# Wind Energy Market&Technology

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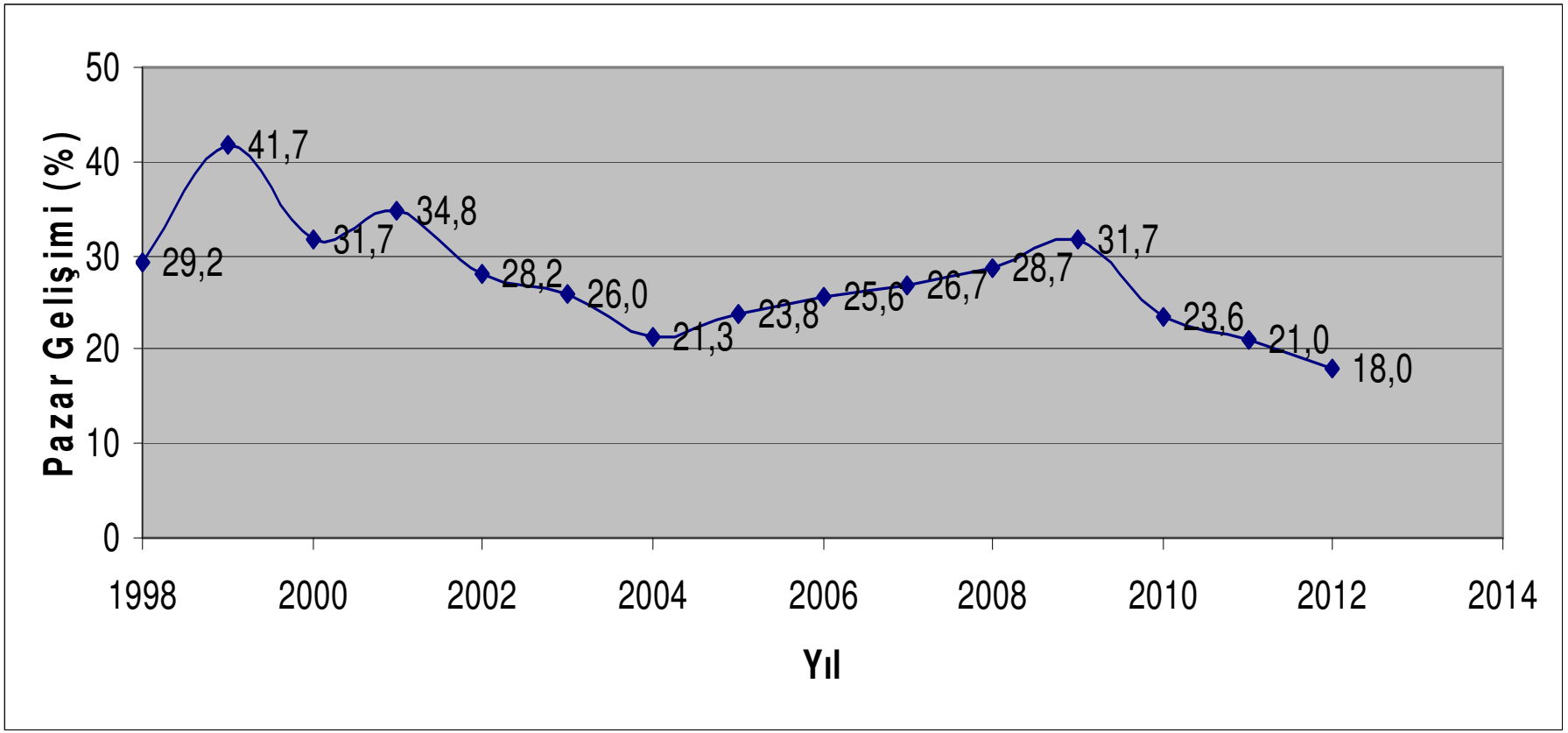
**November, 2013**

## Content

- Global Wind Energy Market
- Turkey Wind Energy Market
- Basics of Wind Energy
- Offshore Wind Energy
- Rotor Blade Production Techniques

