GOBIERNO DE ESPAÑA | MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Convocatoria de Acciones de Programación Conjunta Internacional

PROGRAMA ESTATAL DE I+D+I ORIENTADA A LOS RETOS DE LA SOCIEDAD

2016

MEMORIA CIENTÍFICO-TÉCNICA

INSTRUCCIONES PARA COMPLETAR LA MEMORIA CIENTÍFICO-TÉCNICA DE ACCIONES DE PROGRAMACIÓN CONJUNTA INTERNACIONAL DEL PROGRAMA ESTATAL DE INVESTIGACIÓN, DESARROLLO E INNOVACIÓN ORIENTADA A LOS RETOS DE LA SOCIEDAD

Lea detenidamente estas instrucciones para completar correctamente la memoria-científico técnica.

1. Para completar el modelo, debe utilizarse, siempre que sea posible, la memoria usada para concurrir en la convocatoria internacional enumerada en el anexo I de la resolución de la convocatoria 2016.
2. Las memorias pueden completarse en español o en inglés, a excepción del apartado 1. RESUMEN DE LA PROPUESTA, que debe completarse en ambos idiomas.
3. En el caso del apartado 3.3.1. CRONOGRAMA, si tuviese que completar más objetivos, seleccione y copie completa la tabla destinada a este efecto y pegue su contenido entre los corchetes (como se indica en dicho apartado).
4. El apartado 8. PRESUPUESTO DE LA AYUDA SOLICITADA debe completarse exclusivamente en los proyectos presentados a las convocatorias de la Empresa Común ECSEL.
5. Para completar los textos, sitúe el cursor en cada una de las tablas, entre los corchetes que aparecen en las mismas.
6. Este modelo de memoria tiene un número máximo de caracteres y ha de limitarse a los espacios y secciones indicados al completarla.
7. Una vez terminada la memoria, guarde su archivo en forma de pdf. Incluya dicho archivo (de no más de 4Mb) en la solicitud telemática del proyecto en el apartado “Añadir documentos”.
8. Las memorias tendrán que escribirse obligatoriamente con tamaño de letra mínimo de 11 puntos.
9. Se recomienda completar la memoria empleando un PC con sistema operativo Windows y usando como procesador de textos MS Word (MS Office).

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1. RESUMEN DE LA PROPUESTA / SUMMARY OF THE PROPOSAL

(Debe rellenarse tanto en castellano como en inglés / It should be completed in English and Spanish)

INVESTIGADOR PRINCIPAL (Nombre y apellidos)**:**
Javier Sanz Rodrigo

TÍTULO DEL PROYECTO:
Desarrollo del Nuevo Atlas Eólico Europeo Fase II

ACRÓNIMO DEL PROYECTO:
NEWA II

TITLE OF THE PROJECT:
Development of a new European Wind Atlas 2nd Stage

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RESUMEN DEL PROYECTO

Máximo 3500 caracteres

La industria de la energía eólica tiene todavía la preocupación de que muchos proyectos muestran discrepancias entre los valores calculados y reales en producción y condiciones de operación. El nuevo Atlas Eólico Europeo está dirigido a reducir estas variaciones y está estructurado en torno a tres áreas de trabajo que se implementarán en paralelo:

1. Creación y publicación de un Atlas Eólico Europeo en formato electrónico, el cual incluirá los datos fundamentales y una nueva base de datos eólicos para la UE, que contará como mínimo con: el recurso eólico y sus varaciones asociadas; viento extremo y variación; turbulencia característica; otras condiciones ambientales adversas y la posibilidad de que ocurran; el nivel de predicción a corto plazo con el pronóstico y la evaluación de las variaciones; guías y buenas prácticas para el uso de los datos, especialmente para micrositing.
2. Desarrollo de metodologías dinámicas a pequeña escala y modelos de código abierto validados mediante campañas de medida, para permitir una evaluación precisa del recurso eólico y de la climatologíaasí como la predicción de alta resolución a corto plazo con cobertura europea. Las metodologías de downscaling y de los modelos desarrollados serán ampliamente documentados y puestos a disposición pública, y serán usados pàra aportar l mapasgenerales de recurso eólico y otros datos relevantes a diferentes alturas y con una alta resolucion horizontal.
3. Campañas de medición para validar la cadena de modelos usada en el atlas eólico. Al menos cinco campañas de medida coordinadas serán llevadas a cabo y cubrirán terreno complejo (montes y bosques), offshore, grandes cambios en las caracterísiticas de la superficie (aspereza) y climas fríos.

PALABRAS CLAVE

Máximo 200 caracteres

Atlas de recurso eólico, turbulencia, vientos extremos, variaciones, micrositing, campaña de medidas, downscaling

SUMMARY OF THE PROJECT

Maximum 3500 characters

The wind energy industry is still troubled by many projects showing considerable negative discrepancies between calculated and actually experienced production numbers and operating conditions. The New European Wind Atlas is aimed at reducing these uncertainties, and is structured around three areas of work, to be implemented in parallel.

1. Creation and publication of a European wind atlas in electronic form, which will include the underlying data and a new EU wind climate database which will as a minimum include: wind resources and their associated uncertainty; extreme wind and uncertainty; turbulence characteristics; other adverse weather conditions and their probability of occurrence; the level of predictability for short-term forecasting and assessment of uncertainties; guidelines and best practices for the use of data especially for micro-siting.
2. Development of dynamical downscaling methodologies and open-source models validated through measurement campaigns, to enable the provision of accurate wind resource and external wind load climatology and short-term prediction at high spatial resolution and covering Europe. The developed downscaling methodologies and models will be fully documented and made publicly available and will be used to produce overview maps of wind resources and other relevant data at several heights and at high horizontal resolution.

