



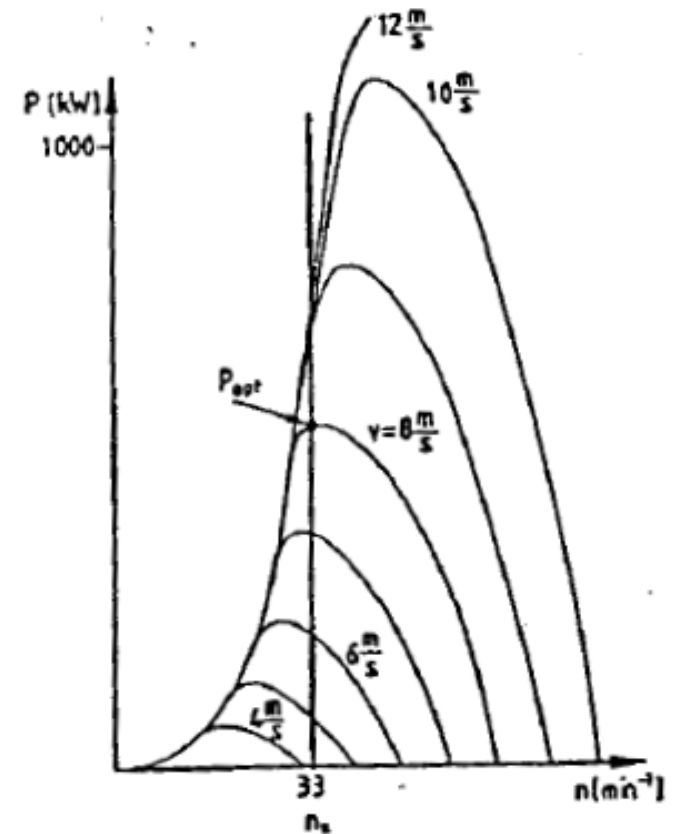
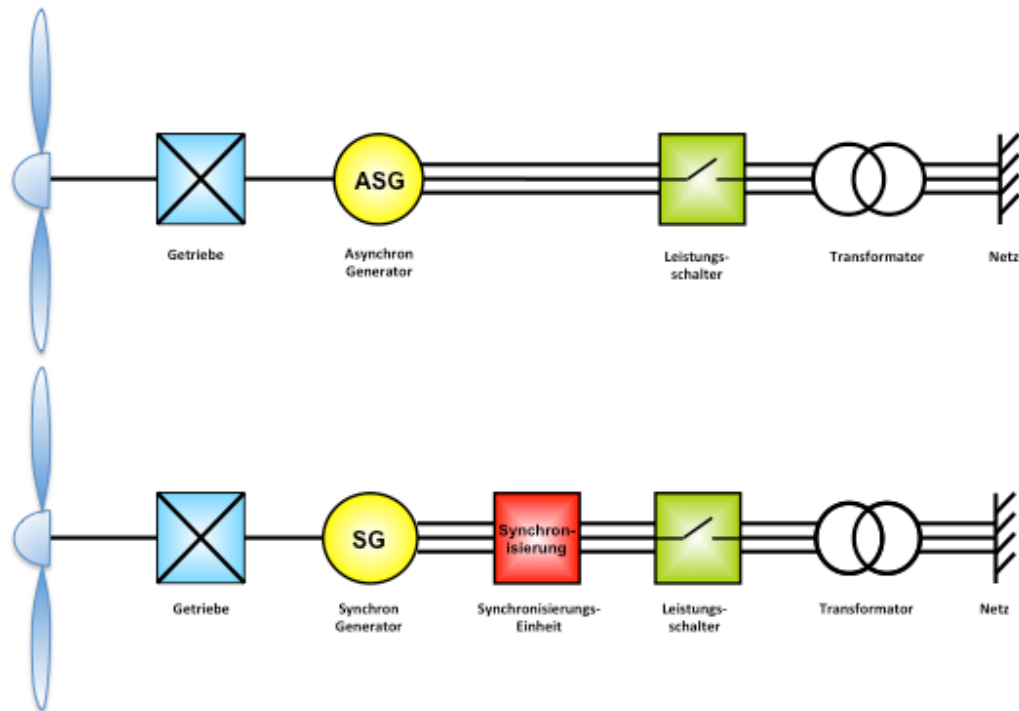
Triebstrang - Energieabgabe

KIT



Elektrisches System

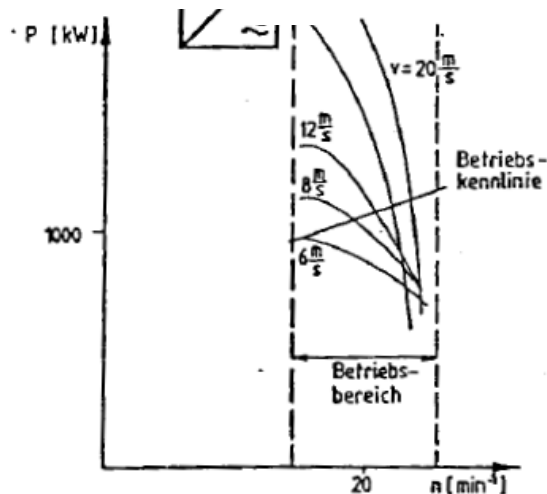
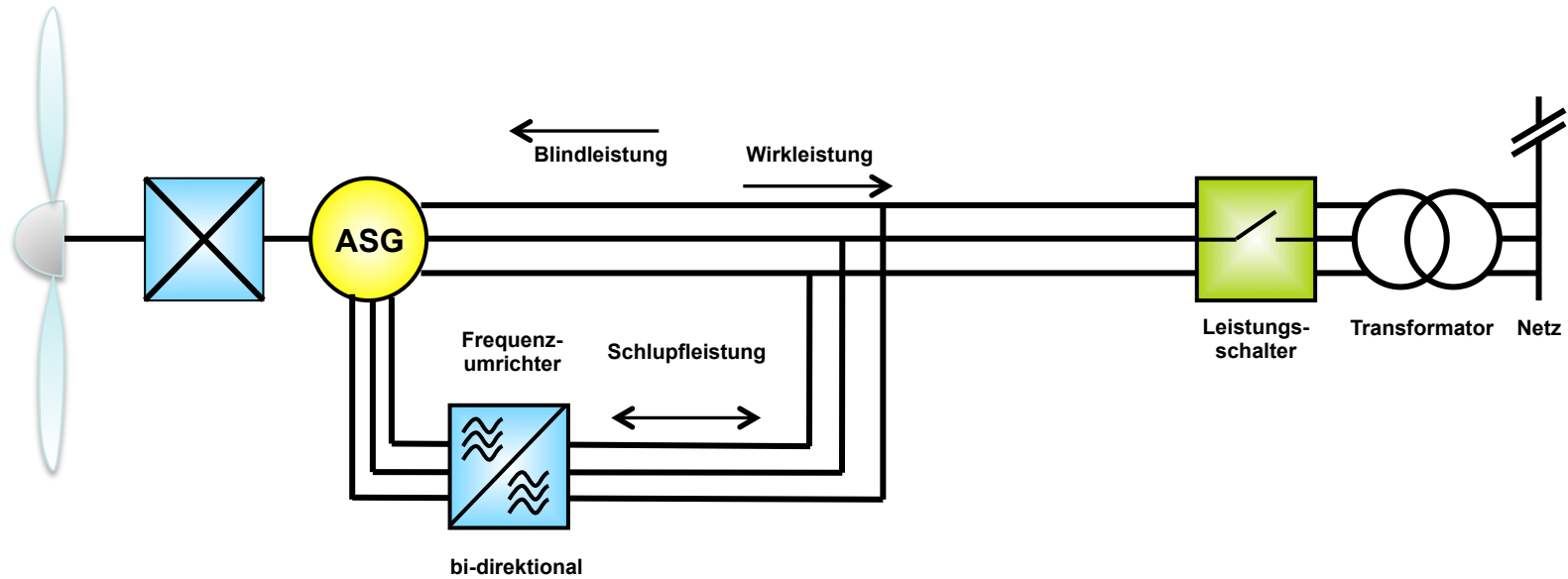
Drehzahlfeste Kopplung / Drehzahlstarr



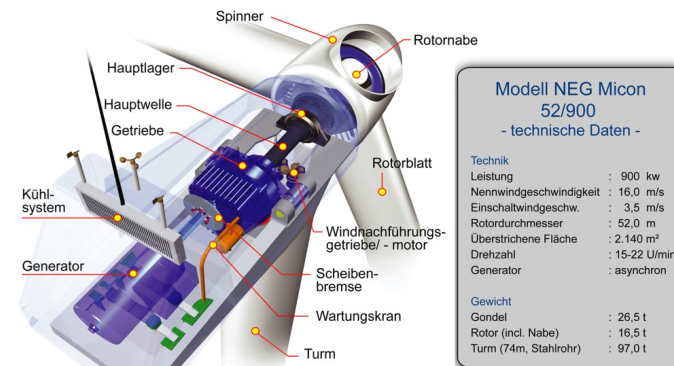


Elektrisches System

Drehzahlvariabel – Doppelt gespeister Asynchrongenerator

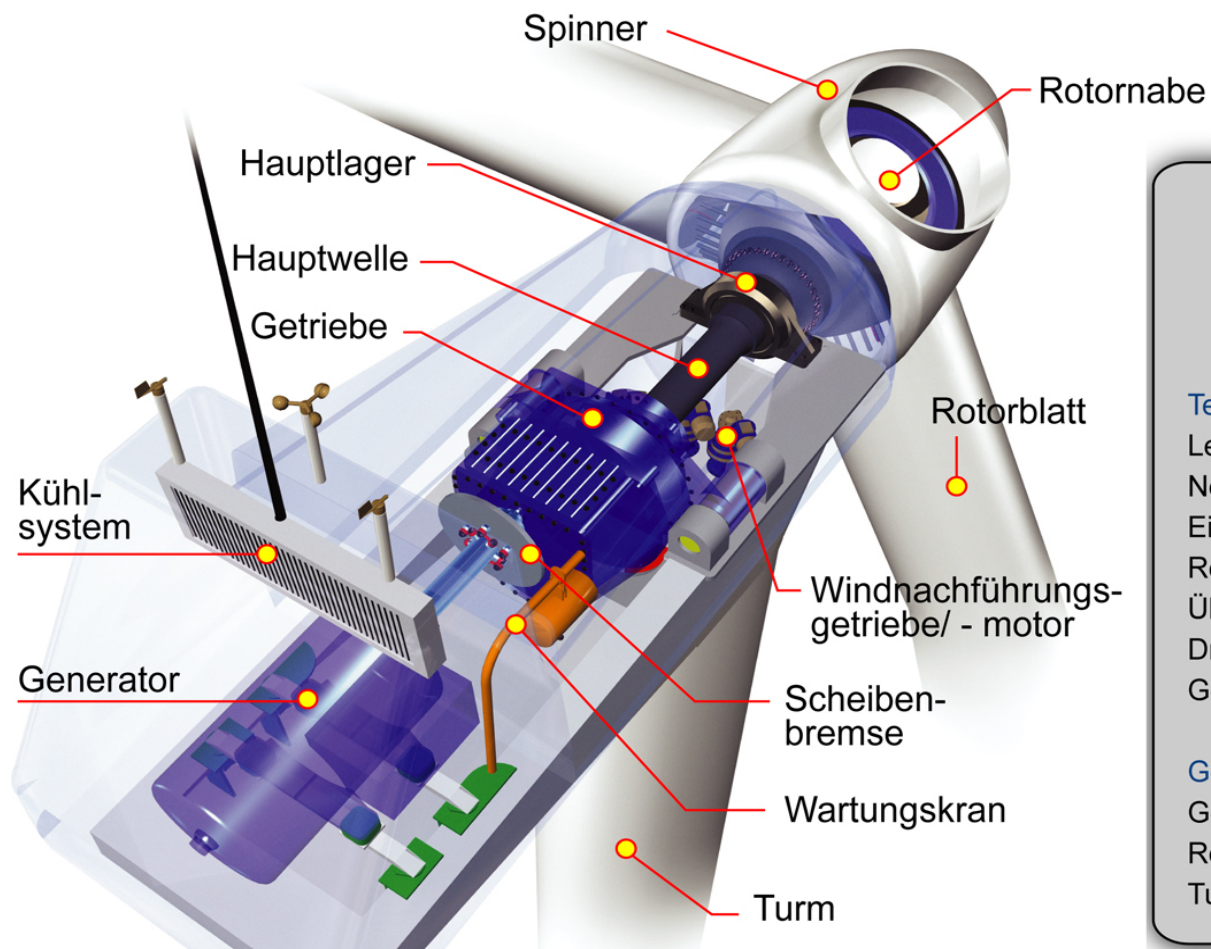


Aufbau einer Gondel - mit Getriebe



Aufbau

Triebstrang – Klassischer Aufbau



Modell NEG Micon 52/900 - technische Daten -

Technik

Leistung	: 900 kw
Nennwindgeschwindigkeit	: 16,0 m/s
Einschaltwindgeschw.	: 3,5 m/s
Rotordurchmesser	: 52,0 m
Überstrichene Fläche	: 2.140 m ²
Drehzahl	: 15-22 U/min
Generator	: asynchron

