Energy over view and wind power

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20140502

Extremt höga halter av koldioxid

Aldrig på flera miljoner år har det funnits så mycket koldioxid i jordens atmosfär som just nu. Under fjolåret ökade halten av denna växthusgas snabbare än någon gång sedan 1700-talets slut.

Igår kom siffror från den nordamerikanska havs- och atmosfärövervakningen NOAA som visar att koldioxidhalten i jordens atmosfär steg med 2,6 miljondelar under fjolåret. Det är den kraftigaste årliga ökningen sedan industrialismens början i slutet av 1700-talet. En enda miljondel motsvarar drygt två miljarder ton rent kol.

– Koldioxidhalten har ökat kraftigt under hela 2000-talet men fjolårets siffra innebär ett rekord, kommenterar Lennart Bengtsson, professor i meteorologi i Hamburg och Reading i England.

– Förmodligen är det Kinas och Indiens allt större förbrukning av fossila bränslen som ger utslag ovanpå utsläppen från industrinationerna.

Jordens hav och växtlighet tar hand om en hel del av koldioxidutsläppen men allt mer hamnar i atmosfären.

– Det är förmodligen så att världshaven under vissa omständigheter avger koldioxid till luften, säger Lennart Bengtsson.

– Man vet att det sker under de vädersituationer i Stilla havsområdet som går under namnet El Nino. Men någon sådan rådde inte under 2005, vilket gör ökningen av koldioxidhalten än mer oroande.

Koldioxid står för den största delen av den ökning av växthuseffekten som mänsklig verksamhet orsakar. Vid 1800-talets början var halten i atmosfären 270 miljondelar, nu har den ökat till 381 miljondelar och om 20 år kan den ligga på 550 miljondelar.

– En fördubbling av koldioxidhalten beräknas ge en höjning av den globala temperaturen i atmosfären med en grad, fortsätter Lennart Bengtsson.

Men klimatet kan bli ännu varmare.

– Utvecklingen är otrevlig, säger Lennart Bengtsson. Människan måste snart komma till rätta med problemen med fossila bränslen.

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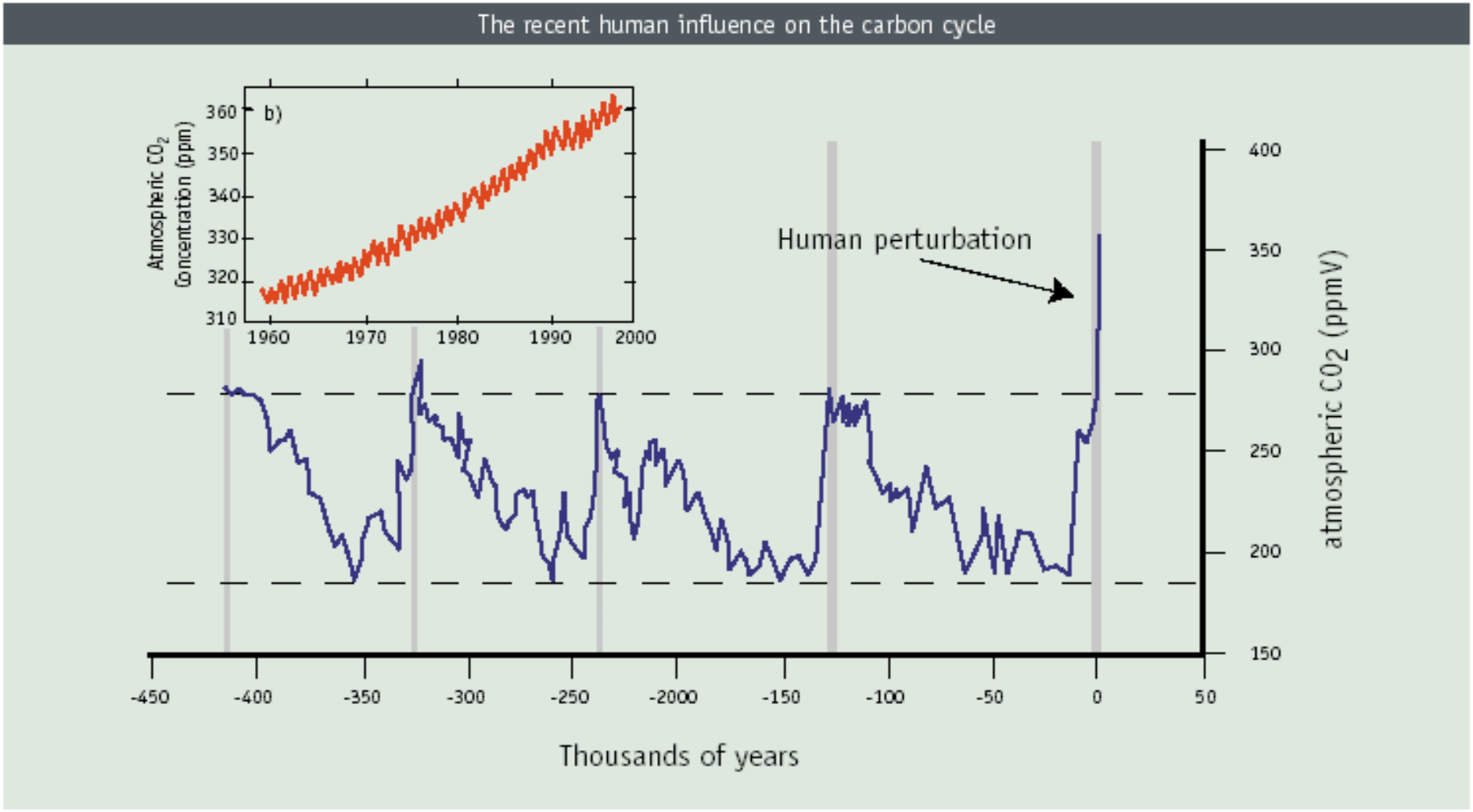
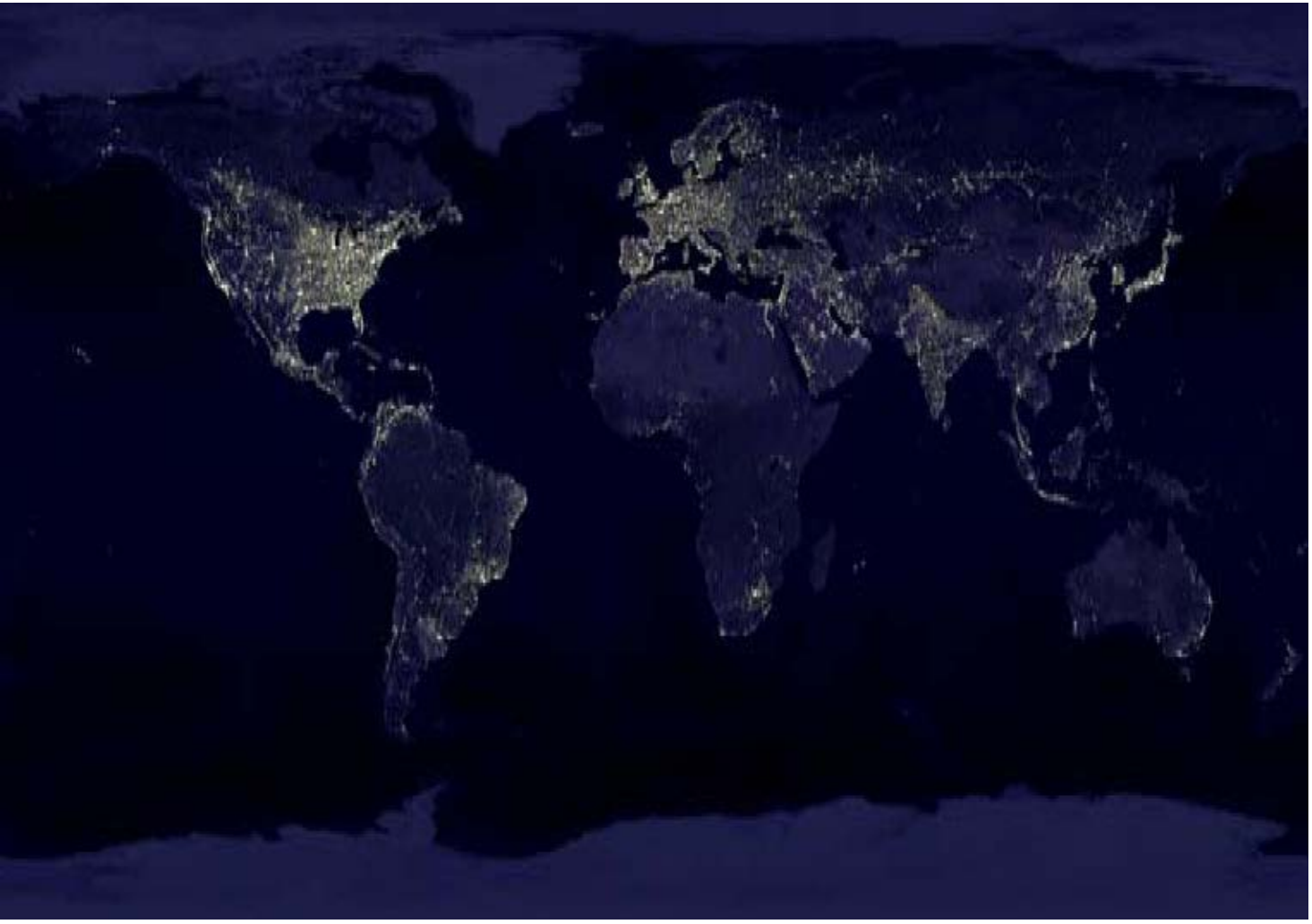


Figure 2 Atmospheric CO_2 concentration from the Vostok ice core record with the recent human perturbation superimposed. The inset shows the observed contemporary increase in atmospheric CO_2 concentration from the Mauna Loa (Hawaii) Observatory.

Sources: Petit et al. (1999) Nature 399, 429-436 and National Oceanic and Atmospheric Administration (NOAA), USA

The world a dark night



1.6 billion persons without electric power

What is life without Electric Energy ?

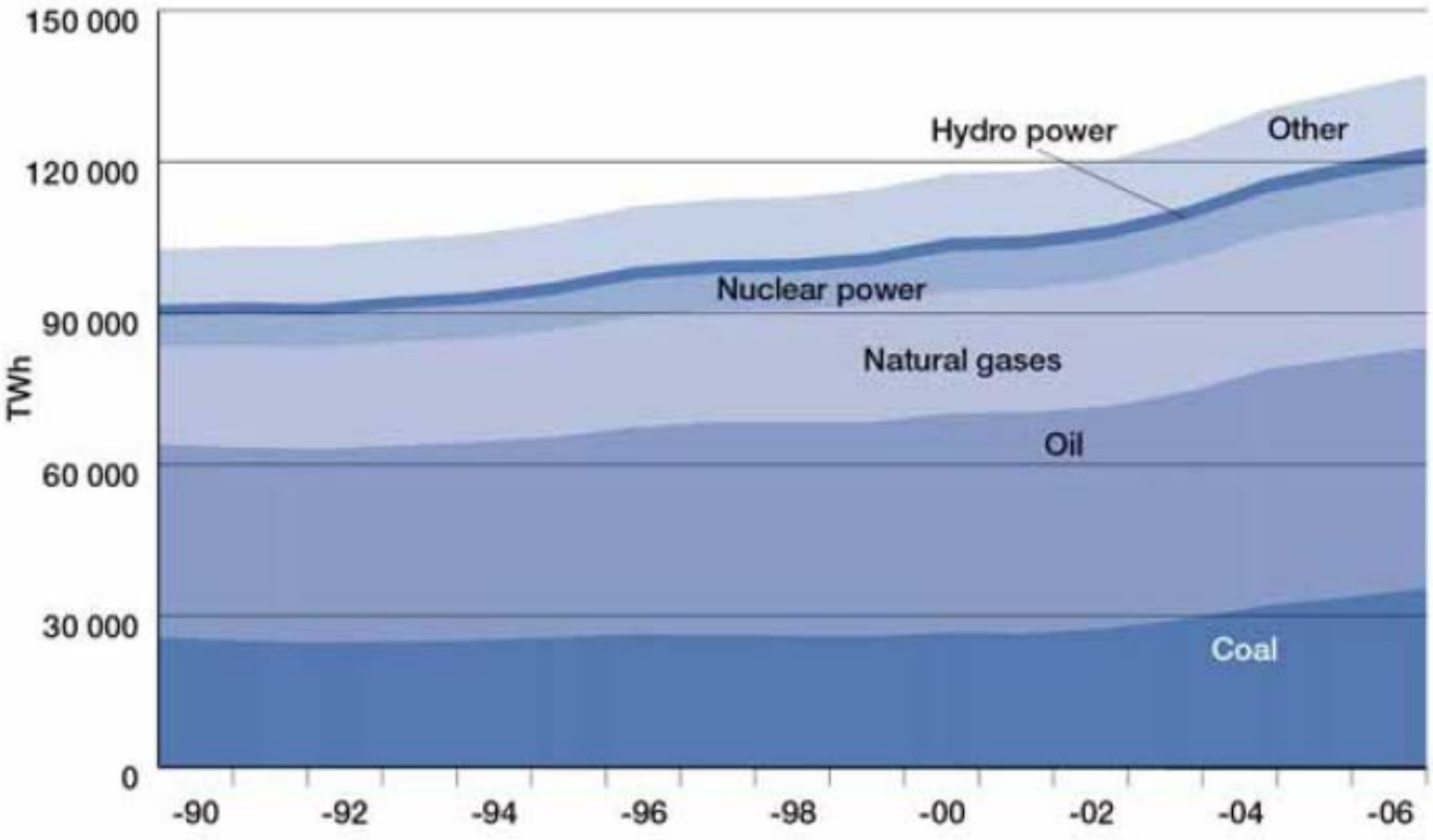
- No light
- No electric heat
- No electric motors
- No computers, phones, TV

and

- Oil has reached its top production
- Gas soon on top production, but CO2
- Coal can be used for many years, but CO2

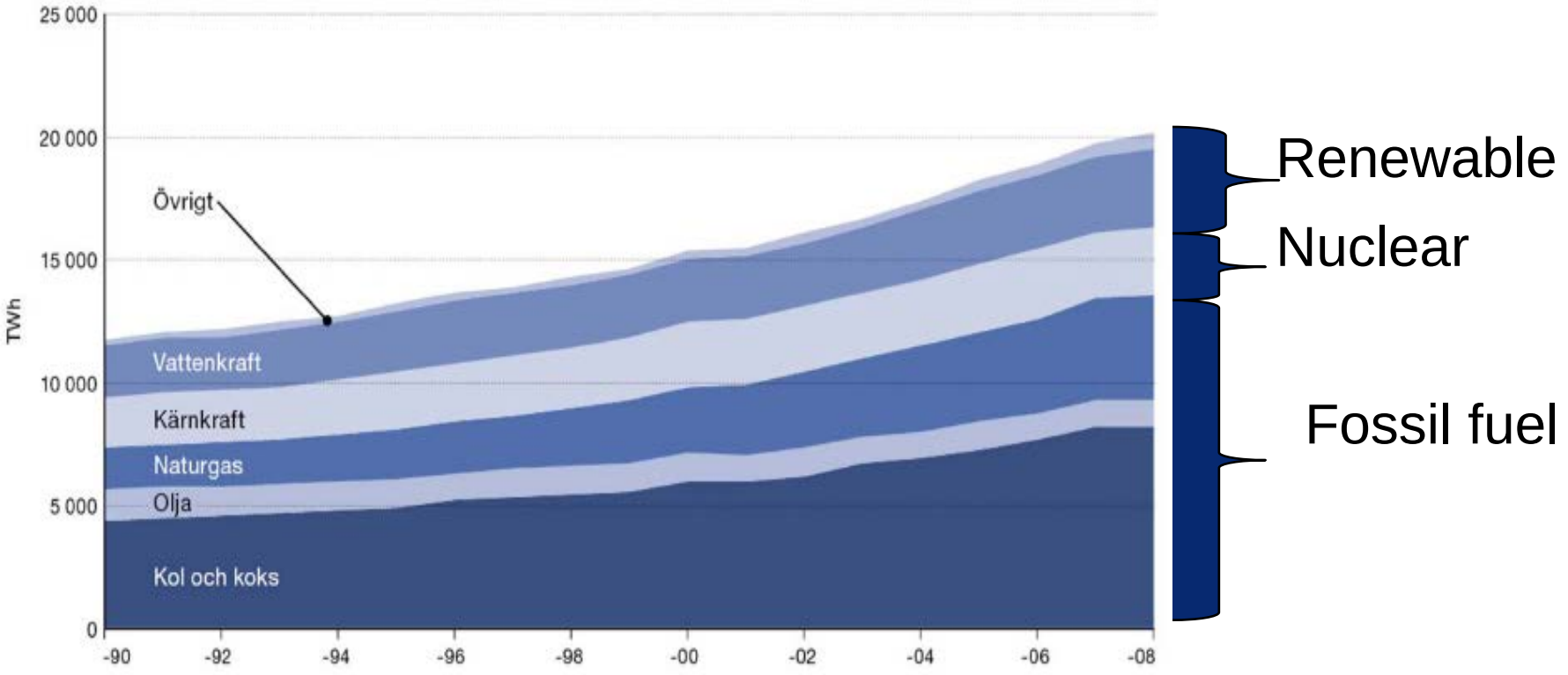
Needs for renewable electric power is great and there is a Need for Electric Power Engineers to develop the future

