



iDesignRES

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

Updates to the Scenario Explorer and related user guidelines

Deliverable title

Deliverable 4.1



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Document information

Deliverable Number and Name	D4.1
Work Package	Work Package 4
Dissemination Level	Public
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Date Due	31/01/2026
Date Submitted	30/01/2026
File Name	iDesignRES_Deliverable_4.1_v1.docx
Status	
Reviewed by (if applicable)	Ehsan Nokandi (NTNU)
Suggested citation	n/a

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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.

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1. EXECUTIVE SUMMARY

Since the launch of the iDesignRES project, the Scenario Services team at IIASA worked closely with the modelling teams in the consortium to extend the features of the “Scenario Explorer” web user interface, the database infrastructure backend and related packages for scenario validation and processing. The key developments are 1) support for **regional resolution at the NUTS 1/2/3 level** across the entire scenario processing workflow and front-end data visualization, 2) implementation of **subannual timeseries data** handling, in particular hourly timeseries data, in the database infrastructure, the scenario processing, and the front-end web user interface, 3) more user-friendly plotting features and customizable legends in the front-end, and 4) a feature to **save and share “workspaces”** (i.e., configurations of selection and visualization settings) in the data explorer component of the front-end.

The features were implemented following an **iterative process of requirements-elicitation, prototyping and user testing** with multiple modelling teams.

All new functions and features related to the scenario processing, the database infrastructure and the detailed spatial resolution are implemented as **open-source Python packages** following best practices of collaborate scientific software development.

This document also references user guidelines related to the data format and specifications, extending the previous Deliverable 1.1 on data collection and formats.

2. Background

The IIASA database ecosystem is a suite of tools and packages to support scenario analysis, scientific analysis and dissemination of project results to a wider audience. The main component is a web user interface (aka “Scenario” Explorer) where modelers can submit scenarios developed in a project for analysis and comparison. The ecosystem includes a processing workflow infrastructure for validation and region-aggregation at the time of submission (upload) of scenarios to the database.

The infrastructure is used by many projects, each of them having their own instance of a database backend, front-end web user interfaces (usually one for project-internal collaboration and one for public dissemination of scenario results) and independent configuration and validation criteria. New features for the Scenario Explorer and the related tools are usually developed as prototypes in one project and then deployed across relevant other projects.

Task 4.1 of the iDesignRES project implements extensions to the front-end, the database infrastructure and related tools for the specific needs for iDesignRES, in particular for high spatial and temporal disaggregation of scenario data.

3. NEW FEATURES IN THE IIASA DATABASE WEB USER INTERFACE (“SCENARIO EXPLORER”)

3.1 Regional resolution at the NUTS 1/2/3 level

The “Map Explorer” component of the Scenario Explorer web user interface was extended to show scenario data at the various sub-national “Territorial Units for Statistics (NUTS)” levels. The geojson files used for this representation were compiled from EUROSTAT and merged the latest NUTS version (2024 release) with an earlier version to include the United Kingdom, which is not included by default in EUROSTAT shapefiles following Brexit. The shapefiles are shared via a public GitHub repository (see 6.4)

