

Business Plan

WindScanner.pt Research
Infrastructure

National Research
Infrastructure
(PINFRA/22207/2016)



WindScannerPT

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Summary

Wind energy is becoming one of the leading sources of power in Europe. The installed capacity increases each year, with the offshore wind gradually evolving with even more significant potential than onshore [1].

This growing tendency has also been promoting a more extensive research effort in this area, pushed by the climatic crisis that has also driven political support from multiple nations across Europe. Wind energy has employed over 250 thousand EU citizens and contributed to around 10% of European electrical consumption.

Although high milestones have been achieved, there is still much room to grow in the wind energy sector, particularly cost reduction.

Figure 1 shows the annual installed power in Europe [2].



Figure 1. Annual installed wind power in Europe.

The WindScanner.pt project aims to create a European distributed research infrastructure based on high precision sensors able to analyze fluid dynamics in tridimensional volumes, offering the ability to understand atmospheric conditions and turbulence better.

This asset will not only allow better assessment of the wind conditions. Still, it will also enable the evaluation of projects in other areas where fluid dynamics are relevant, such as civil engineering and the building industry, by scanning the surroundings of large structures such as bridges and viaducts and measuring structure oscillations [3].

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1. Introduction

The Portuguese WindScanner Research Infrastructure was, at the beginning of the process, intended to be one of the National Nodes of European infrastructure – WindScanner.eu. However, as the European IR did not move forward due to a series of situations related to the infrastructure financing rules of the various members of the European consortium, the Portuguese consortium nevertheless decided to go ahead with the planning of the implementation of the Portuguese infrastructure. Thus, in the next chapters, the preliminary business plan for the operation of this infrastructure is presented, which is an integral part of the final report of the windScanner.pt project.

1.1. The need and added value for Portugal

Portugal has the potential to be one of the most resourceful countries regarding wind energy [4]. The prominent growing process that's about to happen in this sector requires a strong research infrastructure that offers the ability to explore and develop emerging methods and technologies. Figure 2 shows the annual production in Portugal [5].

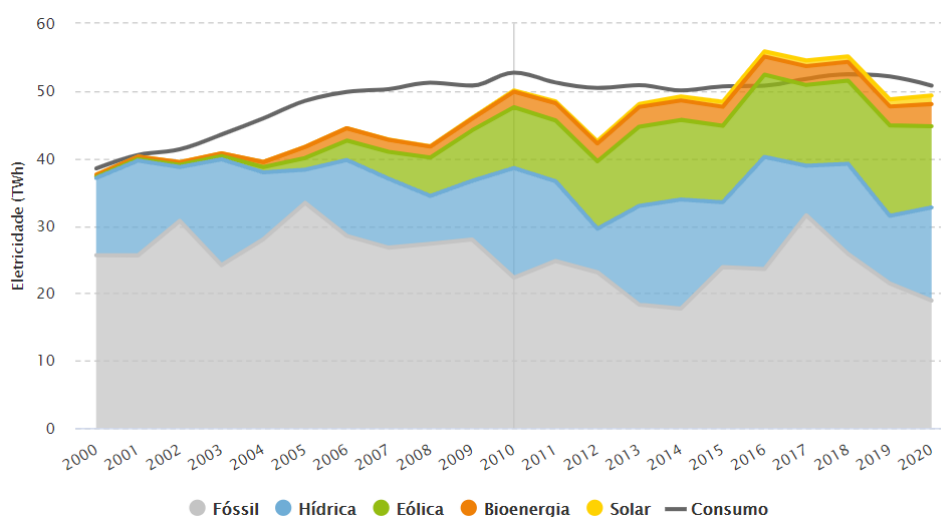


Figure 2. Annual energy production sources share in Portugal

WindScanner.pt aims to be a valuable contributor for the completion of this objective, by forming a wide European distributed research infrastructure. The main activity of this infrastructure will be the execution of experimental in-situ campaigns using high resolution sensors, with remote laser scanning technology. Bypassing the previous limitation of performing measurements on a single point using fixed measuring masts.

