



Net0Pathways through impRoved IAMs across Sectors, diMensions, and scAles

Deliverable 1.4

Linked overview of available open-source models and tools with up-to-date model documentations of IAM models

Deliverable
July 29, 2026



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Deliverable Title	Linked overview of available open-source models and tools with up-to-date model documentation of IAM models
Deliverable number	1.4
Brief Description	A linked, regenerable overview of the open-source IAM frameworks, modules and tools developed or used in PRISMA, with licence, version, citation (DOI) and documentation links for each.
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Author(s)	Jan Philipp Dietrich
Internal reviewer(s)	Laurent Drouet, CMCC
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PRISMA Deliverable D1.4

Linked overview of available open-source models and tools with up-to-date model documentation of IAM models

Executive summary

This deliverable provides a linked, openly accessible overview of the Integrated Assessment Models (IAMs), model components and supporting software tools that are developed and used within the PRISMA project. For each entry it records the maintained code repository, the software licence, the current release version, the responsible authors and institutions, and – where available – a persistent citation identifier (DOI) and a link to the up-to-date documentation maintained by the respective development team.

The overview covers 17 software packages spanning eight IAMs and related modelling frameworks (REMIND, MAgPIE, MESSAGEix, WITCH, RICE50+, IMACLIM-R World, IMAGE-materials and OPEN-PROM) and nine supporting data-processing, analysis and modularisation tools. All listed software is publicly available. With the exception of IMAGE-materials, which is currently under copyright pending its integration into the IMAGE framework, all software is released under open-source licences. The overview is produced based on an automated, reproducible reporting routine built on standardised CITATION.cff metadata that was added to the repositories during the project. This design was chosen deliberately as a sustainable alternative to a one-off manual compilation: the citation metadata is maintained at source with the software, so the overview can be regenerated at any time and the benefit persists beyond the project lifetime (Section 2.3).

1. Introduction and scope

A central objective of PRISMA is to increase the transparency, robustness, trustworthiness and practical usability of IAMs for researchers, practitioners and policymakers. This is pursued through the public release of code, data and scenario outcomes and through enhanced, easily usable model documentation.

This deliverable (D1.4) reports on the outcome of the project's software-publication and documentation work: it compiles a single, linked overview of the open-source models and tools associated with the project and points to their maintained documentation. The overview is intended to allow other researchers and interested parties both within and outside the consortium to locate, cite, obtain and reuse the relevant code and serves as a showcase for the open source work related to PRISMA.

The deliverable is scoped to software that is (a) developed or substantially used within PRISMA and (b) publicly released under an open-source licence. Scenario data and results are reported through the dedicated data deliverables (D2.4, D3.4, D4.4, D5.3) and are referenced rather than reproduced here.

2. Method: how the overview is produced and reproduced

The overview in Section 3 is generated using a reproducible routine based on the open-source citation R package (<https://github.com/pik-piam/citation>). While the detailed software records in Section 3.3 are a direct output of this automated pipeline, the summary tables in Sections 3.1 and 3.2 were manually curated and enriched to improve clarity and



presentation for this deliverable. To maintain full transparency, the project-specific inputs for the routine—the list of tracked repositories and the driver code—are reproduced in full below, allowing the underlying metadata records to be regenerated at any time.

2.1 Tracked repositories

The authoritative list of tracked, PRISMA related repository URLs is:

TRACKED REPOSITORIES

```
https://github.com/remindmodel/remind
https://github.com/magpiemodel/magpie
https://github.com/pik-piam/madrat
https://github.com/pik-piam/magclass
https://github.com/pik-piam/gms
https://github.com/pik-piam/citation
https://github.com/pik-piam/gdx2
https://github.com/pik-piam/lucode2
https://github.com/iamconsortium/pyam
https://github.com/iamconsortium/nomenclature
https://github.com/iiasa/message_ix/
https://github.com/polca/premise
https://github.com/witch-team/witchmodel
https://github.com/witch-team/RICE50xmodel
https://github.com/imagepbl/Residential-Sector-IMAGE-TIMER-
https://github.com/GLOBIO4/GlobioModelPublic/wiki
https://github.com/CIRED/IMACLIM-R_World
https://github.com/imagepbl/image-materials
https://github.com/e3modelling/OPEN-PROM
```