Figure 49: Global primary energy supply, 1990–2006



SOURCE: IEA ENERGY BALANCES OF NON-OECD COUNTRIES, 2008

Global electric power production



Sweden electrical production

Hydro power in the north, 48 %

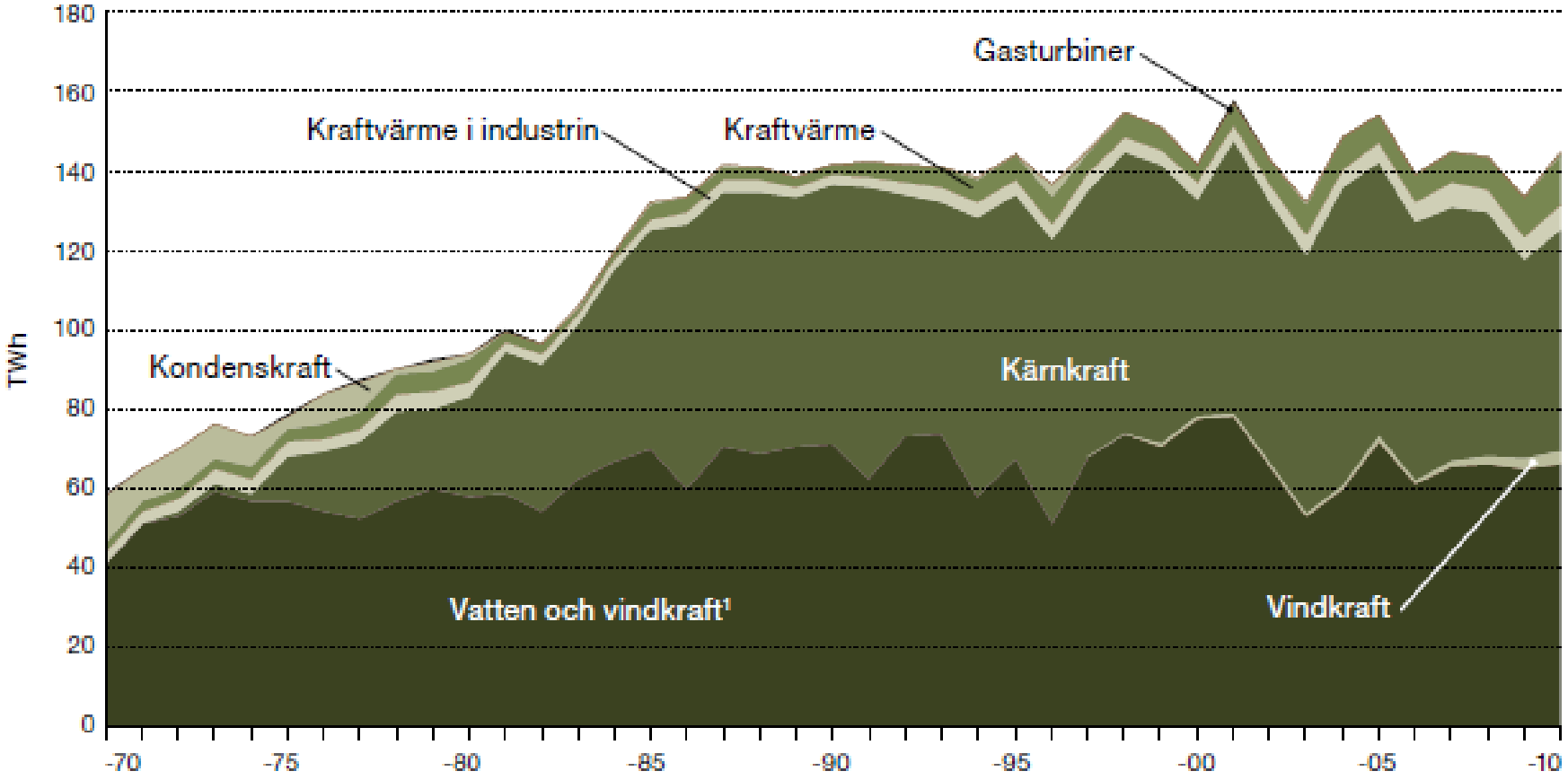
Nuclear in the south, 37 %

Combined heat and power production 16%

Wind Power, 7 %

Sum 108 % = Export

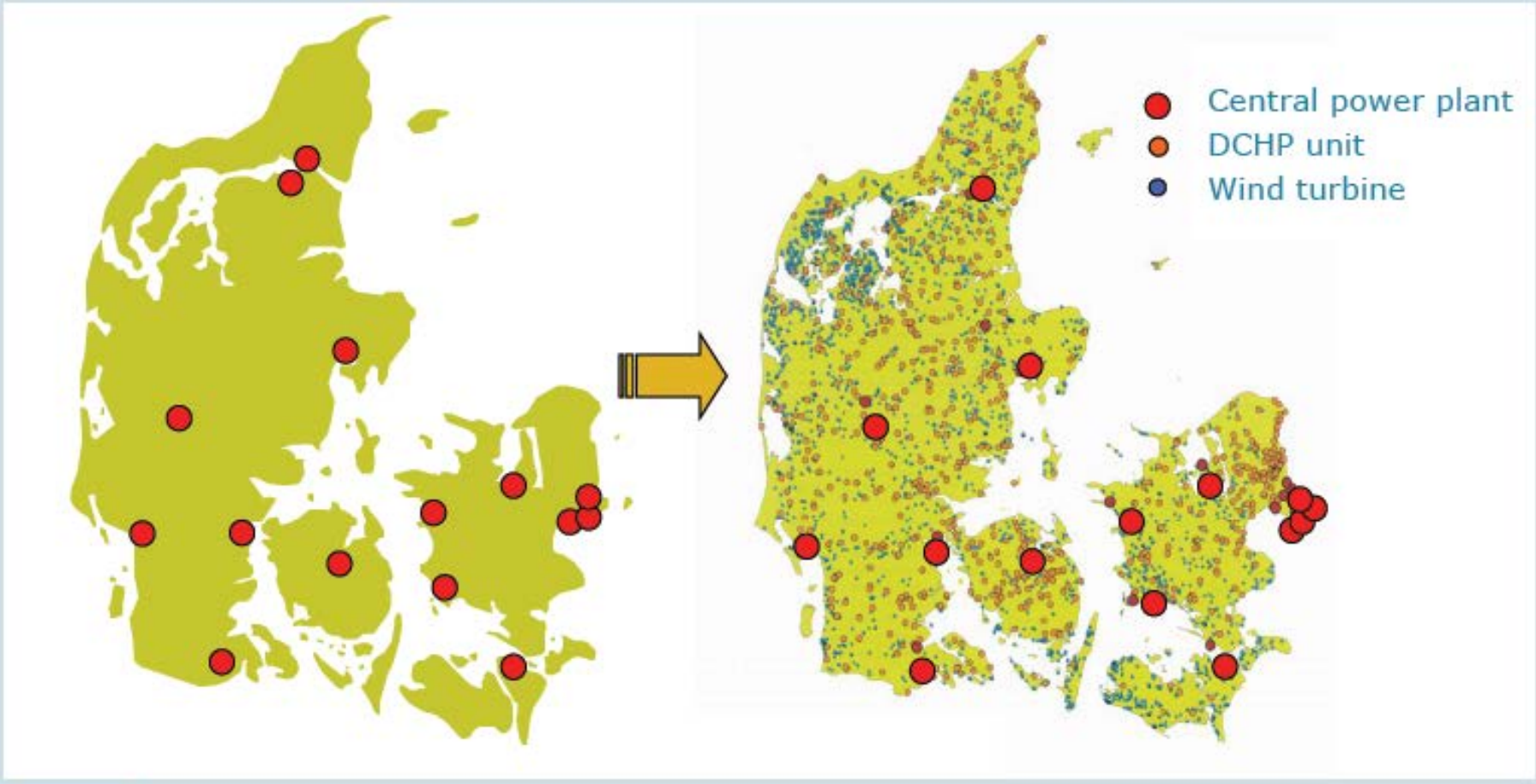
Figur 21 Sveriges elproduktion per kraftslag, 1970–2010, uttryckt i TWh



Källa: Energimyndigheten och SCB.
Anm. 1. Vattenkraft och vindkraft samredovisas till och med 1996, därefter särredovisas vindkraften i en egen serie.

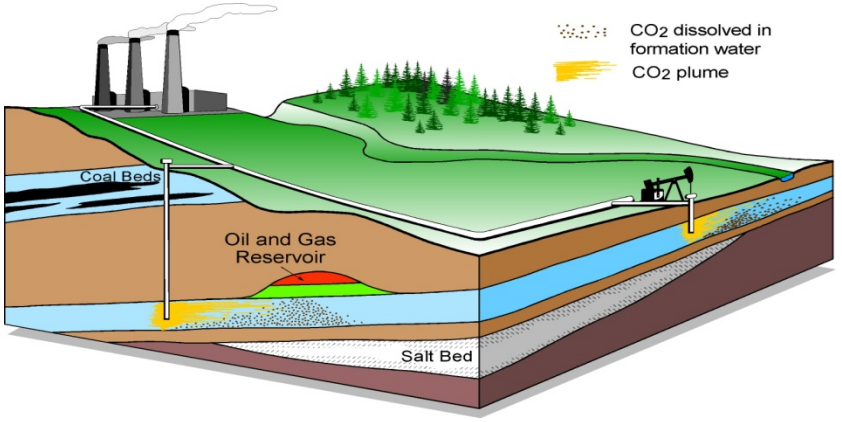
ENERGINET.DK

Development from the late 1980s to present

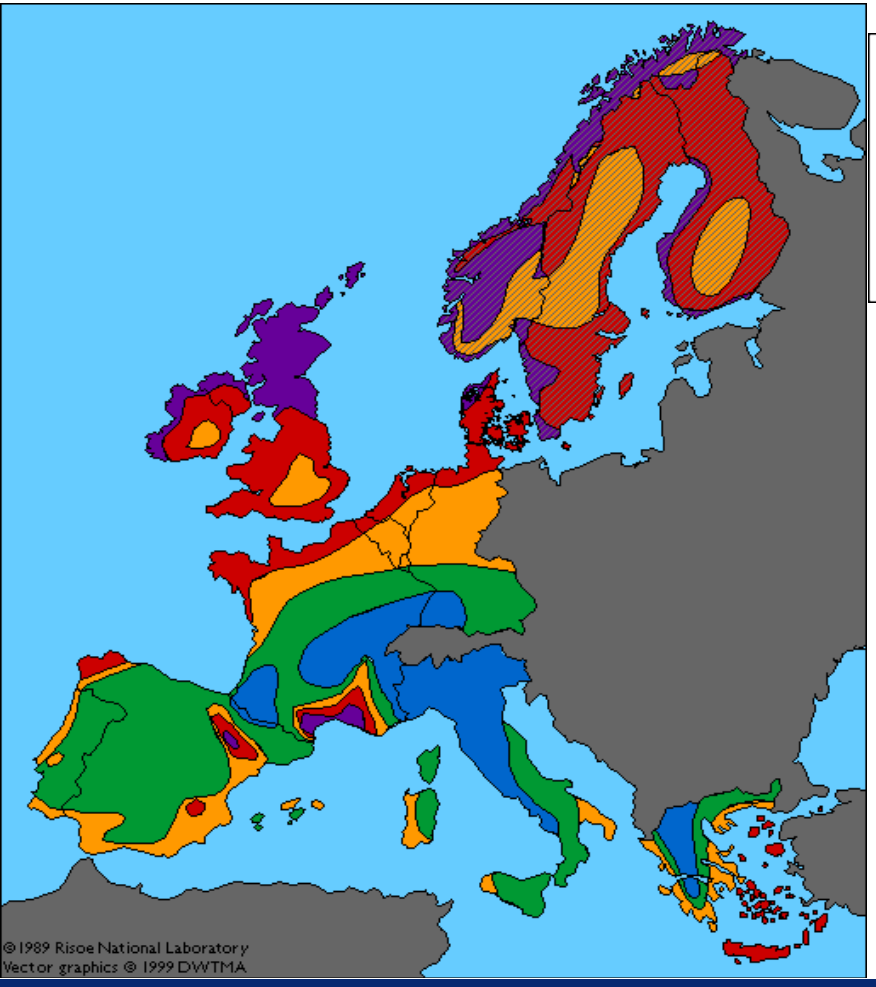


Renewables and new energy systems

- Hydro power
- Wind power
- Solar energy
- Wave Energy
- CO_2 separation and storage for converting natural gas to power
- Green certificates trading

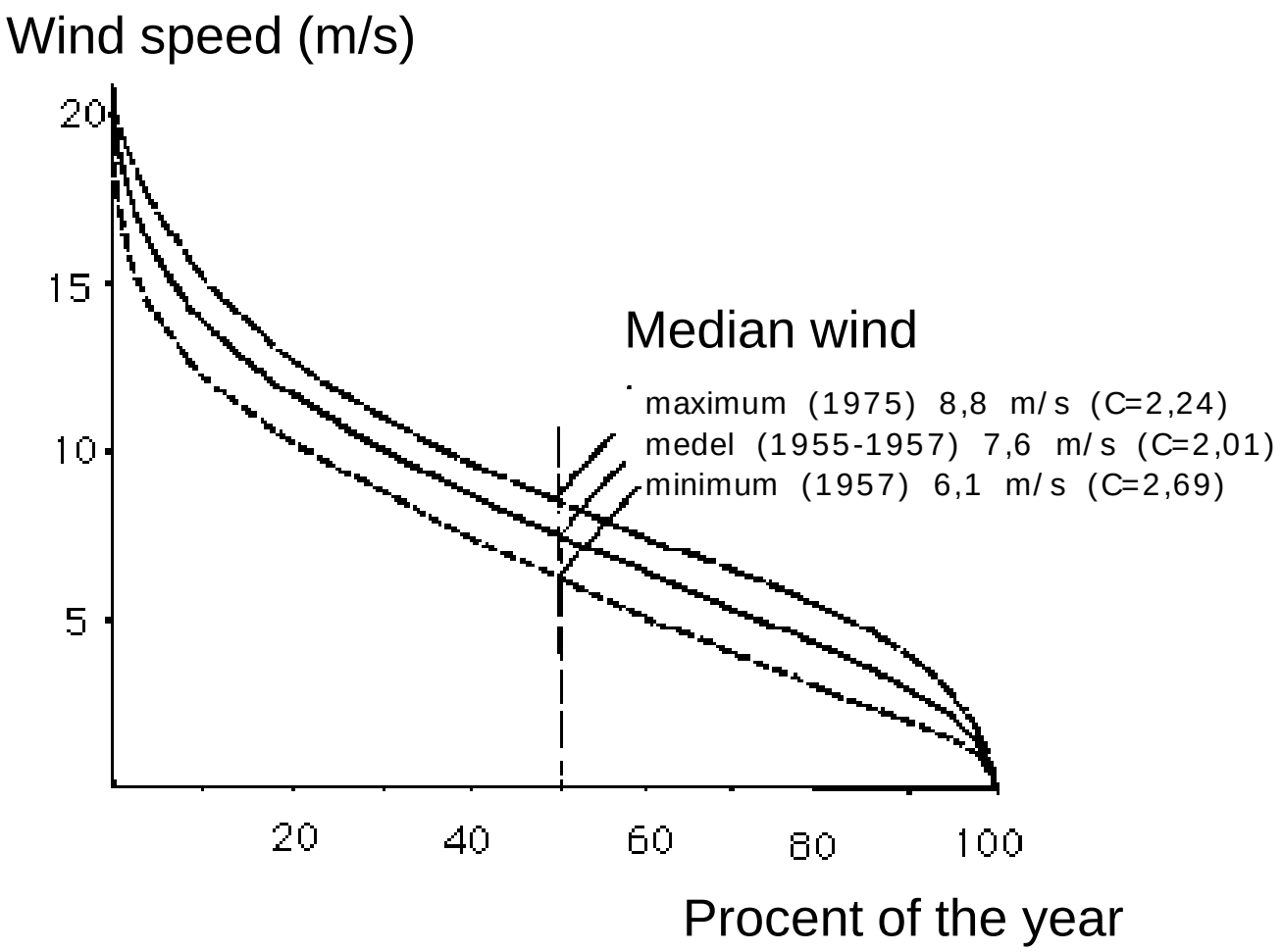


Wind conditions

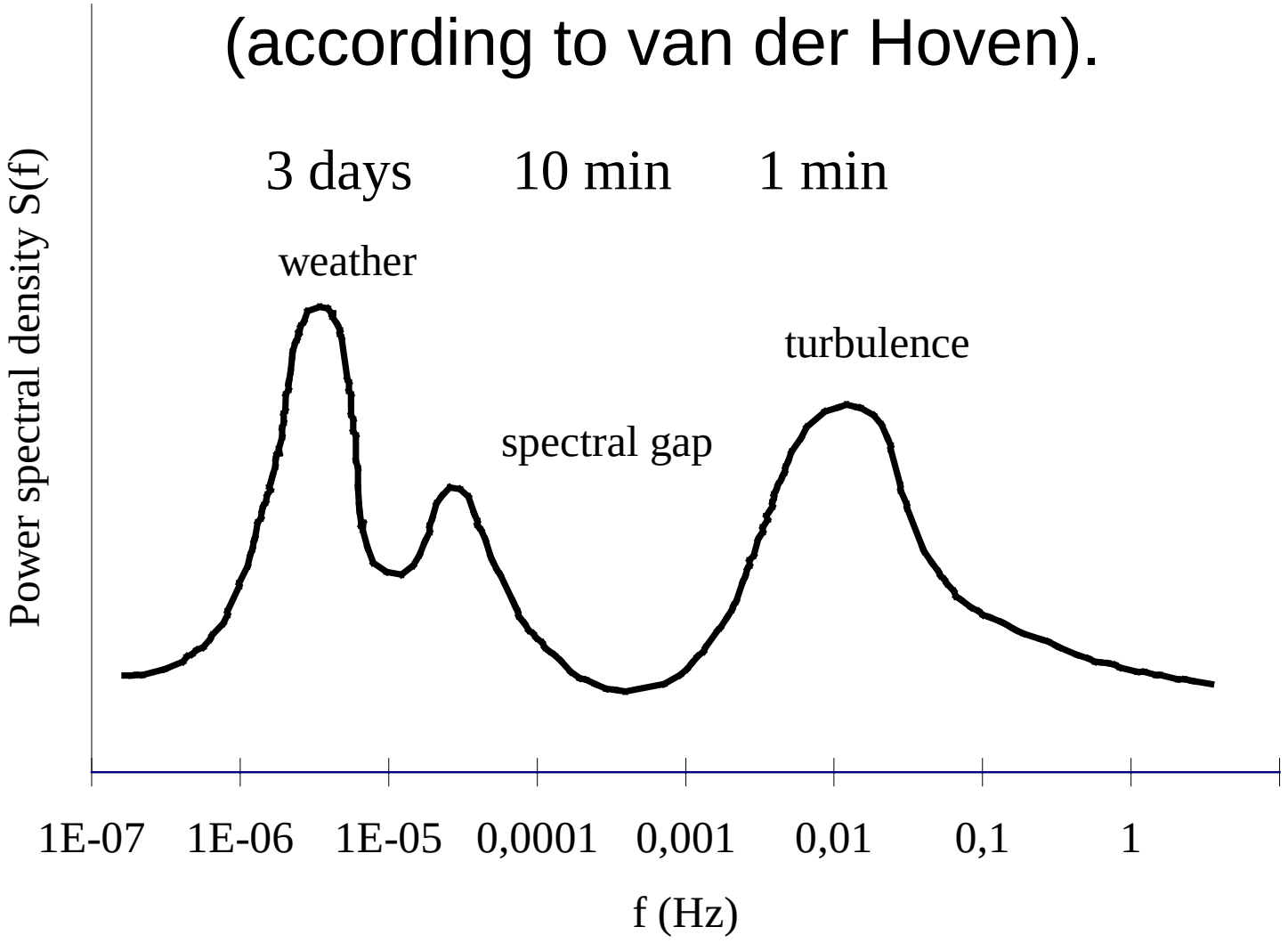


	m/s	W/m²	m/s	W/m²	m/s	W/m²	m/s	W/m²	m/s	W/m²
	>6.0	>250	>7.5	>500	>8.5	>700	>9.0	>800	>11.5	>1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0-8.5	400-700
	<3.5	<50	<4.5	<100	<5.0	<150	<5.5	<200	<7.0	<400
			>7.5							
			5.5-7.5							
			<5.5							

