



aphelion
wind

**Multifunctional
energy and weather
forecasting platform.**



Aphelion.com.es



About Aphelion

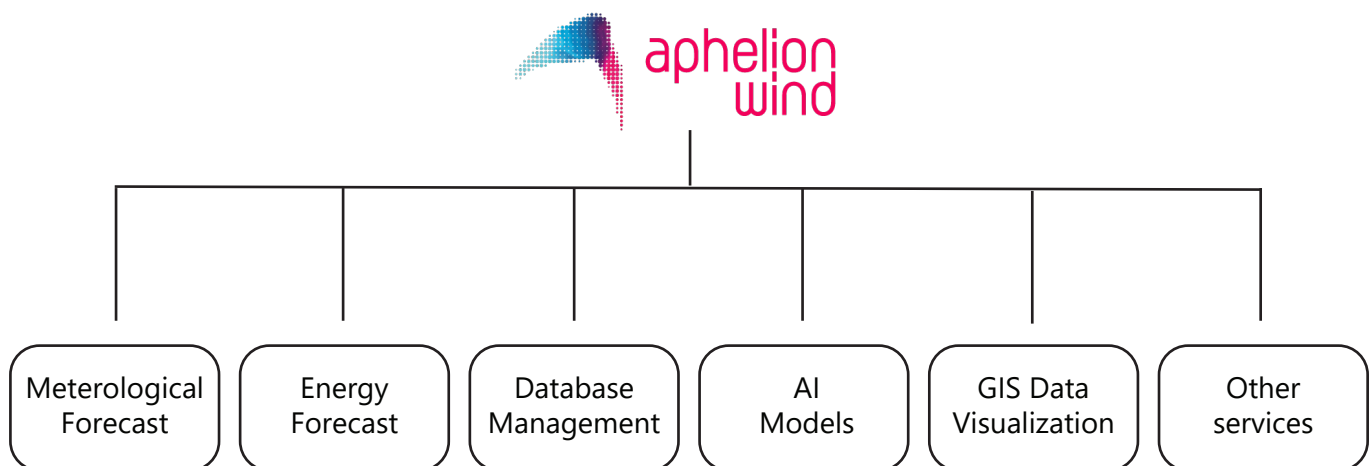


Meteorological forecast services from a multimodel perspective

Aphelion is a platform which offers meteorological forecast services focused on giving support and contributing on the decision-making process within the renewable energies industry.

Our meteorologists, data scientists, and software engineers are specialized in tools optimization in order to obtain the most accurate forecast for a wide variety of projects and clients.

From a high-resolution forecast, Aphelion offers meteorological and energy forecast as well as climate consultancy within a two-weeks time horizon. Moreover, these capacities can be useful for both as company-driven and particular-driven services.



