“Engineering Education going global: academic networking and international cooperation to face grand challenges on renewable (wind) energy resources”

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1. The globalisation of EE

2. Best practices in the field of Academic Networking: some exemples

3. Next challenges in EE
World Engineers’ Convention 2011
Geneva, 4-9 September 2011

4. **20-20-20, TPWind, EWI-SET Plan and other EU targets**

5. **On & Off-Shore installed and planned wind power**

6. **On & Off-Shore technologies; other future grand challenges**
1. Why a globalisation of Engineering Education?
Because a fast changing world needs a flexible, responding and fast changing Education
Because the voice of European Education will gain weight if we take profit of networking efforts.
Because Universities must look for a deeper and more stable collaboration with non Academic partners
2. The value of EC supported cooperation projects
EUGENE
EUropean and Global ENgineering Education

an LLP-ACADEMIC Network
(2009 – 2011)

Supported by DG EAC of the European Commission
LLP Academic Networks are designed to promote innovation in a specific discipline, set of disciplines or multidisciplinary area, e.g.: law, literature, economics, etc.

EUGENE’s main goal is to improve the impact of EEE on competitiveness, innovation and socio-economic growth in a global context.

Overall aim: Setting–up a top-level “discussion & action” forum to follow the continuous evolution of EE in Europe and enhance its competitive profile worldwide (opening the borders)
The EUR-ACE® accreditation system and its implementation
The EUR-ACE accreditation system was envisaged by the EU-supported EUR-ACE project (2004-06) to make up for the lack of a European accreditation system of engineering education accepted on the continental scale.

To implement the EUR-ACE system, the European Network for Accreditation of Engineering Education (ENAEES) www.enaeee.eu was founded in February 2006 by 14 concerned Associations. ENAEES secretariat is permanently hosted by FEANI
3. Mission accomplished? Not quite ... and not entirely yet
Next challenges of Education (in Engineering and Technology)

(a) widening the concept of employment

(b) ensuring financial services and access to education and technology to the poorest person

(c) recognising every single human being as a potential entrepreneur

(d) recognising technology entrepreneurs as potential agents for creating a better world
Next challenges of EE (contnd)

(e) recognising the role of globalisation and (education in) technology in reducing poverty (information technology, etc.; cfr. M. Yunus’ Commonwealth speech, 2004)

(f) Educating future generations of engineers with competences in sustainable development, environmental issues, interdisciplinary attitudes, cross-disciplinary skills, and recognising ...

... RENEWABLE ENERGY ISSUES AS A KEY SECTOR FOR INNOVATION IN EE
Next challenges of EE (contnd)

EDUCATING ENGINEERS IN RENEWABLE ENERGY ISSUES ...

- Wind, sun, water, etc have no geographical boundaries: transnational/regional policies are needed (also in educational matters)

- By all renewable energy sources, new technologies with high inter- and trans-disciplinary content are arising: upgrading of present curricula strongly required

- The renewable Energy puzzle: the grid absorption (smart grids, optimisation of power distribution lines, EU energy mix, etc.)

- New Energy balance between continents: the role of Africa (s. DESERTECH project)
Next challenges of EE
(contnd)

EDUCATING ENGINEERS IN RENEWABLE ENERGY ISSUES ...

- a new role of Ph D studies/degrees in renewable Energy issues at INTERNATIONAL level, mainly through a ...

- new role of industry within the puzzling dilemma: market competitiveness vs. research in public institutions

- industry-university cooperation in Ph D studies, innovation strategy to avoid isolation of the sector from the scientific world

- upgrading curricula for match the very fast developments going on ....
Next challenges of EE (contnd)

EDUCATING ENGINEERS IN RENEWABLE ENERGY ISSUES ...

- and therefore, eventually:

THE MAIN QUESTION FOR EE ...

“How can education in Science and Technology help to reduce poverty, to boost socio-economic development and to take the right decisions for a sustainable and environmentally compatible development?”
IFEES – The International Federation of Engineering Education Societies

www.ifees.net
4. 20-20-20, TPWind, SET Plan and other EU targets
TPWind Structure - Overview
R&D is not the only issue to be considered in the development of wind energy!
European Wind Energy Technology Platform

EWI – The European Wind Initiative

....... Delivering today the energy of tomorrow
European Industrial Initiatives - EII

- **SET Plan - COM(2007) 723 final:**
  
  “The European Industrial Initiatives will be implemented in different ways, depending on the nature and needs of the sector and the technologies. ... The European Technology Platforms will assist in the preparation phase.”

- EII are one component of the Strategic Energy Technology Plan:
  - Proposed by the European Commission in October 2007
  - Endorsed by the Council and Parliament in March 2008

- Six EII were proposed: Wind, Solar, Bio-energy, CCS, electricity grid, nuclear fission.
EWI – focus and objectives

4. 20-20-20, TPWind, SET Plan and other EU targets

6. On & Off-Shore technologies
## European Wind Initiative – SET-Plan objectives

### 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.

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4. 20-20-20, TPWind, SET Plan and other EU targets

6. On & Off-Shore technologies
EWI – objectives

To make wind energy the most competitive energy source on the market during the decade 2020-2030, and as a first step decreasing the wind energy costs by at least 20% by 2020.

