Wind Energy – The Facts

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European Wind Energy Association

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WHAT IS THE EUROPEAN WIND ENERGY ASSOCIATION?

EWEA is the voice of the wind industry, actively promoting the utilisation of wind power in Europe and worldwide.

Resources are focussed on lobbying, communication and policy activities, and responding to enquiries from our member organisations.
MORE THAN 600 MEMBERS FROM OVER 60 COUNTRIES

Manufacturers covering 90% of the world wind power market
Component suppliers
Research institutes
National wind and renewables associations
Developers
Electricity providers
Installation & logistics
Operation & maintenance
Finance and insurance companies
Consultants

This combined strength makes EWEA the world's largest and most powerful wind energy network
I. Technology

II. Grid Integration

III. The Economics of Wind Power

IV. Industry and Markets

V. Environment

VI. Scenarios and targets
Wind maps are a good starting point.

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

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?
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 2/3

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’s.)
Large amounts of wind power (2020, 2030 scenarios) will increase congestions in interconnectors.

Prediction errors results affect actual cross-border flow during a substantial part of the time can aggravate the congestions.
∆ Investment costs
∆ O&M costs
∆ Electricity production
∆ Average wind speed
∆ Turbine lifetime
∆ Discount rate

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

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

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

Source: EWEA 2009 report “The Economics of Wind Energy”
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 POWER: Electricity price

Wind energy reduces power price

△ 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
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
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.
Employment breakdown across sectors

- Manufacturers: 37%
- Component manufacturers: 22%
- Developers: 16%
- IPP/Utility: 9%
- Installation/Repair/Operations & maintenance: 11%
- Consultancy/Engineering: 3%
- R&D/University: 1%
- Financial/Insurance: 0.3%
- Others: 1%
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
Environmental Positive Impacts

Wind energy also offers an opportunity to practice ecological restoration:

- Changes in land management next to wind farms may benefit the creation of new vegetation and animal habitats
- Wind farms may act as refuge if hunting is not allowed within the wind farm area (new bird species appearing in the area)
- Restoration of blanket bogs, peat and wetlands – both between and around the turbines

Any impacts of wind energy should not be viewed in isolation. They should be judged against the far more serious environmental impacts of producing electricity from other energy sources.
Wind Energy – The Facts

Benefits of wind energy

Latvian wind market
EU is importing 54% of its energy...

<table>
<thead>
<tr>
<th>Resource</th>
<th>EU share of proven global reserves</th>
<th>Years of domestic production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>0.5% - 0.8%</td>
<td>7.7–7.8 years</td>
</tr>
<tr>
<td>Gas</td>
<td>1.4% - 2%</td>
<td>14.4–14.8 years</td>
</tr>
<tr>
<td>Coal</td>
<td>3.5%</td>
<td>50 years</td>
</tr>
<tr>
<td>Uranium</td>
<td>1.9%</td>
<td></td>
</tr>
</tbody>
</table>

Source: European Commission 2008
WIND LEADS THE EU POWER SECTOR

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

- Wind: 8,484 MW (36%)
- Gas: 6,932 MW (29%)
- Photo voltaic: 4,200 MW (18%)
- Fuel Oil: 2,495 MW (10%)
- Coal: 762 MW (3%)
- Hydro: 473 MW (2%)
- Biomass: 296 MW (1%)
- Other: 149 MW (1%)
- Nuclear: 60 MW (0.3%)

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

European Union: 64,935 MW
Candidate Countries: 452 MW
EFTA: 442 MW
Total Europe: 65,933 MW

Source: EWEA Wind Map 2008
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
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’s 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

Growth Markets
- Greenfield opportunity with barriers due to immaturity

Scaling Markets
- Booming high growth with steady project flow

Consolidating Markets
- Massive pipelines, saturated greenfield

Source: Emerging Energy Research
Rising energy demand and contribution from wind power

1980s-1990s: Two decades to install 0.9% of EU electricity demand
- Demand: 2,577 TWh

2008: Accelerating pace: reaching 4.2% end 2008
- Demand: 3,380 TWh

2020: 11.6%-14.3% despite growing demand
- Demand: 4,107 TWh

2030: Meeting between 20.8% & 28.2% of the EU need
- Demand: 4,503 TWh

Source: EWEA
EU 27 - WIND ENERGY ANNUAL INSTALLATION 2000-2020 (GW)

Source: EWEA
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DIFFERENTIATED NATIONAL TARGETS

- 2005 RES share
- Flat increase of 5.5%
- Additional effort based on GDP
- Adjustment for early start bonus

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Come to this year’s 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

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