3. Measurement campaigns to validate the model chain used in the wind atlas. At least five coordinated measurement campaigns will be undertaken and will cover complex terrains (mountains and forests), offshore, large changes in surface characteristics (roughness change) and cold climates.

KEY WORDS

Maximum 200 characters

Wind resource atlas, turbulence, extreme winds, uncertainties, wind turbine micrositing.

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2. FINALIDAD Y OBJETIVOS DEL PROYECTO

Even if the ERA Net Plus call on the Wind Energy Atlas was part of the last FP7 work program fo 2013: "Topic ENERGY.2013.10.1.2: ERA-NET Plus – European wind resources assessment", the NEWA project is perfectly in line with the new European and national R&D priorities up to 2020 concerning energy. The Project takes place in the framework of and will contribute to find solutions to the **Energy Challenge** (Secure, efficient and clean energy) of the EU and the national R&D program.

The national energy policy concerning renewable energy sources (RES) and the R&D objectives of the sector are determined in a great extent by the European framework (Directive EC/2009/28/; SET-Plan; Horizon 2020). Both Horizon 2020 and the Spanish State Plan for R&D&i identify among their pillars research and innovation oriented to societal challenges. Reseach activities in the RES field are included in the Challenge **Secure, Efficient and Clean Energy**. According to the State Plan, which is alligned with Horizon 2020, "*el objetivo específico de este RETO es promover la transición hacia un sistema energético que permita reducir la dependencia de los carburantes fósiles en un escenario en el que se contemplan, simultáneamente, la escasez de los mismos, el crecimiento de la demanda a nivel mundial y el impacto de la misma en el medioambiente*." Scientific-technological and enterpreneur priorities include wind energy.

The NEWA consortium is entirely in line with this strategy, as it will contribute with its research to reduce uncertainties in the use of the wind energy source, and consecuently will reduce the levelized cost of energy (LCOE) and increase the efficiency of the technology.

2.1 State-of-the-art in wind resource assessment and limitations

At national and regional level, wind atlases have been produced which assess the wind speed to be expected in particular areas. At European level, a wind atlas was published by Risø National Laboratory for the European Commission in 1989. As of today, this remains the only public atlas covering several EU Member States in a uniform way. Still, the 1989 atlas does not cover new EU Member States (Figure 1.1) has a coarse resolution, and was developed using a model for wind assessment – WAsP (Wind Atlas Analysis and Application Program) – based on a linearized flow model.

Country	Coverage in European Wind Atlas from 1989	Covered in other mapping methods	Covered in the new Wind Atlas
EU27			
Austria		•	•
Belgium	•		•
Bulgaria		•	•
Cyprus			•
Czech Republic		•	•
Denmark	•	•	•
Estonia		•	•
Finland		•	•
France	•		•
Germany	•		•
Greece	•	•	•
Hungary		•	•
Ireland	•	•	•
Italy	•	•	•
Latvia		•	•
Lithuania		•	•
Luxemburg	•		•
Malta			•
The Netherlands	•		•
Poland		•	•
Portugal	•		•
Romania		•	•
Slovakia		•	•
Slovenia		•	•
Spain	•		•
Sweden		•	•
UK	•	•	•
Other countries			
Turkey		•	•
Armenia		•	
Croatia		•	
Georgia		•	
Norway		•	
Russia		•	
Switzerland		•	

Figure 1.1: Different wind atlases coverage [Wind Energy - The Facts, Part I. 2009].

Currently, wind assessment technology is facing an inflection point from linear flow models to more sophisticated methods based on non-linear flow models combined with mesocale models developed independently by meteorological and engineering communities. This inflection point is occurring due to the availability of the necessary computational resources, and to the advent of better meteorological and experimental databases. Since the late 80's, the de facto standard model for wind assessment has been WAsP which estimates the effect of the micro-scale (0.05-5 km scale) terrain and vegetation variations on the wind resource. As wind turbines have grown, such a micro-scale approach needs to be complemented with the modelling of the planetary boundary layer (PBL) and associated temperature gradients within the PBL. Whereas the micro-scale flow models can be seen as bottom-up approaches for wind resource assessments over a smaller area, the use of meso-scale models has since the 1990ies offered a top-down approach to wind resource estimations over large areas to produce wind atlases.

However, the meso-scale models cannot accurately predict the wind variability caused by micro-scale features. State-of-the-Art in wind power meteorology is facing several research challenges that need to be overcome in order to decrease the uncertainty of wind energy production and wind conditions to less than 10%: A main objective of the NEWA project is to fundamentally change the state-of-the-art during the course of the project by developing and introducing a new methodology for the assessment of wind conditions. The development will be based on dedicated large scale wind measurement campaigns, which focus on situations important for wind power utilization. The methodology to be developed will be validated by local measurements, and include detailed turbulence models; considering extreme winds, extreme shears, high wind variability, among other extremes. The development of such a highly accurate methodology represents the main challenge in the new Wind Atlas research project. The measurement campaigns which will form the basis for the development of the new methodology will for the first time make full use of new measurement techniques like the windscanner lidar system.

Mesoscale models are, in general, not specifically developed for wind energy applications, and the models will be adapted and tested for this purpose. The choice of models skill and validation criteria will be elaborated. High resolution data on surface conditions (e.g. land-use and topography) will be evaluated and adapted for use in the models. Microscale models will be linked to the mesoscale models in a consistent way. Today there are two approaches: Direct dynamical down scaling and the “Lib-file” method developed for the 1989 European Wind Atlas. A generally approved method is highly needed so that data generated by the mesoscale model can be adapted and collated for use in various microscale models. The Microscale-mesocale model-linking will be established and validated using high quality field data – in particular the data obtained in the experimental campaigns in the project.