To enable the required large-scale deployment and grid integration of wind energy offshore and onshore with the aim of reaching wind penetration levels beyond 20% of European electricity consumption in the early 2020’s.

Ensuring the European technology leadership on- and offshore, and developing large offshore wind turbines, including exploring concepts up to 20 MW.
World Engineers’ Convention 2011  
Geneva, 4-9 September 2011

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  
-designing economic and spatial planning instruments)

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

64.5 GW onshore / 1.5 GW offshore

4. 20-20-20, TPWind, SET Plan and other EU targets

6. On & Off-Shore technologies

High competitiveness / High penetration levels / Technology leadership
**4. 20-20-20, TPWind, SET Plan and other EU targets**

**6. On & Off-Shore technologies**

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**Total installed capacity (GW)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Offshore</th>
<th>Onshore</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>1.5 GW</td>
<td>64.5 GW</td>
</tr>
<tr>
<td>2020</td>
<td>40 GW</td>
<td>190 GW</td>
</tr>
<tr>
<td>2030</td>
<td>120 GW</td>
<td>180 GW</td>
</tr>
</tbody>
</table>

- **2030: Exports from EU are strong; repowering is key market**
- **Offshore is main market: 25% of EU electricity**
- **Offshore takes off: >18% of EU electricity**

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**Technology leadership**

**Max. competitiveness**

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*World Engineers’ Convention 2011*

*Geneva, 4-9 September 2011*
Short term targets: within 2020 to reduce the greenhouse gas emission by 20% and ensure 20% of renewable energy sources in the EU.

Long term targets: decarbonization. To reduce by 60–80% the greenhouse gas emission.

To meet the 2020 targets, among many other research lines, for the EC it is imperative to:

**Double the power generation capacity of the largest wind turbines, with offshore wind as the lead application**
World Engineers’ Convention 2011
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INSTALLED AND PLANNED WIND POWER

Wind now leads EU power sector

**New power capacity installed in 2008**

Source: EWEA and Platts Power Vision

Total: 23,851 MW

- Wind: 8,484 MW
- Gas: 6,932 MW
- Photovoltaic: 4,200** MW
- Fuel Oil: 2,495 MW
- Coal: 762 MW
- Hydro: 473 MW
- Biomass: 296 MW
- Other*: 149 MW
- Nuclear: 60 MW

* Geothermal, peat and waste
** This is a preliminary figure for solar photovoltaic installations (source: European Photovoltaic Industry Association (EPIA)).
## INSTALLED AND PLANNED WIND POWER

### Wind power capacity in 2008

<table>
<thead>
<tr>
<th></th>
<th>Installed in 2008 [MW]</th>
<th>End 2008 (cumulative) [MW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total EU-27</td>
<td>8484</td>
<td>64935</td>
</tr>
<tr>
<td>Of which Offshore</td>
<td>357</td>
<td>1471</td>
</tr>
</tbody>
</table>

65 GW satisfies 4.2% EU electricity demand!
World Engineers’ Convention 2011
Geneva, 4-9 September 2011

INSTALLED AND PLANNED WIND POWER

State by State Capacity

Wind power installed in Europe by end of 2008 (cumulative)

- GERMANY: 23.9 GW
- SPAIN: 3.2 GW
- ITALY: 3.74 GW
- FRANCE: 3.40 GW
- UK: 3.2 GW

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

4. 20-20-20, TPWind, SET Plan and other EU targets

6. On & Off-Shore technologies
In March 2009 the EWEA target for total installations by 2020 has been increased from **180 GW** to **230 GW**, of which **40 GW** will be offshore.

This would mean **14-18% of the EU electricity demand (60% of EU households)**.
INSTALLED AND PLANNED WIND POWER

**Operational offshore wind farms**

- **United Kingdom**: 39% - 590.80 MW
- **Denmark**: 28% - 409.15 MW
- **Netherlands**: 17% - 246.80 MW
- **Sweden**: 9% - 133.30 MW
- **Belgium**: 2% - 30.00 MW
- **Ireland**: 1% - 25.20 MW
- **Finland**: 2% - 24.00 MW
- **Germany**: 1% - 12.00 MW

**TOTAL**: 1,471.33 MW

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**4.** 20-20-20, TPWind, SET Plan and other EU targets

**6.** On & Off-Shore technologies

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**Offshore at the end 2008**
It should be installed:

- 3.5 GW by 2010,
- 35 GW by 2020;
- 120 GW by 2030;
More than 10% of total demand within 2030. (ref ch. 3 SRA)

2030 Priorities:

**Offshore Wind Power Meteorology:**
- Development of a fully integrated wind/waves/current interaction models

**Substructures: (25% of the whole offshore investment!)
- Development of new substructure concepts
- Develop improved designs to extend the life of structures, to reduce costs and to incorporate risk based life–cycle approaches.**