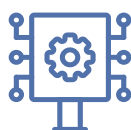
Backed and developed by experts



Meteorologists



Data scientists



Software Engineers

3 | Meteorological models data

6 | Machine Learning Architectures

+ 15 | Meteorologists & WRA experts

+ 10 | Countries where Projects

Hybrid Model

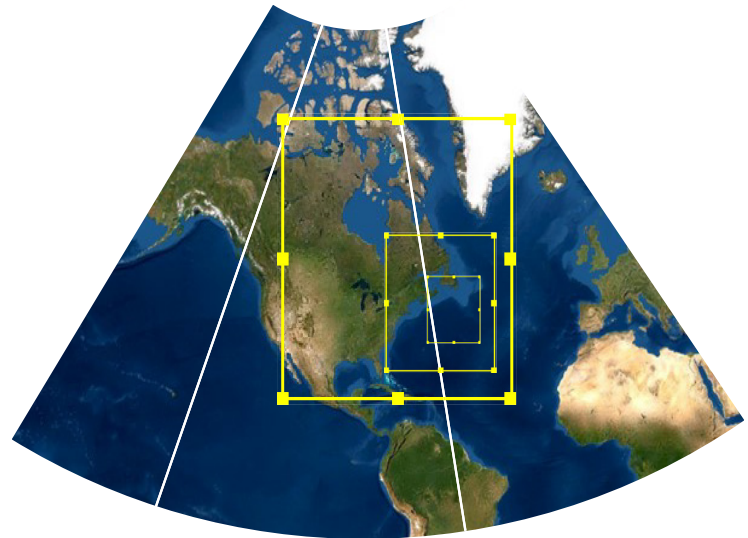


Aphelion's engine

The most important meteorological agencies, on a global scale, provide initial data for the hybrid model.

The model combines sequentially:

- Wide NWP database (historical and operative)
- Dynamical downscaling through limited area models. High resolution topography data base for accuracy representation of wind flow at surface.
- Statistical downscaling through machine and deep learning algorithms optimization



Machine learning + WRF Model

All strategies convert a general forecast into a local forecast

Aphelion WRF Model

**High-resolution modeling
O&M**
(3 km - 1 km)

Global coverage
Software MQWRF allows
optimization of WRF model at any
site

Assimilation system
for 3D-VAR data

Lateral conditions
from ICON and GFS models

Mesoscale reconstructions
for ERA supplier data

Periodic validation reports
KPI: NMAE, RR2, RMSE and IEV

Machine Learning

Aphelion possesses six different types of machine learning models for converting weather forecast into energy (intraday and day-ahead market). Pursuing this further, the following features are part of this fundamental step.

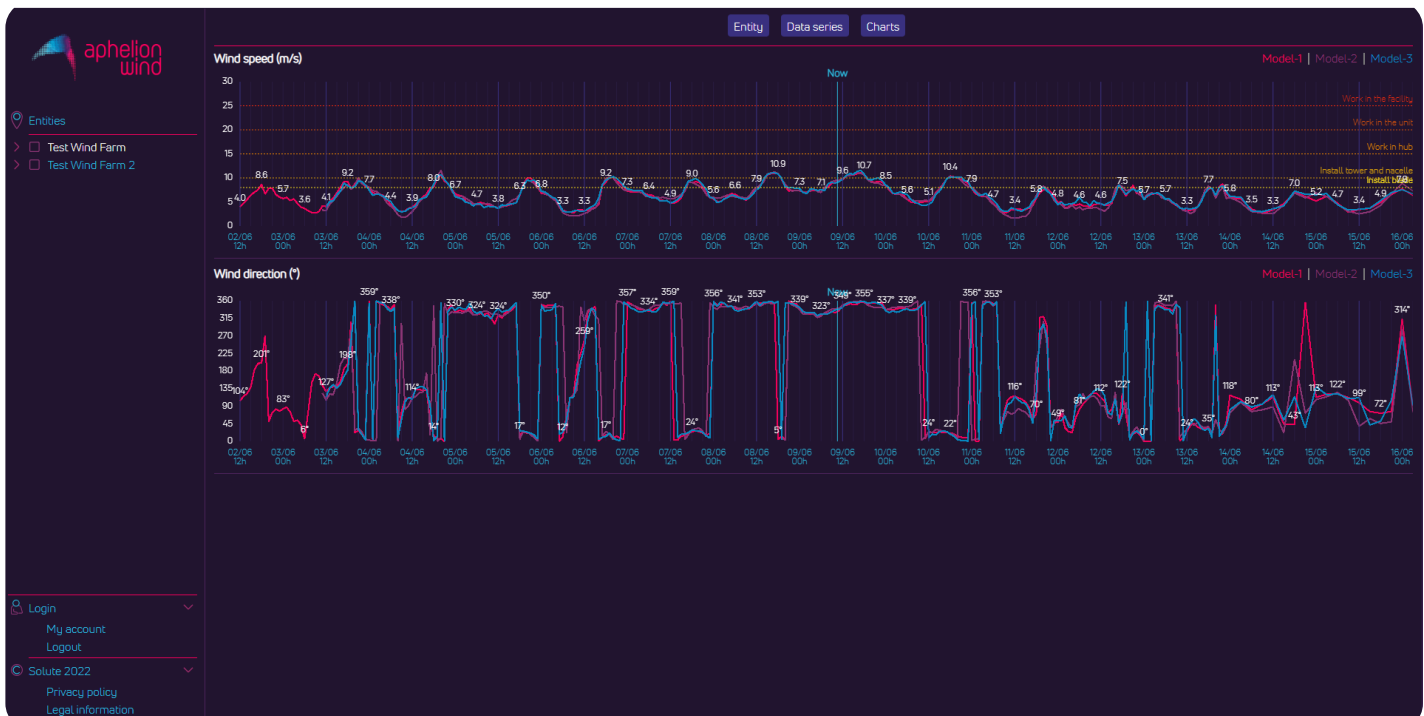
Moreover, the ML models can calculate uncertainty estimations for production assessment scenarios (p90, p10, among others), based on individual abilities of each forecast model

