



iDesignRES

Integrated Design of the Components of the Energy System to Plan the Uptake of Renewable Energy Sources: An Open Source Toolbox

Cloud Hub platform and related user guidelines

Deliverable title

Deliverable 4.2



Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Document information

Deliverable Number and Name	D4.2
Work Package	Work Package 4
Dissemination Level	Public
Author(s)	Felipe van de Sande Araujo (NTNU)
Primary Contact and Email	felipe.van.de.s.araujo@ntnu.no
Date Due	30/09/2026
Date Submitted	30/09/2026
File Name	iDesignRES_Deliverable_4.2_v1.0.docx
Status	Completed
Reviewed by (if applicable)	Daniel Huppmann (IIASA)
Suggested citation	n/a

© iDesignRES Consortium, 2026

This deliverable contains original unpublished work except when indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation, or both. Reproduction is authorised if the source is acknowledged.

This document has been prepared in the framework of the European project iDesignRES. This project has received funding from the European Union's Horizon Europe programme under grant agreement no. 101095849.

The sole responsibility for the content of this publication lies with the authors. It does not necessarily represent the opinion of the European Union. Neither the CINEA nor the European Commission are responsible for any use that may be made of the information contained therein.

TABLE OF CONTENTS

TABLE OF CONTENTS.....	3
1. EXECUTIVE SUMMARY	4
2. BACKGROUND	4
2.1 Linkage with other work packages.....	5
3. FEATURES OF THE ENERGY CLOUD HUB (ENSOLVECLOUD)	6
3.1 Vision and scope	6
3.2 Functional overview	6
3.3 Architecture	10
3.4 Code organisation	11
3.5 Security and access control.....	11
3.6 Reproducibility and FAIR principles.....	12

1. EXECUTIVE SUMMARY

This report summarises the activities, results and outcomes of task 4.2 in Work Package 4 (*Open database and cloud hub platform*) of the iDesignRES project over the reporting period M17–M36 (April 2024 – September 2026). WP4 is the technical work package at the centre of **openness and data-exchange standardisation** in iDesignRES: it improves the IIASA Scenario Explorer database infrastructure, delivers the *Energy Cloud Hub*, the cloud-based platform that runs the iDesignRES models in the cloud—and supports external stakeholder engagement with the resulting tools.

The main result of task 4.2 is **PR2 - the open-source cloud hub platform**, delivered as Deliverable **D4.2** (M36). The platform, internally named *EnSolveCloud* (or *Energy Cloud Hub*), is a fully operational web application that allows authenticated users to configure, launch and inspect runs of the iDesignRES energy-system models, OpenEMPIRE, EMX (North Sea Case), TransComp Model and GCAM, directly from a browser. It bridges the IIASA database infrastructure (Scenario Explorer, PR1) with the external stakeholders, and is deployed as a public, open-access service following the FAIR principles.

By M36, the platform satisfies Milestone **MS8 (Cloud hub platform running)**. A first version of user guidelines and a stakeholder-engagement package (T4.3) accompanies the release of D4.2.

Key achievements at M36

- D4.2 delivered (M36): operational Energy Cloud Hub running at <https://energycloudhub.site> (production) and a mirror running on a local test server hosting OpenEMPIRE, EMX, TransComp Model and GCAM.
- Authentication, run orchestration, dataset upload, configuration editing, run history and results visualisation implemented. Remote execution on the NTNU HPC cluster (*Solstorm*) and on a dedicated Windows runner integrated.
- Ready for handover to WP5's second wave of validation use cases.

2. BACKGROUND

The transition to a carbon-neutral energy system requires decisions that are increasingly supported by quantitative energy-system analysis. However, the models that underpin this analysis have historically been difficult for anyone outside the teams that develop them to access. Running these tools typically requires specialised technical capabilities such as installing solvers and managing software dependencies, familiarity with Linux environments, access to high-performance computing (HPC) resources, and days of set-up before the first result can be produced. This barrier limits uptake of state-of-the-art modelling tools by the planners, consultants, researchers, and policymakers who need them, and it makes results hard to reproduce and compare across studies and organisations.