Preliminary investigations show that using several mesoscale models and using a weighted average, the so-called ensemble average, could reduce the bias of the predicted wind resources. This will be further validated and extended to external design parameters. A method for estimation of the wind resource uncertainties will be developed by relating prediction errors to the ensemble spread producing a probabilistic wind atlas using similar techniques as applied to weather forecasting methodologies.

A major reason for the shortcomings of the existing models in the context of wind energy is the lack of suitable validation data. Only very few measurement campaigns of sufficient scope and data quality are available for the validation of microscale models, such as the Bolund hill. For the development and validation of the models, experiments are designed for situations important for wind energy and at the same time challenging for the models, e.g. complex terrain, forested sites, offshore and cold climate.

Validation of mesoscale models is inherently difficult due to the size of the grid cells and and a relatively unknown discrepancy between numerical and physical resolution. Measurement methods will be developed which improve the validation of model results with experimental data. The model chain will be comprehensively tested and validated using high quality climatological and shorter term datasets.

Uncertainties will be quantified, and the potential short to long term wind predictability quantified in terms of climatic area and terrain characteristics. Combined, the partners of the NEWA consortium have developed a range of state-of-the-art models, which will be used in the model chain.

2.2 Description of the research hypothesis(es)

Four main research hypothesis and lines of enquiry form the core of the project:

Selection of the best model chain output

Here we propose a multi-model ensemble philosophy, at the same time requiring that both the models and the downscaling from meso- to micro-scale are theoretically well. Experience from meteorology shows that an ensemble of models that are run with slightly different initial conditions or slightly different formulations of the physics produce good estimates of the uncertainty and the mean of the models has on average less error than any of the individual model. This method will be investigated for wind energy purposes and used for the final atlas.

Propagation of uncertainties through the model chain

The progression of uncertainties through a model chain is one of the cutting edge research questions in the wind energy industry. All project developments are based on projections of uncertain estimates over a short term, to long term resource estimates. A more thorough understanding and description of the propagation of the uncertainty through each stage in the model chain is an investigation that can yield overall reduction in resource assessments through targeted remedial actions. The goal of these investigations is to reduce the long term resource estimate error in complex terrains to 10%. A significant error reduction will come by understanding of the propagation of uncertainty in the model chain.

Models for siting parameters, extremes, turbulences, predictability, among others

The backbone of the wind atlas is a database of at least ten years of meso-scale model runs covering Europe in a resolution of at least two kilometers. The question in this task is how to downscale and use these data for the prediction of site specific mean winds, extreme winds (e.g. the 50-year wind), turbulence and predictability. Even over flat terrain meso-scale models will, due to their limited spatial and temporal resolution, underestimate the 50-year wind. Robust techniques correct for that should be developed and tested.

Will higher fidelity micro-scale models finally be superior?

Large-eddy simulation (LES) is due to its computational complexity not going to be used for the final wind Atlas, but it is going to be used for the experimental complex terrain sites in NEWA. The few applications of LES in complex terrain have so far not yet proven superior to the simpler Reynolds-averaged Navier Stokes (RANS) solvers. Eventually, LES is most likely to prove superior to RANS, but it remains to be demonstrated in practice. The nesting of LES into meso-scale simulations for micro-scale wind predictions introduces a particular scientific challenge. It is the determination of the turbulent boundary conditions in the LES, as turbulent fluctuations with time scales between seconds and tens of minutes are not resolved in the meso-scale simulations that are used to drive the LES.

2.3 Concept and objective

2.3.1 NEWA technological concept

In this project a New European Wind Atlas will be developed to be used as a **standard for site assessment**. The new Atlas, based on improved modelling competencies on atmospheric flow, together with the guidelines and best practices for the use of data, should become a key tool not only for manufacturers and developers, but also for public authorities and decision-makers, by **reducing overall uncertainties in determining wind conditions**.

The new Atlas, the structure of which is presented in Figure 1.2, will involve the development of new dynamical downscaling methodologies as well as improvements and extensions of the models involved, with high temporal and spatial resolution. The Atlas will take advantage of newly created long term datasets and incorporate comprehensive information about wind conditions for all stages of wind projects' life-cycle.

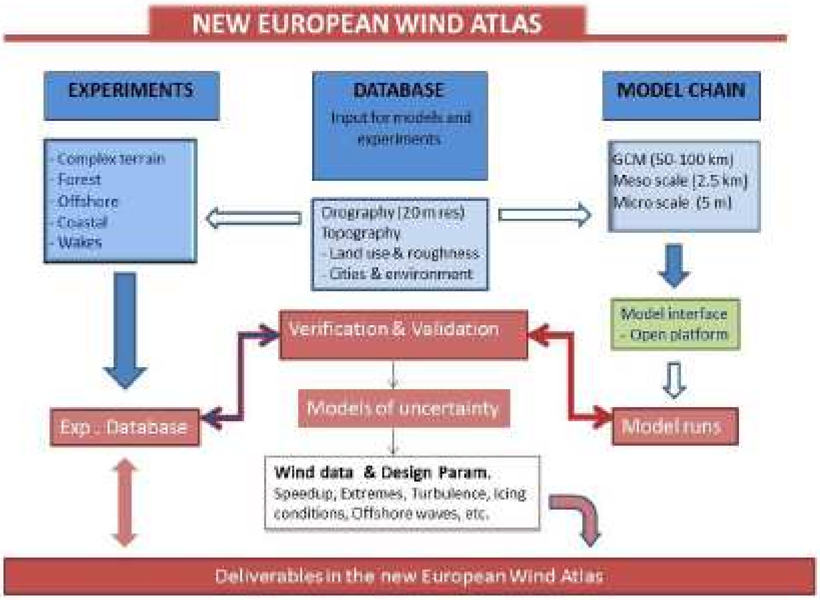

Figure 1.2: Flow chart showing the structure of the new EU Wind Atlas[6]

Overall, the new Atlas will provide a **unified high resolution and freely available data-set of wind energy resource in Europe**. The statistics in the atlas will cover Europe with a resolution 20-30 meters in at least 10 wind turbine relevant heights. This statistical downscaling is built on at least 10 years of mesoscale simulations with a resolution of 2-3 km. These mesoscale data will also be publicly available. The area coverage is the EU countries and 100 km offshore plus the Baltic and the North Sea (see Figure 1 in WP2). In addition to wind resource information, the new Atlas will give measures of wind variability, wind power predictability from day-ahead to decadal as well as parameters for wind turbine design.