AI to find correlation between measured data and historic forecast from the forecast models

Robust, automatic predictive system against unexpected events and failures

Agility and scalability

Visualizator for forecast follow up

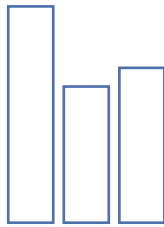


Aphelion Wind offers multi-view features regarding machine learning model visualization, including a "ML model comparison" view, which users enjoy as they can see different model results in one graph.

Energy forecasting for wind farms

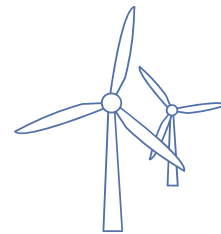


Potential customers



Energy traders

To optimize transactions
within the electricity markets



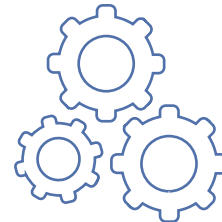
Wind farm operators

To maximize assets
profitability



Grid operators

To successfully manage renewable
energies integrations



Build phase

To ensure logistics and O&M
activities

NWP (Numerical Weather Prediction)

We have access to a large NWP database, which contains a wide variety of meteorological models based on both regional and global levels, being some of them:

- GFS (25 km)
- ICON (7 km)
- WRF (9 km)
- Database increase in progress

Machine Learning Architectures

Most of the suppliers develop their meteorological models on just one architecture, applying modifications on hyperparameters and specific features. However, Aphelion works on its architectures from scratch, which allows us to have access to a wide variety of models that are appropriate for different sites typologies (flat, coast, complex, offshore, etc.). Moreover, an intense labor is carried out regarding the feature engineering for each model, where we combine the statistical techniques proper from Data Science with our background and knowledge in Atmospheric Physics to obtain the best of both worlds. Our efforts have led us to be able to provide our customers with forecasts for the short, medium, and long range. We can provide forecasts going from the next minutes and hours up to one week ahead, curating the most suitable model of our pool of six architectures.

Our architectures are based on the following machine learning model

Autoregressive deep learning models, which are especially suitable for time series nowcasting

Simple feedforward neural networks, powerful for tabular data

Convolutional neural networks, ideal for detecting spatiotemporal patterns

Gradient-boosted tabular models, more classic models which remain machine learning staples for a reason

