EWEA
THE EUROPEAN WIND ENERGY ASSOCIATION

Wind Energy The Facts –Integrating wind power in Sweden

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IEE PROGRAMME

WIND ENERGY - THE FACTS PUBLICATION

BENEFITS OF WIND ENERGY

INTELLIGENT ENERGY EUROPE (IEE) PROGRAMME

- Wind Energy –The Facts: IEE financed project (Renewable electricity area) of 2 years (01/11/07 - 31/10/09)

- **IEE**: EU's **funding tool** to encourage the use of **renewable energy sources and energy saving**

  and

  move towards **a more energy intelligent Europe**

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IV. Industry and Markets

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WIND ENERGY THE FACTS: Authors

- Volume I: Paul Gardner, Andrew Garrad, Lars Falbe Hansen, Peter Jamieson, Colin Morgan, Fatma Murray and Andrew Tindal of Garrad Hassan and Partners, UK; José Ignacio Cruz, Luis Arribas of CIEMAT, Spain; Nicholas Fichaux of the European Wind Energy Association (EWEA).

- Volume II: Frans Van Hulle of EWEA and Paul Gardner of Garrad Hassan and Partners.

- Volume III: Poul Erik Morthorst of Risø National Laboratory, Technical University of Denmark; Hans Auer of the Energy Economics Group, University of Vienna; Andrew Garrad of Garrad Hassan and Partners; Isabel Blanco of UAH, Spain

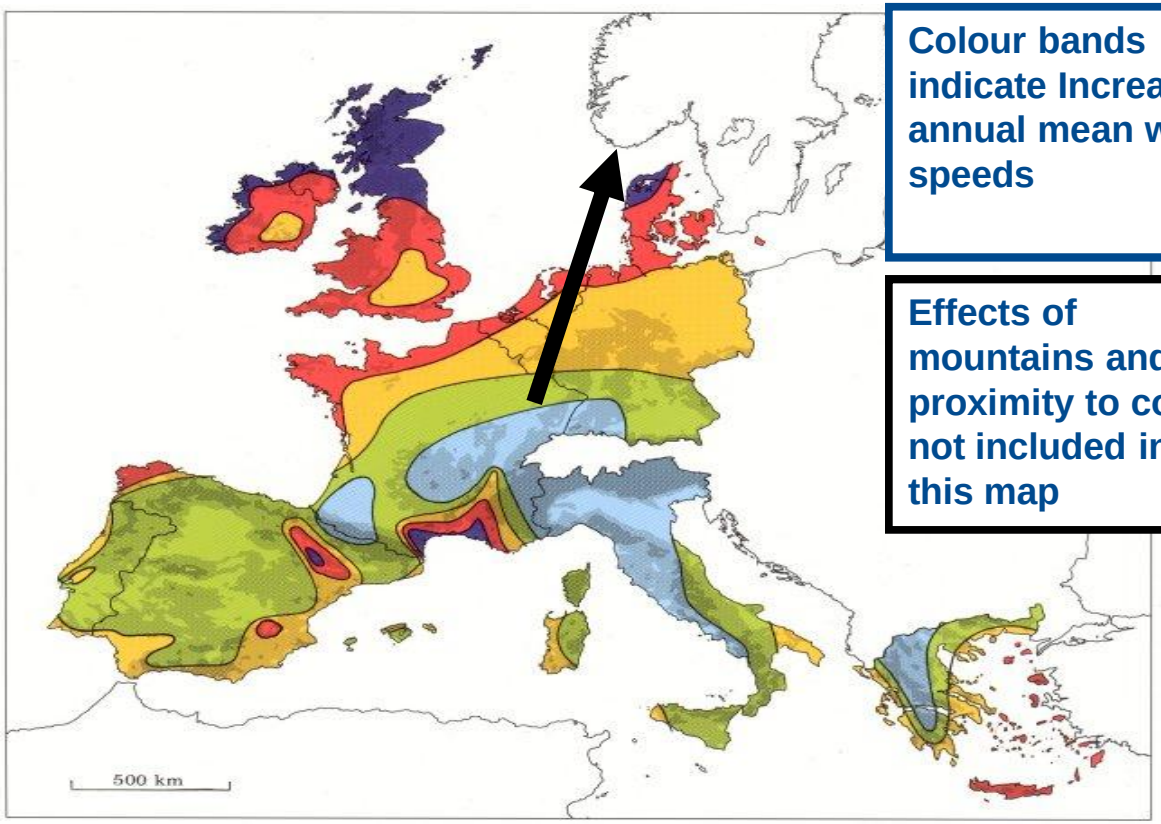
WIND ENERGY THE FACTS: Authors

- Part IV: Angelika Pullen of the Global Wind Energy Council (GWEC), Keith Hays of Emerging Energy Research; Gesine Knolle of EWEA.
- Part V: Carmen Lago, Ana Prades, Christian Oltra and Yolanda Lechón of CIEMAT, Spain; Angelika Pullen of GWEC, Hans Auer of the Energy Economics Group, University of Vienna.
- Part VI: Arthouros Zervos of the National Technical University of Athens, Greece (www.ntua.gr) and Christian Kjaer of EWEA.

I. TECHNOLOGY: Wind resource estimation 1/2

Wind maps are a good starting point

But at each site wind measurements and topography needs to be taken into account



Colour bands indicate Increasing annual mean wind speeds

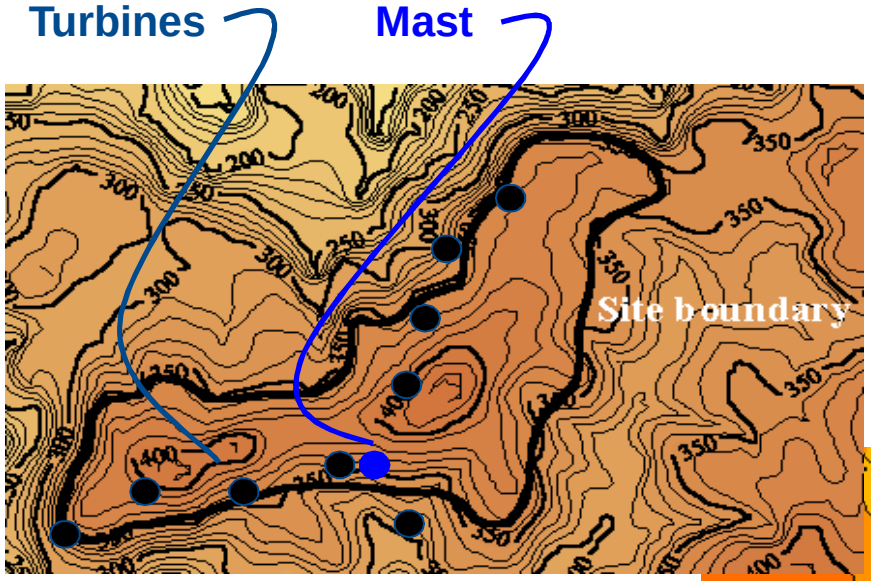
Effects of mountains and proximity to coast not included in this map

Wind resources[1] at 50 metres above ground level for five different topographic conditions

	Sheltered terrain[2]		Open plain[3]		At a sea coast[4]		Open sea[5]		Hills and ridges[6]	
	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}
	> 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

Onshore wind energy resource, as computed on a broad scale for the European Wind Atlas.

