

Next generation of wind models and EU27 Wind Atlas project

Ignacio Martí
Director Técnico Adjunto
CENER
imarti@cener.com





1. Limitations of existing regional maps

One example

2. Next generation of wind models

3. Measurement campaigns

4. Wind Atlas:

State of the art Wind Atlas

Advanced Wind Atlas

5. International interest in this projects

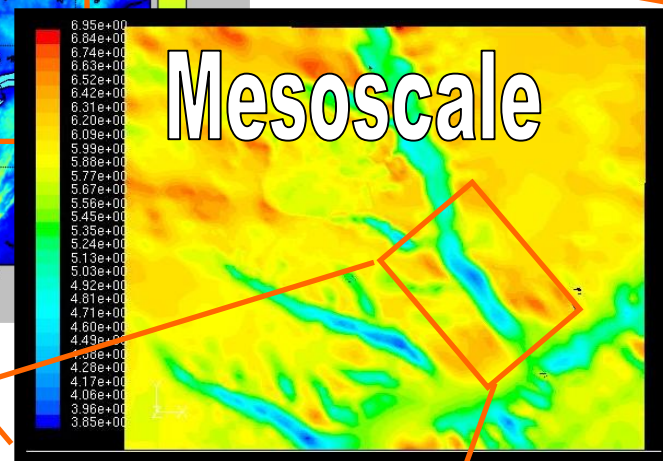
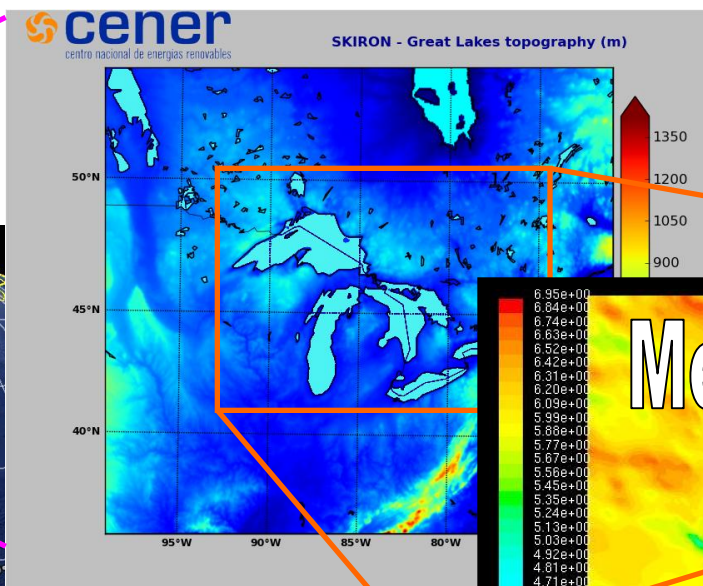
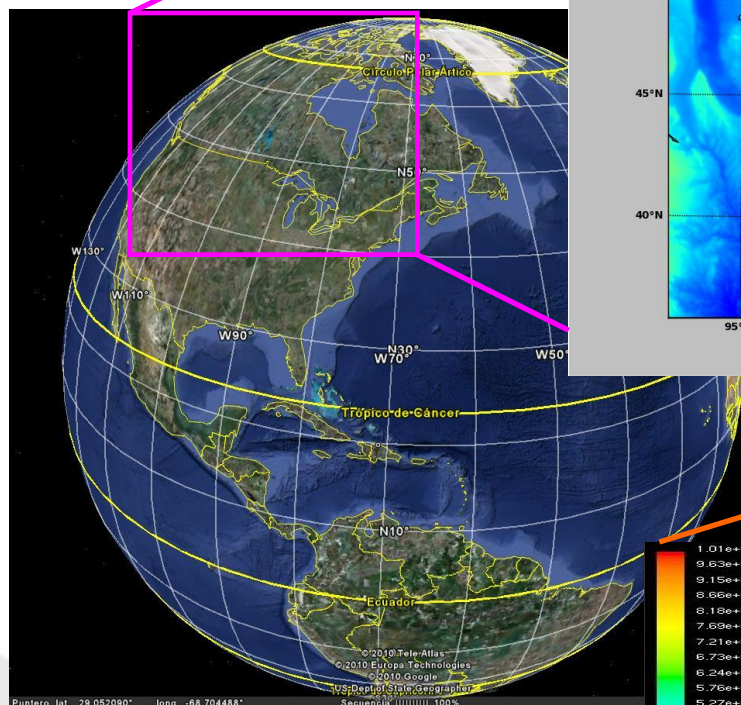
6. Conclusions.