This new infrastructure will provide unique capabilities both to the industry and research sectors within the European continent, allowing users to analyse air flow and flow distribution around turbines, hills, forests and mountains, potentially expanding into other areas such as civil construction. These new implementations will drive wind energy development and turn it into a cheaper and more reliable source of energy.

This infrastructure will also be a large contributor to the expanding offshore wind sector, by providing detailed assessment of the wake phenomena occurring in offshore wind parks.

On the same way, the study and characterization of the wind (especially the 3D wind components) is valuable for other sectors where it's impact influences the behavior of socioeconomic activities, construction of large structures and transports. Special relevance can be given to airports when they are located in areas with difficult meteorological and phenomena – an example is the Madeira Island. In this sense, the knowledge of the wind behaviour will certainly improve the development of several activities in the most diverse sectors, bringing new methods for safety procedures, wind resource evaluation, atmospheric turbulence and other.

Finally, the last main goal is to build a large research data access platform, with cooperation between multiple users/stakeholders and information from multiple campaigns performed across Europe, to contribute to knowledge sharing and optimization of technologies and methods for the improvement of the wind related activities.

The main problem this product will attempt to solve is risk-reduction in large scale engineering projects. The risk-reduction is possible due to the acquaintance with fluid dynamics and turbulence that might affect structures and their surroundings, offering customized information on the atmospheric and construction conditions of the project (extreme conditions, oscillations, construction defects, etc.). The WindScanner.pt infrastructure will provide the service directly via experimentation and simulation scenarios based on the information for the task. The client will have better security and safety conditions for their projects and obtain a higher return on investment.

1.2. The WindScanner technology and measurement systems

Experimental measurements related to wind assessment are usually done through conventional anemometric sensors permanently installed, with towers, in a specific point of a target site. WindScanner provides a considerable upgrade from this type of technology, with a remote, tridimensional, long-range and high-precision method of evaluating wind flow, as these instruments also have the ability to measure parameters several km away from its source. This feature is only possible through multiple LiDAR associations, as a single LiDAR scanner doesn't have the ability to measure both wind speed and direction. Figure 3 shows an example of the WindScanner technology [6].

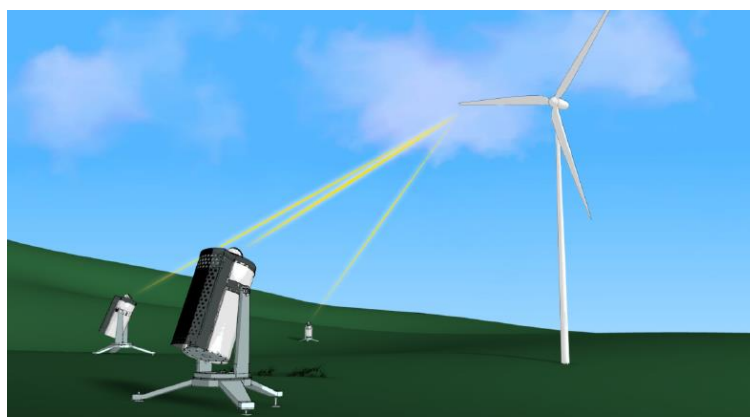


Figure 3. WindScanner technology

WindScanner technologies consist in a variety of different sensors that differ from each other mainly on their range of measuring, typically the best option relies on combining both of these technologies in experimental campaigns.

Short-range WindScanners cover up to 250 m, with future improvements they can go up to 300 m. While long-range WindScanner covers distances of around 10 km, and has the potential to cover up to 30 km in the future, but with less resolution.

This infrastructure also includes the logistical equipment for campaigns, such as transportation, lifting equipment, power supplies, surveying equipment, etc.