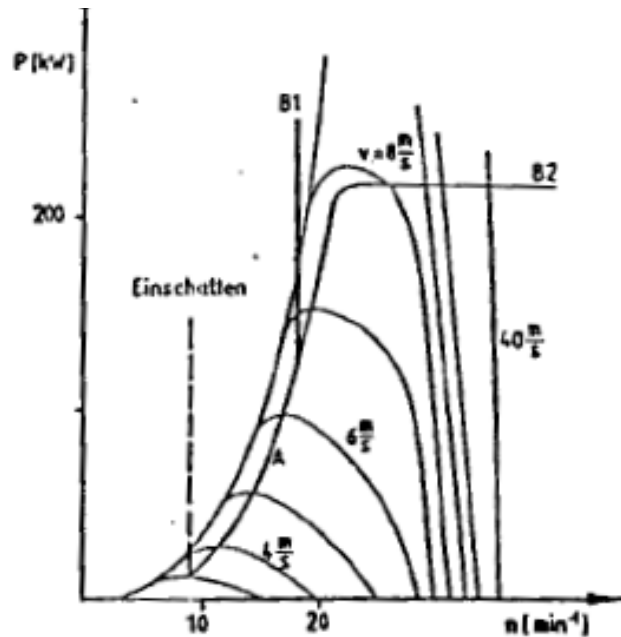
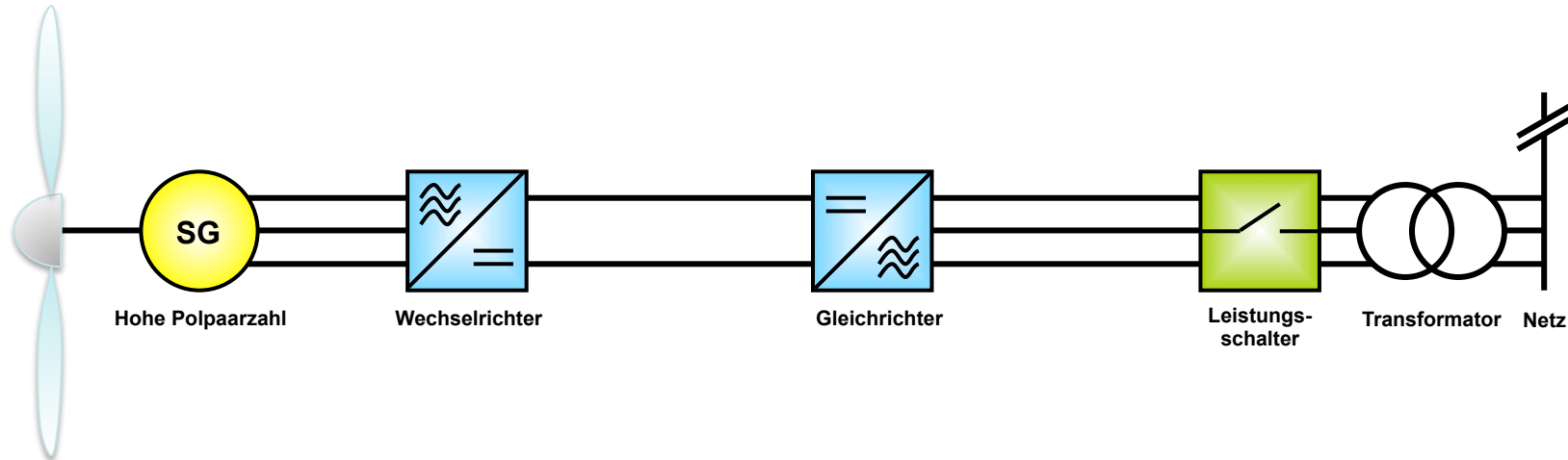
Gewicht

Gondel	: 26,5 t
Rotor (incl. Nabe)	: 16,5 t
Turm (74m, Stahlrohr)	: 97,0 t

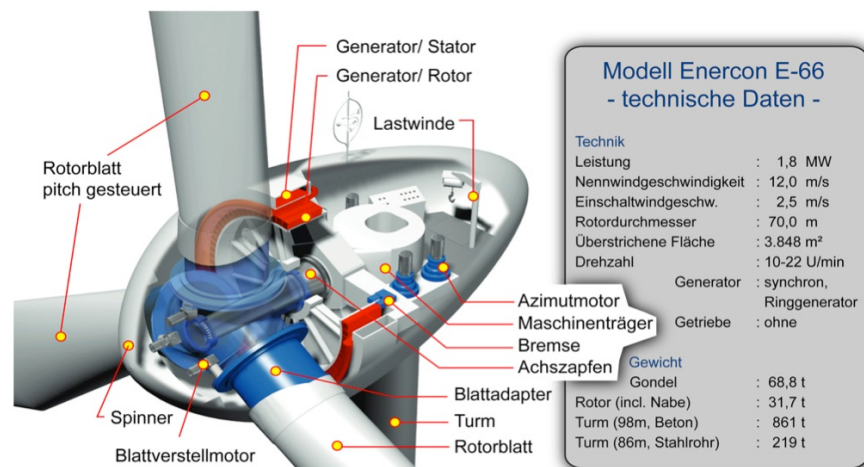


Elektrisches System

Drehzahlvariabel - Enercon

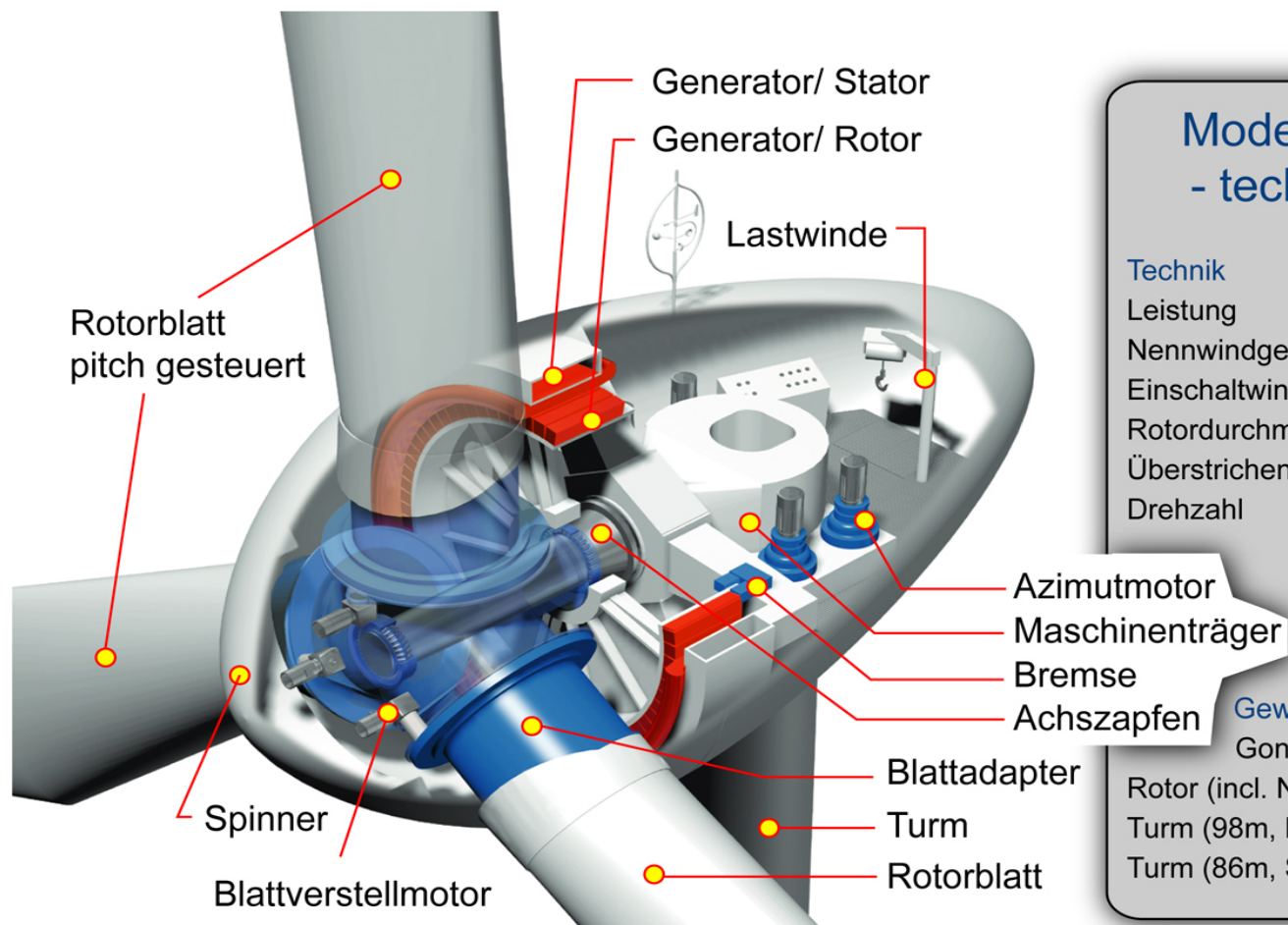


Aufbau einer Gondel - getriebeles



Aufbau

Triebstrang - Getriebelos



Modell Enercon E-66 - technische Daten -

Technik

Leistung	: 1,8 MW
Nennwindgeschwindigkeit	: 12,0 m/s
Einschaltwindgeschw.	: 2,5 m/s
Rotordurchmesser	: 70,0 m
Überstrichene Fläche	: 3.848 m ²
Drehzahl	: 10-22 U/min
Generator	: synchron, Ringgenerator
Getriebe	: ohne

