SmartRIVER: The Digital Twin solution for AI-driven hydropower energy forecasting

Prototype short manual

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Lead: [GECOsistema SRL]

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www.i-nergy.eu

Executive Summary

"One forecast service ranging from single Hydropower plant to multiple assets everywhere, to optimize resources (reservoir management and energy production strategy) and to save money (energy trading)"

SmartRIVER is a Digital Twin of the plant catchment, relying on worldwide available forecasts, big open climate, geospatial and satellite data, and AI at the core for efficient energy forecasting, with major advantages over complex mechanistic models:

- No specialist hydrologist skills, no physical model to tune.
- Easy integration of upstream services and public datasets (e.g., Copernicus Climate Data Store)
- Lightweight cloud deployment, just a web browser is required to users.

SmartRIVER Software as a Service (SaaS) prototype showcases energy traders; can be activated for every hydropower plant of interest, to support water resources management and energy production.

Online prototype

The operational SmartRIVER prototype is accessible to the following link, a common web browser is necessary to access the service (Google Chrome recommended):

climate-tools.com:3000

(Choose I-NERGY service)

user: inergy

password: mDU7Jy3D

DISCLAIMER: Operational prototype is for demonstrational and inspirational purposes only, actual prototype version periodically retrieves meteorological forecast by ECMWF MARS system as input features, thus operationalization is bound to these data availability. Access to the public datasets is currently (by the time of this report finalization) unavailable due to ECMWF moving move of its Meteorological Archival and Retrieval System (MARS) to the new Data Centre in Bologna, please refer to official ECMWF page to checkout when the dataset will be put online again:

Due to the move of our Meteorological Archival and Retrieval System (MARS) to the new Data Centre in Bologna there will be no or degraded access to the datasets listed here at times between June and October 2022. Please visit our **dedicated data centre migration pages** for more information. Thank you for your patience and support during this important move, which will allow exciting scientific developments and overall better service.

Prototype interface

SmartRIVER prototype is a *one-page* web service where all core information (used features, discharge and energy forecasts, performance metrics) are provided in intuitive and self-explain manner.

Here after we provide screenshots of the Service prototype interface at its current development stage:

0. Login/logout button (to access the service)
1. Input features
2. AI powered discharge forecast @ lead times of interest
3. Time series of all variables plus forecasts (dynamic plot with possibility to zoom to the period of interest) including discharge and energy
4. Lumped error metrics for the selected period
5. Examples of error graphs and graphic indicators of forecast performances, e.g., scatter plot of forecasted differences or errors distribution
6. Reset button to start a new time windows selection

