EMP-E

Energy Modelling Platform for Europe

EMP-E 2021: Re-Energising Sustainable Transitions in Europe

Energy System Modelling, Methods & Results to support the European Green Deal

26th to 28th October · online

Developing tools for model linkage & cross-sectoral scenario analysis Lessons learned in the openENTRANCE project

Dr. Daniel Huppmann

Plenary III: Collaborative Modelling in Practice

October 28, 2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 835896

Background

What did we aim to do, and what did we learn on the way

The Horizon 2020 project openENTRANCE…

… aims at developing, using and disseminating
an open, transparent and integrated modelling platform
for assessing low-carbon transition pathways in Europe.

Observations and insights:

- Most modellers have understood that open-source work is the “new normal”…
  - ⇒ But knowledge of open-source, collaborative development is not as widespread as it should be
- Modellers like to work on their models…
  - ⇒ And they often wait too long to develop the model-linkage workflows necessary for projects like openENTRANCE

Adopting open & FAIR practices

A one-slide guide to apply better-practices in research

Please cite as: Daniel Huppmann et al., 2020
Five best-practice steps to make your research open & FAIR v1.0
doi: 10.22022/ene/04-2020.16404 | url: openENTRANCE.eu

Five best-practice steps to make your research open & FAIR v1.0

You may think that putting your work* on a website already makes it free & open.
But that's not quite true – follow these steps to implement best practice of ***#openscience***!

* data sets, text, tables, figures & illustrations, source code, scientific software, … even #Horizon2020 deliverables

1. Open — If you want your ***work to be read, used & shared by others***, be explicit about it:
For text, data, figures, … – use the CC-BY license | For code, visit choosealicense.com

2. Findable — To make it easy for others to find and cite your work,
get a digital object identifier (DOI) and add a ***recommended citation***

3. Accessible — Depositing your work in an institutional repository or a service like zenodo
ensures that your work is still ***available even after the end of the project***

4. Interoperable — Using established community standards, data formats and
software packages lets others ***quickly understand and use your work***

5. Reusable — To make it easy for others to ***build on your work***, make sure to
assign a version number and relevant (machine-readable) metadata

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Three approaches to develop model linkages

Comparing approaches chosen by three projects: Data formats, a common language and workflows for model linkage

- The holistic approach: The **Open Energy Ontology**
  - ⇒ Develop a comprehensive ontology of the entire energy modelling domain including physical and social concepts
  - ⇒ https://openenergy-platform.org/ontology/

- The software-tool-based approach: The **SENTINEL "friendly data" package**
  - ⇒ Provide a solution to convert model-specific formats to common standards
  - ⇒ https://sentinel-energy.github.io/friendly_data/

- The dictatorial approach: The **openENTRANCE nomenclature and data format**
  - ⇒ Require modelling teams to follow well-specified data format
  - ⇒ Develop common language as we proceed in the project

The IAMC template for timeseries data

A community standard for compiling scenario results

The integrated-assessment community (IAMC)
developed a tabular scenario data format for data exchange

⇒ Used in IPCC Reports (AR6, SR15), Horizon 2020 projects, …

⇒ Adopted by ~50 teams globally

	A	B	C	D	E	F	G	H	
1	**Model**	**Scenario**	**Region**	**Variable**	**Unit**	**2005**	**2010**	**2015**	
2	MESSAGE	CD-LINKS 400	World	Primary Energy	EJ/y	462.5	500.7	...	

The Horizon 2020 project openENTRANCE is implementing
an extension to cover sub-annual time resolution.

A common nomenclature across research domains

In the openENTRANCE project, we are developing a nomenclature across sectoral models based on the IAMC template

Aim: develop a nomenclature in a structure that is intuitive and versatile

Approach & features:

- Maintained on GitHub: native tools for discussion & version control
- Based on **`yaml`** text files: human-readable and easy to use in scripts & workflows
- Provides some additional features that are useful to researchers across domains (e.g., ISO2/ISO3-to-country mappings, NUTS hierarchy mappings)
- Includes an installable Python package **`nomenclature`** with useful features for validation, mapping-dictionaries, etc.