2.2 Generation routine

The list above is stored as a plain-text file, one URL per line (RepositoriesPRISMA.txt). With the citation package installed, the overview is produced by the following four lines of R code, which read the repository list and write the generated overview to a Markdown file:

GENERATION ROUTINE

```
library(citation)
repositories <- readLines("RepositoriesPRISMA.txt")
report <- cffReport(repositories)
writeLines(report, "report.md")
```

For each repository, cffReport() retrieves the machine-readable citation metadata (Citation File Format, CFF; see Section 2.3) published alongside the code and renders it as a structured Markdown record. The concatenated result is the overview reproduced in Section 3.3 together with an overview table at the very top. Because the routine reads the citation metadata directly from each repository, the overview reflects the current state of each project



at the time of generation and can be regenerated on demand (subject to the two prerequisites of an installed citation package and network access to the repositories).

2.3 A sustainable reporting approach based on CITATION.cff

Rather than assembling this overview manually as a one-off effort for the duration of the project, PRISMA deliberately invested in a solution that remains useful and maintainable beyond the project lifetime. This solution has two components, both of which were established as part of the project work:

Populating the software repositories with CITATION.cff files. Each tracked repository was equipped with a CITATION.cff file that carries its citation metadata at source.

Building the extraction pipeline `cffReport()`. The `cffReport()` function in the open-source citation R package reads these files across all repositories and compiles a consolidated, up-to-date overview (Section 2).

The decisive property of this design is that the authoritative information lives *with the software*, maintained by the developers who release it, and is retrieved automatically. The overview is therefore not a static snapshot that ages immediately after submission, but a regenerable report that reflects the software's current state whenever the pipeline is run.

What the Citation File Format is. The Citation File Format (CFF, <https://citation-file-format.github.io/>) is an open specification for plain-text files that carry human- and machine-readable citation information for software and datasets. A CFF file uses the YAML syntax and the standardised filename CITATION.cff, placed in the repository's default branch. It records the essential bibliographic metadata of a release, including the software title and version, the authors and their persistent identifiers (e.g. ORCID iDs), the release date, associated Digital Object Identifiers (DOIs), and references to related work and dependencies.

Why CFF is useful. Software is frequently cited inconsistently because users often cannot reliably determine the correct name, version, authorship or preferred reference. CFF addresses this at the source by letting the developers state, in a single standardised file, exactly how their software should be cited. This yields several benefits that are directly relevant to the objectives of PRISMA:

- **Machine-readability and automation.** Because the metadata is structured, it can be harvested and aggregated automatically – which is precisely what `cffReport()` does to build this overview, and what makes continuous, low-effort reporting feasible.
- **Broad tooling support.** CFF is recognised across the research-software infrastructure. GitHub displays citation information on a repository's landing page and offers ready-made citation snippets; the GitHub–Zenodo integration uses CFF metadata when archiving software releases and minting DOIs; and reference managers such as Zotero can import CFF data directly. Correct citation metadata therefore propagates automatically to the tools that researchers already use.
- **Accurate and persistent citation.** By tying versions to authors and DOIs, CFF supports reproducibility and ensures that the developers of open-source IAMs and tools receive proper academic credit.
- **Added value beyond PRISMA.** Because the CITATION.cff files remain in the repositories and continue to be maintained by the developers, and because tools such as GitHub, Zenodo and Zotero consume them independently of any single report, the



benefit of this work persists well after the project ends: every tracked model and tool remains correctly and consistently citable, and the overview can be regenerated at any future point. Populating the repositories with CITATION.cff is thus a lasting contribution to the transparency and reusability of the open-source IAM landscape, not merely an input to this deliverable.