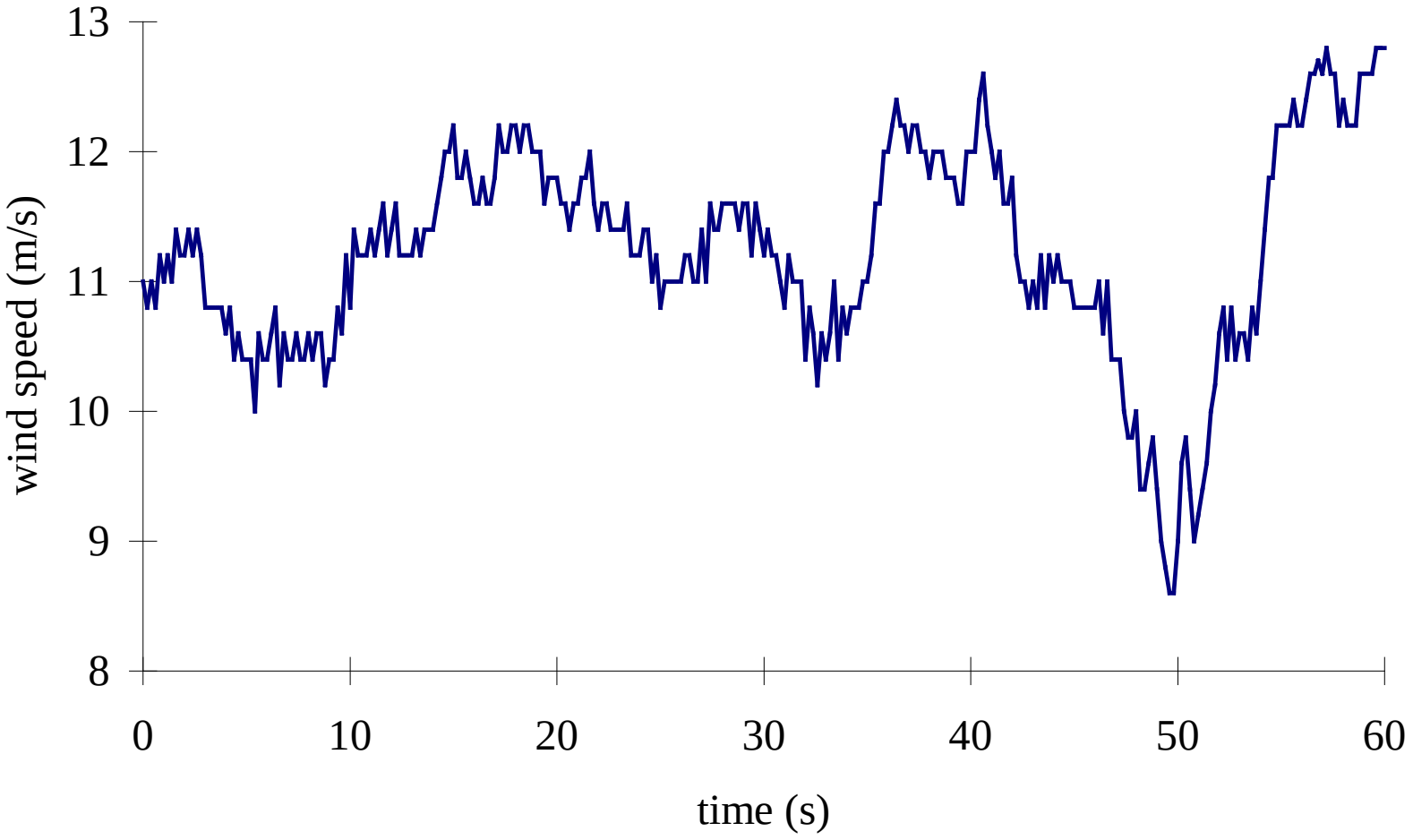
Weibull distribution



Schematic power spectrum of wind speed (according to van der Hoven).

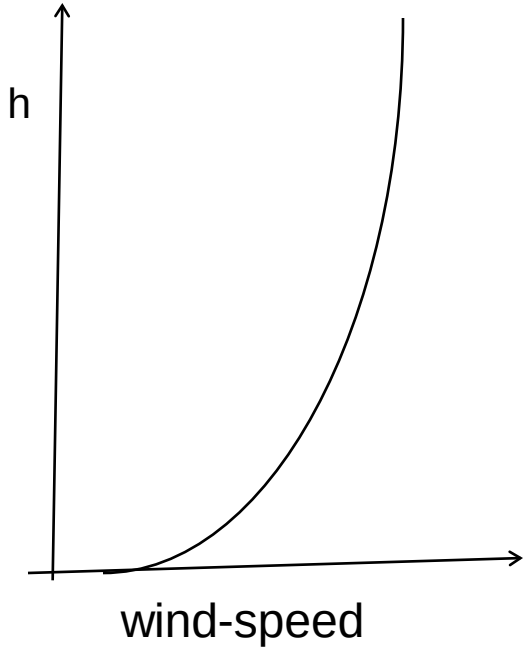


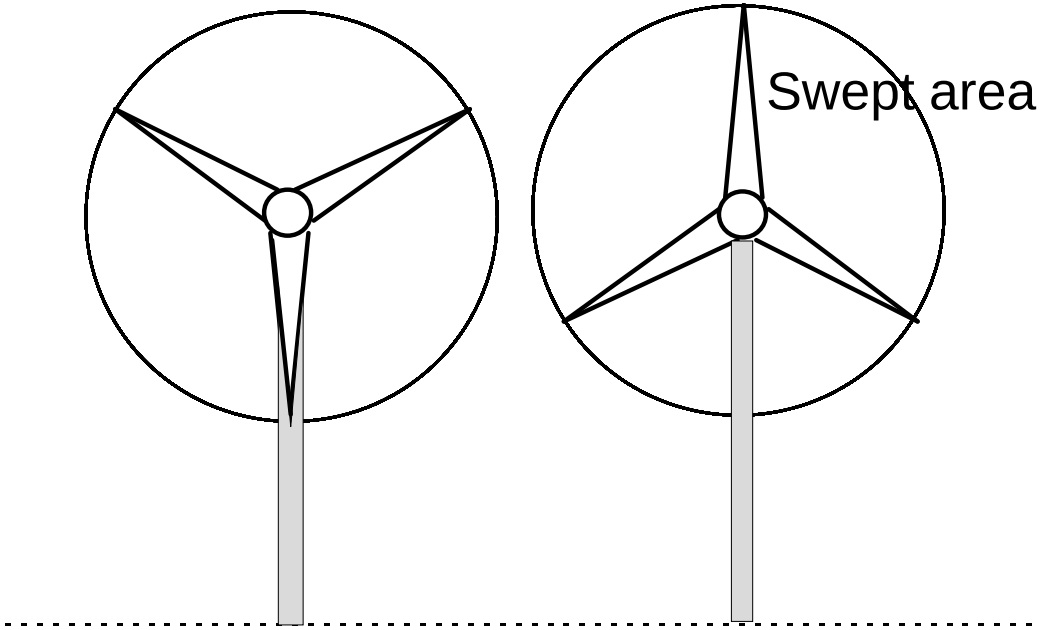
Wind speed measured at the harbour of Gothenburg, Sweden



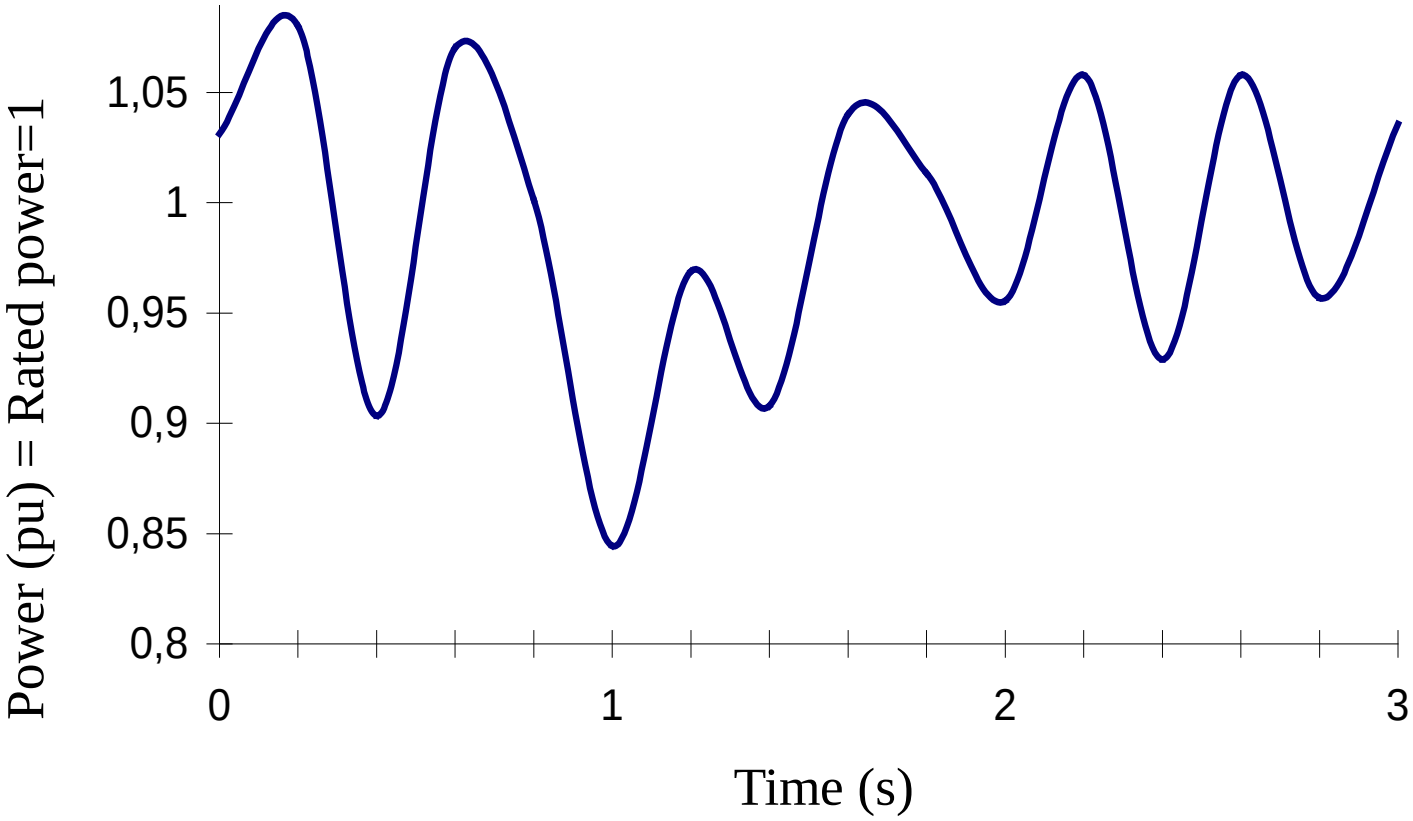
Higher up more wind

Different rotor positions of a three-blade turbine. The tower shadow and the wind gradient, both contribute to power fluctuations