I. TECHNOLOGY: Wind resource estimation 2/2

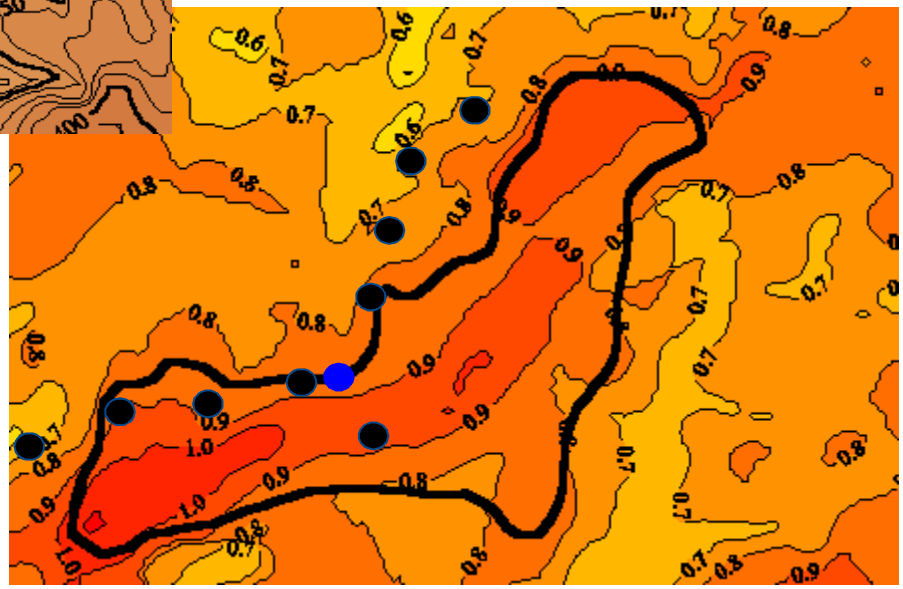


Computational flow modelling initiated from wind conditions at mast

Input - topography

Have predicted wind conditions at each turbine location

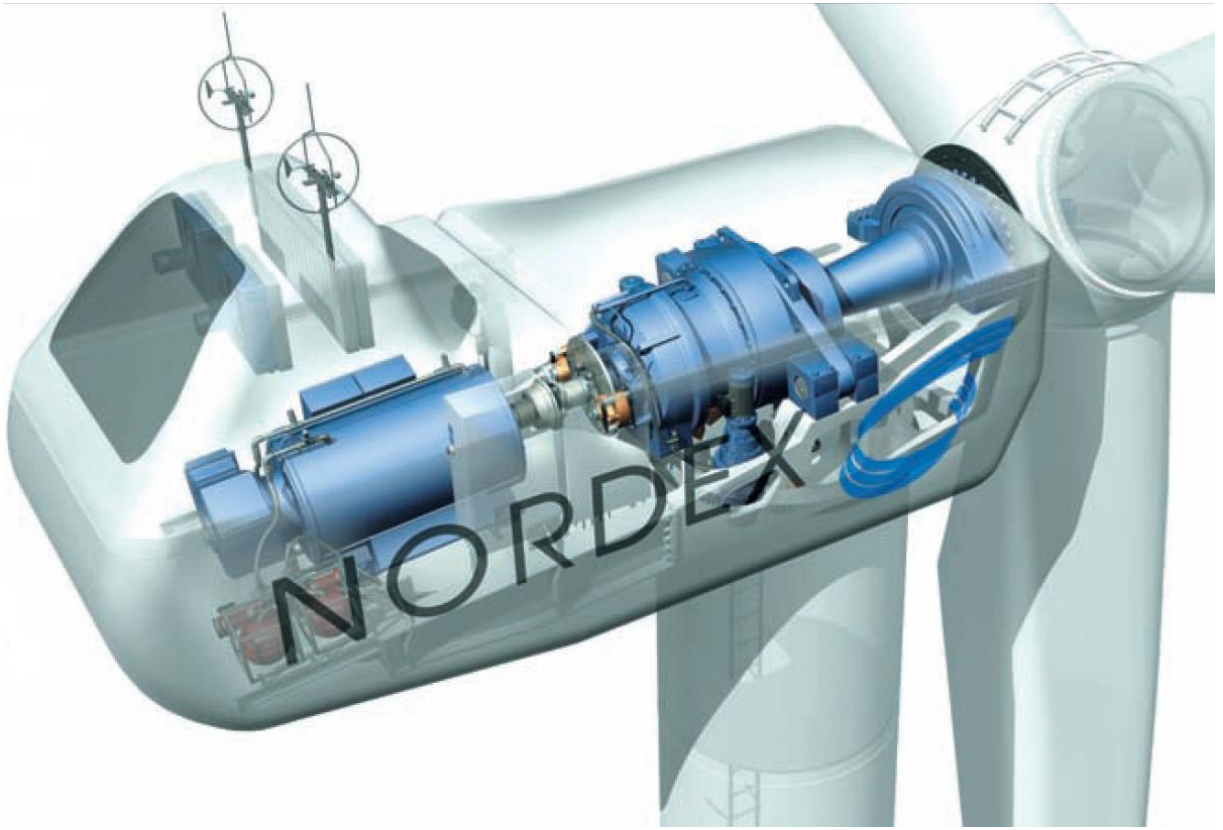
In this example annual mean wind speed varies by 30 % over site area



Output normalised wind speed

I. TECHNOLOGY: Wind turbine 1/2

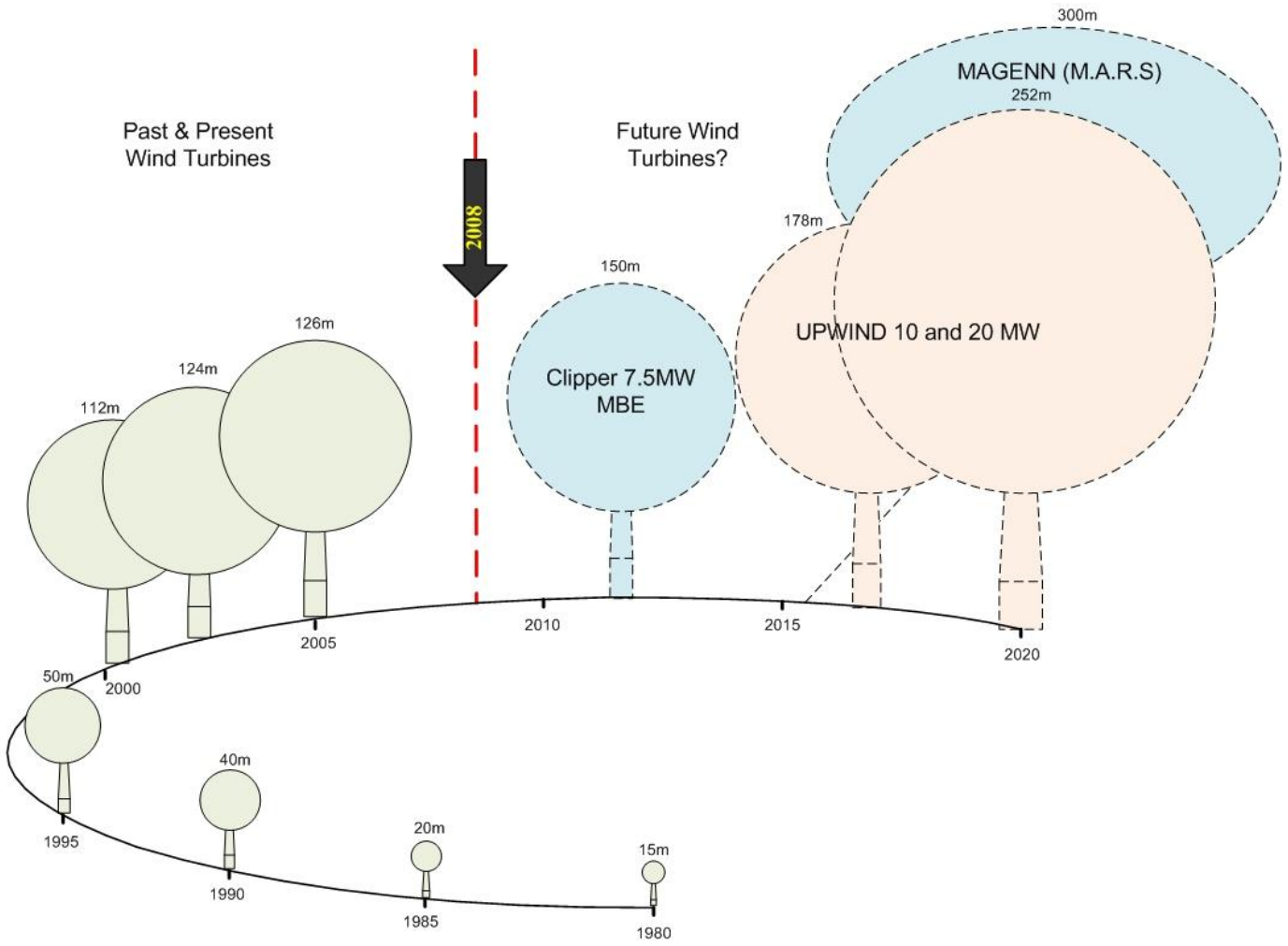
WIND TURBINE –WHAT'S INSIDE?



I. TECHNOLOGY: Wind turbine 2/2

WIND TURBINES

How big will they get?



II. GRID INTEGRATION 1/4

- Wind power fits well in power systems, the need for additional 'integration efforts' depend on:
  - Wind power penetration
  - Flexibility of the power system in question:
    - Generation (up and down regulation capability)
    - Demand management and storage
    - Interconnection (available capacity)
    - Power market characteristics (e.g. for balancing services): time, geographical area.

- Flexibility varies widely in EU. Integration efforts (e.g. moving to more flexibility) can be implemented by suitable market design (rules, incentives).