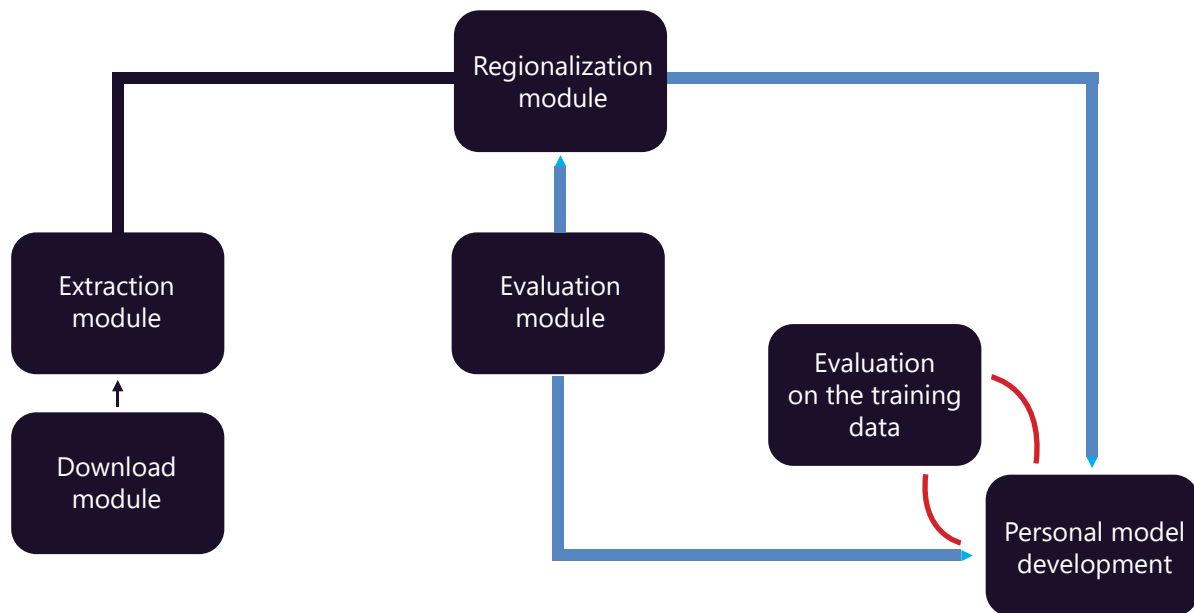
Ensembles of the previous, because there is strength in diversity

Forecast evaluation and validation



All the resulting weather forecasts data must be analyzed, evaluated and validated according to a planned and established procedure, in order to ensure its accuracy and veracity. That procedure and data is shown as follows, making a difference between the meteorological data and the energy data validation.

MLops Aphelion



Once the entry of a new asset (wind farm or wind turbine) has been detected, the MLops automatic system trains all the available machine learning models, evaluating their accuracy for different time horizons (+24, +48, +7d). Finally, it puts into operation the most appropriate solution for each asset.

Meteorological Data Validation

Variables	MAE	BIAS	RMSE	R2
q	0.85	-0.38	1.40	0.84
HR	9.67	-1.87	16.12	0.85
HRq	10.73	-4.82	17.63	0.85
T	1.68	-0.72	2.85	0.78

GFS 25 km

Variables	MAE	BIAS	RMSE	R2
q	0.32	-0.15	0.56	0.98
HR	4.32	0.13	7.75	0.96
HRq	4.17	-1.89	7.40	0.98
T	1.06	-0.28	1.84	0.89

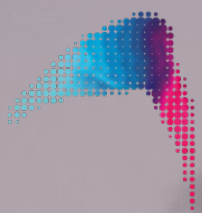
GDPS 15km

Variables	MAE	BIAS	RMSE	R2
q	0.50	-0.33	0.84	0.94
HR	5.60	-1.46	9.81	0.94
HRq	6.28	-4.36	10.74	0.94
T	1.01	-0.65	1.71	0.90

Aphelion WRF 9km

Variables	MAE	BIAS	RMSE	R2
q	0.38	-0.21	0.67	0.96
HR	4.87	-1.19	8.77	0.95
HRq	4.44	-2.62	7.92	0.97
T	0.77	-0.29	1.32	0.95

Aphelion WRF 3km



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Aphelion Wind home

Aphelion Wind is the ultimate and optimal solution for wind farm operators, energy traders, and more.

