Commission modelling inventory and knowledge management system (MIDAS)
Report generation date 19/10/2020

MIDAS includes the descriptions of models in use by the Commission in support to the policy cycle. MIDAS is developed and managed by the **Competence Centre on Modelling** of the European Commission.

Find out more at https://ec.europa.eu/knowledge4policy/modelling_en
Contact: EU-MIDAS@ec.europa.eu

Factsheet

SWD/2017/0383 final

Impact assessment accompanying the document Commission Regulation (EU) No .../... on: establishing a Guideline on Electricity Balancing

Supporting model(s)

METIS

Impact assessment
SWD/2017/0383 final

Fact sheet on model contributions

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 19/10/2020

Overview

Title
Impact assessment accompanying the document Commission Regulation (EU) No .../... on: establishing a Guideline on Electricity Balancing

Document ID
SWD/2017/0383 final

Year of publication
2017

Led by
ENER

Model(s) used
METIS

METIS

Full title

Markets and Energy Technologies Integrated Software

Run for this impact assessment by

Artelys

Contributed to

Baseline and assessment of policy options

Details of the contribution

Used to assess the activation of balancing energy

METIS- Markets and Energy Technologies Integrated Software

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 19/10/2020

Overview

Acronym METIS
Full title Markets and Energy Technologies Integrated Software

Main purpose
Energy system model designed to simulate the operation of electricity, gas and heat markets and to assess impacts of policy initiatives on the European energy system and markets.

Summary
METIS is an energy model covering with high granularity the European energy system with a focus on electricity, gas and heat. The original model has been developed by the company Artelys. It is currently improved with respect to the representation of energy networks and renewable energy potentials with the aim of modelling and integrated European energy system. The model covers all EU Member States at the regional (NUTS2) level and can by run for medium term projection in an hourly resolution.

The METIS power system captures the European power system, representing power production, consumption and transmission assets. The gas system embeds gas-specific assets and performs simulations for the security of the gas supply or supply source dependence analysis. The intra-day module of METIS allows assessing the impact of the re-adaptation of the generation dispatch up-to real-time, while the balancing module allows simulating the real-time dispatch of the reserve units to face imbalance. Both system- and market-wide results can be computed also stochastically, to account for unpredictable events in the energy supply. The model incorporates four bidding strategies as a post treatment of power system simulations: marginal, strategic, oligopoly and fixed-operating costs.

The model can be used for the policy formulation. METIS is able to simulate the entire European energy system and markets operation for electricity, gas and heat energy carriers under a stochastic uncertainty, capturing for example weather variations and other stochastic events.

Keywords
Energy , energy system analysis , energy market analysis

Model category (thematic)
Energy

Model home page
https://ec.europa.eu/energy/en/data-analysis/energy-modelling/metis

Ownership & license

Ownership
Multiple copyright [Original code owned by European Union]

Ownership details
No information provided

Licence type
Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

METIS structure and approach

The METIS model consists of three main modules: *power system*, *gas system* and *power market*. Each of the three modules interact with each other mutually, as the output of one module is fed into other modules as input. Alternatively, the three modules can be run independently, when analysing electricity, gas and heat energy separately.

The *Power System module* of METIS has been designed to analyse multiple power systems issues, following a welfare-maximisation principle. It is also being used to analyse the European power systems' dynamics, by providing production plans, electricity flows, production costs, systemic marginal costs, scarcity periods and loss of load, or other standard indicators detailed further in the document. The Power System module contains a library of assets for production, consumption and transmissions that can be attached to each node of the network.

The Power System module contains the following assets: thermal non-renewable energy assets, hydro assets, other renewable energy assets, other storage assets, power consumption, power transmission, fuel contracts, CO2 emissions, reserve requirements, loss of load, and surplus of energy at each node.

The *Gas System module* has been designed to address multiple gas systems issues, following a welfare-maximisation principle, as in the Power System module. It allows the analysis of the European gas systems' dynamics, by providing production plans, gas flows, loss of load, etc.

The Gas System module contains the following assets: the gas consumption as described by the national demand of natural gas, the gas production as captures by the indigenous production of natural gas, the gas storage as described by storage facilities for gas, the liquefied natural gas (LNG) terminal as captured by gasification terminals that are receiving and transforming LNG into natural gas, LNG imports as described by imports of LNG sent to LNG terminals, LNG exports as captured by the liquefaction train liquefying natural gas and exporting, gas imports as captured by imports of natural gas from non-modelled countries through pipelines, gas exports as described by exports of natural gas to non-modelled countries through pipelines, pipelines as captured by gas transmissions between modelled zones, and CO2 emissions as described by CO2 emissions due to the consumption of natural gas associated with a CO2 price.

