Energy Strategy Reviews 22 (2018) 127–135

Contents lists available at ScienceDirect

Energy Strategy Reviews

journal homepage: www.elsevier.com/locate/esr

METIS – An energy modelling tool to support transparent policy making

Kostis Sakellaris[a,b,*], Joan Canton[a], Eleni Zafeiratou[a,c], Laurent Fournié[d]

[a] Directorate-General of Energy (DG ENER), European Commission, Rue de Mot 24, B-1049, Brussels, Belgium
[b] Athens University of Economics and Business, Department of Economics, 76 Patission Str., 10434, Athens, Greece
[c] UCL Energy Institute, University College London, 14 Upper Woburn Place, London, WC1H 0NN, UK
[d] Artelys, 81 Rue Saint-Lazare, 75009, Paris, France

ARTICLE INFO

Keywords:
Energy modelling
European energy system
Electricity markets
Energy policy

ABSTRACT

The European Commission (EC) is continuously improving its evidence-based policy making in the energy field. In that context, it is developing a new energy model to analyse detailed features of constantly evolving European Union's energy systems. The model – METIS –simulates the operation of both energy systems and energy markets for electricity, gas and heat on an hourly basis for a whole year. It can also factor in uncertainties like weather variations– a feature particularly important for dealing with the integration of renewable energy. Most importantly, to ensure transparency, a webpage dedicated to METIS contains significant model related information: from studies performed using it to relevant data, documentation, and eventually its source code. METIS has already been used in the EC's Impact Assessments supporting the proposals under the Clean Energy for All Europeans package.

1. Introduction

The European Commission (EC) adopted in 2015 an Energy Union Strategy [1], which aims to make energy more secure, affordable and sustainable. Important groundwork has already been done. The European Commission has tabled a policy framework for energy and climate for 2030 [2], as well as an energy security strategy. Meanwhile, an efficient, interconnected and transparent European Union (EU) internal energy market is closer than ever before, notably due to the new set of proposals for the EU energy market [3] adopted in 2016.

Accordingly, the EU energy system is confronted with several challenges. These include, amongst others, decarbonising the energy mix in response to climate change, increasing the flexibility of the grid and managing its stability with a high share of renewables, empowering consumers to take a more active role, and building sufficient transmission infrastructure.

In this context, a number of energy models have been used by policy makers to capture the techno-economic impacts of these new challenges. Various reviews of available models have been performed (see for instance: IRENA [4]; Connely et al. [5]; Hall and Buckley [6]; Bhattacharyya and Timilsina [7]; Hemmati et al. [8]). One of the main conclusions of these reviews is that there is no model capable of addressing all energy related questions; therefore one needs to select the area of focus and angle of approach to identify the best-suited model for each purpose. Moreover, in many cases the practice of soft-linking models focusing on different time horizons or aspects is recognised as a best-practice.

Aiming to further support transparency and evidence based policy making, the Directorate-General for Energy (DG ENER) of the European Commission aimed to develop an in-house powerful modelling tool that can quickly provide robust insights on complex energy related questions, focusing on the short term operation of the energy system and markets. The tool would complement the analysis performed using other models, mainly long-term energy system models. METIS (Markets and Energy Technologies Integrated Software)[1] is the result of this endeavour. It is developed by a Consortium comprised of Artelys, IAEW (RWTH Aachen University), ConGas and Frontier Economics. METIS is owned and operated by the European Commission. The project is expected to end in December 2018. The supply side part of METIS is already operational, with several software releases already having been delivered and the software itself has been used successfully to run studies on infrastructure cost benefit analysis, flexibility needs for variable renewable energy integration and market design.[2] The closing phase of the project (in 2018) mainly focuses on developing the demand side module of METIS for power, gas and heat, in order to capture potential synergies between these energy vectors.

* Corresponding author. Directorate-General for Climate Action (DG CLIMA), European Commission, Avenue de Beaulieu 24, B-1160, Brussels, Belgium.
E-mail address: konstantinos.sakellaris@ec.europa.eu (K. Sakellaris).

[1] https://ec.europa.eu/energy/en/data-analysis/energy-modelling/metis.

[2] All studies available on the METIS website.

https://doi.org/10.1016/j.esr.2018.08.013
Received 14 July 2017; Received in revised form 4 April 2018; Accepted 21 August 2018

The software has been customized to the European Commission's requirements in order to be able to explore and analyse the effects of different policies and trends at regional, national and European level, by running several scenarios for different years in the future (2020, 2030, 2050). At the same time, METIS follows an innovative approach in an effort to: i/bring policy makers closer to the quantitative tools used to support energy policy making, and ii/better inform the discussions with stakeholders and modelling experts on the latest policy thinking. This is achieved in the following ways:

1. Providing an easy-to-use graphical interface for policy makers and analysts. The attractiveness of the visualisation platform is crucial in facilitating the engagement of non-modelling experts.
2. Conducting and publishing studies with METIS on emerging energy topics with EU relevance. Certain of these studies support concrete policy initiatives (e.g. Ref. [9]), while others have as a primary aim to inform about issues of future policy relevance (e.g. Ref. [10]).
3. Ensuring full transparency concerning input data and the modelling techniques applied. Following recent trends in the energy modelling community concerning the openness of models and data (like [11] [12]), data of scenarios and studies performed using METIS are published or will be published on METIS website. Moreover, after the completion of the project the whole source code will be published, following an "open-book approach" (see Fig. 1 below). This way, stakeholders will be better able to understand METIS results and replicate its studies, using METIS results as a benchmark.