A second, related problem is fragmented data and results. Scenario data are often exchanged in ad hoc formats, stored on personal or project-specific drives, and documented inconsistently, which conflicts with the FAIR principles (Findable, Accessible, Interoperable, Reusable) that publicly funded research is expected to follow. Without a shared, open infrastructure, stakeholders cannot easily reuse, compare, or scrutinise scenario results, and the transparency of model-based policy advice suffers.

WP4 addresses these two problems together. It combines an open, versioned scenario database built on the IIASA Scenario Explorer infrastructure (PR1) with an open-source cloud hub platform (PR2), in which, as described in the project proposal, “*models can be run in the cloud, without the need for downloading software, thus ensuring easier operation by end-users and systematic data sharing*”. The cloud hub removes the technical entry barriers described above and also guarantees systematic data sharing: every run is tied to a documented dataset and configuration, and its results are exported in the common IAMC format, making them directly available for upload to the Scenario Explorer and the project’s visualisation tools. Task 4.2, reported in this deliverable, develops and operates this platform (Section 3); task 4.3 complements it with stakeholder engagement so that external users can apply the tools to their own cases and add their own data, feeding the user guidelines and training material that accompany the platform (see Annex A for the public workshop held on 8 September 2026).

WP4 is composed of three tasks:

Table 1: WP4 tasks, partners and timeline.

Task	Title	Months	Lead
T4.1	Adaptation of the Scenario Explorer and related database infrastructure	M17–M28	IIASA
T4.2	Development of a cloud hub platform	M23–M36	NTNU
T4.3	Stakeholder engagement to use the platform	M29–M36	NTNU

2.1 Linkage with other work packages

WP4 is tightly coupled to the rest of the project:

- **WP1 (multi-physics components):** provides the data and nomenclature standards that the database and platform consume.
- **WP2 (system models):** OpenEMPIRE, EMX, TransComp Model and GCAM, all hosted in the Energy Cloud Hub.
- **WP3 (use cases):** first wave of demonstrators used to test the platform and feed back improvements into T4.1 and T4.2.
- **WP5 (visualisation & operational tools):** the Energy Cloud Hub feeds results into the Scenario Explorer and the WP5 visualisation layer (PR6).
- **WP6 (dissemination):** outreach, workshops and the project website use the Scenario Explorer and the Energy Cloud Hub as examples of the project’s flagship outputs.

3. FEATURES OF THE ENERGY CLOUD HUB (EnSolveCloud)

3.1 Vision and scope

The Energy Cloud Hub (*EnSolveCloud*) implements PR2 as described in the proposal: “an open-source cloud hub platform where all models can be run in the cloud, without the need for downloading software, thus ensuring easier operation by end-users and systematic data sharing”. The platform removes the historical entry barrier to the iDesignRES models (solver, dependency management, HPC access, Linux proficiency) and exposes them through a uniform, model-agnostic web interface.

3.2 Functional overview

From the end-user’s perspective, a typical session on the Energy Cloud Hub follows the journey:

1. **Register and authenticate.** Self-service sign-up with email verification and admin approval (Figs. 1 and 2).



EnSolve Cloud

[About](#) [Select model](#) [Profile](#)

What is EnSolve?