Measurements from a 660 kW wind turbine constant speed and pitch control



Speed 40 rpm

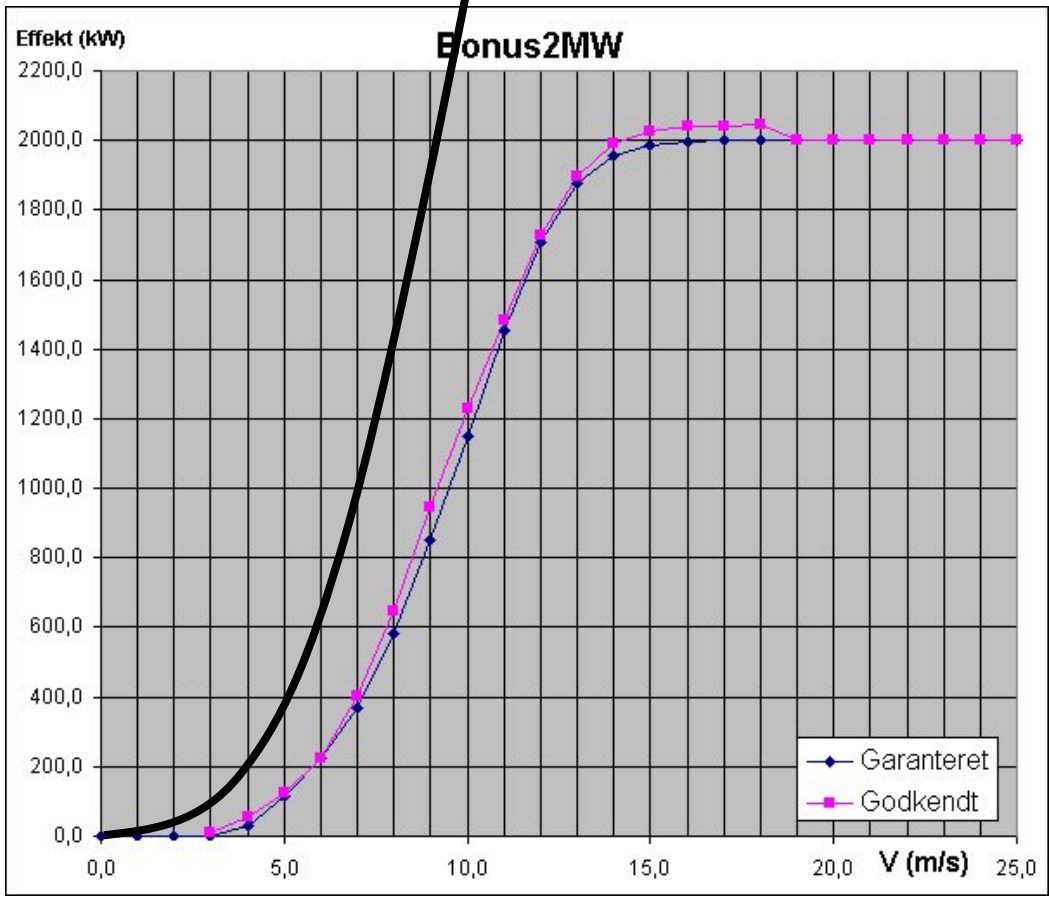
Pulsation 3/turn

Frequens 2 Hz

Power from the wind turbine

$$P = \frac{1}{2}\rho A C_p V^3$$

Where Cp is power coefficient

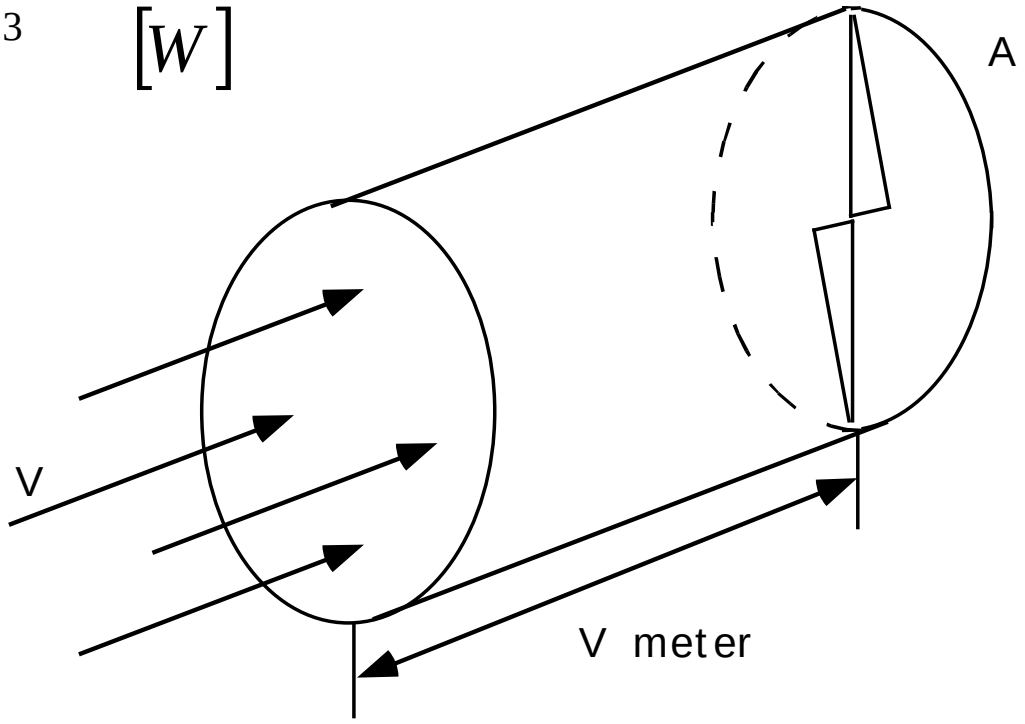


Power of the wind

$$P_{kin} = \frac{1}{2}(\rho A V)V^2 = \frac{1}{2}\rho A V^3 \qquad [W]$$

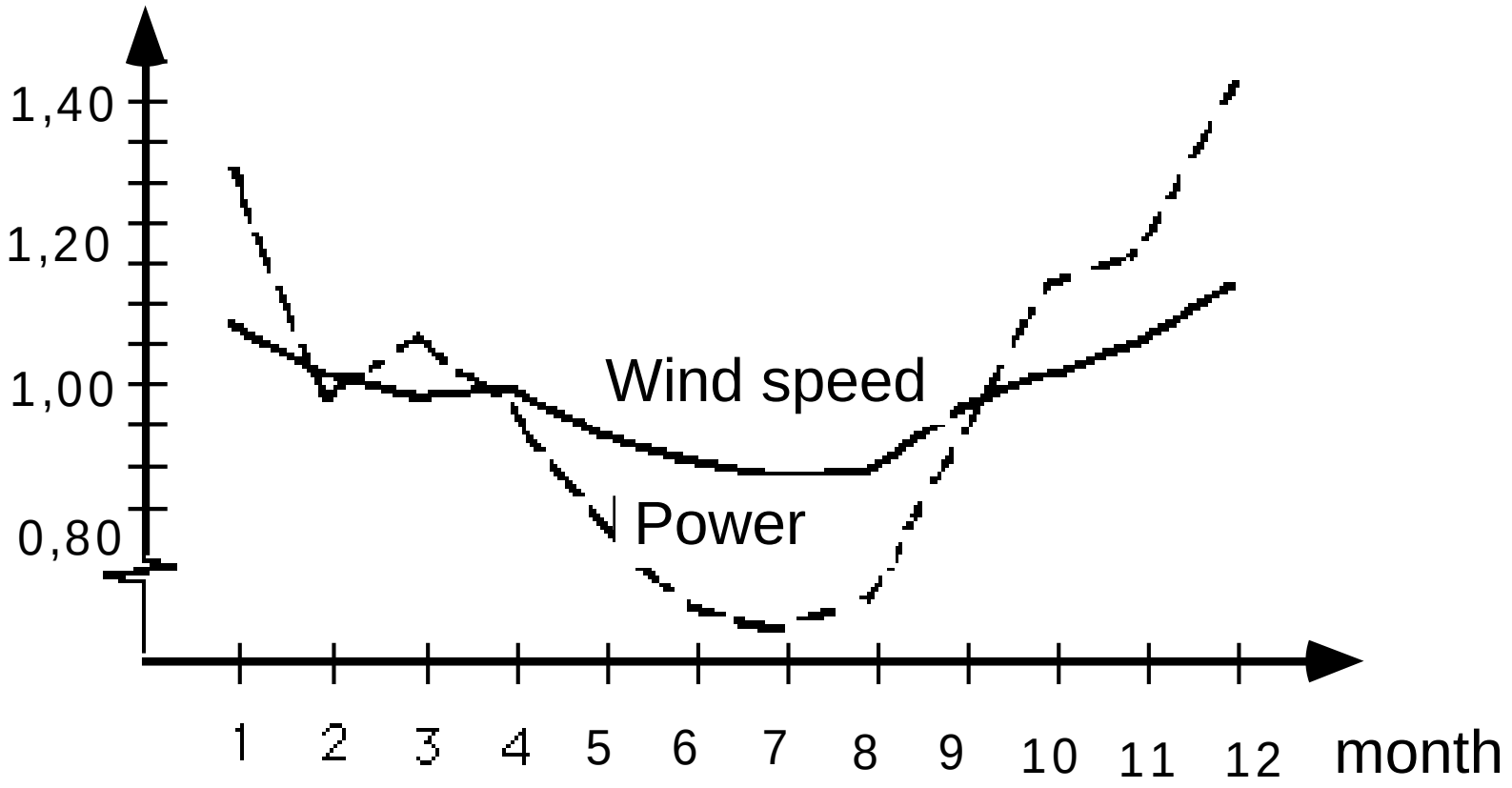
Mass flow rate

$$\dot{m} = \rho A V$$

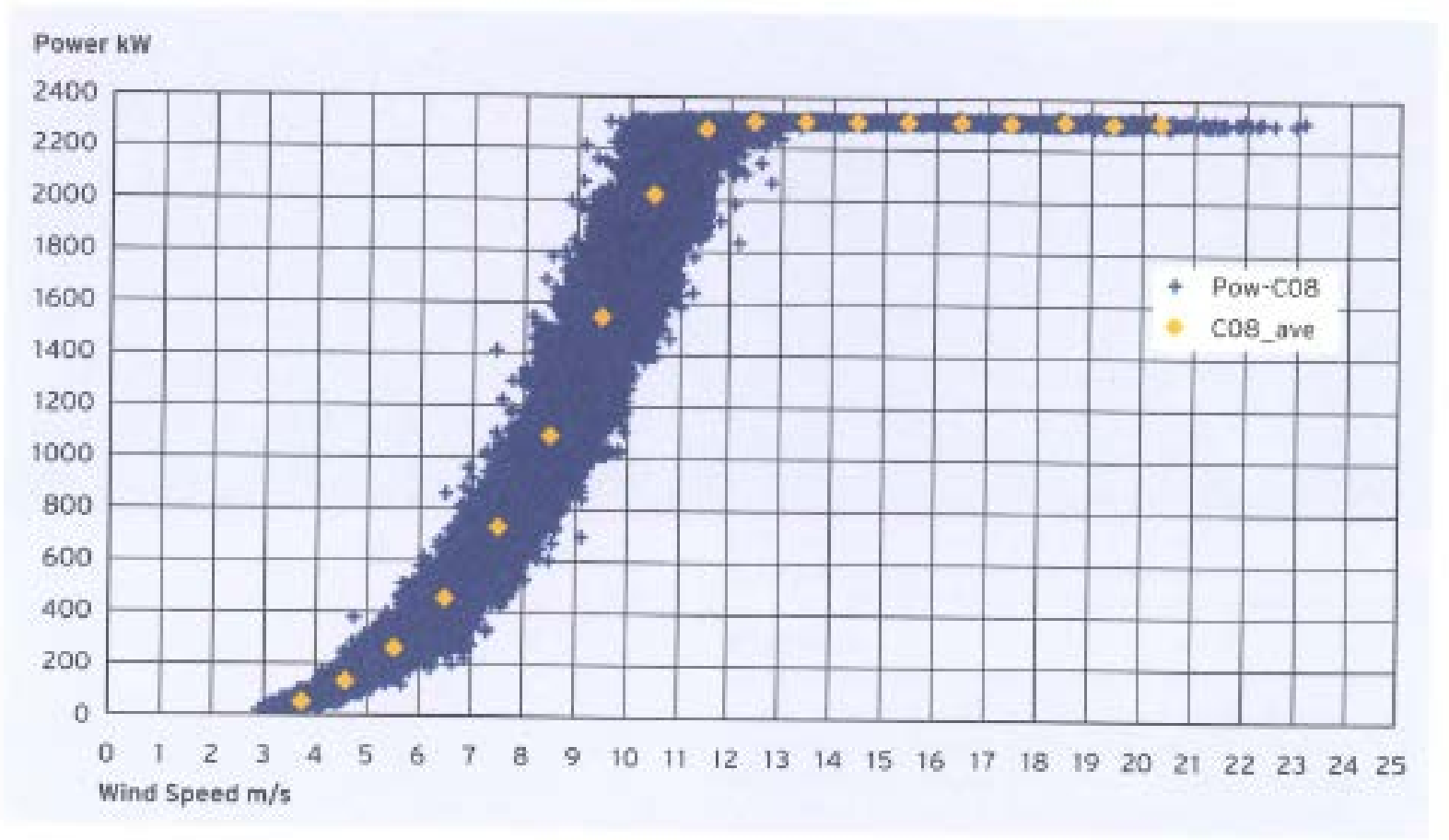


ρ = air density[kg/m^3]
V = air velocity[m/s]
A = rotor disk area[m^2]
m = mass of the air

Average value

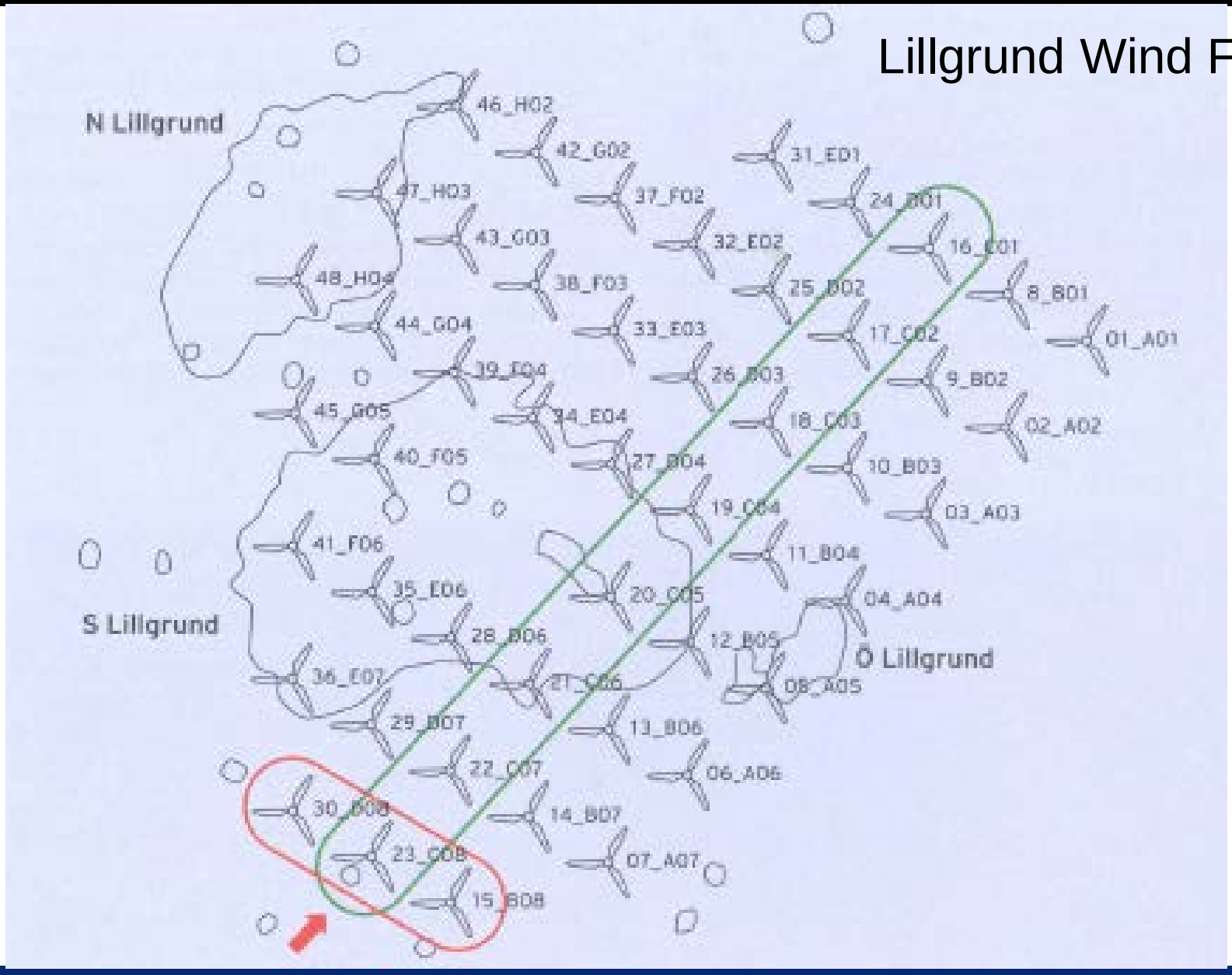


Power Curve from a 2.3 MW wind turbine at Lillgrund



I grafen presenteras resultatet av vind-effektmätningen för vindkraftverk C-08. Medelvärdet (gul symbol) i varje fack...

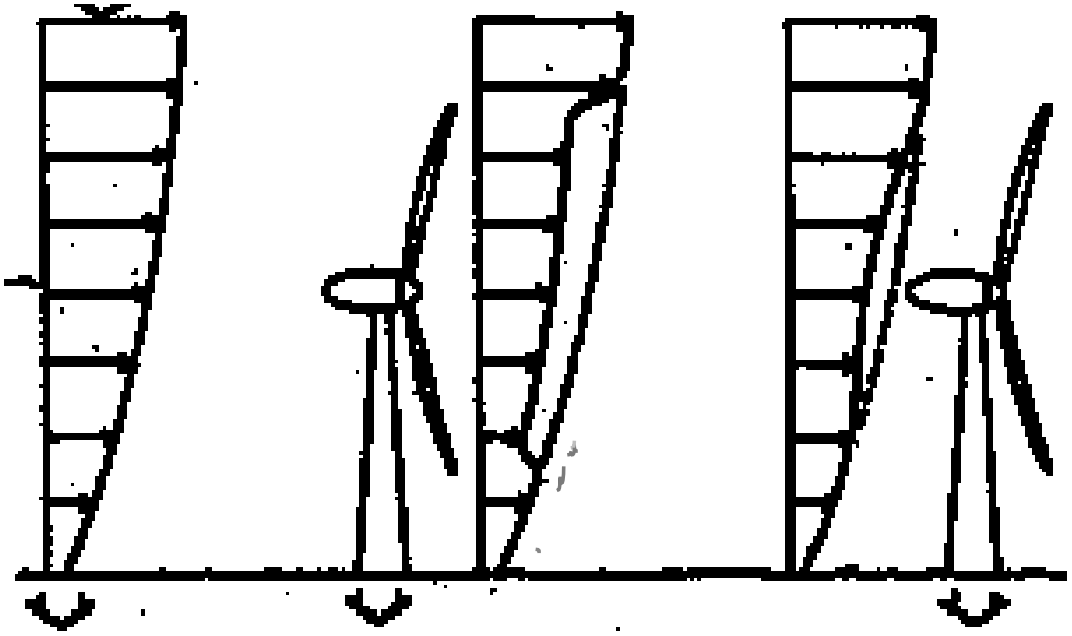
Lillgrund Wind Farm



Gradient of the wind

Wind decreases due to turbine

Wind reforms



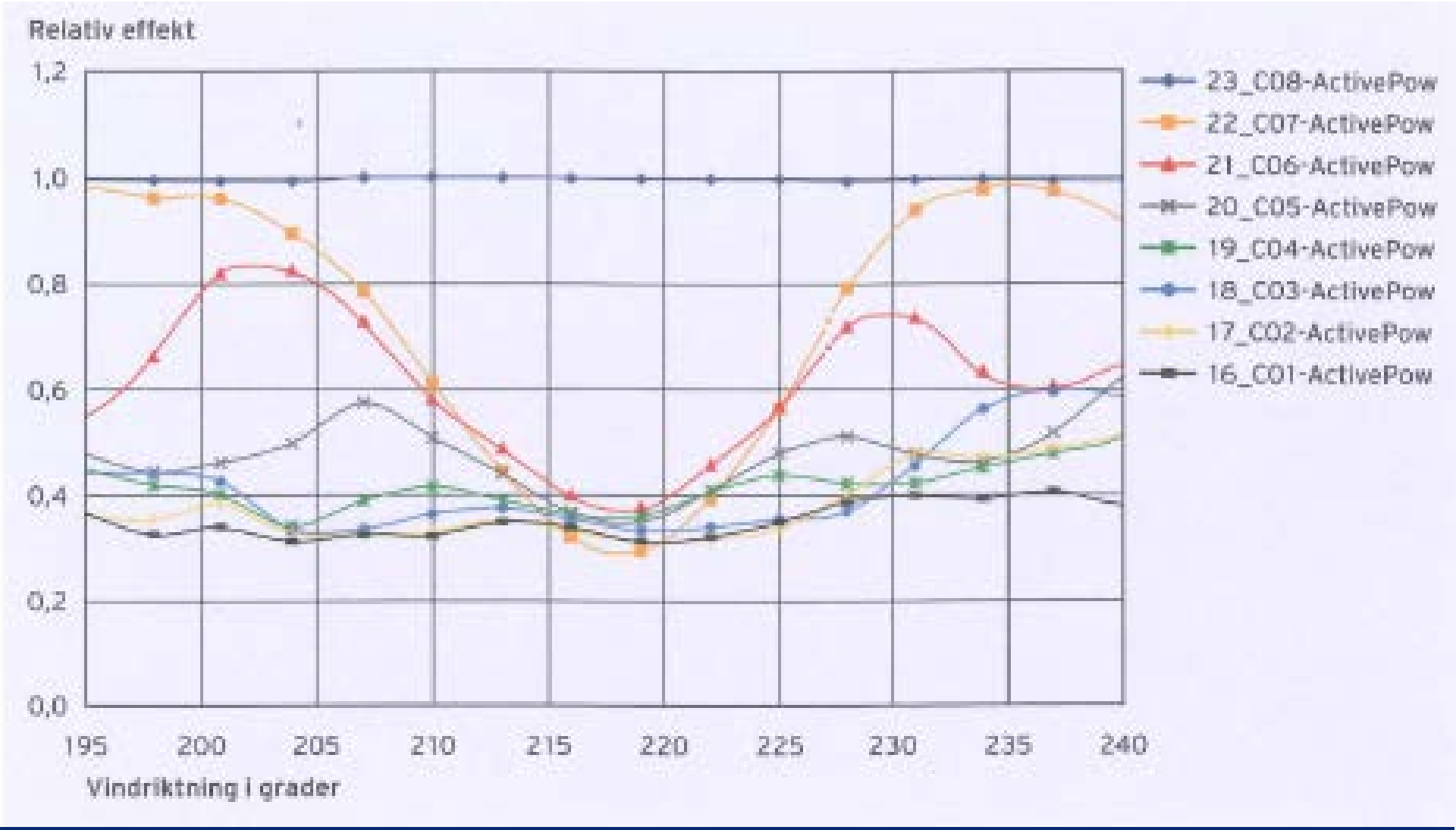
Energy decreases due to land friction

Energy to the grid

How much left?