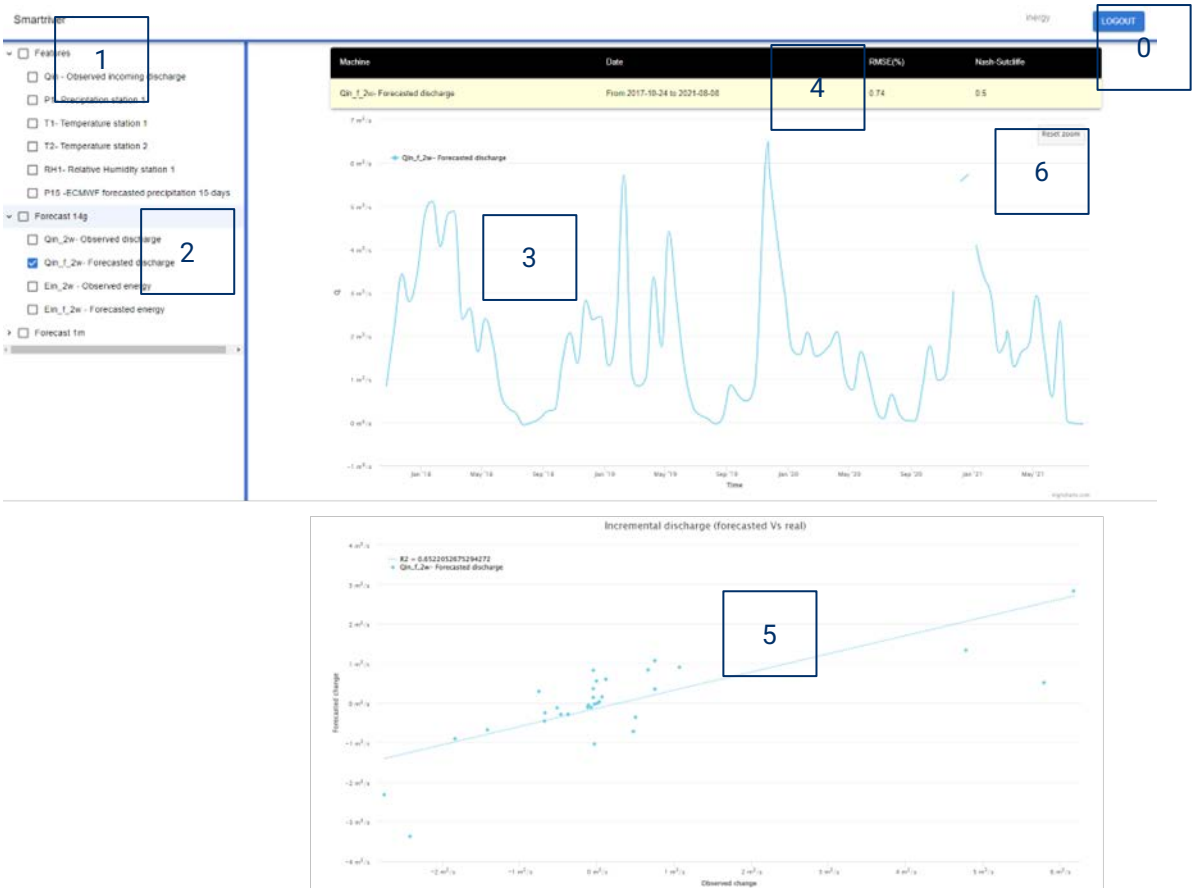

Figure 1 – overall one page view

The Features panel summarize input features used in input for the ML forecast model (e.g., rainfall and temperature @groung stations, recorded discharge, meteorological forecast provided by upstream providers) normally these variables are plotted at their original time steps (e.g., daily).

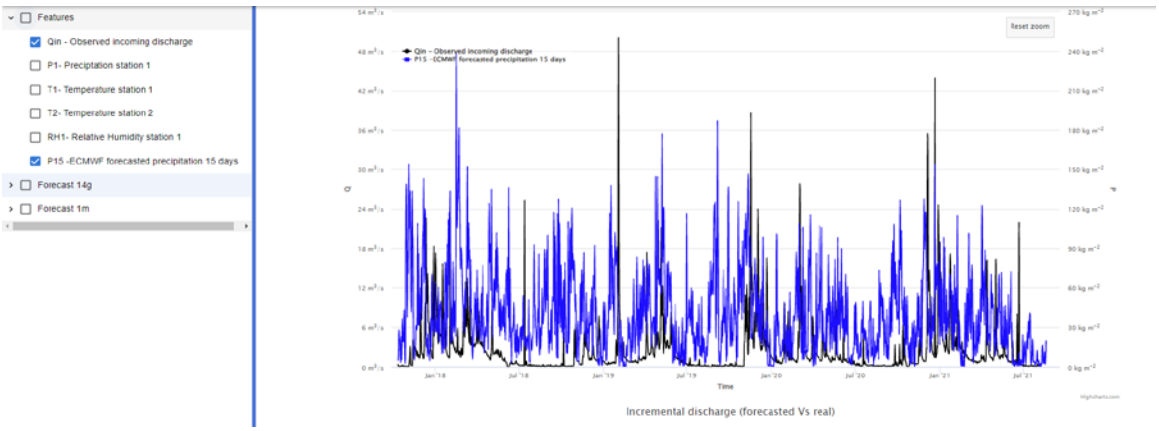

Figure 2 – Input features panel

The forecast panels activate forecast for the different lead time of interest (in this prototype 2 weeks and 1 month ahead).

The user has access to the observed values up to the launch of the forecast and, for comparison, the forecasted one by means of ML (for longer lead times also historic Climatic Average is provided as reference forecast)

In the same panel the user can activate Energy forecast both for the record values and for the forecasted ones) by moving the cursor over the graph the user access the values of plotted variables @the day of forecast launch.