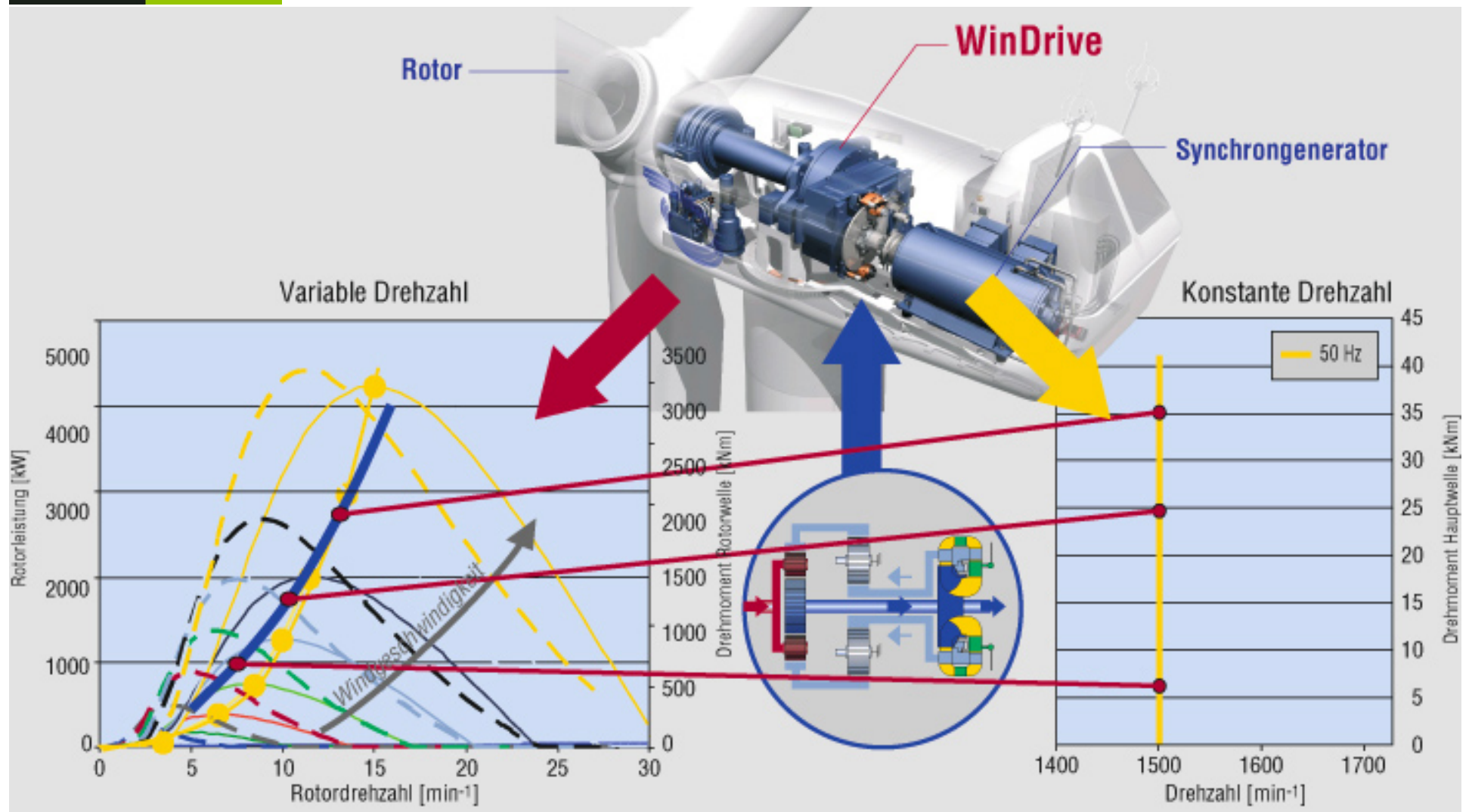
Gewicht

Gondel	: 68,8 t
Rotor (incl. Nabe)	: 31,7 t
Turm (98m, Beton)	: 861 t
Turm (86m, Stahlrohr)	: 219 t