7. Oportunidades para el sector

8. Apoyo desde CENER



Synoptic scale





🌀 Wind maps at regional scale are becoming popular, but limitations are important:

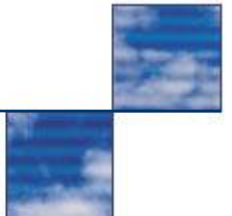
- ❑ There is a **lack of transparency** in the methodologies used (model description, parameterizations, input data, coupling of different models, etc) which makes difficult or impossible the verification of the results by third parties (this is a problem for financing institutions when due diligences or external audits are requested at project level). Commercial interests impose strong limitations to the transparency of the calculations.
- ❑ **Not enough validation** of mesoscale models in all relevant types of terrain and climate has been done (what implies a lack of confidence by the end users and financing institutions).
- ❑ Uncertainty is often not calculated or calculations are not based on extensive validations. This is a crucial limitation because the absence of properly calculated uncertainty is equivalent to **uncontrolled risk of the wind resources estimations.**





🌀 Wind maps at regional scale are becoming popular, but limitations are important:

- ❑ Some parameters that could be extracted from regional simulations (i.e. extremes statistics) **need more research and validation to be used safely.**
- ❑ **There is not a commonly accepted and scientifically demonstrated “model chain”**, covering from synoptic scale to wind farm scale.