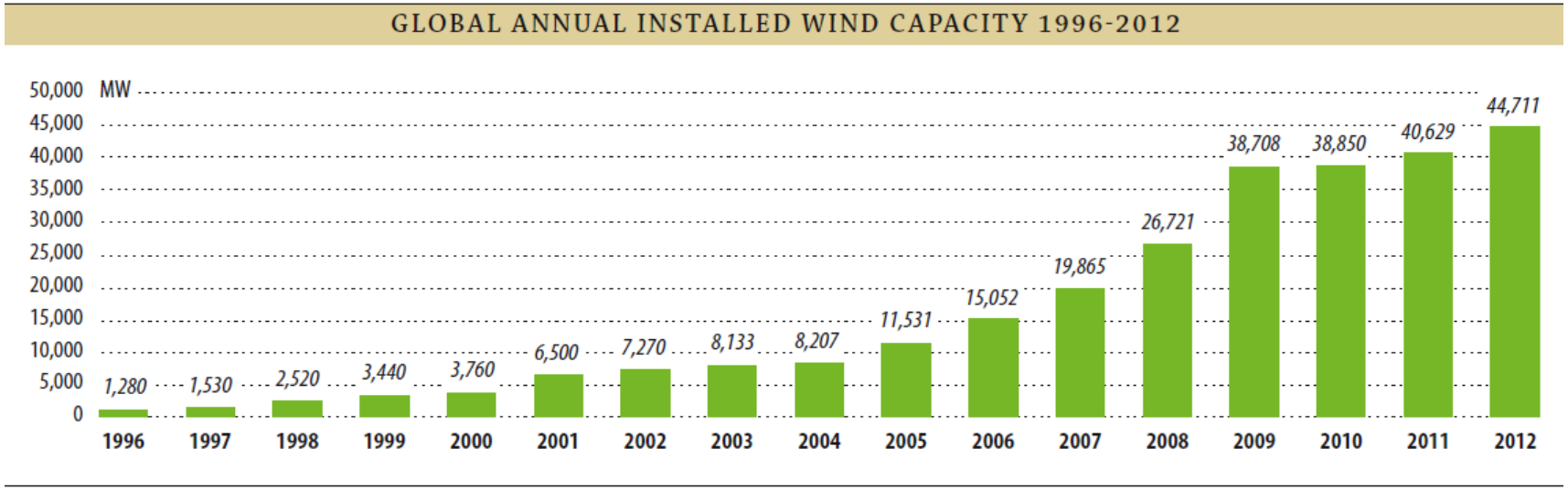
# Global Wind Energy Market

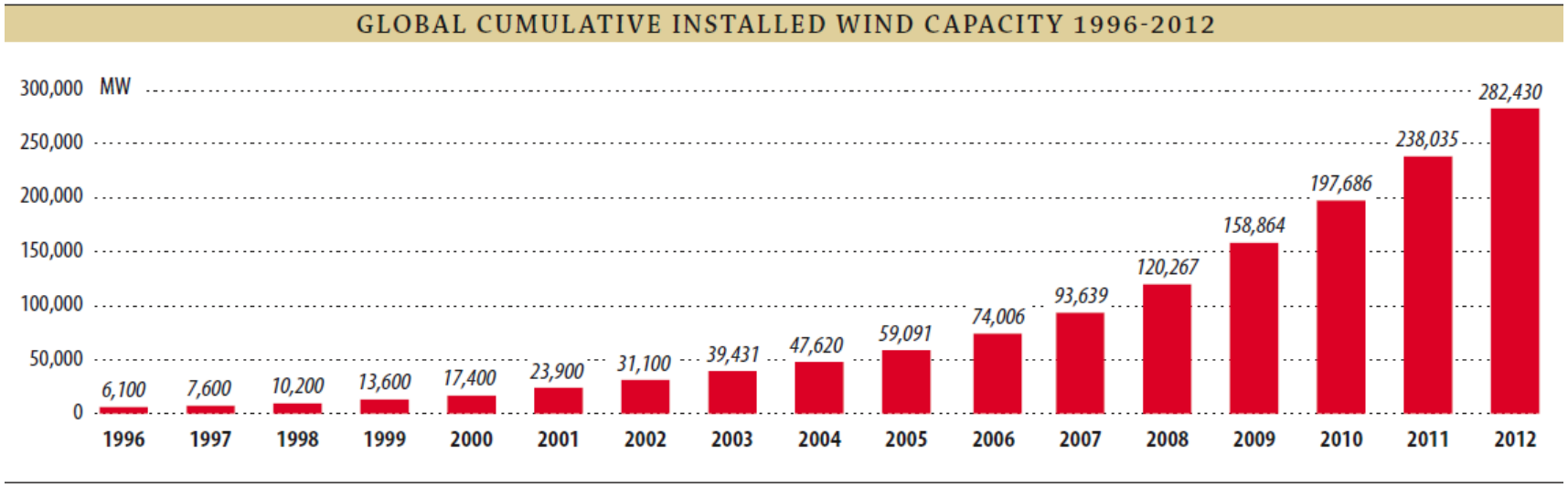
# Global Wind Energy Market Growing




**Global average growing rate; 25%**

# Global Wind Energy Market



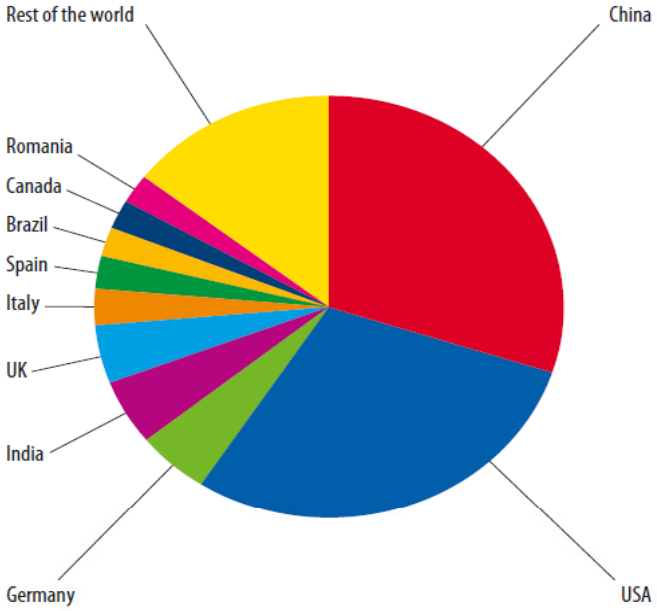






**At end of 2013**, with new **36 GW** cumulative wind capacity will be reach **318 GW**

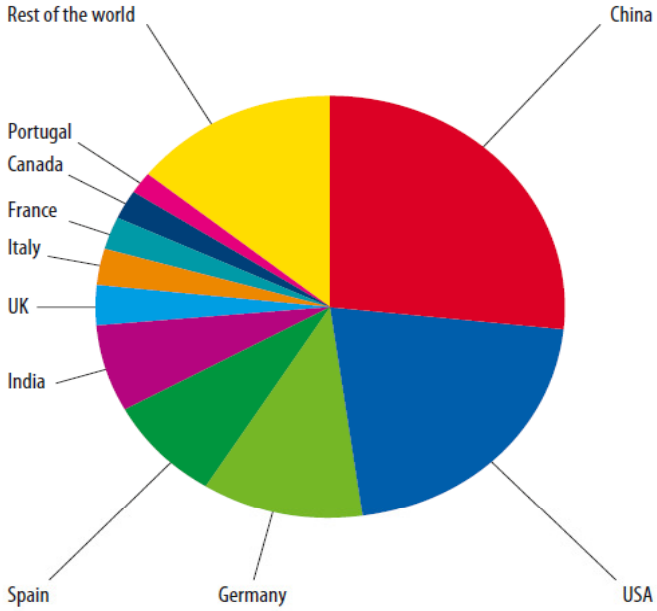
# Global Wind Energy Market

## TOP 10 NEW INSTALLED CAPACITY JAN-DEC 2012



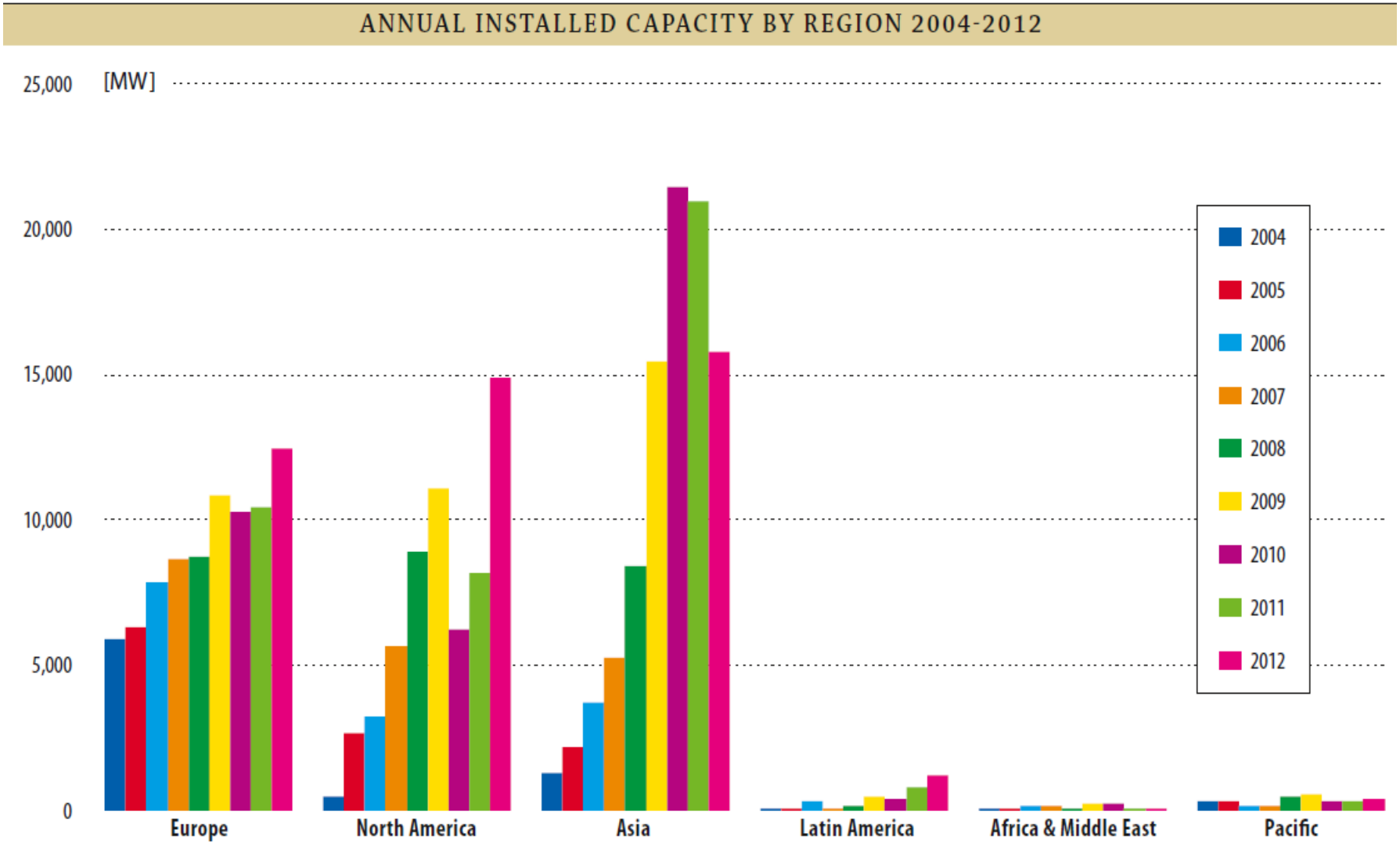

| Country | MW | % SHARE |
|---|---|---|
| PR China** | 13,200 | 30 |
| USA | 13,124 | 29 |
| Germany | 2,439 | 5 |
| India | 2,336 | 5 |
| UK | 1,897 | 4.2 |
| Italy | 1,273 | 2.8 |
| Spain | 1,122 | 2.5 |
| Brazil | 1,077 | 2.4 |
| Canada | 935 | 2.1 |
| Romania | 923 | 2.1 |
| Rest of the world |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

## TOP 10 CUMULATIVE CAPACITY DEC 2012



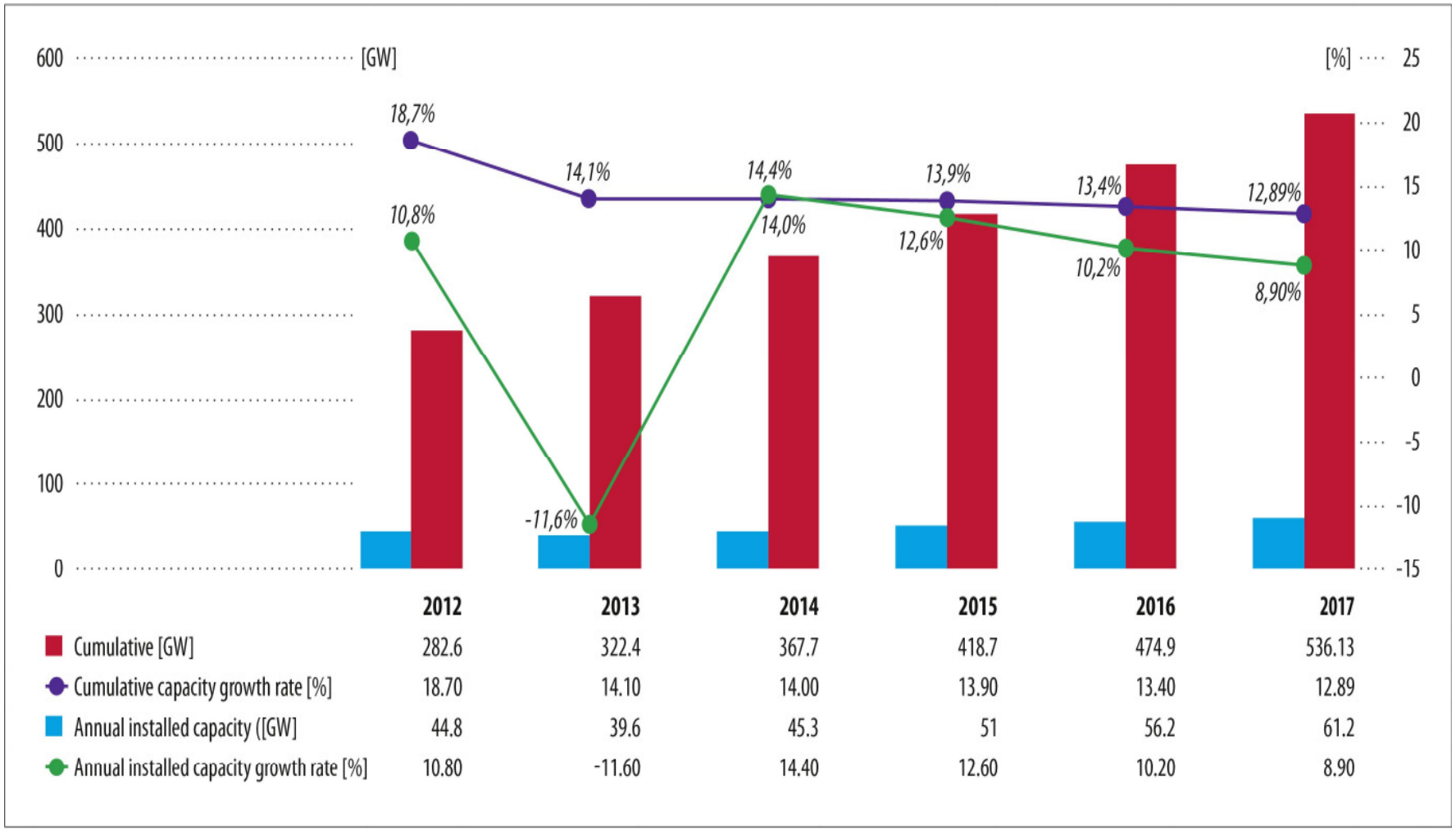

| Country | MW | % SHARE |
|---|---|---|
| PR China** | 75,564 | 26.8 |
| USA | 60,007 | 21.2 |
| Germany | 31,332 | 11.1 |
| Spain | 22,796 | 8.1 |
| India | 18,421 | 6.5 |
| UK | 8,445 | 3.0 |
| Italy | 8,144 | 2.9 |
| France** | 7,196 | 2.5 |
| Canada | 6,200 | 2.2 |
| Portugal | 4,525 | 1.6 |
| Rest of the world | 39,853 | 14.1 |
| **Total TOP 10** | **242,630** | **85.9** |
| **World Total** | **282,482** | **100.0** |

