

Digital Monitoring and Environmental Intelligence for Hydropower

From Data to Decisions: *Digital Platforms for Hydropower*

The iAMP Platform and Integrated Solutions

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AGENDA

What We'll Cover

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Why hydropower digitalisation, now

Energy security drivers and the O&M challenge

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Inside the iAM Platform

Architecture: iDML and iDOL, from raw plant data to decision-ready outputs

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iAM Platform at a Glance

Quick overview of platform's functionalities

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Validated AI analytics solutions

Cavitation, impeller health, weather/flow, day ahead price forecasting

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Validation across 5 EU pilot sites

0.8 MW to 108 MW capacity, diverse operating regimes

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Value Across the Hydro Value Chain

What operators, vendors, markets and policymakers each gain

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Built With the Sector and Ready to Scale

Co-development, interoperability, and the path beyond the project

THE CONTEXT

Hydropower's Digital Moment



- Europe's fleet of hydropower assets is ageing → it's older than most generating capacity and was designed for predictable baseload or seasonal irrigation duty.
- Environmental flow obligations exist today that did not exist at construction time

But the role Hydropower is being asked to play today has changed completely: it's now a flexibility and firm-capacity asset for a decarbonising grid.

- Operators face a shared challenge: how to extract more value, resilience and predictability from existing ; without the need for large capital works.



As you've just heard, iAMP-Hydro answers this with single cloud-based integrated platform, the intelligent Asset management (iAM) Platform capable of transforming scattered plant, weather and market data into decision-ready guidance for operators.

An ageing fleet, with a growing role

Existing hydro assets are core to grid flexibility and firm capacity, even as investment cycles slow.

Data already exists; insight doesn't

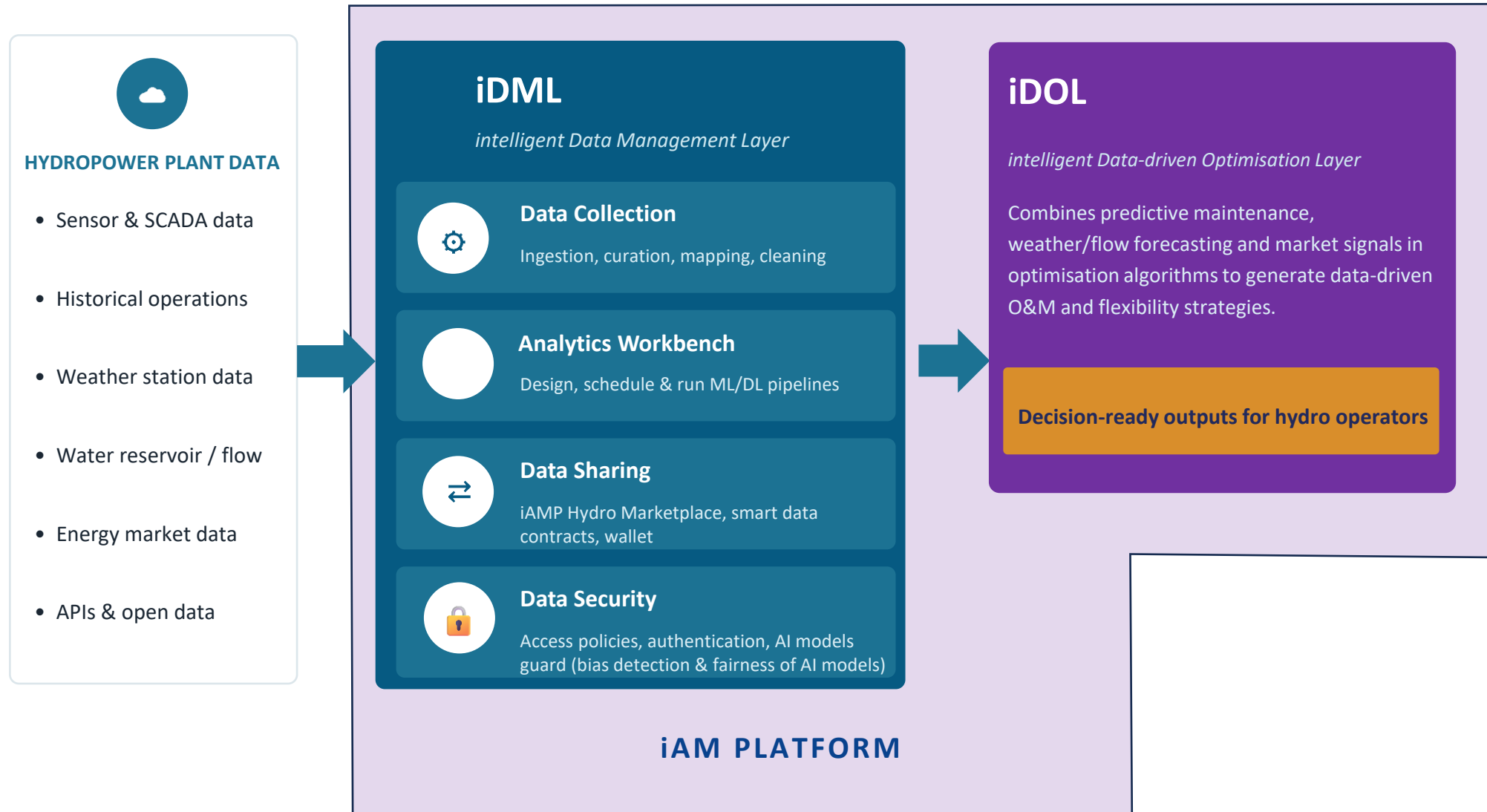
SCADA, sensors, weather and market feeds sit in silos across vendors and departments.

