EUA-EPUE
European Platform of Universities in Energy Research & Education

23 November 2015

Response to SET-Plan consultation: Initiative for Global Leadership in Offshore Wind

Introduction

This "Input Paper" is a response of the European Platform of Universities in Energy Research & Education (EUA-EPUE) to the invitation of the European Commission to contribute to the consultative process on the European Strategic Energy Technology Plan (SET Plan).

EUA-EPUE responds to the consultation from the perspective of the universities' role in society. Universities constitute a significant part of the research capacity in Europe. At the same time, they educate the highly skilled work force of our societies. It therefore seems important to mobilise the capacity of Europe's universities to contribute to successful implementation of the SET Plan.

In this light, EUA-EPUE wants to emphasise that the long-term goal of technological leadership should not only focus on high-TRL, close-to-market technologies. It also requires **sustainable support for next generation technologies made available through fundamental research, including "use-inspired basic research"**.[1] Similarly, the goal demands the **development of a highly skilled workforce** capable to sustain innovation and technological leadership in the long run. The availability of highly skilled professionals is bound to be a limiting factor for how well Europe can position itself in the global energy market.

According to the OECD, "Countries should step up their investment in long-term R&D to develop frontier technologies that will reshape industry, healthcare and communications and provide urgently needed solutions to global challenges like climate change."[2] Both the IEA and the IPCC also state a clear need for a paradigm shift in renewable energy, which also calls for supporting research that has a longer time horizon to the market, but is use-oriented towards renewable energy.

The UNI-SET project's survey of activities at universities show that many universities, in particular the technology universities engage with industry and research institutes in applied research for technology development. Integration of education with innovation oriented applied research is a very effective way of disseminating new research knowledge, and converting it into industrial innovation. Experience shows that disruptive innovations often come from young innovators, we see that the world's innovation hotspots are fuelled by talented students. It seems that Europe is not as effective as the US in exploiting the innovation potential of young graduates.

We consider therefore that setting up the SET Plan projects with ensured integration of innovative research with education, including industrial partners, will provide a high pay-off towards achieving the energy system transition that is the objective of the SET plan.

In the SET-Plan process, universities have contributed to the SET-Plan Education & Training and the SET-Plan Integrated Roadmap initiatives. EUA-EPUE is now taking forward this commitment with the UNI-SET project, an FP7 Coordination & Support Action aiming to mobilise the university sector in the SET-Plan process and the Energy Union (http://www.uni-set.eu/).

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[1] A term coined by Donald Stokes in "Pasteur's Quadrant – Basic Science and Technological Innovation", Brookings Institution Press, 1997

[2] See OECD "Governments must step up R&D in frontier technology", press release available at http://www.oecd.org/newsroom/governments-must-step-up-rd-in-frontier-technology.htm, full report "OECD Science, Technology and Industry Scoreboard 2015" is available at http://www.oecd.org/science/oecd-science-technology-and-industry-scoreboard-20725345.htm (links accessed 16/11/2015).

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23 November 2015

This is our main input concerning the stakeholder groupings and areas of cooperation for the implementation process.

Offshore wind energy

Targets

Harvesting wind energy offshore will be an important contribution to the world's energy supply. The oceans have relatively stable wind conditions, boding for high efficiency factors, and offer large areas where wind turbines can be located with less interference with other activity than can often be the case with land-based installations.

The state-of-art technology for offshore wind energy today has a significantly higher cost than competing technologies. The installed base worldwide is small, due to the fact that in today's situation it is not commercially competitive. Therefore, the stated ambitious cost reduction targets are required to achieve more market uptake.

The levelised cost of energy (LCoE) target cannot be met by research alone. Significant cost reduction requires industry to invest in larger scale deployment. Several of the means for cost reduction mentioned in the issue paper are driven to a large extent by scale. Well known industrial learning processes leading to reduced cost kick into action when the activity scales up, this has been shown in other areas of renewable energy, solar PV and on-shore wind being two good cases.