3. Linked overview of models and tools

This section is the core output of the deliverable. It presents the tracked software in two complementary forms: a structured summary (Sections 3.1–3.2), which groups the software into IAM modelling frameworks and supporting tools and adds the responsible institutions and documentation links; and the full generated records (Section 3.3), which reproduce the citation metadata – descriptions, author lists and formatted citations – as compiled by the routine described in Section 2. In the summary tables, “Version” reports the released version in the citation metadata at the time of generation; “Documentation” links to the documentation maintained by the respective development team, with the repository README serving as the entry point where no dedicated documentation site is recorded.

3.1 Summary – IAMs and modelling frameworks

Model	Institution	Version	Licence	Links
IMACLIM-R	CIRED	2.0	AGPL-3.0	Code · DOI · Docs
IMAGE-materials	PBL / Uni Utrecht / Uni Leiden	3.5.1.0	Copyright (all rights reserved)	Code · DOI · Docs
MAgPIE	PIK	4.14.0	AGPL-3.0	Code · DOI · Docs
MESSAGEix	IIASA	3.11.1	Apache-2.0	Code · DOI · Docs
OPEN-PROM	E3M-WSP	2.2.0	AGPL-3.0	Code · Docs
REMIND	PIK	3.7.0	AGPL-3.0	Code · DOI · Docs
RICE50+	CMCC / RFF-CMCC EIEE	2.6.0	GPL-3.0	Code · Docs
WITCH	CMCC / RFF-CMCC EIEE	5.2.1	Apache-2.0	Code · Docs

3.2 Summary – supporting tools, data-processing and analysis packages



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Tool	Institution	Version	Licence	Links
citation	PIK / Univ. Oslo	0.13.1	BSD-2-Clause	Code · DOI · Docs
gdx2	PIK	0.6.0	BSD-2-Clause	Code · DOI · Docs
gms	PIK	0.35.0	BSD-2-Clause	Code · DOI · Docs
lucode2	PIK	0.56.1	BSD-2-Clause	Code · DOI · Docs
madrat	PIK	3.37.5	BSD-2-Clause	Code · DOI · Docs
magclass	PIK	7.5.0	LGPL-3.0	Code · DOI · Docs
nomenclature	IIASA	0.31.0	Apache-2.0	Code · DOI · Docs
premise	PSI / PIK / INFRAS / PBL	1.4.2	BSD-3-Clause	Code · Docs
pyam	IIASA	1.0	Apache-2.0	Code · DOI · Docs

3.3 Full generated software records

The following records are the verbatim output of the generation routine (Section 2), i.e. the consolidated citation metadata retrieved from the CITATION.cff files of the tracked repositories. They constitute the primary result of this deliverable and provide a detailed overview about the open source software used and developed within PRISMA (in alphabetical order; extracted July 17 2026).

citation: Software Citation Tools

A collection of functions to extract citation information from 'R' packages and to deal with files in 'citation file format' (<https://citation-file-format.github.io/>), extending the functionality already provided by the citation() function in the 'utils' package.

Authors: [Jan Philipp Dietrich](#), Waldir Leoncio

Affiliations: Potsdam Institute for Climate Impact Research, University of Oslo

Version: 0.13.1 (2026-07-08) | **License:** BSD-2-Clause

Keywords: tool

Code Repository: <https://github.com/pik-piam/citation>

Citation: Dietrich J, Leoncio W (2026). "citation: Software Citation Tools." doi:10.5281/zenodo.3813429 <https://doi.org/10.5281/zenodo.3813429>, Version: 0.13.1, <https://github.com/pik-piam/citation>.

gdx2: Interface package for GDX files in R

A wrapper package for the gamstransfer package extending its functionality and allowing to read GDX files directly in R. It is emulating the basic features of the readGDX function in the gdx package but now based on gamstransfer instead of gdxrrw which served as a basis for gdx.

Authors: [Jan Philipp Dietrich](#)



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Affiliations: Potsdam Institute for Climate Impact Research

Version: 0.6.0 (2026-07-08) | **License:** BSD-2-Clause

Keywords: tool

Code Repository: <https://github.com/pik-piam/gdx2>

Citation: Dietrich J (2026). "gdx2: Interface package for GDX files in R." doi:10.5281/zenodo.21256770 <https://doi.org/10.5281/zenodo.21256770>, Version: 0.6.0, <https://github.com/pik-piam/gdx2>.

gms: 'GAMS' Modularization Support Package

A collection of tools to create, use and maintain modularized model code written in the modeling language 'GAMS' (<https://www.gams.com/>). Out-of-the-box 'GAMS' does not come with support for modularized model code. This package provides the tools necessary to convert a standard 'GAMS' model to a modularized one by introducing a modularized code structure together with a naming convention which emulates local environments. In addition, this package provides tools to monitor the compliance of the model code with modular coding guidelines.