Although the WindScanner facility mainly relies on the use of remote sensors such as high-precision LiDARs, its campaigns also benefit from the use of other types of measurement systems such as meteorological towers and masts, sondes, ground sensors and other monitoring equipment. This wide range of equipment allows one to better assess the site's weather and wind conditions, while also providing an alternate and less sensible wind measurement source. Anemometric towers are the most conventional mode of experimental wind resource evaluation. This technology consists of the installation of wind masts/anemometers on fixed towers, on a particular location and height. This equipment usually can operate for larger periods compared to LiDAR sensors (1 year or longer), providing information in 10-minute intervals of the wind speed and direction.

The Perdigão Field Experiment (Fernando et. al) performed in 2017 joined a large group of partners to assess the flow characteristics in Vale do Cobrão, Portugal. This wide variety of partners also allowed the use of a large variety of measuring instruments and systems during the campaign, including 49 towers, 26 LiDARs, SODARs, radiosondes, radiometers, seismometers, microbaremeters, and a few other instruments. The towers installed at the site also recorded other parameters rather than wind speed and velocity, such as temperature, heat and moisture.

2. Business model

2.1. Value proposition

Monitoring and evaluation of risk in large scale engineering projects is usually done through experimental tests with aerodynamic tunnels, for simulation of real-life conditions. These types of techniques might not be as accurate or precise as they need to be, as natural conditions have a high level of complexity, and are very hard to replicate in a laboratory environment.

The WindScanner service brings an evolution to the conventional forms of studying aerodynamics in large scale constructions. Clients will now be able to monitor the conditions at real time in the project's location, using high precision sensors able to measure fluctuations in the project's components. The experimental part of the project will now be performed in real life situations, increasing the precision of risk analysis.

This will help engineers and project managers to provide clients with safer and more robust constructions, consequently increasing security in buildings and in the population.

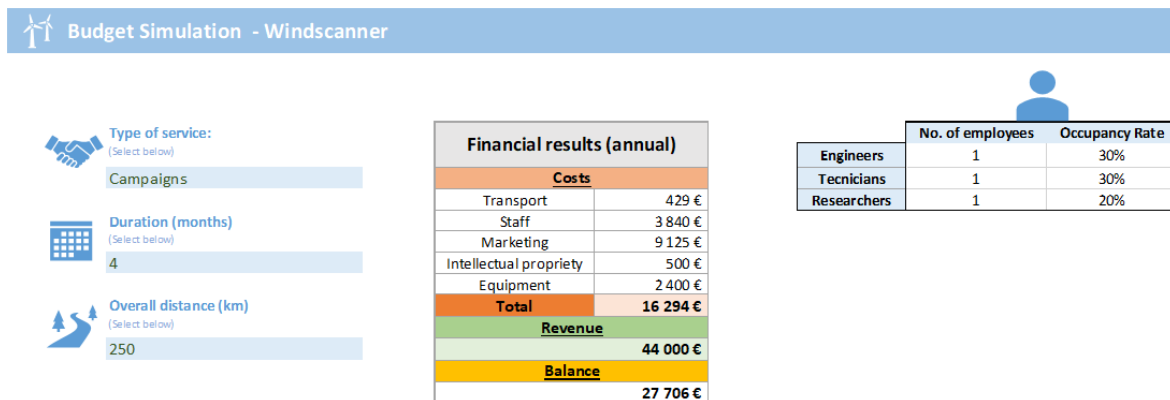


Figure 4. WindScanner.pt Budget Simulator

2.2. Key Activities

The project's activities will be related to problem-solving but also networking information and knowledge:

- Notoriety - Firstly, the product/project must be noticed and recognized as a new tool in the market.
- Value spreading - The first step is related to the second one, where the project will promote and extend the value of the information the product provides.
- Execution - The third step will be planning and executing the project itself with the clients.
- Development - Finally, the aim will be to push further into the project developments by improving its notoriety and technology, aided by the project stakeholders and customers.