EIFER

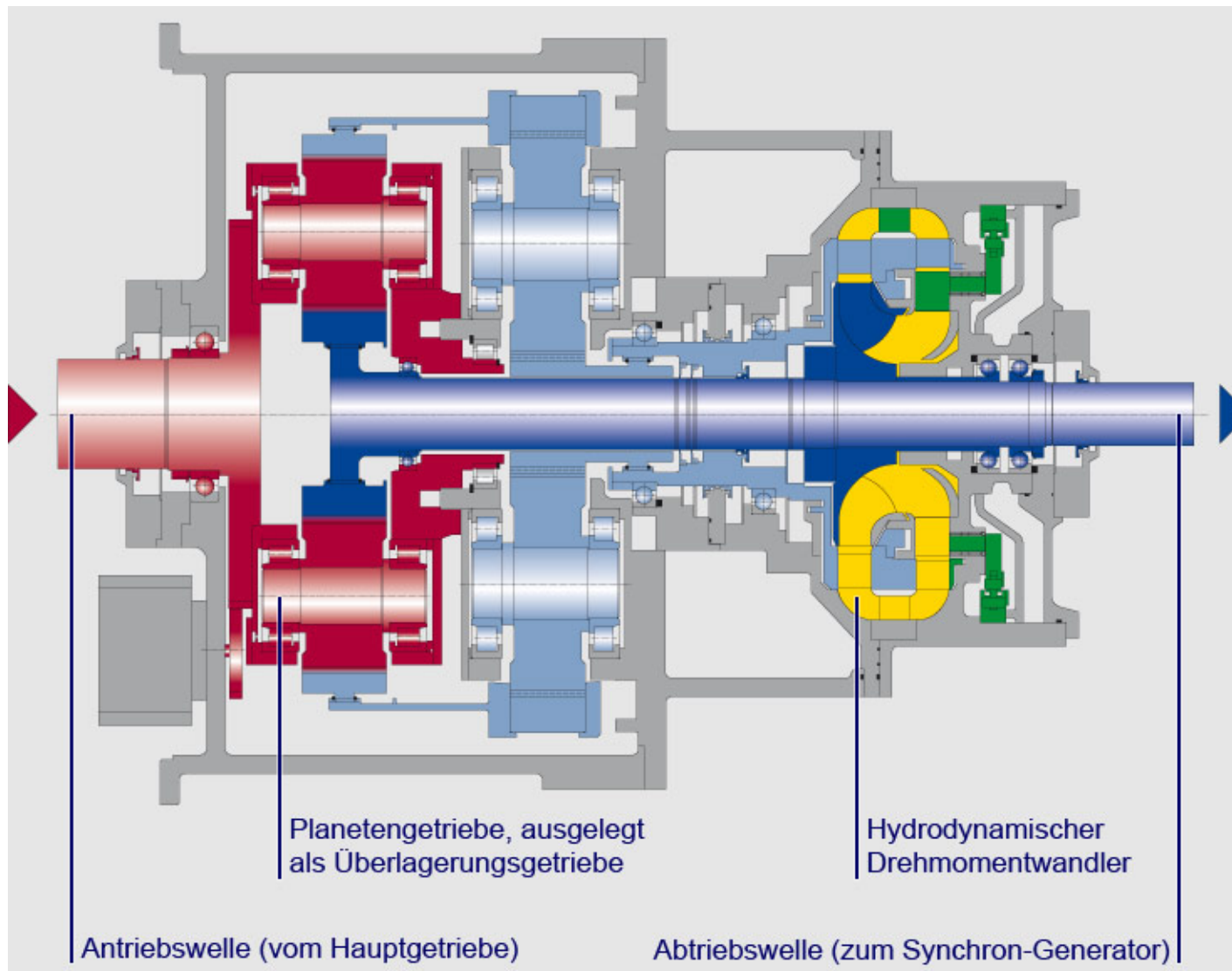
Voith - WinDrive





EIFER

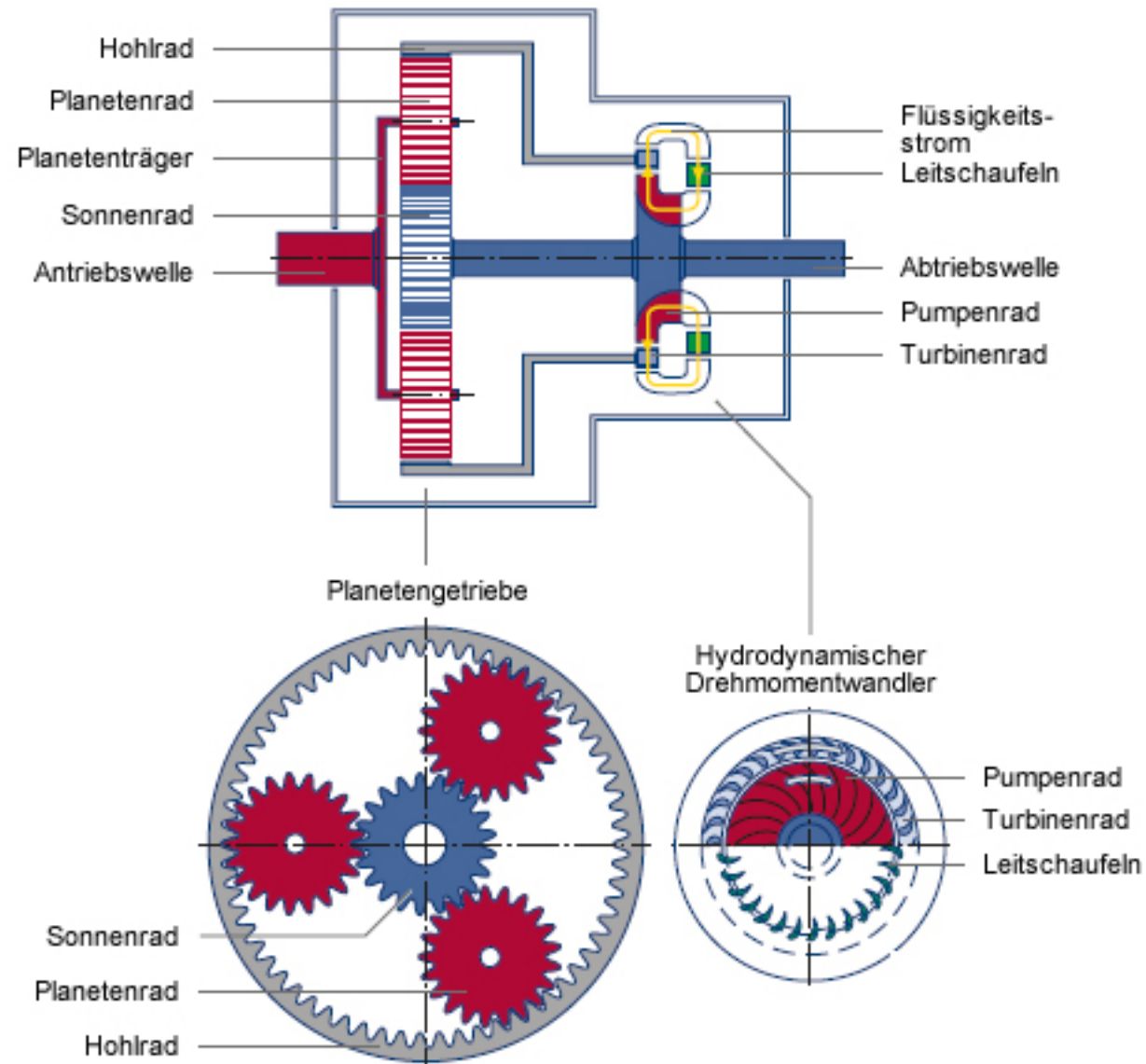
Voith – WinDrive - Drehmomentwandler





EIFER

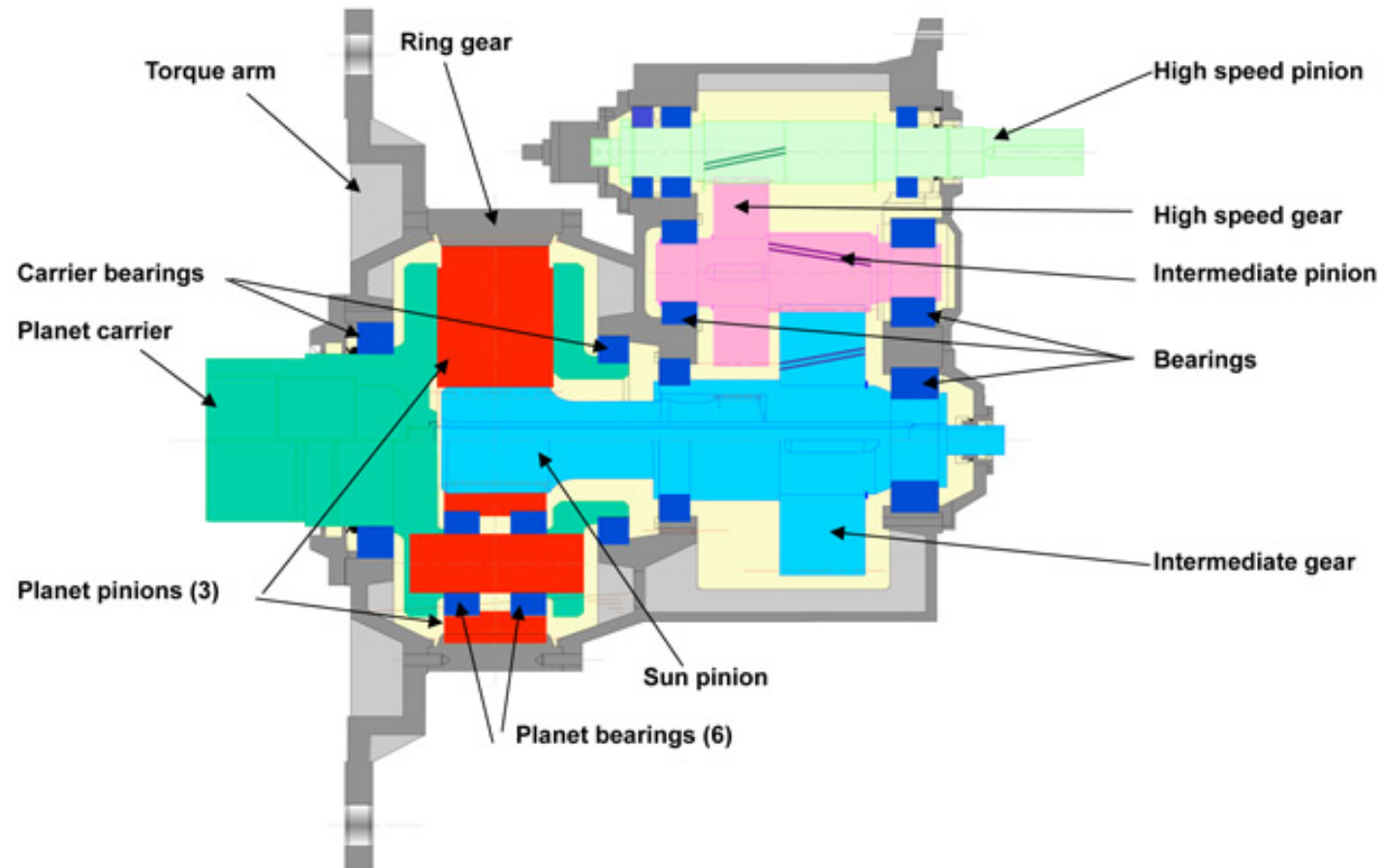
Getriebe ? Voith WinDrive

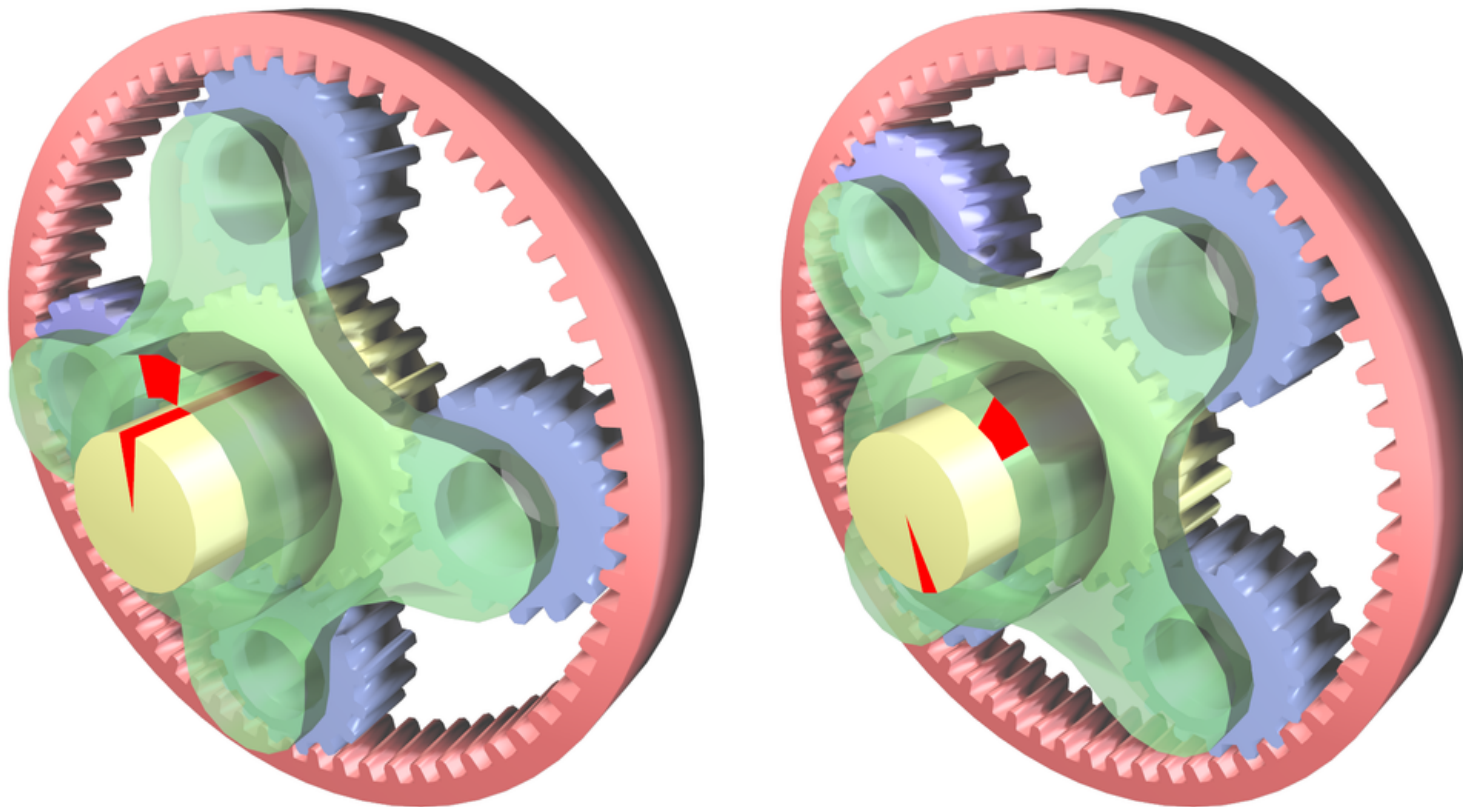




EIFER

WKA Getriebe

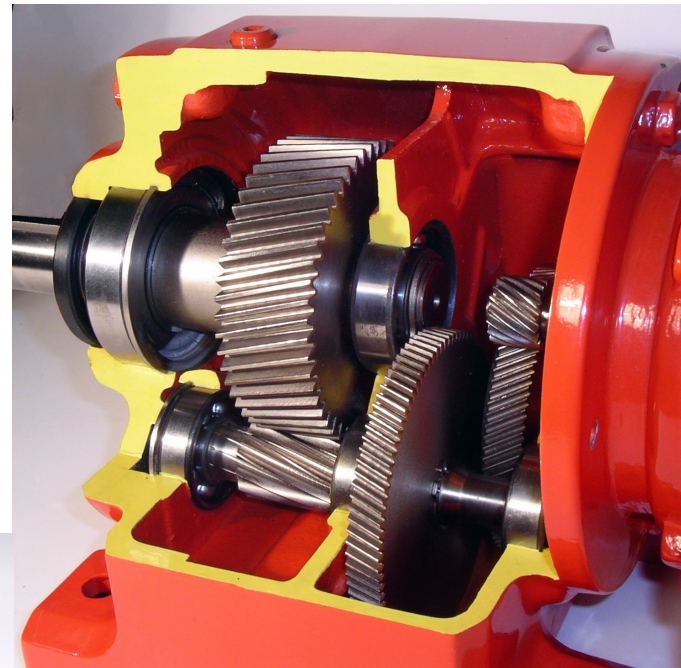






EIFER

Getriebe parallel

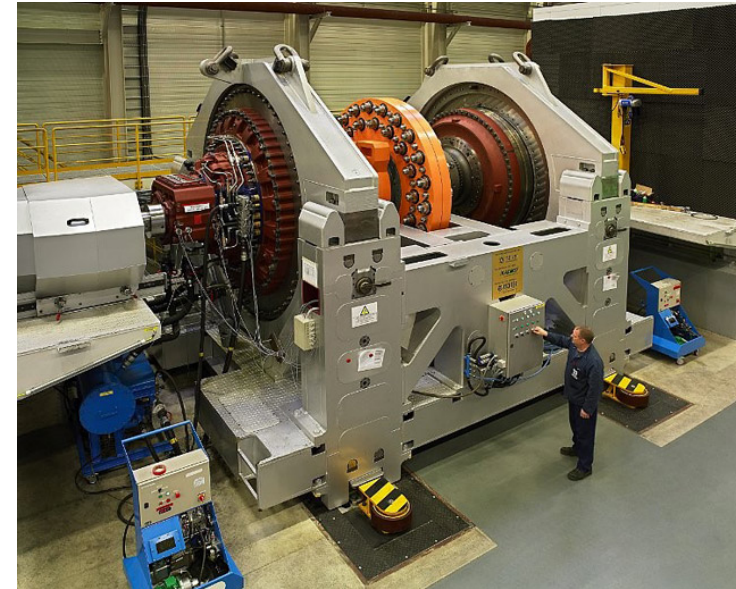


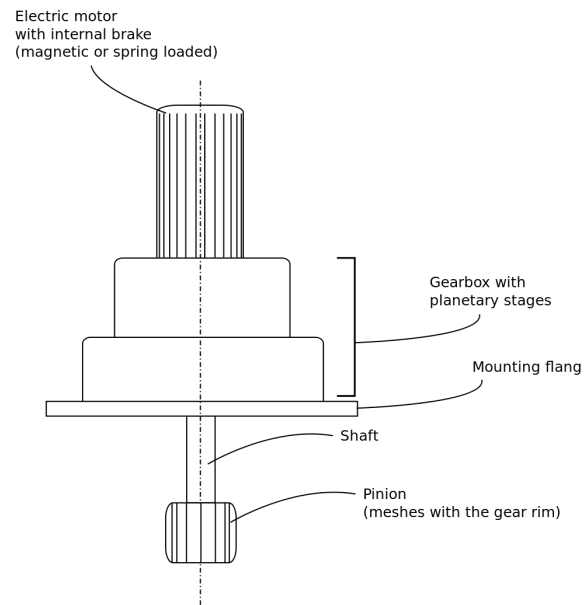
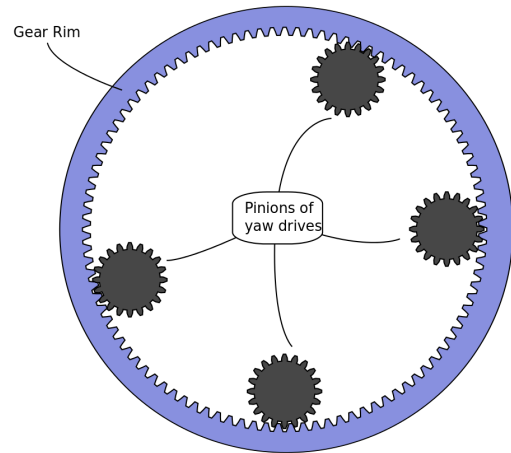


EIFER

WKA Getriebe Daten

- 15-60 rpm input
- 1,500 rpm output
- Hybrid
 - Parallel
 - Planetary
- 20 years lifetime
- Cooling system

