



Sustainable Energy Authority of Ireland

National Energy Research,
Development & Demonstration
Funding Programme

FINAL REPORT TEMPLATE

SECTION 1: PROJECT DETAILS – FOR PUBLICATION

Project Title	Development of a data management platform and open-source data analysis library for wind & solar resource data enabling industry cooperation and research.
Lead Grantee (Organisation)	Brightwind Ltd.
Lead Grantee (Name)	Stephen Holleran
Final Report Prepared By	Stephen Holleran
Report Submission Date	29 July 2021

	Name	Organisation
Project Partner(s)		
Collaborators		

Project Summary (max 500 words)

4 GW of additional wind energy capacity is expected to be built in Ireland by 2030. Open wind resource datasets for research purposes would contribute to reaching this target and can also contribute to optimising their energy export to the grid once built. For example, to improve site selection and ensure that these projects are located on the windiest sites, more open resource datasets could further validate the available wind maps. For optimising energy export, open resource datasets can contribute to research developments in short term wind power forecasting allowing EirGrid to optimise the wind farms around the country. Getting access to high quality reliable wind resource data is very challenging with lack of data standards and lack of data sharing amongst the industry.

This project aims to deliver a platform, [BrightHub](#), that would allow cloud-based open access to

wind and solar resource data which could be used to improve the research and validation of nationwide resource maps and short-term forecasting of renewable energy. By collating wind and solar resource data on an integrated platform, traditionally difficult to manage data can now be made available to both academia and industry for research purposes. This platform is the first implementation of the new internationally recognised IEA Task 43 WRA Data Model standard which allows the data to be automatically parsed and used directly in data analysis enabling big data scientific research. The availability of standardized datasets acquired at multiple points around the country will provide a valuable resource for the improved calibration and validation of the models which are used to derive short-term weather forecasts and national scale wind and solar resource maps. These open datasets will also contribute to other research projects that are not even known to us yet.

As a result of this project there is now an open access data platform that can host wind & solar resource datasets for locations in Ireland. There are currently 5 datasets with more in the pipeline to come. There is huge opportunity to encourage other organisations to share their data and provide a valuable data resource for Irish research and development.

Another impact of this project and launching BrightHub is that BrightWind are considered experts in wind resource data management and platform development incorporating the IEA WRA Data Model. As a result, we are consulting one of the world's largest renewable electricity provider as a Product Owner in the development and build out of their own internal wind resource data management and analysis system. This is a huge achievement for a small Irish company providing such critical, intellectual services to such a large player in the global renewables market. This is a successful outcome of one of SEAI's remits to provide energy-related products and services internationally.

Keywords (min 3 and max 10)

Wind, Solar, Resource data, Data science, Open-Source, Software, Resource Maps, Big Data Analysis

NB – Both Section 1 and Section 2 of this Final Report will be made publicly available in a Final Technical Report uploaded online to the National Energy Research Database.

In the following Section, please provide a clear overview of your project, including details of the key findings, outcomes and recommendations. The section headings below are provided as a guide, please update or add to these as best suits your project.

By submitting this project report to SEAI, you confirm you are happy for Section 1 and Section 2 of this report to be made publicly available. If you wish to request edits to this section in advance of publication, please contact SEAI at EnergyResearch@seai.ie.

SECTION 2: FINAL TECHNICAL REPORT – FOR PUBLICATION

(max 10 pages)

2.1 Executive Summary

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2.2 Introduction to Project

4 GW of additional wind energy capacity is expected to be built in Ireland by 2030. Open wind resource datasets for research purposes would contribute to reaching this target and can also contribute to optimising their energy export to the grid once built. For example, to improve site selection and ensure that these projects are located on the windiest sites, more open resource datasets could further validate the available wind maps. For optimising energy export, open resource datasets can contribute to research developments in short term wind power forecasting allowing EirGrid to optimise the wind farms around the country. Getting access to high quality reliable wind resource data is very challenging with lack of data standards and lack of data sharing amongst the industry.

BrightWind estimate that these projects will require approximately 200 new meteorological masts to measure the resource, not to mention solar measurement stations to support solar projects.

National wind maps are limited in accuracy due to their wide extent and the limited number of measurement points available for calibration. Over the years, BrightWind have compared existing SEAI wind maps with data from more than 70 meteorological masts and identified discrepancies of up to 20%. Calibration and validation data from measurement stations is required to improve the numerical models upon which these maps are based.