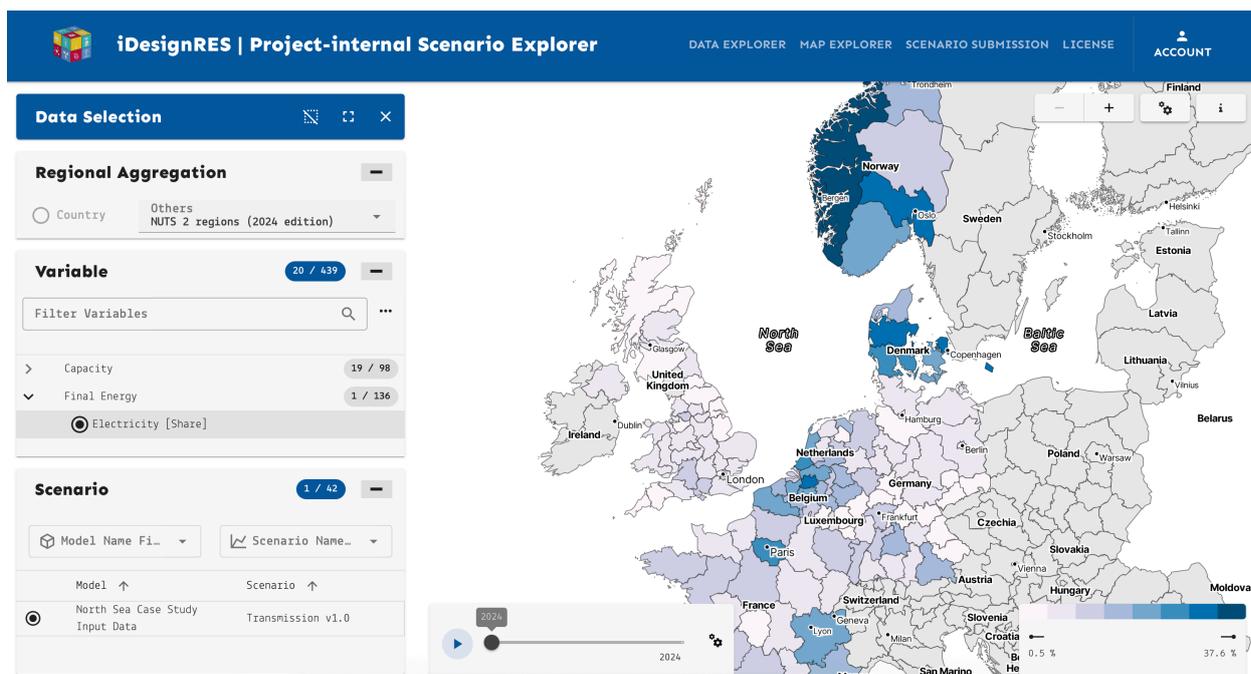


Figure 1: Screenshot of the Map Explorer, showing input data for the North Sea Case study