Authors: [Jan Philipp Dietrich](#), David Klein, Anastasis Giannousakis, Felicitas Beier, Johannes Koch, Lavinia Baumstark, Mika Pflüger, Oliver Richters

Affiliations: Potsdam Institute for Climate Impact Research

Version: 0.35.0 (2026-06-22) | **License:** BSD-2-Clause

Keywords: tool

Code Repository: <https://github.com/pik-piam/gms>

Citation: Dietrich J, Klein D, Giannousakis A, Beier F, Koch J, Baumstark L, Pflüger M, Richters O (2026). "gms: 'GAMS' Modularization Support Package." doi:10.5281/zenodo.4390032 <https://doi.org/10.5281/zenodo.4390032>, Version: 0.35.0, <https://github.com/pik-piam/gms>.

IMACLIM-R World - Impact Assessment of CLIMate policies

IMACLIM-R is a multi-sectoral, macroeconomic process-based Integrated Assessment Model (IAM) that simulates the co-evolution of economic systems, energy systems, and technological change within a consistent framework. Unlike aggregated IAMs, IMACLIM-R explicitly represents the interplay between macroeconomic dynamics and sector-specific constraints through a hard coupling of a general equilibrium core—based on Leontief production functions and operating under market imperfections—and bottom-up techno-economic sectoral modules. The model's recursive-dynamic resolution ensures that macroeconomic trajectories are shaped by energy and technological constraints, reflecting the physical and economic limits of substitution in production and consumption patterns. This approach contrasts with traditional CGE models by embedding input-output representations where technical coefficients evolve only through the recursive dynamics and sectoral modules, rather than assuming perfect substitutability or market clearing. IMACLIM-R thus captures how energy systems and technological rigidities fundamentally



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influence macroeconomic outcomes, offering a robust framework for exploring pathways aligned with climate and sustainability goals.

Authors: [Ruben Bibas](#), [Thibault Briera](#), Renaud Crassous, [Gabriele Dabbaghian](#), [Augustin Danneaux](#), Liesbeth Defosse, [Patrice Dumas](#), [Vivien Fisch-Romito](#), [Yann Gaucher](#), Nicolas Graves, [Céline Guivarch](#), [Meriem Hamdi-Cherif](#), [Thomas Le Gallic](#), [Florian Leblanc](#), [Julien Lefèvre](#), [Aurélié Méjean](#), [Eoin Ó Broin](#), [Julie Rozenberg](#), Olivier Sassi, [Adrien Vogt-Schilb](#), [Henri Waisman](#), Séverine Wiltgen

Affiliations: Centre International de Recherche sur l'Environnement et le Développement (CIRED)

Version: 2.0 (2024-01-01) | **License:** AGPL-3.0

Keywords: economy, energy, modeling, model

Code Repository: https://github.com/CIRED/IMACLIM-R_World

Citation: Bibas R, Briera T, Crassous R, Dabbaghian G, Danneaux A, Defosse L, Dumas P, Fisch-Romito V, Gaucher Y, Graves N, Guivarch C, Hamdi-Cherif M, Le Gallic T, Leblanc F, Lefèvre J, Méjean A, Ó Broin E, Rozenberg J, Sassi O, Vogt-Schilb A, Waisman H, Wiltgen S (2024). "IMACLIM-R World - IMpact Assessment of CLIMate policies." Version: 2.0, https://github.com/CIRED/IMACLIM-R_World.