The combination of an ambitious research agenda, and active political measures to incentivise deployment can lead to success in reaching the cost targets.

The use of the LCoE metric

The LCoE as a measure of merit must be used with caution. It expresses a static life cycle energy cost, based on a set of assumptions. The cost of a field development will depend much on location properties, distance to the field, water depth, and cost level of the region/country. A field developer's decision criterion must be based on what he can expect to fetch from the market delivering the energy with the variability characteristics of his technology the location. This depends also on the mix of energy supply sources that are constituting the energy system he operates in.

To move the technology development forward, and contribute to European industrial leadership we need to prioritise research towards objectives that produces transferable enabling cost reducing technologies. The relative cost reduction to a significant cost element in the total operation therefore seems to be a relevant evaluation criterion for prioritising research.

It is the intrinsic competitiveness of the technical solutions, and the experience embedded in the industrial base that will determine the global competitiveness of European industry.

The observed LCoE may be suited to measure the competitive position of offshore wind relative to other energy sources in the overall European energy market. But it is not particularly well suited alone as an assessment criterion for investment decisions, or for prioritising research actions.

Reliability

Risk reduction is extremely important for investing in offshore wind technology, so increased reliability, and a high and stable capacity factor is important for investment to take place, so the target formulated on reliability and capacity factor is very important for technology uptake.

Gaps

One of the most important barriers against large scale deployment of 10-15 MW offshore wind energy facilities besides the noncompetitive cost level, is the related lack of technological verification of 10-15 MW turbine/substructure assemblies for offshore use. Reliable industrial design methods for large offshore wind turbines, in particular for floating turbines are lacking. One hurdle is that there is no verified analysis methods to perform integrated dynamic analysis of the whole turbine/substructure assembly on this scale.
Data from laboratory scale experiments are not sufficient to verify design models, data from larger scale field installations than exist now, are required. At the moment, data from a few existing large scale installation of floating turbines are mostly treated as proprietary by the developers. The lack of publicly available data is limiting the unleashing of a larger research community to engage in the development of improved concepts that can be installed under acceptable risk for the investor.

The European Academy of Wind Energy (eawe)

The **eawe** (http://www.eawe.eu/) is a registered body of research institutions and universities in Europe working on wind energy research and development: a vital academic, research community to keep Europe in the world forefront of wind energy pre-competitive innovation. This is an example of a network which is engaging in long term research, to fill the basic knowledge gaps and remove barriers that can enable paradigm shifts for wind energy technology. They work to spread excellence through joint international education and training activities, and is an example of a grouping that addresses the long term use-inspired research that is needed in addition to the close to market research to get wind energy deployed in the nearer future.

COMMENTS ON ACTIONS

In the following, the actions are commented on with reference to those give in the Integrated Roadmap, by detailing the description of some items, but primarily by adding features that are not explicitly mentioned. These comments represent our inputs on R&I activities that should be considered.

The reference is the SET-plan; i.e. the reference for the targets is Key issues and for the gaps the actions under the following research and development areas:

- Advanced research programme (ARP)
- Industrial research and demonstration programme (IRDP)
- Innovation and market-uptake programme (IMUP)

Comments on ARP – Action 1

- Develop novel design of rotors, drivetrains, control systems, tower (and support structure – see IRDP – Action 1). It is important in this connection also to devote efforts to "revolutionary" (high risk/high reward) innovation.
- Besides larger rotors, 2 vs. 3 blades, Vertical vs. Horizontal axis rotors, down vs. upwind rotors should be considered
- Develop control procedures to increase power capture as well as reduced extreme and fatigue loads should be addressed by better inflow wind measurements, independent blade control, use of actively/passively controlled blade flaps, improved fault tolerant control
- Improve reliability of geared and direct as well as hybrid drive trains by design by first principles and model based monitoring and maintenance (including focused life cycle assessment of drive trains for floating wind turbines)
- Introduce new materials, less use of rare earth materials, in power electronics
- Develop and validate comprehensive simulation tools for integrated dynamic analysis of wind turbine systems – with respect to estimating the power production and system integrity management. This implies account of
    - aero-, hydro-, servo-elastic features
    - possible faults