Check out github.com/openENTRANCE/nomenclature for details!

The *pyam* package

A community package for scenario processing, analysis & visualization following best practice of collaborative scientific software development

Use cases and features

⇒ Data processing — Aggregation, downscaling, unit conversion, I/O to xlsx, csv & frictionless datapackage…

⇒ Validation — Checks for completeness of data, internal/external consistency, numerical plausibility …

⇒ Analysis & visualization — Categorization and statistics of scenario ensembles, plotting library, …

Huppmann *et al*. pyam: Analysis and visualisation of integrated assessment and macro-energy scenarios. *Open Research Europe* 2021, **1**:74 (https://doi.org/10.12688/openreseurope.13633.2)

License Apache 2.0 | python 3.7 | 3.8 | 3.9 | chat Slack | mail groups.io

code style black | pytest passing | docs passing | codecov 95%

DOI 10.5281/zenodo.1470400 | ORE 10.12688/openreseurope.13633.2

Repository hosted on GitHub

Community supported by Groups.io slack

Documentation hosted by Read the Docs

#pyam_iamc

pyam-iamc.readthedocs.io

Design principles of the *pyam* package

We aimed to create a community package that is useful – and that can serve as a best-practice example of open-source, collaborative work

Intended users include modellers, researchers & analysists irrespective of Python knowledge

- ⇒ Tutorials and a full-fledged documentation (and even a tutorial for R users)
- ⇒ Two published manuscripts (2019, 2021) plus DOI's of each release via Zenodo
- ⇒ Several active communication channels:
  a mailing list, Slack channel, GitHub repository, social media
- ⇒ Based on the widely used *pandas* package for data analysis
- ⇒ Supporting multiple data formats, file types, reference data sources, …
- ⇒ Adopt best-practice of open-source, collaborative scientific software development including continuous integration (test coverage ~ 95%) and release management

Ambition: relying on a well-maintained, structured package instead of ad-hoc scripts
will free up researchers' time to do more research!