The aim of this paper is to introduce METIS project to a wider audience and especially place it in the radar of the modelling community. Since METIS is a tool intended to be used for policy making, constructive criticism and peer reviewing its deliverables can help validate its results and the techniques followed. Although the full source code of METIS will become available at a later stage, there is already a significant amount of information published on its website, including detailed html documentation. It is hoped that modelling teams will take interest in it; this could range from just peer reviewing METIS policy runs/studies to even developing alternative versions of METIS software and thus building a community around it.

Table 1
Summary of METIS main characteristics.

Time frame:	1 year
Time Granularity (power module):	1 h
Time Granularity (gas module):	1 day
Geographical Coverage:	28 EU Member States plus Switzerland, Norway, Serbia, former Yugoslav Republic of Macedonia, Montenegro and Bosnia-Herzegovina
Modelling language:	Python
Solver:	FICO Xpress

The paper is organised as follows: Section 2 provides a high level overview of METIS; Section 3 presents the details of each basic module; Section 4 discusses key technical issues concerning module integration and software development; Section 5 presents an illustrative case study performed by policy makers for the scope of this paper; Section 6 presents the next steps regarding the future development of METIS.

2. Overview of METIS

2.1. High level overview

METIS is an energy model covering with high granularity (geographical, time etc) the whole European energy system for electricity,

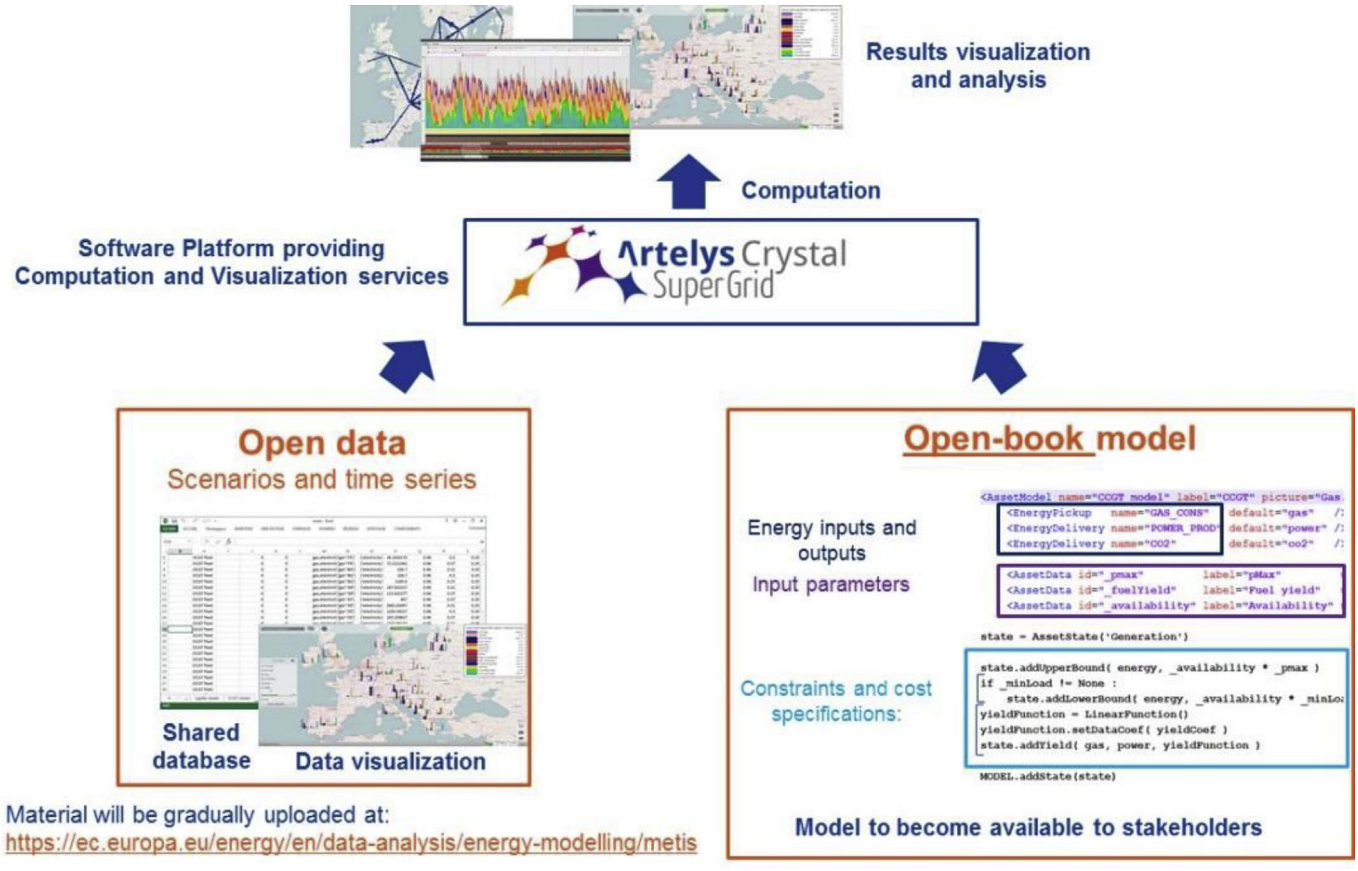

Fig. 1. METIS open approach.