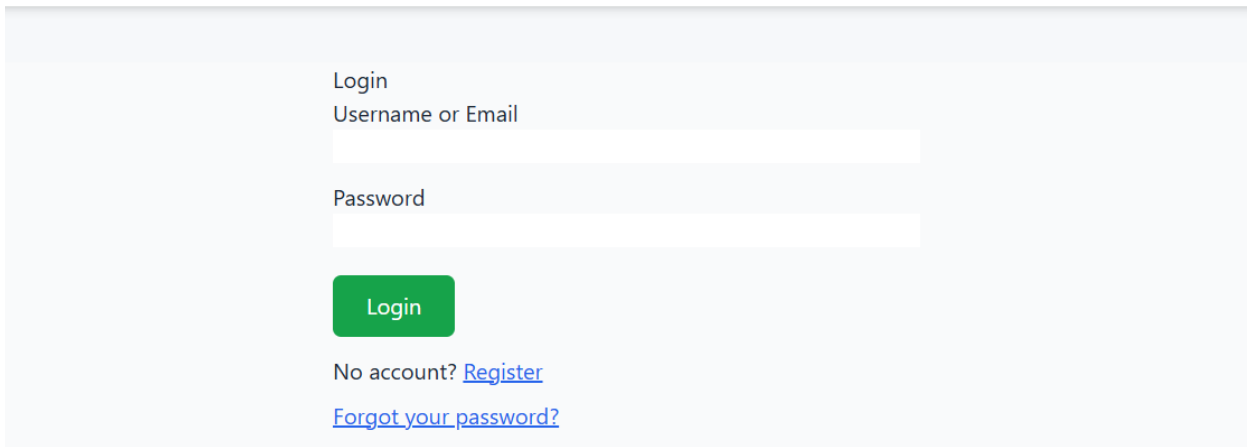
EnSolve is an open-source cloud platform where energy optimization models are hosted. These models often require significant computing power and domain expertise — something this platform helps users overcome.

By simplifying how input data and configurations are managed, **anyone** can modify model parameters without needing advanced software skills. Once the model setup is complete, it can be executed on a high-performance computing cluster (HPC), enabling simulations that require hundreds of gigabytes of memory — far beyond what a typical personal computer can handle.

As a user, you can select a model that fits your needs, adjust inputs and configuration, and submit the job with one click. After execution, the results will be available for download and review.

► EnSolve empowers energy researchers, students, and planners to simulate complex energy systems with ease.

Figure 1: EnSolveCloud’s homepage. User registration is under the “Profile” menu.



Login

Username or Email

Password

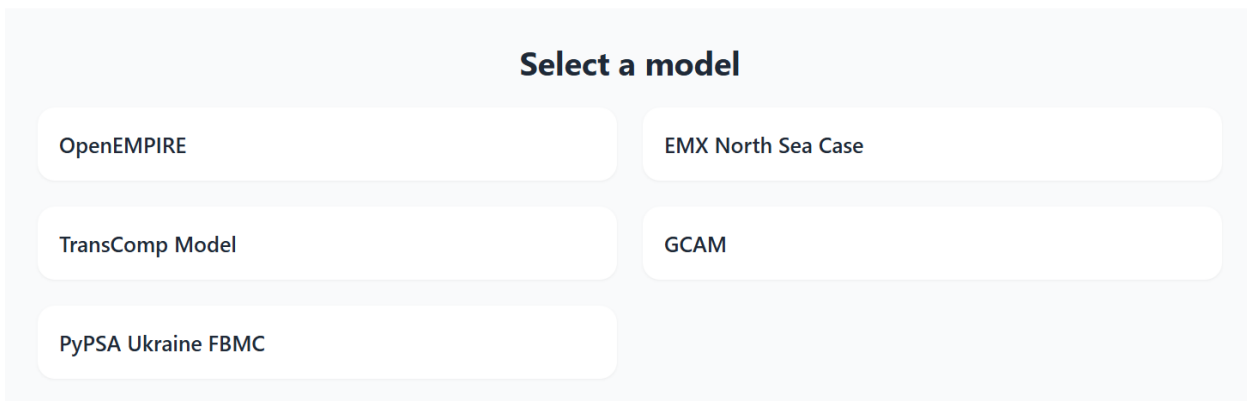
[Login](#)

No account? [Register](#)

[Forgot your password?](#)

Figure 2: User login or new user registration.

