

## Specific Power Lay-out of Wind Turbines

### Possible optimization reasons:

- Economic profit optimization for the wind farm operator
- Profit optimization for the manufacturer of the wind turbine
- Cost optimization of the energy transportation and distribution grid
- Energy cost optimization of a wind turbine/storage system
- Increase the supply reliability for an energy generating system using different energy sources
- **Best fulfillment of a long term nationwide energy supply plan, e.g. a successful Energiewende (Energy Transition) in Germany**
- **Best lay-out to achieve the lowest energy costs for the consumer**

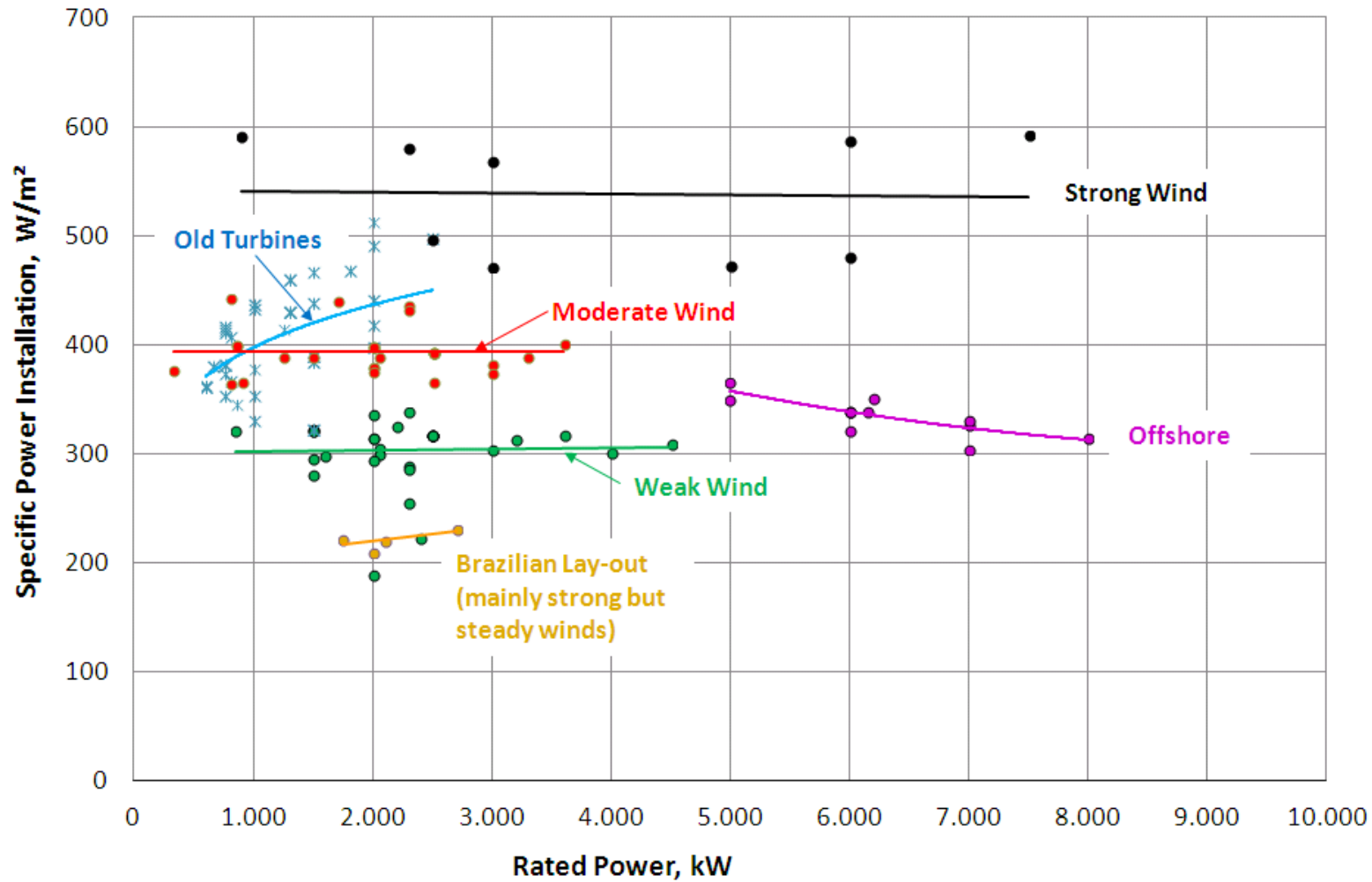
## Consequences

- All these optimization reasons will lead to different specific power installations of the wind turbines.
- The fulfillment of politically desired higher-level goals cannot be achieved by market driven conditions.
- Therefore the “Energiewende” in Germany needs clear guidance for the lay-out of the energy supply chain to meet the goal of a sustainable energy generation at affordable costs for the consumer.