# Global Wind Energy Market



# Global Wind Energy Market

Market Forecast 2013-2017

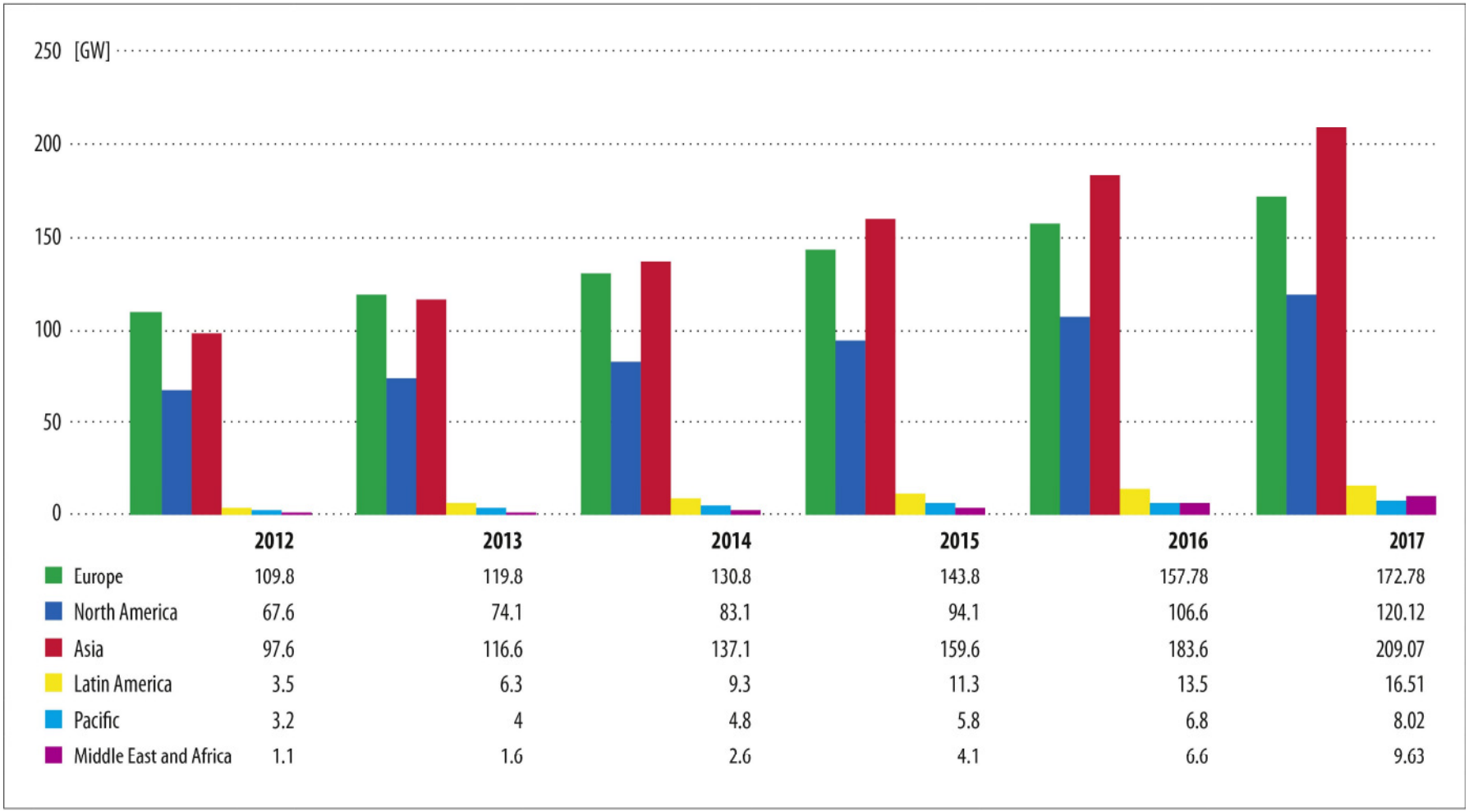



| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Cumulative [GW] | 282.6 | 322.4 | 367.7 | 418.7 | 474.9 | 536.13 |
| Cumulative capacity growth rate [%] | 18.70 | 14.10 | 14.00 | 13.90 | 13.40 | 12.89 |
| Annual installed capacity ([GW] | 44.8 | 39.6 | 45.3 | 51 | 56.2 | 61.2 |
| Annual installed capacity growth rate [%] | 10.80 | -11.60 | 14.40 | 12.60 | 10.20 | 8.90 |

Source: GWEC

# Global Wind Energy Market

Cumulative Market by Region 2012-2017




| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Europe | 109.8 | 119.8 | 130.8 | 143.8 | 157.78 | 172.78 |
| North America | 67.6 | 74.1 | 83.1 | 94.1 | 106.6 | 120.12 |
| Asia | 97.6 | 116.6 | 137.1 | 159.6 | 183.6 | 209.07 |
| Latin America | 3.5 | 6.3 | 9.3 | 11.3 | 13.5 | 16.51 |
| Pacific | 3.2 | 4 | 4.8 | 5.8 | 6.8 | 8.02 |
| Middle East and Africa | 1.1 | 1.6 | 2.6 | 4.1 | 6.6 | 9.63 |

*Source: GWEC*

# Global Wind Energy Market

FIGURE 2.3 EU POWER MIX 2000

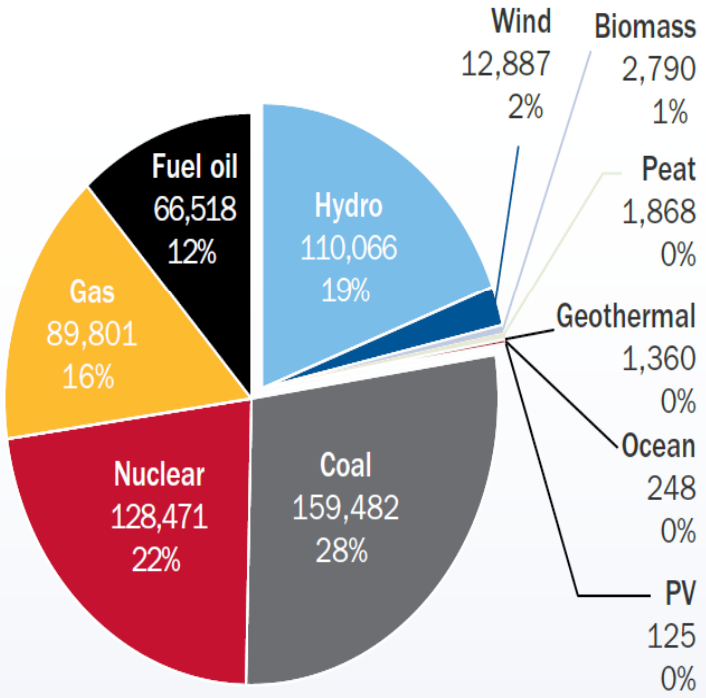
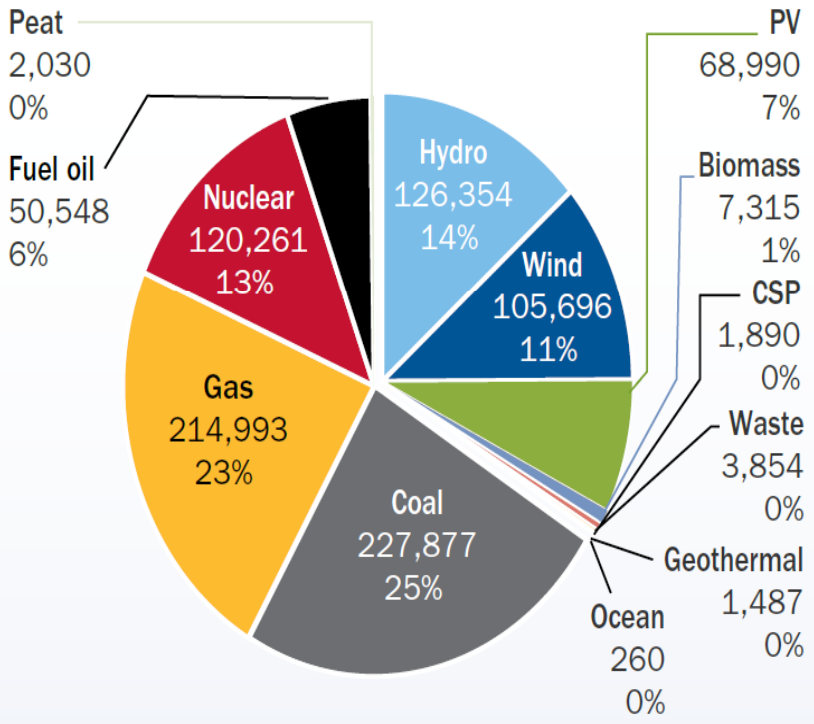
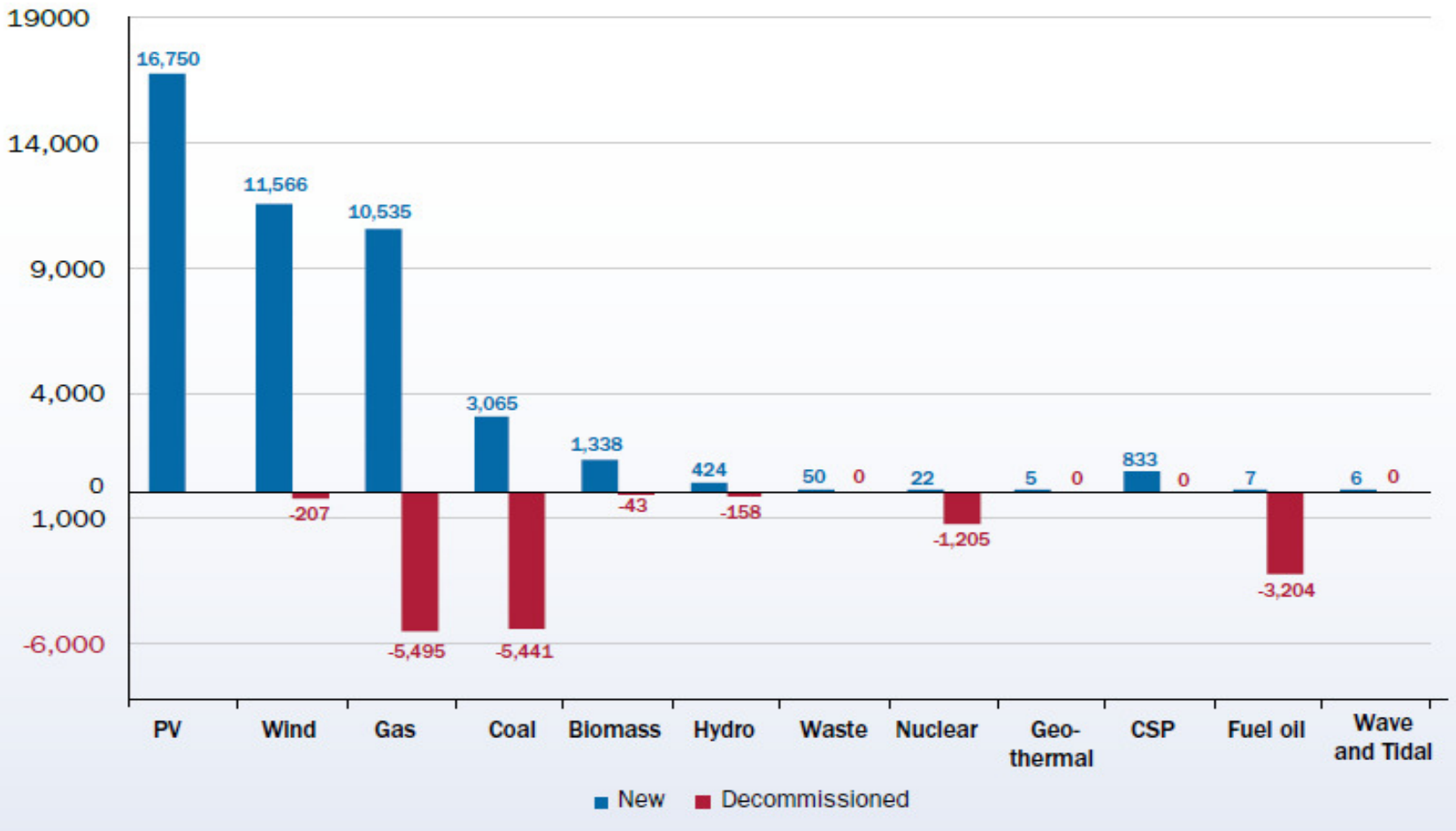