IMAGE-materials

The IMAGE-materials model is a stock-driven dynamic material flow analysis model, part of the IMAGE integrated assessment model (IAM) framework. By combining modelling principles from the IAM and Industrial Ecology (IE) communities, the model quantifies material inflows, stocks, and outflows affected by climate and resource policy scenarios. IMAGE-materials is a recursive yearly simulation model that projects global material demand until 2100 for 26 world regions on a sectoral level for a wide variety of bulk and critical materials. The model includes buildings, vehicles, electricity, rail and road infrastructure, and a residual sector capturing the remaining demand, including different types and modes (e.g., housing types and transport modes). It is written using a modular, object-oriented Python architecture, enabling the easy addition of new sectors and data. Key assumptions include product lifetimes, material intensities, and technology mixes. The model is driven by service demand scenarios produced by the IMAGE framework, based on socio-economic and climate policy assumptions. IMAGE-materials can flexibly simulate the adoption of numerous circular economy measures, such as service demand reductions, lifetime extension, lightweighting, and recycling. Therefore, IMAGE-materials enables scientists and policymakers to explore mitigation pathways with a detailed additional dimension of material flows. It can thus assess the synergies and trade-offs between climate and circularity policies by explicitly accounting for their material implications. As such, IMAGE-materials integrates the fields of IAMs and IE, building on the strengths of each.

Authors: Luja von Köckritz, Anke Frederike Arp, Judith Tettenborn, Marianne Zanon-Zotin, Martijn van Engelenburg, Sebastiaan Deetman, Raoul Schram, Roelof Jacob Jan Brouwer, Parisa Zahedi, Christine Staiger

Affiliations: Copernicus Institute of Sustainable Development - Utrecht University, Planbureau voor de Leefomgeving, Institute of Environmental Sciences (CML) - Leiden University, Information and Technology Services - Utrecht University



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Version: 3.5.1.0 | **License:** Copyright IMAGE-materials team, Utrecht University 2026, all rights reserved

Keywords: dynamic material flow analysis, stock-driven, recursive simulation, modular, object-oriented, circular economy, sectoral, global, service demand, mitigation pathways, top-down, bottom-up, scenario analysis

Code Repository: <https://github.com/imagepbl/image-materials>

Citation: von Köckritz L, Arp A, Tettenborn J, Zanon-Zotin M, van Engelenburg M, Deetman S, Schram R, Brouwer R, Zahedi P, Staiger C (2026). "IMAGE-materials." Version: 3.5.1.0, <https://github.com/imagepbl/image-materials>.

lucode2: Code Manipulation and Analysis Tools

A collection of tools which allow to manipulate and analyze code.

Authors: [Jan Philipp Dietrich](#), Pascal Sauer, David Klein, Anastasis Giannousakis, Markus Bonsch, Benjamin Leon Bodirsky, Lavinia Baumstark, Oliver Richters, Mika Pflüger, [Patrick Rein](#)

Affiliations: Potsdam Institute for Climate Impact Research

Version: 0.56.1 (2026-06-25) | **License:** BSD-2-Clause

Keywords: tool

Code Repository: <https://github.com/pik-piam/lucode2>

Citation: Dietrich J, Sauer P, Klein D, Giannousakis A, Bonsch M, Bodirsky B, Baumstark L, Richters O, Pflüger M, Rein P (2026). "lucode2: Code Manipulation and Analysis Tools." doi:10.5281/zenodo.4389418 <https://doi.org/10.5281/zenodo.4389418>, Version: 0.56.1, <https://github.com/pik-piam/lucode2>.

madrat: May All Data be Reproducible and Transparent (MADRaT) *

Provides a framework which should improve reproducibility and transparency in data processing. It provides functionality such as automatic meta data creation and management, rudimentary quality management, data caching, work-flow management and data aggregation. * The title is a wish not a promise. By no means we expect this package to deliver everything what is needed to achieve full reproducibility and transparency, but we believe that it supports efforts in this direction.