*Consider: forces (and somehow costs) increase by the square of wind/water velocity!!*
Figura 1 Top wind energy producing countries at 31.12.2010

Worldwide: 194,390 MW  Europe: 84,074 MW

- China: 42,287 MW
- USA: 40,180 MW
- Germany: 27,214 MW
- Spain: 20,676 MW
- India: 13,065 MW
- Italy: 5,797 MW
- France: 5,660 MW
- UK: 5,204 MW
- Denmark: 3,752 MW
- Portugal: 3,702 MW
Fig. 2: Distribution by continents of wind power generation (2003-2010)

Source: GWEC

4. 20-20-20, TPWind, SET Plan and other EU targets

6. On & Off-Shore technologies
POTENTIAL

The European onshore potential

Minimum cost-effective wind speed = 4 m/s

POTENTIAL

The European offshore potential

Wind resources over open sea (more than 10 km offshore) for five standard heights

<table>
<thead>
<tr>
<th>Height (m)</th>
<th>10 m</th>
<th>25 m</th>
<th>50 m</th>
<th>100 m</th>
<th>200 m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m/s²</td>
<td>m/s²</td>
<td>m/s²</td>
<td>m/s²</td>
<td>m/s²</td>
</tr>
<tr>
<td>10 m</td>
<td>&gt; 8.0</td>
<td>&gt; 700</td>
<td>&gt; 9.0</td>
<td>&gt; 10.0</td>
<td>&gt; 1100</td>
</tr>
<tr>
<td></td>
<td>7.0-8.0</td>
<td>7.5-8.5</td>
<td>8.0-9.0</td>
<td>8.5-10.0</td>
<td>9.5-11.0</td>
</tr>
<tr>
<td></td>
<td>6.0-7.0</td>
<td>6.5-7.5</td>
<td>7.0-8.0</td>
<td>7.5-8.5</td>
<td>8.0-9.5</td>
</tr>
<tr>
<td></td>
<td>4.5-6.0</td>
<td>5.0-6.5</td>
<td>5.5-7.0</td>
<td>6.0-7.5</td>
<td>6.5-8.0</td>
</tr>
<tr>
<td></td>
<td>&lt; 4.5</td>
<td>&lt; 100</td>
<td>&lt; 5.0</td>
<td>&lt; 6.0</td>
<td>&lt; 6.5</td>
</tr>
</tbody>
</table>

Minimum cost-effective wind speed = 4 m/s

TECHNOLOGIES

The technological challenge

A (offshore) wind turbine is a very sophisticated system, combination of components and sub-systems that have to be designed in an interdisciplinary and integrated manner. In addition, the size and complexity of wind turbines is increasing rapidly over time:
TECHNOLOGIES

From onshore to the deep ocean

- The monopile substructure technology is limited to water depth up to 30m.
- w.d. > 30 m = deep water
- Fixed-bottom substructure technologies (e.g. tripod) are limited to water depth up to about 80m.
- For w.d. > 40 m floating supports necessary.
TECHNOLOGIES

Several types of floating systems

Source: NREL

The floating technology seems to be the leading solution as deep waters represent a promising resource for many countries, e.g. Italy, US.

This makes fundamental further investigations on the best technology to be adopted!

(See “Blue H” and “Hydro” prototypes)

4.  20-20-20, TPWind, SET Plan and other EU targets

5. On & Off-Shore: Installed and planned wind power
4. 20-20-20, TPWind, SET Plan and other EU targets

5. On & Off-Shore: Installed and planned wind power

- The water depth achievable depends on the substructure type;
- Substructure is ca 25% of the whole cost!
4. 20-20-20, TPWind, SET Plan and other EU targets

5. On & Off-Shore: Installed and planned wind power

TECHNOLOGIES

More terminology

6. On & Off-Shore technologies: the present (or is it already the past?)
6. On & Off-Shore technologies: the present (or is it already the past?)
1. INTRODUCTION

2. WIND FLOW ON SOLAR UPDRAFT TOWERS

3. WIND TUNNEL INVESTIGATION

4. FUTURE OUTLOOKS

6. Other technologies: grand challenges for the future?
Non-conventional wind loading on ultra-high towers in Solar Updraft Power Plants

Dipl.-Ing. Francesca Lupi, Università degli Studi di Firenze
Prof. Dr.-Ing. Claudio Borri, Università degli Studi di Firenze
Prof. Dr.-Ing. Hans-Jürgen Niemann, Ruhr-Universität Bochum
WORKING PRINCIPLE

Solar Updraft Towers
FROM COOLING TOWERS TO SOLAR UPDRAFT POWER PLANTS

ICWE13
Amsterdam, The Netherlands
ANSWERING THE MAIN INITIAL QUESTION ...

“ How can education in Science and Technology help to reduce poverty, to boost socio-economic development and to take the right decisions for a sustainable and environmentally compatible development ?”

... Let us attract and gain future generations of engineers to dream with us of a clean, sustainable and technologically advanced environment for creating a better world to live in.

All this is possible just NOW.
Thank you for your kind attention

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