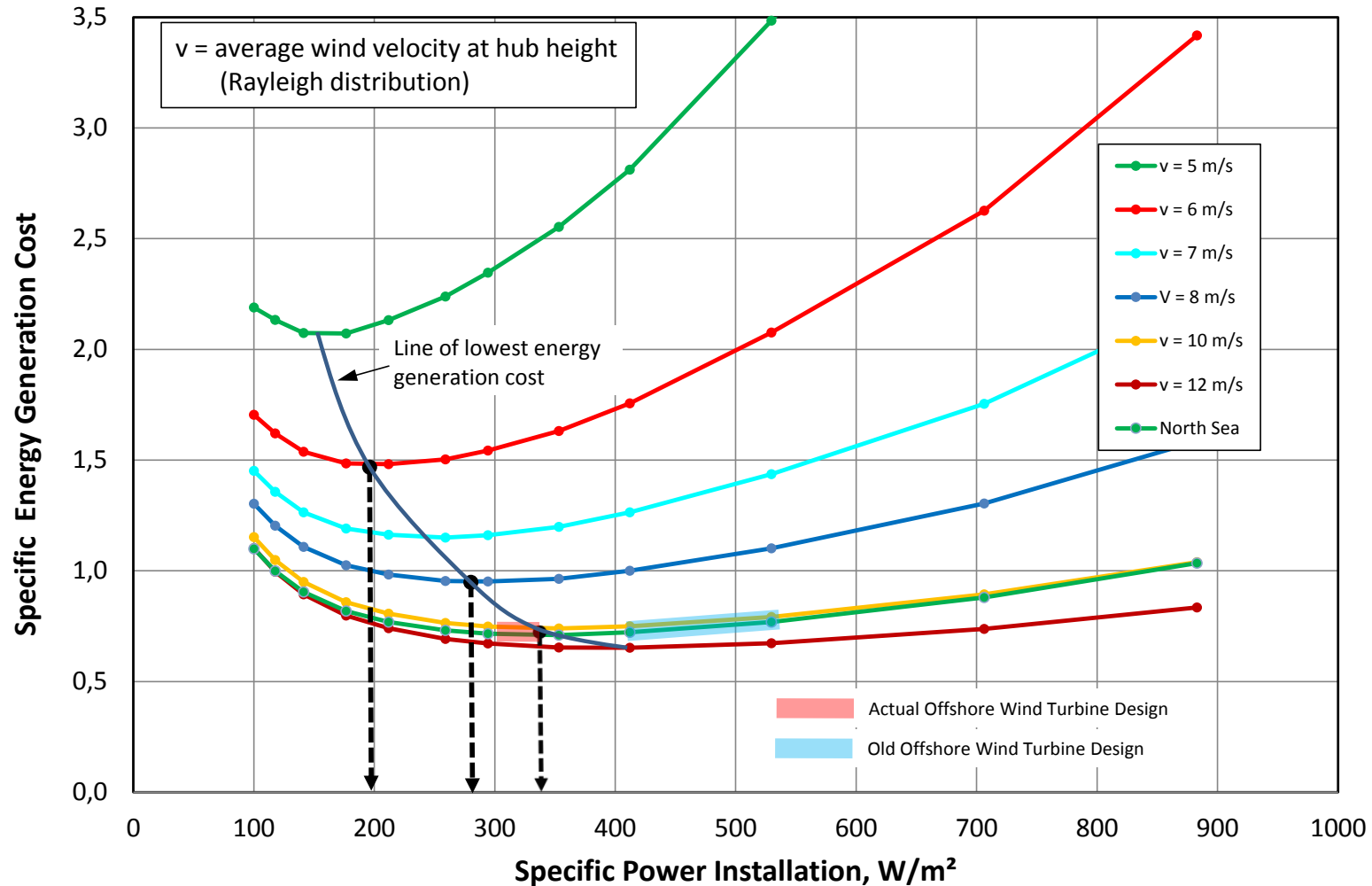
## Today's Situation in Germany

- With the today's regulations of the Renewable Energies Act (EEG), no possibilities exist to influence the wind turbine lay-out into the desired direction.
- Well designed participation conditions for a tender or auction system would allow to influence the wind turbine lay-out in the desired manner.