5 to 10 rotor diameters

Relativ Power from wind turbines in the wind farm



Electric power from Swedish wind turbines per day

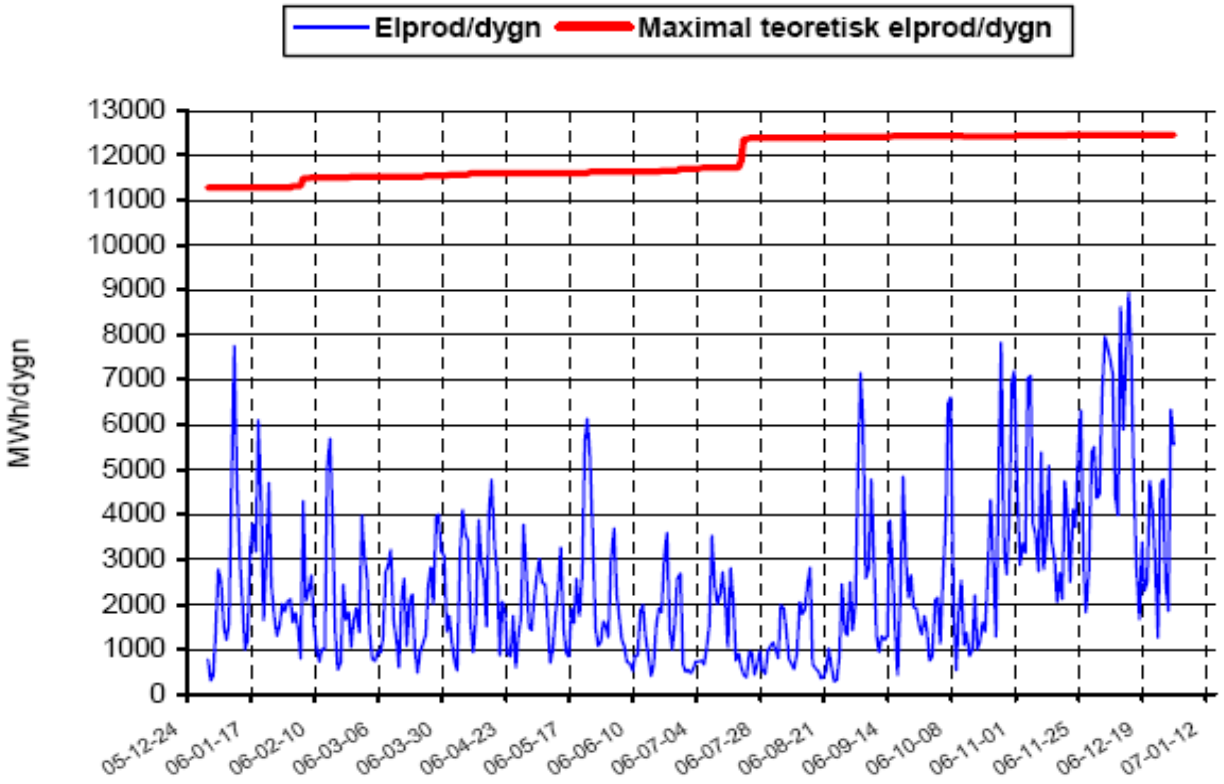
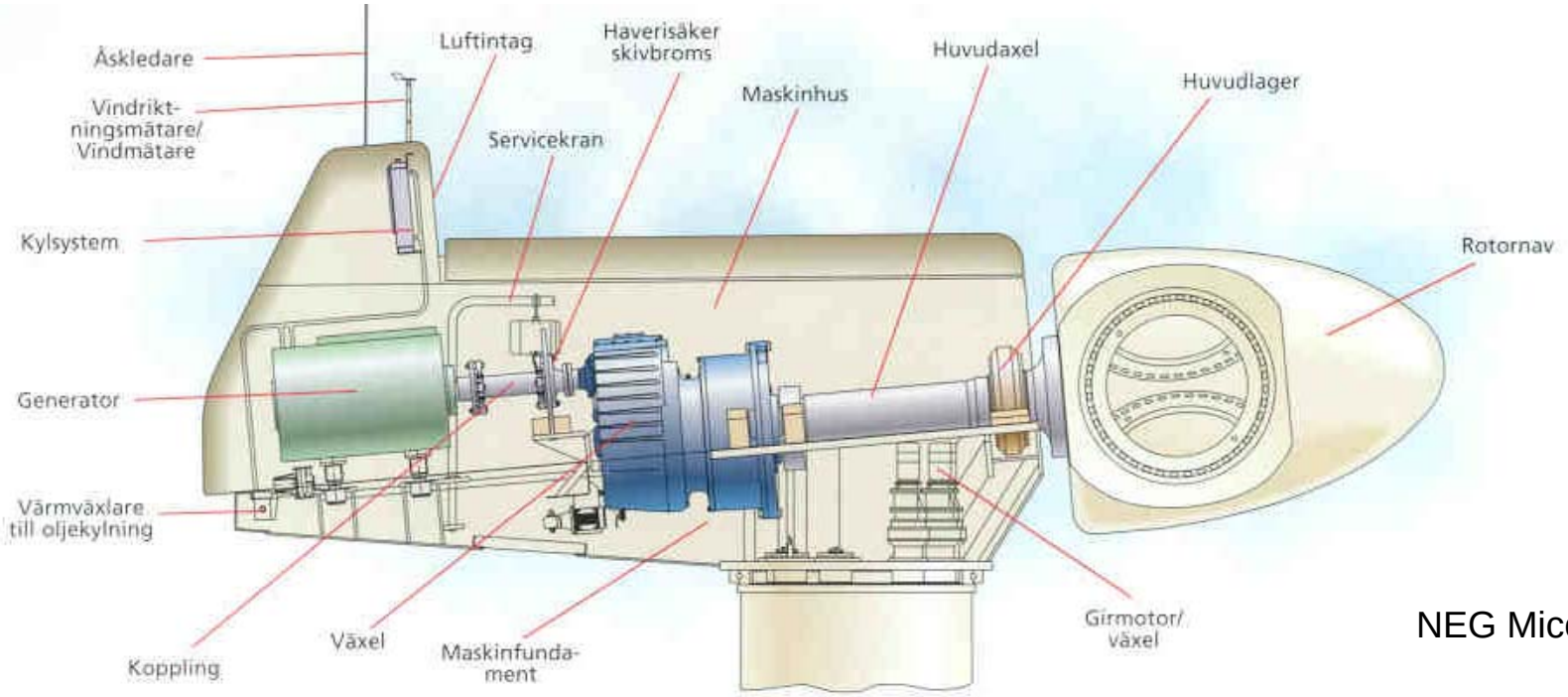


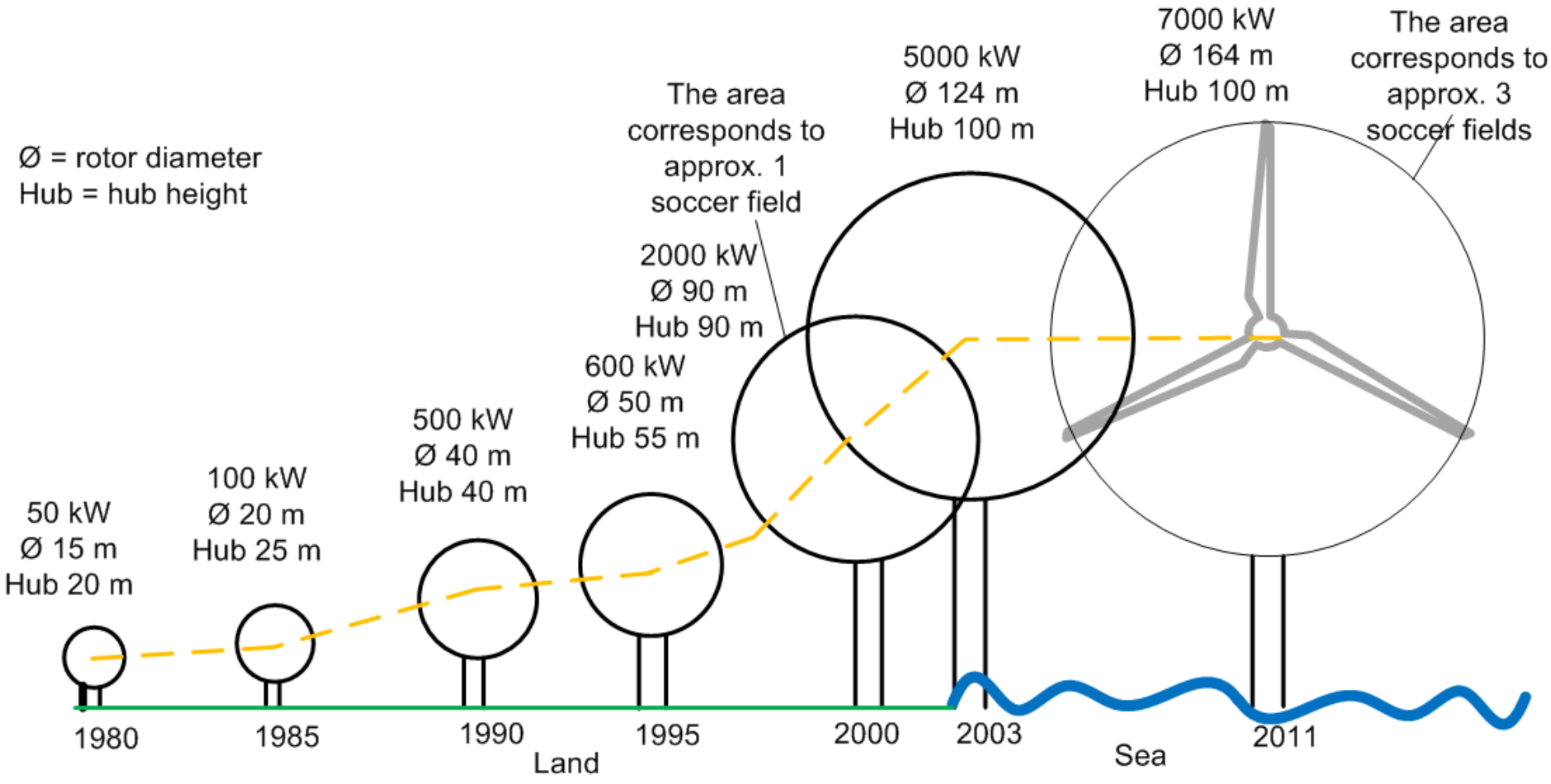
Diagram 3, verkens elproduktion per dygn över året.

Typical wind power nacelle



NEG Micon 750/48

Size Development of Wind Turbines

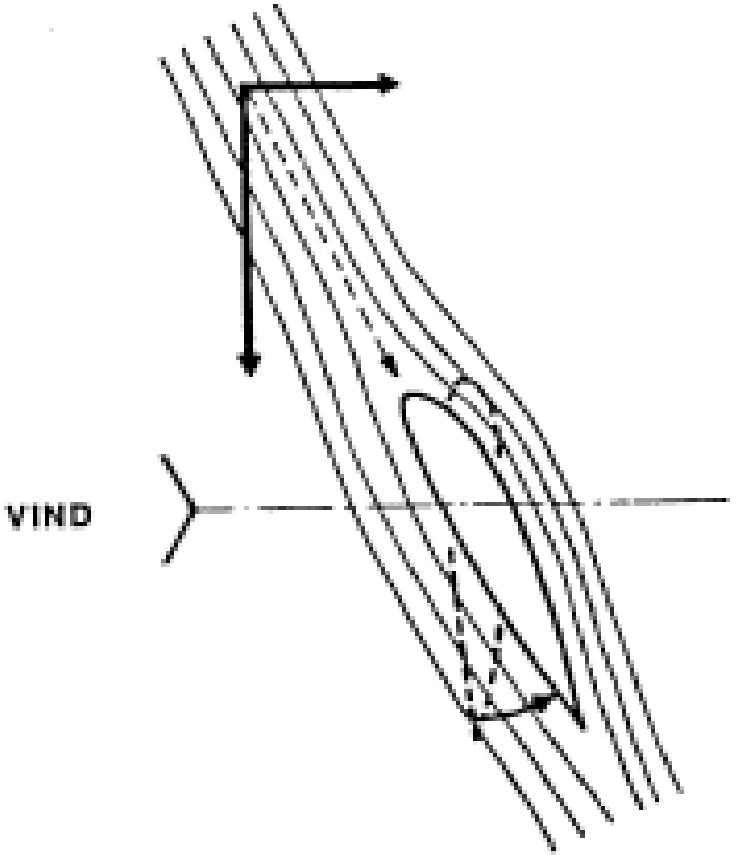


Limitations of wind power

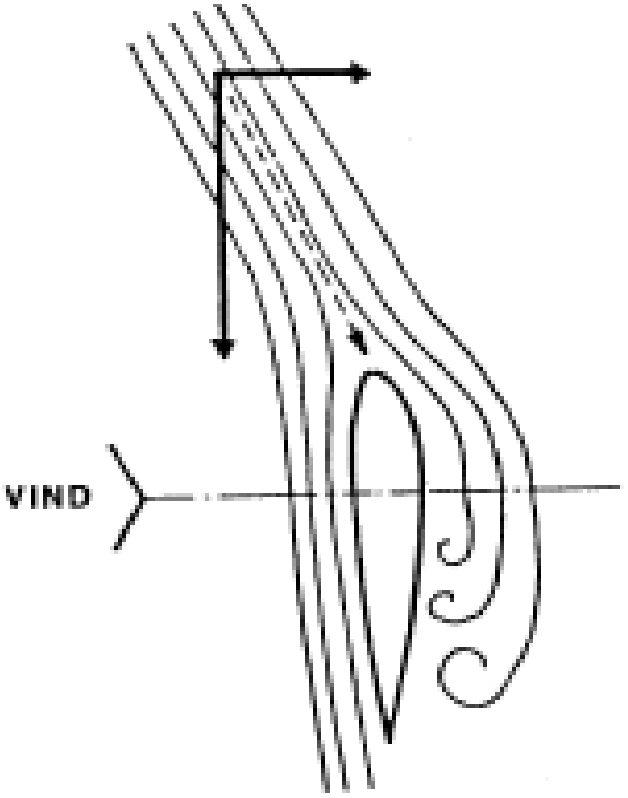
- Pitch control
  turn the blades
- Stall control
  Ridged blades, turbulence limit the power
- Active stall
  the pitch angle can be adjusted

- At emergency stop will the blades turn
- At emergency stop will the outer part of the blades turn
- At emergency stop will the blades turn