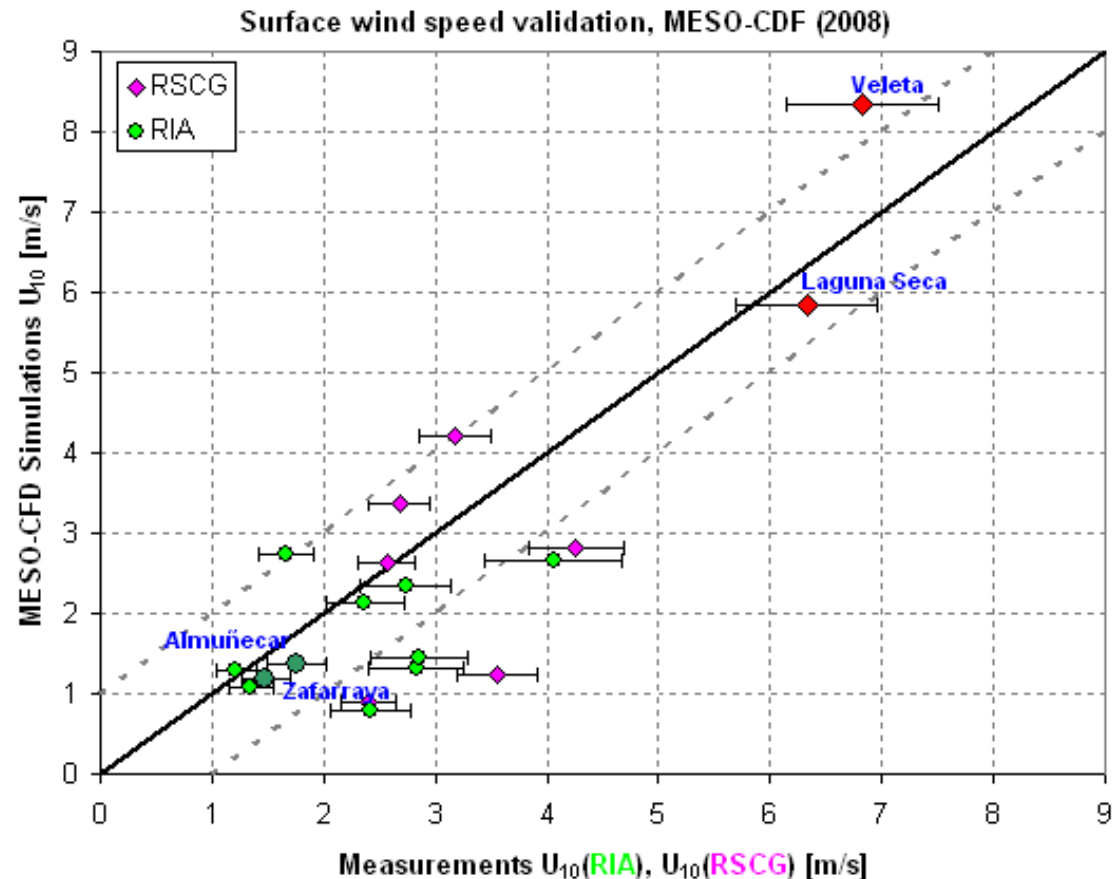




- Mesoscale model validation in a set of stations in Spain.
- CFD correction of the mesoscale model, still a number of sites with errors > 2m/s in average wind speed.

CENER

Mesoscale model
+ CFD validation



🌀 In order to achieve the objective of very high accuracy of the wind potential assessment (3% as long term reference), a **new generation of models** has to be developed:

- ❑ **Covering all scales** from synoptic to microscale.
- ❑ Based not only in local measurements but also in **global atmospheric databases** (i.e. reanalysis) and new measurement techniques.
- ❑ With much more detailed turbulence models, being able to give **information useful for the design of wind turbines**
- ❑ Considering **extremes** specifically (extreme winds, extreme shears, high wind variability, etc).
- ❑ Models being able to simulate onshore and offshore conditions, with stability effects and large offshore wind farms with cumulative wake effects and modified atmospheric boundary layer.