II. GRID INTEGRATION 2/4

THE MAIN CHALLENGES

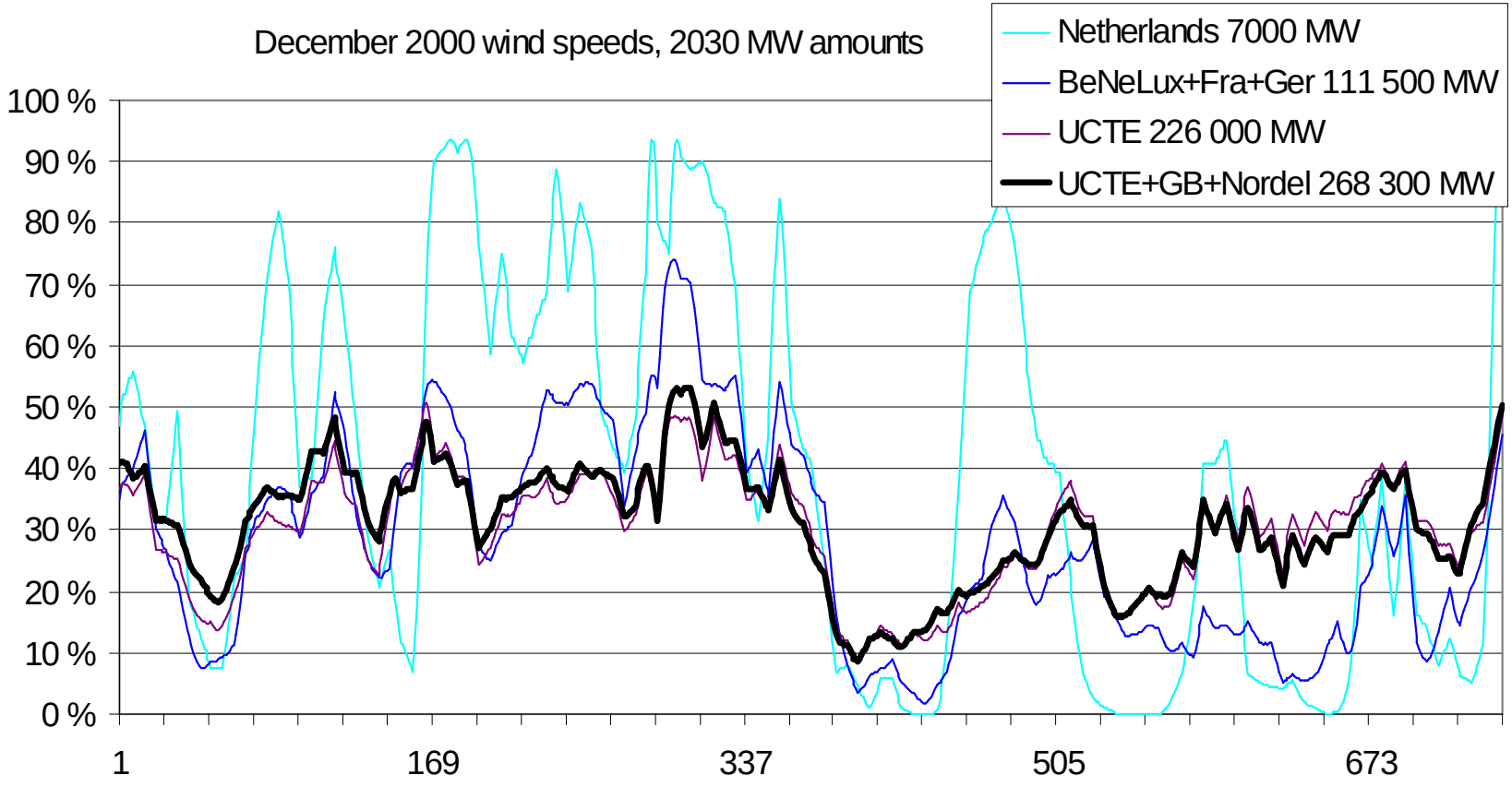
- Increased power flows as wind power capacity increases
- Distance of wind power from load centres

ISSUES

- European grid is weak on interconnections
- Often weak distribution grids
- Interconnection projects face long lead times (10 years) due to planning obstacles.
- Cost allocation : example approach = Infrastructure planning law in Germany (offshore grids for wind power to be built by TSO ś).

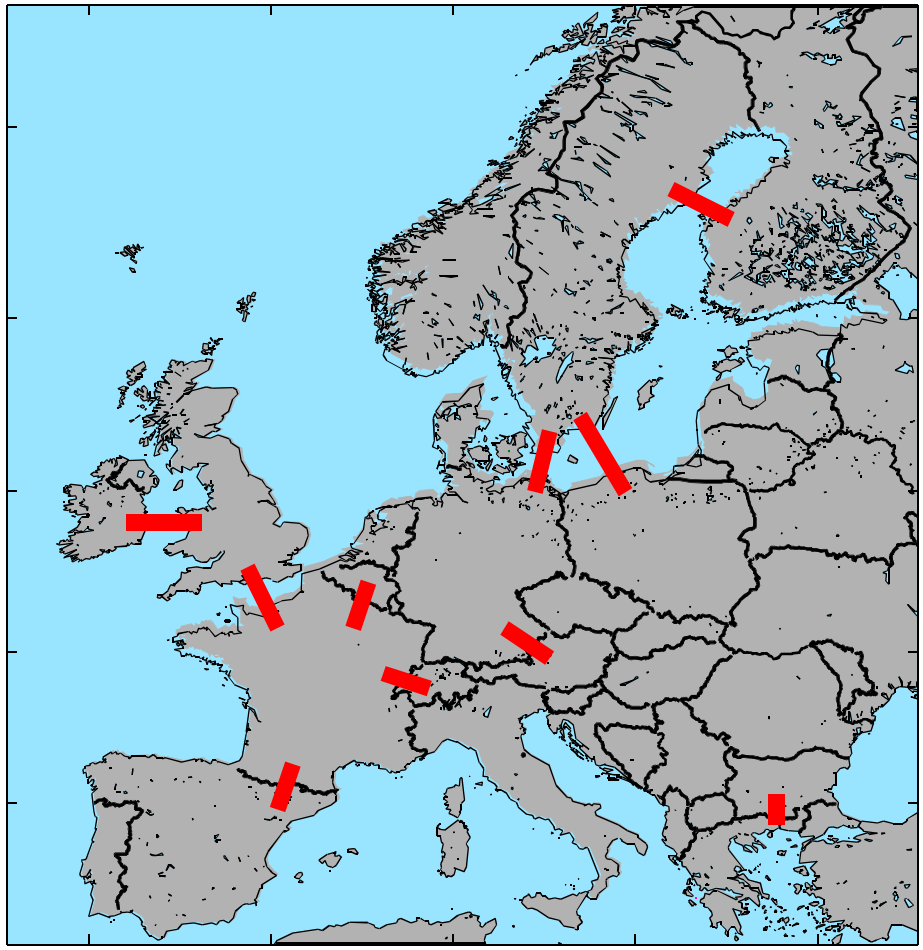
II. GRID INTEGRATION 3/4

The need for interconnexion: spatial smoothing effect



II. GRID INTEGRATION 4/4

- Large amounts of wind power (2020, 2030 scenarios) will increase congestions in interconnectors
- Strong adequate interconnectors will allow for a 27 GW firm generating capacity for 2020 (200 GW scenario).



III. ECONOMICS OF WIND: Costs 1/2

- Investment costs
- O&M costs
- Electricity production
- Average wind speed
- Turbine lifetime
- Discount rate

Cost structure of a typical 2 MW wind turbine installed in Europe (€2006)

	INVESTMENT (€1,000/MW)	SHARE OF TOTAL COST %
Turbine (ex works)	928	75.6
Grid connection	109	8.9
Foundation	80	6.5
Land rent	48	3.9
Electric installation	18	1.5
Consultancy	15	1.2
Financial costs	15	1.2
Road construction	11	0.9
Control systems	4	0.3
TOTAL	**1,227**	**100**

Source: EWEA 2009 report "The Economics of Wind Energy"

