760 hours)
- 20 bn Euros investment in the EHV grid in the next 10 years identified
- New transmission technologies as integral part of the plan



# G2P in the NEP 2012

	TWh	Avg. full load hours
Saldo DE	31,8	
Load DE	562,1	
Wind onshore	93,6	2130
Wind offshore	41,2	4223
PV	48,7	901
Gas	41,6	1509

TenneT is Europe's first cross-border grid operator for electricity. With approximately 20.000 kilometres of (Extra) High Voltage lines and 36 million end users in the Netherlands and Germany we rank among the top five grid operators in Europe. Our focus is to develop a north-west European energy market and to integrate renewable energy.

**Taking power further**

[www.tennet.eu](http://www.tennet.eu)