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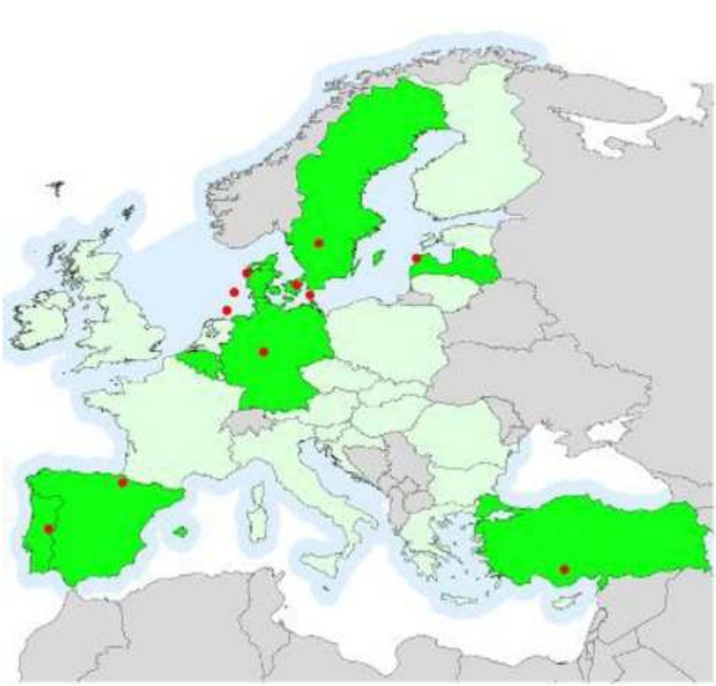

Figure 1: Approximate positions of the experimental sites in Portugal, Spain, Germany and Turkey together with the many stations available for the Northern European meso-scale experiment. The green countries are partners in NEWA, while the light green is the EU showing the coverage on land of the wind atlas. The light blue shows the coverage offshore.

2.3.2 Scientific and Technological (S&T) objectives

The main objective of NEWA is the development of a new European Wind Atlas and the improvement of advanced models towards the **reduction of uncertainties to less than 3% for flat homogenous terrains** – strategic **key performance indicator** for "Resource assessment and spatial planning" of the European Industrial Initiative on wind energy – and to less than 10% for any terrain, as suggested by The European Wind Energy Technology Platform (TPWind). This overall goal is broken down into several technological and scientific objectives:

- **Development of a high-value data bank from a series of wind measurement campaigns**
  Current tall wind turbines are often placed in remote areas on steep ridges and in forested terrain. This project aims to provide a detailed and accurate description of the wind flow at selected sites in such terrain based on well-instrumented meteorological field experiments covering a wide range of topographical and climatological conditions. The produced data will be public available and can beused by private and public partners to develop models and engineering tools.
- **Development of methodology and improvement of advanced models for wind farm development, wind turbine design conditions, spatial planning, and policy promotion**
  This project aims to determining the wind conditions with a very low uncertainty when planning wind farms. Hence it is necessary: to develop the essential models (based on results from the experimental campaigns) so that they are tailored to the Wind Atlas and can provide results with accuracy unseen today. How to link the wind resource information provided by the micro- and meso-scale models is an

intense research area – NEWA aims to establish a new methodology for the coupling between the two, which will be open-source knowledge contributing to innovative research in wind energy.

- **Creation and publication of a European Wind atlas (database on wind data, environmental and other constrains)**
  The new European Wind Atlas database to be developed will include: wind resources and external design parameters and their associated uncertainty; the level of predictability for short to long term forecasting; guidelines and best practices for the use of data, (particularly relevant for micrositing).The Atlas will cover all EU Member States and a group of Associated Countries, as well as their exclusive economic zones, and restricted areas (Natura 2000 sites, military areas). The interface of the NEWA database will include an interactive web-based map with a responsive.
- **Verification and estimation of uncertainty**
  An uncertainty map will calculate the confidence of the Wind Atlas and the intensity to which in situ measurement must be employed before development of a wind farm. The uncertainty will be verified by a large number of wind climate data and wind farm production data covering the total area including offshore areas. The experimental results will also be used especially for theoretical work, developing new procedures for uncertainty calculations**.**

Within this general framework, **specific objectives of the BSC** for NEWA-II linked with the European project are:

- Development of ABL microscale models (RANS/LES) with thermal coupling and implementation in Alya (in-house code optimized for HPC).
- Methodologies for model validation using as benchmarking examples data from the experiments in Alaiz, Perdigao and Kassel.
- Definition of dynamic and statistical downscaling strategies.
- Implementation of the model chain .
- Assistance and support for the atlas production runs in MareNostrum and facilitate access to European tier-0 supercomputing facilities (PRACE).
- Assessment of the predictability of the forecast systems to simulate the wind speed, from short-term forecasts to cilmate predictions.
- Analysis of the sources of predictability of wind at different time scales and for different regions.
- Comprehensive overview of their potential applications, available prediction systems and verification methodology.

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3. METODOLOGÍA, PLAN DE TRABAJO Y RESULTADOS PREVISTOS

3.1 Descripción de los materiales, infraestructuras y equipamientos singulares a disposición del proyecto que permitan abordar la metodología propuesta.