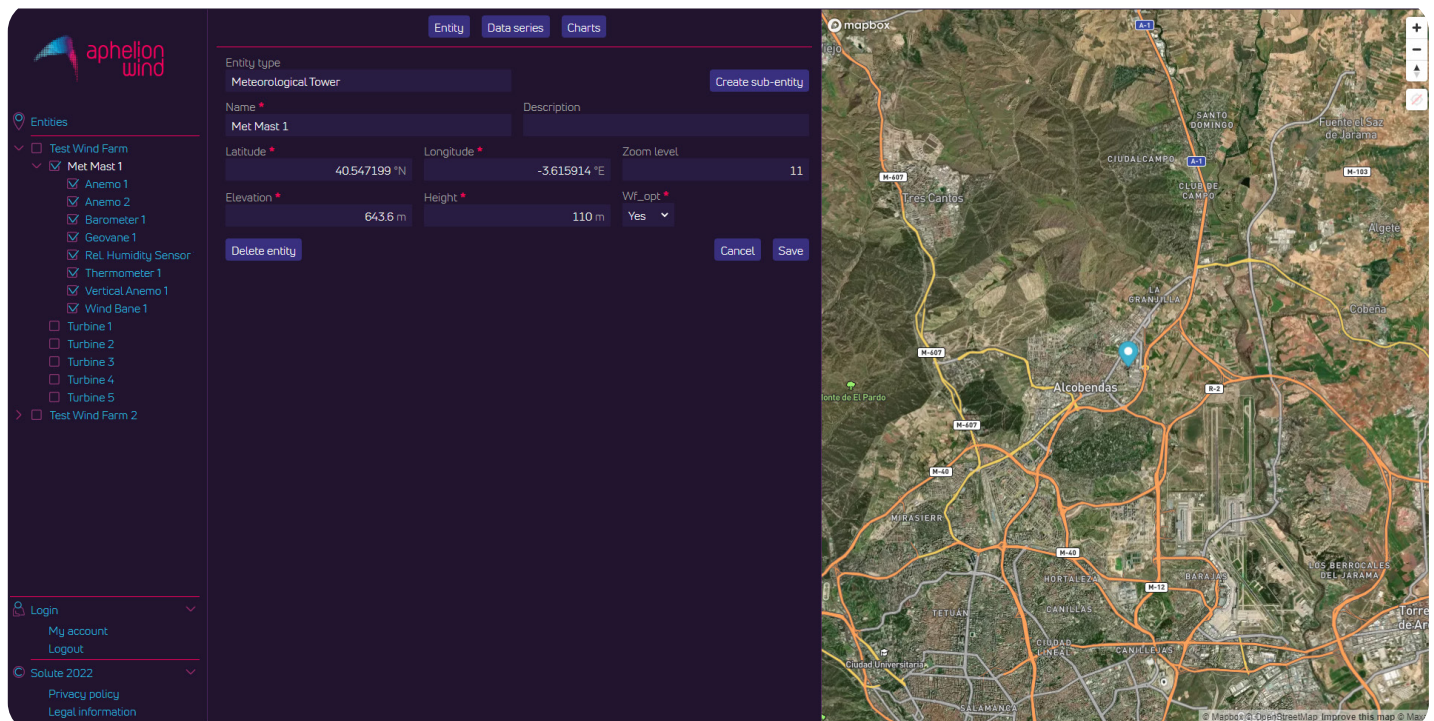
Its user-friendly interface will enhance the users' experience. Furthermore, technical online support will always be available in case users request further details on the platform's extensive list of capabilities.