A platform, not another point tool

iAMP-Hydro integrates governance, analytics and optimisation in one place, ready to plug into existing operations.

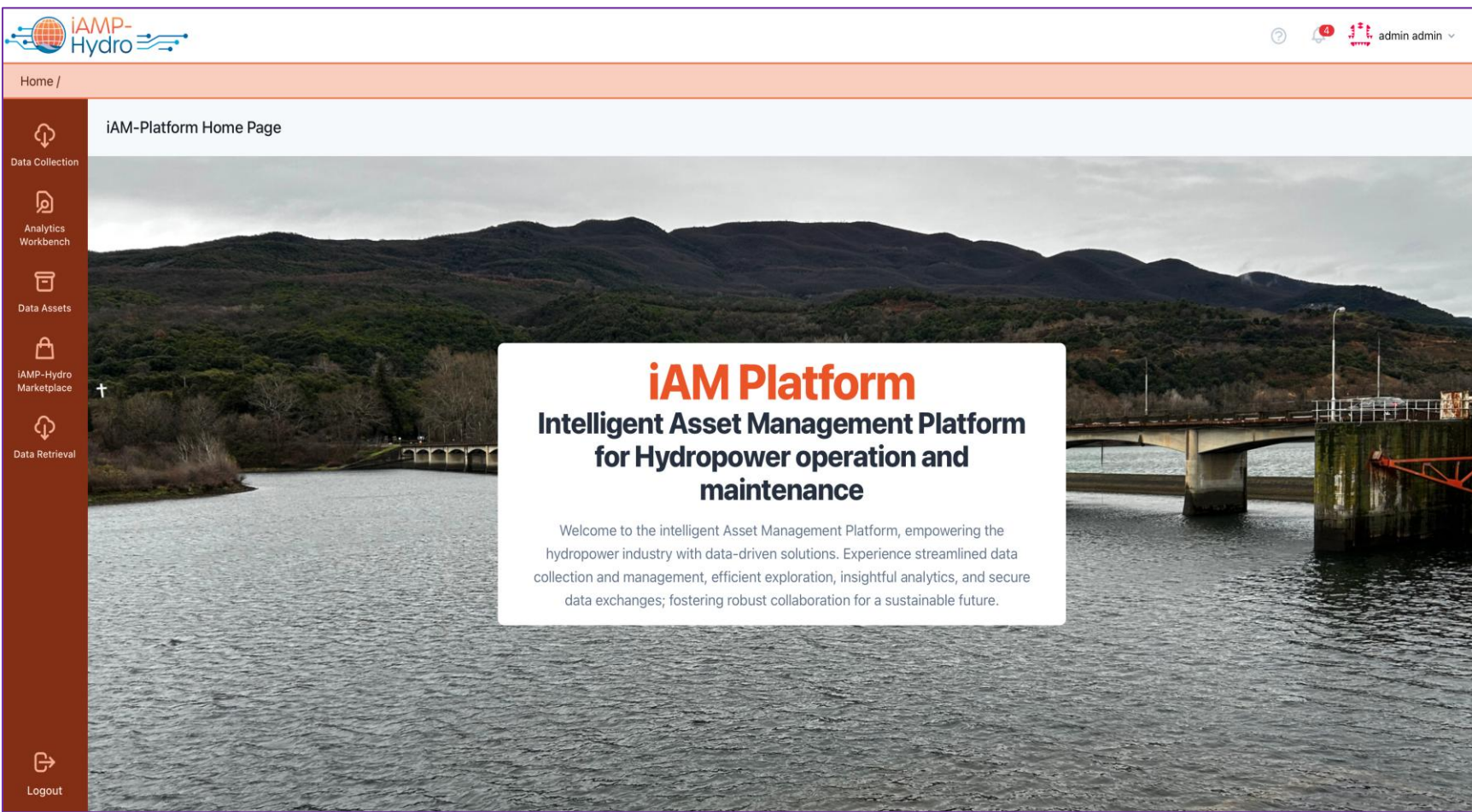
THE iAM PLATFORM

Platform Architecture: From Data to Decisions



The iAM Platform at a Glance

Five functions on the Home menu, take the user from raw data to shared, decision-ready insights.



Platform Engagement metrics

- 9 active organisations (8 countries)
- 27 Active users
- 143 Data Assets (with 61 shareable through the Marketplace)



Data Collection:

The main entry point to upload data assets (supporting batch files upload, streaming data uploads (MQTT broker), uploads through the platforms' own API, or upload through 3rd party APIs), with built-in data mapping and data cleaning functions