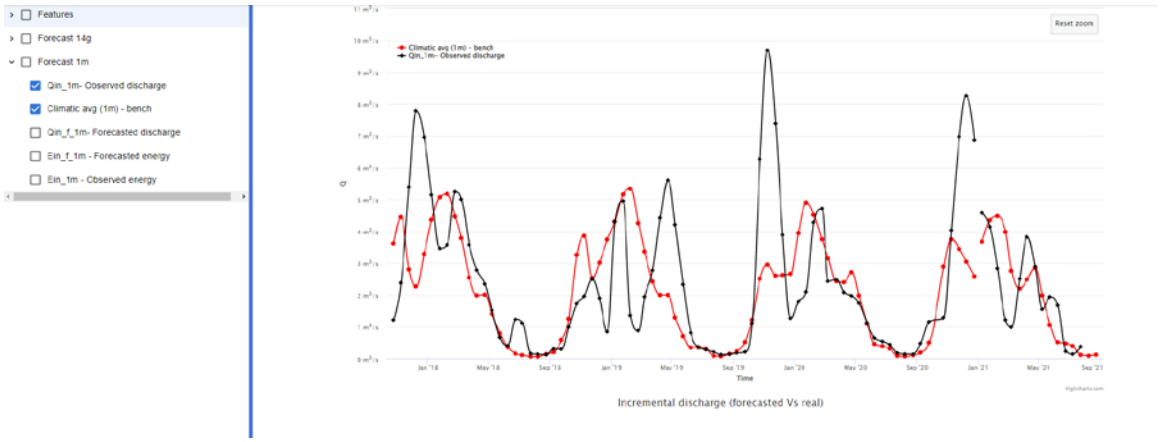

Figure 3 – lead time selection

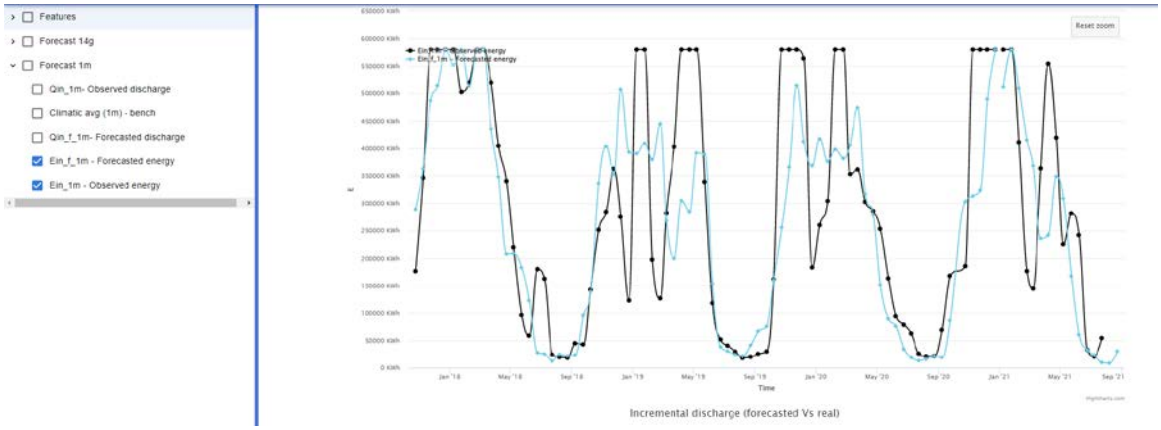

Figure 4 – time series of variables of interest

Once a forecast is selected the lumped error metric table appears at the top of the page, showing the Root Mean Squared error % and the Nash Sutcliffe Index.

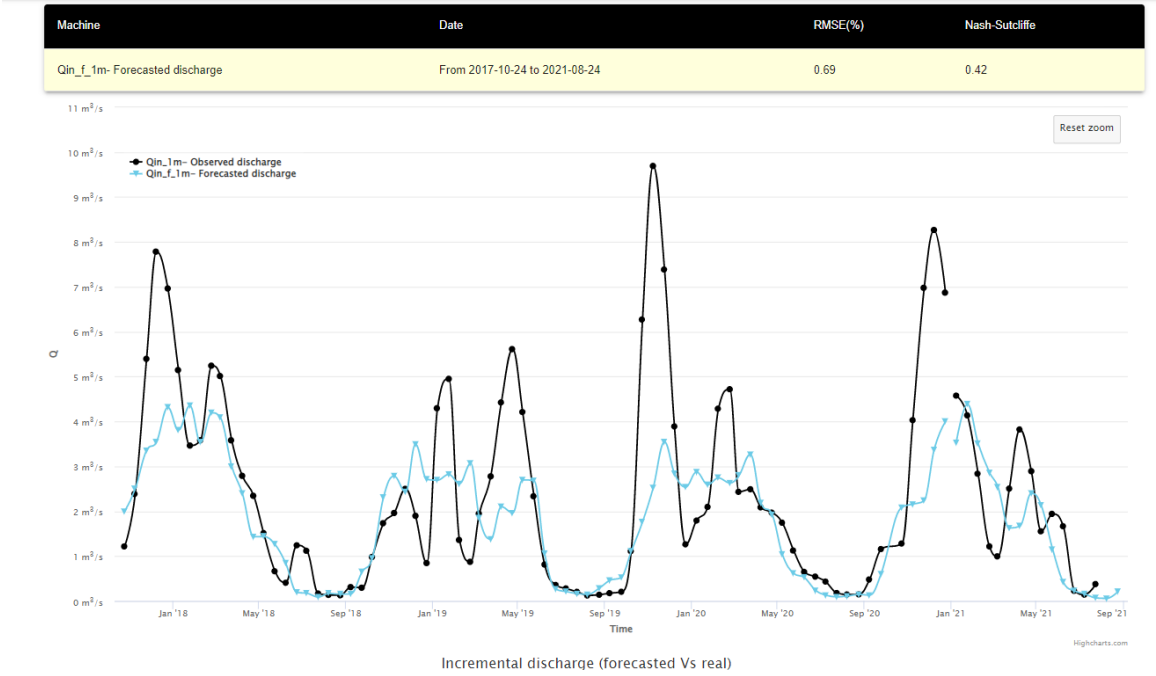

Figure 5 – Lumped error metrics

Beside lumped error metrics two error graphs are available (dynamically adapting to the time window the user selects and eventually rest with the Reset Zoom button):