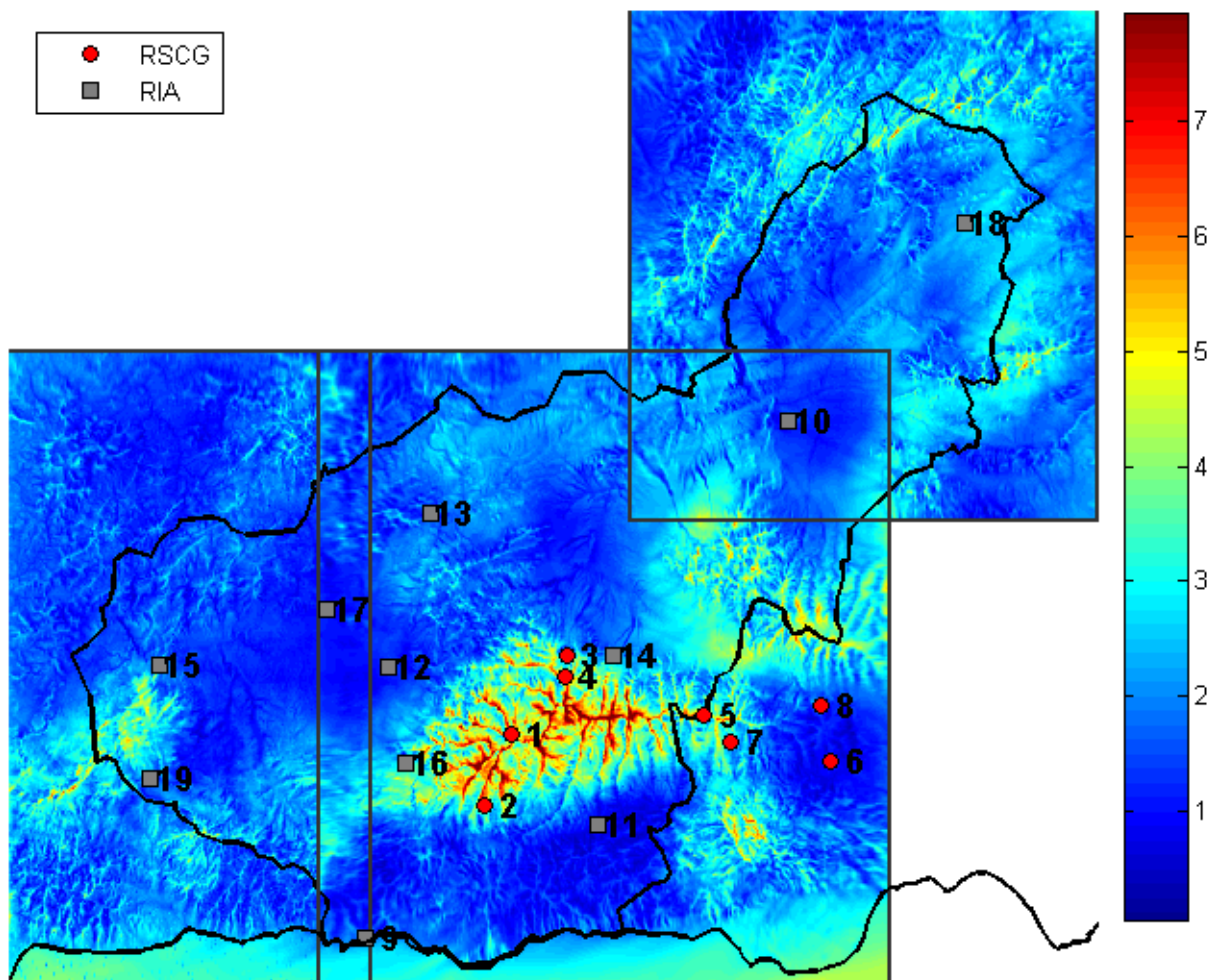


- 🌀 **Predictability** is an important factor especially when wind energy penetration is high. It will have a relevant impact in the business model and nowadays it is not properly considered.
- 🌀 **Open source models:** as a result of the project models will be developed, validated and published as open source to ensure the impact of the project and to guarantee the transparency.

- ✿ The basis for the next generation of wind models are the experimental campaigns as it has been in the past (Askerwein hill experiment).
- ✿ Intensive, scientifically designed and **with public databases**, they will allow present and future generations of researchers to know the details of the wind in some of the most representative geographic conditions for wind farms: complex and flat terrain, onshore and offshore, cold and hot environments, etc.
- ✿ This public databases with the results of the experiments will allow **the verification of models**, benchmarking, uncertainty estimation and as a consequence the **reduction of the risk in wind resources assessment and wind turbine design**.

