

Rumi

An open-source energy systems modelling platform
developed by Prayas (Energy Group)



Overview

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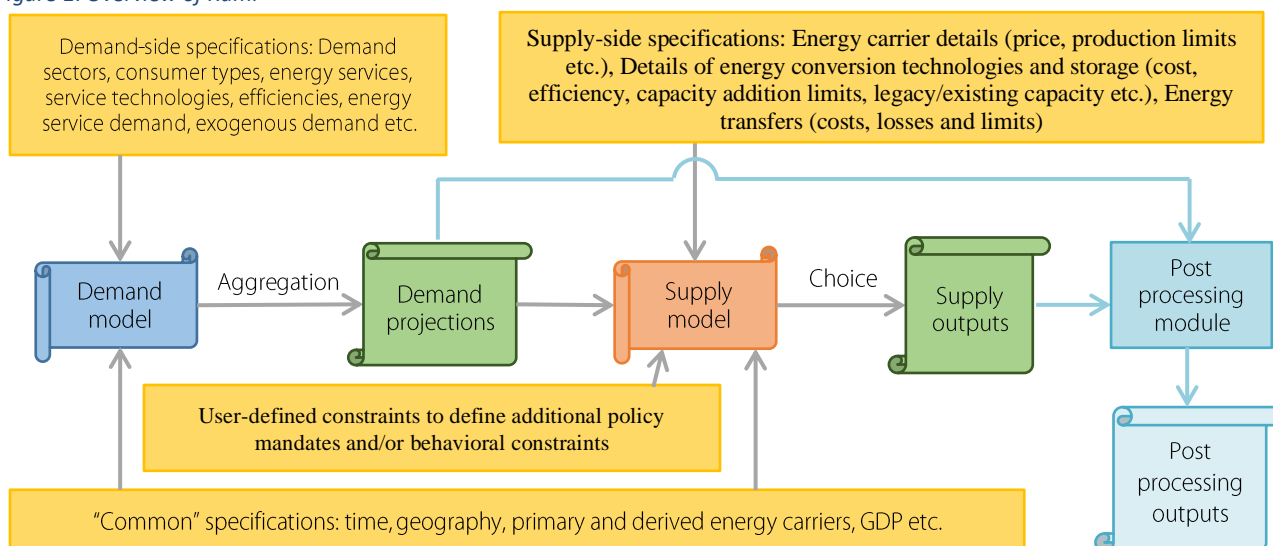
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1 Overview

Rumi is a generic, open-source energy systems modelling platform developed by Prayas (Energy Group) to aid policy-relevant analysis. Its design enables spatially and temporally disaggregated modelling, and modelling of energy demand in detail. This documentation pertains to version 2.0 of Rumi.

Given suitable inputs, the demand estimation component of Rumi estimates energy demand for various sectors, energy carriers, energy services etc., at the temporal and geographic granularity specified. The supply estimation component of Rumi identifies supply sources to meet the estimated demand at least cost, based on various supply-side inputs. Figure 1 depicts this architecture of Rumi.

Figure 1: Overview of Rumi



2 Installing Rumi

To support easy interoperability and open-sourcing, Rumi has been built on Python and Pyomo. Python needs to be installed on the computer on which Rumi will be installed and run. Instructions to install Rumi (and all the software it depends on) are provided in the `README.md` file available in the root directory of the Rumi platform repository. In addition to this, a solver¹ needs to be installed to run the supply component of Rumi. All documentation about Rumi is available in the `Docs.zip` file available under the latest release tag on the Rumi platform repository (<https://github.com/prayas-energy/Rumi>).

3 Setting up a Rumi model instance

To use Rumi and obtain results from running the model, one has to set up a *model instance*. A model instance is nothing but a collection of data files describing the kinds of things that are being modelled (e.g. the geographic areas, the time period, the energy carriers and their characteristics, the technologies used to produce some energy carriers and their characteristics etc.). Details of the input data files are given in Section 4. PIER is a complete energy systems model for India built using Rumi. Version 2.0 of PIER can be downloaded from: <https://zenodo.org/uploads/14603084>