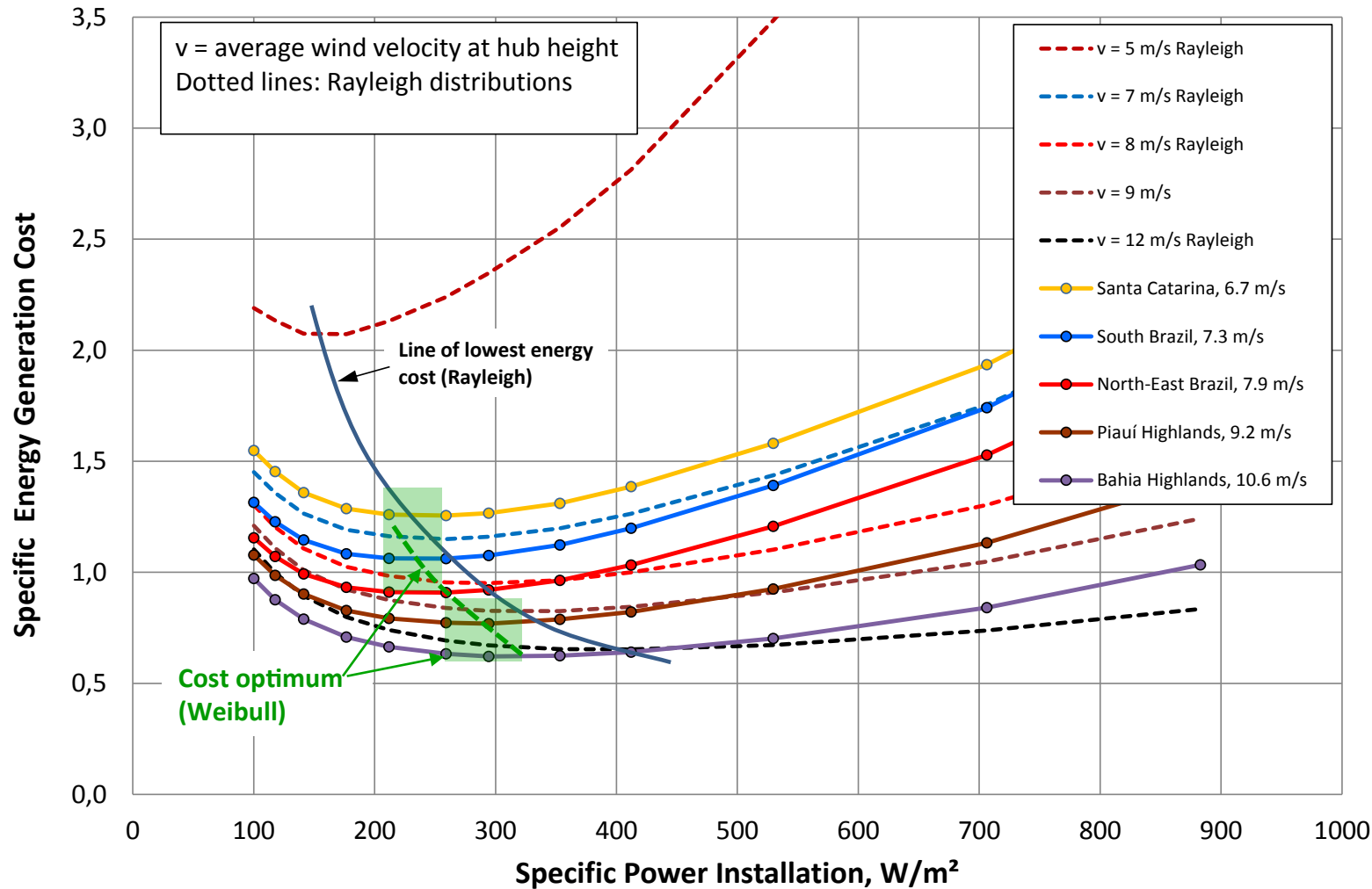
## Typical Specific Power Installations



## How to Find the Best Specific Power Installation



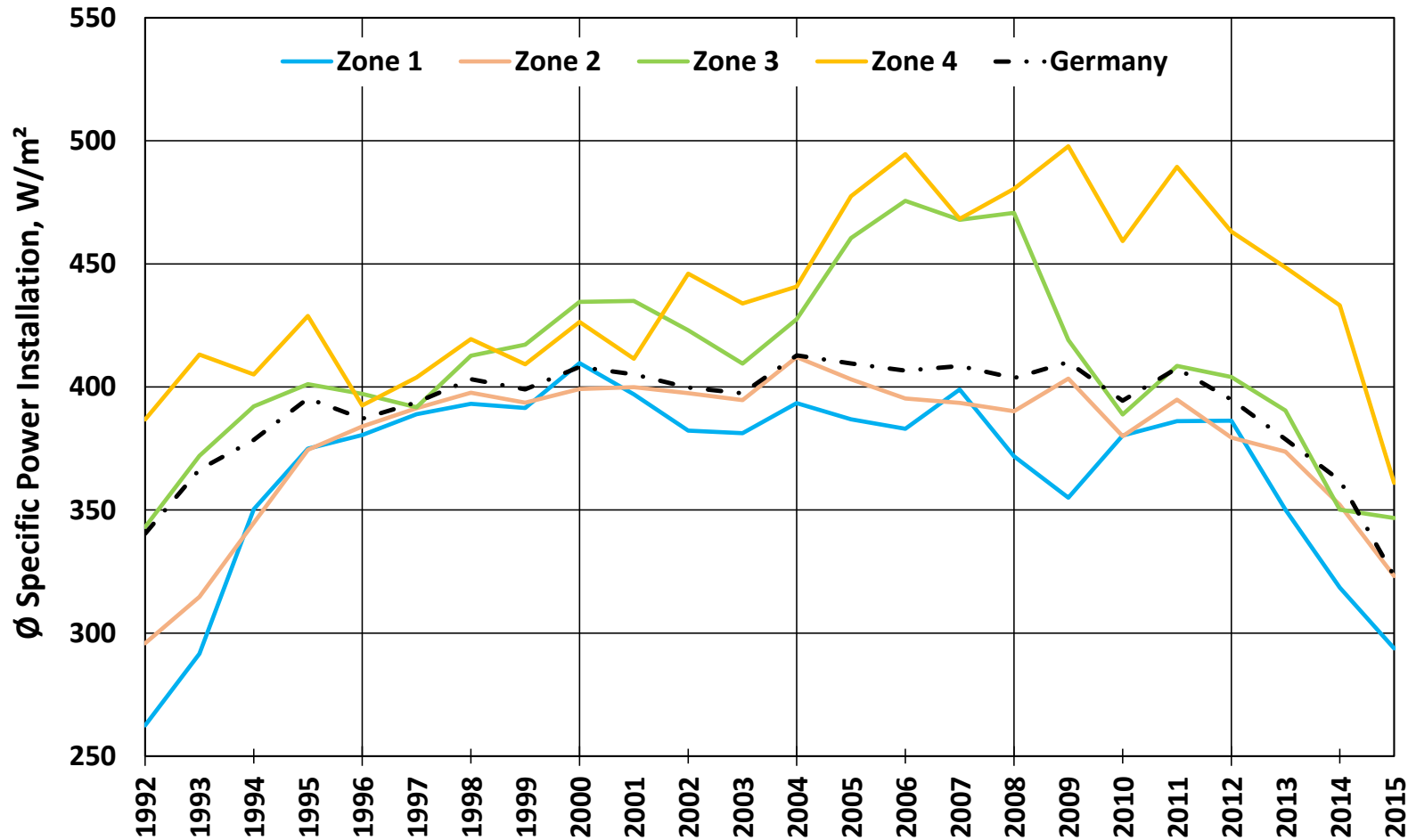
# Influence of Weibull Distributions on Specific Power Installation



## Specific Power Installation Tendencies

- New wind turbine designs have about 20 to 30 % lower installed power per m<sup>2</sup> rotor disc area than before.
- Mostly achieved by increasing the rotor diameter and maintaining the generator power.
- The result is a win/win situation: the manufacturer spends less money for the wind turbine manufacturing and the wind farm investor earns more energy due to the larger rotor disc area.