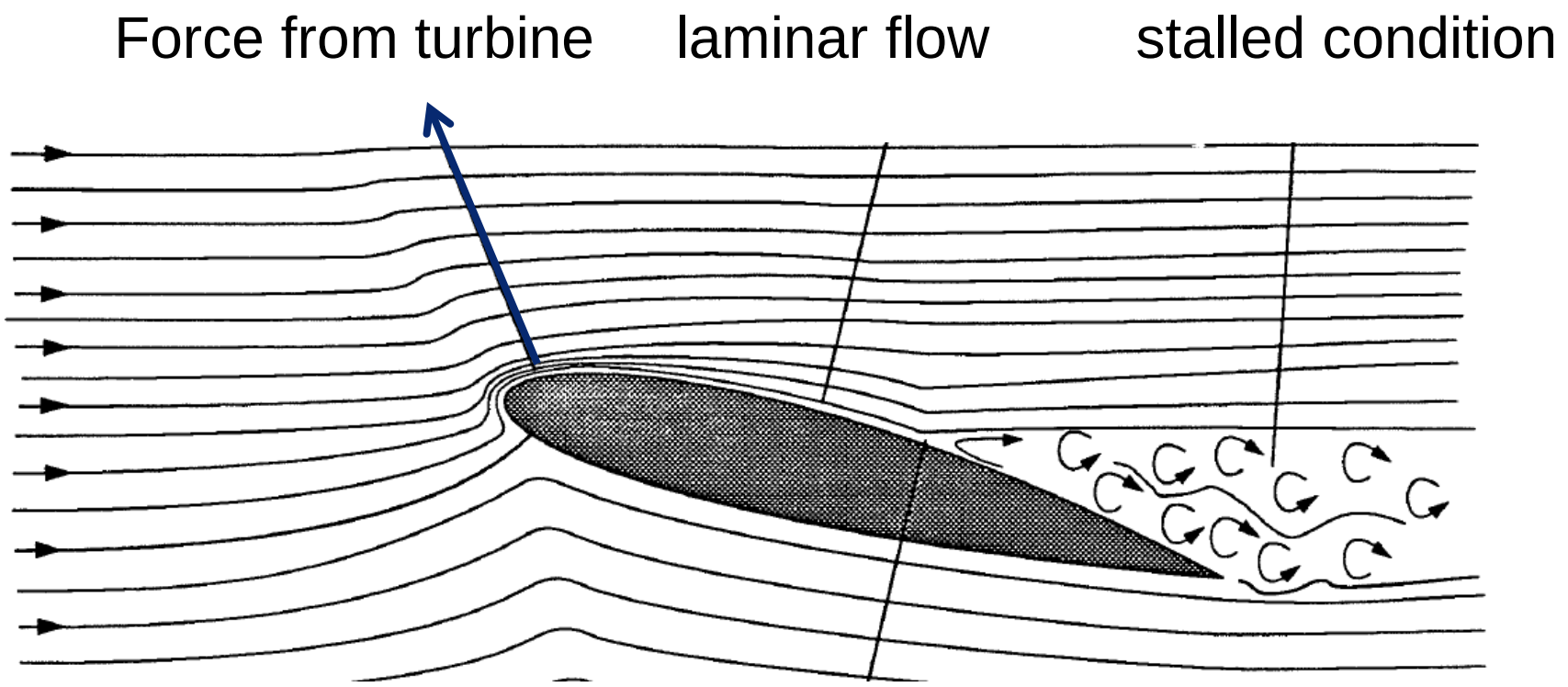
Pitch contol



Stall control



Stall control



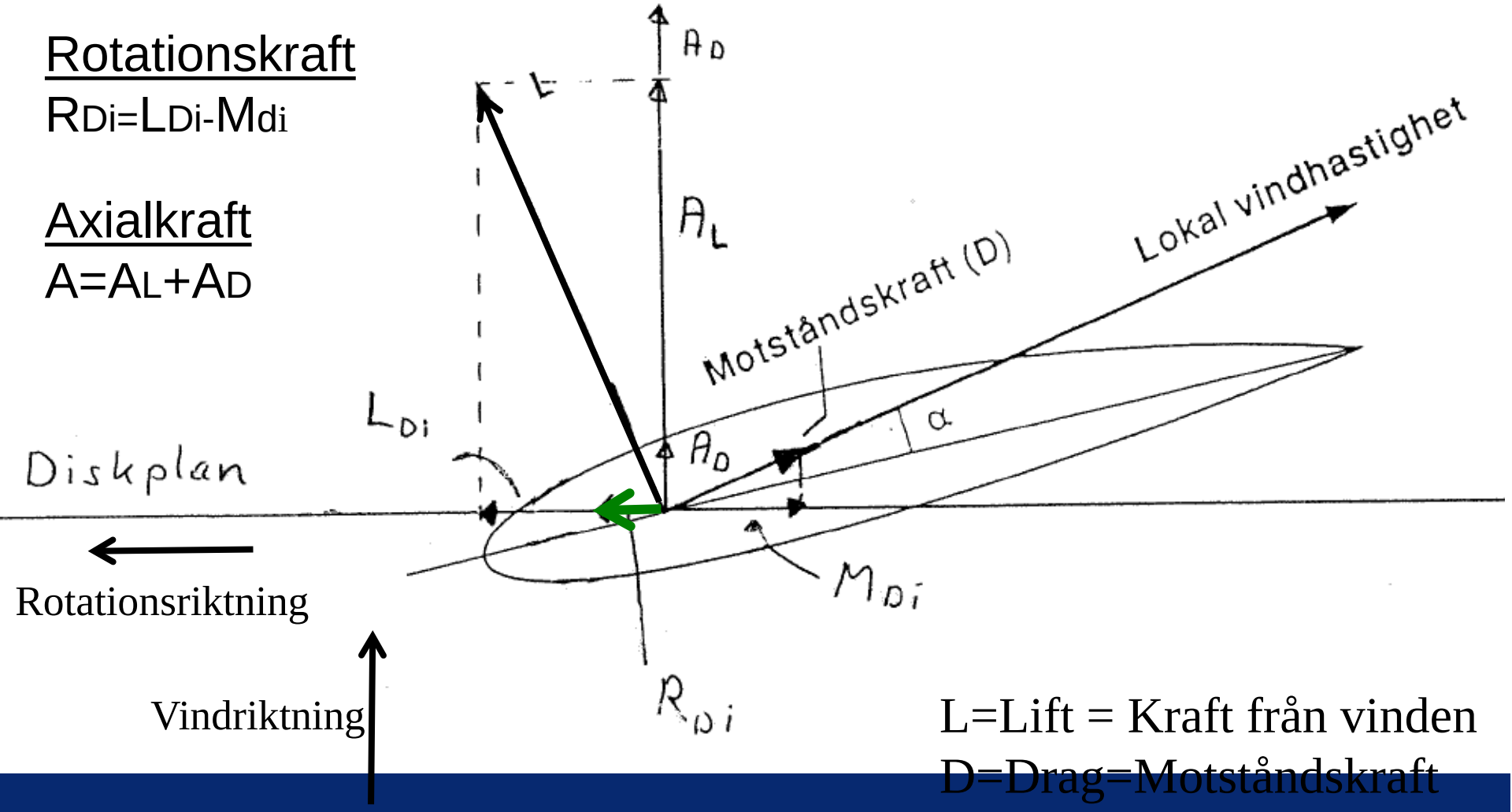
Axial- och rotationskraft

Rotationskraft

$R_{Di}=L_{Di}-M_{di}$

Axialkraft

$A=A_L+A_D$



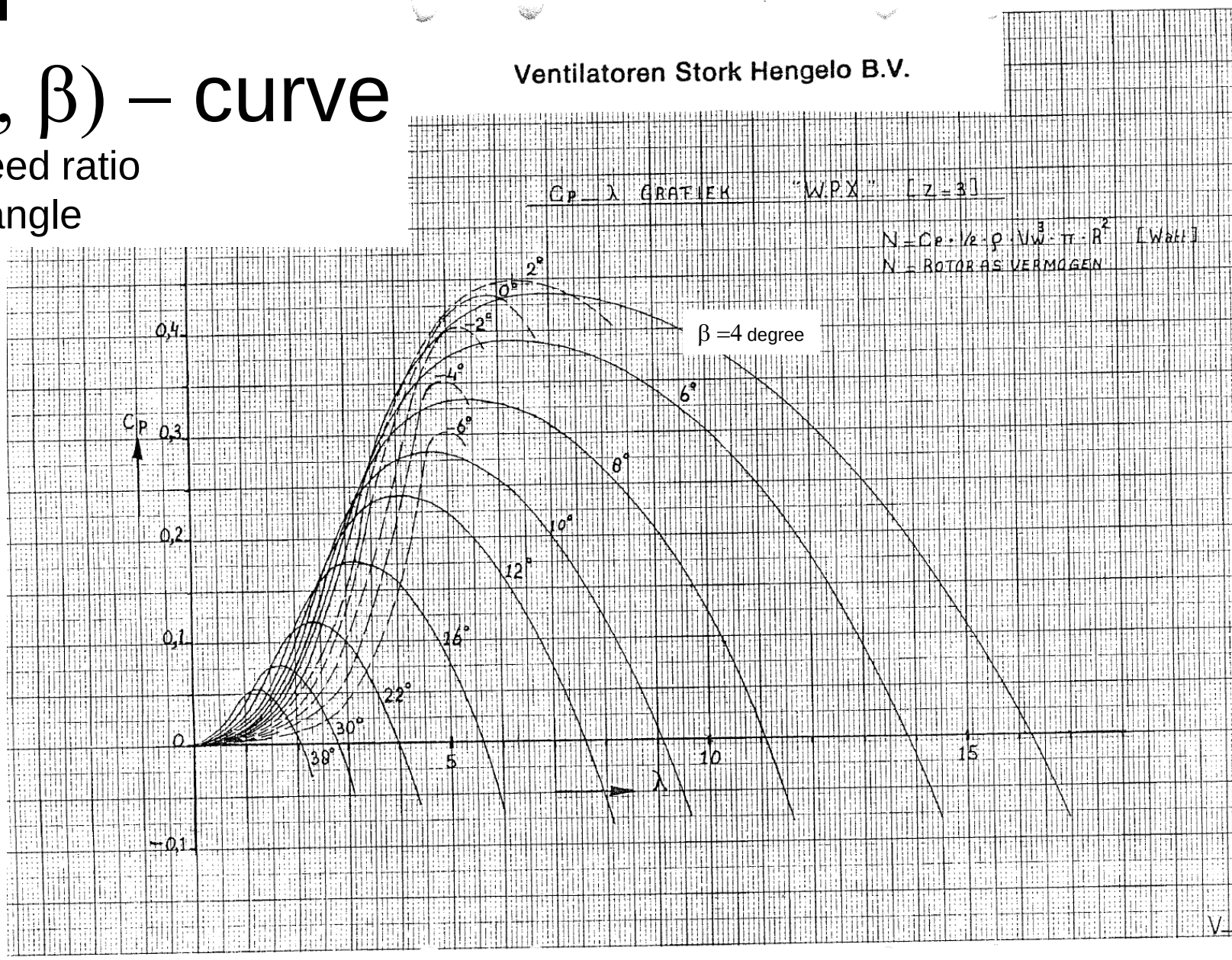
L=Lift = Kraft från vinden

D=Drag=Motståndskraft

Cp(λ, β) – curve

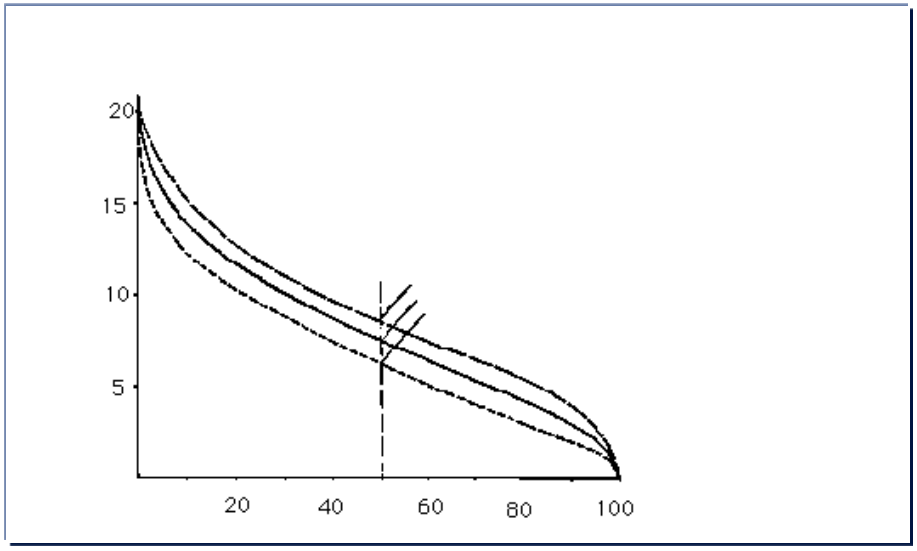
λ= tip-speed ratio

β= pitch-angle

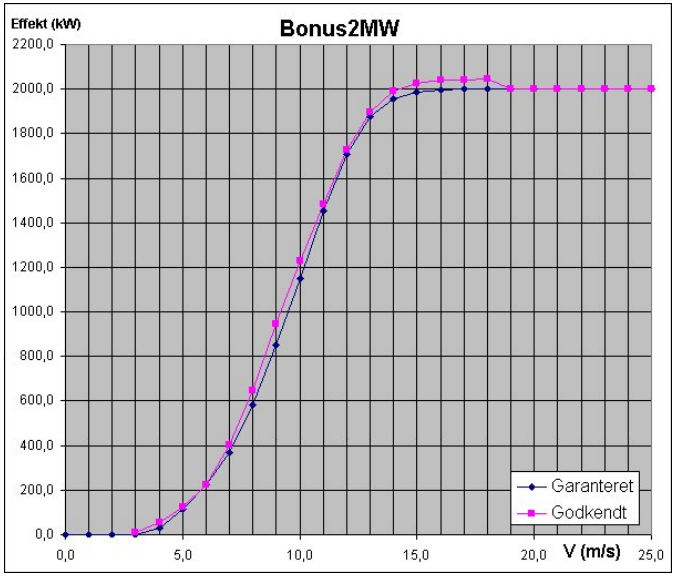


Energy from one year =

Weibull distribution x Wind-power-curve



x



=…+tid(5-6 m/s) x effekt(5-6 m/s) + tid(6-7 m/s) x effekt(6-7 m/s) + ….

=….+0.08*190kW + 0.08*290kW

Energy from a wind turbine

4 kW wind turbine	600 kW wind turbine	3.000 kW wind turbine
gives 10 MWh/year	gives 1300 MWh/year	gives 8900 MWh/year
10 m high,	40 m high, 42 m	80 m high
5 m diameter	diameter	90 m diameter
0.5 house / turbine	65 house / turbine	445 house / turbine

Electric heaten house 20 MWh/year

Wind turbine pays back

A wind turbine in a windy place has after
4 to 6 months produced, as much energy as was needed for the production of the wind turbine

There after will the turbine be in operation 20-25 years

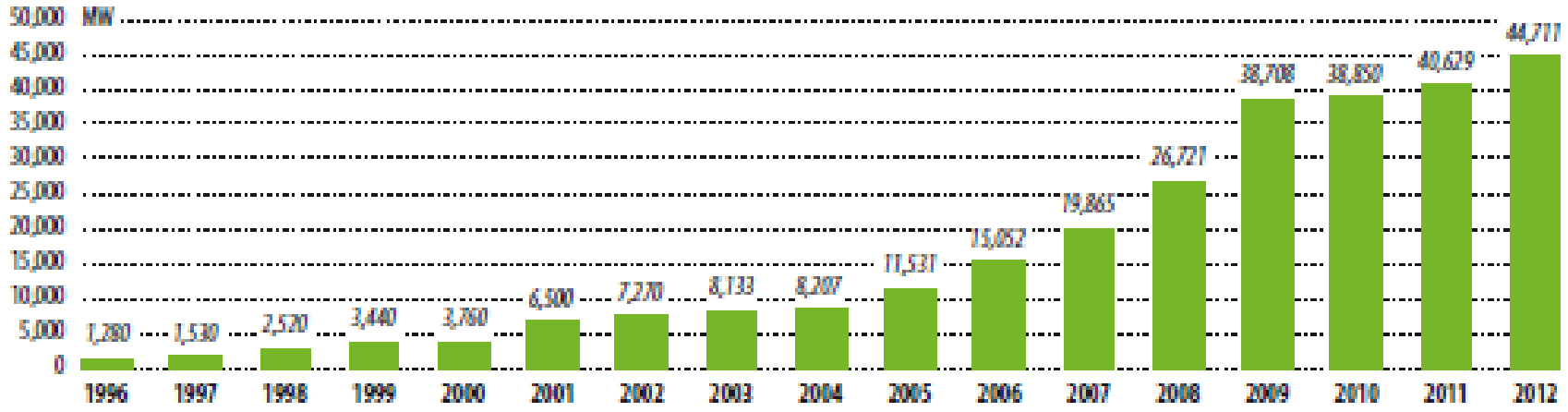
But it takes 10-15 years to make a profit.

When the life time of the wind turbine is ended it is just to take down the turbine and use the land for something else

Costs for 25 TWh

Sweden plans for 25 TWh wind power,
The investment will be10-15 billion Euro

GLOBAL ANNUAL INSTALLED WIND CAPACITY 1996-2012



GLOBAL CUMULATIVE INSTALLED WIND CAPACITY 1996-2012

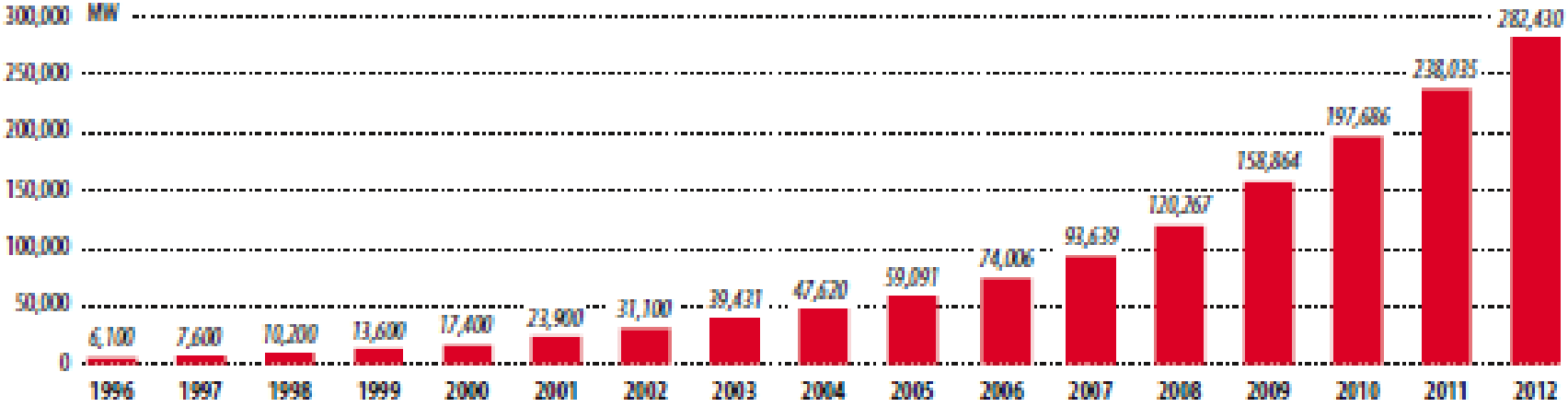
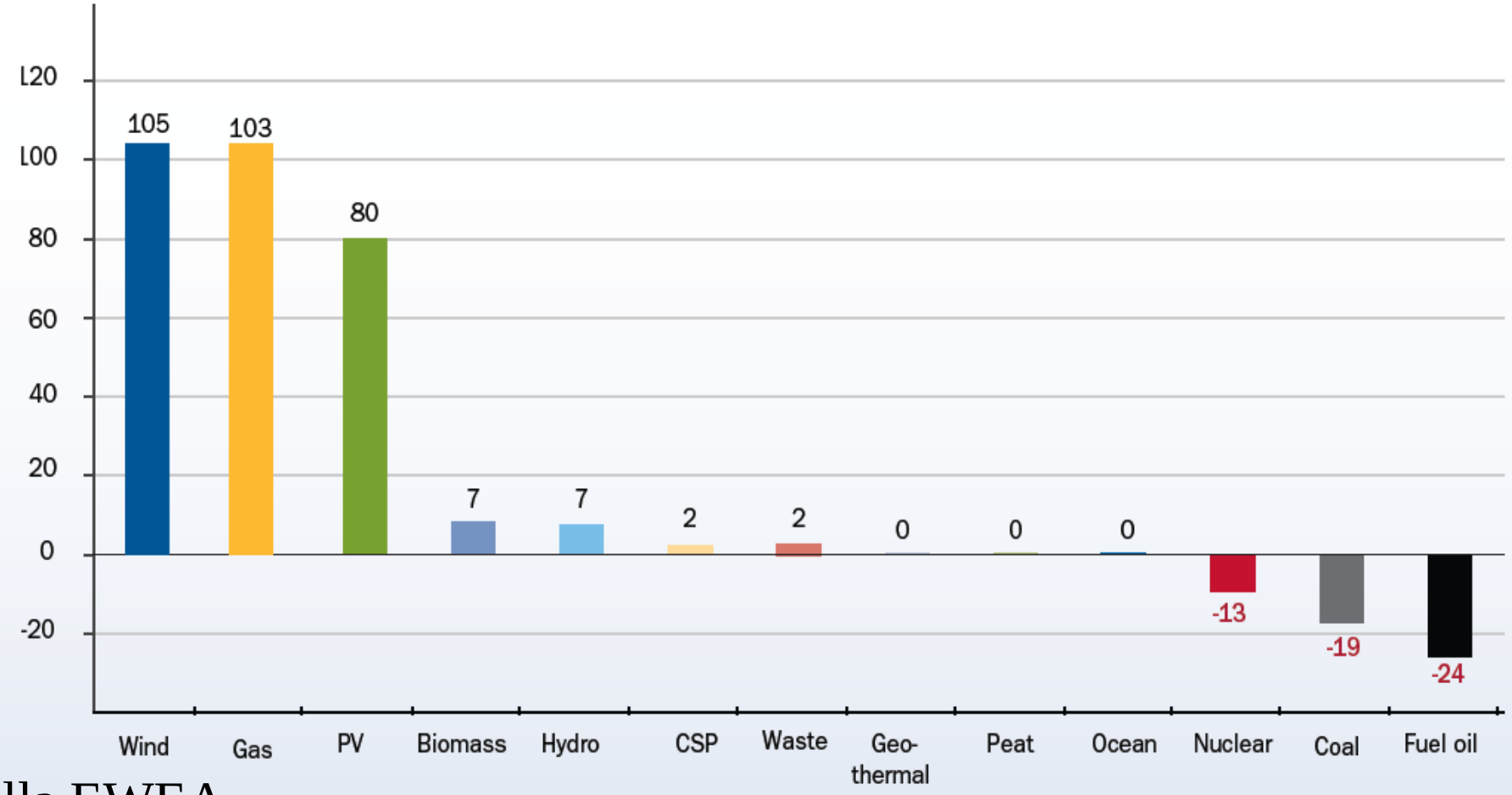
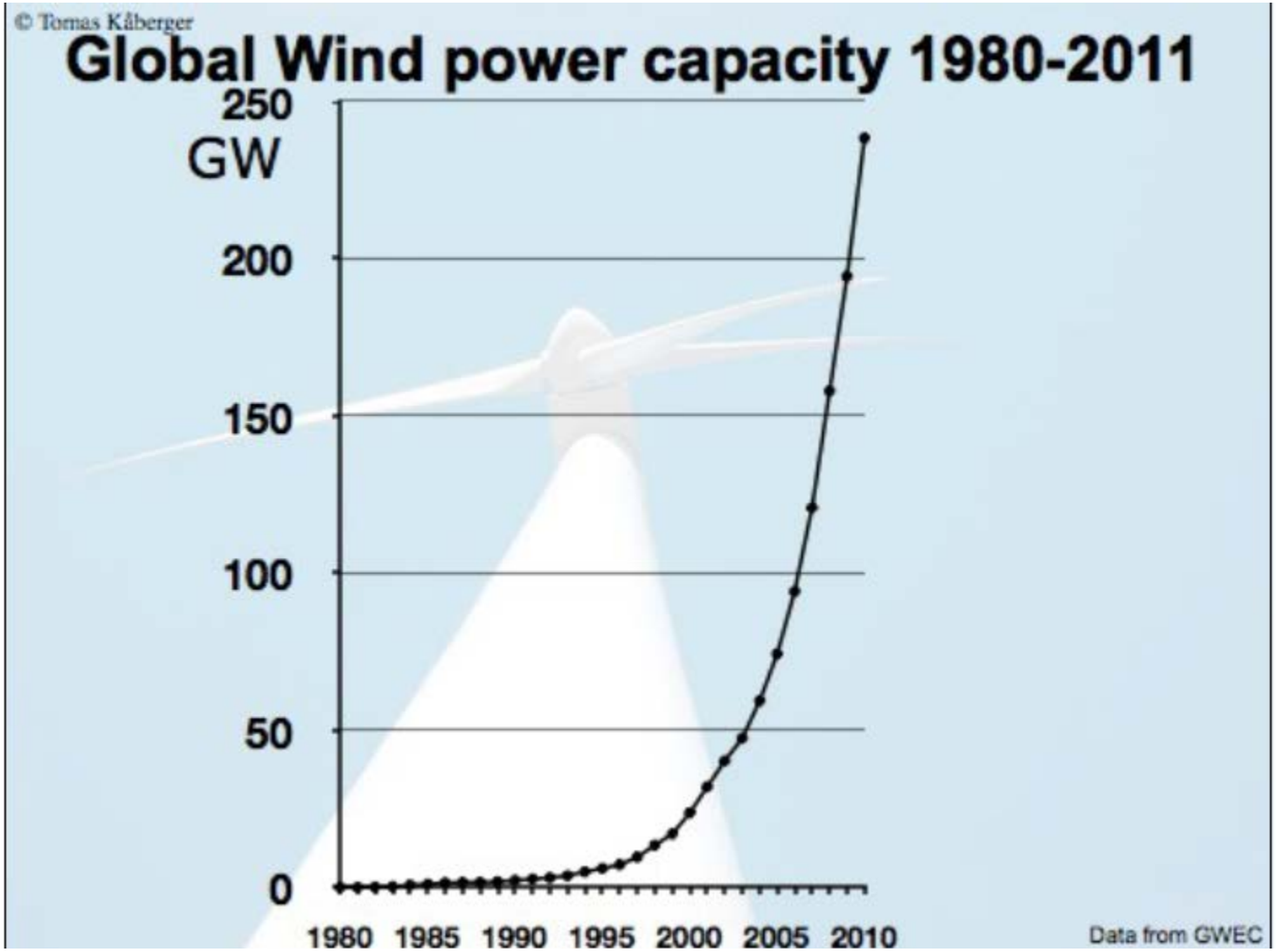