The *Power Market module* replicates the market participants' decision process. For a given period (typically, hours or days), the generation plan (including both energy generation and balancing reserve supply) is first optimised based on day-ahead demand and renewable energy generation forecasts. Market coupling is modelled via net transfer capacity (NTC) constraints for interconnectors. Then, the generation plan is updated during the day, taking into account updated forecasts and asset technical constraints. Finally, imbalances are drawn to simulate balancing energy

procurement. Imbalances are the result of events that could not have been predicted before the gate closure.

The METIS model files, technical documentation and user's instructions can be found on the model's website:

https://ec.europa.eu/energy/data-analysis/energy-modelling/metis_en

Input and parametrization
METIS requires as inputs the following types of data (up to hourly granularity):

- Capacity and technical characteristics of infrastructure
- Capital and technology costs
- Fuel prices
- CO2 emission factors and prices
- Weather data (actual data and forecasts)
- Wind, solar and hydro profiles
- Demand profiles and level of demand

The main sources of data are derived from publically available sources, in particular Eurostat, ENTSO-E and ENTSO-G.

Data for renewable energy potentials and time series are currently updatedA significant part of the input is context dependent, i.e. on the scenario against which METIS is calibrated (e.g. relevant PRIMES scenarios as in the case of the Market Design studies).

In general METIS is very flexible in using very different sources of data and not being restricted to specific databases or sources.

Main output
The model provides the dispatch of energy assets at hourly (or otherwise specified) time resolution.

Spatial - temporal extent
The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	The model can be used at EU country or regional level,as specified by analysts.
(Spatial) resolution	MS level or finer granularity if specified.
Temporal extent	One year unless specified differently.
Temporal resolution	Hourly.

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	METIS allows stochastic simulations.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Sensitivities runs are included in several METIS studies. These are highly dependent on the context rather than the model.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	Review by expert panel, led by JRC in 2019.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	not_applicable	Most of the analysis performed with METIS addresses future time periods

References related to external peer-review and publication in scientific journals:

- No references provided in MIDAS

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	Based on Eurostat, ENTSO-E, ENTSO-G
Can model outputs be made publicly available?	yes	At request or by re-running publically available scenario files.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	Fully documented. All documentation can be found on the METIS website: https://ec.europa.eu/energy/data-analysis/energy-modelling/metis_en
Is the model source code publicly accessible or open for inspection?	yes	Model scripts are available for download from DG ENER's website.

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Energy

The model is designed to contribute to the following phases of the policy cycle

- Formulation

The model's potential

The model can be used for the policy formulation. METIS is able to simulate the entire European energy system and markets operation for electricity, gas and heat energy carriers under a stochastic uncertainty, capturing for example weather variations and other stochastic events (short to medium term).

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	METIS contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2017	Impact assessment accompanying the document Commission Regulation (EU) No .../... on: establishing a Guideline on Electricity Balancing SWD/2017/0383 final	ENER	Baseline and assessment of policy options	*Artelys*	Used to assess the activation of balancing energy

Bibliographic references

- *Wholesale market prices, revenues and risks for producers with high shares of variable RES in the power system. - MJ-04-19-401-EN-N*
- *Cost-efficient district heating development. - MJ-04-19-410-EN-N*
- *The role and potential of Power-to-X in 2050 : METIS Studies : Study S8. - MJ-01-19-431-EN-N*
- *Effect of electromobility on the power system and the integration of RES : study S13. - MJ-02-19-296-EN-N*
- *Effect of high shares of renewables on power systems : study S11. - MJ-03-19-327-EN-N*
- *Simulating electricity market bidding and price caps in the European power markets : S18 report. - MJ-01-19-439-EN-N*
- *Weather-driven revenue uncertainty for power producers and ways to mitigate it : study S16. - MJ-03-19-328-EN-N*
- *Assessing market design options in 2030 : study S12. - MJ-02-19-302-EN-N*
- *The role and need of flexibility in 2030 focus on energy storage : study S07. - MJ-01-19-440-EN-N*
- *Assessing TYNDP 2014 PCI list in power : study S02. - MJ-02-19-303-EN-N*
- *Impact of PCIs on gas security of supply in Europe : study S05. - MJ-02-19-305-EN-N*
- *Generation and system adequacy analysis : study S04. - MJ-03-19-329-EN-N*
- *Optimal flexibility portfolios for a high-RES 2050 scenario : METIS Studies : study S1. - MJ-01-19-415-EN-N*
- *Decentralised heat pumps : system benefits under different technical configurations : METIS Studies, study S6. - MJ-02-19-295-EN-N*