Authors: [Jan Philipp Dietrich](#), [Pascal Sauer](#), Lavinia Baumstark, Stephen Wirth, Anastasis Giannousakis, Renato Rodrigues, Benjamin Leon Bodirsky, Debora Leip, Michael Crawford, Ulrich Kreidenweis, David Klein, [Patrick Rein](#)

Affiliations: Potsdam Institute for Climate Impact Research

Version: 3.37.5 (2026-07-16) | **License:** BSD-2-Clause

Keywords: tool



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Code Repository: <https://github.com/pik-piam/madrat>

Citation: Dietrich J, Sauer P, Baumstark L, Wirth S, Giannousakis A, Rodrigues R, Bodirsky B, Leip D, Crawford M, Kreidenweis U, Klein D, Rein P (2026). "madrat: May All Data be Reproducible and Transparent (MADRaT) *." doi:10.5281/zenodo.1115490
<https://doi.org/10.5281/zenodo.1115490>, Version: 3.37.5,
<https://github.com/pik-piam/madrat>.

magclass: Data Class and Tools for Handling Spatial-Temporal Data

Data class for increased interoperability working with spatial-temporal data together with corresponding functions and methods (conversions, basic calculations and basic data manipulation). The class distinguishes between spatial, temporal and other dimensions to facilitate the development and interoperability of tools build for it. Additional features are name-based addressing of data and internal consistency checks (e.g. checking for the right data order in calculations).

Authors: [Jan Philipp Dietrich](#), Benjamin Leon Bodirsky, Markus Bonsch, Florian Humpenoeder, Stephen Bi, Kristine Karstens, Debbora Leip, [Pascal Sauer](#), Lavinia Baumstark, Christoph Bertram, Anastasis Giannousakis, David Klein, Ina Neher, Michaja Pehl, Anselm Schultes, Miodrag Stevanovic, Xiaoxi Wang, Felicitas Beier, Mika Pflüger, Oliver Richters, [Patrick Rein](#)

Affiliations: Potsdam Institute for Climate Impact Research

Version: 7.5.0 (2026-06-25) | **License:** LGPL-3.0

Keywords: tool

Code Repository: <https://github.com/pik-piam/magclass>

Citation: Dietrich J, Bodirsky B, Bonsch M, Humpenoeder F, Bi S, Karstens K, Leip D, Sauer P, Baumstark L, Bertram C, Giannousakis A, Klein D, Neher I, Pehl M, Schultes A, Stevanovic M, Wang X, Beier F, Pflüger M, Richters O, Rein P (2026). "magclass: Data Class and Tools for Handling Spatial-Temporal Data." doi:10.5281/zenodo.1158580
<https://doi.org/10.5281/zenodo.1158580>, Version: 7.5.0,
<https://github.com/pik-piam/magclass>.

MAGPIE - An Open Source land-use modeling framework

The *Model of Agricultural Production and its Impact on the Environment* (MAGPIE) is a modular open source framework for modeling global land-systems, which is coupled to the grid-based dynamic vegetation model LPJmL, with a spatial resolution of 0.5degx0.5deg. It takes regional economic conditions such as demand for agricultural commodities, technological development and production costs as well as spatially explicit data on potential crop yields, land and water constraints (from LPJmL) into account. Based on these, the model derives specific land use patterns, yields and total costs of agricultural production for each grid cell. The objective function of the land use model is to minimize total cost of production for a given amount of regional food and bioenergy demand. Regional food energy demand is defined for an exogenously given population in 10 food energy categories, based on regional diets. Future trends in food demand are derived from a cross-country regression analysis,



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based on future scenarios on GDP and population growth.

Authors: [Jan Philipp Dietrich](#), [Benjamin Leon Bodirsky](#), Isabelle Weindl, [Florian Humpenöder](#), Miodrag Stevanovic, Ulrich Kreidenweis, Xiaoxi Wang, Kristine Karstens, [Abhijeet Mishra](#), Felicitas Dorothea Beier, [Edna Johanna Molina Bacca](#), [Patrick von Jeetze](#), Michael Windisch, [Michael Scott Crawford](#), Debbora Leip, David Klein, Vartika Singh, Geanderson Ambrósio, Ewerton Araujo, Anne Biewald, [Pascal Sauer](#), [Alexandre Köberle](#), [Jan Steinhauser](#), David Hötten, Georg Schröter, [Patrick Rein](#), [Hermann Lotze-Campen](#), [Alexander Popp](#)