NEWA deals with several interdisciplinary concepts requiring a wide range of specific competencies, skills, and knowledge as well as project management. The team behind NEWA consists of 31 partners from 8 different European countries. DTU, CENER and IWES are the work packages' leaders and national representatives of Denmark, Spain and Germany, respectively. DTU, the coordinator, is a world leading centre in meteorological experiments for wind energy purposes. The group has produced more than 100 journal publications relevant to NEWA and they have one patent that will be used freely in NEWA experiments. Moreover, the team is highly experienced in leading and coordinating several large EU projects. CENER – Wind energy department – has a cutting-edge technological infrastructure, with the most modern laboratories and facilities in Europe – the unique Wind Turbine Test Laboratory and a field test facility in the complex terrain of the Alaiz Mountain which supports testing in real conditions of up to 5 prototype multimegawatt turbines. Fraunhofer IWES is highly experienced in wind measurements and offshore meteorology. The group is active in several relevant committees and expert groups on national and international level; including EERA, TPWind, IEC, IEA.

Similarly, the other 28 partners play a crucial role in the project and they each bring different areas of excellence into the consortium . The quality of each group is also demonstrated by the track record of the principal investigator.

NEWA is founded in a strong European consortium which forms a strategic research alliance of carefully selected world leading partners from European universities, institutions and industry. The project is based on a true cooperation, through which all partners contribute to and benefit from the project results. The consortium mobilises a broad group of partners around the core challenges, and benefits from complementarities, synergies and capabilities. NEWA consortium synergies are provided by previous joint participation in international projects, and research capacity has already been proved by the outputs and products generated by already collaborative activities between partners:

- Research projects: **IRENA** (DTU, DLR (external partner), CENER); **Windscanner** (DTU, IWES, UPORTO, LNEG, CENER, ForWind); **NORSEWInD** (DTU, IWES, ERI VIRAC, IPE, LNEG, 3E, DNV-GL); **ClusterDesig**n (3E, ForWind); **IRPWIND** (DTU, CENER, IWES, ForWind, UPORTO, LNEG, IC3, CIEMAT), **EERA DTOC** (IWES, DTU, CENER, ForWind, UPORTO, Iberdrola (external partner)); **IceWind** (DTU, VESTAS, UU, WeatherTech) **ANEMOS-ANEMOS.Plus-SAFEWIND** (DTU, CENER, ForWind), **WAUDIT** (CENER, DTU, ForWind, UCM, DNV-GL)
- **IEA Wind Task 31 Wakebench** (CENER, DTU, ForWind, Fraunhofer, Vestas, BSC)
- Several co-authorships on scientific publications;
- Training programs and shared students' supervision. Erasmus Mundus Wind Energy Master (DTU, ForWind). Several PhD networks and PhD summer schools through the European Academy of Wind Energy (almost all academic partners)

Through the sum of national competences and existing infrastructures, the consortium exhaustively covers the core aspects of the envisioned research for the future wind energy Atlas. Access to and sharing of research infrastructure and IPR will be an essential part of this project. In conclusion, NEWA will create an improved network within Europe's wind energy communities to facilitate open access to knowledge skills and best practices, and to create a close community of actors and institutions involved in wind energy. The continuation of the database after the end of the project will be secured through IRENA, and we envisage that commercial partners could make a business out of updating the database at that time. The academic continuation of the activities in NEWA will be facilitated by the European Academy of Wind Energy (EAWE), where research projects and applications will be coordinated

3.2 Methodology

Detalle la metodología propuesta de acuerdo con los objetivos del apartado 2.

- Deberá indicarse la viabilidad metodológica de las tareas y reseñar los hitos o entregables previstos. Si fuera necesario, se incluirá una evaluación crítica de las posibles dificultades de un objetivo específico y un plan de contingencia para resolverlas.

El personal implicado en cada una de las tareas deberá especificarse en el cronograma.

- Si solicita ayuda para la contratación de personal, justifique claramente su necesidad y las tareas que vaya a desarrollar.

Máximo 32 000 caracteres

NEWA is structured as a highly collaborative and integrative project – all technical work packages engage partners from a variety of disciplines, from both industry and academia and from different EU Member States and one Associated Country. This is critical for the development of a Wind Atlas covering all EU Member States and some Associated Countries and also to achieve the synergy between the leading experts within wind assessment, meteorology, computational fluid dynamics, interactive mapping and surface characterization that composed the consortium. From a scientific perspective NEWA is organized to mitigate the resulting risks by multiple parallel and interacting research tracks. The European project work plan includes 5 work packages (WPs) which have been designed to ensure a broad involvement among the partners and to promote the integration of national research efforts and identification of synergies:

- WP2 addresses wind measurement campaigns and collection and processing of data
- WP3 focus on the development, improvement and implementation of models and downscaling methodologies.
- WP4 aims to validate the developed approaches and estimate the uncertainty, as well as, to develop the NEWA database and its interface.

During the first phase of the project (NEWA-1, 2014-2015) BSC has implememnted and tested the CFDWind model with thermal coupling in the in-house finite element based solver Alya as a part of the WP3.3. Within Task 3.2, BSC has also been working comparing different sub-seasonal forecast systems assessing the predictatiblity of those systems to properly reproduce wind speed. Concerning seasonal time scales, we have been working on the relationship between wind speed and its various sources of predictability

During the second phase (NEWA-2), the BSC-CNS Research Group, led by Arnau Folch, has the following project objectives:

- In WP3 developing strategies for downscaling models from mesoscale to microscale in collaboration with other partners (PD).
- In Task 3.2 the probabilistic mesoscale model chain will be complemented with climate predictions to produce predictability information at different scales/horizons: hours, days, weeks and seasons. This predictability information will address operational costs of wind farms related to the lack of predictability of wind power and met-oceanic weather conditions. Together with the wind resource assessment information of the atlas it

will be possible to improve spatial planning tools considering life-cycle cost models of wind farms. As a result financial risks will be also better evaluated throughout Europe. BSC and CENER will bring together their experience on short-term (FP7-SAFEWIND) and sub-seasonal to seasonal (FP7-SPECS) predictability assessment to develop forecasting models in the intermediate sub-seasonal range from a few days to months. This is especially relevant to quantify offshore installation and operation and maintenance logistic costs.