Analytics Workbench:

Design and run custom analysis pipelines, then visualise the resulting insights



Data Assets:

View, access datasets and edit their metadata, access policies and models you own or have acquired via the Marketplace.



iAMP Hydro Marketplace:

Share, discover and acquire data assets among platform users through smart data contracts.



Data Retrieval:

Query and retrieve owned or acquired data assets from the platform's APIs.

Getting Data In: Three Ingestion Modalities



Single/Batch Files upload

Historical files, supporting CSV, JSON, XML Parquet files uploaded directly



MQTT streaming

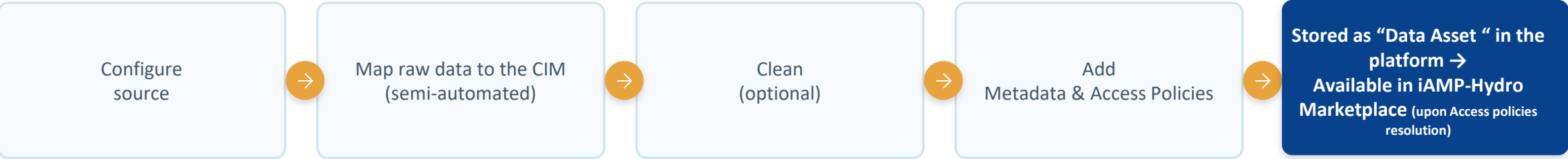
Near real-time data (from deployed sensors) consumed through an integrated MQTT broker