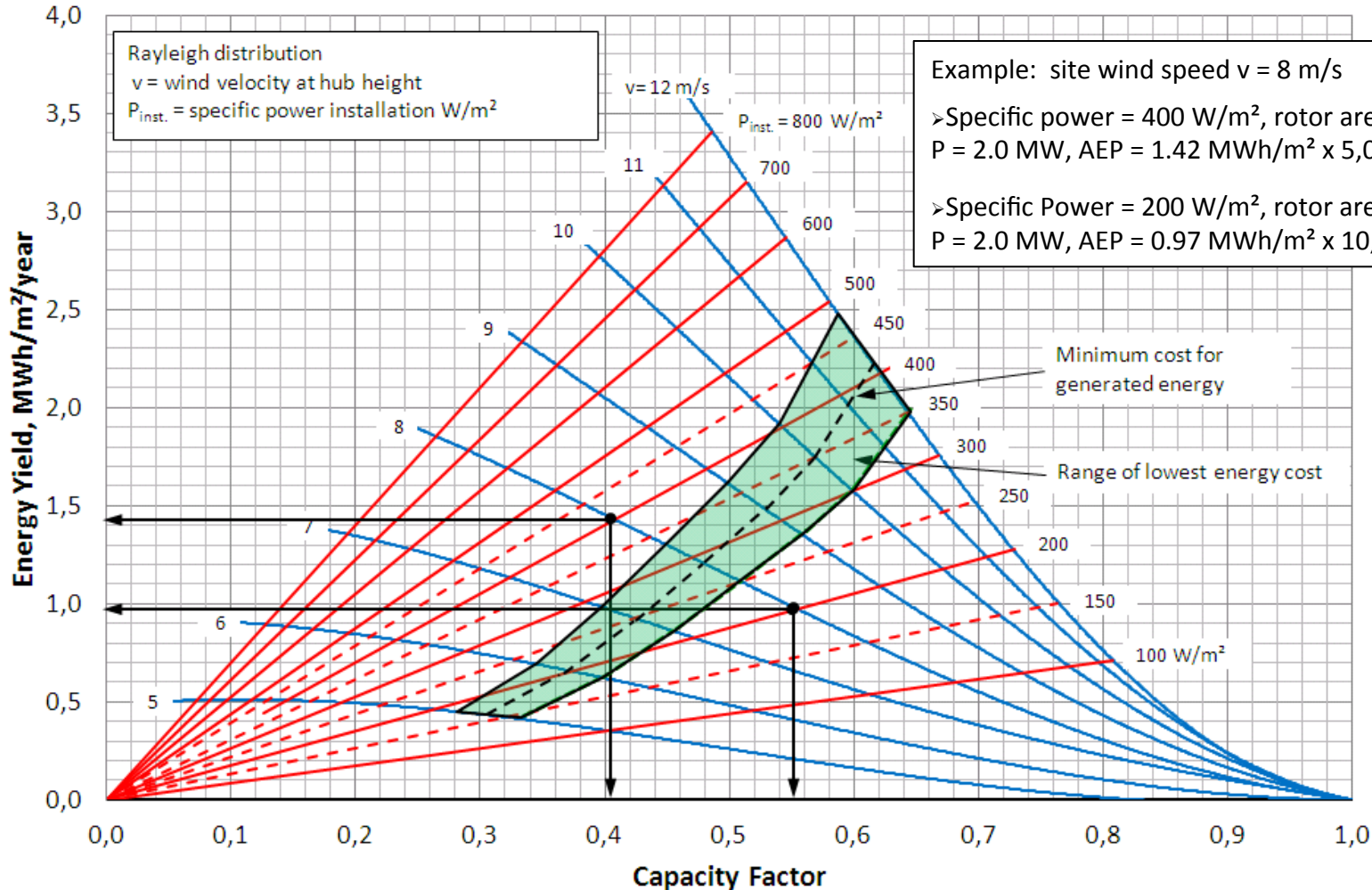
## Specific Power Installation in Germany since 1992