- In WP3.5 develop methodologies for model validation using as benchmarking examples data from the experiments in Alaiz (complex terrain) and Kassel (forest) (PD). The purpose of the experiments in WP2 is to challenge the predictions made by the model chain developed in WP3, and thus producing a more reliable wind atlas in WP4. In order to stimulate the development a number of blind comparison benchmarks will be formulated to assure and gauge the quality of the predicted parameters and to be able to improve the modelling along the project duration to optimize the wind atlas model chain. A hierarchy of benchmarking exercises will be developed in order to target specific objectives of the model chain at increasing levels of complexity. Benchmarks will be based on data generated in WP1 from experiments and high-fidelity LES simulations on idealized and experimental conditions. Variables of interest and performance indicators will be identified to anticipate experimental needs and guide model developers. CENER will manage the benchmarking process through the windbench.net portal adopting and improving the model evaluation protocol defined in the IEA Task 31 Wakebench. Blind benchmarks will be open for external participation, notably through the IEA Task Wakebench. Strong-sense benchmarks will be produced from the high-quality experiments of the project. These are engineering standards that define a comprehensive framework for model testing, the requirements for model intercomparison and a set of acceptance criteria considering the intended use of the models. These test cases will be complemented with idealized test cases based on high-fidelity LES simulations, a database of long-term meteorological measurements and production data from weather services and industrial partners collected in WP2.
- In Task 4.3 participate in the beta production runs (T). The open-source platform will be installed and parallelized to run in high-performance computing facilities accessible to the consortium partners. This will allow to apply for national and European computational resources to run the wind atlas database and other costly simulations of the project. Furthermore, the platform will be installed by BSC at the petaflop MareNostrum HPC facility of Spain, to gain access to the PRACE European supercomputing research infrastructure. A proposal to apply for PRACE HPC resources will be formulated in order to enhance the production of the NEWA wind atlas runs. The intention is to find the best setup in terms of input data (e.g. atmospheric data, oceanographic data, land use data), model configuration (grids,nesting) and in terms of physical schemes. The assessment of the different model setups is based on a comparison of model results with data from the measurements taken in the project. All models of the model chain will be improved continuously when validated against measurements that are taken in the project or have been made available for the project. Furthermore, different initialization and forcing data are tested to understand and quantify the sensitivity of used models. Depending on the gained experiences the computational resources for the final production are estimated by each partner and either joint or individual applications to European HPC infrastructures are prepared.
- In Task 4.6 participate in the final production run of the model chain. When completing thorough testing of the developed model chain final production kicks off. This includes the migration of models to the desired HPC infrastructure in case the beta production has been performed elsewhere. Three partners (CIEMAT, DTU, ForWind) commit to carry out mesoscale atmospheric simulation for Europe from Reanalysis data for a time period of 10 years using the best setup figured out in Task 3.1 and during the beta runs. Simulations with LES and many other microscale models that are included further down in the model chain are performed at the measurement sites using the final mesoscale results as input. One or a weighted average of a few microscale models will be used to down scale the meso-scale statistics everywhere in Europe on a grid with a resolution of 20-30 m and at ten wind turbine relevant heights. All data will be freely available at the end of the project

andarchived in the NEWA database according to the catalogues of output parameters defined in "Task 4.1: Definition of wind atlas output parameters". Final products will be a meso-scale grid and a defined methodology for downscaling to local conditions with open source software yielding an estimate of the appropriate wind conditions at the site and including an estimate of the spatially and temporally based uncertainty for the obtained results depending on the model types and coupling options selected. The short to long-term predictability models developed in Task 3.2 will be used to produce predictability maps at various horizons according to the end-user needs.

In odrer to accomplish these tasks it will be necessary to contract a post-doc (background in meteorology) with experience on CFD and numerical modelling.

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Para completar los apartados 3.3.1 y 3.3.2 debe utilizarse, siempre que sea posible, el cronograma usado para concurrir en la convocatoria internacional enumerada en el anexo I de la resolución de la convocatoria 2016. En su defecto, deben utilizarse los modelos propuestos.

3.3.1 Cronograma. Para cada objetivo debe indicarse: el investigador responsable del mismo, los participantes involucrados, el período de ejecución (expresado en trimestres) y los hitos y entregables esperados con indicación del trimestre previsto (Tx) para su consecución.
Máximo 32 000 caracteres

BSC Subproject

O1: Implementation of the model chain (WP3.4)
Person in charge : Arnau Folch
Participants : Arnau Folch, Matias Ávila, Post-doc
Execution : T1-T12
H1. Assist on the parallelization and installation of the open-source platform in the MareNostrum supercomputer (1 Pflop of peak capacity) during the duration of the project.
H2. Support NEWA members on the elaboration of competitive proposals to gain access to the PRACE HPC resources in order to enhance the production of the NEWA wind atlas simulations.

O2: Beta production run of the model chain (WP4.3)
Person in charge : Arnau Folch
Participants : Herbert Owen, Matías Ávila
Execution : T1-T6
H3. Methodologies for model validation using as benchmarking examples data from the experiments in Alaiz (complex terrain) and Kassel (forest) (T6).

O3: New European Wind Atlas database (WP4.3-4.6)

BSC and CENER will produce predictability information for the wind atlas for different forecasting horizons.