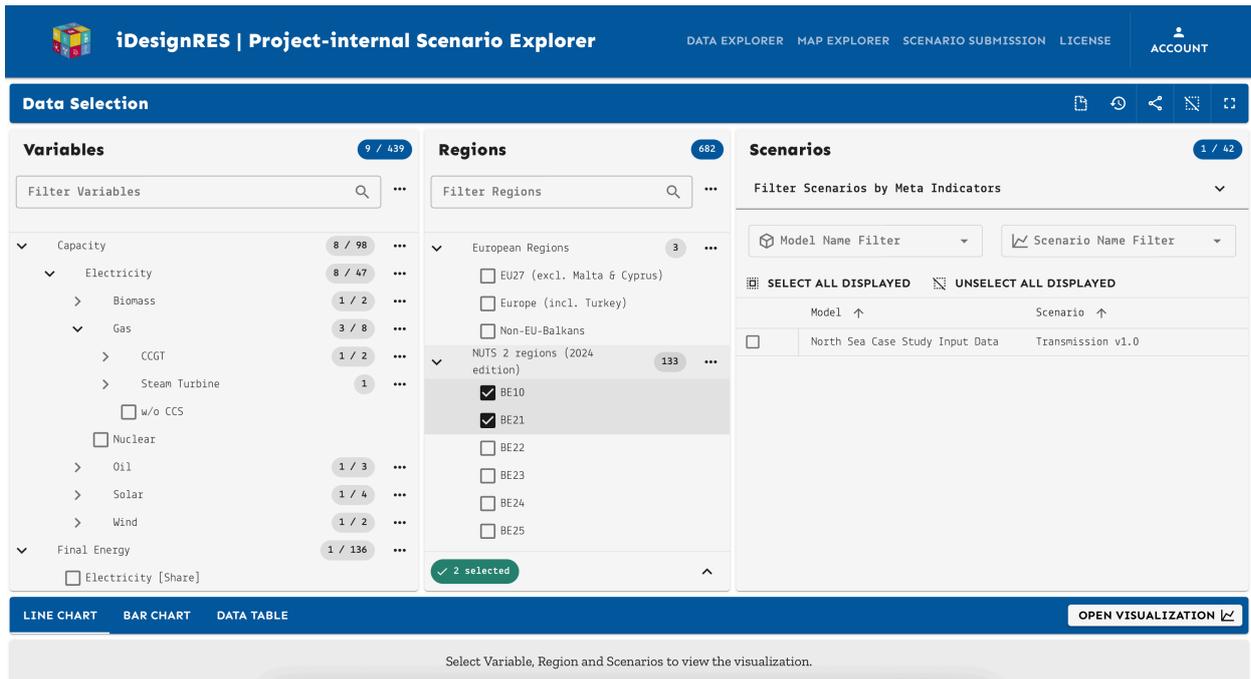


Figure 2: Screenshot of the Data Explorer showing the data-selection for the NUTS 2 regions

3.2 Implementation of subannual timeseries data

The “Data Explorer” component was extended to support visualization of hourly timeseries data.



Figure 3: Screenshot of the Data Explorer, showing a selection of hourly data as line plot

3.3 User-friendly plotting features and customizable legends

The visualization and plots of the data explorer component were redesigned to support customizable, intuitive legends and configurable stacking options.

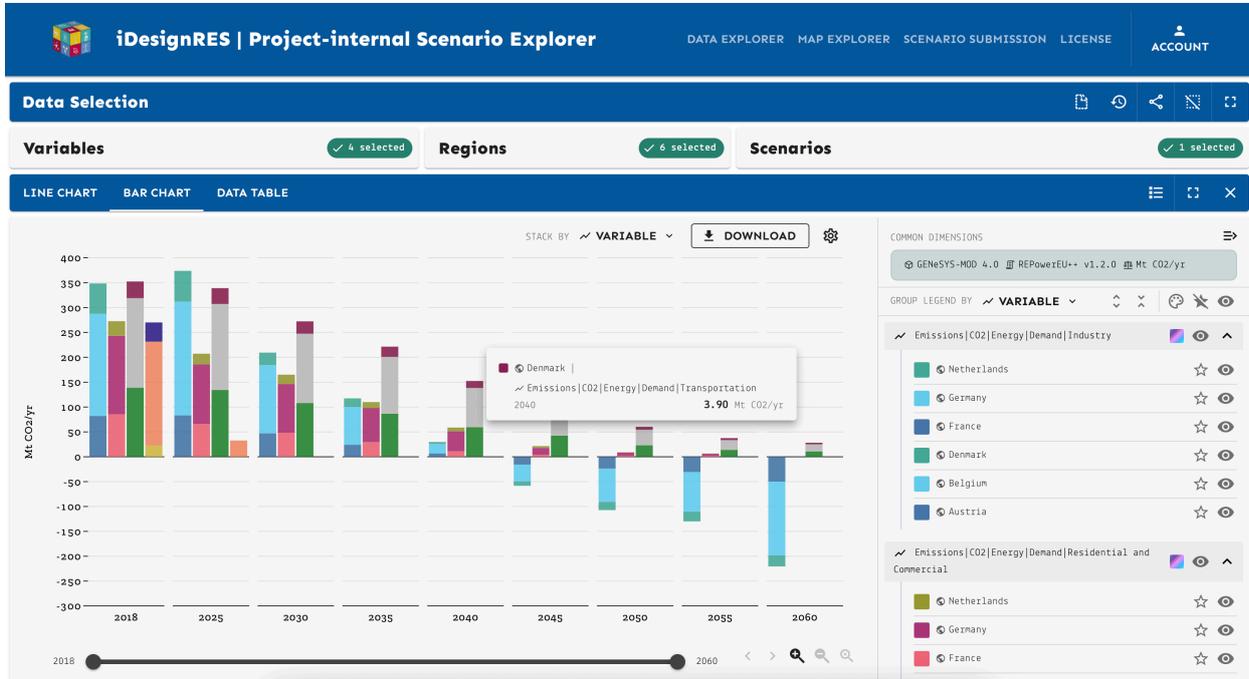


Figure 4: Screenshot of the Data Explorer component stacked bar chart visualization with a detailed legend and a mouse-over info icon

3.4 Feature to save and share “workspaces”

One common request from users was the option to create, save and share “workspaces”, i.e. selections of data and custom visualization configurations. Such a feature was now implemented for the data explorer component.