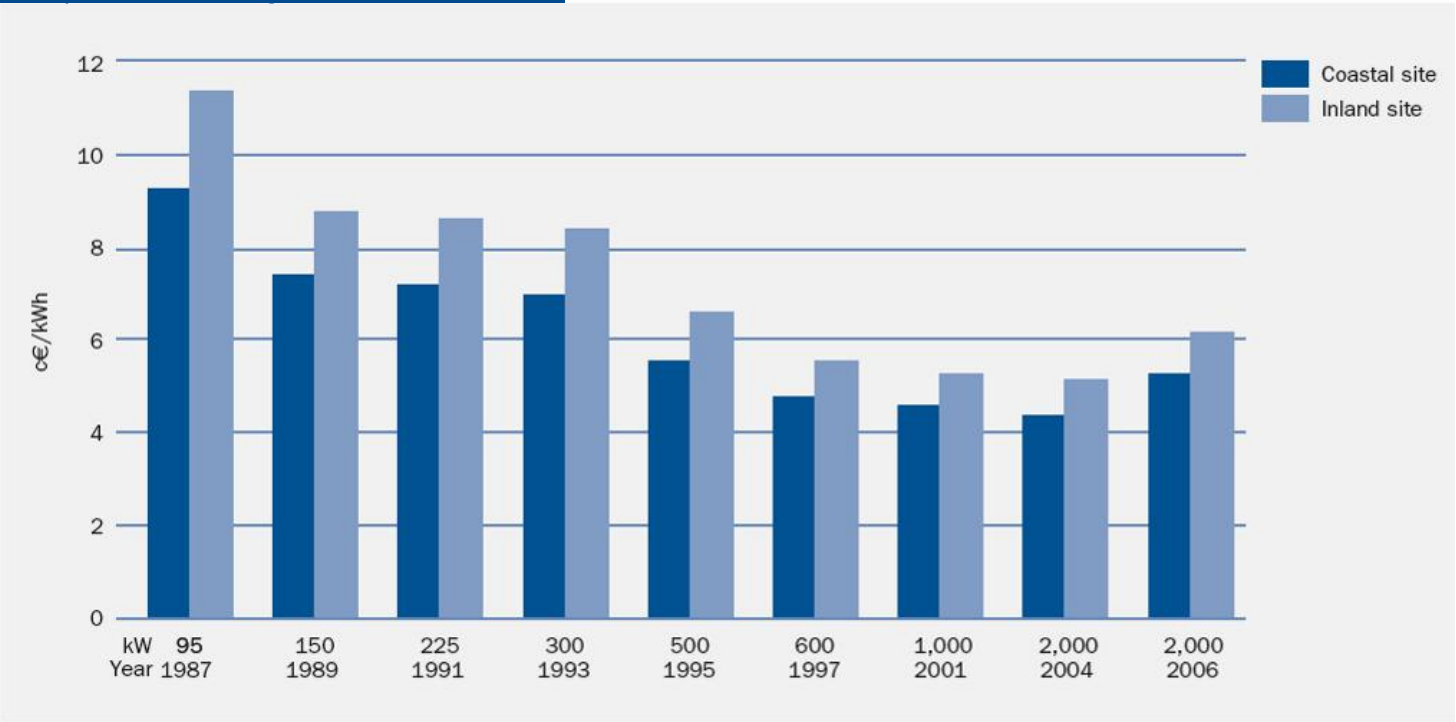
- Wind energy: 75% of costs paid upfront
- Conventional power: less capital intensive – uncertain fuel and carbon costs

III. ECONOMICS OF WIND: Costs 2/2

Production costs are decreasing

- Trend towards larger turbines
- Trend towards improved cost-effectiveness
- Costs have gone down by more than 40%

Total wind energy costs per unit of electricity produced, by turbine size (c €/kWh, constant €2006 prices), and assuming a 7.5% discount rate



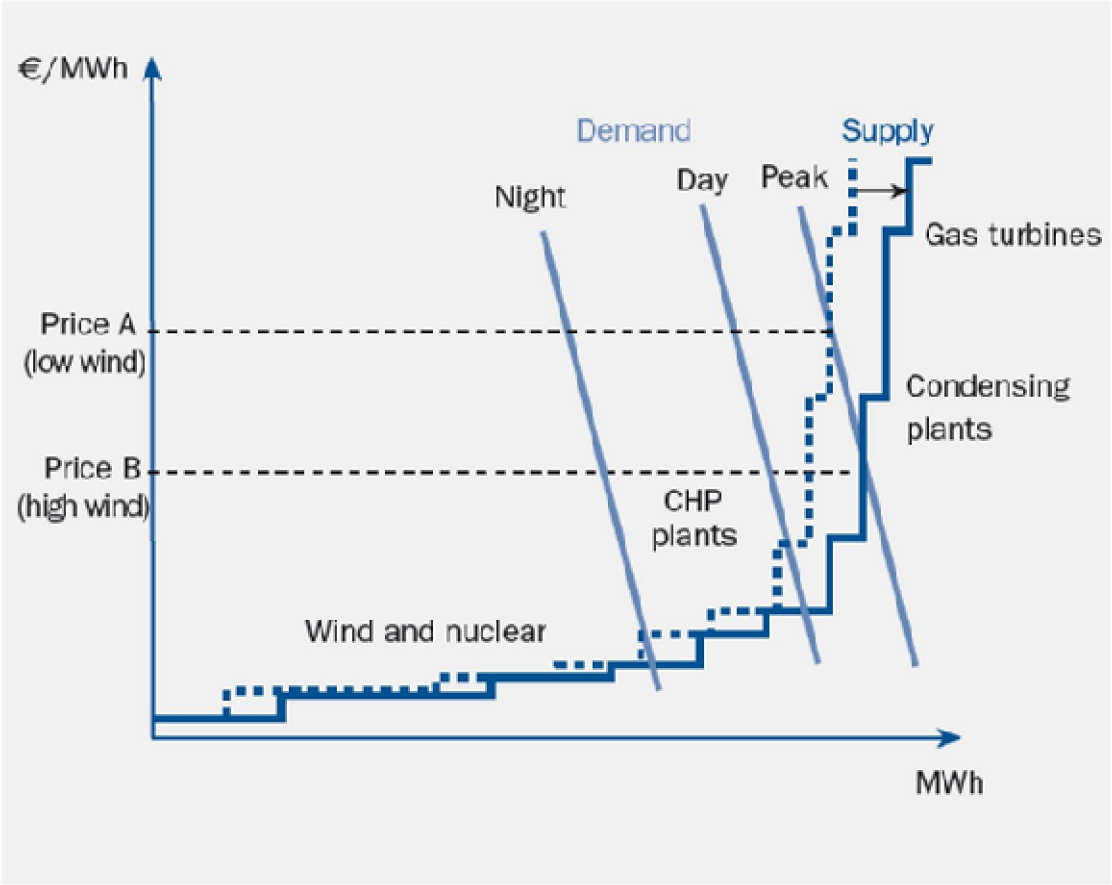
Source: EWEA 2009 report "The Economics of Wind Energy"

III. ECONOMICS OF WIND: Electricity price

Wind energy reduces power price - merit - order effect

- Impact of wind power depends on time of the day
- High demand and high wind impact the spot power price significantly
- Lower power spot price is beneficial to all consumers

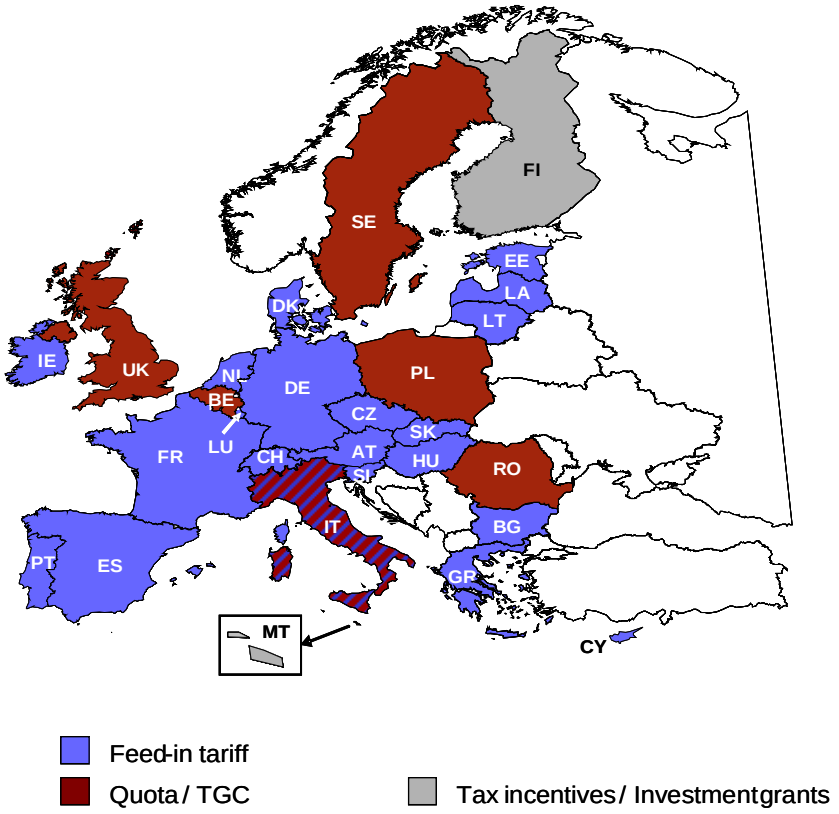
How wind power influences the power spot price at different times of day



Source: EWEA 2009 report "The Economics of Wind Energy"

IV. INDUSTRY AND MARKETS: Support schemes for RES-E 1/2

- National support schemes
  - Each Member State can choose its own support scheme
  - Strong tendency towards:
    - Feed-in tariffs
    - Quota obligations with tradable green certificates



IV. INDUSTRY AND MARKETS: Support schemes for RES-E 2/2

1. Feed-in tariffs (FIT)

- Renewable electricity can be fed into the grid at a guaranteed tariff for a determined period of time