Affiliations: Potsdam Institute for Climate Impact Research

Version: 4.14.0 (2026-05-05) | **License:** AGPL-3.0-or-later

Keywords: landuse, modeling, model, nlp, partial equilibrium

Code Repository: <https://github.com/magpiemodel/magpie>

Citation: Dietrich J, Bodirsky B, Weindl I, Humpenöder F, Stevanovic M, Kreidenweis U, Wang X, Karstens K, Mishra A, Beier F, Molina Bacca E, von Jeetze P, Windisch M, Crawford M, Leip D, Klein D, Singh V, Ambrósio G, Araujo E, Biewald A, Sauer P, Köberle A, Steinhauser J, Hötten D, Schröter G, Rein P, Lotze-Campen H, Popp A (2026). "MAgPIE - An Open Source land-use modeling framework." doi:10.5281/zenodo.1418752
<https://doi.org/10.5281/zenodo.1418752>, Version: 4.14.0,
<https://github.com/magpiemodel/magpie>.

MESSAGEix

MESSAGEix is a versatile, dynamic, model framework for energy-engineering-economy-environment (E4) systems research.

MESSAGE (without "...ix") is a specific formulation of a generic linear programming (LP) optimization model for strategic energy planning and integrated assessment of E4 systems, developed by the IIASA Energy, Climate, and Environment (ECE) Program since the 1980s. To incorporate feedback between prices and demand levels for energy and commodities, the LP model can optionally be linked to the economic general equilibrium (GE) MACRO model.

The message_ix Python package—also fully usable from R—includes:

Implementations of MESSAGE, MACRO, and their linkage, in GAMS,
Application programming interfaces (APIs) and tools for model building and scientific programming, Extensive documentation and a complete test suite.

The framework is built on IIASA's ix modeling platform (ixmp), which provides data warehouse features for high-powered numerical scenario analysis.

Authors: [Paul Natsuo Kishimoto](#), [Fridolin Glatter](#), [Maik Budzinski](#), [Miguel Poblete Cazenave](#), [Oliver Fricko](#), [Matthew J. Gidden](#), [Daniel Huppmann](#), [Jarmo S. Kikstra](#), [Peter Kolp](#), [Diamantis Koutsandreas](#), [Volker Krey](#), Nikolay Kushin, [Francesco Lovat](#), [Marek Makowski](#), [Alessio Mastrucci](#), [Measrainsey Meng](#), [Jihoon Min](#), [Clara Orthofer](#), Michael Pimmer, [Jan Steinhauser](#), [Gamze Ünlü](#), [Adriano Vinca](#), [Laura Wienpahl](#), [Behnam Zakeri](#), [Thomas Zipperle](#)

Affiliations: IIASA, Aalborg University

Version: 3.11.1 (2025-06-03) | **License:** Apache-2.0



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Keywords: integrated assessment, energy systems, macro-energy, modelling, scenario analysis, data visualisation, Python package

Website: <https://docs.messageix.org/en/stable/index.html>

Code Repository: https://github.com/iiasa/message_ix

Citation: Kishimoto P, Glatter F, Budzinski M, Cazenave M, Fricko O, Gidden M, Huppmann D, Kikstra J, Kolp P, Koutsandreas D, Krey V, Kushin N, Lovat F, Makowski M, Mastrucci A, Meng M, Min J, Orthofer C, Pimmer M, Steinhauser J, Ünlü G, Vinca A, Wienpahl L, Zakeri B, Zipperle T (2025). "MESSAGEix." doi:10.5281/zenodo.4005684
<https://doi.org/10.5281/zenodo.4005684>, Version: 3.11.1,
https://github.com/iiasa/message_ix.

nomenclature

Authors: [Philip Hackstock](#), [David Almeida](#), [Daniel Huppmann](#), [Laura Wienpahl](#), [Lucie Castella](#)

Affiliations: International Institute for Applied Systems Analysis (IIASA)

Citation: Hackstock P, Almeida D, Huppmann D, Wienpahl L, Castella L. "nomenclature."