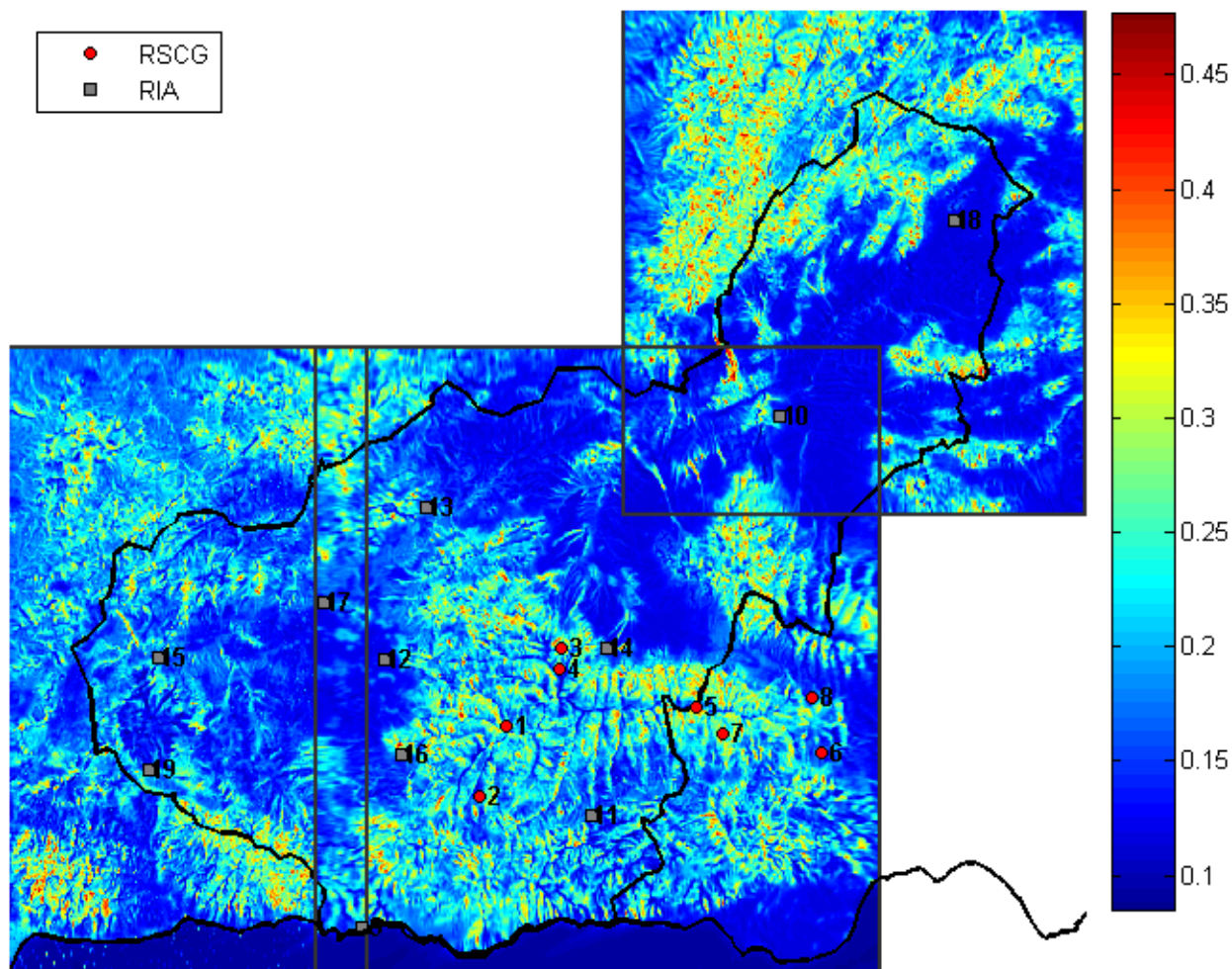
Average wind speeds

Mean velocity at 10m, MESO-CFD model (2004-2009) [m/s]