FIGURE 2.4 EU POWER MIX 2012



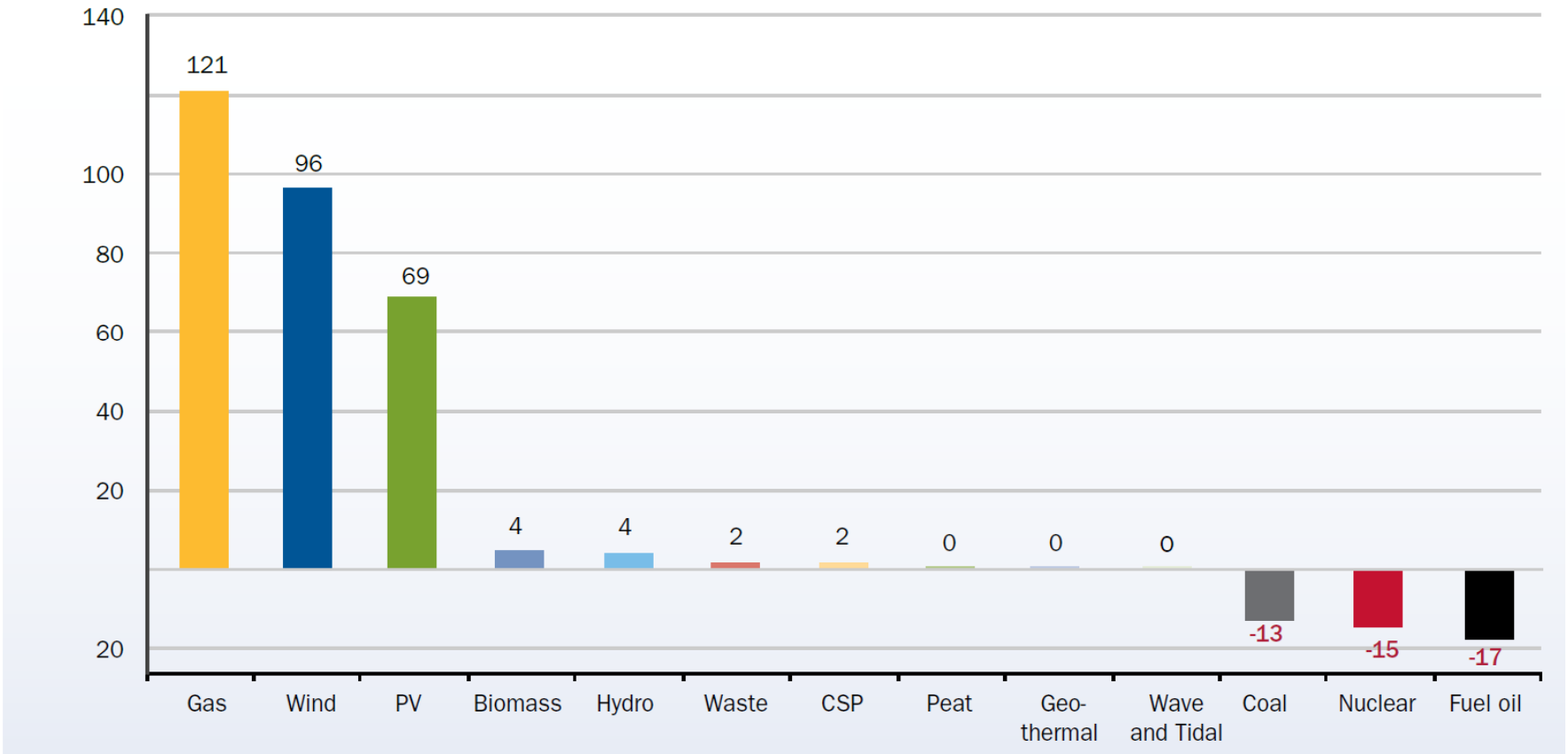
# Global Wind Energy Market

FIGURE 1.3 NEW INSTALLED POWER CAPACITY AND DECOMMISSIONED POWER CAPACITY IN MW



# Global Wind Energy Market

FIGURE 2.2 NET ELECTRICITY GENERATING INSTALLATIONS IN THE EU 2000-2012 (GW)



# Global Wind Energy Market

## General Structure of Global Wind Energy Market

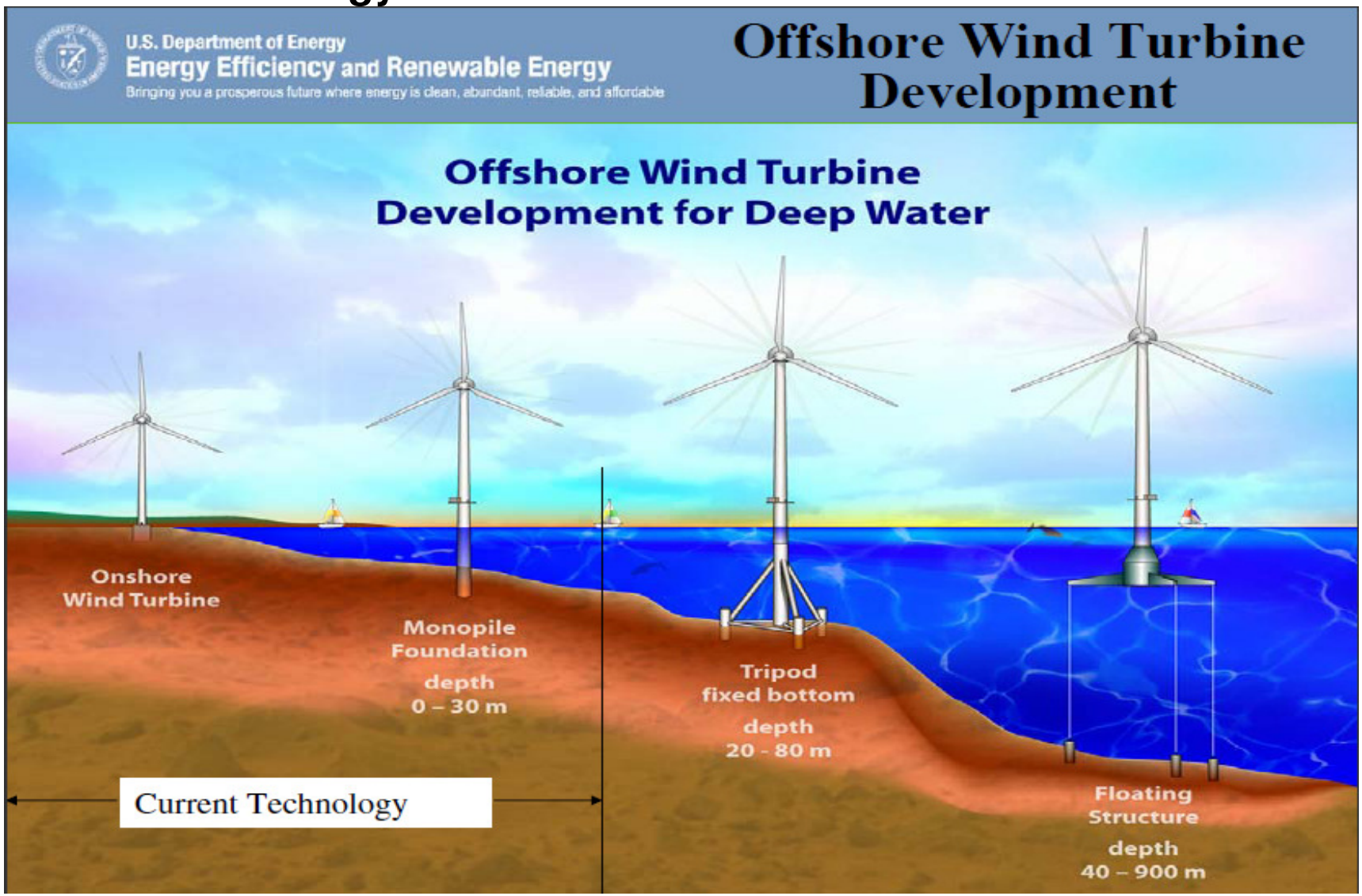
- Learning curve of commercial wind turbine system is approx. 95%
- 60% of global insalled wind power is in China, USA, Germany,
- Max. Nominal power of the biggest commercial wind turbine is 7.5 MW

**New Trends in Global Wind Energy Market**

- Bigger wind turbine more than 10 MW,
- Repowering,
- Developing of Deep offshore technologies,

# Global Wind Energy Market


# Global Wind Energy Market



**Global Wind Energy Market**

## Hot Topics in Wind Energy Market

- Repowering,

(repowering market in Europe approx. **30-35 GW**, in market value is **35 billion Euro**)

