



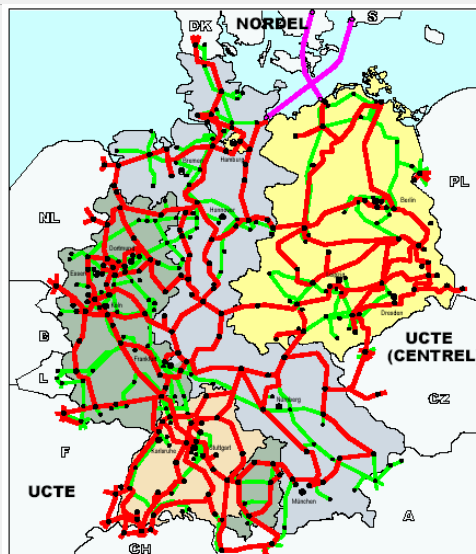
# “DENA-Grid-Study”


## Integration of Onshore and Offshore Wind Energy into the German Power System – Planning Study 2003 - 2020

Dr.-Ing. Markus Pöller




### German Power Transmission System






## Actors




- *EWI-Consortium*
  - *DEWI: Part 1/Scenarios*
  - *E.ON/RWE/Vattenfall: Part 2/Grid*
  - *EWI: Part 3/Power Plant Development*
- ISET and DIGSILENT: Independent assessors
- Project control: Around 50 delegates from different organisations who financed the study.

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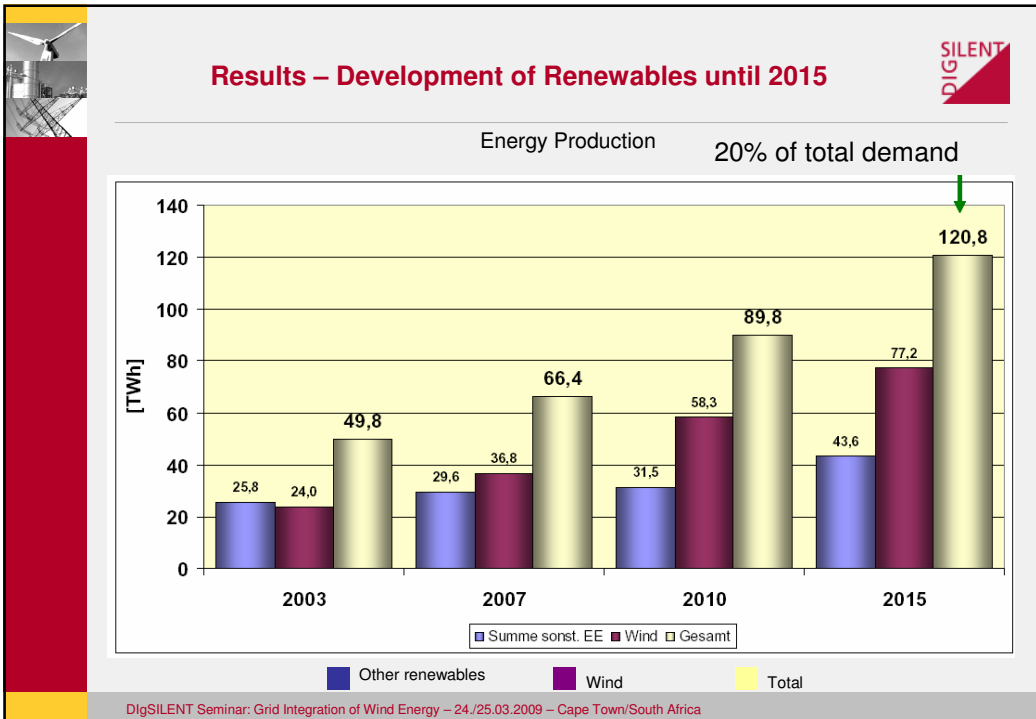
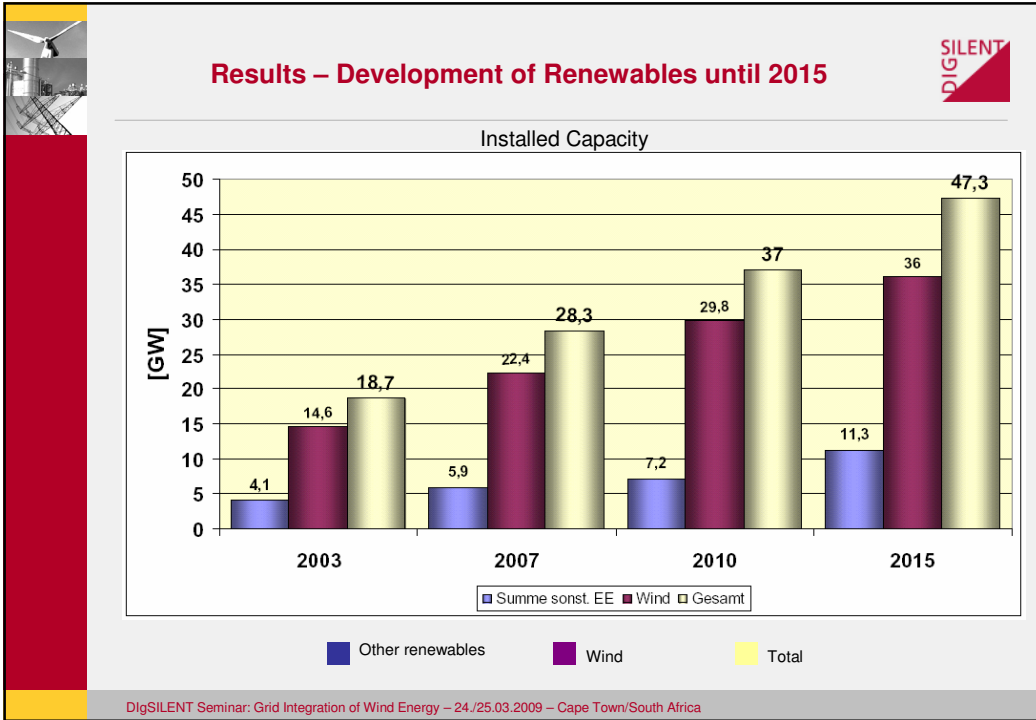