API Harvester

Configurable push endpoint offered by the platform or scheduled polling of third-party APIs

All three data ingestion modalities converge on the same downstream workflow, so an asset's origin never determines how it can later be used.



iDML

Semantic Harmonisation via a Common Information Model (IAMP HYDRO CIM)

- Extends most prominent and relevant standards and ontologies with hydro-mechanical concepts (E.G., reservoir state, ecological flow, vibration sensing measurements, etc.), aligning with (IEC 61970 CIM base (electrical / grid interface), SAREF, SAREF4ENER, SAREF4ENVI, IEC 61850:2023, IFC 4.3, ODM2, OGC WaterML2, SSN-SOSA, INSPIRE Hydro, and IEC 61970 ,etc.)
- Draws additional terms from the WHOS hydrological ontology
- THE IAMP HYDRO CIM is delivered as a versioned artefact: users of the platform, during the data onboarding can propose new concepts/fields in the mapping interface; then a model administrator reviews the new attributes recommendations before publishing

CIM GOVERNANCE TRADE-OFF

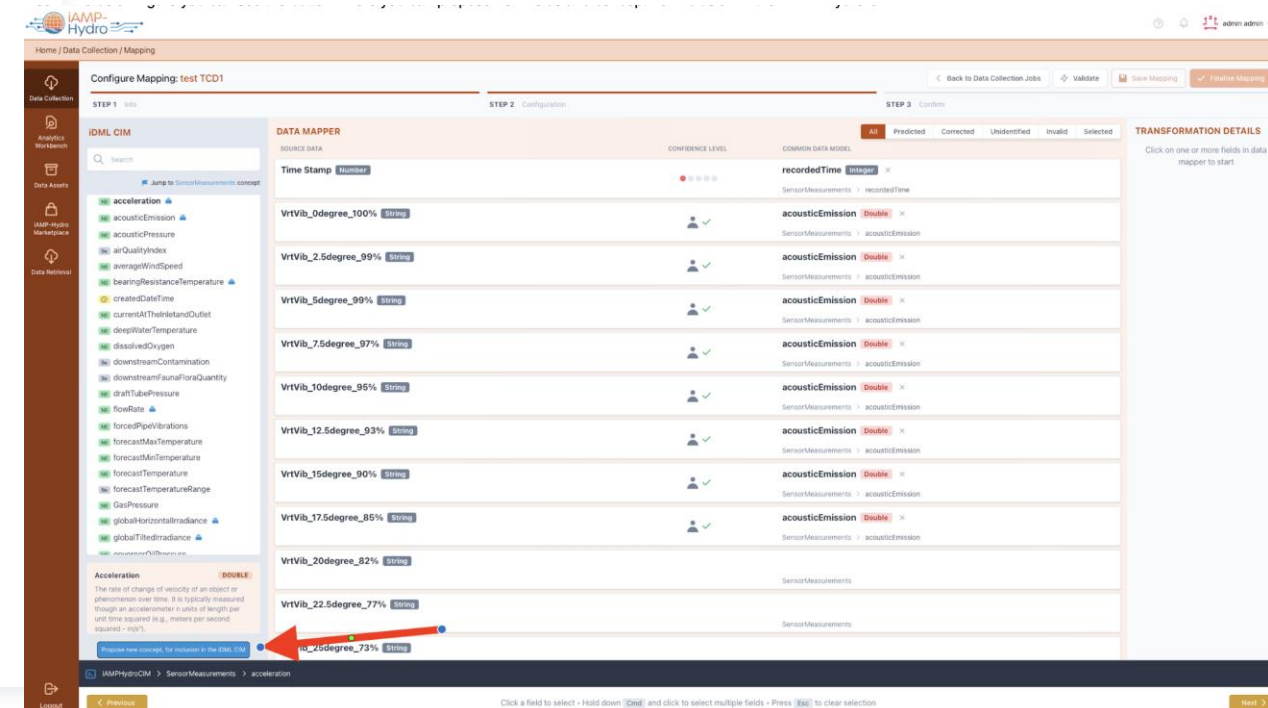
A mapping needing a new concept waits for review; deliberately accepted, since an unreviewed data model typically accumulates duplicate concepts and cross-site analytics becomes impossible.