2. Quota obligation with tradable green certificates (TGC)

- Additional revenue above market price from selling TGCs

3. Tender procedures

- In a bidding round projects with the lowest generation costs can obtain financial support

4. Incentives

- Tax incentives or investment grants

IV. INDUSTRY AND MARKETS: Employment 1/2

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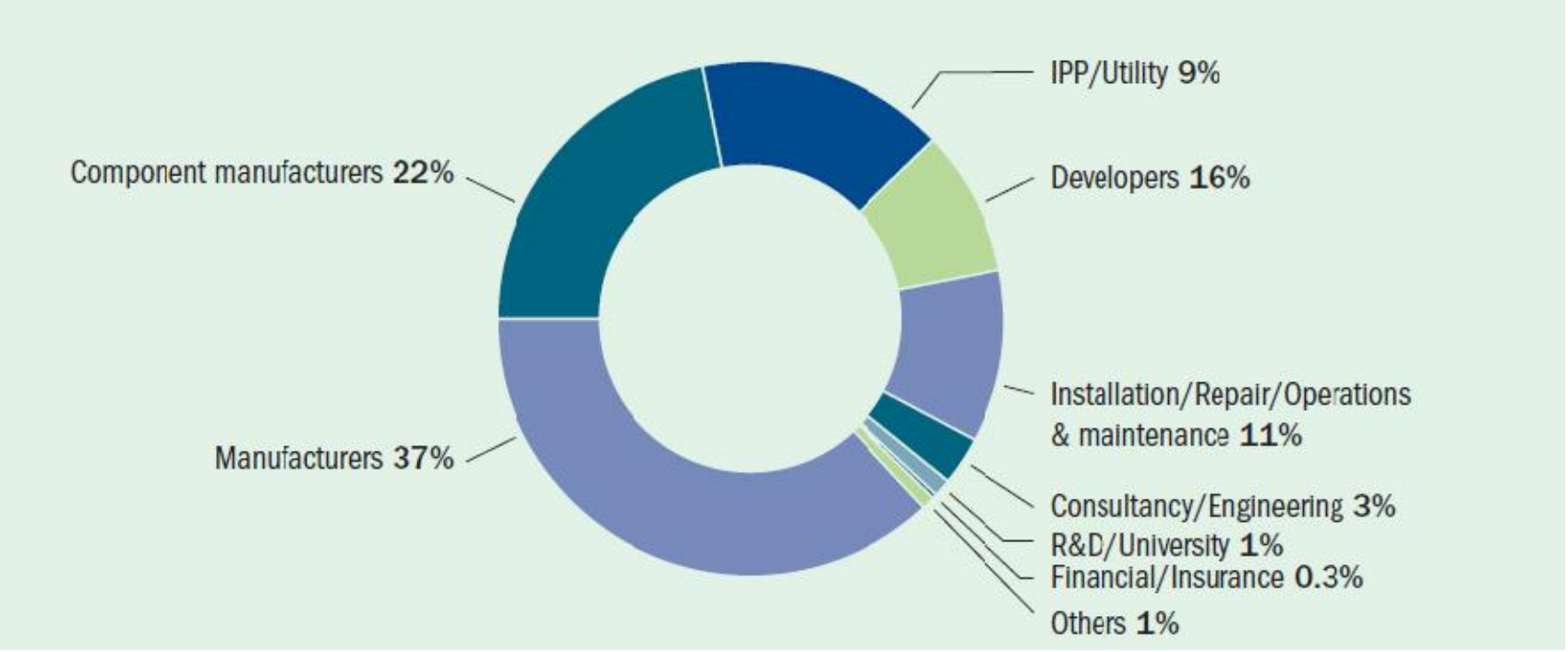
What is the current employment situation?

- The EU wind energy sector directly employed approximately **108,600 people** in 2007
- Including indirect jobs, the sector employed **154,000 people**
- Direct employment has increased by **60,237 (125%)** since 2002
- On average, the wind energy sector in Europe has created **33 new jobs every day, seven days a week over the past five years**
- Wind turbine and component manufacturers are responsible for the 59% of direct wind energy employment

IV. INDUSTRY AND MARKETS: Employment 2/2

Employment breakdown across sectors



V. ENVIRONMENT

- Global environmental benefits
  - Wind energy is a clean energy source
- Local environmental impacts
  - Are site-specific, vary among the different species and should be put in context
  - Can be avoided/minimised: the role of environmental assessments, mitigation and compensation measures
- Conclusions and recommendations
  - Achieving the 20% RES target while respecting biodiversity

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BENEFITS OF WIND ENERGY

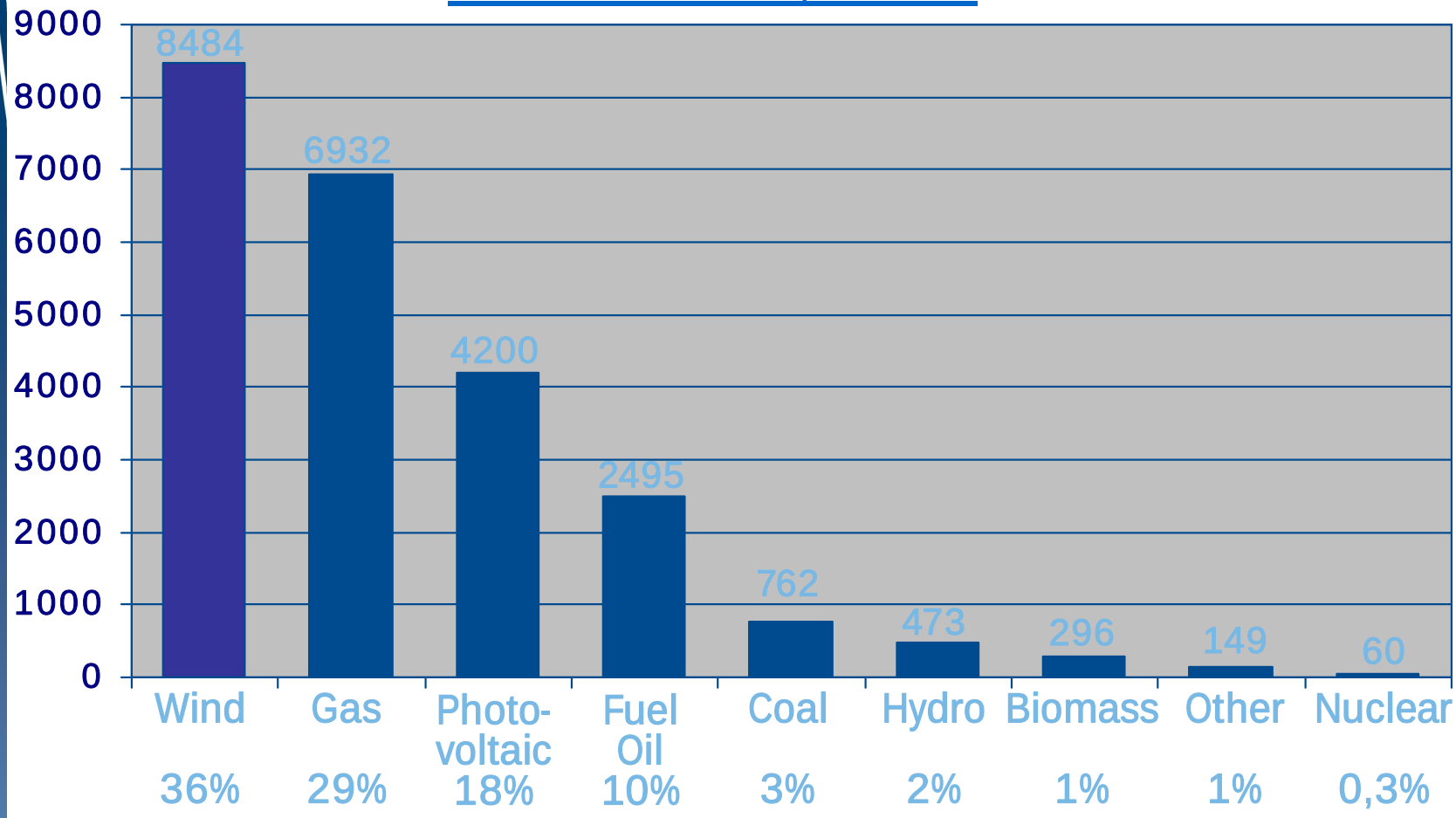
EU IS IMPORTING 54% OF ITS ENERGY…

	EU share of proven global reserves	Years of domestic production
Oil	0.5% - 0.8%	7.7 –7.8 years
Gas	1.4% - 2%	14.4 –14.8 years
Coal	3.5%	50 years
Uranium	1.9%	