- East Europe energy market,

- Effect of European dept crisis on financial support system,

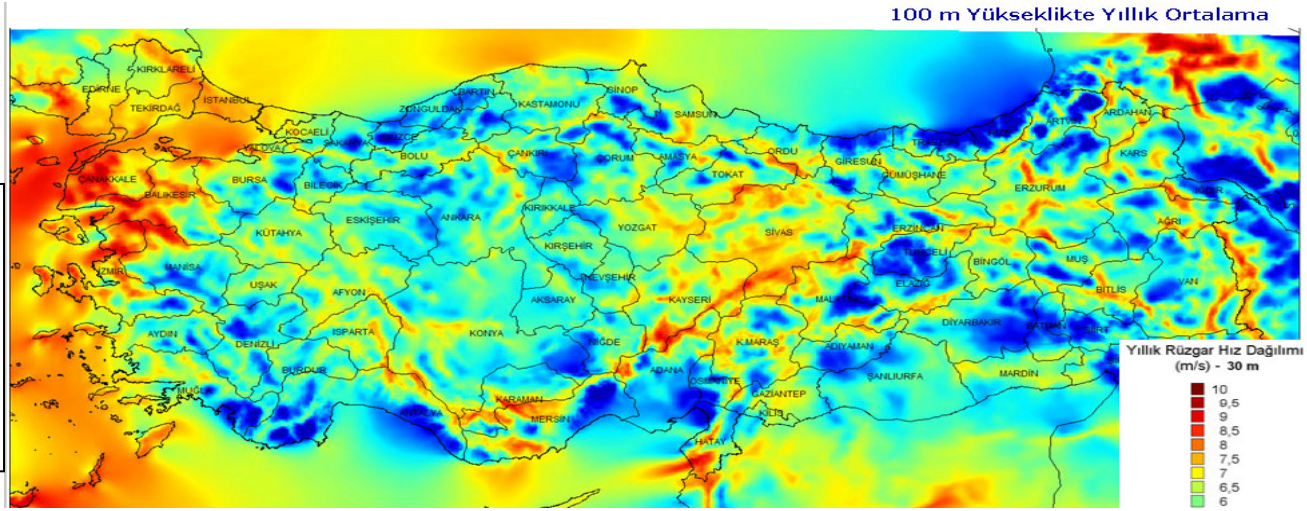
- Direct/indirect negative effects of shale gas,

# Turkey Wind Energy Market

## Turkey Wind Energy Market

- Total installed power is 57,000 MW at **end of 2012** in Turkey
- Total installed wind power is 2,312 MW by the end of 2012
- Total wind energy potential of Turkey is 48,000 MW (10,000 MW of this potential is offshore)
- Turkey's electricity demand increase between 6-8% each year

Total 9.959 MW license is given and just 2.312 MW is commissioned.



# Turkey Wind Energy Market

## Total Wind Energy Potential in Turkey

| Wind Speed (m/s) | Wind Power Density ($W/m^2$) | Total Capacity (MW) |
|---|---|---|
| 7,5-8,0 | 400-500 | 29.259 |
| 8,0-8,5 | 500-600 | 12.994 |
| 8,5-9,0 | 600-800 | 5.400 |
| >9,0 | >800 | 196 |
| **Total** | | **47.849** |

**37.386 MW-onshore Potential**

**10.463 MW-offshore Potential**

# Turkey Wind Energy Market

**Places of licensed projects.**

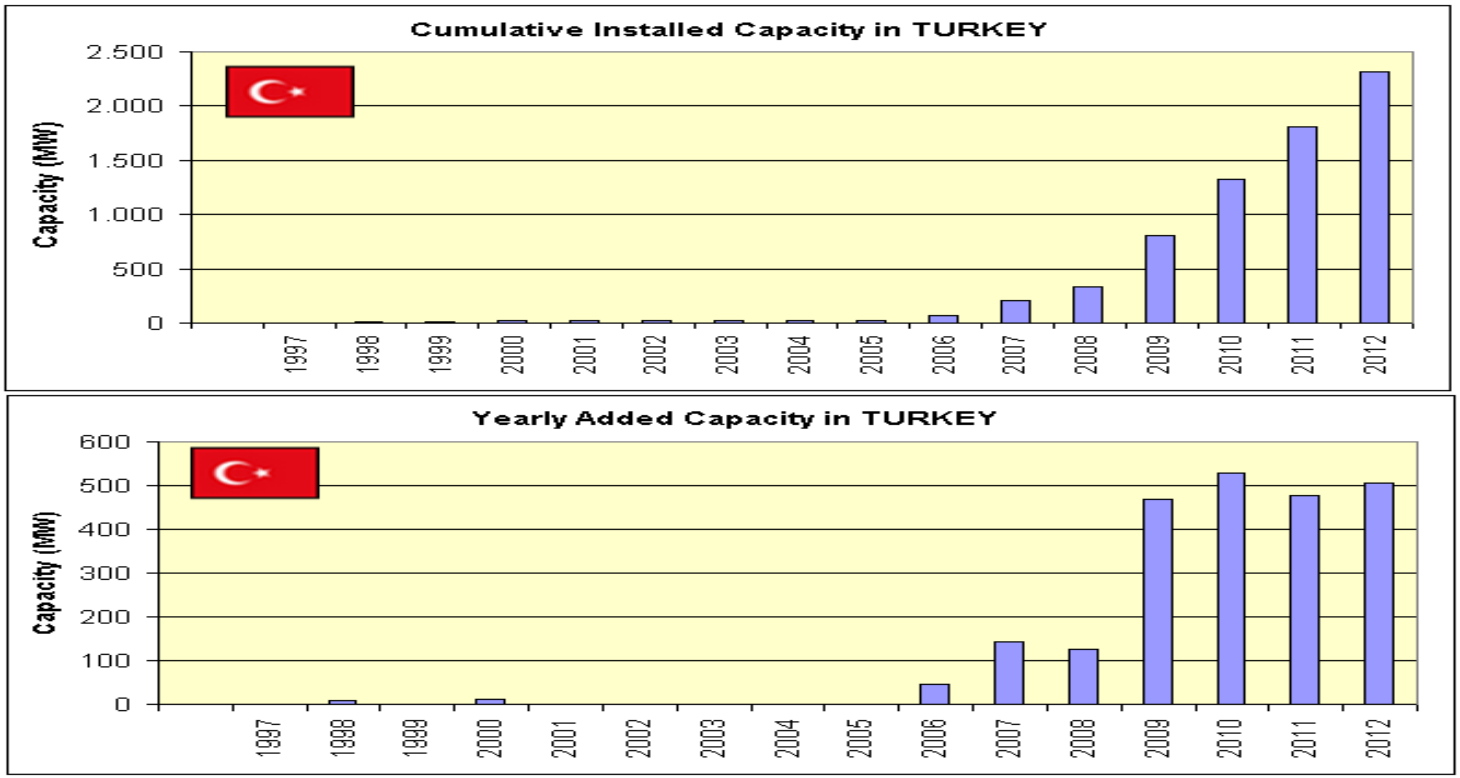
# Energy Source Distribution According to Installed Power

| Energy Source | % |
|---|---|
| Natural Gas | 32 |
| Hydroelectric | 32 |
| Coal | 23 |
| Wind | 3 |
| Fuel-Oil | 2.5 |
| Others | 7.5 |

- **4 GW power should be installed each year to meet this growth rate in Turkey**