43

concepts

991

fields / attributes



Access Control & Data Sovereignty



User Authentication

Keycloak handles identity provider and authentication for all platform users



Fine-Grained Permissions

Attribute-based access control (ABAC) module layered on top



Data Sovereignty

DLT-based Wallet Manager + Smart Data Contract lifecycle manager govern how non-public data assets are shared and acquired through the iAMP-Hydro Marketplace



Verifiable Control

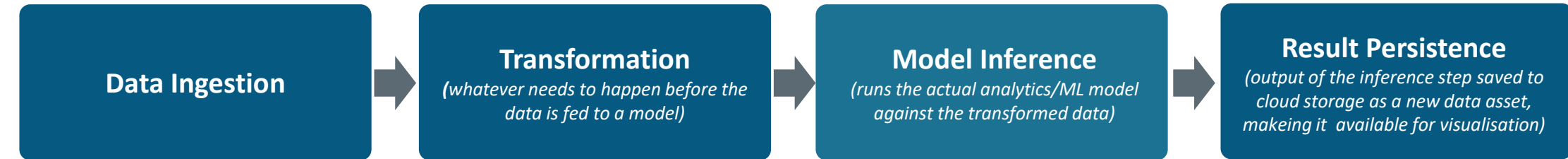
Data Providers keep a record of terms of use and of every transaction executed against them

“Data Owners/Providers uploading a data asset onto the platform keep control of how it gets used downstream (through configuration of their access policies), rather than losing control the moment it appears in the platform’s marketplace.”

The screenshot displays the iAMP-Hydro Marketplace interface. The top navigation bar includes 'Home / iAMP-Hydro Marketplace / Explore', a search bar, and user controls for 'admin admin'. The main content area is titled 'iAMP-Hydro Marketplace' and shows a grid of datasets. A sidebar on the left contains navigation links: 'Data Collection', 'Data Assets', 'iAMP-Hydro Marketplace', and 'Data Retrieval'. The 'Data Assets' section is active, showing filters for 'Category' (SensorMeasurements, WeatherMeasurements, Sensor, WeatherStation, Location) and 'Accessibility' (Through an API, As a downloadable file). The dataset grid includes items like 'CUE_8_Bermejales_sensors', 'CUE_8_Berchules_sensors', 'Asomata - Precipitation Temperature 2010-2025', 'Ilarion - Precipitation Temperature 2015-2024', 'Makrochori intake NORCE Sensors', 'Asomata intake NORCE Sensors', 'Asomata Outlet NORCE Sensors', 'LaVega Outlet NORCE Sensors', 'Berchules outlet NORCE sensors', and 'Bermejales outlet NORCE sensors'. An 'Overview' modal is open for the 'Asomata intake NORCE Sensors' dataset, showing details like 'Title', 'Description', 'Owner', 'Created At', 'Updated At', 'Size', and 'License'. The bottom of the page has a note: 'Note: Data assets may be omitted due to access control limitations'.

iDML

Analytics Workbench: Build Pipelines Without Code



Modular graphical blocks assembled by data scientists without writing code. A built-in library of analytics blocks (data prep, feature engineering, modelling) allows users train and test pipelines directly in the Workbench.