On the same way, the WindScanner.PT infrastructure will provide the users a set of services that will, on one hand, improve and maximize the use of the windscanner technology, and on the other, contribute for the development of the wind sector. Examples are listed in Table 1 [1]:

Table 1 - Application examples

Scientific research: <ul style="list-style-type: none"> - Wind turbine inflow and their induction zones - Wind wake interactions - Boundary layer meteorology - Testing and validation of methods and models - Wind effects on structures - Atmospheric modelling - Wind turbine and wind farm control - Dispersion of pollutants - other 	Commercial use: <ul style="list-style-type: none"> - Wake effects - Power performance of wind turbines - Prevision of inflow for feed-forward control - Rotor design, wind turbine and wind farm control - Power production optimization - Resource assessment - Meteorological applications - Turbulence and wind effects on airports - other
Other usage: <ul style="list-style-type: none"> - Risk/safety (Turbulence, 3D wind speed) - Air traffic control 	Air pollution studies: <ul style="list-style-type: none"> - Wind Flow above and within urban areas - Better understanding of dispersion of pollutants
Meteorology: <ul style="list-style-type: none"> - Short-term forecasting of localized extreme events (e.g. wind speed ramps) 	Civil construction industry: <ul style="list-style-type: none"> - Turbulence and coherence of wind approaching buildings and bridges

2.3. Key Resources and Partners

The type of resources needed for the project will depend on its scope, duration, and dimension. It will consist of:

- Equipment (WindScanner technologies, sensors of distinct types, software, and staff equipment).
- Human (investigators, technicians, teachers, and engineers) and Intellectual resources, such as the knowledge of the software and hardware of the equipment and the ability to transform its data into useful information for the user/customer.

The key partners should ensure three major features: supply, resources, and activities. The consortium will agree as to what role each partner should play. There are known and established partners, the WindScanner infrastructure members, but some more partners can be involved in the future, depending on the missing parts of the project that present partners cannot ensure. The main drivers for the partners' interest will be optimization, economy, risk and uncertainty reduction, acquisition of information on resources, and planning activities.

2.4. Customer segments

The primary customer segments will be engineering, research and education.

The consortium will focus on the research and educational level of Universities, Research Centers, and Institutes from multiple areas (Meteorological, Architecture, Building Physics).

At the engineering level, the consortium will focus on construction companies that deal with bridges, viaducts, skyscrapers, or any other large dimension constructions that might experience some flow-induced risks related to their building or the surroundings. Wind Energy, navigation and transportation in ports and airports is also an engineering market for the consortium activities.



Figure 5. The complexity of the terrain that cannot be reproduced in control laboratory conditions or be simulated

2.5. Customer relationships

At customer relationship level there is the need to determine what type of relationship the customer expects to have with the project and the product, also what are the already existing relationships, how these relations are integrated in the business model and,

finally, how much will it cost to maintain relationships with the customers. This feature is going to be defined in future group meetings [7].



Figure 6. Customer relationships

2.6. Channels

At the basic level, business model channels are the mechanism for communicating with and delivering our value propositions to our customer segment. What channels have in common is that touchpoints play a critical role in customer satisfaction and customer retention. Channels are typically broken down into types: distribution channels; communication channels. The distribution channels are how the RI will get the service to the customer. The communication channels are how the RI will reach the customer segment. Communicating with them is vital to growing the business. The RI will explain your value proposition, influence potential customers, and close sales by the communications. For this RI, the distribution and communication channels are simultaneously the same entities members of the RI.

The communication goals are to:

- Raise awareness among customers about the RI business and service;
- Communicate clear and in a short amount of time the RI's value proposition;
- Influence customers to permit the RI to communicate with them.

Customers often require a degree of persuasion, which is done through a marketing funnel prepared after the RI creation.

After purchasing the service, the communication channels are used to maintain a relationship and have repeat purchases.

Notoriety demands an independent visual identity, parallel and complementary communication via the members own networks, social media, websites, and promoting partners webinars, events complemented by the concerted diplomatic moves.