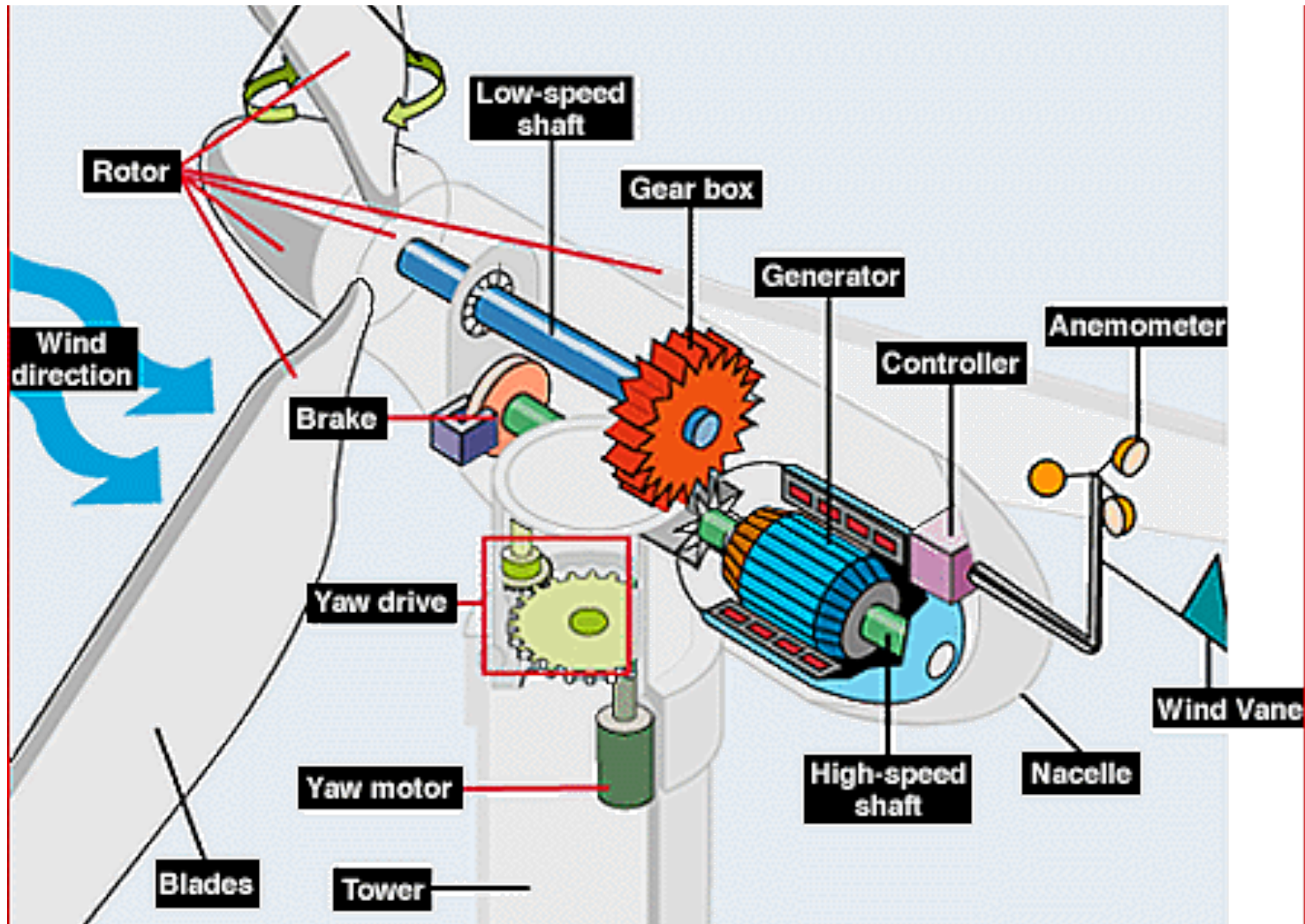






EIFER

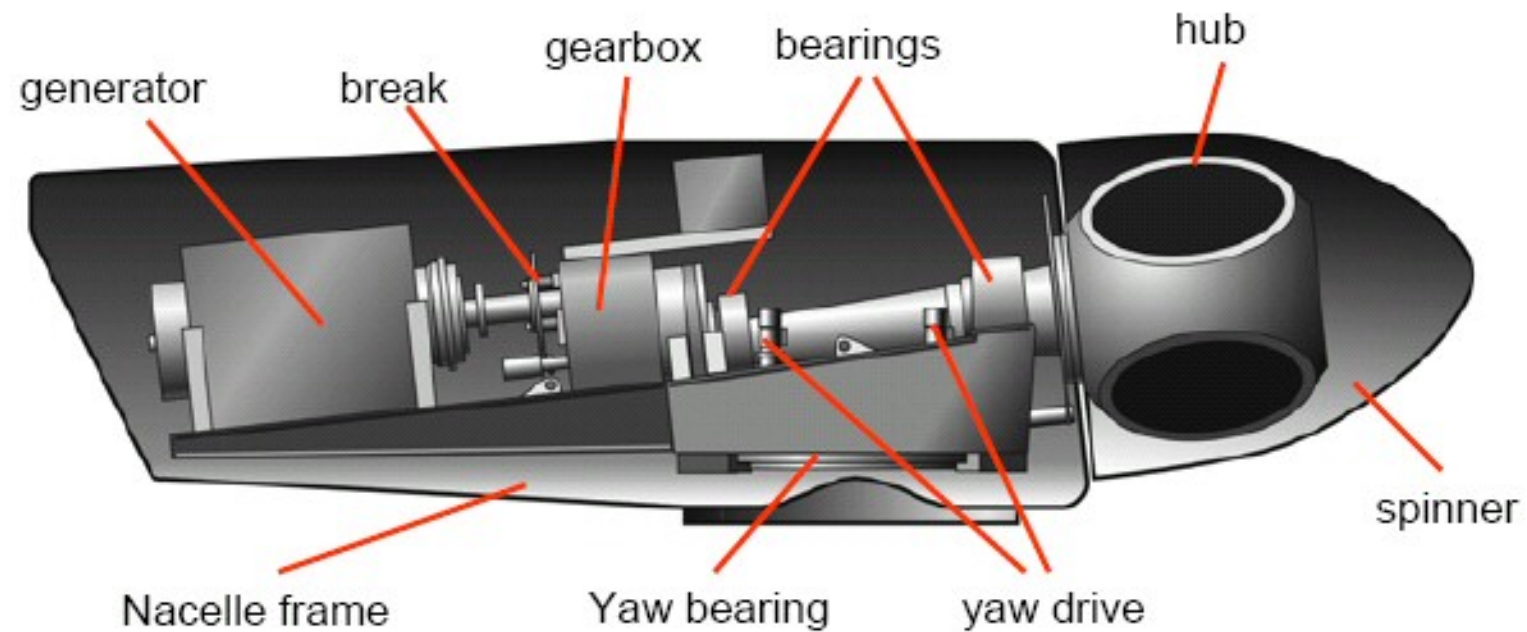
Triebstrang





EIFER

Gondel mit Triebstrang

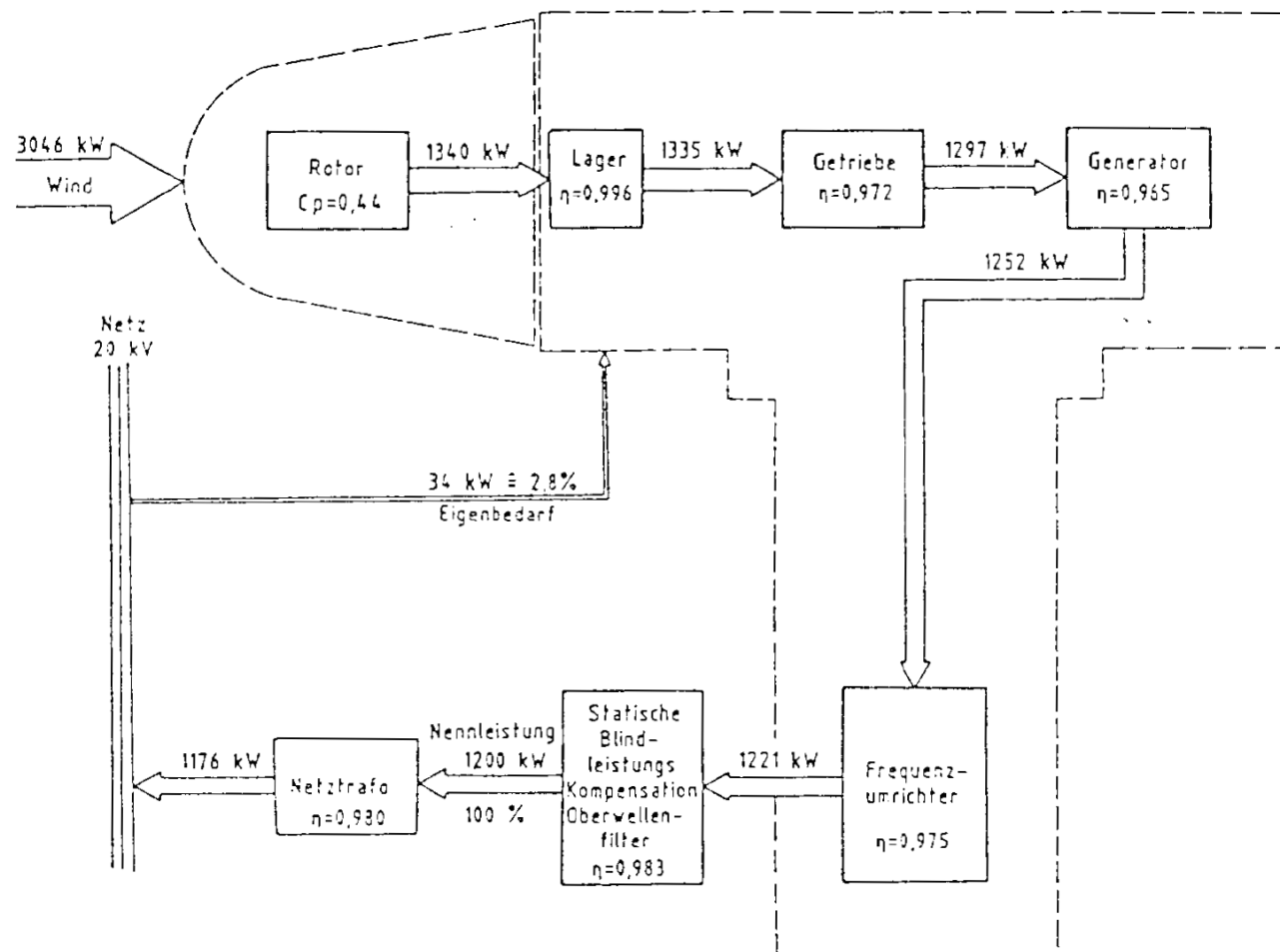




EIFER

Leistungsabgabe

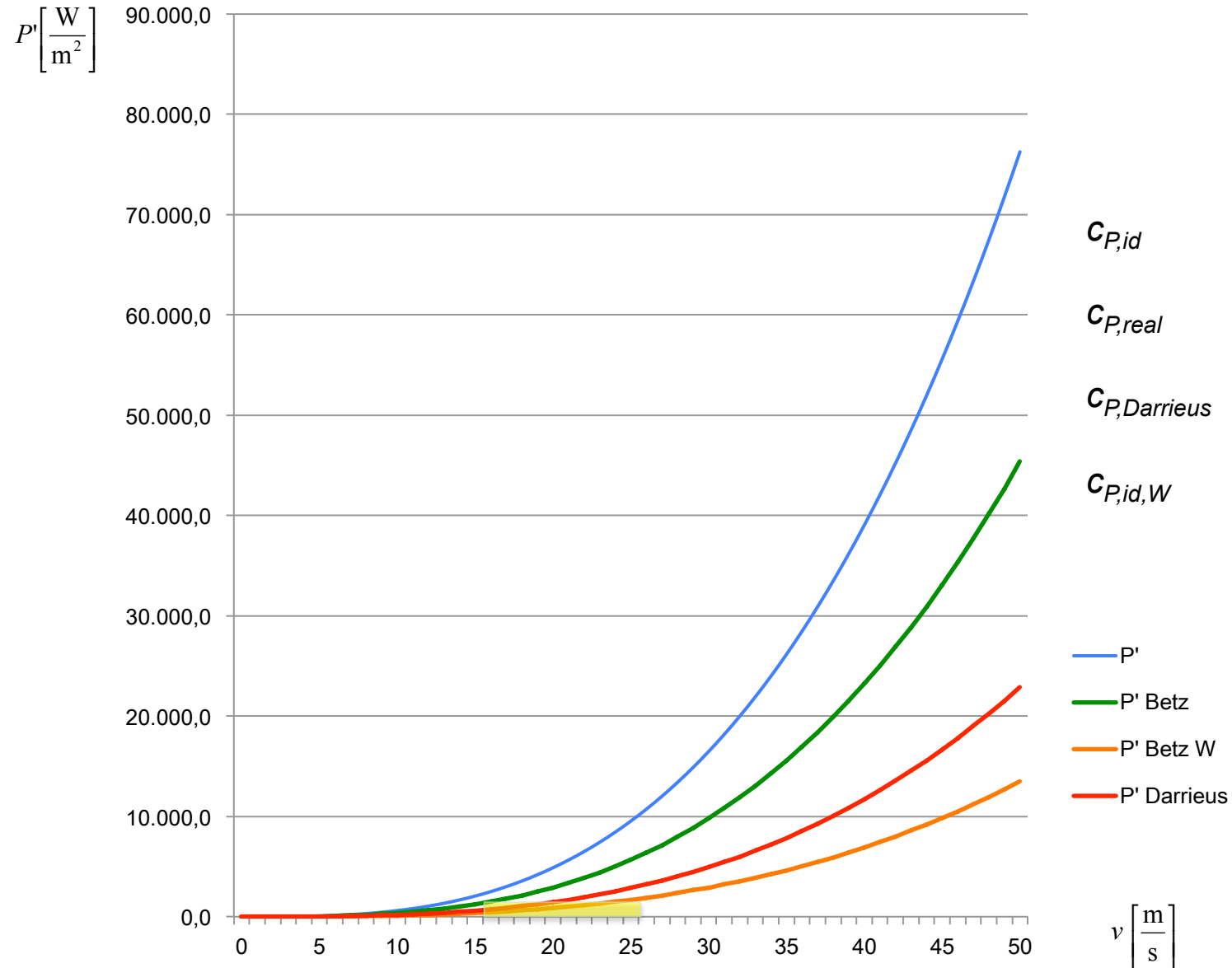
Wirkungsgrade





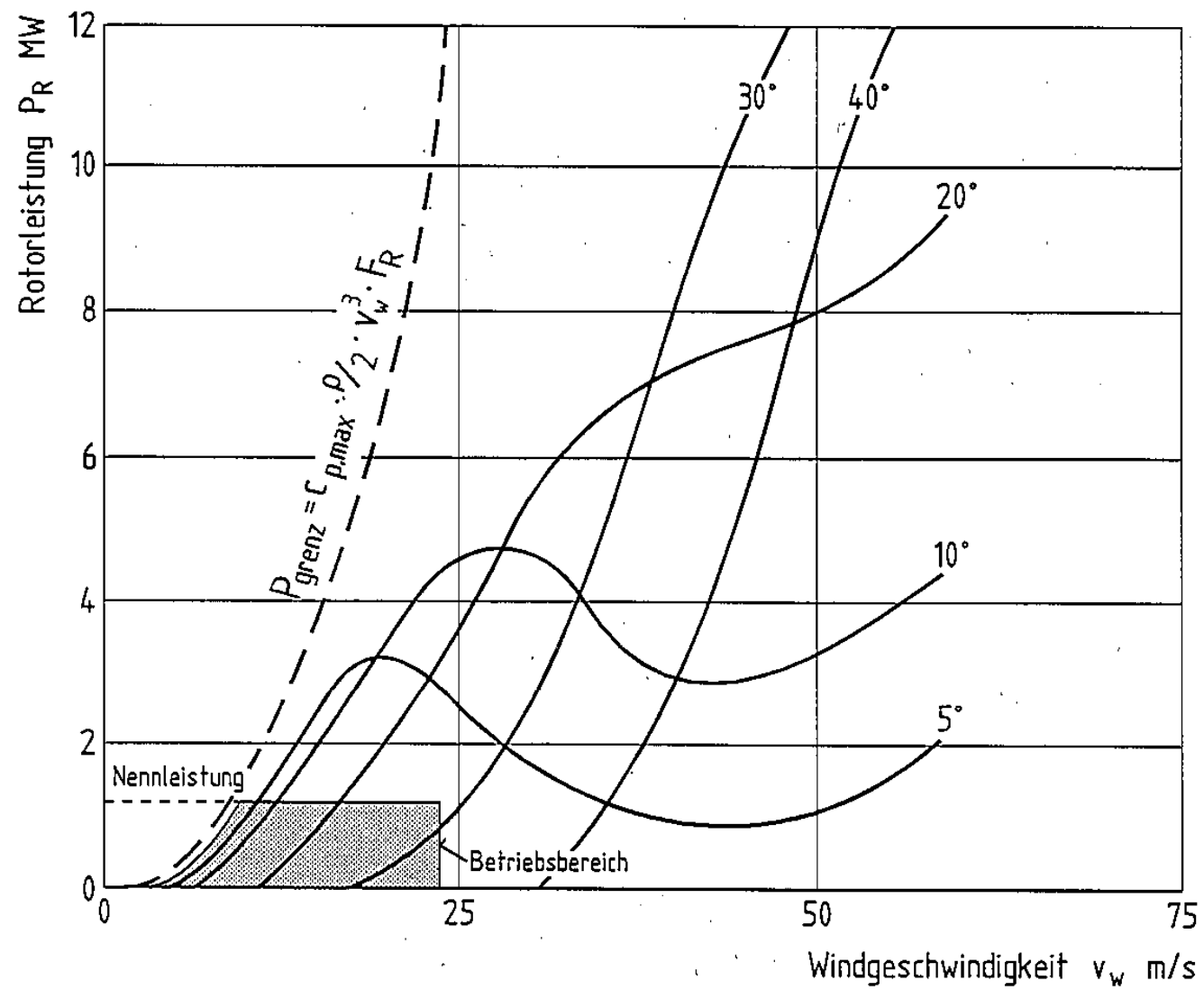
Spezifische Leistung

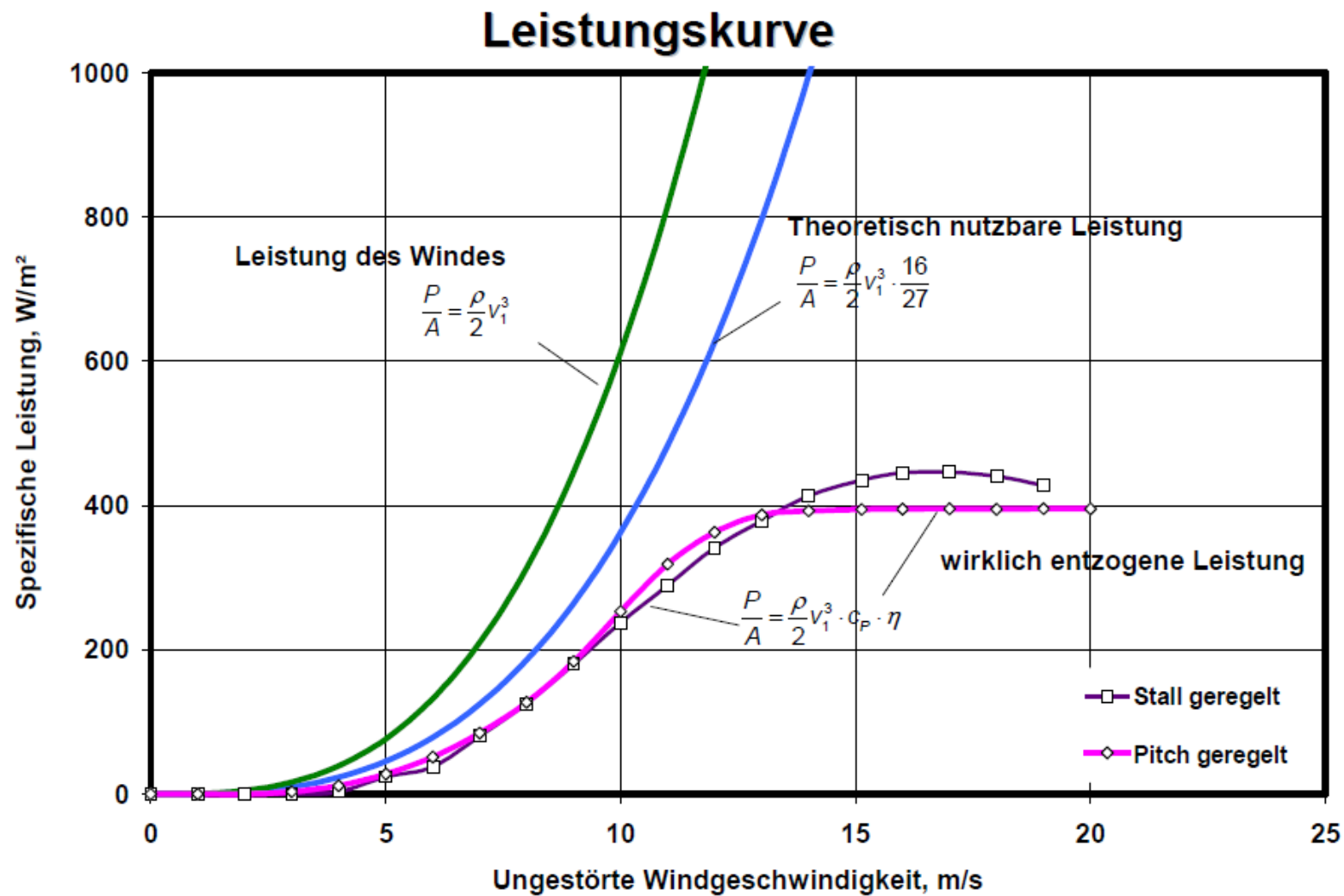
Ideale und reale Beiwerte





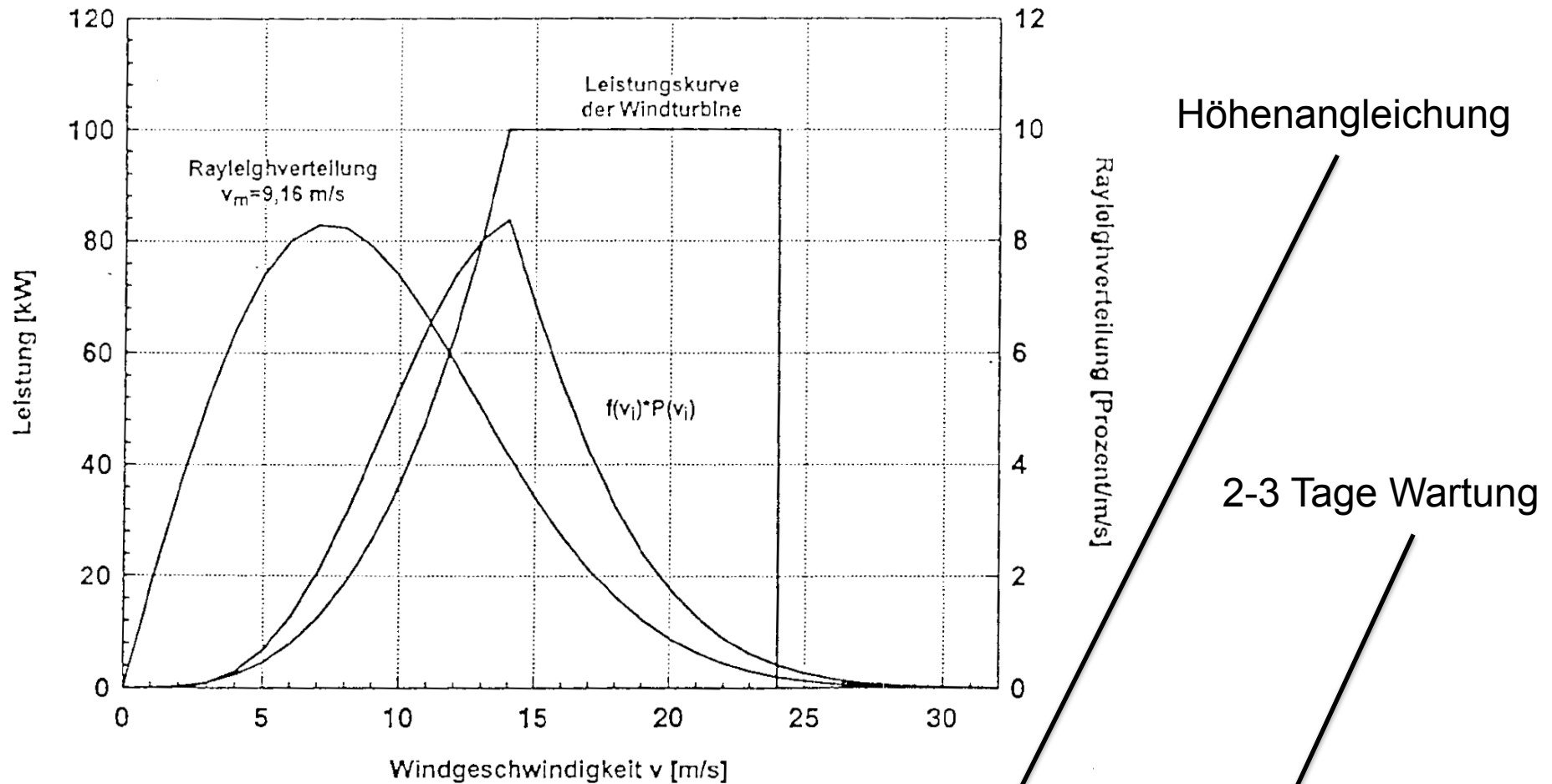
Rotorleistungskennlinien





Leistungsabgabe