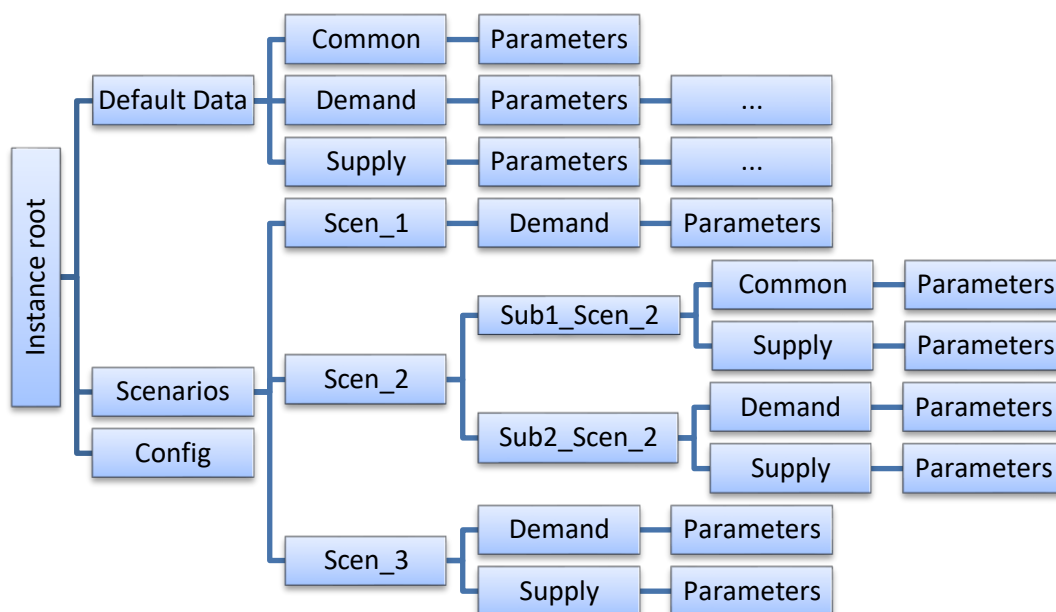
The model instance is expected to follow a certain directory (folder) structure as described below. One directory, called `Scenarios` is expected in the root directory of the model instance. As the name suggests, this directory contains the data pertaining to all the scenarios that are modelled. Data pertaining to each scenario that is modelled is expected under one directory which is (directly or indirectly) under the `Scenarios` directory.

Each scenario directory can consist of three sub-directories called `Common`, `Demand` and `Supply`, each of which have of a further sub-directory called `Parameters`. The `Parameters` directory contains a set of `.csv` files which contain the actual data used by Rumi. There is also a directory structure that is expected within the `Demand` and `Supply` directories, which is explained in their respective documentation. Typically, much of the input data is common across the various scenarios. To facilitate this, Rumi supports a directory called “Default Data” (without the double-quotes) in the root directory which contains the data inputs to be used by default in any scenario. This directory has a structure similar to the scenario directories. That is, `Default Data` too has three sub-directories called `Common`, `Demand` and `Supply`, each of which consists of a further sub-directory called `Parameters` containing the actual `.csv` data files that are to be used by default across scenarios. Each individual scenario directory can then only have the data files that are specific to that scenario. If a scenario does not contain some input data file, that file is taken from the `Default Data` directory. Thus, typically, the directory structure of a model instance would be as shown in Figure 2².

¹ `cbc`, `glpk`, `cplex` and `gurobi` are some of the commonly known and used solvers. Not all solvers are available freely, i.e., they may have to be purchased. Please see Section 3 of this document to understand how to tell Rumi which solver you are using.

² Strictly speaking, the `Default Data` directory need not be present, if all data is provided for each scenario.

Figure 2: Typical directory structure of a model instance



It's essential to adhere to the above directory structure to define parameters, scenario, and configuration. However, users can create other directories to store background calculations and references that will not be read by Rumi.

The `Config` directory in the Rumi installation contains a (default) configuration file named `Config.yml`. The modeller should specify configuration parameters for Rumi in this file. In this release, configuration parameters are supported only for the supply component of Rumi. The only mandatory configuration parameter in this configuration file is `solver_name` which specifies the name of the solver to be used by the supply component. All the other configuration parameters that can be specified in the configuration file viz. `solver_executable`, `solver_options_file`, `symbolic_solver_labels` are optional. The supplied `Config.yml` file in Rumi contains explanatory documentation for all these parameters. Note that if a line in the configuration file starts with the `#` character, it is treated as a comment line and ignored. Section 5 explains how to run the Rumi components.

Rumi also provides the facility to optionally have a `Config.yml` configuration file for each model instance. In that case, the file should be present in the `Config` directory of the model, and will override the default `Config.yml`.

The `Config` directory in Rumi also contains an `EnergyUnitConversion.csv` file. This file contains the numerical constants required to convert one energy unit to another – specified in a matrix format. In this release, the supplied file in Rumi specifies conversions from and to 24 different energy

units. This file is used by the supply component to perform the required energy unit conversions. The modeller can choose to modify or extend this file in Rumi's `Config` directory as required. Rumi also provides the facility to have an `EnergyUnitConversion.csv` file with the model instance (in its `Config` directory) – in which case, the file present in the model overrides the default file available in the `Config` directory of Rumi.