**8-10 billion $ investment should be done in energy market of Turkey**

# Turkey Wind Energy Market

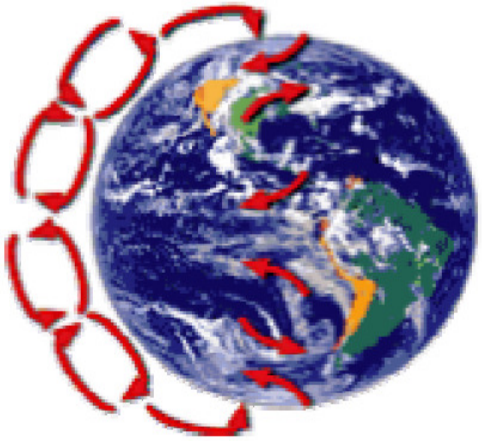


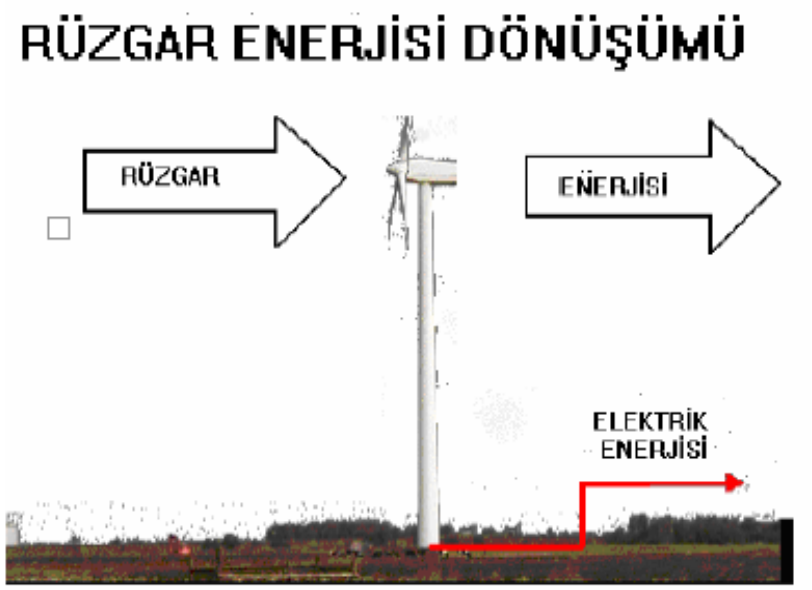

**In last 4 years, 495 MW per year was been installed in average**

# Basics of Wind Energy

## Basics of Wind Energy

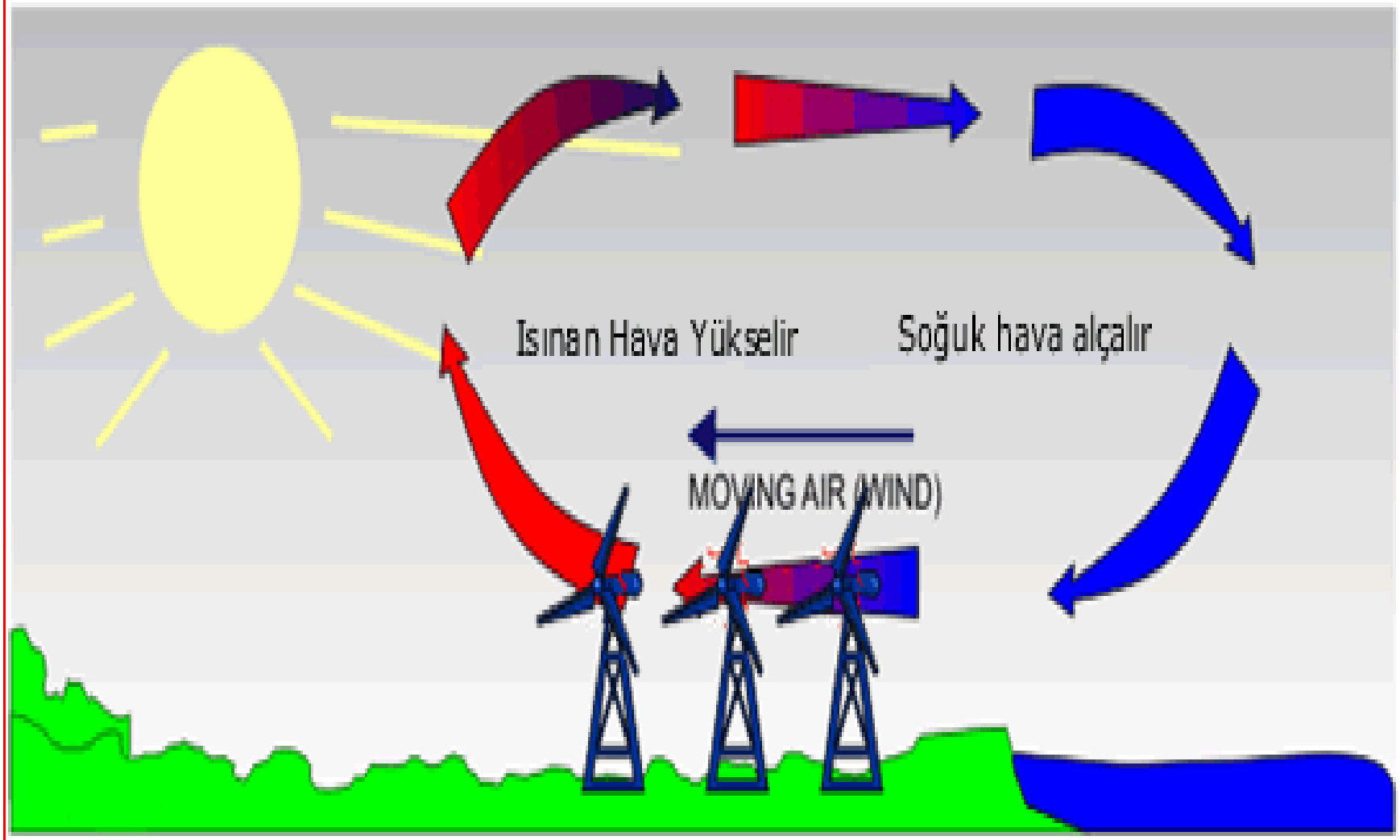
Wind energy is a kind of solar based energy. Sun can not heat grounds and seas homogenous so temperature difference and pressure difference are occurred in the world. Wind is created these pressure differences



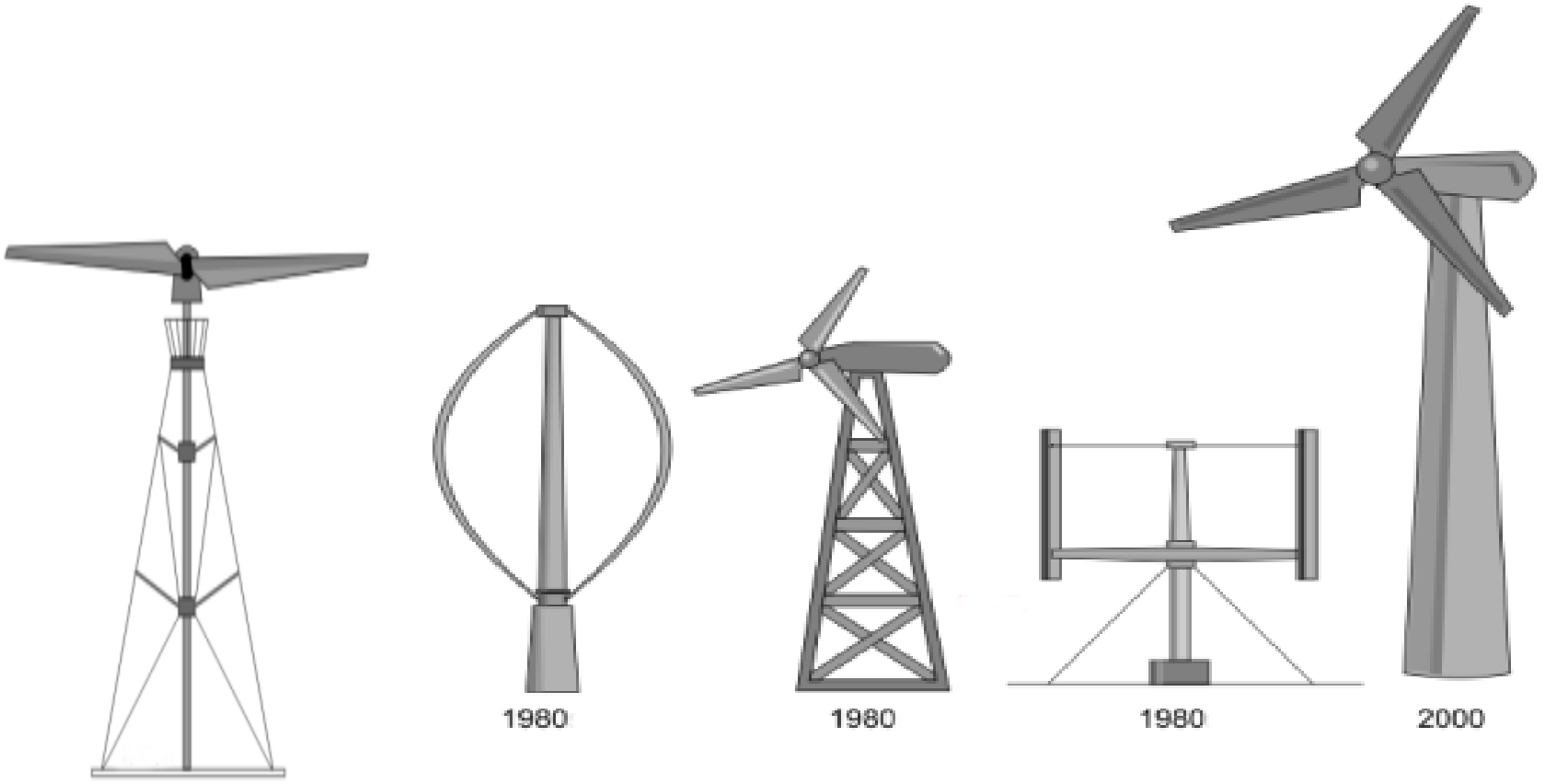



Wind turbine is the key element for wind energy conversion chain

## Basics of Wind Energy

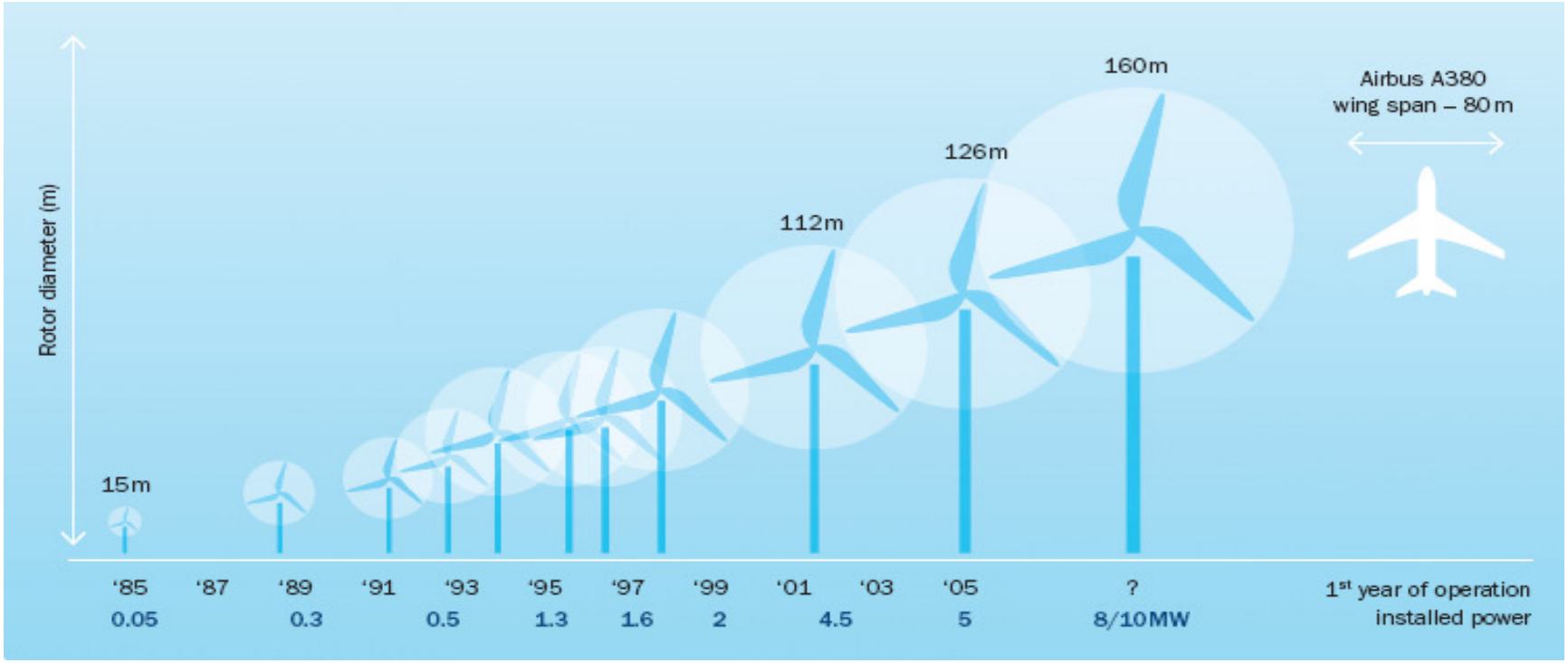


# Wind Turbine Types



# Basics of Wind Energy

- With increasing demand for wind power, bigger size wind turbine systems are developed and installed to increase ratio of power per unit used area
- Nominal rated power level reach to 8 MW for an onshore wind turbine




Strategic Research Agenda Market Deployment Strategy From 2008-2030, European Wind Enery Technology Platfrom

## Basics of Wind Energy

wind turbines are usually deployed in groups of from two or three to several hundred. These groupings are commonly known as *wind farms*.

When this spacing is taken into account, a wind farm of twenty 500kW turbines will occupy an area of 3–4km$^2$. Of this, only around 1% is actually taken up by the turbines. The remainder can still be used as farmland.