- The graphs showing scatter plot of residuals (discharge for the next period minus previous time step, the change is plotted for both for forecasted Vs observed values)
- The graph showing error frequency distribution

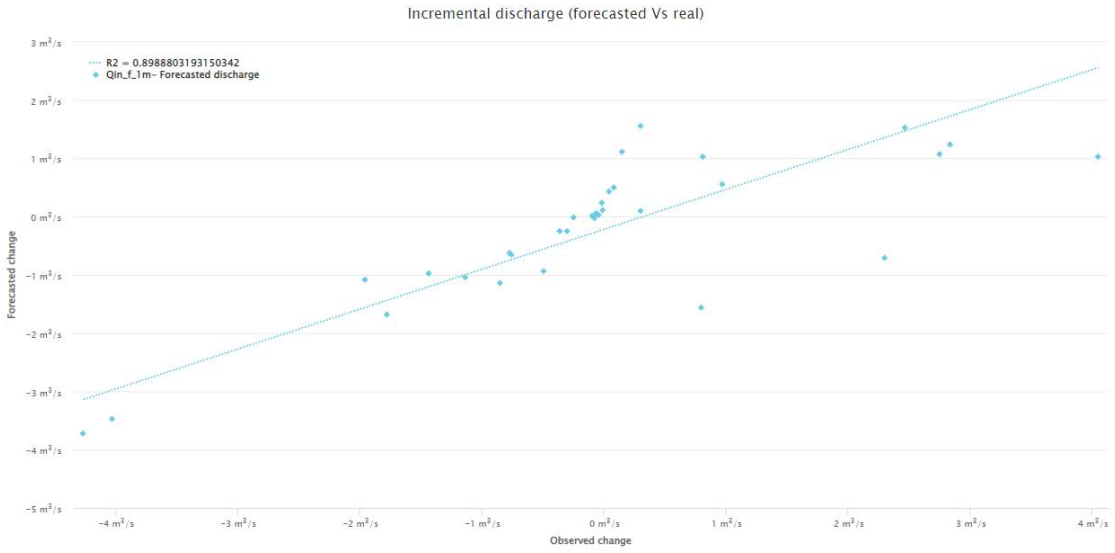

Figure 6 – error graphs and graphic indicators of forecast performances – scatter plot of residuals

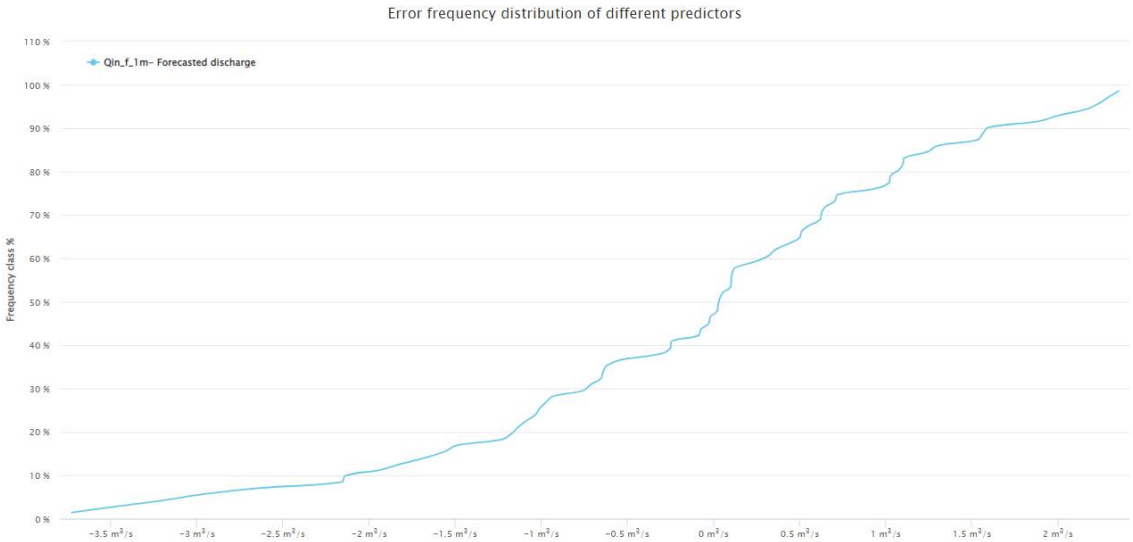

Figure 7 – error graphs and graphic indicators of forecast performances – error frequency distribution