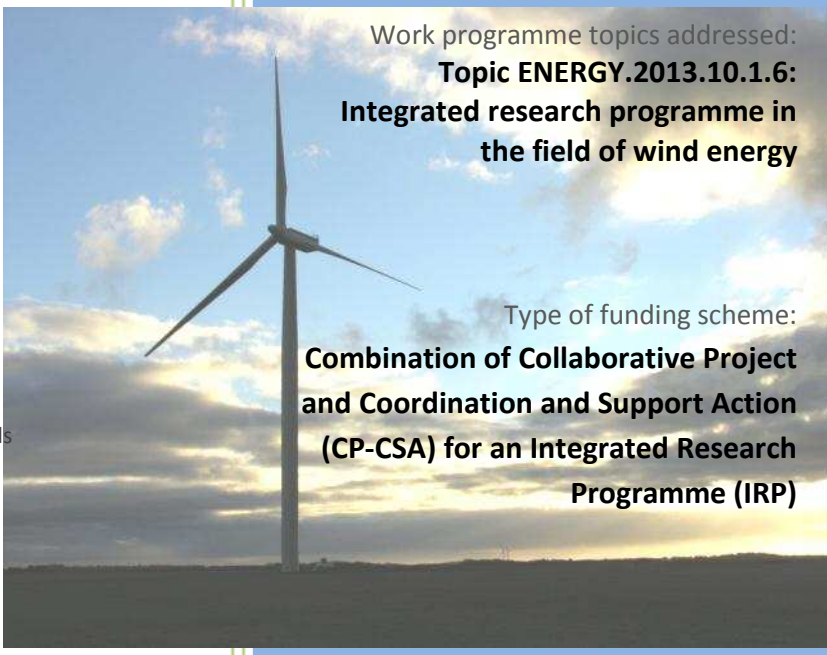
Proposal full title:

Integrated Research Programme on Wind Energy

Proposal acronym:

IRPWIND



Work programme topics addressed:

Topic ENERGY.2013.10.1.6: Integrated research programme in the field of wind energy

Type of funding scheme:

Combination of Collaborative Project and Coordination and Support Action (CP-CSA) for an Integrated Research Programme (IRP)

List of participants

Participant number	Participant organisation name	Country
1. Coordinator	**DTU Wind Energy -** Technical University of Denmark	Denmark
2.	**CRES** - Centre for Renewable Energy Sources and Saving	Greece
3.	**ECN** - Energy Research Centre of the Netherlands	Netherlands
4.	**IWES -** Fraunhofer Institute for Wind Energy and Energy Systems	Germany
5.	**SINTEF -**SINTEF Energy Research	Norway
6.	**CENER -**National Renewable Energy Centre of Spain	Spain
7.	**CNR -**National Research Council of Italy	Italy
8.	**EWEA-** The European Wind Energy Association asbl/vzw	Belgium
9.	**TUBITAK -** Scientific and Technological Research Council of Turkey	Turkey
10.	**VTT -** VTT Technical Research Centre of Finland	Finland
11.	**NTNU-** Norwegian University of Science and Technology	Norway
12.	**UoS -** University of Strathclyde	UK
13.	**Tecnalia -** Tecnalia Research & Innovation	Spain
14.	**ForWind - OL** - Center for Wind Energy Research – Univ. of Oldenburg	Germany
15.	**ForWind – H -** Center for Wind Energy Research - Univ. of Hannover	Germany
16.	**NKUA -** National and Kapodistrian University Of Athens	Greece
17.	**CIRCE -** Centre of Research for Energy Resources and Consumption	Spain
18.	**IREC -** Catalonia Institute for Energy Research	Spain
19.	**LNEG -** National Laboratory for Energy and Geology	Portugal
20.	**CTC -** Technological Centre of Components	Spain
21.	**AAU -** Aalborg University	Denmark
22.	**WMC -** Stichting Kenniscentrum Wind turbine Materialen en Constructies	Netherlands
23.	**CIEMAT -** Centro de Investigaciones Energéticas, Medioambientales Tecnológicas	Spain
24.	**MARINTEK -** Norwegian Marine Technology Research Institute	Norway

Name of the coordinating person:

Peter Hauge Madsen

npha@dtu.dk

DTU Wind Energy

Denmark

1. SCIENTIFIC AND/OR TECHNICAL QUALITY

1.1 Concept and objectives

In a context of increasingly fragmented, dispersed and under-funded EU energy research, IRPWIND is an integrated research programme that combines strategic wind energy research projects and support activities, with the aim of leveraging the long term European research potential, to accelerate the route to market for breakthrough innovations, which will ultimately translate into securing the demanding European ambitions for wind energy generation in 2050.