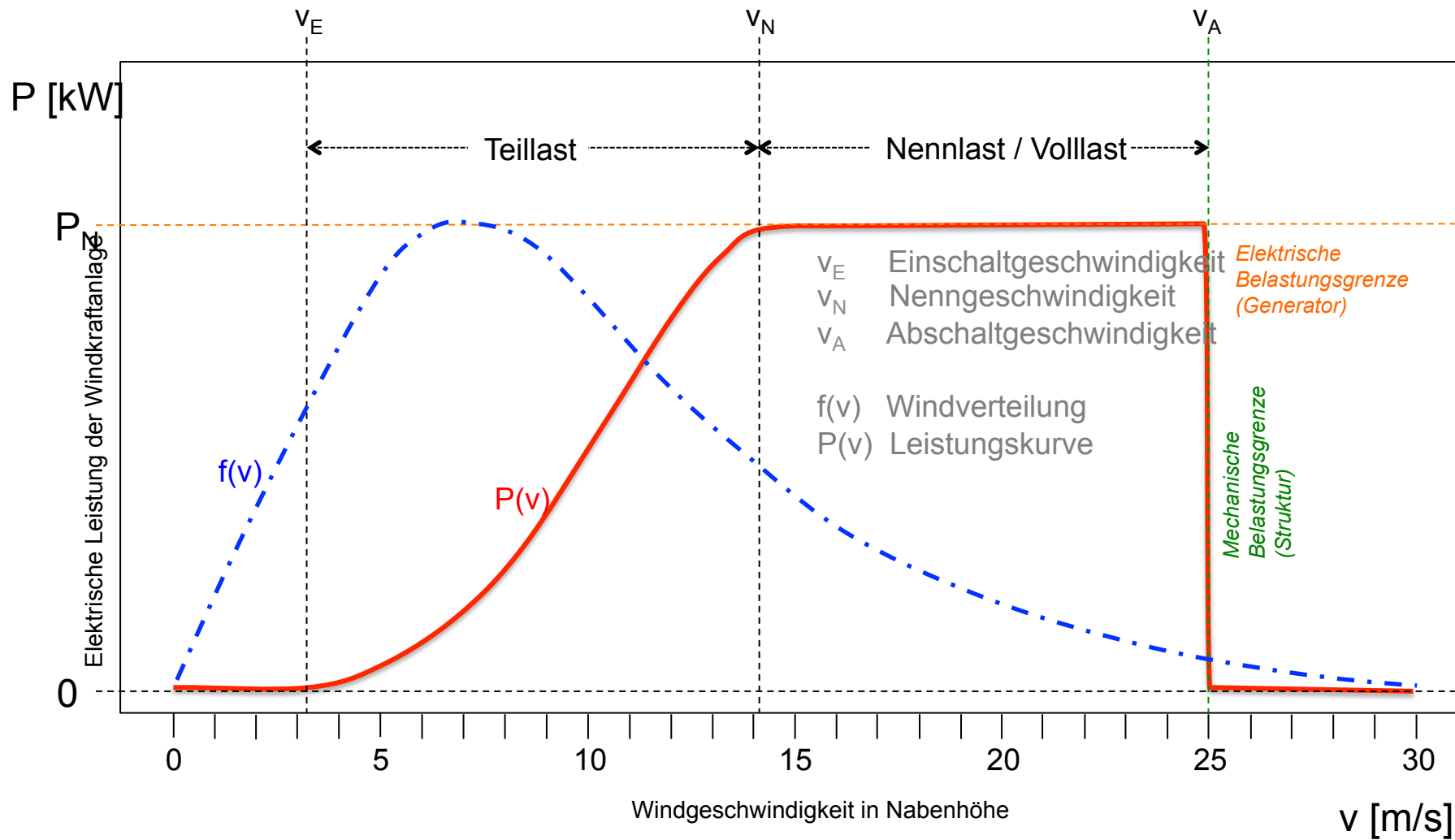
Jährlicher Energieertrag



$$W = \sum_{v_E}^{v_A} f(v) \cdot P(v) \cdot \Delta v \cdot 8760h$$

$$W = \int_{v_E}^{v_A} f(v) \cdot P(v) \cdot dv \cdot 8760h$$

Leistungskennlinie



Leistungsabgabe

Energieertrag Bsp. BWE

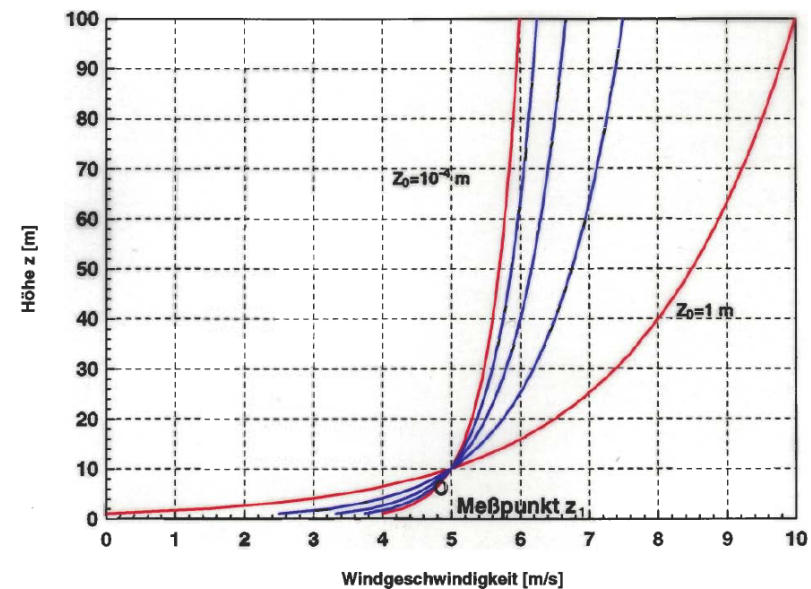
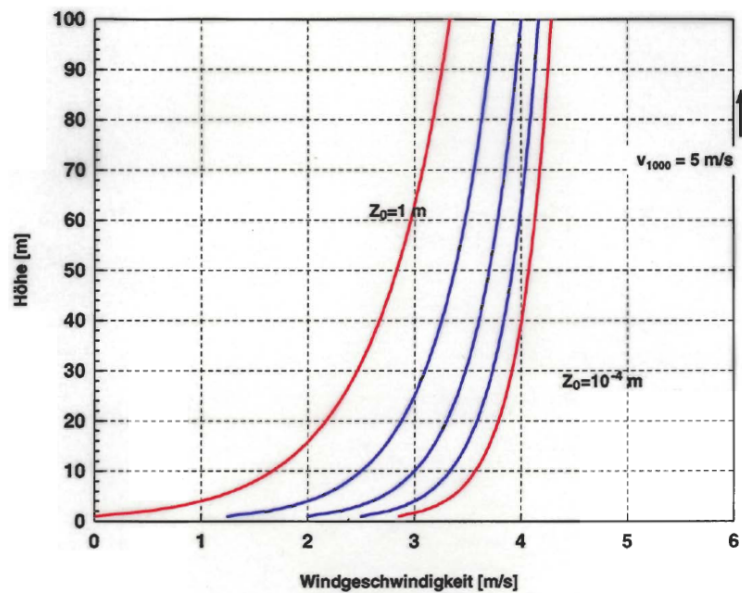
www.energie.de

Verband Energie e.V.

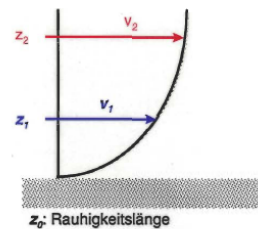
**Steigerung in Leistung und Effizienz:
Entwicklung der Anlagentechnik bis heute**