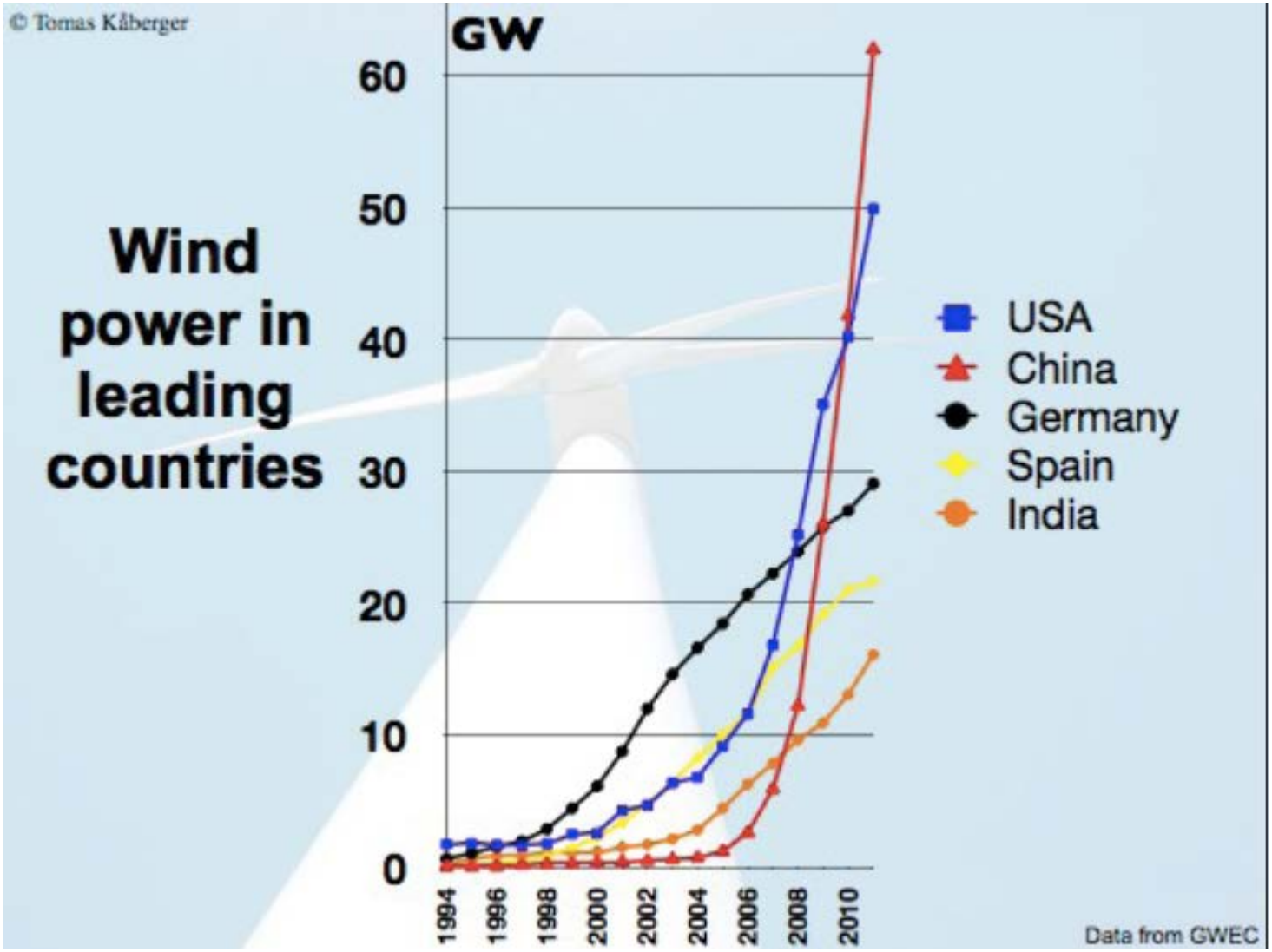
FIGURE 2.2: NET ELECTRICITY GENERATING INSTALLATIONS IN THE EU 2000-2013 (GW)



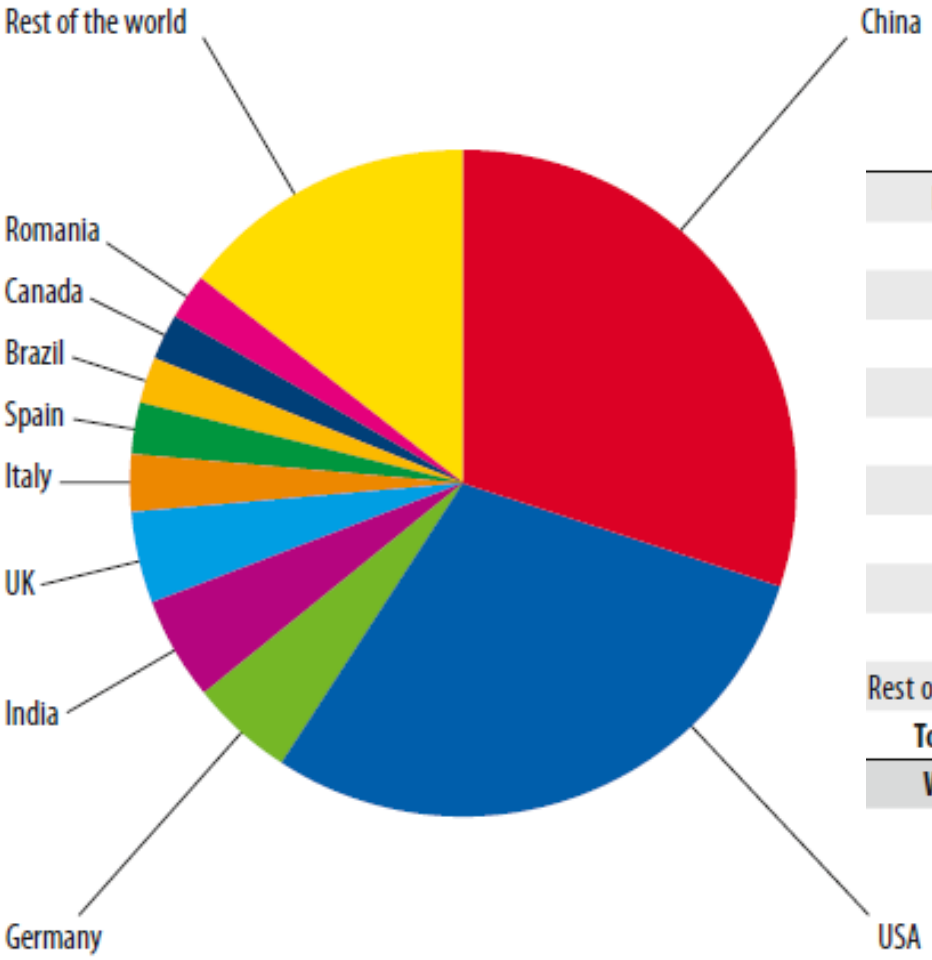
Källa EWEA

Solar PV, Globally


© Tomas Kåberger
Global Wind power capacity 1980-2011
250
GW
200
150
100
50
0
1980 1985 1990 1995 2000 2005 2010
Data from GWEC


© Tomas Kåberger
Wind power in leading countries
GW
60
50
40
30
20
10
0
1994
1996
1998
2000
2002
2004
2006
2008
2010
USA
China
Germany
Spain
India
Data from GWEC

TOP 10 NEW INSTALLED CAPACITY JAN-DEC 2012



Country	MW	% SHARE
PR China**	13,200	30
USA	13,124	29
Germany	2,439	5
India	2,336	5
UK	1,897	4.2
Italy	1,273	2.8
Spain	1,122	2.5
Brazil	1,077	2.4
Canada	935	2.1
Romania	923	2.1
Rest of the world	6,385	14.3
Total TOP 10	**38,326**	**85.7**
World Total	**44,711**	**100.0**

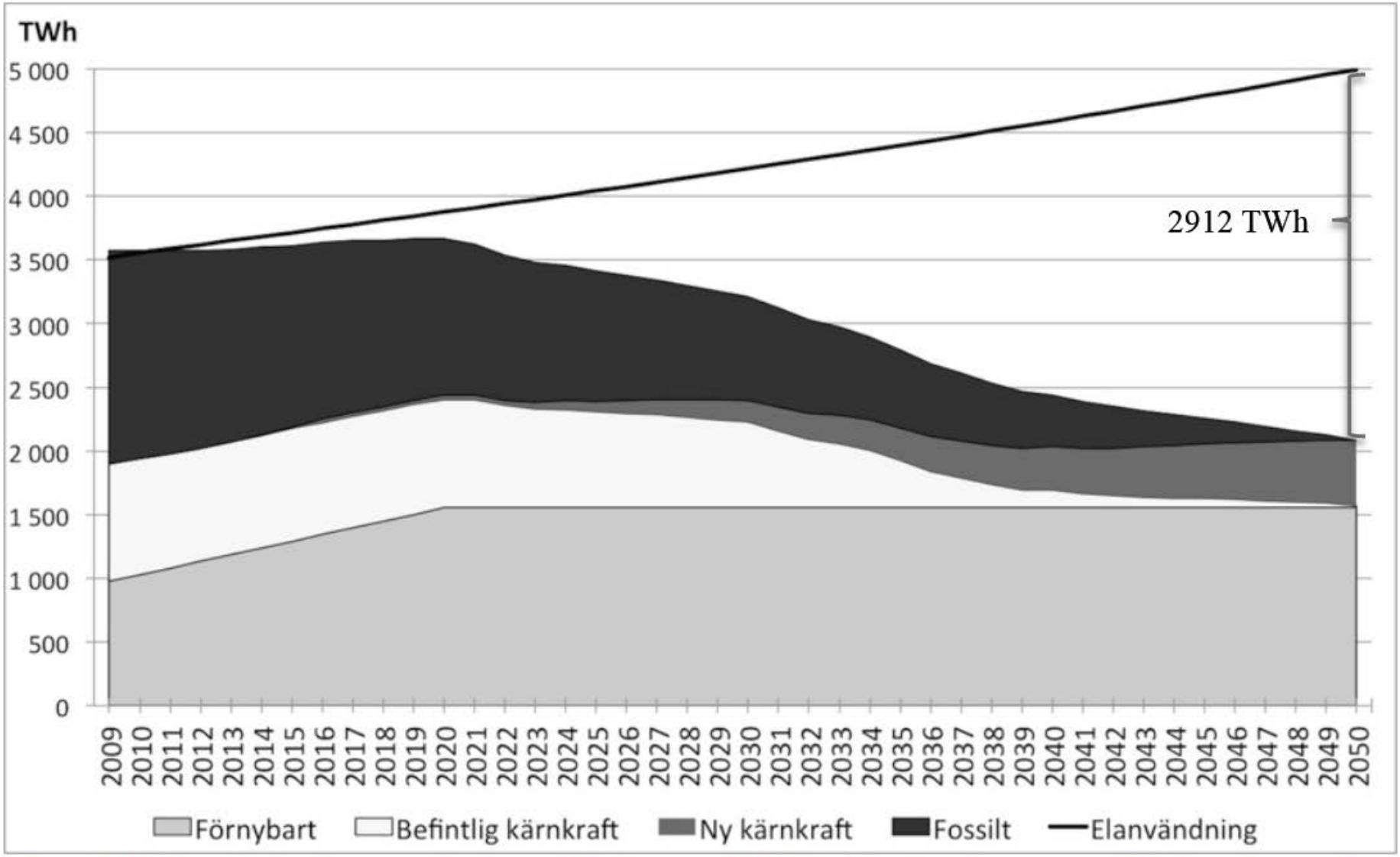
Källa ovanstående bild

Bidrag till en handlingsplan för havsbaserad vindkraft i Sverige

För säkrad eltillförsel, stabilt klimat och industriell utveckling

Staffan Jacobsson
Fredrik Dolff
Kersti Karltorp

Institutionen för energi och miljö
Avdelningen för miljösystemanalys
CHALMERS Tekniska högskola
Göteborg, Sverige, 2013
Rapport Nr. 2013:11



Figur 5. Elanvändningen och elproduktionen i EU, inklusive Norge och Schweiz, med antagande om livslängd på 50 år för kärnkraftverken.

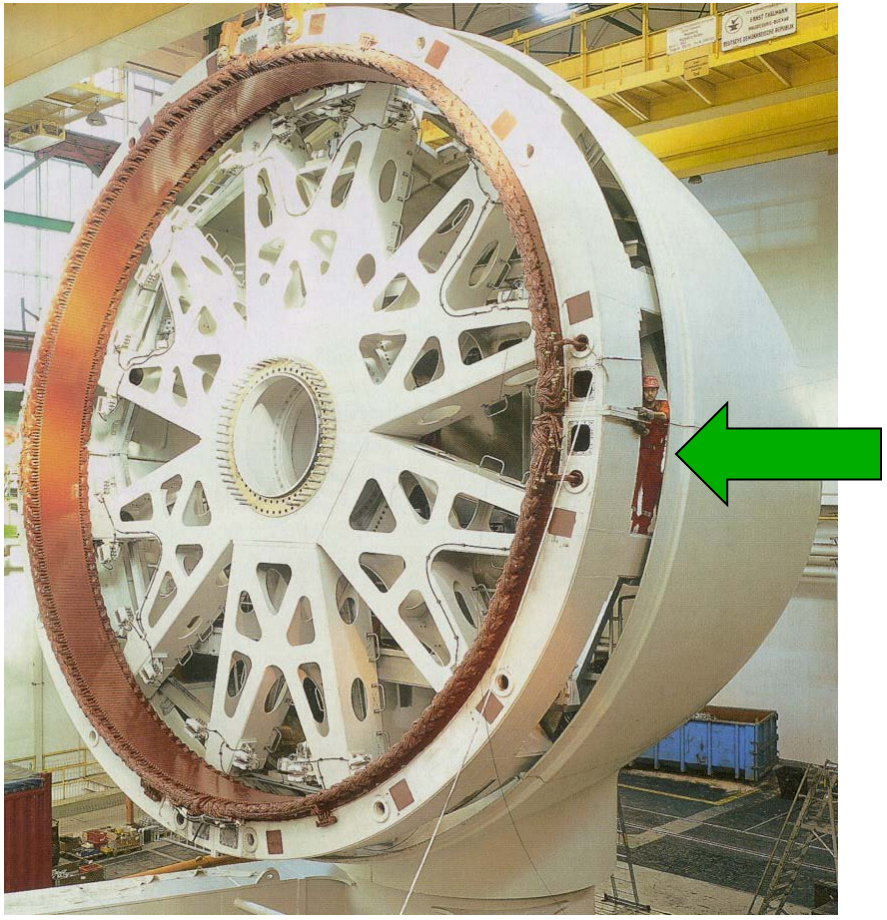
Vestas

- 3 MW,
- Diameter 90 m

Direct driven generator– Enercon

- Extreme high weight due to small air gap
- Generator weight 220 ton

  (4,5 MW)
- Look at the man!