The SET Plan - the technology pillar of the European Climate and Energy Policy - introduced two new implementing instruments, the industry led European Industrial Initiatives (EIIs) and the European Energy Research Alliance (EERA) Joint Programmes (JP) - led by public research organizations. The EIIs focus mainly on applied research, development and demonstration, while EERA JPs deal with pre-competitive medium-to-long-term research initiatives. Both aim at achieving the strategic goals identified by the SET-plan, but EERA JP Wind seeks to lay the foundation for, support and accelerate industry driven initiatives by means of a Strategic Research Agenda and the EII Wind Roadmap, and then formulate and implement the needed underpinning research, addressing the research challenges of the European Industrial Initiative on Wind Energy in the "Wind Energy Roadmap"[1].

The concept behind this programme is *built on the success of these existing European initiatives* for the support of the SET Plan Agenda for 2020 targets, moving them beyond the delivery of research projects, and extending its implementation to integrate capacities and resources around the development of high risk technologies, into a readiness level that will allow Europe to maintain its global competitive leading position both in terms of research excellence and implementation of wind power technologies.

Specifically, within the operational context of the EERA JP on Wind Energy, and in close collaboration with the industrial stakeholders European Wind Energy Association (EWEA) and the European Technology Platform on Wind Energy (TPWind), the current scenario for the development and market uptake of wind power technologies has been evaluated. As a result, several gaps at technical and collaborative levels have been identified that are currently hampering the preparation of the next wave of industrial demonstration and deployment in the field. It is these gaps, aligned with the challenges presented by the European Wind Industrial Initiative[2,3], that IRPWIND now proposes to bridge, with a team that gathers the critical mass of research performers within wind energy across Europe. Besides the research needs identified, the analysis of current research efforts showed a common emphasis on short to medium term research and demonstration, whereas IRPWIND clearly focuses on the medium to long term research.

Consequently, this proposal for an integrated research programme has been developed based on the Strategic Research Agenda (SRA) of TPWind, the Technology Roadmap on Wind Energy, as well as various dispersed national strategies and programmes for wind energy research.

In this scenario, **IRPWIND,** gathering 24 leading research institutions across Europe, **will directly contribute to**

- **The exploitation of European added value by promoting joint collaborative projects and overall reinforcement of research excellence, in a sector which will be key to Europe's sustainability and economic growth;**
- **The optimization of networking benefits from joint use of European facilities and other coordination efforts around national and European R&D initiatives;**

Therefore, through a merging of research efforts and identification of synergies into an integrated research programme, IRPWIND will fulfill the objectives of supporting the research and innovation agenda of the SET plan. IRPWIND appears as an opportunity to seize the enormous potential of wind energy in the development of a new

[1] SEC (2009) 1295 EU Commission Communication on Investing in the Development of Low Carbon Technologies (SET-Plan) – a Technology Roadmap. http://ec.europa.eu/energy/technology/set_plan/doc/2009_comm_investing_development_low_carbon_technologies_roadmap.pdf
[2] Strategic Research Agenda, Market Deployment Strategy, European Wind Energy Technological Platfor008
[3] EWI 2013 Work Programme, TPWind Secretariat, August 2012

generation of decarbonised energy technologies, to successfully combat climate change and securing European and world energy supply.

Background

Wind power is the renewable energy source with the widest most consolidated deployment over the past decades, from 3 GW to 200 GW of global cumulative capacity[4]. The context for development and implementation of IRPWIND derives from the combination of three key enabling elements - political framework, market status and potential and technology development - fostered within the framework of the SET-Plan.

European policies on energy and environment have been implemented since 1997 towards the objectives of *reducing greenhouse gas emissions*, ensuring *security of supply* and *improving EU competitiveness*. Significant progress has enabled the current situation, where Europe obtains approximately 20% of its electricity from renewable sources, including 5.3% from wind energy[5]. In fact, wind energy generation has more than doubled since 2005 (138% increase) and now is the second largest contributor, following hydro power, with a share of 12.6%, in OECD-30 countries[6].