Marktübliche Windenergieanlagen:

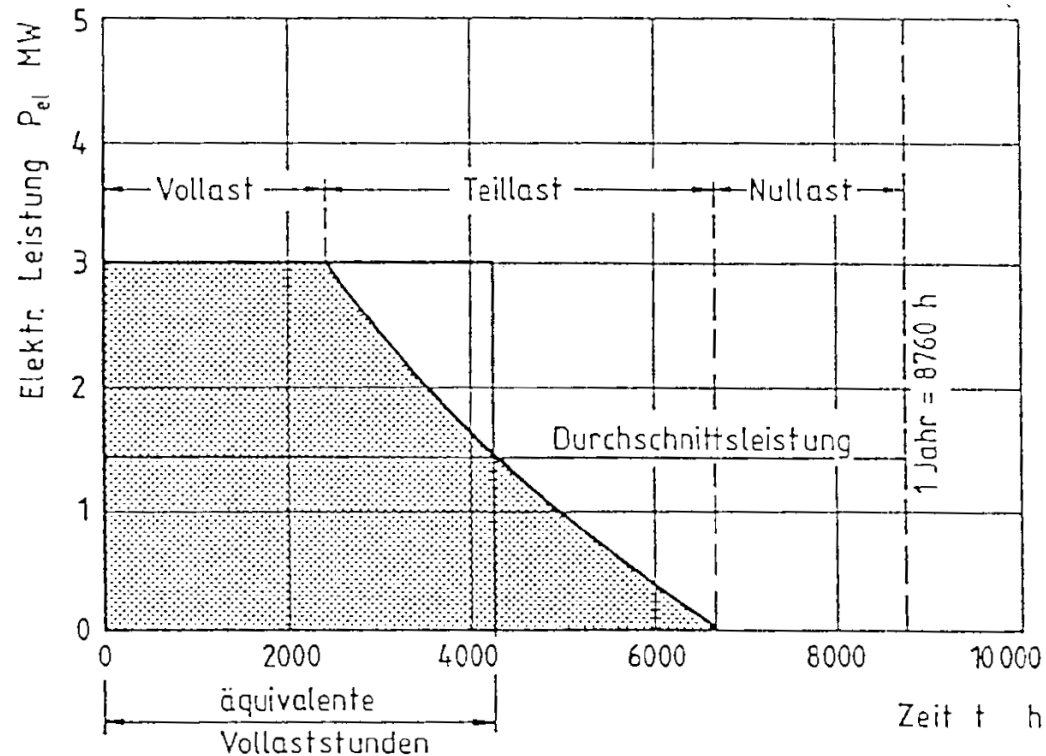
	1995	2011	
Nennleistung	500 kW	3.000 kW	6x
Rotordurchmesser	40 m => 1.256 m ²	100 m => 7.850 m ² 2,5xRotor => 6,25xFläche	
Nabenhöhe	50 m	100 m	2x
Ertrag	1,0 Mio. kWh/a	9,0 Mio. kWh/a	9x
Volllaststunden	2.000 h/a	3.000 h/a	1,5x
Spezifischer Ertrag/m ²	796 kWh/m ² /a	1.194 kWh/m ²	1,45x



$$v(z) = c \cdot \ln\left(\frac{z}{z_0}\right)$$



$$\frac{v(z_2)}{v(z_1)} = \frac{\ln\left(\frac{z_2}{z_0}\right)}{\ln\left(\frac{z_1}{z_0}\right)}$$