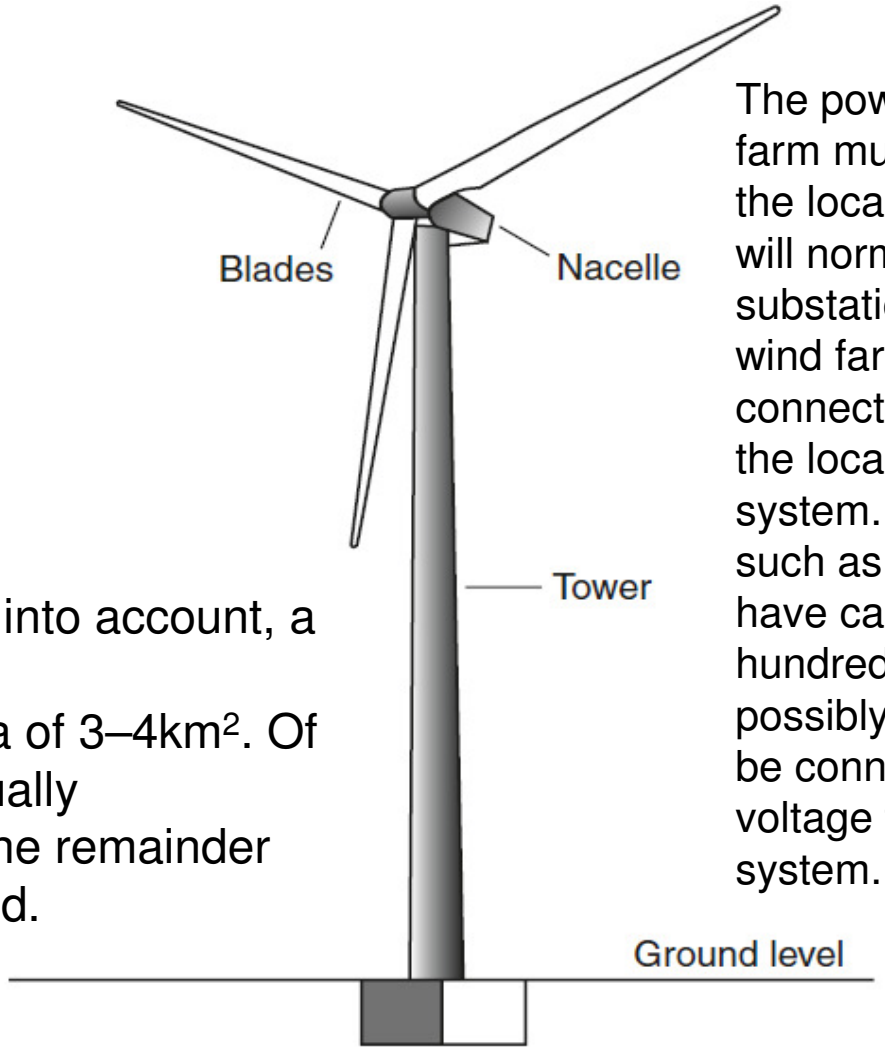


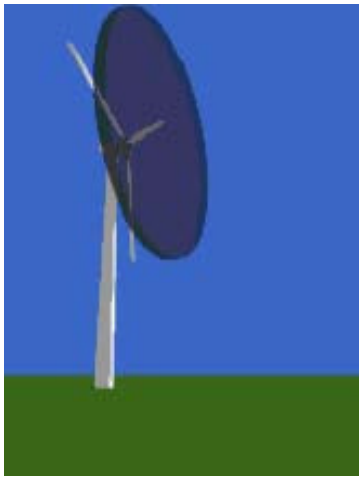

**Figure 11.1** *A horizontal axis wind turbine*

The power from a wind farm must be delivered to the local grid. This will normally require a substation. For a small wind farm, under 100MW, connection may be made to the local distribution system. Larger facilities, such as offshore farms, can have capacities of several hundred megawatts, possibly larger. These must be connected to the high-voltage transmission system.

# Power From Wind Turbine

$$P=0,5 \times C_p \times \rho \times A \times v^3$$

$$A=\pi r^2$$



P = Power (kW)

$C_p$=Capacity coefficent

ρ= Air density (kg/m$^3$)

A= Swept area (m$^2$)

v= Wind speed (m/s)

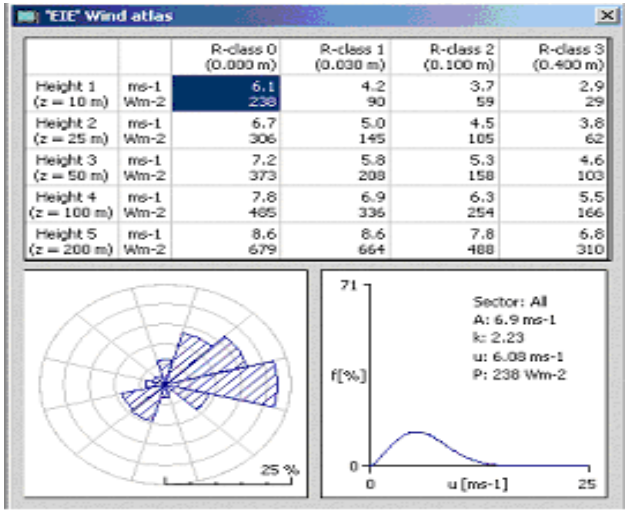
| Rated power [kw] | Range of hub height [m] | Blade length [m] |
|---|---|---|
| 150 | 35-60 | 12-13 |
| 600 | 45-80 | 19-23 |
| 1000 | 50-90 | 26-29 |
| 1500 | 60-100 | 31-37 |
| 2000 | 60-110 | 34-39 |
| 5000 | 80-120 | 40-60 |

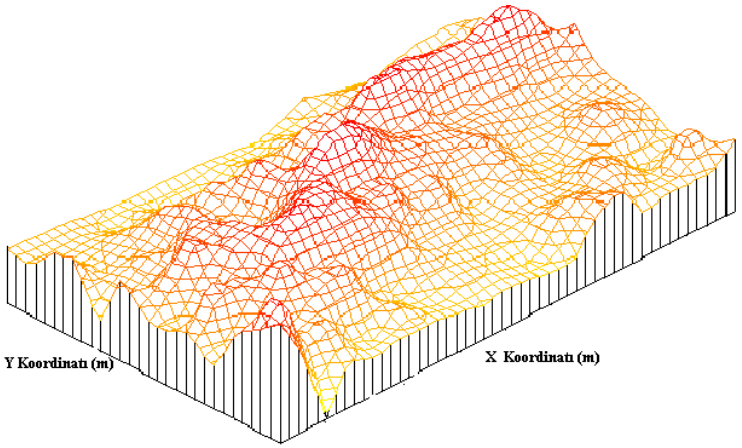
**Sensors (speed, direction)**

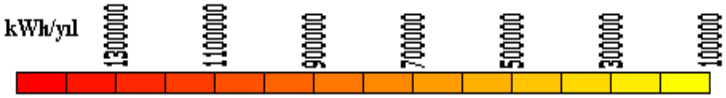
**Wind Measurement Systems**

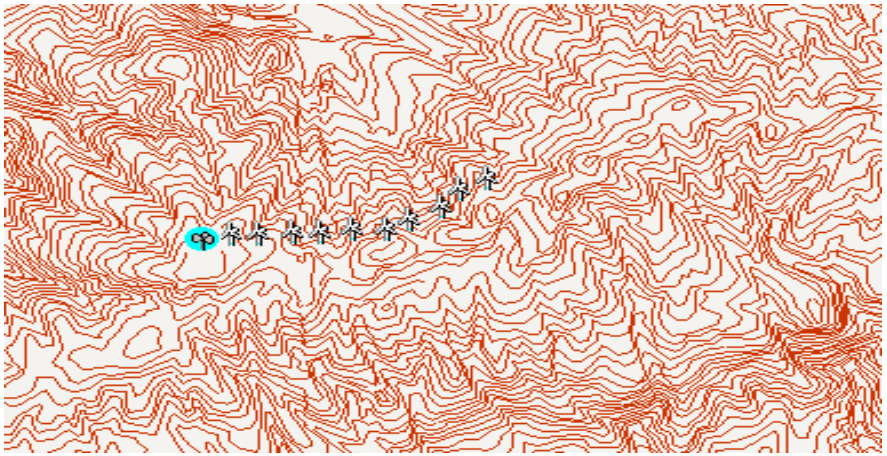

# Wind Data Storage Systems

# Basics of Wind Energy



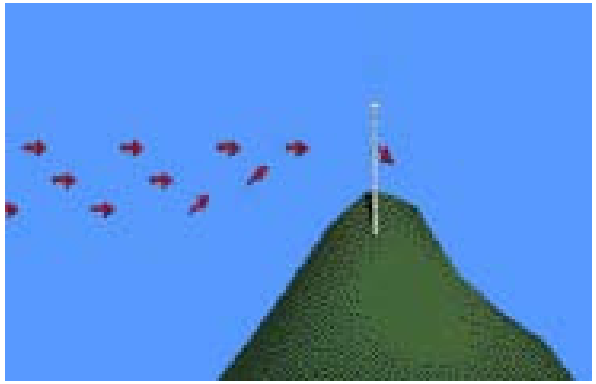



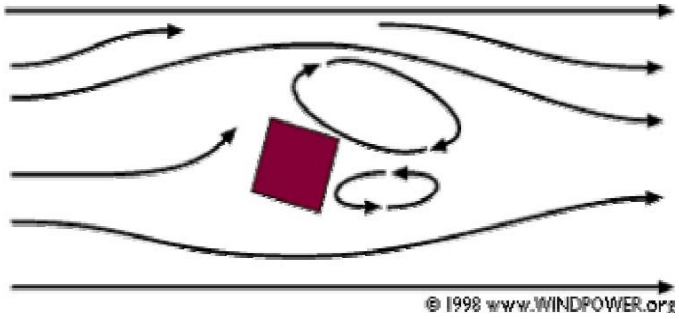
## Micrositing Studies

Hill Effect



Tunnel Effect


Turbulance

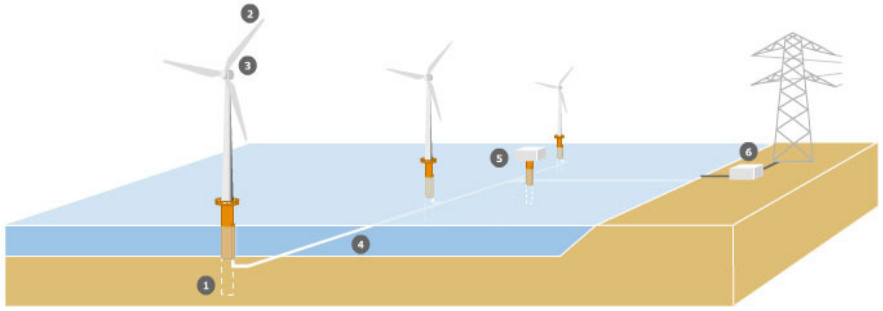


# Wind Resource Risk

This risk parameter relevant with poor feasibility study.