## Organisation




1. Scenarios for future development of wind power and other renewable energies (solar, biomass, hydro, geo-thermal)
2. Power system impact/required network reinforcements
3. Influence on conventional power plant park, reserve requirements, costs and CO2 emission.

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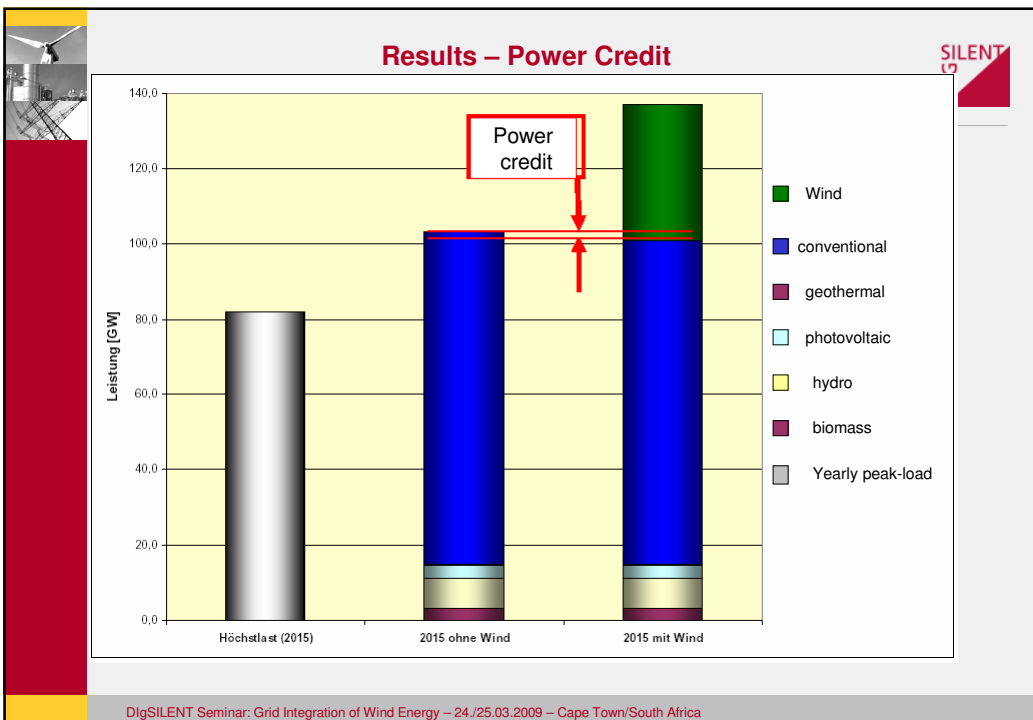