Responsible: **Francisco Doblas-Reyes**

Participants: **Francisco Doblas-Reyes, Albert Soret Miravet**

Execution: **T4**

H4. Beta production run: HPC facilities for the production run are granted; Fixed model setting for all models in the model chain, T4

E5. Report on model adjustments and specifications for final production run based on results from beta production run, T4

3.3.2 Cronograma (gráfico). En el cronograma marque la duración del OBJETIVO (X) y señale con H1...Hx los HITOS y con E1…Ex los ENTREGABLES, en su caso, de cada objetivo:

	Año 1 (trimestres)				**Año 2 (trimestres)**				**Año 3 (trimestres)**			
Objetivo	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
O1	X	H2	X	X	x	H2	X	H1	X	X	X	X
O2					H3	X	X	X				
O3	X	X	X	H4-H5								

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4. IMPACTO ESPERADO DE LOS RESULTADOS

Máximo 3500 caracteres

By developing a new Wind Atlas, this project will contribute to:

· **The reduction of the cost of electricity** generated by wind farms by mitigating risks related to the design and operation of large-scale wind turbines through an enhanced knowledge of wind conditions;

· **Better quantification of European wind energy potential**, and provision of data and models that can improve spatial planning tools and operations, ensuring an effective deployment of wind power.

The most significant implication of the new Wind Atlas is that a reduction of technical and financial uncertainties will accelerate the penetration of wind energy in the EU which should be beneficial for local industry. As a result, this project will contribute to **preserved/enhanced employment in the European wind energy sector**, as well as to a significant reduction in the cost of energy and CO_2 emissions. The reduced cost of energy will **increase competitiveness of the European wind industry**. The reduction of uncertainties will decrease the financial risk for investors, making wind energy a more attractive investment. This way, the project will **help Europe to maintain a strong position in terms of wind energy knowledge, technology, and deployment.**

The creation of the new Wind Atlas and the development of improved models **is only possible with the incentive of the NEWA ERA-NET PLUS Programme**. Although strongly committed to the project's objectives, the consortium alone would not be able to mobilise all the resources needed to reach the expected S&T advancements as early as 2019.

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5. DIFUSIÓN Y TRANSFERENCIA DE LOS RESULTADOS

5.1 PLAN DE DIFUSIÓN.

Máximo 4000 caracteres

This WP will be lead by CENER, in close cooperation with DTU. **Partners will also assist the EDM** (Exploitation and Dissemination Manager) **as required.**

Communication, Dissemination and Outreach – spreading results (lead by CENER and DTU)

The dissemination and communication activities will be performed as a continuous process with a timeline right from the beginning of the project and will involve all consortium partners. DTU, together with CENER, will establish how best to disseminate the project results with the partners of the consortium and publically. Every effort will be made during the course of the project to disseminate information about the goals of the project, ongoing activities, progress, results and the potential benefits and opportunities afforded by the development of the project concept. A specific part of dissemination/outreach activities will possibly be subcontracted to a third party, including communication material (design, set-up and maintenance of the project website and the project identity to be used in all publishable media) and workshops. The consortium is currently in dialogue with the European Wind Energy Association (EWEA) to take part on these activities and effectively help to disseminate project results with the involvement of the whole European area.

The dissemination and communication strategy will be defined to target different groups: stakeholders, policy makers, general public, scientific community (researchers and students), relevant industrial sectors, national and regional authorities.

Dissemination activities will include, inter alia, for the general public:

- Management of a project website (that will be updated continuously on the progress of the project and will be used as a repository of publishable reports);
- Publication of the results in the Commission's public websites and on the NEWA ERA-NET PLUS
- Joint Call brochure. The consortium will provide periodic reports that include a publishable summary of such quality that the Commission and the NEWA ERA NET PLUS Joint Call Secretariat can publish it right away in the public domain and will be understandable for a lay audience;
- General public events (e.g. seminars, open days at host institutions);
- Non-scientific press articles (e.g. CORDIS Wire, Outreach Magazine) and development of newsletters on the progress of the project.

Moreover, the following scientific dissemination activities are envisioned:

- Participation in conferences and workshops (e.g. EWEA Conference, EAWE Torque Conference, IEA Task 31 Wakebench and Task 11 Topical Expert Meetings, EERA WG1 workshops);
- Participation in and presentation at two NEWA status seminars (mid-term and final seminar);
- Elaboration of open-access publications through journals as well as self-archiving repositories;
- Set up of open model design benchmarks (WP3), managed at windbench.net to seek internacional collaboration through IEA-Wakebench and other forums;
- Publishing of the experimental database through winddata.com, as soon as the data are qualitychecked and documented;
- Publishing of open-source model-chain codes through windbench.net, as soon as the codes are verified and documented;
- Publishing of the European Wind Atlas database through the IRENA Global Wind Atlas GIS web platform

The measures proposed for communication and dissemination of project results will increase the impact of the project in the following way:

- Attract the interest of potential partners and public or private investors;
- Draw the attention of national governments and regional authorities;
- Encourage talented students and scientists to join the consortium research groups and enterprises;
- Enhance partners' reputation and visibility at local, national and international level;
- Generate market demand for the project results – enhance exploitation potential

Two workshops will be organized, one at the beginning of the project addressing end-user requirements and another one at the end of the project to summarize results, provide guidelines on the use of the NEWA databases and promote the exploitation plans of the project. These public workshops will be jointly organized with annual meetings.

In addition to these European-wide workshops, additional dissemination activities will be conducted at national level in some countries (e.g. Germany). This includes the set-up of a national industry mirror group, which is informed about the project plans and results and is invited to give advice and feedback to the project.

A Dissemination and Data Management Plan will be established at the beginning of the project on how the research data shall be handled during the project duration and beyond. Dissemination procedures for research results and data will be established to guide project participants and ensure open-access and long-term preservation.