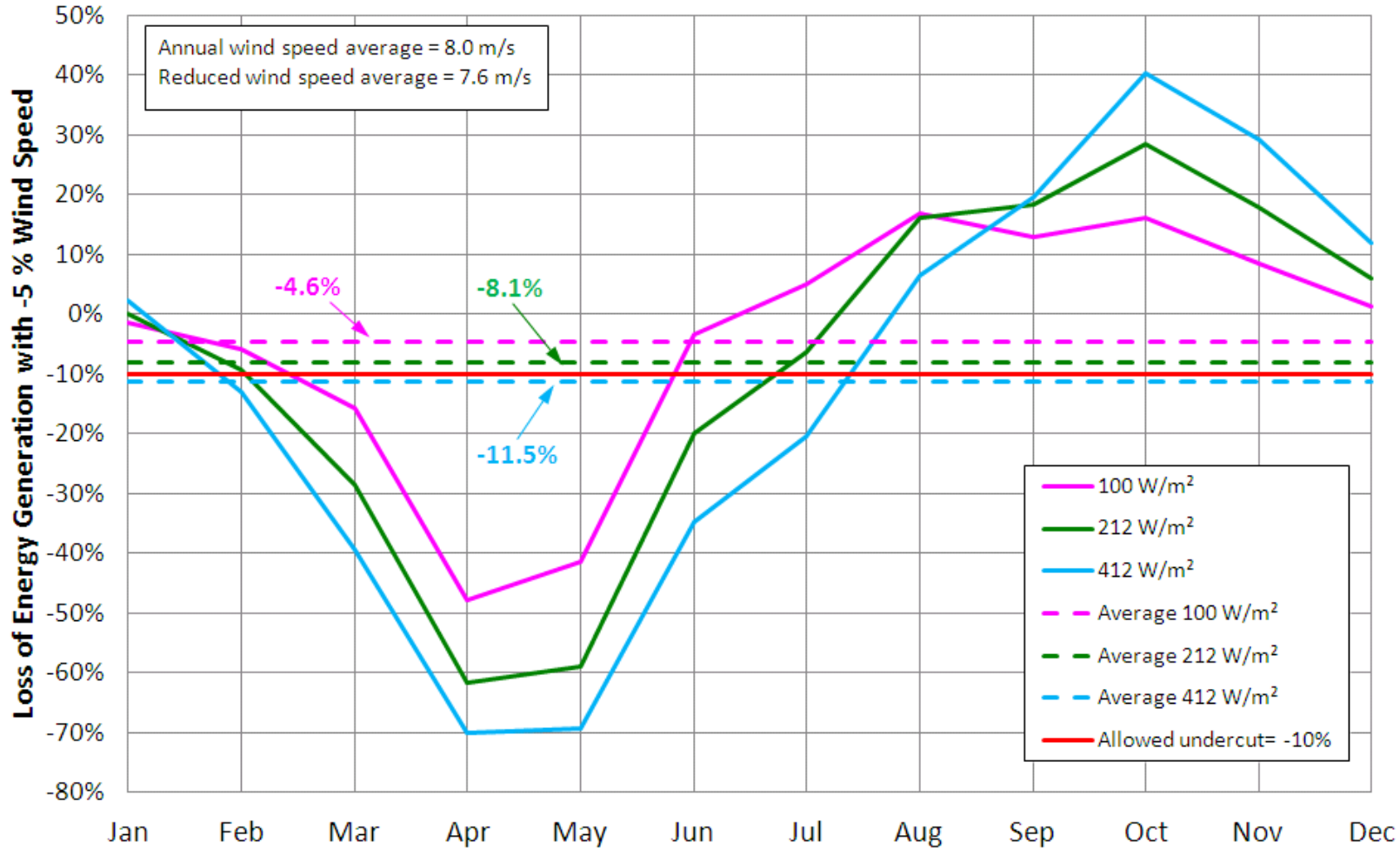
Source: C. Ender, B. Neddermann, Wind Energy use in Germany, DEWI-Magazin 48, 2016