Enercon

- 2,0 MW
- Diameter 82m
- Navhöjd 58-113 m

WinWinD WWD-1, WWD-3

- Finish manufacture
- 1MW and 3MW
- Compact design with 1-step planetary gerabox
- Permanent magnet synchronous low speed generator

You need a reliable wind turbine. We kan supply one.

Wind turbines between the buildings

- Bahrein World Trade Center, in operation 2006
- 240 m high buildings
- 3 x 22 kW wind turbines
- Designer – Danish Ramboll and Norwin

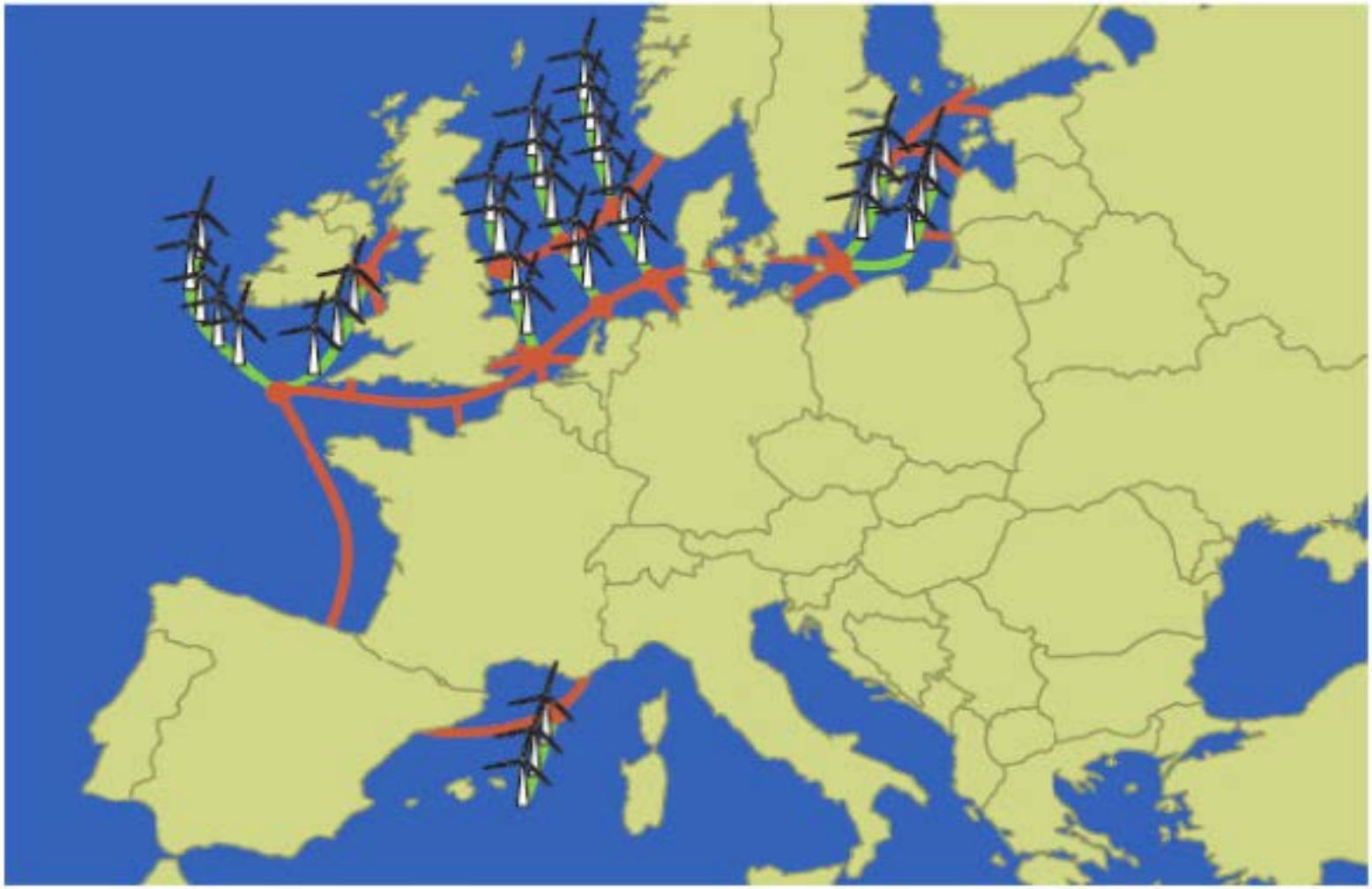
2 MW, 78-100 m

Repower

6,12 MW, 126 m

Offshore GE-wind turbines outside Kalmar, Utgrunden

1.5 MW

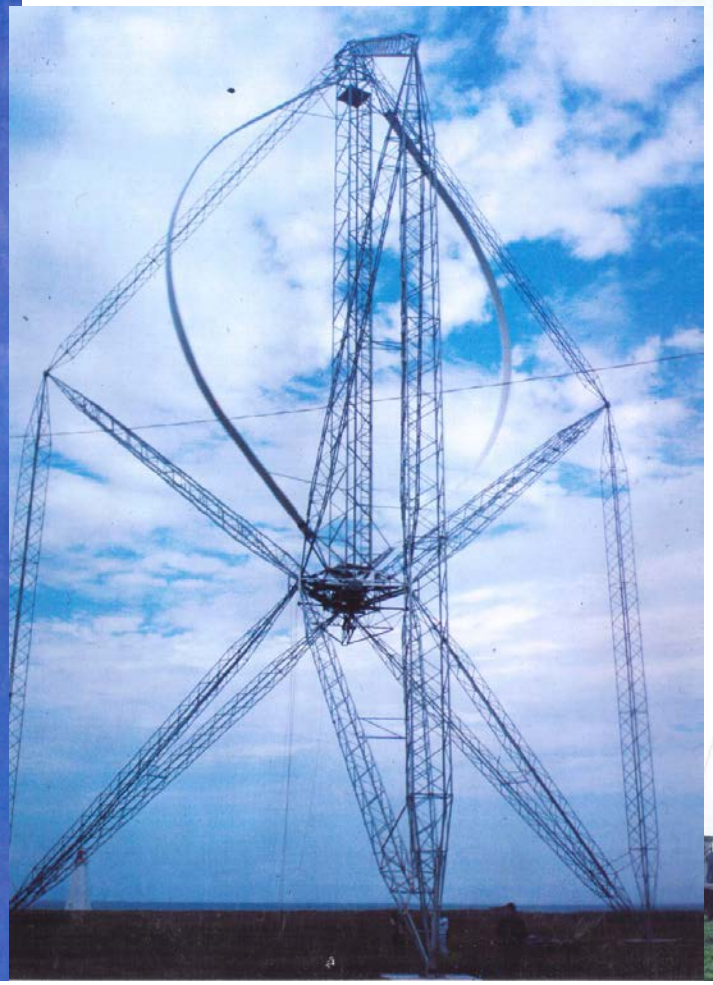


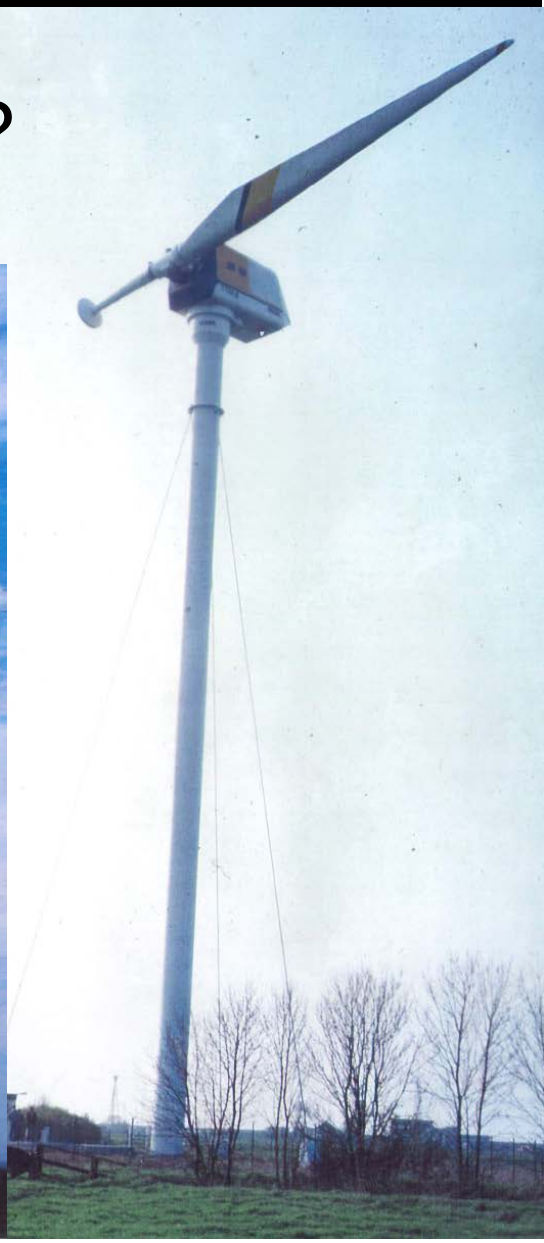
The European Offshore Supergrid

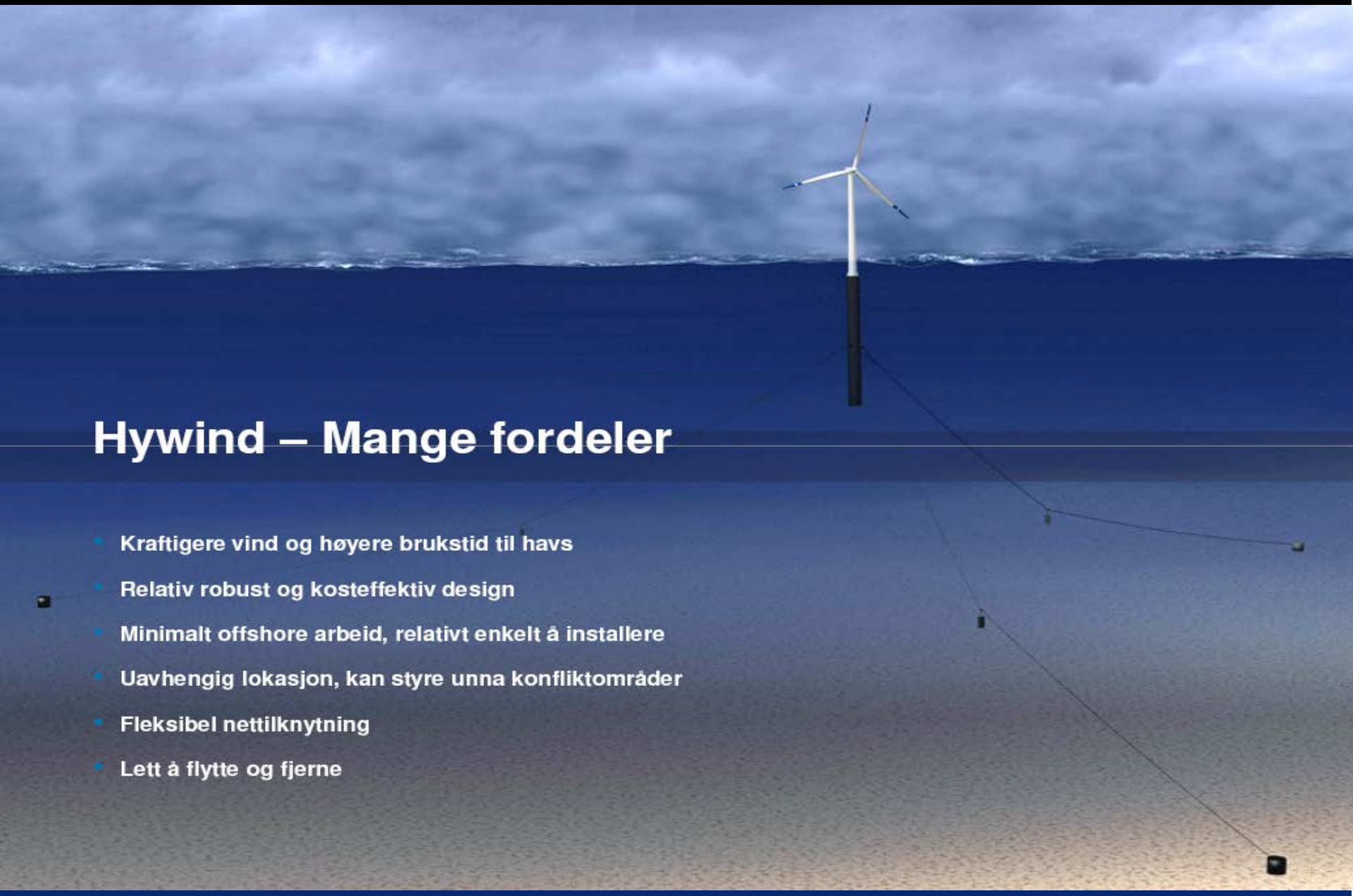
Lillgrund vindkraftpark – Tekniska data

- 48 vindkraftverk
- >2 MW/st
- Transformatorplattform 30/130 kV
- ca 330 GWh medelårsproduktion
- Medelvindhastighet ca 8.5 m/s (65m)
- Höjd: 60-65 meter
- Höjd inkl rotor: drygt 100 meter
- Rotordiameter: 70-80 meter

Success ??????







Hywind – Mange fordeler

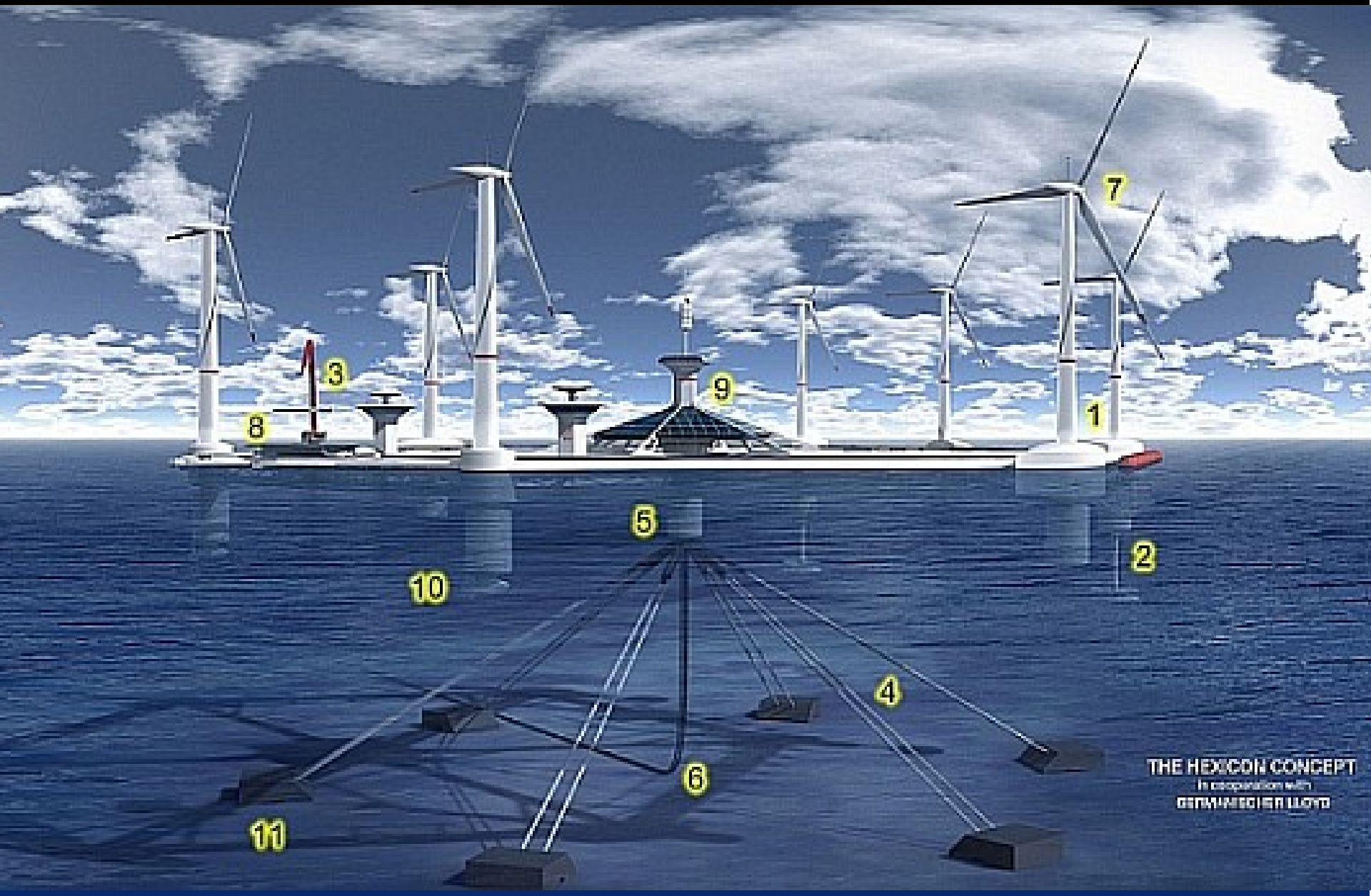
- Kraftigere vind og høyere brukstid til havs
- Relativ robust og kosteffektiv design
- Minimalt offshore arbeid, relativt enkelt å installere
- Uavhengig lokasjon, kan styre unna konfliktområder
- Fleksibel nettilknytning
- Lett å flytte og fjerne

Hywind – konseptet

- Betong eller stålsylinder med ballast
- 120 m draft (base case)
- Oppankret med tre anker liner
- Egnet for vanndyp mellom 100 – 700 m
- Ståltårn festet til understellet 12 meters under vannlinjen
- 80 m opp til nacellen
- Rotordiameter inntil 120 meter
- Effekt 3 - 5 MW
- Displacement: 6500 tonn
- Diameter understell: 8 m

Future?

▲ Mounted on semi-submersible platforms, the floating wind turbines being developed by Principle Power can be built in shipyards and towed into place.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GERMANISCHER LLOYD