2. **Select a model.** The model registry currently exposes OpenEMPIRE, EMX (North Sea Case), TransComp Model, GCAM and PyPSA for the Ukraine case (Fig. 3).



Select a model

OpenEMPIRE

EMX North Sea Case

TransComp Model

GCAM

PyPSA Ukraine FBMC

Figure 3: Model selection page.

3. **Inspect/edit input data.** Excel-based data uploads for OpenEMPIRE, JSON/YAML configuration editing, dataset snapshots stored in MongoDB.

Active model
OpenEMPIRE

Overview
Edit data
Edit Config
Run model
Results
Streamlit

Edit Dataset Files

Current dataset: **Baseline**

Modified files in your working copy: 0 of 6 • 0 KB

Upload Files
Save Dataset
Load Dataset
Reset Dataset

Saved datasets: 0/5 • 0 KB / 100 MB

Dataset Files

Baseline dataset is shown by default. Files you have customised are marked **Modified**.

[General.xlsx](#)
Edit

Figure 4. Data selection and editing tab for the OpenEMPIRE model.

4. **Configure the run.** YAML configuration, scenario-generation options, solver selection.

Active model
EMX North Sea Case

Overview
Edit Config
Run model
Results

EMX Config

Configure time horizon, country inclusion, and result exports for EMX website runs.

Time Horizon

Operational periods ⓘ

168

Optimization horizon ⓘ

48

Implementation horizon ⓘ

24

Economic Settings

Carbon Emission Price (CO2)

30

OPEX: Electricity Solar PV Utility Optimal

0.0036

OPEX: Electricity Wind Onshore Average

0.18

OPEX: Electricity Wind Offshore Transitional

0.39312

Figure 5. Config tab for the model variables for Energy Models X (EMX).

8

5. **Launch and monitor the run.** Live status, streamed logs, email notification on completion.

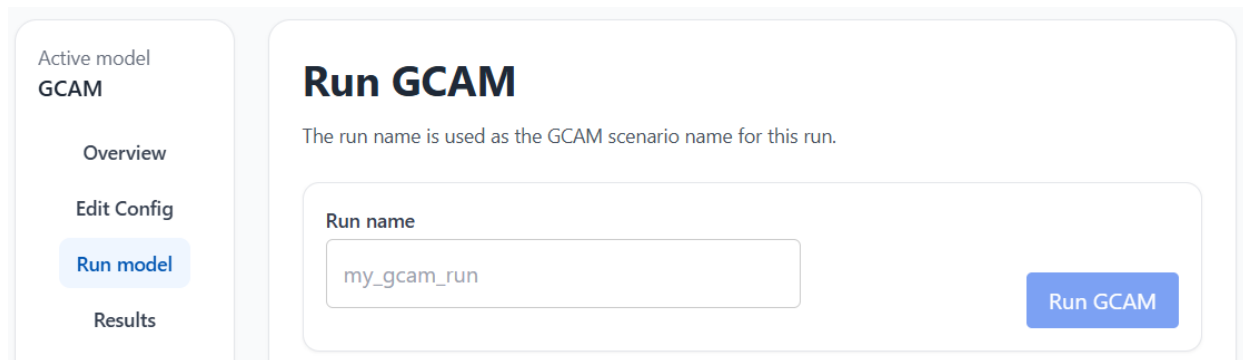


Figure 6. Run tab for the GCAM model.

6. **Inspect results.** List past runs, download files, and view Streamlit visualisation (for OpenEMPIRE).