Automatic software with five machine learning models and ad-hoc functionalities

Online technical support

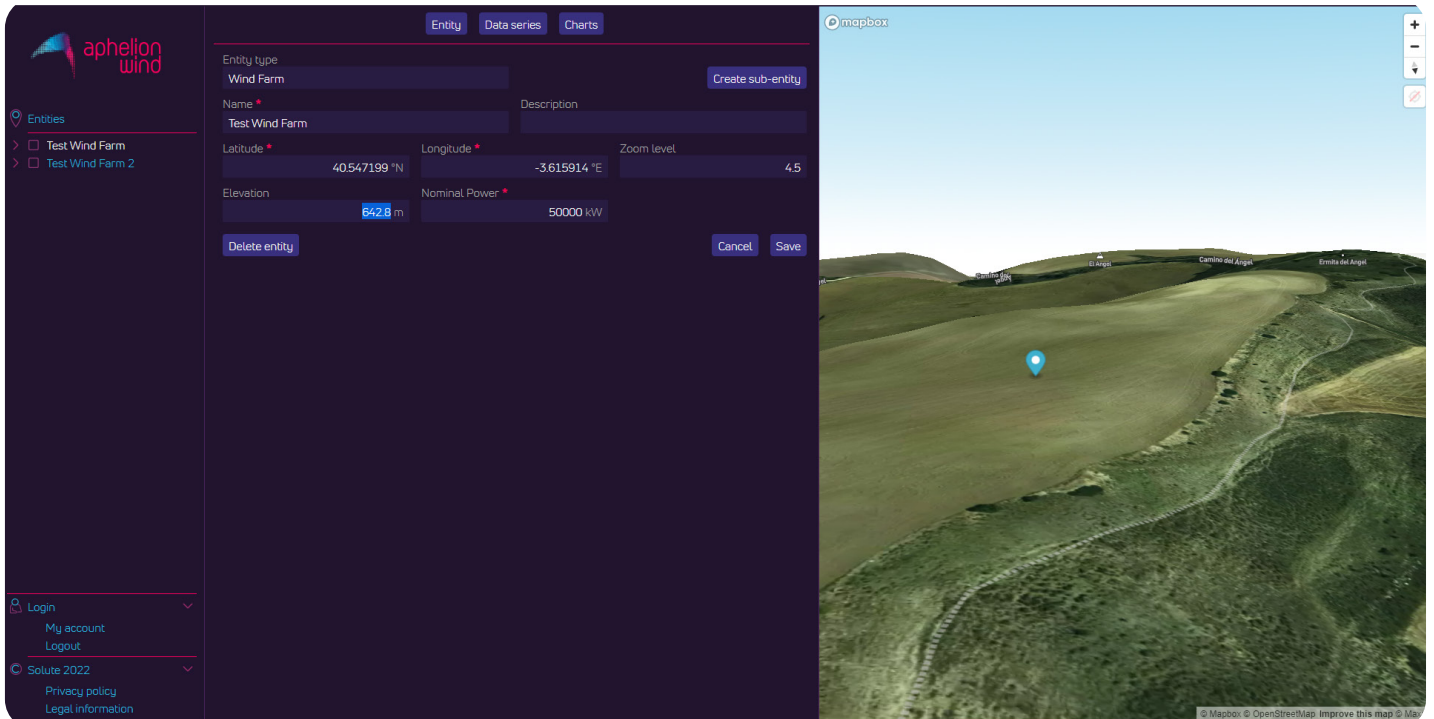
Customizable forecast horizons, updates, granularity and time resolution

Wind farm and wind turbine forecast



Besides having an efficient interface, Aphelion Wind is simple to use and understand.

Designed to be used from left to right, the main dashboard allows user to control variables, wind farms, turbines, among other elements. Moreover, a central module will give users easy access to add properties and must-have data to eventually see a site's location on the always-on 2D and 3D map. Aphelion Wind also has a unique feature of assigning different permissions and actions per user type. That way, tasks can be monitored at all times.



3D maps will allow users to have a better understanding of a site's location and also extract additional information directly from the platform.

Aphelion's API features

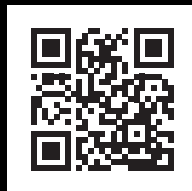
Forecast database easy access

Easy to include in other solutions

Individual accuracy

Data safety guarantee





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