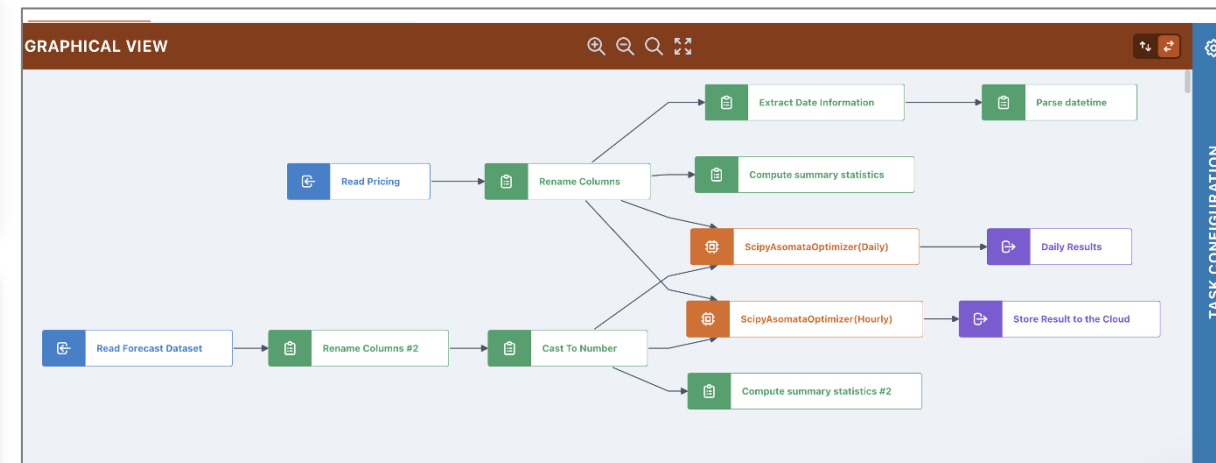
External Models Registration

External models can also be uploaded to the platform as registered data assets, with:

- artefact, metadata (algorithm, type, library)
- access level
- a sample input file* documenting expected feature order.

**The sample input pins the expected feature order explicitly*

AI Models Guard



AI Analytics Solutions onboarded

Developed off-platform (by responsible iAMP-Hydro project partners), then registered and executed end-to-end through the platform's Analytics Workbench (as pre-trained pipelines) ready to run on operator data.



Cavitation Anomaly Detection

Deep-learning classifier on frequency-domain vibration features flags turbine cavitation in near real time.



Weather & Flow Forecasting

Data-driven forecasts of inflow and weather conditions to support production and flexibility planning.