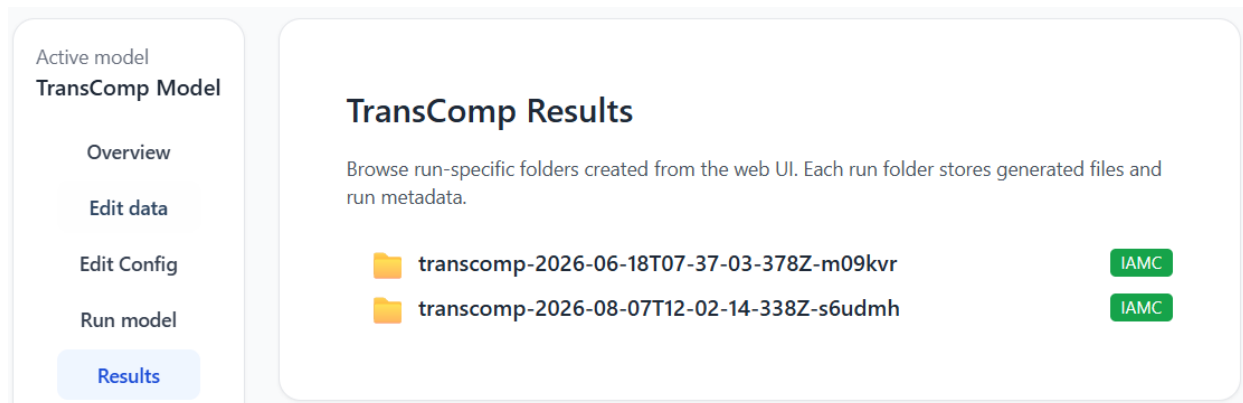


Figure 7. Results tab for the TransComp model.

7. **Administrative tools.** Admin-only views of the user base, approvals and account management.

3.3 Currently supported modelling tools and framework

The current implementation of EnSolve supports five modelling frameworks used in iDesignRES (see Table 2). These frameworks cover different use cases, from global integrated assessment modelling to sectoral models with a high spatial resolution.

Table 2: Models integrated in the Energy Cloud Hub at M36.

Model	Description	Upstream repository
OpenEMPIRE	Stochastic LP for the European power system with high VRES shares; capacity-expansion and operational decisions at hourly resolution.	https://github.com/ntnuiotenergy/OpenEMPIRE

Energy Models X (EMX) North Sea Case	EnergyModelsX.jl model of the North Sea macro region (GB, NL, DE, DK, NO) at NUTS 2 (104 nodes); hourly electricity and heat optimisation with receding horizon.	https://github.com/EnergyModelsX
TransComp Model	Long-distance transport transition model: vehicle stock, modal shift and technological substitution; soft-linked with energy-system and transport models.	https://github.com/antoniamgolab/iDesignRES-transcompmodel
Global Change Analysis Model (GCAM)	Integrated assessment model covering energy, economy, land, water and climate; reference and policy run workflows.	https://github.com/JGCRI/gcam-core
PyPSA Ukraine FBMC	Flow-based market coupling (FBMC) of the European day-ahead electricity market with a high-resolution Ukrainian network, built with PyPSA.	https://github.com/WouterKoksNL/pypsa-fbmc

4. TECHNICAL IMPLEMENTATION AND SOFTWARE STACK

4.1 Architecture

The platform is implemented as a containerised, three-tier web application deployed with Docker Compose and fronted by NGINX.

Technology stack

- **Frontend** — React + Tailwind CSS, model-agnostic *plugin* architecture (each model registers its own Overview / Data / Config / Run / Results).
- **Backend** — Node.js (ESM) with Express, Mongoose for MongoDB, JWT-based authentication, role-based access control (requireAuth, requireAdmin), Multer for file uploads, Brevo SMTP for transactional email.
- **Data layer** — MongoDB (users, runs, saved configs, saved datasets, verification tokens).
- **Compute layer** — Runs are dispatched either to a remote Windows runner (running PowerShell wrappers around conda environments) or to the NTNU HPC cluster *Solstorm* via SSH. Both runners return results to the backend, which stores them on a shared volume.
- **Visualisation** — Streamlit (currently used for OpenEMPIRE results) embedded in the platform.
- **Containerisation** — Docker Compose with services: api, client, mongo, streamlit.