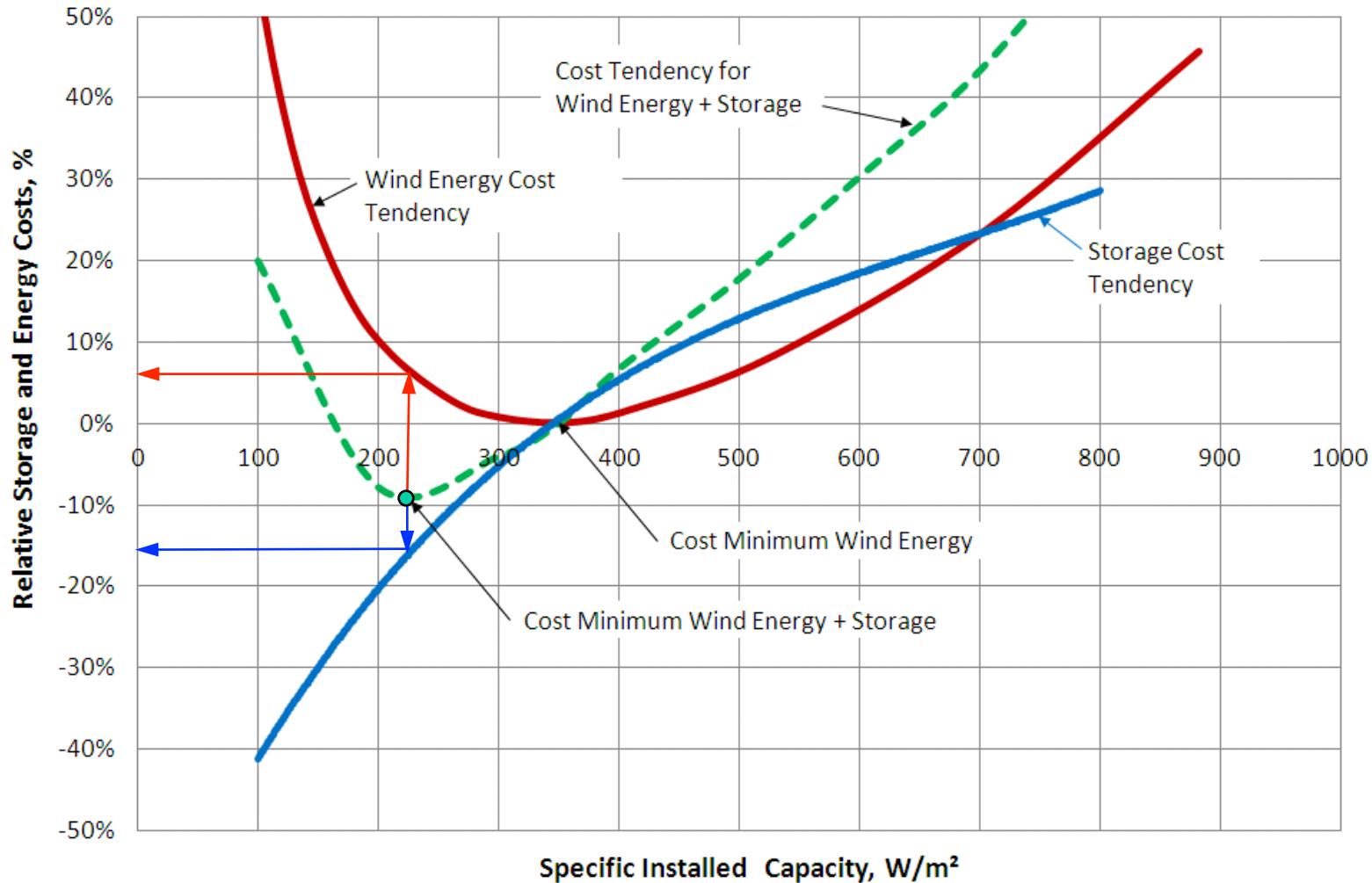
## AEP Dependents on Specific Power Installation



## Energy Production with -5% Wind Speed



## Energy Cost of Wind Turbine/Storage Supply System



## Effect of Specific Tender Conditions

### Tender Conditions

- Define tenders/auctions for guaranteed energy supply within a certain +/- margin.
- Penalties for energy generated outside the margin.

### Resulting Effects

- High capacity factors which lead to lower energy fluctuations  
(less penalties)
- Lower fluctuations cause reduced peak loads in the grid (less grid transportation capacity needed)
- Lower fluctuations result in lower storage capacity costs and more precise energy forecasts

**Vielen Dank für Ihre Aufmerksamkeit**