Combining historical, current and yet to be deployed measurement stations, if a portion of these could be open this represents a great opportunity for the improvement of national wind and solar reference maps and short-term energy forecasting.

A second issue identified is that to date perceived commercial sensitivities in the renewable energy industry have led to the parallel development of data analysis tools owned by individual stakeholders that all do the same thing. This in-house development of software creates a closed siloed environment where errors can propagate, and non-standard methods are developed. It also takes huge effort to create these data analysis tools. The perceived commercial sensitivities are unfounded, and it is just effort that is been protected. By having all these varied, closed, dispersed software tools creates a barrier to entry for others such as researchers or data analysts from smaller organisations. It also means that methods are a lot more difficult to standardise leading to confusion and conflicts which can then delay development projects when Bank's Engineers are required to review work.

2.3 Project Objectives

This project aims to deliver a platform, [BrightHub](#), that would allow cloud-based open access to wind and solar resource data which could be used to improve the research and validation of nationwide resource maps and short-term forecasting of renewable energy. By collating wind and solar resource data on an integrated platform, traditionally difficult to manage data can now be made available to both academia and industry for research purposes. This platform is the first implementation of the new internationally recognised IEA Task 43 WRA Data Model standard which allows the data to be automatically parsed and used directly in data analysis enabling big data scientific research. The availability of standardized datasets acquired at multiple points around the country will provide a valuable resource for the improved calibration and validation of the models which are used to derive

short-term weather forecasts and national scale wind and solar resource maps. These open datasets will also contribute to other research projects that are not even known to us yet.

In parallel, the project also aimed to deliver an open-source analysis library, [BrightWind](#), which would set standard methodology in the processing of wind and solar data, placing Ireland at the cutting edge of international class RD&D in the wind industry. The library provides wind analysts and researchers with easy-to-use tools for working with meteorological data. It supports loading of meteorological data, averaging, filtering, plotting, correlations, shear analysis, long term adjustments, etc. The key benefits to an open-source library is that it provides complete transparency and traceability. Anyone in the industry can review any part of the code and suggest changes, thus creating a standardised, validated toolkit for the industry. By being open-source it also removes a barrier to entry for data scientists and researchers to perform industry leading analysis on their data.

By combining industry specific expertise in the management and analysis of wind and solar data with current best practice in the development of scalable and resilient software systems, the project delivers a cloud-based platform to host open resource datasets and an open-source library for the integration, dissemination and analysis of measured wind and solar data. This powerful combination will contribute significantly to research projects focused on renewable energy.

The platform will be structured to ensure data validation and traceability as changing configurations are documented and version controlled. Similarly, the open-source library allows for external validation of and traceability of the analysis techniques, offering significant improvements in the ease and quality of due diligence review. This also ensures that the data shared with researchers is of high quality.

The above two products, BrightHub and BrightWind, will contribute to developing, in the Irish marketplace, a competitive renewable energy related product in BrightHub, and can contribute to the acceleration of new research which develops new products, processes or services.

In addition, it raises the BrightWind profile as an international company that offers renewable resource data management services globally, creating high quality jobs and expertise here in Ireland.

2.4 Summary of Key Findings/Outcomes

- BrightHub launched

BrightHub (<https://brighthouse.io/>) is an open access platform providing wind & solar resource data. This open and free standardised data is a valuable resource for academic and industry research. Such a platform does not exist anywhere else in the world and this is the first use case of the internationally recognized IEA Task 43 WRA Data Model.

- BrightWind released

BrightWind (<https://github.com/brightwind-dev/brightwind>) is an open-source Python library that aims to empower wind resource analysts and establish a common industry standard toolset. It breaks down barriers to performing big data analysis on wind & solar resource data for data analysts and researchers alike.

2.5 Project Impact

As a result of this project there is now an open access data platform that can host wind & solar resource datasets for locations in Ireland. There are currently 5 datasets with more in the pipeline to come. There is huge opportunity to encourage other organisations to share their data and provide a valuable data resource for Irish research and development.

Utilising the internationally recognised IEA Task 43 WRA Data Model standard, the data from this platform is moving towards meeting the [FAIR principles](#) (Findable, Accessible, Interoperable, Reusable) which are guiding principles for “scientific data management and stewardship.” This allows the data to be automatically parsed and used directly in data analysis enabling big data scientific research.