If wind potential measurements of invested area and micrositing procedure are wrong, all calculations and all investment will be wrong

# OFFSHORE Wind Turbines

www.bwea.com/offshore/how.html

## Offshore Wind Turbines

### Offshore wind farming has some significant advantages

- The wind regime is both more predictable and more reliable.
- Turbulence is lower,
- Offshore sites also offer the possibility of building wind farms with capacities of 1000 MW or more.

### Barriers for Offshore Wind Energy

- Maintenance costs are higher
- The main additional cost is for construction of the wind turbine foundation. This can cost up to 25% of the total installation cost offshore. Onshore it is likely to be 16% or less.
- Grid connection is also more expensive

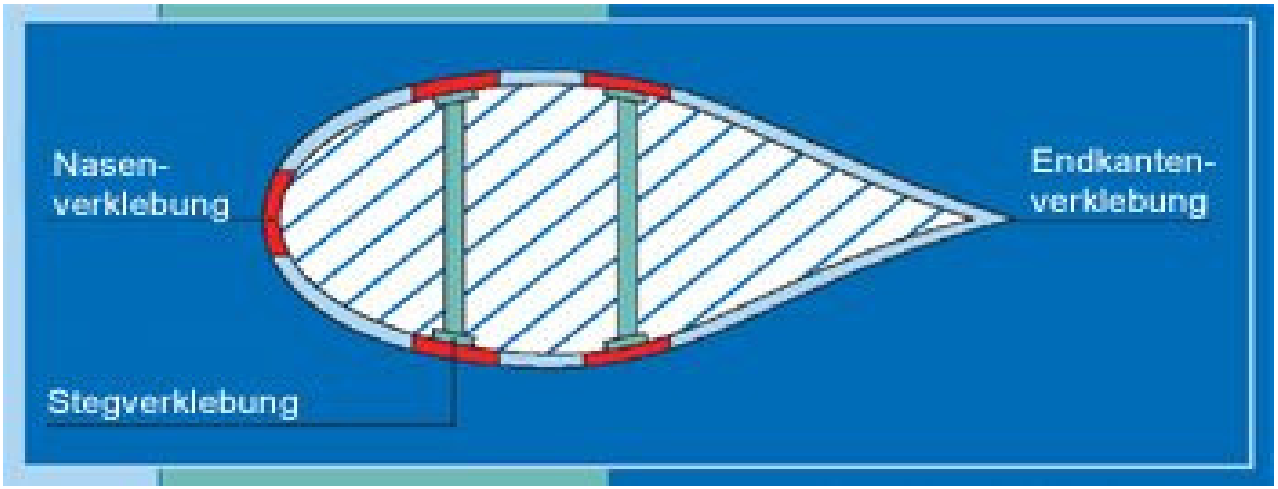
**For offshore wind energy investments, the primary barrier is cost. Building a wind farm offshore costs between 40% and 100% more than building a similar farm onshore.**

# Rotor Blade Production

## Rotor Blade Production

- Wind turbine rotor blades are the first element of the conversion from wind energy to electricity chain

- Polymeric composite technology is used for wind turbine rotor blade production



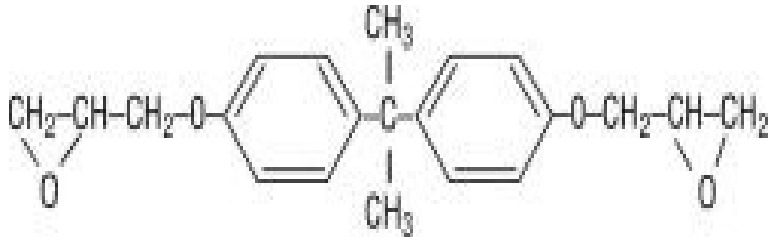

### Most Important Claims for Rotor Blades

- High tensile strength and breaking elongation
- High material stiffness
- light weight

# Basic Raw Materials for Rotor blade Production

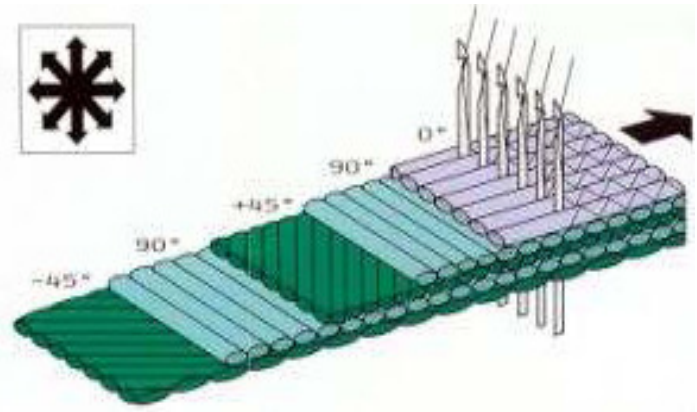
## Polymer Matrix

### Epoxy Resin




## Reinforced Material

### Woven Glass Fabrics




## Core Materials

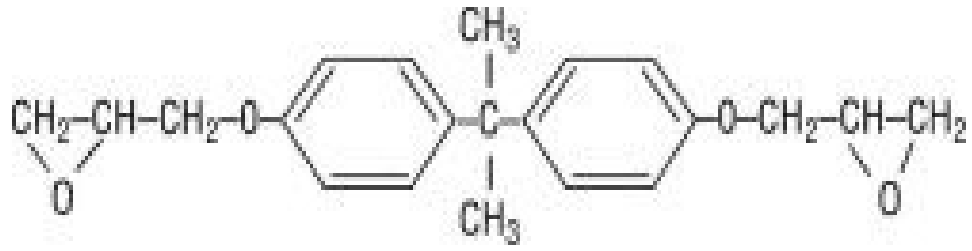
### PVC-PET Foam

### Balsa Wood

# Basic Raw Materials for Rotor blade Production

## Polymer Matrix

## Epoxy Resin

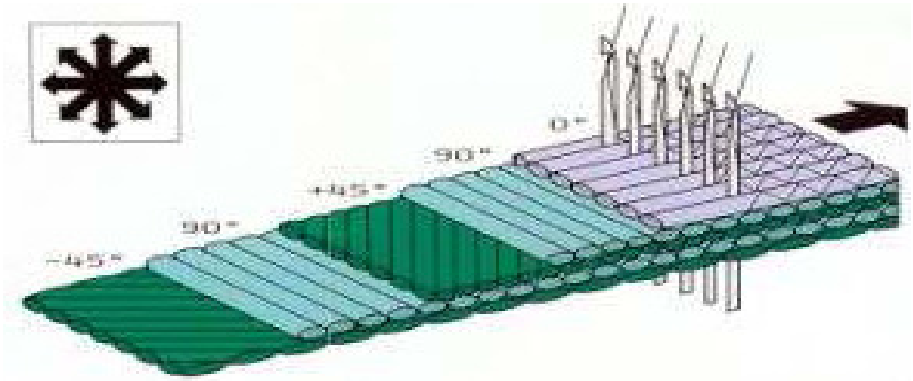



Generally epoxy and amine hardener systems are preferred for big rotor blade production. According to other thermo set resin systems, the most important advantage of epoxy system is dimensional stability after curing (volumetric shrinkage is between 1% and 3% )

# Reinforced Material

## Woven Glass Fabrics

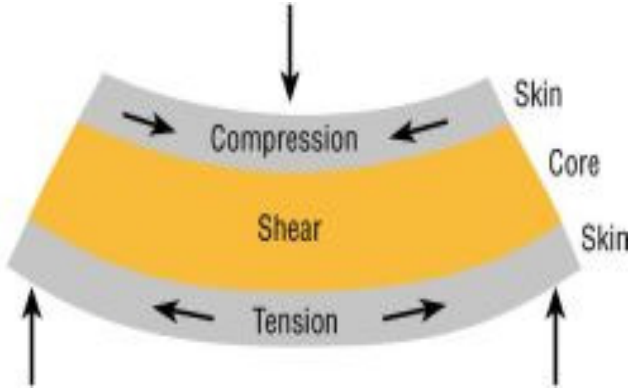
Woven glass fabrics which are produced E-glass are preferred for the wind turbine rotor blade production. This type of reinforced materials have better cost/strength ratio according to other reinforced materials.




Mechanical strength of glass fabrics is limited by the woven type. Glass fabrics are woven and used according to load distribution on the rotor blade.

# Core Materials

PVC Foam




Balsa Wood

- Homogeneous load distribution on the rotor blade
- Increasing of shear strength
- Increasing of bending strength, (weight raise 3%, bending strength raise 3,5 times)

# Production Method
# Vacuum Infusion Technique

- The pressure difference between the ambient pressure in the component is used to suck the required quantity of matrix into the component
- The infusion system serves to equally distribute the matrix in the component.

- For a vacuum infusion , all fabric layer are still dry when they are placed in the component mould.
- The infusion system is placed on the dry layers and the vacuum system is placed on top of it

# Coating Process Of Rotor Blades

- Polyurethane based gelcoat and paints are used for rotorblade surface coating after infusion process

- Manuel or robotic sprey system is used for coating application

- There are two main goal for using coating application, one of them is that protection of composite structure against the enverinomental effects such as UV, rain etc. (gelcoat) Other one is that decreasing of air friction (paint)

## References


Arslan, S., Rüzgar Türbin Montajı, 2011

Breeze, P., Power Generation Technologies, Elsevier, 2005

Jensen F.M.,Falzon B.G.,Ankersen J.,Stang H.Structural testing and numerical simulation of a 34 m composite wind turbine blade,Composite Structures, 76;52-61,2006

Schlager, N. and Weisblatt, J., Alternative Energy, Thomson Gale, 2006

SEVİM, C., , Wind Energy Market and Methodology of Rotor Blade Production, 9th World Wind Energy Conference and Exhibition (WWEC 2010), İstanbul, Türkiye, June 2010

## References


EİEİ, Türkiye Rüzgar Potansiyeli Atlası

GWEC-Global Wind Statistics 2011

Strategic Research Agenda Market Deployment Strategy From 2008-2030, European Wind Energy Technology Platform

Sevim, C., Energy Production Based CO2 Emissions and Wind Energy Market Developments for Turkey, 10th International Conference on Clean Energy (ICCE 2010), 57 pp., Gazimagusa, N.Cyprus, September 2010

Wind in Power 2011 European Statistics, EWEA

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