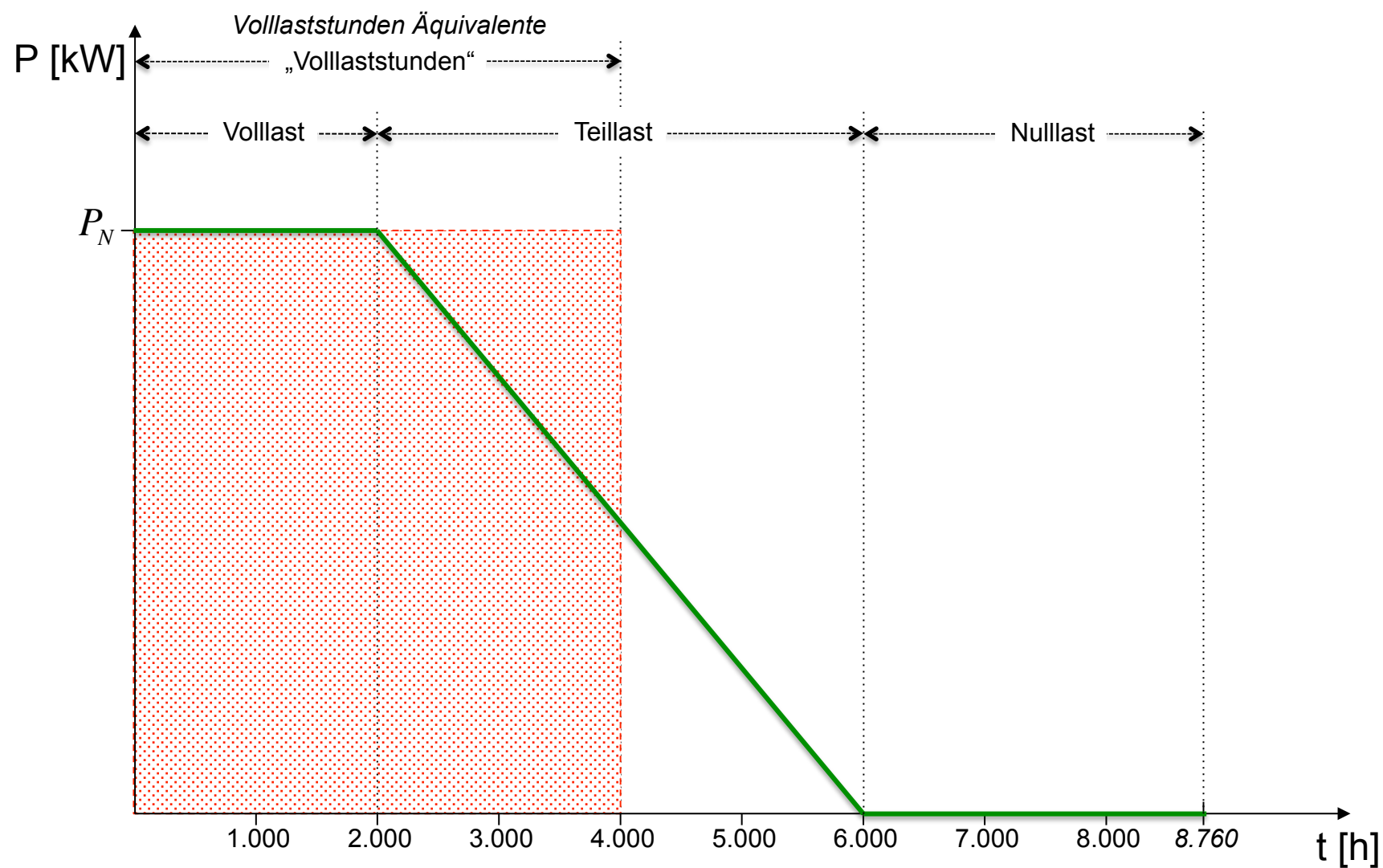
Energieträger

Volllaststunden (2007)

Kernenergie	7.710
Braunkohle	6.640
Biomasse	ca. 5.000
Wind offshore ^{a)}	4.450
Steinkohle	3.550
Wasser (L&S)	3.510
Erdgas	3.170
Wind ^{b)}	1.680
Mineralöl	1.640
Pumpspeicher	970
Photovoltaik	910

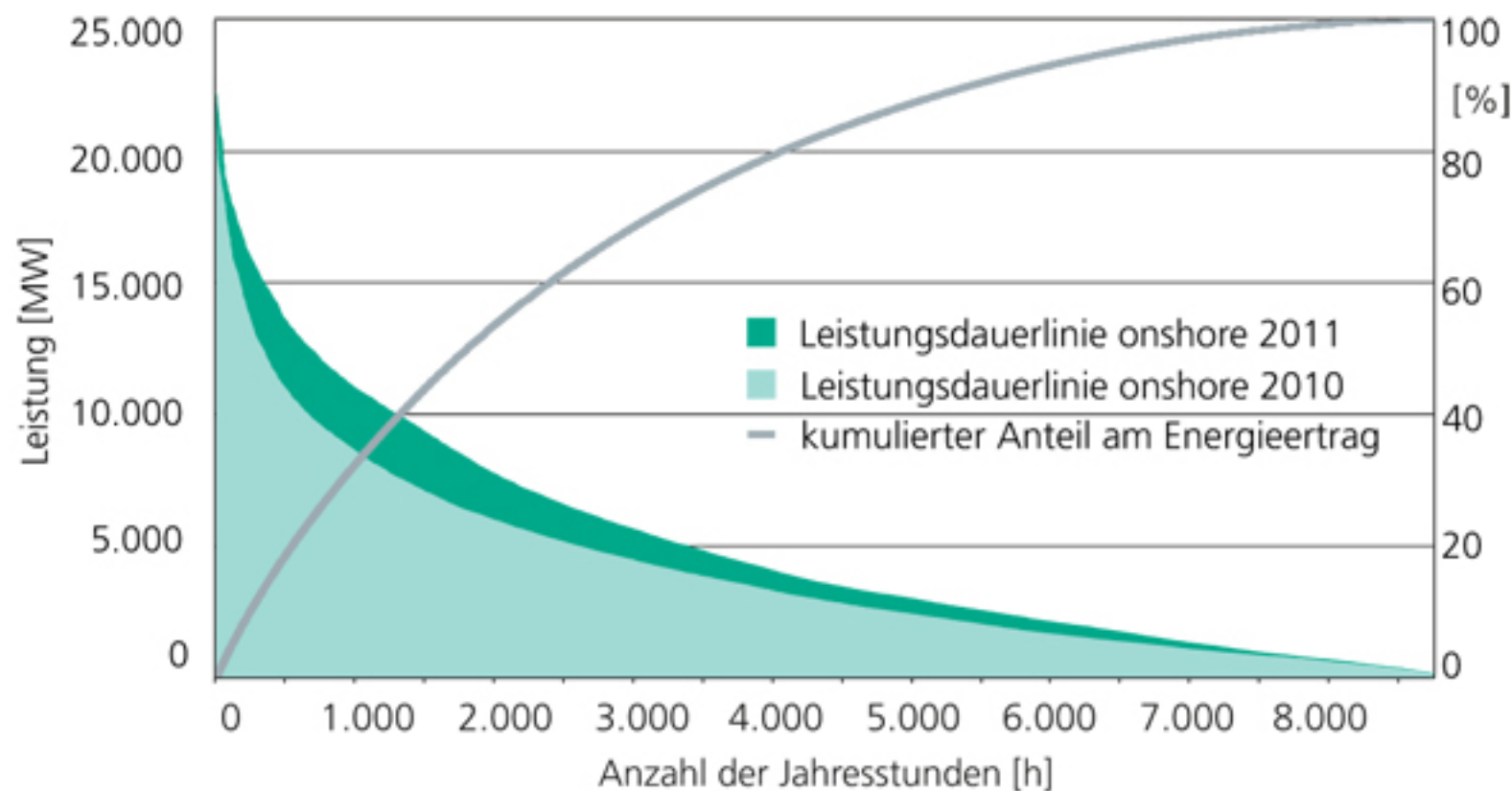
Volllaststunden = äquivalenten Volllaststunden !

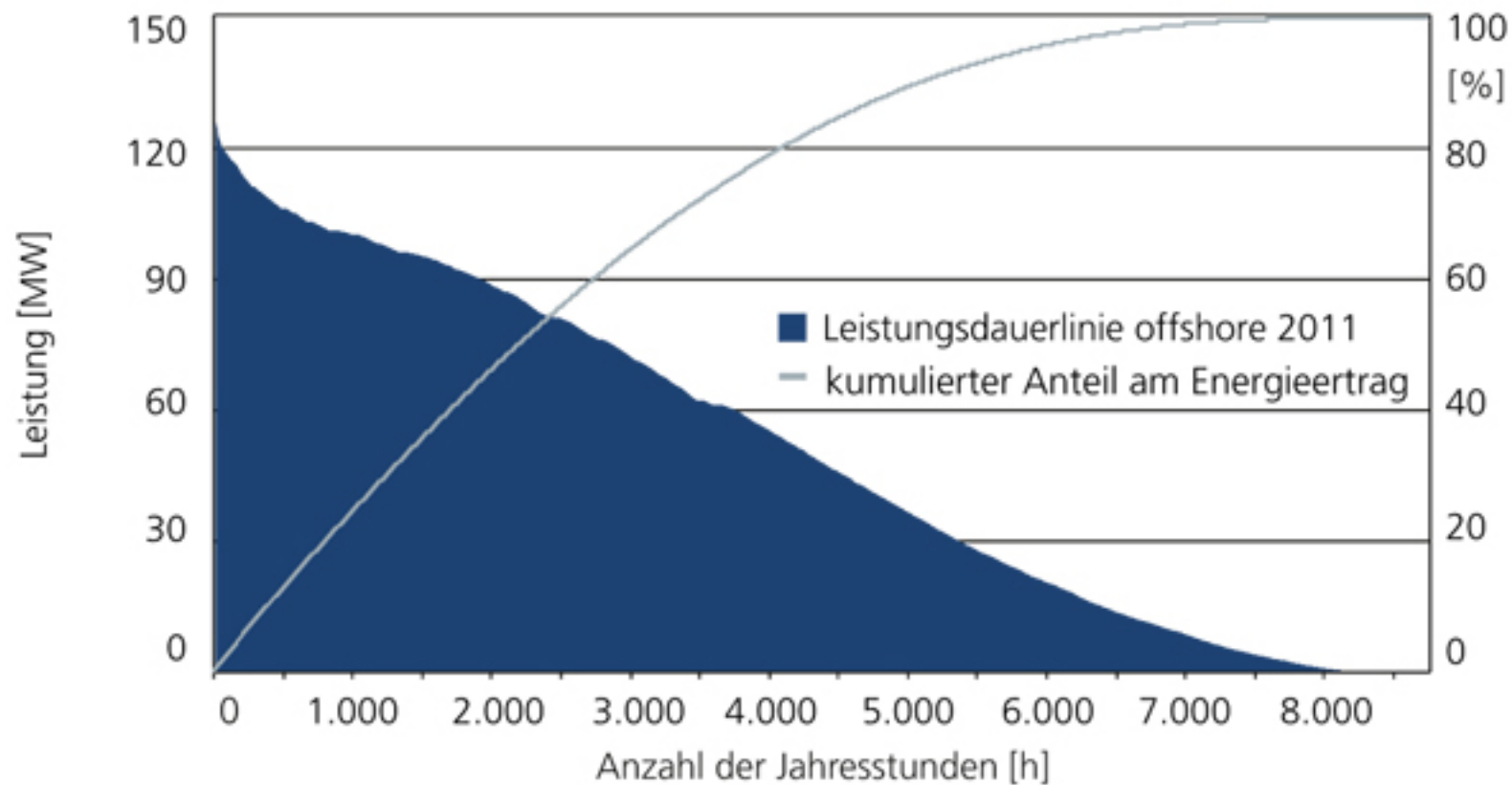
Geordnete Leistungs-Dauerlinie



Leistungsabgabe

Leistungsdauerlinie onshore





Leistungsabgabe

Vollaststunden