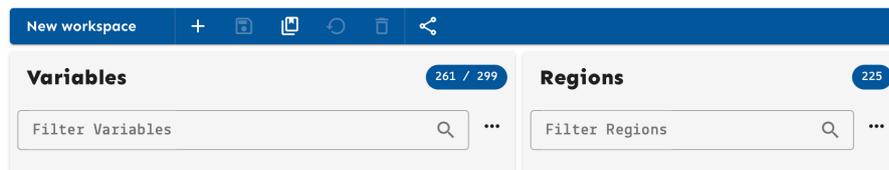
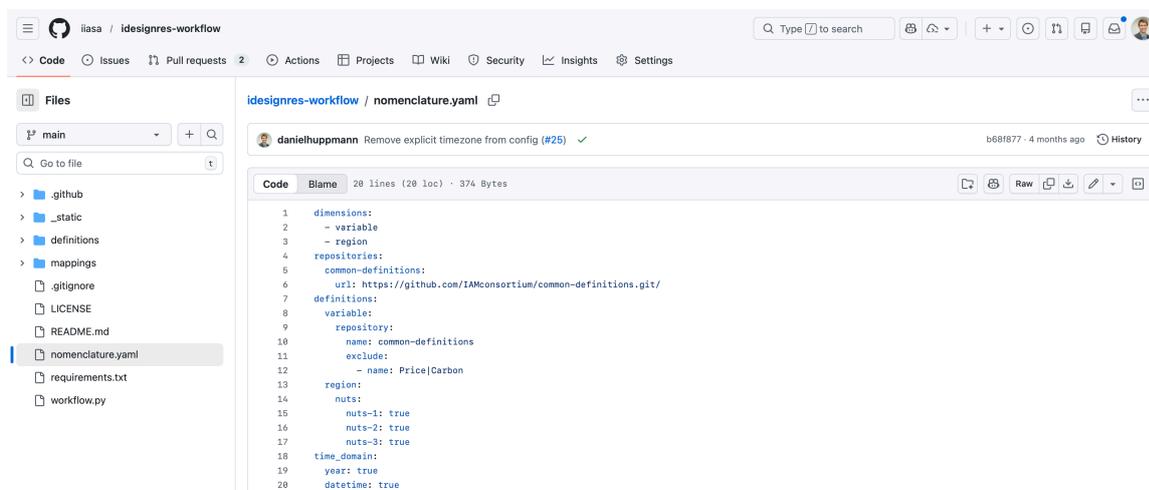


Figure 5: Screenshot of the new feature to create, save and share workspaces

4. CONFIGURATION OF THE SCENARIO PROCESSING INFRASTRUCTURE

The Scenario Explorer web user interface is not just a tool for data visualization and dissemination, but it is also the submission portal for modeling teams to upload their scenarios developed in this project. The submission is connected to a validation and processing workflow to ensure consistency of submitted scenarios with the data formats adopted in this project.

Configuration of the processing infrastructure, including region-processing and “codelists” (i.e., list of variables and regions used in a project) are managed via project-specific GitHub repositories. In the example below, the file nomenclature.yaml specifies that the iDesignRES projects uses all NUTS levels (imported from the pysquirrel package, see 6.3) and allows scenario submission using the datetime format, i.e., subannual time resolution.