4 Inputs to Rumi

Rumi accepts three kinds of inputs corresponding to the three sub-directories that are expected under any scenario, namely:

- Inputs for demand processing in the `Demand` directory
- Inputs for supply processing in the `Supply` directory
- Inputs that are common to both supply and demand processing in the `Common` directory

The three specification document files available in the `Docs` directory of the Rumi installation, namely `common-inputs-documentation.pdf`, `demand-documentation.pdf` and `supply-documentation.pdf` describe the various input files that are expected, where they need to be located, and what they should contain.

Similar to demand and supply, details about inputs and outputs for post processing is in the document `postprocess-documentation.pdf`

All data input files to Rumi are `.csv` (comma-separated value) files. Most of these input files also contain a header row with pre-defined names for columns in the file³. For all such files with a header row, the order of the columns does not matter, since the column heading indicates what each column represents. Moreover, such files can also have extra columns with headings not recognized by Rumi. Such columns are simply ignored and can be useful to document some features of the input data being provided.

³ The few exceptions where column headers are not required are described in the respective inputs' description files. For such files, the order of columns matters.

5 Running Rumi

Once Rumi has been installed, and a model instance has been set-up, it can be run as follows. This document only provides a broad overview of the commands to run the model and does not provide all the options available to the modeller. Options are generally in three categories: mandatory parameters that must be supplied, optional parameters to change some defaults, and optional parameters to define the scope of the command. Details of all the options available for the commands are provided in the `README.md` file available in the root directory of the Rumi platform repository. Here, we briefly mention the mandatory parameters that must be supplied with the Rumi commands.

To run the demand component of Rumi, use the following command on the command line:

```
rumi_demand -m MODEL_INSTANCE_PATH -s SCENARIO
```

To run the supply component of Rumi, use the following command on the command line:

```
rumi_supply -m MODEL_INSTANCE_PATH -s SCENARIO
```

In both the above examples:

<code>MODEL_INSTANCE_PATH</code>	➔	Root directory of the model instance
<code>SCENARIO</code>	➔	Relative path of the scenario directory with respect to the Scenarios directory of the model

Information regarding option can be seen with `–help` or `-h` arguments. ‘`rumi_demand`’ by default performs validation of input data. There is option to skip validation with argument `—no-validation`. Validation can be performed independently about which more explanation can be found in next section.

Note that all the parameters are case sensitive.

In addition to the above commands to run the demand and supply components of Rumi, there is an additional command which processes the outputs produced by the demand and supply components to produce some useful aggregate results. Currently, the only aggregation supported is to compute the various emissions that are specified as part of the input. In future, other types of post-processing may also be added.

```
rumi_postprocess -m MODEL_INSTANCE_PATH -s SCENARIO
```

where `MODEL_INSTANCE_PATH` and `SCENARIO` have the same interpretation as with the above commands. This command processes the outputs of the demand and supply models for the given scenario of the given model instance, and computes the quantities of various emission types for the scenario as defined in the model instance. By default, post processing module picks its inputs from respective output folders of demand and supply. Please see the `README.md` file for details of all the

options supported by this command. More details about post processing can be found in post processing user document.

6 Running Rumi Validation

Rumi platform facilitates validation of model inputs. It's advisable to run validation before running `rumi_demand` or `rumi_supply`.

To run the validation of Rumi, use the following command on the command line:

```
rumi_validate -m MODEL_INSTANCE_PATH -s SCENARIO -p PARAMETER_TYPE
```

In the mentioned command, `MODEL_INSTANCE_PATH` and `SCENARIO` arguments are the same as mentioned in supply or demand runs.

Following is more elaborate example.

```
rumi_validate -m MODEL_INSTANCE_PATH -s SCENARIO -p PARAMETER_TYPE  
- l LOGGER_LEVEL -t NUM_THREADS
```

Below are additional parameters which are also available

PARAMETER_TYPE	➔	Parameter type to validate. It can be one of, Common, Demand or Supply.
LOGGER_LEVEL	➔	Level for logging: one of DEBUG, INFO, WARN, ERROR (default: INFO). This is optional
NUM_THREADS	➔	Number of threads/processes (default: 2). This is optional.

Information regarding option can be seen with `-help` or `-h` arguments.

Running the above validation produces warning and error messages found during validation of parameter inputs. It is essential to fix errors before running `rumi_demand` or `rumi_supply`. However, warnings generally provide information about missing but optional inputs.

Please note that validation of user constraints will not be done if `rumi_validate` is run with parameter type as `Supply`, as they can only be validated after a problem instance to be created which happens while running `rumi_supply`. However, while running `rumi_supply` user constraints will be validated.

Contact Prayas (Energy Group) at energy.model@prayaspune.org for any queries regarding Rumi.