Source: European Commission 2008

WIND LEADS THE EU POWER SECTOR

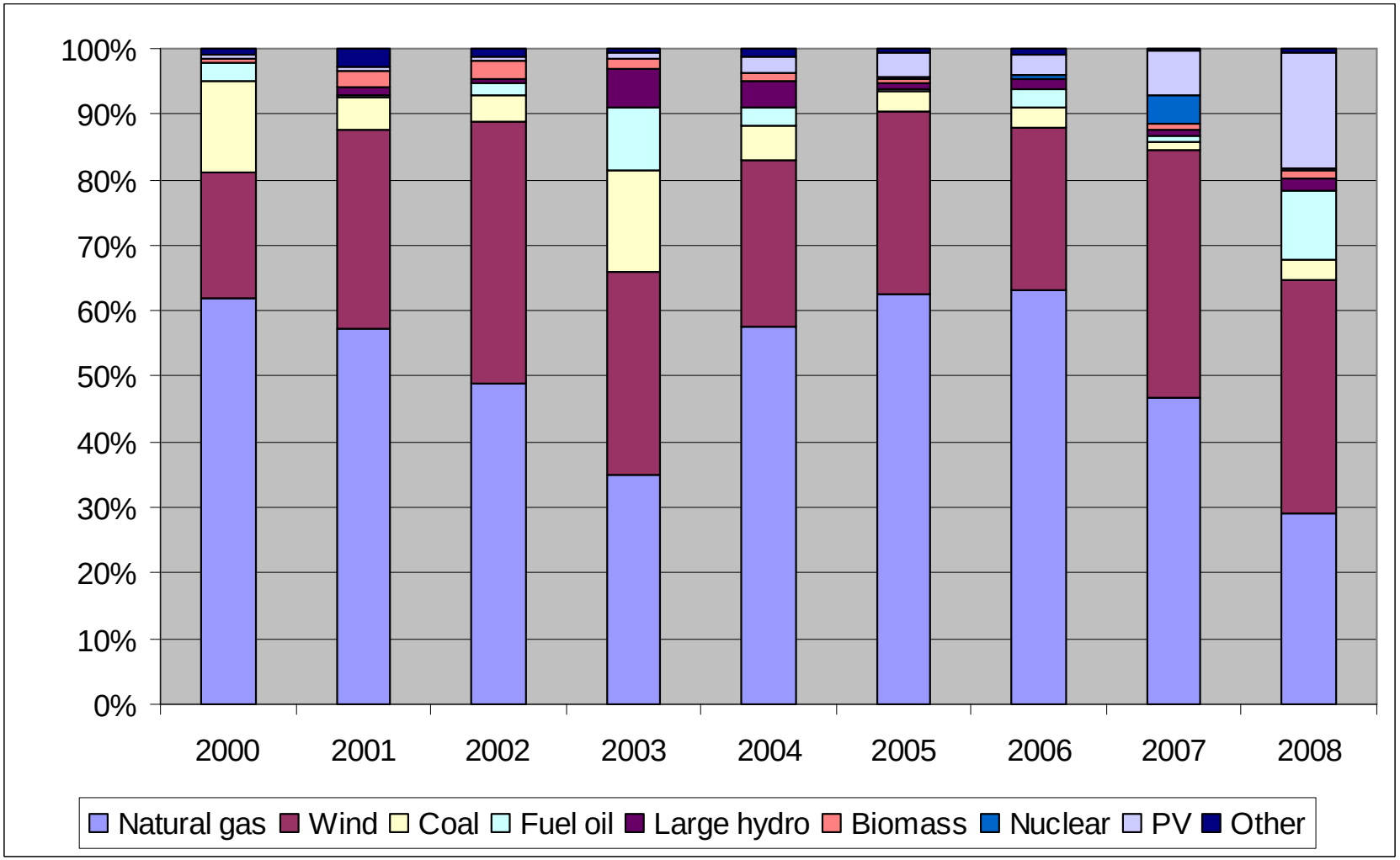
NEW POWER CAPACITY INSTALLED IN 2008
Total installed: 23,851 MW



Note: Preliminary figures for solar photovoltaic installations

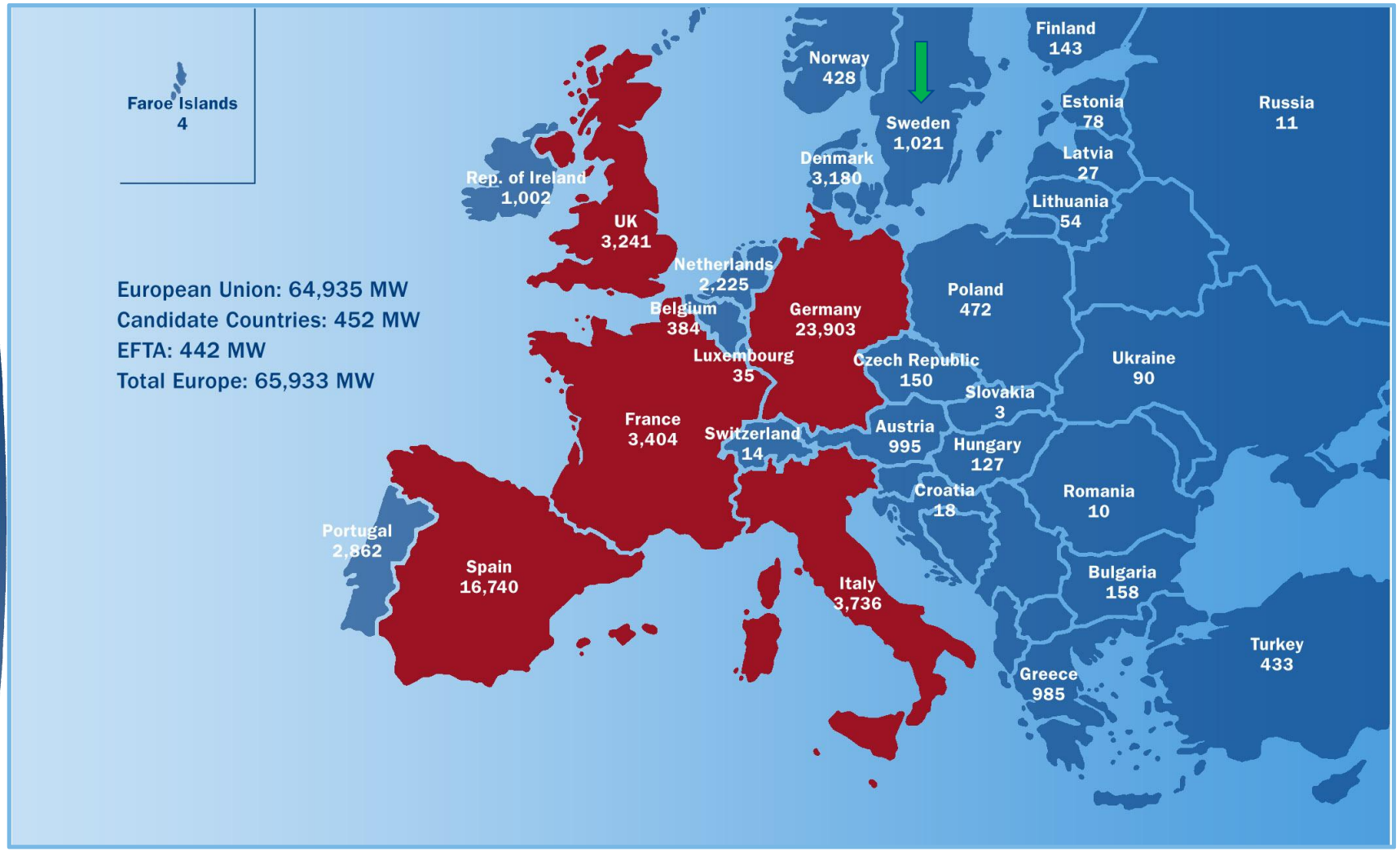
Source: EWEA, EPIA and Platts PowerVision

NEW CAPACITY INSTALLED BY ENERGY SOURCE IN EU (2000-2008)