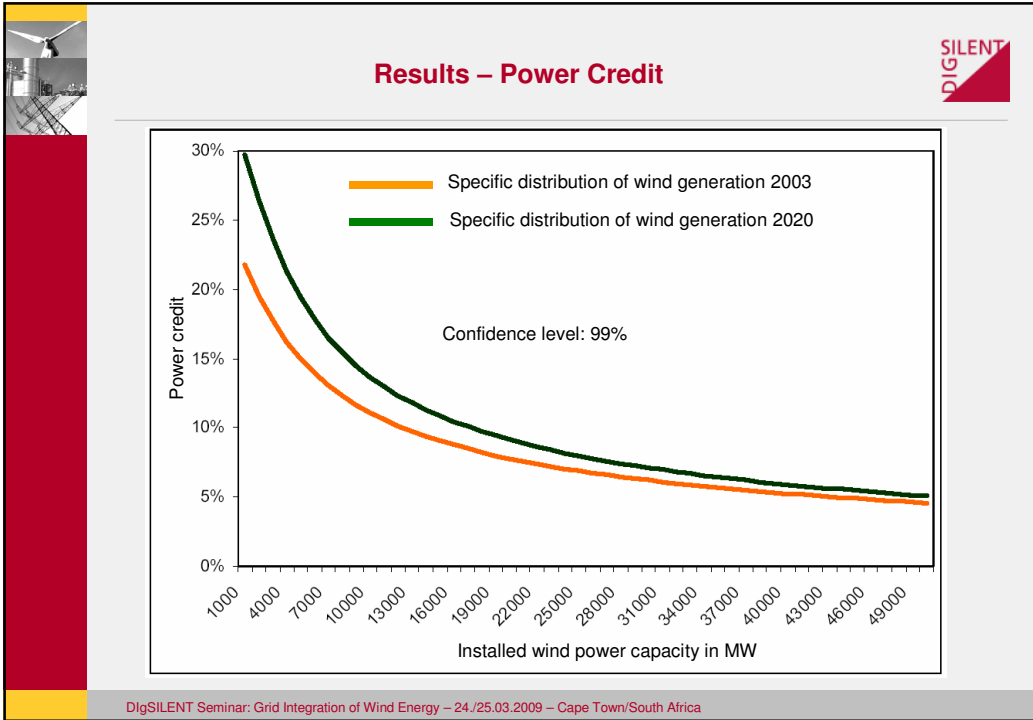
## Results – Network Reinforcements




- Reinforcement of 392km of existing overhead lines
- 850km of new transmission lines (until 2015)
- Additional reactive power sources (Capacitors, SVCs)
  
- Costs: ca 100 Million/year -> tarif increases by 0,025 cent/kWh

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- ### Challenges – Power Plants
- 
- Replacement of 40000MW thermal power plants until 2020 (facing out nuclear power, age)
  - Integration of wind energy and other renewables
  - CO2 trading, development of fuel costs
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## Scenarios




- Scenario 1:
  - Constant fuel costs (gas, oil, coal)
  - No costs of CO2 emission certificates
- Scenario 2:
  - Constant fuel costs (gas, oil, coal)
  - Auction for distributing CO2-certificates -> Equivalent increase in fuel costs -> more gas/oil
- Scenario 3:
  - Moderate increase of oil and gas price, coal price constant.
  - Auction for distributing CO2-certificates -> Compensation of CO2-costs on coal by increasing oil and gas prices

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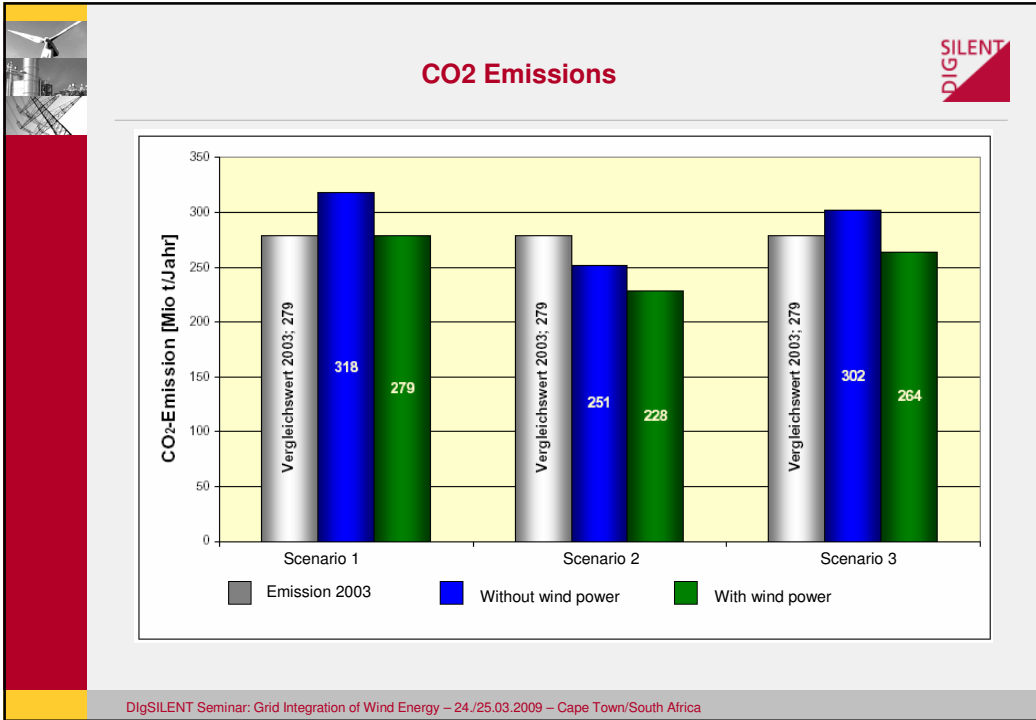


## Results – Influence on Regulating and Reserve Power



- 2003:
  - Positive: 1200MW average, 2000MW max.
  - Negative: 750MW average, 1900MW max.
- 2015
  - Positive: 3200MW average, 7000MW max.
  - Negative: 2800MW average, 5500MW max

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- ### Costs
- Scenario 1: 0,485 Cent/kWh
  - Scenario 2: 0,415 Cent/kWh
  - Scenario 3: 0,385 Cent/kWh
  
  - Network Reinforcement: 0,025 Cent/kWh
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