European Wind Energy Technology Roadmap

Making Wind the most competitive energy source
TPWind – The European Wind Energy Technology Platform

Key data:

- Official Technology Platform
- Launched in 2007
- 150 members
- 6 working groups
- SRA / MDS published in 2008
TPWind involvement in SET-Plan process
European Wind Initiative – SET-Plan objectives (2007)

- **European Wind Initiative:** focus on **large turbines and large systems** validation and demonstration (relevant to on and off-shore applications).

- **SET-Plan - Reaching 2020 objectives**
  - Double the power generation capacity of the largest wind turbines, with off-shore wind as the lead application.
  - Enable a single, smart European electricity grid able to accommodate the **massive integration of renewable** and decentralised energy sources.

- **SET-Plan - Reaching 2050 objectives**
  - Bring the next generation of renewable energy technologies to **market competitiveness**.
EWI in 3 objectives

- To make wind energy the most competitive energy source on the market onshore in 2020, and offshore in 2030

- To enable the required large-scale deployment and grid integration of wind energy offshore and onshore with the aim of reaching wind penetration levels:
  
  20% in 2020, 33% in 2030 and 50% in 2050

- Ensuring the European technology leadership on- and offshore, and developing large offshore wind turbines:

  Including exploring concepts up to 20 MW (10-20 MW range)
EWI – Large-scale high-tech roadmap

Total installed capacity (GW)

- Offshore:
  - 200 GW (57%)
  - 150 GW (43%)
- Onshore:
  - 220 GW (43%)
  - 170 GW (35%)
  - 60 GW (12%)

- Year 2008:
  - Offshore: 6.5 GW (98%)
  - Onshore: 1.5 GW (2%)
- Year 2020:
  - Offshore: 190 GW (83%)
  - Onshore: 40 GW (17%)
- Year 2030:
  - Offshore: 200 GW (57%)
  - Onshore: 150 GW (43%)

Technology leadership
Max. competitiveness

Offshore is main market
33% of EU electricity from wind

Offshore takes off
20% of EU electricity from wind

Export from EU is strong; repowering is key market

2050: Exports from EU are strong; repowering is key market
EWI1: Wind conditions
(easing site assessment for both on and offshore wind parks)

EWI2: New generation of on and offshore wind turbines
(optimising O&M, reliability and manufacturing)

EWI3: Offshore takeoff
(ensuring offshore leadership)

EWI4: Grid integration
(enabling grid integration for on and offshore wind parks)

EWI5: Wind energy deployment
(designed economic and spatial planning instruments)

EWI6: Human Resources
(securig workforce for on and offshore deployment)

64.5 GW onshore / 1.5 GW offshore

High competitiveness / High penetration levels / Technology leadership
Impact of the Wind Industrial Initiative:

- Fully competitive wind power generation

- Capable of contributing up to 20% of EU electricity by 2020 and as much as 33% by 2030

- More than 250 000 skilled jobs could be created.
Technology roadmap SEC(2009) 1295

- **Strategic objective**
  - To improve the *competitiveness* of wind energy technologies, to enable the exploitation of the offshore resources and deep waters potential, and to facilitate grid integration of wind power.

- **Industrial sector objective**
  - To enable a *20%* share of wind energy in the final EU electricity consumption by 2020.
Technology roadmap

SEC(2009) 1295
New turbines and components - Objectives

- New turbines and components to lower investment, operation and maintenance costs
  - To develop large scale turbines in the range of 10 - 20 MW especially for offshore applications.
  - To improve the reliability of the wind turbine components through the use of new materials, advanced rotor designs, control and monitoring systems.
  - To further automate and optimise manufacturing processes such as blade manufacturing through cross industrial cooperation with automotive, maritime and civil aerospace.
  - To develop innovative logistics including transport and erection techniques, in particular in remote, weather hostile sites.
New turbines and components - Actions

New turbines and components to lower investment, operation and maintenance costs:

- A R&D programme focused on new turbine designs, materials and components addressing on- and offshore applications coupled with a demonstration programme dedicated to the development and testing of a large scale turbine prototype (10-20MW).

- A network of 5-10 European testing facilities to test and assess efficiency and reliability of wind turbine systems.

- An EU cross-industrial cooperation and demonstration programme drawing upon the know-how from other industrial sectors (e.g. offshore exploration) for mass production of wind systems focused on increased component and system reliability, advanced manufacturing techniques, and offshore turbines. A set of 5 – 10 demonstration projects testing the production of the next generation of turbines and components will be carried out.
Offshore Technology - Objectives

- Offshore technology with a focus on structures for large-scale turbines and deep waters (> 30 m).
  - To develop new stackable, replicable and standardised substructures for large scale offshore turbines such as: tripods, quadropods, jackets and gravity-based structures.
  - To develop floating structures with platforms, floating tripods, or single anchored turbine.
  - To develop manufacturing processes and procedures for mass-production of substructures.
Offshore Technology - Actions

- Offshore technology with a focus on structures for large-scale turbines and deep waters (> 30 m).

  - A development and demonstration programme for new structures distant from shore aiming at lower visual impact and at different water depths (>30m).

  - At least 4 structure concepts should be developed and tested under different conditions.