Source: Platts PowerVision 2008

EU TOP 5 WIND ENERGY CAPACITY



Source: EWEA Wind Map 2008

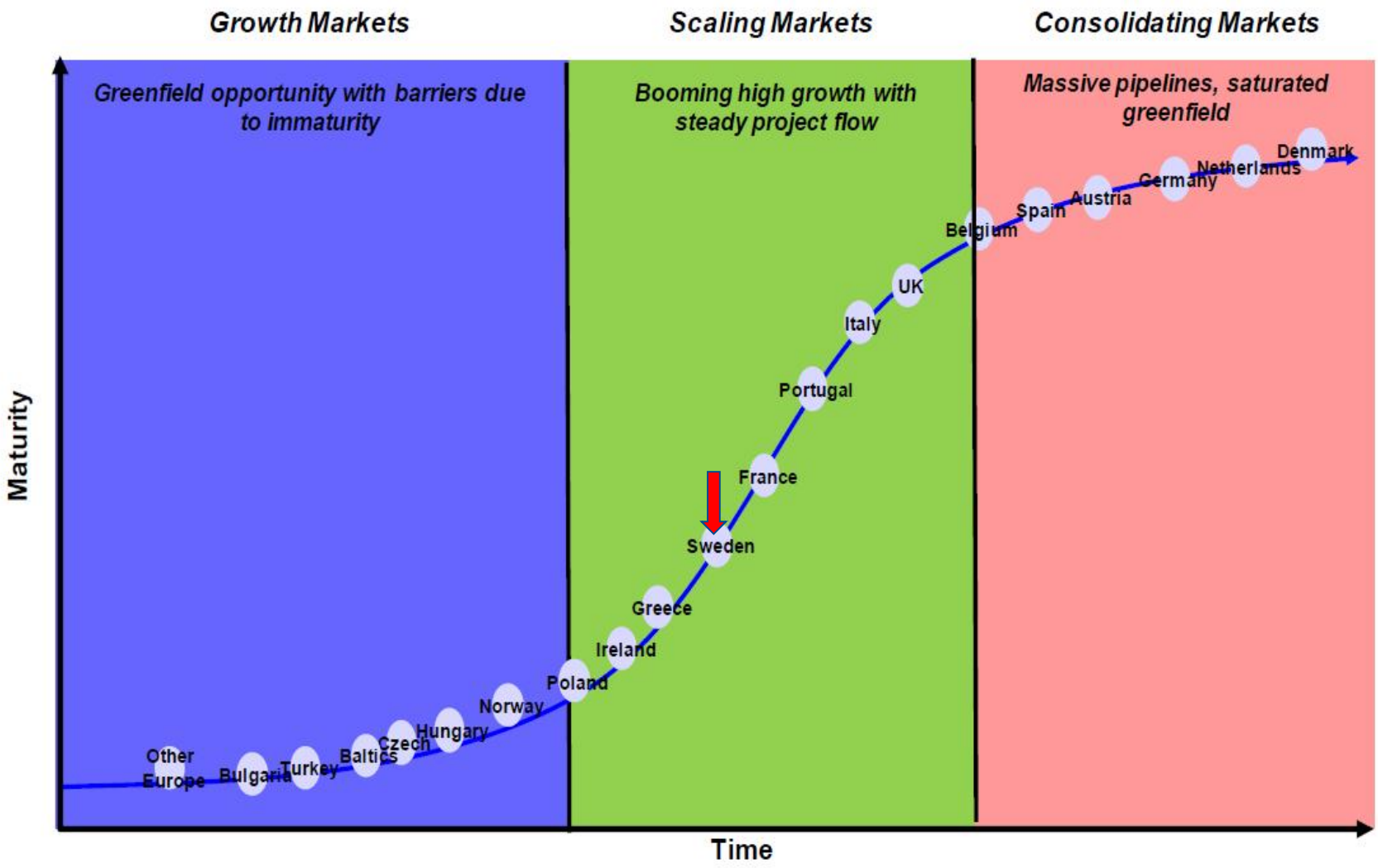
WIND ENERGY IN EU-27 - 2008 FACTS (I)

- 65 GW installed capacity, incl. 1.47 GW offshore
- Annual installations of 8.5 GW, incl. 0.35 GW offshore
- Electricity production of 142 TWh
- Meeting 4.2% of total EU electricity demand
- Providing power equivalent to the needs of 35 million average EU households

WIND ENERGY IN EU-27 –2008 FACTS (II)

- Avoiding 108 Mt of CO2 –equivalent to taking more than 50 million cars off the road (20% of the EU car fleet) and equal to 31% of the EU-15 ś Kyoto obligation
- Annual avoided fuel cost of €5.4 billion
- Annual avoided CO2 costs of approximately €2.4 billion
- Annual investments in wind turbines of €11 billion

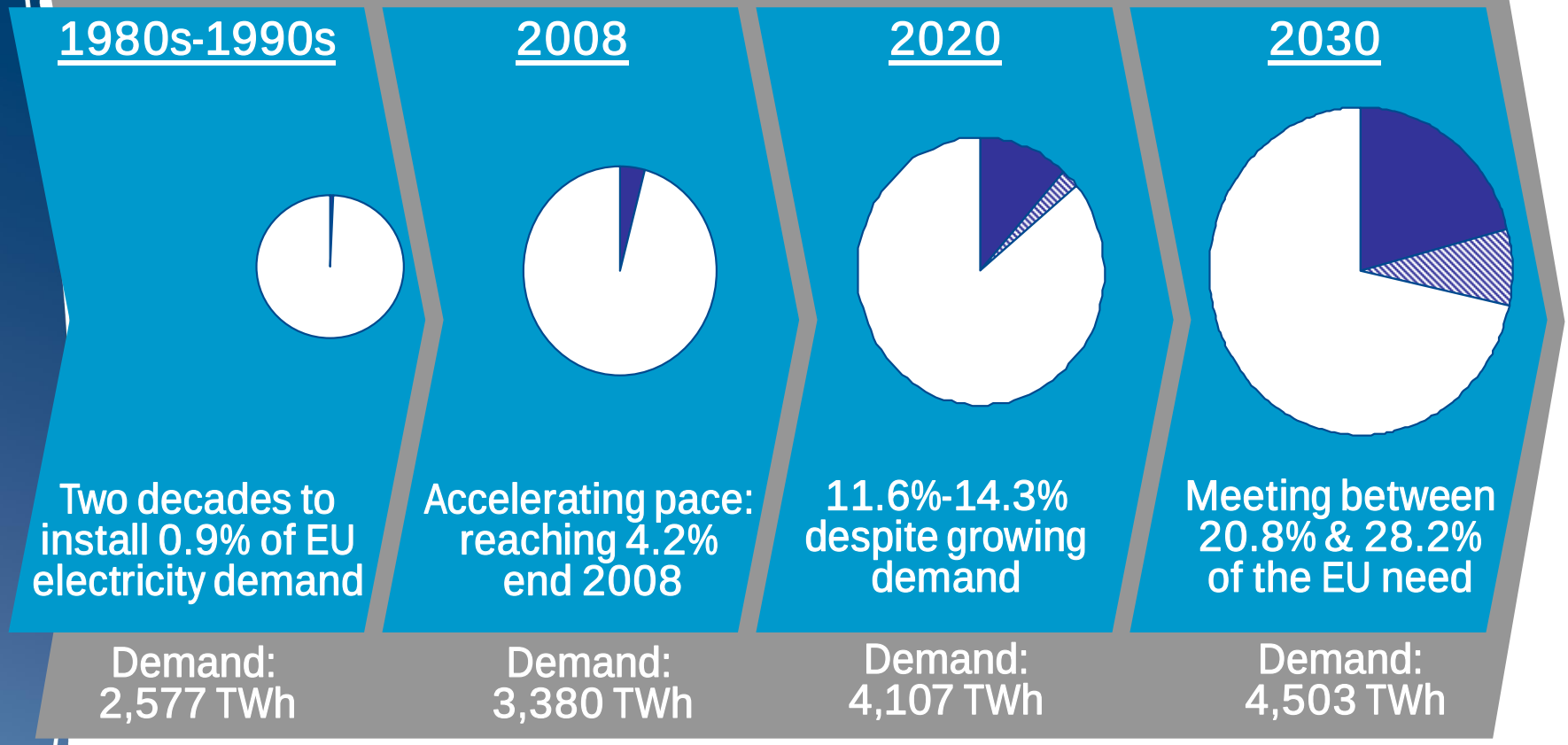
ONSHORE MARKETS ARE DEVELOPING AT THREE SPEEDS



Source: Emerging Energy Research

WIND ENERGY EXPANSION

Rising energy demand and contribution from wind power



Source: EWEA

HOW MUCH RES-E?
HOW MUCH WIND POWER?