Ambitious targets have been set for 2020 by the EC's 28/2009 Directive on the promotion of the use of energy from renewable sources, later adopted by Member States with even more challenging targets, as depicted in Figure 1.

Country	2020 RES target in Directive 28/2009/EC	2020 RES-E target in NREAP	2020 wind capacity in NREAP	2020 wind Production in NREAP	2020 wind share of electricity consumption in NREAP
Austria	34%	71%	2,578 MW	4.8 TWh	6.5%
Belgium	13%	20.9%	4,320 MW	10.5 TWh	9.5%
Bulgaria	16%	21%	1,256 MW	2.3 TWh	6.3%
Cyprus	13%	16%	300 MW	0.5 TWh	6.8%
Czech Republic	13%	14.3%	743 MW	1.8 TWh	1.5%
Denmark	30%	51.9%	3,960 MW	11.7 TWh	31%
Estonia	25%	17.6%	650 MW	1.5 TWh	14%
Finland	38%	33%	2,500 MW	6.1 TWh	6%
France	23%	27%	25,000 MW	57.9 TWh	10.6%
Germany	18%	38.6%	45,750 MW	104.4 TWh	18.6%
Greece	18%	39.8%	7,500 MW	16.8 TWh	24.5%
Hungary	13%	10.9%	750 MW	1.6 TWh	3.1%
Ireland	16%	42.5%	4,649 MW	11.9 TWh	36.4%
Italy	17%	26.4%	12,680 MW	20 TWh	5.3%
Latvia	40%	59.8%	416 MW	0.9 TWh	10.4%
Lithuania	23%	21%	500 MW	1.3 TWh	9.4%
Luxembourg	11%	11.8%	131 MW	0.2 TWh	3.6%
Malta	10%	13.8%	109.5 MW	0.24 TWh	7.6%
Netherlands	14%	37%	11,178 MW	32.4 TWh	23.9%
Poland	15%	19.1%	6,650 MW	15.2 TWh	9%
Portugal	31%	55.3%	6,875 MW	14.6 TWh	22.6%
Romania	24%	42.6%	4,000 MW	8.4 TWh	11.4%
Slovakia	14%	24%	350 MW	0.6 TWh	1.8%
Slovenia	25%	39.3%	106 MW	0.2 TWh	1.3%
Spain	20%	40%	38,000 MW	70.5 TWh	20.8%
Sweden	49%	62.9%	4,547 MW	1.5 TWh	8.1%
United Kingdom	15%	30%	27,880 MW	78.3 TWh	20.8%

Figure 1 - Targets on renewable electricity generation and specifically for wind energy in the different EU member States for 2020 – compiled from [3]

According to the EC National Renewable Action Plans (NREAPs), a total of 1.160 TWh are expected to be generated from renewable sources by 2020, in OECD-EU countries, with wind power expected to supply 478 TWh[6]. Comparative forecasts on the potential of different renewable energy sources (RES) for electricity generation show a substantial increase for 2030, with wind power accounting for 40% (onshore 18%, offshore 22%) of a total potential of around 4 900 TWh[6] - see Figure 2.

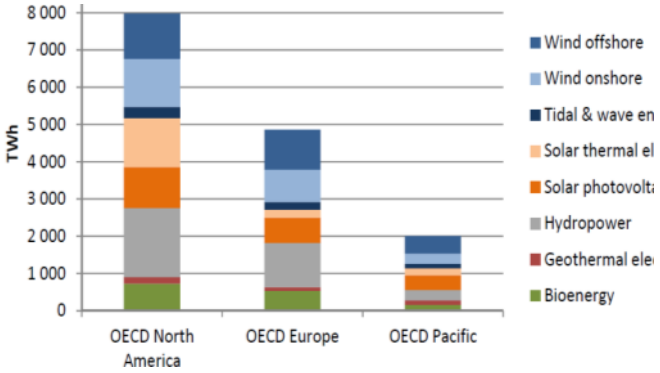


Figure 2 - Renewable electricity potentials for 2030 in major OECD-30 sub-regions [4]

Despite the significant potential of wind power as major source of energy and the expected increase in Europe's overall installed capacity, already in a pre-crisis period global demand for wind energy was greater than production capacity[7]. The trend of globalization, with the industry rapidly growing in regions like India and China, has resulted in a continuous contraction of EU's share of cumulative installed capacity from 50.9 % in 2006 down to 44.3 % of the world's wind energy market in 2010[8].