  - A demonstration programme on advanced mass-manufacturing processes of offshore structures.
Grid integration - Objectives

- Grid integration techniques for large-scale penetration of variable electricity supply.

  - To demonstrate the feasibility of balancing power systems with high share of wind power using large-scale storage systems and High Voltage Alternative Current (HVAC) or High Voltage Direct Current (HVDC) interconnections.

  - To investigate wind farms management as “virtual power plants".
Grid integration - Actions

A programme focused on wind farms management as “virtual power plants” to demonstrate at the industrial-scale:

- Offshore wind farms interconnected to at least two countries and combined with the use of different grid interconnection techniques.

- Long distance High Voltage Direct Current.

- Controllable multi-terminal offshore solutions with multiple converters and cable suppliers.

A virtual power plant is a cluster of distributed generation installations which are collectively run by a central control entity in order to increase the system flexibility (including with the support of existing storage systems) and to make the best of available potential (spatial smoothing).
Resource assessment & spatial planning - Objectives

- Resource assessment and spatial planning to support wind energy deployment.
  - To assess and map wind resources across Europe and to reduce forecasting uncertainties of wind energy production.
  - To develop spatial planning methodologies and tools taking into account environmental and social aspects.
  - To address and analyse social acceptance of wind energy projects including promotion of best practices.
A R&D programme for forecasting distribution of wind speeds and energy production that includes:

- **Wind measurement campaigns.**
- **Database** on wind data, environmental and other constrains.
- **Spatial planning tools** and methodologies for improved designs and production.
R&D Programme focused on new turbines designs and use of new materials

Development & testing of a large scale turbine prototype (10 - 20 MW)

Implementation of testing facilities and demo for new turbines, components, manufacturing processes

Demonstration of a optimised logistic strategy

5 Testing facilities and 5 demo

Implementation of 5 additional testing facilities and 5 demo

Standardised harbours to service the next generation of wind turbine

Development & testing of new structures

Demonstration of mass manufacturing processes and procedure for structures

4 prototypes of new structures

Offshore structures

Demonstration with wind farm as virtual power plant:
- Demonstration of long distance HVDC
- Offshore flexibility connection to at least 2 countries
- Demonstration of multi terminal offshore solutions

Two operational sites

Grid integration

Resource Assessment and Spatial Planning

Wind resources assessment: 5-10 measurement campaigns

Statistical forecast distribution on wind speed and energy production

EU spatial Planning implemented

Publication of an EU 27 MS Wind Atlas

Results of the public acceptance analysis
## EWI / Wind Roadmap – 75 % match

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<th>EWI component</th>
<th>EWI Action</th>
<th>Roadmap</th>
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<td><strong>New generation of on and offshore turbines</strong></td>
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<td>Industry-led full-scale European demonstration activities</td>
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<td>Cross-industrial cooperation and demonstration program</td>
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<td><strong>Offshore takeoff</strong></td>
<td><strong>Development of offshore access vessels, and best practices</strong></td>
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<td>Automated manufacturing of steel and concrete substructures of varying designs</td>
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<td>Sponsorship of demonstration programmes to test innovations in offshore technology</td>
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<td><strong>Development of onshore facilities supporting offshore deployment</strong></td>
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<td>Strong coordination with the offshore oil &amp; gas service sector</td>
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<td><strong>Grid Integration</strong></td>
<td>Grid management solutions</td>
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<td><strong>Long-term planning</strong></td>
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<td>New grid technology solutions</td>
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<td>Social acceptance of wind energy projects</td>
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<td><strong>Human Resources</strong></td>
<td>A European training institute</td>
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*Note: The Roadmap column contains smiley faces representing the progress status.*
Missing elements

- **Grid planning** – coordination with the European Grid Initiative
- **Training** – coordination with the European Energy Research Alliance and the European Institute of Technology
- **Missing:**
  - Offshore access vessels, and best practices
  - Onshore facilities supporting offshore deployment
Indicative costs (2010-2020)

“The overall breakdown of non-nuclear energy research financing in 2007 was 70% private to 30% public. Given the public policy-driven nature of the energy transition and the current economic situation, a significant rise in the public share of the burden in the short term towards a more equal level of commitment would have to be explored.” COM(2009) 519 final.

<table>
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<th>Technology objectives</th>
<th>Costs (M€)</th>
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<td>1. New turbines and components</td>
<td>2 500</td>
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<td>2. Offshore structure-related technologies</td>
<td>1 200</td>
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<tr>
<td>3. Grid integration</td>
<td>2 100</td>
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<tr>
<td>4. Resource assessment and spatial planning</td>
<td>200</td>
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<td>Total</td>
<td>6 000</td>
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  - Industry 292 M€ (76%)
  - Public 91 M€ (24%)

- **SET-Plan 600 M€/y**

- 4 policy options are compared:
  - No action – BAU (business as usual)
  - Increased funding channeled through the existing investment vehicles
  - A strengthening of the existing investment vehicles within modified institutional arrangements / specific mandate for the EIB to invest in infrastructural funds / using the Capacity Building Scheme
  - New investment vehicles

- Possible sources of funding:
  - ETS system from 2013 onwards, ETS NER, EEPR
  - Research Framework Programmes
  - CIP High Growth and Innovative SME Facility (GIF)
  - EIB: RSFF, Marguerite fund, a new “efficiency and renewables” instrument