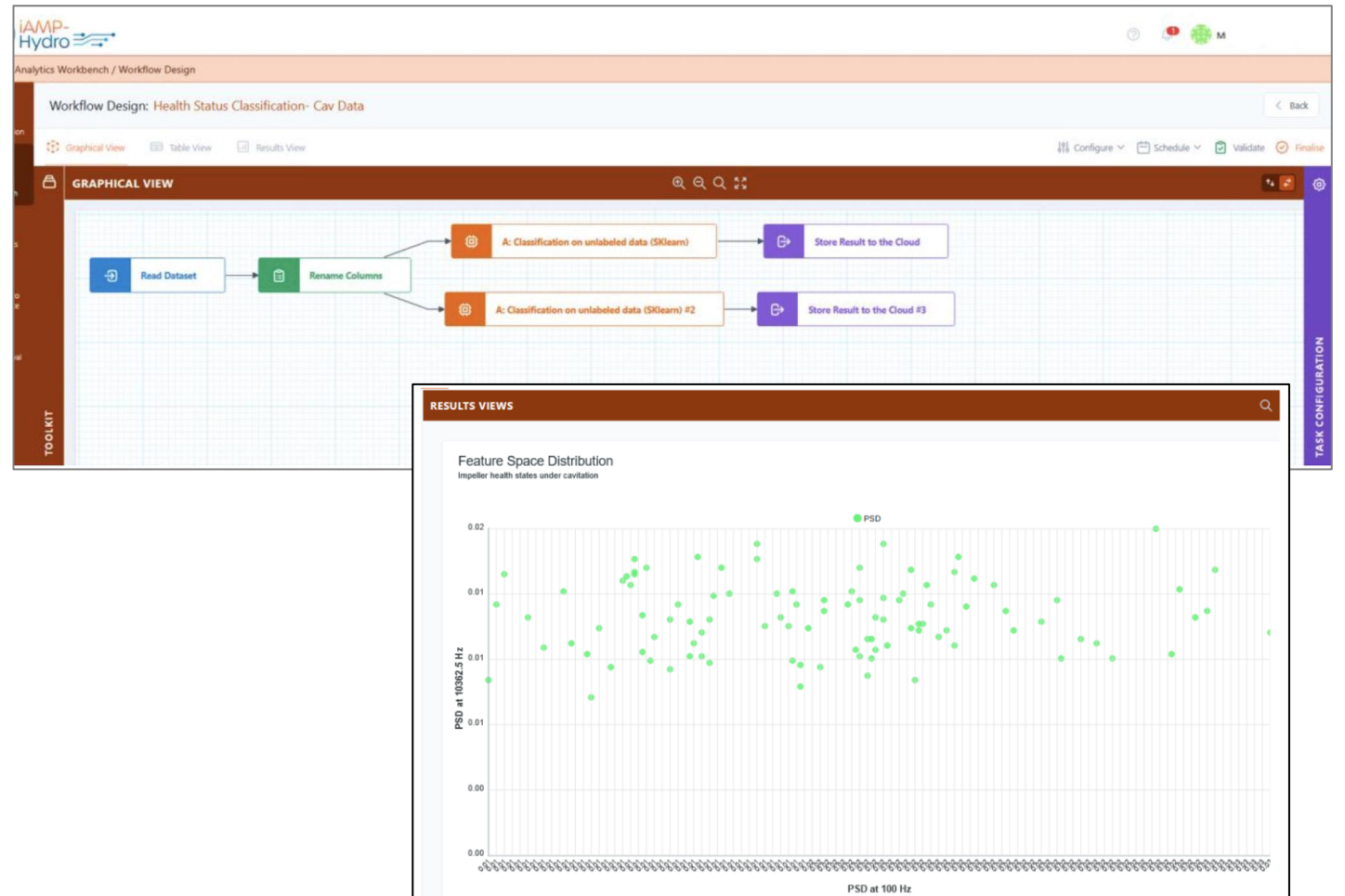
Impeller Health Diagnosis

Ensemble models (Random Forest, XGBoost) classify healthy vs. eroded impeller states from vibration signatures.



Day-Ahead Energy Price Forecasting

Market price forecasts feeding the optimisation layer for smarter dispatch and flexibility decisions.



VALIDATION of the IAM Platform

Five European Validation Sites

		P (MW)	Head (m)	Turbine	Type
ES	Berchules	0.8 MW	138	Francis	Run-of-river, dry climate, irrigation & drinking water
ES	Bermejales	2.1 MW	56.5	Francis	Dam-toe, seasonal flow, flexibility & market participation
ES	La Vega	2.4 MW	185	Pelton	Run-of-river, Sierra Nevada, ecological & biodiversity focus
GR	Makrochori	10.8 MW	15	3 x Kaplan	Dam-toe, irrigation canal, diversified water use
GR	Asomata	108 MW	42	3 x Kaplan	Dam-toe, same river catchment, largest-scale validation

PILOT'S HETEROGENEITY AS AN ADVANTAGE

- A harmonisation layer across similar plants offers little benefit , as similar plants integrate ad hoc anyway
- La Vega (Sierra Nevada national park) → biodiversity focus
- Bermejales follows a seasonal irrigation pattern → hybridisation & flexibility markets focus

- *Capacity spans 0.8 – 108 MW (2 orders of magnitude)*
- *Francis, Pelton & Kaplan turbines*
- *Head: 15 - 185 m*

WHY THIS MATTERS TO YOU

Value Across the Hydro Value Chain

iAM Platform is designed as a cloud-based platform: one integration point that creates distinct value for every stakeholder in the hydro-energy ecosystem.