In further detail, and specifically for wind energy until 2050, Figure 3 shows the differences between the maximum potential expected to be exploited in a baseline scenario, as derived from the EU's "Energy and Transport Trends 2007: Business as usual Scenario"[9], and the

[4] 2011 Update of the Technology Road Map for the SET-Plan, JRC SETIS Work Group

[5] EU Energy Policy to 2050 - Achieving 80-95% emissions reductions, European Wind Energy Association, March 2011

[6] *RENEWABLE ENERGY MARKETS AND PROSPECTS BY REGION,* Simon Müller, Ada Marmion and Milou Beerepoot, International Energy Agency, 2011

[7] Capacities Map 2011 - Update on the R&D Investment in Three Selected Priority Technologies, EUR 25024 EN, JRC Scientific and Technical Reports

[8] EurObserv'ER Wind Energy Barometers 2008, 2009, 2010; GWEC, 2010, 2011

[9] Tool kit available on SETIS

remaining potential that could in fact be exploited provided sufficient support in R&D and demonstration efforts are made.

As can be seen from Figure 4, investment in R&D in the sector has been increasing, mainly driven by a market pull and the needs of the private sector, as the engine behind European R&D is the European Wind Initiative (EWI) of the SET-Plan, led by the industry, also composed by EU Member States and the European Commission[10].

In fact, the implementation of the SET-Plan started with the establishment of these European Industrial Initiatives which bring together different stakeholders in risk-sharing, public-private partnerships aimed at the rapid development of key energy technologies at European level. At the same time, technologies in the field have reached a maturity state which allows for a risk profile that is acceptable to all major turbine manufactures and several national utility companies, who are involved in R&D projects related to wind energy.

At National levels, resources mobilized in 2011 to promote R&D activities and wind energy are summarized below in Figure 5, with the information here compiled from participants in IRPWIND.

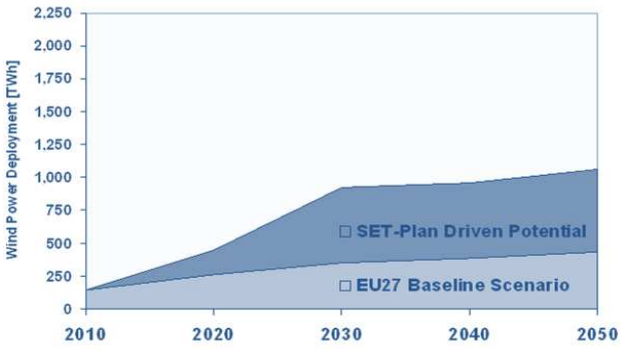


Figure 3- Estimated production figures for wind energy during 2010-2050 [EU Energy technology potential – SETIS tool kit]

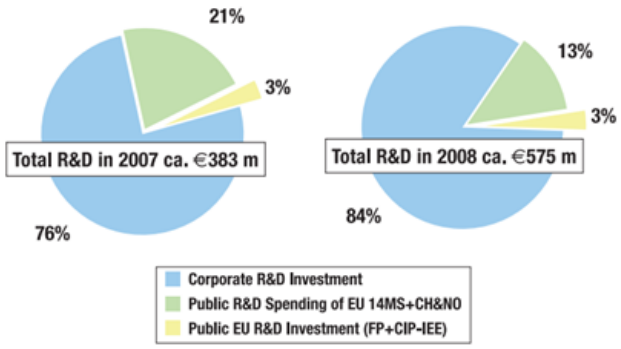


Figure 4- European R&D expenditure on wind energy [6]

