National University of Science and Technology
POLITEHNICA Bucharest,

Faculty of Energy Engineering

EU project, iAMP-Hydro, will improve EU hydropower sustainability with potential to save €1 billion per year

National University of Science and Technology POLITEHNICA Bucharest, together with nine partners from across Europe is conducting a €4.1 million Horizon Europe project to develop digital solutions that improve the efficiency, flexibility and sustainability of the existing EU hydropower fleet. The project has the potential to make a huge impact on energy sustainability in the EU, where 50% of the current hydro fleet may require upgrading by 2030 and *will reduce CO_2 emissions by 1,260 tonnes, create 10,000 future-proof jobs, and enable environmentally sustainable flow regulation using digital solutions.*

The involvement of POLITEHNICA Bucharest in this project – iAMP-Hydro, Intelligent asset Management Platform for Hydropower operation & maintenance, aims at several important directions, namely:

- For data sources identification and data preparation for flow forecast (WP6) POLITEHNICA Bucharest will contribute to gathered that includes all relevant variables to build a data-based model and to parametrize physical models. Data used for hydrological modelling will include the historical flows measured in different upstream stations, weather data (mainly precipitation and temperature), humidity, vegetation factor, soil properties, land use, Digital Elevation Model, and upstream water uses. Thus, a common data framework that can be applied in every validation site will be defined including data model definition, data storage engine, data ingestion tools (e.g. from file, from public repositories, climate services…) and data retrieval and visualization tools. Transparency and openness criteria will be considered in the selection of data sources and development of the required tools for data management. A unified cloud service for all the validation sites will be developed and deployed.

- POLITEHNICA Bucharest will lead the task which are responsible for defining the physical models approach for flow forecasting and carry out sensitivity analysis in Asomata and Agia Varvara – Makrochori hydropower sites from Greece. As different configurations for the hydropower plants (diversion, impoundment) and a variety of climate areas have been considered for the validation sites, a detailed pre-deployment study of the model for each selected site will be carried out. First, the modelling approach will be selected according to pre-validation data available for both flow forecast and available power prediction. For the flow forecast physical models (SWAT and NBD), data-based models (LSTM neural networks) and hybrid models will all be assessed. For the available power prediction, modelling the water use and required outflows will be carried out in order to calculate the available hydropower in a 7-day future time horizon. In this case GIS and satellite data together with operation management strategies will be key for outflow forecasting. In this task a sensitivity analysis for the selected data and model at each site will also be carried out. This will be critical for AI models, as it will be needed to select the variables that influence the output and also how many previous values of these variables are significant. This analysis will be conducted using principal components and correlation analysis.

- The team of POLITEHNICA Bucharest will develop a flow forecast and available power prediction tool (WP7) for: i) validate the developed algorithms in real use cases comparing different possible approaches to find the best option for every plant type and climate; ii) predict the available power during a 7-day time horizon according to the existing reservoir, forecasted inflow, outflow and operation specifications and restrictions. The historical data interval will be selected to optimise model parametrization and machine learning training. This data will include the maximum variety of operation conditions to increase the forecast accuracy. Preprocessing of raw data will be conducted to calculate supporting variables for the selected model (e.g. smoothing variables, normalized variables, calculated variables such as average areal rainfall…). The training and validation of the neural networks will be conducted, and physical models will be parametrized. The different method developed will be compared for each validation site. Finally, the use of an ensemble learning approach for improving the prediction accuracy through the combination of two or more of the validated prediction methods will be developed and evaluated. The process of selecting and tuning the ensemble algorithm will be particular for each site as the different conditions could lead to different accuracy in the forecasting models.

- POLITEHNICA Bucharest will lead the task *Forecast validation and replicability guideline* and be responsible for leading the replicability analysis and compiling the lessons learnt. This task will focus on the deployment of the developed algorithms for each of the validation cases. More than one approach/algorithm will be deployed for each site with automatic flow forecast calculations. A validation of the obtained results will be performed to evaluate the accuracy of the algorithms for the new data not used in the training and offline validation. Both flow forecasts and available power prediction will be compared with real data and an iterative process will be carried out for error minimization. Finally, a guideline for flow forecasting will be compiled with the lessons learnt from the comparison among the different methods and stating similarities and differences that arise from the different types of hydroelectric power plant and climate conditions.

- For task WP8, *Semantic Interoperability Mechanisms for Hydropower, Energy and Other Relevant Data*, together with the other partners, POLITEHNICA Bucharest examine the hydro and energy data modelling landscape and select specific open standards, semantic models and ontologies for further elaboration depending on their relation to the iAMP-Hydro scope. An in-depth analysis and assessment of such standards and data models is performed to determine their appropriateness to address the data needs of the project and their completeness, while identifying relevant data modelling gaps.

- For task WP10, *iAMP-Hydro Platform intelligent Data Management Layer implementation*, the project partners will implement the data governance mechanisms of the iDML that will facilitate the effective handling and collection of upstream and downstream data in the form of batch data uploaded directly in the data space, data collected through 3rd party APIs, or streaming data through PubSub mechanisms. This task, will also configure the mechanisms for mapping the collected data assets to the iDML and for specifying appropriate data curation rules to address poor

data quality issues (e.g. completing missing parts of data, identifying and correcting data outliers, excluding irrelevant data from a dataset, etc). Finally, this task will develop the data exploration and retrieval features of the iDML, to allow the external stakeholders (i.e. digital solutions and services providers being granted with access to the validation site data assets) to create their queries, discover the data assets of interest and retrieve them in an easy and seamless manner, through dynamically configured APIs.

- For task WP11, *Data Analytics and Hydro Asset Management Platform Development*, the project partners will collect continuous data and integration of the different datasets recorded from various sources within hydro assets, including data read by the sensors developed. External data referred from other RES and energy markets will be also collected and stored in the iDML. Also, will create or integrate the data analytics, either trained on partner's premises or in the iAMP-Hydro iDML, which will allow the creation of an analytics pipeline for different ends. The main aim of this task is to equip hydro operators with a unique toolbox for asset management, towards increasing hydro plant availability and competitiveness. The baseline predictive maintenance, biodiversity and weather and flow forecasting AI data analytics together with external data related to other RES and energy markets will comprise the main input for the provision of a bundle of services to hydro operators. This information will be retrieved by the iDOL from the iDML within the iAM Platform and will be used as input for the optimisation algorithms for enhanced and data-driven operations. Such services will aim at improving maintenance of assets, minimising biodiversity impact, enhancing water resources management through more accurate weather and flow forecasting, optimising operations by assessing hybridization with other RES, and enhanced market positioning, which will improve overall competitiveness.

- For the task WP12, *System Validation in Operating Hydro plants & Case studies*, POLITEHNICA Bucharest will be leader. This task will include: i) the compilation of 5 detailed case studies of existing hydro plants from Eastern Europe, Africa, Latin America and Central Asia to enhance export potential in key international markets (DI5). Data on these sites will be obtained via existing partner contacts in other hydro projects; ii) T12.5 will also include compilation and dissemination of aggregated KPIs (Key Performance Indicators) on the 5 validation sites on the COP (Community of Practice) online portal to showcase the cost and environmental savings achieved, and digital functionalities without compromising sensitive operational information from individual assets.

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