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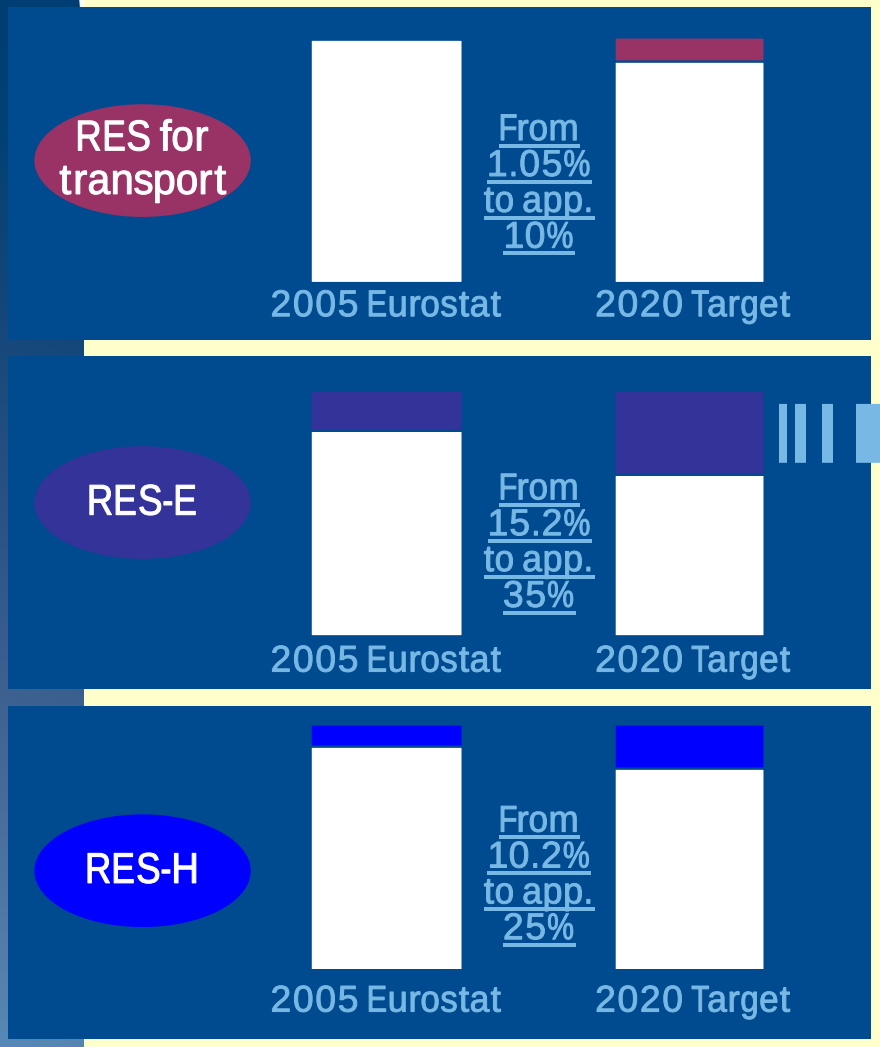
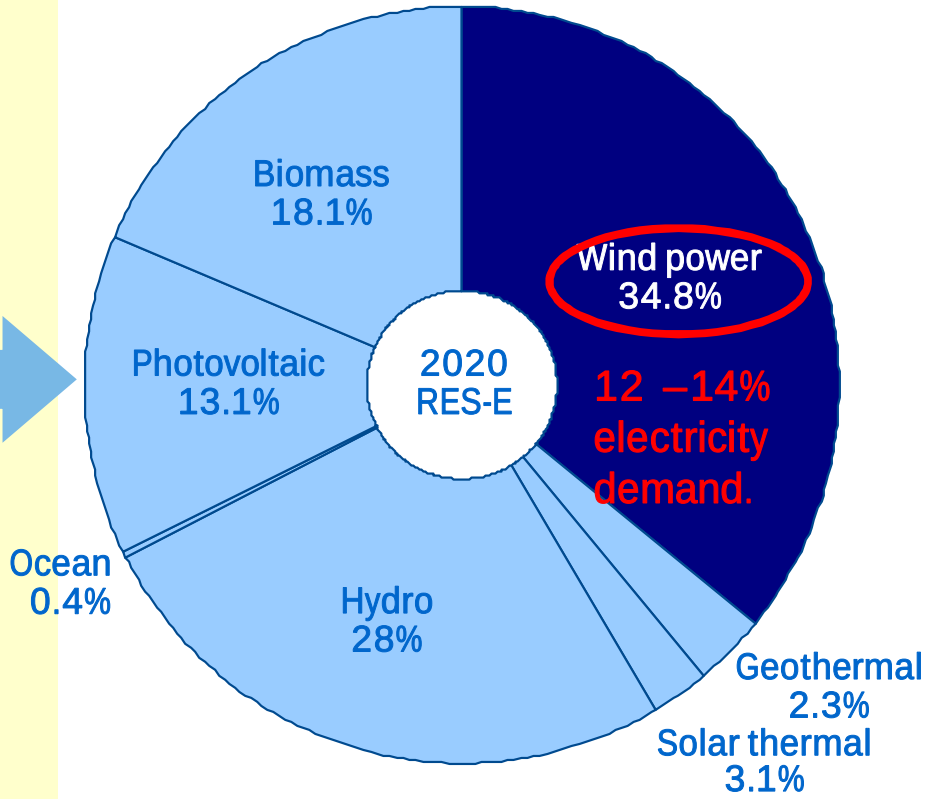
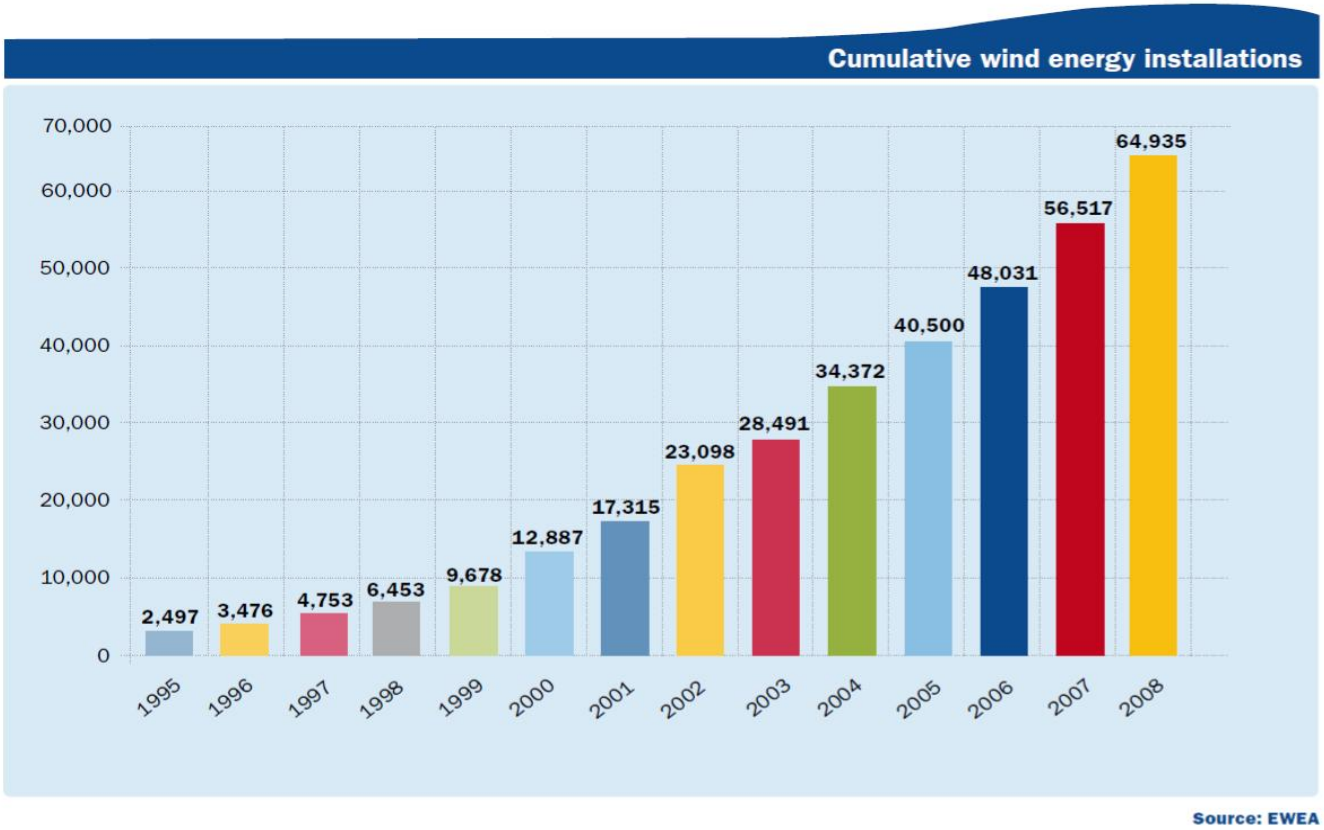
How to reach the 20% target





Source: EREC Renewable Energy Technology Roadmap –20% by 2020, November 2008 and Eurostat, EC 2007 communication

CUMULATIVE WIND ENERGY INSTALLATIONS



Source: EWEA

EUROPEAN WIND ENERGY EVENTS

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EUROPEAN
OFFSHORE WIND 2009
Conference & Exhibition
14 - 16 September, Stockholm, Sweden

- Come to this year ś offshore wind event in Stockholm (14 - 16 September 2009)
  - Over 80% of the exhibition space has already been sold.
    - 2000 participants expected
    - More information: www.eow2009.info

ewec 2010
WARSAW
Europe's premier wind energy event

- EWEAs annual event will take place in Warsaw, Poland (20 –23 April 2010).
  - More information: www.ewec2010.info

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Thank you very much for your attention

www.ewea.org

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