5.2 PLAN DE TRANSFERENCIA Y EXPLOTACIÓN, en su caso, de los resultados del proyecto, incluyendo aquellas entidades interesadas en los resultados del proyecto, concretando su participación y/o aportaciones al desarrollo del mismo.

Máximo 4000 caracteres

The EDM will be responsible for the Exploitation plan for the Use and Dissemination of the Knowledge. This plan will include agreements between the parties as to the conditions for access to background IPR and the license agreements for use of both background and foreground IPR. These conditions will also be included in the Consortium Agreement, elaborated based on the DESCA model. The plan will detail how to exploit the project results in terms of additional R&D, commercialization and financing. In specific, the following items will be included in the Exploitation Plan:

- European Wind Atlas database: pre-agreement with IRENA for maintenance within the Global Wind Atlas database;
- Experimental database;
- Open-source model-chain codes;
- Other exploitation items related to the specific developments of each partner

As a result of the project, the consortium will identify knowledge gaps (experimental and modeling). A NEWA research roadmap will summarize this as background to guide future uses of the databases in other research projects. This roadmap will be initially implemented by the setting up of a European network using appropriate coordination and support actions under H2020 or COST. An application will be presented during the last term of the project to support this networking activity.

At Spanish level the project was supported by a large number of institutions as part of a call for Expression of Interest (EoI) launched by CENER by the end of 2012. The EoI report was submitted to MINECO to justify the relevance of the NEWA project both for industry and academia. In total 12 institutions participated in the EoI including large industry players like Acciona and Iberdrola and the Spanish Technology Platform REOLTEC (see attached letters of support).

The possibility to have access to high-fidelity experimental data to develop and validate models as well as the wind atlas methodologies that will be developed by NEWA were welcome as an inflection point in this technology, with high impact in reducing the cost of energy of wind energy deployment by reducing financial risk. At research level the experimental databases will be a very significant instrument for the development of meteorological models in the future.

Work Package Deliverables			Delivery month
D5.1	Project website and identity		3
D5.2	Dissemination and Data Management Plan		6
D5.3	Public workshop on end-user requirements		12
D5.4	General public events		24, 36, 48
D5.5	Press articles (non-scientific) and e-Newsletters		12, 24, 36, 48, 60
D5.6	Exploitation Plan		60
D5.7	Project results' description for the Joint Call brochure		60
D5.8	Public workshop on NEWA results and guidelines for end-users		60
D5.9	Participation in and presentation at NEWA mid-term seminar		30
D5.10	Participation in and presentation at NEWA final seminar		60
D5.11	Research roadmap for NEWA databases		60
Work Package Milestones		**Delivery month**	**Means of verification**
M5.1	Dissemination and Data Management Plan implemented	60	Dissemination and Data Management Plan approved
M5.2	European Wind Atlas database released publically	60	European Wind Atlas published

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6. RELACIÓN DE LAS PERSONAS QUE COMPONEN EL EQUIPO DE TRABAJO

Relacione las personas del equipo de trabajo que participarán en la ejecución del proyecto de investigación (de acuerdo con el artículo 26 de la convocatoria).
***Indique NOMBRE Y APELLIDOS** y las siguientes claves según proceda:*
TITULACIÓN: Doctor (D); Licenciado o ingeniero (L); Graduado (G); Máster (M); Formación profesional (FP); Otros (O)
TIPO DE CONTRATO: En formación (F); Contratado (C); Técnico (PT); Entidad extranjera (EE); Otros (OC)
DURACIÓN DEL CONTRATO: Indefinido (I); Temporal (T)

1. Arnau Folch Duran: D-C-I
2. Francisoco Javier Doblas-Reyes: D-C-I
3. Albert Soret Miravet: D-C-I
4. Matías Ávila: D-C-T
5. Herbert Owen: D-C-T
6. Post-doc: D-F-T

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7. IMPLICACIONES ÉTICAS Y/O DE BIOSEGURIDAD DE LA INVESTIGACIÓN PROPUESTA

Si en la aplicación electrónica de solicitud ha contestado **afirmativamente** en alguno de los aspectos relacionados con implicaciones éticas o de bioseguridad allí recogidos, explique los aspectos éticos referidos a la investigación que se propone; las consideraciones, procedimientos o protocolos a aplicar en cumplimiento de la normativa vigente, así como las instalaciones y las preceptivas autorizaciones de las que dispone para la ejecución del proyecto.

Máximo 8000 caracteres

The NEWA consortium foresees no ethical issues stemming from the developments proposed in the project. All the envisioned activities respect fundamental ethical principles, including those reflected in the Charter of Fundamental Rights of the European Union. This project does not involve the use of humans in any way and thus the issue of informed consent is not relevant in this case. Also, NEWA does not involve the use of animal species or methods.
No specific legal requirements are applied to the study. Permitting processes to run the experiments will be carried out at a Regional or National level.

8. PRESUPUESTO DE LA AYUDA SOLICITADA

Únicamente en el caso de proyectos solicitados a las convocatorias de la Empresa Conjunta ECSEL, desglose la ayuda solicitada en los distintos conceptos de gasto de acuerdo con la solicitud presentada en la convocatoria ECSEL.

		Presupuesto total (Total Costs)	**Subvención solicitada a MINECO**
Costes de personal		0,00 €	0,00 €
Costes de ejecución	Inventariable (incluida amortización)	0,00 €	0,00 €
	Fungibles	0,00 €	0,00 €
	Viajes y dietas	0,00 €	0,00 €
	Otros gastos	0,00 €	0,00 €
Total costes directos		0,00 €	0,00 €
Costes indirectos		0,00 €	0,00 €
Total coste del proyecto		0,00 €	0,00 €