Country	*National R&D efforts in Wind Energy*				*National incentives to promote Wind Energy*
	Focus areas	***R&D programs***	*R&D funding* ***(in million EUR)***	*Person Months committed per year in the EERA JPWind (IRP participants in bold)*	
DK	Reduce the cost of energy for offshore wind; test and demonstration facilities; Development, test and demonstration of grid integration and smart grids	Green Lab DK; Fornyelsesfonden (Renewal Fund); Megavind; The Energy Development and Demonstration Program (EUDP); Energinet.dk's; ForskEL program and ForskNG program (PSO);The Danish Council for Strategic Research's (DCSR) Programme Committee on Energy and Environment; The Danish National Advanced Technology Foundation (HTF)	134.00 for renewable energy technologies	524 (**DTU, AAU**, DHI)	Energy Strategy 2050
FI	Power electronics, generators, permanent-magnet technologies, gearboxes, wind turbines, foundry technologies, manufacturing technologies, construction technologies, automation solutions, and services.	SGEM Smart Grids program, GROOVE Growth from Renewables program.	10.00	74 (**VTT**)	Feed-in premium scheme; Negotiations for an investment subsidy for the first large offshore demonstration wind power plant.
GR	Wind assessment and characterization, standards and certification, wind turbine development, aerodynamics, structural loads, blade development, noise, power quality, wind desalination, and autonomous power system integration	Offshore wind farms – ESPA, Exploitation of offshore wind potential AVRA, Green Island "Ai Efstratis"	0.5	150 (**CRES**, NTUA, UP)	New law to simplify and accelerate licensing procedures.
DE	Grid integration and WPP control, support structures, foundation and component	Six Energy Research Program in August 2011 Offshore R&D initiative RAVE	117.00 (74 projects - 42 offshore,	361 (**IWES, ForWind**)	Renewable Energy Sources Act (EEG)

[10] 2011 Update of the Technology Road Map for the SET-Plan, JRC SETIS Work Group

	development, rotor blades, reliability, operation and maintenance, wind power forecasts, model regions with high share of wind energy.		9 onshore, 23 comprehensi -ve)		
TU	Large scale integration of wind generation and system operation. Wind turbine design including following technologies: power electronics, generators, gearboxes, blades	National R&D Programs of TUBITAK: Public Institutions Funding Program, Energy Storage Program, Industry and Academic Funding Programs. Wind Power Forecasting R&D Program of Ministry of Energy and Natural Sources	10.00	72 (**TUBITAK**)	New Law for Renewable Energy Sources to clarify and reorganize support mechanisms like Feed-In Tariff (FIT)
IT	There are no national RD&D programmes on wind energy (WE). The Italian Energy Research Alliance, (AIREn) , including CNR, ENEA, the Polytechnics of Milan, Turin, and Bari is now taking shape under the supervision of the Italian Ministry of Research (MIUR) for translating the EERA objectives into the Italian perspective. WE projects are funded under the Italian National Research Programme and European Funding for the Regional Development , within "smart cities" and "smart grids" topics, including other entities i.e. RSE S.p.A.; universities; industrial companies and associations.		3.00	244 (**CNR**, ENEA)	RES support scheme: RES quota obligation and TGCs
NL	Offshore wind power – Large national potential need for reduction of the Cost of Energy must be reduced. The Energy Research Subsidy scheme (EOS) is finalizing and other schemes are in place. Support to national industry is important as well as the availability of test and demonstration capabilities (Wind turbine test site, blade test facility, wind tunnels)	In NL the Far and Large Offshore Wind (FLOW) programme (50 M€) is running until 2014. The Top Consortium for Knowledge and Innovation (TKI) is the mechanism of the government to support R&D in energy for the future. The TKI Offshore Wind Power started in 2012 and its budget in 2012 is 12M€ and in 2013 20M€.	7.08	234 (**ECN, WMC**, TUDelft)	SDE-plus production subsidy
NO	Offshore wind and grid integration, including balancing by hydro, are main focus areas. Targets are to reduce cost of energy from offshore wind, and develop technologies and services for the international market.	The Research Council of Norway funds R&D on wind energy through RENERGI, now ENERGIX, through the CEER-scheme and other programmes. NOWITECH and NORCOWE are both cofounded through the CEER-scheme, and are the two largest offshore wind R&D projects in Norway, with a total budget of EUR 70 million (2009-20017). Research infrastructure may also be funded by RCN, e.g. NOWERI (floating test turbine). Prototypes and demonstrations may be funded in part through Innovation Norway and ENOVA, e.g. the full scale floating turbine HyWind was receiving support from ENOVA and the scaled SWAY floating turbine by Innovation Norway.	54.00	171 (IFE, **NTNU, SINTEF**)	Common green certificate program between Norway and Sweden with joint target of 26 TWh new renewable energy by 2020; half of this will likely be by wind farms.
PT	Main wind energy R&D priorities (SetPlan EII): grid integration of wind generation and system operation with high wind penetration; development of floating offshore technology; development of small wind turbine technology.	National R&D Programmes: FCT, ADI, QREN and FAI.	7.00 (excluding private funding)	190 (**LNEG**, UoP)	Remuneration for producers of renewable energy defined by Dec.Lei 33-A/2005. (…) NRAEP plan; Incentive programs for Portugal target micro-generation (up to 11 kW), Dec.Lei 118-A/2010 and mini-generation (up to 250 kW) renewable en-ergy installations (Dec.Lei 34/2011).
ES	Large advance wind turbines, reduction of LCOE, offshore floating, demonstration and validation of concepts plus development of enabling technologies. However Spain's R&D calls are mostly not topic oriented so that themes are selected by the consortia. Most relevant projects have been led by industry and have an important demo share.	Main national R&D programs: INNFLUYE; INNPACTO; INNPLANTA& CENIT; Regions have their own schemes supplementary to the national ones (such as ETORGAI)	150.0	311 (**CENER, CIEMAT, CTC, IREC**)	Feed-in scheme for electricity generated by wind farms with supple-mental incentives for upgrade to facilitate the integration of wind energy into the grid. Royal Decree 1699/2011 for small size wind power.