The screenshot shows a GitHub repository for 'iiasa / idesignres-workflow'. The file 'nomenclature.yaml' is open, showing the following configuration:

```

1 dimensions:
2   - variable
3   - region
4 repositories:
5   common-definitions:
6     url: https://github.com/IAMconsortium/common-definitions.git/
7 definitions:
8   variable:
9     repository:
10      name: common-definitions
11      exclude:
12        - name: Price|Carbon
13 region:
14   nuts:
15     nuts-1: true
16     nuts-2: true
17     nuts-3: true
18 time_domain:
19   year: true
20   datetime: true

```

Figure 6: Screenshot of the GitHub repository <https://github.com/iiasa/idesignres-workflow> that handles scenario processing configuration for this project

5. DOCUMENTATION AND GUIDELINES

5.1 Improving documentation

Deliverable 1.1 of the iDesignRES project established the data format and naming conventions for scenario analysis, building on the work of the Horizon 2020 project “openENTRANCE” and the work in the Integrated Assessment Modeling Consortium (IAMC). These standards have been adopted successfully by the modeling teams in the iDesignRES consortium.

In parallel to the developments of the front-end and the software stack, the Scenario Services team reworked the documentation at <https://docs.ece.iiasa.ac.at>, adding user guides and FAQ pages. These pages will be continuously extended and improved based on user feedback.

5.2 Datetime format conventions

Following discussions with modelling teams, IIASA proposed to use UTC time format without a timezone identifier for data with continuous subannual resolution that can be represented in the datetime format. This departs from the openENTRANCE project, where the CET was used and required adding a timezone identifier to all timesteps information.

Modelers in this project will use UTC if reporting data for countries from distinct timezones (e.g., North Sea region including UK) and using the local timezone implicitly (but without an explicit timezone timestamp) if working with countries from a single timezone (e.g., only Central European countries).

6. RELEVANT OPEN-SOURCE PACKAGES AND RESOURCES

The following packages and resources are developed and maintained by the IIASA Scenario Services team. The implementation follows best practices of collaborative, agile scientific software development, including version control on Github, release under established open-source licenses, distribution via pypi, and continuous-integration workflows with high test coverage.

6.1 The ixmp4 database management package

<https://docs.ece.iiasa.ac.at/ixmp4>

This package is a data warehouse for high-powered scenario analysis in the domain of integrated assessment of climate change and energy systems modeling. It provides the database infrastructure backend for the IIASA Scenario Explorer environment.

For iDesignRES, this package was extended to support subannual timeseries data in the IAMC format. See <https://docs.ece.iiasa.ac.at/iadc.html#iamc-format> for more information about this data format.

6.2 The nomenclature package for scenario processing and validation

<https://nomenclature-iamc.readthedocs.io/>

This package facilitates validation and processing of scenario data. It allows to manage definitions of data structures for model comparison projects and scenario analysis studies using the data format developed by the Integrated Assessment Modeling Consortium (IAMC).

For iDesignRES, this package was extended to support efficient validation of subannual timeseries data and regional resolution at the NUTS 1/2/3 level.

6.3 The pysquirrel package for NUTS region management

<https://github.com/iiasa/pysquirrel>

This package facilitates working with the “Nomenclature of territorial units for statistics” (NUTS) administrative divisions developed by Eurostat, including the “Statistical regions” (SR) for non-EU neighbouring countries (e.g., United Kingdom, Ukraine).

The structure of the source code follows the widely used **pycountry** package (see <https://github.com/pycountry/pycountry> for more information).

This package was started in response to user needs within the iDesignRES consortium.

6.4 Geojson source repository for European sub-national administrative regions

<https://github.com/iiasa/scse-geojson>

The geojson shapefiles provided by Eurostat for the current version of the “Nomenclature of territorial units for statistics” (NUTS) do not include the United Kingdom following Brexit. Alas, having detailed region resolution is important for European energy systems models, in particular related to the study of the North Sea region. This repository provides geojson shape files combining the latest NUTS regions for EU countries with similar statistical regions in the UK.

This repository was started to make the geojson shapefiles implemented for the spatial data explorer in the Scenario Explorer easily reusable by other modeling teams.



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More information on iDesignRES project:



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



<https://idesignres.eu/>



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