As an example of this platform, the publications and the openness of this project, a final year ME in Energy Systems Engineering student in UCD, Rachel Duggan, has used both the BrightWind library and some wind datasets from BrightHub for her final year project entitled “*An Investigation of Multivariate Machine Learning Algorithms to improve Measure-Correlate-Predict for Wind Resource Assessment*”. This is just one example that we heard of and there will surely be many over the years to come. These research projects will contribute to the efficient development and operation of the 4 GW of additional wind energy capacity expected to be built in Ireland by 2030.

Another impact of this project and launching BrightHub is that BrightWind are considered experts in wind resource data management and platform development incorporating the IEA WRA Data Model. As a result, we are consulting to [RWE Renewables](#) as a Product Owner in the development and build out of their own internal wind resource data management and analysis system. RWE Renewables are one of the world's largest owners and developers of renewable energy projects with up to €5 billion available for renewables and innovative storage technologies by 2022. The Americas, their European core markets and new markets in the Asia Pacific region are their main focus. This is a huge achievement for a small Irish company providing such critical, intellectual services to such a large player in the global renewables market. This is a successful outcome of one of SEAI's remits to provide energy-related products and services internationally. *(Note: I would need to get approval from RWE Renewables if this is to be published.)*

The BrightWind Python library is slowly gaining traction in the industry and is already proving very useful. Along with the example above another example is from a wind analyst using the library in conjunction with timeseries wake modelling for producing offshore wind energy yield assessments. This demonstrates the usefulness and power of the library in both industry and research and is a complementary product to BrightHub and the promotion of BrightWind as a global leader in this space.

2.6 Recommendations

This project is the start of developing an open and sharing environment for wind & solar resource data that can be used for research purposes. Two potential research opportunities could be in improving the short-term wind power forecasting output from wind farms allowing EirGrid to optimise the grid around the country. The second could be to improve wind farm site selection, ensuring that these projects are located on the windiest sites, by further validating the available wind maps. Both potential research projects would rely heavily on high quality hub height wind data from various locations around the country. These datasets can be hosted on the BrightHub platform making them accessible to the research community.

2.7 Conclusions and Next Steps

BrightWind has successfully completed the project with the launch of BrightHub and the release of the BrightWind Python library.

Further work could be to develop BrightHub into a global open access repository of wind & solar resource data for nationally sponsored programs, research organisations, and project developers/owners who wish to share their data. It could also empower industry analysts and researchers to find, access, understand and trust input data for their research leading to better insights across the industry. A critical component of this is to make it efficient to gather, upload and insert meta data in the form of the IEA Wind Task 43 WRA Data Model and to build tools to validate the meta data so industry analysts and researchers can immediately process and have trust in the quality data they are using.

To enable a global reach and host large numbers of datasets, a more efficient toolset for 3rd party data owners to upload their own data and not rely on BrightWind staff is required. A significant amount of information, meta data, needs to be gathered to give meaning to the time series wind data measured by a met mast. This meta data comes from several sources such as the mast installer's installation and maintenance reports, the logger programme, site photos and the data files themselves. A future development could be to develop a toolset that can automate the meta data gathering as far as possible and build user friendly, intuitive web applications for the remaining meta data that would need to be inserted manually. On top of that a toolset that can contribute to the validation of the meta data gathered and inserted will ensure industry analysts and researchers can trust the data they use. These tools do not exist and would be a critical component in processing significant numbers of datasets to grow the platform and encouraging 3rd party data owners to share their data.

It is currently not possible to process the large amounts of data involved in wind & solar research activities (such as developing new machine learning algorithms) directly where the data is hosted and utilising cloud computing. A further development could be to incorporate the open-source brightwind Python library into BrightHub to enable this. This would bring together the two components of this project together into a cloud-based data analysis application. It would allow industry analysts and researchers to perform analyses directly in the platform removing the technical barrier of managing, downloading and uploading large amounts of data from one system to another. It also utilises cloud computing to perform the analyses enabling large processes to be performed. In addition, we could incorporate other tools and datasets such as reanalysis datasets (MERRA-2 and ERA5) for long-term analysis. This has the potential to provide all the tools and datasets to perform a bankable wind resource assessment speeding up the process and making it traceable.