UK	Offshore wind with the objective of reducing the cost of energy. Installation and support structures, operation and maintenance, offshore networks and shore connection, components and testing, e.g. condition monitoring systems, offshore wind drive-train test rig; offshore wind floating platforms; next generation bigger blades.	The Carbon Trust Offshore Wind Accelerator (OWA); Energy Technology Institute Offshore Wind Technology Programme (ETI); RCUK Sustainable Power Generation and Supply Wind Energy Technology (Supergen Wind); RCUK Centre for Doctoral Training in Wind Energy Systems; DECC Offshore Wind Component Technologies Development and Demonstration Scheme.	132	66 (**UoS**)	The Renewables Obligation (RO); Feed-In Tariff (FIT); Electricity Market Reform (EMR); Transitional Arrangements

Figure 5 – Summary of National R,D&D efforts and incentive programs in Europe for 2011 (adapted from [11])

The above figure illustrates the European reality for Wind Energy research in Europe. It is an important point that the bulk of the funding of research at the participating institutions goes into *projects*, and thus not into basic or programmatic funds. Secondly, in spite of the potential and need for cost reductions, risk reduction and technology development, wind energy is seen as a mature technology, where initiatives and calls for proposals normally have a focus on demonstration and testing. Hence there is an urgent need for more medium to long term research.

The IRPWIND is about aligning and accelerating the research effort done by the research organizations. As the partners in the IPRWIND are the key players in the sector and interaction with national research programmes and authorities are part of the anticipated IRP activities, the IRP will indirectly have an effect on alignment of national funding programmes. In the proposed IRP, three core RTD projects (CPs) will be defined as self-contained institutional research programmes, the implementation of which will to a large extent be based on the different national projects already funded by research councils, ministries, etc. In this way, the partners will seek to align, optimize and develop R&D in these gap areas by conducting the proposed research activities and setting up various coordination and support actions (CSAs). The aim is to gradually enhance the research efforts included in the IRP during the next four years and thus take a significant step towards a single complete European Programme covering all relevant research.

In order to tap the potential of wind energy while contributing to securing a European leading position, a Technology Road Map[10] has been defined to cover the short- medium- and long-term advancements needs in the sector, based on a Strategic Research Agenda[12]. Current technology objectives to serve as enablers of industrial development until 2050 include:

1. New turbines and components
2. Offshore structure-related technologies
3. Grid integration
4. Resource assessment and spatial planning

Focus on these objectives is expected to improve the competitiveness of European research capacity, which in turn will enable the exploitation of offshore and deep waters resources, and facilitate grid integration of the electricity produced, ultimately contributing to an effective market uptake of disruptive technologies, in response to the ever increasing economic and environmental demand of renewable electricity generation.