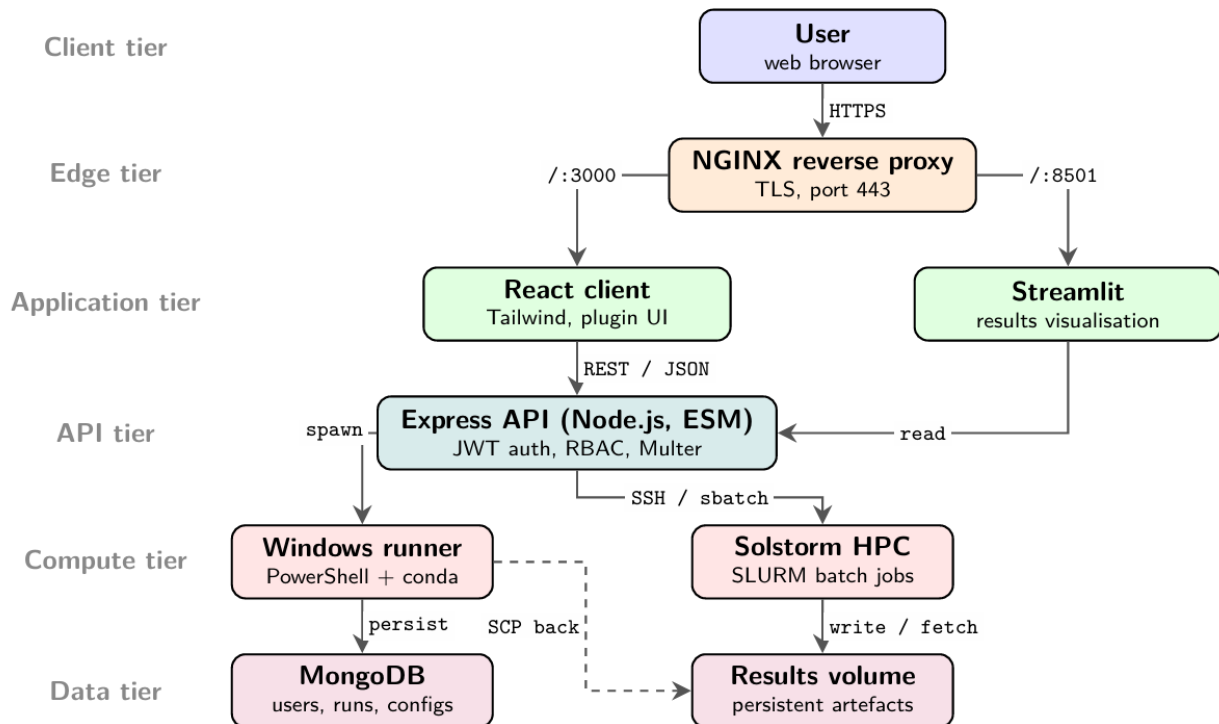


Figure 8: High-level architecture of the Energy Cloud Hub platform at M36. The client tier (browser) talks to the edge tier (NGINX) over HTTPS, which routes to the application tier (React front-end on port 3000 and Streamlit on port 8501). All model interactions flow through the API tier (Express), which dispatches jobs to the compute tier (a Windows runner for short jobs and the Solstorm HPC cluster for long scenarios). Run metadata and artefacts land in the data tier (MongoDB plus a persistent results volume).

4.2 Code organisation

The repository cleanly separates the frontend, backend, and integrated models.

```

EnSolveCloud-worktree/
|-- client/           # React + Tailwind frontend (model plugin architecture)
|-- server/           # Express + MongoDB backend
|-- OpenEMPIRE/       # OpenEMPIRE model (sub-module)
|-- EMX/              # EnergyModelsX helpers and IAMC export
|-- TransCompModel/   # Transport model (sub-module)
|-- scripts/          # PowerShell + Julia runner scripts
|-- docker-compose.yml # Local development
|-- docker-compose.production.yml # Production deployment
`-- streamlit_app.py   # Streamlit dashboard
  
```

4.3 Security and access control

- Self-service registration with mandatory e-mail verification (token model).
- Pending-approval flow: an admin must approve new accounts before they can run models (aligned with the project's data-management policy).