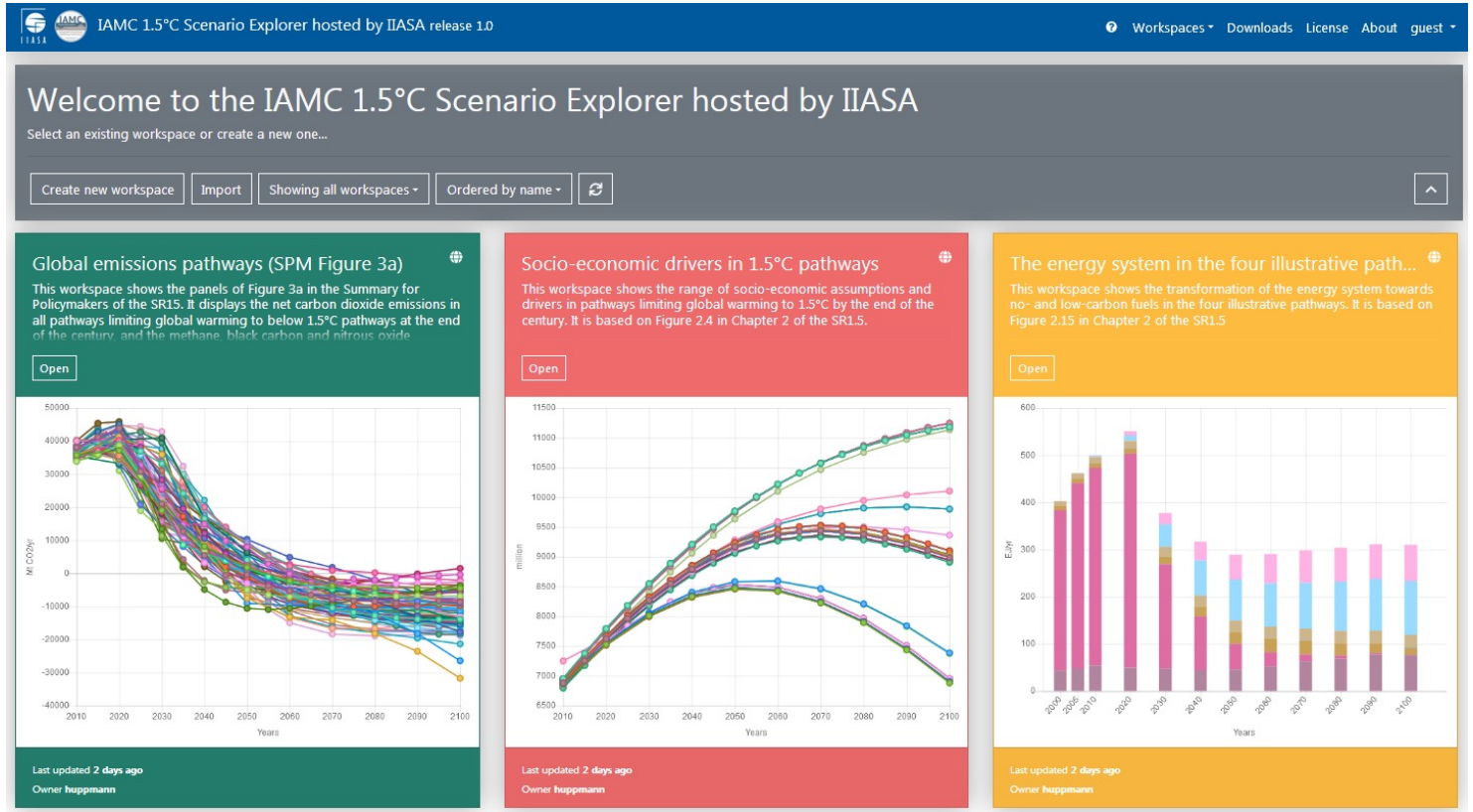
The IIASA Scenario Explorer

An interactive, versatile web user interface for model comparison projects and dissemination of results to researchers, policymakers & stakeholders

Scope and features

- Make scenario results accessible including documentation
- Manage scenario results in model comparison projects
- Facilitate “post-processing” of scenario results

Currently used in various projects



The Scenario Explorer was initially developed for the IPCC’s Special Report on 1.5°C. Visit the IAMC 1.5°C Scenario Explorer https://data.ece.iiasa.ac.at/iamc-1.5c-explorer

Opening up the openENTRANCE Scenario Explorer

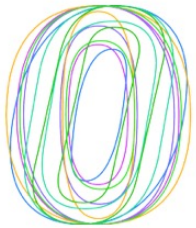
We are inviting modelling teams to use the openENTRANCE Scenario Explorer as a central data repository for dissemination of their results

- As part of our mission to promote open science and transparency, the openENTRANCE project enables any modelling team working on European decarbonization scenarios to use the public openENTRANCE Scenario Explorer for dissemination of their results.
- Advantages:
  - ⇒ Make your data available via a state-of-the-art web user interface
  - ⇒ Compare results between openENTRANCE pathways and your studies
  - ⇒ Use the IIASA database infrastructure and related tools for further work
- Read more about the “Data Submission” Terms of Use on https://data.ece.iiasa.ac.at/openentrance
- Feedback? Are modellers interested in this offer?

Re-using the openENTRANCE infrastructure in the ECEMF project

The just-starting project ECEMF will build on the openENTRANCE tools

- The Horizon 2020 project ECEMF started in May 2021, bringing together a consortium of modelling teams



EUROPEAN CLIMATE + ENERGY MODELLING FORUM

- Similar aims to openENTRANCE:
  - ⇒ Develop scenarios of European decarbonization policy and carbon neutrality
  - ⇒ Implement new tools for data analysis, visualization and model linkage
  - ⇒ Facilitate a community of European modelling activities

- Implementation strategy for tools and database infrastructure:
  - ⇒ Build on solutions implemented by openENTRANCE rather than re-invent the wheel…

Visit https://www.ecemf.eu for more information

Thank you very much for your attention!

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