In this scenario, IRPWIND appears as a means to optimize EU's public R&D expenditure in the field, and to structure the efforts of different stakeholders from industry and academia, integrating specific market technology needs with cutting-edge research capacities.

Objectives

The aforementioned context demonstrates an efficient deployment and a secured track for EU to reach the established targets in 2020 with respect to wind energy. However, external threats to industrial leadership combined with greater ambitions for 2050, to reduce greenhouse gas emissions by 80 - 95%, call for **new strategies to simultaneously address technical and non-technical barriers, in order to fully realise the potential of wind energy** electricity generation in Europe.

[11] Adapted from IEA Wind Annual Report for 2011
[12] Strategic Research Agenda, Market Deployment Strategy, European Wind Energy Technological Platform, 2008

The European Energy Research Alliance (EERA), mandated by the SET-Plan Steering Group, has been working since 2008 to develop and implement strategic research required for delivering on the SET-Plan priorities, and to establish a joint programming framework at the EU level. A core objective of EERA's JP Wind is to contribute to reducing the cost of energy (CoE) from wind energy and improving the implementation and integration through development of knowledge and innovations, from concept phase through research, up to a certain technology readiness level (TRL). The TRL scale was first developed by NASA in the 1980s, and has since then developed and gained application in a range of public agencies and industries. It defines 9 levels where 1-3 is for research, 4-5 development and 6-9 is for industry prototyping and demonstration. As can be seen from the positioning on the chain of innovation (Figure 6), EERA JP Wind is working within TRL 1 to 4-5, whereas the further development, testing and demonstration will typically be industry led.

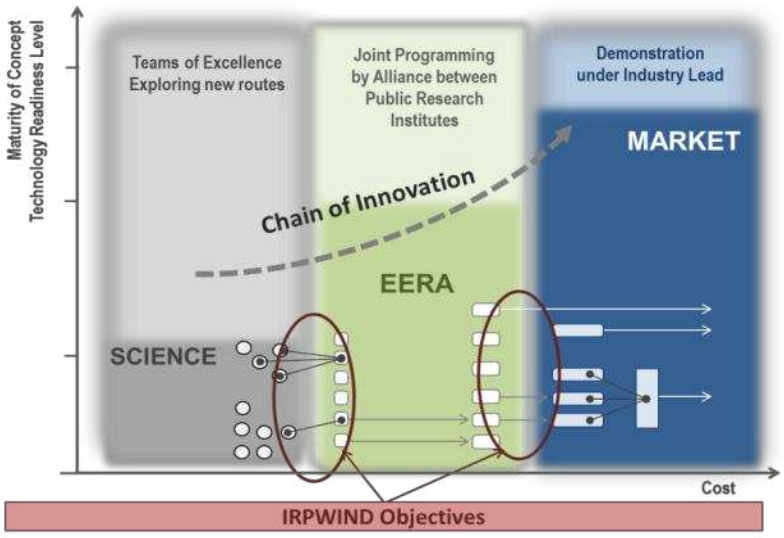


Figure 6- IRPWIND Objectives within EERA's JP Wind positioning in the Innovation Chain

Specifically in IRPWIND, both technical and non-technical barriers have been identified – see section 1.2 – which respectively require actions upstream and downstream of this innovation chain. To address these actions, the consortium behind this programme has defined the following objectives:

1. Accelerate the development of ground breaking technologies for reducing costs of wind energy generation, in particular for the development of large offshore wind turbines and improving the efficiency of substructures;
2. Overcome technological barriers identified in the SET-Roadmap, such as large scale grid integration of wind energy, which have not yet been sufficiently addressed in public funded projects;
3. Foster collaboration and knowledge transfer between European researchers for the progress of a low carbon economy;
4. Bridge cooperation gaps between different stakeholders, in Europe and worldwide, to advance the research agenda of the SET-Plan;
5. And, finally, optimize and promote shared use and increased availability of infrastructural resources.

The overall objective of IRPWIND is to implement an integrated research programme to foster long-term collaborative research and open innovation within the key research per ormers in Europe, led by the EERA's Wind Joint Programme partners. Specific scientific, technological and cooperation objectives are further detailed in the section below.