Hydro Plant Operators

Earlier fault detection, fewer unplanned outages, and forecast-driven dispatch that captures more value from flexibility markets.



Energy Market Stakeholders (TSOs / DSOs / retailers)

More predictable, forecastable hydro flexibility to support grid balancing and higher renewables penetration.



Equipment & Sensor Providers

A standards-based route to market: a proven, interoperable platform to integrate and showcase new hardware and sensing technology.



Data & Analytics Companies

An Analytics Workbench and Data Marketplace to plug in, validate new models across a live hydro network.



Policymakers & Regulators

A real-world evidence base (validated across 5 pilot sites) on the impact and readiness of hydro digitalisation.



The Wider Sector

A replicable, co-developed model for unlocking more value from the existing EU hydro fleet without the need of new capital works.

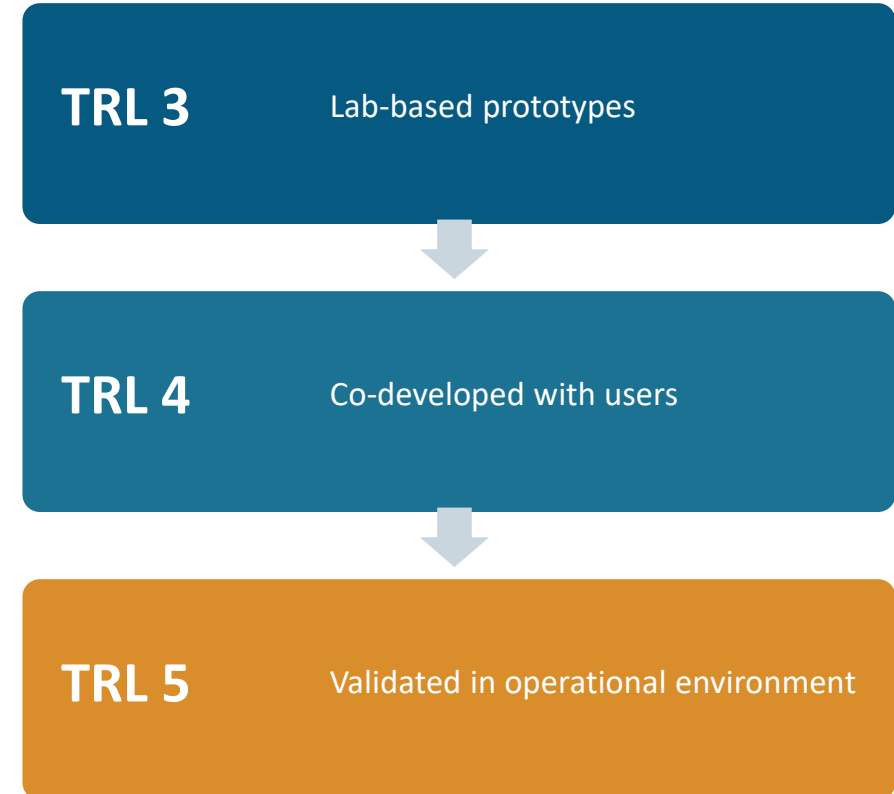
ENGAGEMENT

Built With the Sector, Not Just For It

iAMP-Hydro advanced its digital solutions from TRL3 to TRL5 through structured co-development, engaging hydropower domain stakeholders (operators, technology vendors, etc.) via a user-feedback methodology.

Why this matters for this room:

- ✓ The iAM Platform is supported by a standards-aligned data model; built for interoperability across vendors and operators
- ✓ A finished validate platform; proven in the iAMP-Hydro project, ready to demonstrate, adopt or replicate today
- ✓ A growing evidence base for policy: real baseline-to-improvement insight across 5 real hydro-plants





Thank you!

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