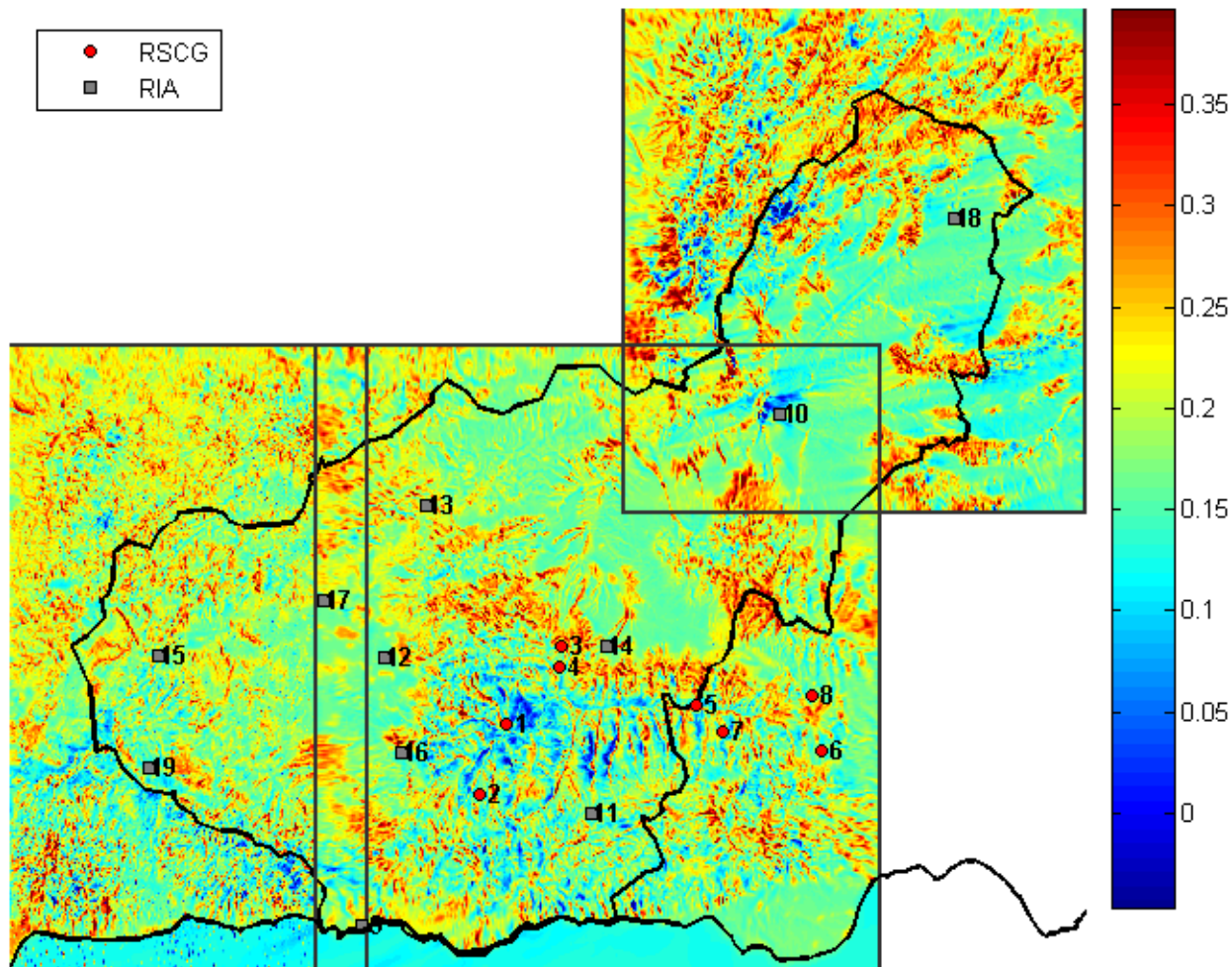
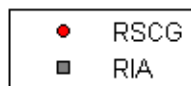


Turbulence intensity

Turbulence Intensity at 10m, MESO-CFD model (2004-2009)



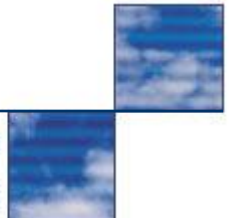
Wind shear exponent 70/100m, MESO-CFD model (2004-2009)



 Wind shear



- ✿ A new generation of wind models covering all relevant scales from synoptic to microscale are needed to reduce the present uncertainty. This is especially true for the mesoscale models where there is not a long trajectory in wind energy related applications. Opensource models.
- ✿ Measurement campaigns are needed to understand with deeper knowledge the characteristics of the wind; campaigns designed with a scientific focus, including the latest measurement techniques and resulting in public databases.
- ✿ A new Wind Atlas can be produced with clear a added value:
 - ❑ Based on the next generation of models (lower uncertainty).
 - ❑ With a homogeneous, transparent and scientifically established methodology.
 - ❑ Public database useful for the administrations, promoters, wind turbine manufacturers, financing institutions, insurance companies, researchers, etc.