- JWT-based session, HttpOnly cookies, CORS allow-list, password reset and account-deletion flows.
- Role separation: user/admin; admin routes are guarded by a requireAdmin middleware.
- Secrets are kept out of the repository as recommended by NTNU's IT operations.

4.4 Reproducibility and FAIR principles

- Each run is associated with the user, the model, the dataset snapshot, and the configuration digest of the model code at the time of the run.
- IAMC-compatible outputs are produced and made available for download (except for the GCAM model), ensuring compatibility with the IIASA Scenario Explorer and the WP5 visualisation layer.
- The platform can be re-deployed on any NTNU-compatible host or, with minimal adaptation, on any cloud provider.
- NTNU and IIASA have committed to keep the platform available for at least five years after the end of the project, in line with the sustainability plan agreed in WP6.

4.5 Code repository

The website code is available in the following public repository:

<https://github.com/FelipeVdSAraujo/EnergyCloudHub>. To replicate the full functionality as currently available, the energy models must also be installed from their repositories.

Annex A: Public workshop on the Scenario Explorer and the Cloud Hub (8 September 2026)

As part of task 4.3 (stakeholder engagement to use the platform), the consortium organised a public online workshop introducing the iDesignRES Scenario Explorer and the Energy Cloud Hub to external users and researchers. The workshop took place online on Tuesday 8 September 2026, 14:00–16:00 CEST, and was organised by Pedro Crespo del Granado, Pankaj Ravindra Gode and Felipe van de Sande Araujo (NTNU), and Daniel Huppmann (IIASA), with approximately 20 participants.

The workshop pursued two aims: (i) to enable external users to work with the iDesignRES open database and cloud platform, encouraging wider adoption of the tools developed in WP4; and (ii) to collect structured participant input for the practical guidelines that show how to add data and adapt the tools to specific cases, requirements and constraints.

The programme combined live demonstrations with interactive feedback:

- **Opening and framing** (14:00–14:25): welcome and introduction to the iDesignRES project and the aims of the workshop, followed by a presentation of the Energy Vision scenarios and the framing of the project's main case.
- **Scenario Explorer** (14:25–14:55): a high-level introduction to the Scenario Explorer and a detailed walkthrough of the North Sea case, demonstrating how scenario data produced by the project models can be navigated, compared and re-used.
- **Cloud Hub** (14:55–15:30): a high-level introduction to the Energy Cloud Hub, followed by detailed examples of the EMX and EMPIRE models, including the configuration of receding-horizon parameters (operational period and optimisation horizon) and key cost (OPEX) parameters, running the models in the cloud, and inspecting the resulting dispatch profiles.
- **Usability and feedback** (15:30–16:00): three breakout rooms, each led by one of the organisers, collected participant input on adding data, adapting the tools and drafting the user guidelines, followed by a wrap-up of the next steps.

The demonstrations were based on the North Sea cases and the Energy Vision / GENeSYS-MOD scenarios hosted on the Scenario Explorer and the Cloud Hub. The plenary part of the workshop was recorded and will be edited for publication; the consortium archives the agenda and recording.

The feedback collected in the breakout groups feeds directly into the user guidelines delivered alongside this report and into the second wave of validation use cases in WP5. It confirmed a strong interest in the “run from the browser” paradigm, while participants highlighted the need for step-by-step documentation for adding their own datasets — a need that is addressed by the guideline documents and training material further developed in WP4 and WP6.

More details available at : <https://www.youtube.com/@iDesignRESEUProject>



iDesignRES

Integrated Design of the Components of the Energy System to Plan the Uptake of Renewable Energy Sources: An Open Source Toolbox

More information on iDesignRES project:



<https://www.linkedin.com/company/idesignres>



<https://idesignres.eu/>



Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.