2.7. Cost structure

Cost structure refers to the various expenses a business incurs and is typically composed of fixed and variable costs. Fixed costs remain unchanged regardless of the amount of output a company produces, while variable costs change with production volume. The fixed charges are incurred regularly and are unlikely to fluctuate over time. A vital feature of this RI is that the fixed expenses are meagre compared to traditional infrastructures once embedded and distributed over the country, recurring to the member's buildings. Examples of fixed costs are overhead costs such as rent, interest expenses, property taxes, and depreciation of fixed assets. One particular example of a fixed price is direct labour cost.

The variable costs are expenses that vary with production output. Examples of variable costs include direct labour, direct material, utilities, bonuses and commissions, and marketing expenses. Variable costs tend to be more diverse than fixed costs. For project-based businesses, in this RI case, costs such as wages and other project expenses are dependent on the number of hours invested in each of the projects. The cost fluctuations due to different project characteristics were included in the simulation model.

The main costs of the project will be related to:

- Equipment needed for the campaigns and project execution.
- All types of insurances related to equipment and other assets.
- Transport and travel for workers and equipment.
- Intellectual work (knowledge), that will be provided from our partners and workers.
- Promotion, dissemination, and marketing related to the project.
- Intellectual propriety, to protect the project's unique identity and value.

2.8. Revenue

To obtain a financial balance of the project's activities, one also needs to estimate the revenue related to the activities done in the infrastructure, analyzing the main sources of profit.

The main sources of revenue of the project will be:

- Lending, renting, or leasing. By offering the customer the possibility of temporary use of the product or the product services.
- Measurement campaigns, which will consist of paid campaigns where the project provides real time information and analysis to the customer.
- Projects that can be funded via public or private institutions and will have dynamic pricing based on negotiation, yield and current market.
- Asset sale, by making data obtained from projects and campaigns available to the customers.
- Advanced courses, teaching the knowledge aspects of the project (working with the hardware/software and transforming data into useful information).
- Brokerage and success fees, by being entitled to fees based on the success of the customers (how much the customer was able to save or profit due to the project).



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- Advertising, by disseminating other products or companies along with our project.
- Visits done by students and universities interested in the project.

3. Final Notes

This document presents the preliminary business plan for the operationalization of the Research Infrastructure WindScanner.PT. The main activities to be developed are presented as well as the target groups that will beneficiate from the foreseen services.

To support the activities, during the first phase of the activities of this RI, the business plan will be updated with the cooperation of all the RI members and published on the dedicated web platform already under development.

4. References

- [1] Knudsen S S 2015 WindScanner.eu Business Plan 1–37
- [2] WindEurope 2021 Wind energy in Europe windeurope.org 2020 Statistics and the outlook for 2021-2025 1–37
- [3] Fernando H J S, Mann J, Palma J M L M, Lundquist J K, Barthelmie R J, Belo-Pereira M, Brown W O J, Chow F K, Gerz T, Hocut C M, Klein P M, Leo L S, Matos J C, Oncley S P, Pryor S C, Bariteau L, Bell T M, Bodini N, Carney M B, Courtney M S, Creegan E D, Dimitrova R, Gomes S, HaGen M, Hyde J O, Kigle S, Krishnamurthy R, Lopes J C, Mazzaro L, Neher J M T, Menke R, Murphy P, Oswald L, Otarola-Bustos S, Pattantyus A K, Veiga Rodrigues C, Schady A, Sirin N, Spuler S, Svensson E, Tomaszewski J, Turner D D, Van Veen L, Vasiljevic N, Vassallo D, Voss S, Wildmann N and Wang Y 2019 Peering into microscale details of mountain winds *Bull. Am. Meteorol. Soc.* **100** 799–820
- [4] The Royal Academy of Engineering 2014 *Wind energy: Implications of large-scale deployment on the GB electricity system*
- [5] En P T, Associados A, Renov E, Publica V, Legisla E S C and Produ N 2019 Produção Balanço da Produção de Eletricidade de Portug (julho de 2019) Evolução da Produção de Eletricidade por Fonte em P Balanço da Produção de Eletricidade na Região Autónom 2017–20
- [6] Anon 2019 Big Data Europe 2019
- [7] Anon Picture 4325014