  in order to provide load effects for design based on first principles of the total wind turbine system.
  (Simulation tools also need to be developed for the farm level – based on simplified models of each wind turbine – which are calibrated based on the refined models of the wind turbines).
- Develop reliability and risk based standards and certification procedures
- Establish model test and field demonstration facilities to test functionality and safety. Demonstration facilities are especially needed for floating wind turbines – to test functionality, fault tolerance
- Systematic collection of operational data – relating to power production, faults – and establishment of a data basis by joint efforts between operators, regulators, and research organisations.
- Develop best practice for model-based monitoring/inspection, maintenance and repair
    - Develop health monitoring methods, based on novel sensors/devices especially for drivetrain
- Assess uncertainties in data and methods to establish a rational basis for life cycle decision during design and operation under uncertainties (e.g. based on reliability and risk analysis methodology).

Comments on ARP – Action 2

Environmental conditions are needed to estimate wind resources as well as a basis for assessing the system integrity; and planning installation and operations.

- Improve met-ocean data basis and methods for hind-/forecasting environmental conditions on four spatial scales
  - Turbine scale (i.e. relating to wind shear, turbulence at large heights)
  - Micro siting and array scale
  - Mesoscale processes
  - Climate effects

  and the following temporal scales
  - seconds (relating to measurement of the wind speed as a basis for operational control)
  - min/hours
  - months (seasons) and years (for design and operations planning/siting)
- Establish best practice for measurements of met-ocean conditions
  - use of new measurement techniques (LIDAR, SODAR)
- Establish a condensed data basis for met-ocean conditions in terms of joint probability density functions of wave, wind and possibly current parameters

Other conditions: temperature, bathymetry, soil conditions

Comments on IRDP – Action 1

- Develop novel support structures – bottom fixed and floating – to accommodate larger and possibly other types of rotors (two-bladed or vertical axis etc.)
- Develop mooring systems for floating systems for shallow water depths.
- Develop drivetrains for floating systems
- Demonstrate functionality and safety (e.g. with respect to faults) for floating systems
- Improve standards and certification (challenging because of limited experiences with floating systems)

Comments on IRDP – Action 2

- Establish cost-efficient methods for assembling and installing offshore wind turbines – i.e. methods that increase the weather window
- Develop criteria for critical events (contact, motions etc.) during marine (lifting..) operations and methods to predict the behaviour during such operations
- Develop novel vessels for transport/installation – not only management of the operations
- Improve manufacturing/fabrication, especially of unique wind turbine systems components
- Increase efficiency/reduce costs of (mass) fabrication of support structures e.g. by using robotics and simpler designs to facilitate robotics operations
- Develop innovative technologies for maintenance, inspection and access (for inspectors, repair, replacements etc.)
- Optimize logistics in the life cycle (manufacturing, transport, assembly, construction, installation
- Develop aftermarket technologies, upgrading for reuse.

23 November 2015

Comments on IMUP – Action 1

- Develop wind farm design tool
- Develop advanced grid control system
- Develop tools for optimizing grid architecture and integration

Comments on IMUP – Action 2

- Develop understanding of the socio-economics of offshore wind farms
- Evaluate the potential competitive use of the ocean space; e.g.
  - Aquaculture, fisheries
  - Maritime shipping
  - Wave energy production

  and how multiple use of the oceans can be facilitated
- Develop better tools for siting and risk assessment
- Provide information to different stakeholders about wind power impacts and benefits to improve the public understanding
- Foster cooperation regarding R&D, standardization, policy developments within and outside the European Union

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