- ☼ In February 2011 an international workshop was celebrated in Porto to discuss this project. 60 participants of R&D institutions from several EU countries and USA jointly with wind turbine manufacturers agreed that such a project would be beneficial for the wind energy sector.
- ☼ This project is one of the priorities in the European Wind Industrial Initiative (EWII). TPWind and EERA support actively the idea and have contacted many EU countries to get their support.
- ☼ The project budget could be in the range of 20 M€ with a duration of 5 years.





- ✿ Promotores: disponer de modelos que **calculan el recurso eólico, estelas y la producción energética de parques con menor incertidumbre**. Modelos en código abierto sin coste de licencias.
- ✿ Fabricantes de aerogeneradores: disponer de modelos que **calculan la clase del emplazamiento con menor incertidumbre**. **Modelos en código abierto sin coste de licencia**.
- ✿ Promotores, fabricantes y entidades financieras. Modelos muy verificados, aceptados por la comunidad científica y por la industria, lo que facilitará la interpretación y la **aceptación de los resultados por todas las partes** en el proceso de promoción de parques eólicos.
- ✿ Consultores en evaluación de recursos eólicos. Ofrecer **servicios de valor añadido** a partir de los modelos open source, pudiendo desarrollar nuevos módulos o herramientas de postproceso.
- ✿ CENER ya está trabajando con otros centros de I+D internacionales (Riso, NREL,...) en esta línea de trabajo



- 🌀 CENER ya está trabajando con otros centros de I+D internacionales (Riso, NREL,...) en esta línea de trabajo:
 - ❑ Modelo CFD para simulación de viento CFDWind en código abierto Openfoam, apoyado con 2 tesis doctorales. Operativa versión 1.0.
 - ❑ Modelo CFD para simulación de estelas CFDWake en código abierto Openfoam, apoyado con 2 tesis doctorales. Operativa versión 1.0.
 - ❑ Coordinación del proyecto europeo Marie Curie "WAUDIT" con 18 tesis doctorales sobre CFD.
 - ❑ Coordinación de la tarea de la Agencia Internacional de la Energía sobre validación de modelos de estela "WAKEBENCH".
- 🌀 El proyecto marcará un antes y un después en la evaluación de recursos eólicos.
- 🌀 El proyecto es una ERA NET+ lo que implica que parte de la financiación es nacional y parte de la UE. Actualmente estamos a la espera de que se apruebe el proyecto, se espera que la convocatoria pueda salir para Julio de 2012.

- ✿ CENER participa en las siguientes organizaciones relacionadas con el proyecto:
 - ❑ EERA:
 - ✍ Coordinamos el WP sobre infraestructuras de I+D.
 - ✍ Miembros del Comité de Dirección de EERA.
 - ✍ Participamos en todos los WP de EERA-JP Eólica.
 - ❑ TPWind:
 - ✍ Miembro del Comité de Dirección (Ignacio Martí).
 - ✍ Vice chair WG1 (Wind conditions).
 - ✍ Participamos en los demás grupos de trabajo.
- ✿ Desde esta posición relevante y con capacidad de influencia sobre programas de trabajo y definición de prioridades de I+D en Europa ofrecemos nuestro apoyo al sector eólico nacional, incluyendo centros de I+D y empresas.



Avda. Ciudad de la Innovación, nº 7
31621 Sarriguren. Navarra (España)

Tel. +34 948 25 28 00
Fax. +34 948 27 07 74
Email. info@cener.com

www.cener.com



 **cener**
centro nacional de energías renovables