OPEN-PROM

OPEN-PROM is a global energy-system simulation model based on the PROMETHEUS modelling framework. It is a recursive-dynamic model that simulates the year-by-year evolution of energy demand, energy supply, technology deployment, and emissions under alternative socioeconomic, technological, and policy assumptions, while explicitly accounting for path dependencies and transition dynamics. The model provides a detailed representation of energy demand across the industry, transport, and residential sectors, alongside energy supply, power generation, and fuel-transformation technologies, and it captures the interactions between energy consumption, fuel use, industrial production, and technology adoption. This structure makes OPEN-PROM well suited to analysing industrial decarbonisation pathways, resource-efficiency measures, energy transitions, and climate-policy scenarios at both the European and global levels.

Authors: [Maro Baka](#), [Margarita Efthymiadou](#), [Panagiotis Fragkos](#), [Anastasis Giannousakis](#), [Christos Koumparakis](#), [Michael Madianos](#), [Giorgos Plessias](#), [Dionysis Pramangioulis](#), [Sonja Sechi](#), [Fotis Sioutas](#), [Alexandros Tsimpoukis](#), [Songmin Yu](#), [Giannis Tolios](#), [Eleftheria Zisarou](#)

Affiliations: E3Modelling-WSP

Version: 2.2.0 (2026-06-26) | **License:** GNU AGPLv3

Keywords: prometheus

Code Repository: <https://github.com/e3modelling/OPEN-PROM>

Citation: Baka M, Efthymiadou M, Fragkos P, Giannousakis A, Koumparakis C, Madianos M, Plessias G, Pramangioulis D, Sechi S, Sioutas F, Tsimpoukis A, Yu S, Tolios G, Zisarou E (2026). "OPEN-PROM." Version: 2.2.0, <https://github.com/e3modelling/OPEN-PROM>.



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premise

Coupling the ecoinvent database with projections from Integrated Assessment Models (IAM)

Authors: [Romain Sacchi](#), [Tom Terlouw](#), [Kais Siala](#), [Alois Dirnaichner](#), [Christian Bauer](#), [Brian Cox](#), [Christopher Mutel](#), [Vassilis Daioglou](#), [Gunnar Luderer](#)

Affiliations: Paul Scherrer Institut, Potsdam Institute for Climate Impact Research, INFRAS AG, PBL Netherlands Environmental Assessment Agency

Version: 1.4.2 (2023-02-01) | **License:** BSD-3-Clause

Keywords: life cycle assessment, integrated assessment model, prospective scenario, ecoinvent

Code Repository: <https://github.com/polca/premise>

Citation: Sacchi R, Terlouw T, Siala K, Dirnaichner A, Bauer C, Cox B, Mutel C, Daioglou V, Luderer G (2023). "premise." Version: 1.4.2, <https://github.com/polca/premise>.

pyam: analysis and visualization of integrated-assessment and macro-energy scenarios

Authors: [Daniel Huppmann](#), [Matthew J. Gidden](#), [Zebedee Nicholls](#), [Jonas Hörsch](#), [Robin D. Lamboll](#), Paul Natsuo Kishimoto, Thorsten Burandt, Oliver Fricko, Edward Byers, [Jarmo S. Kikstra](#), Maarten Brinkerink, [Maik Budzinski](#), Florian Maczek, Sebastian Zwickl-Bernhard, Lara Welder, [Erik Francisco Alvarez Quispe](#), Christopher J. Smith

Version: 1.0 | **License:** Apache-2.0

Keywords: integrated assessment, energy systems, macro-energy, modelling, scenario analysis, data visualisation, Python package

Citation: Huppmann D, Gidden M, Nicholls Z, Hörsch J, Lamboll R, Kishimoto P, Burandt T, Fricko O, Byers E, Kikstra J, Brinkerink M, Budzinski M, Maczek F, Zwickl-Bernhard S, Welder L, Alvarez Quispe E, Smith C. "pyam: analysis and visualization of integrated-assessment and macro-energy scenarios." doi:10.12688/openreseurope.13633.2 <https://doi.org/10.5281/zenodo.1158580>, Version: 1.0.

REMIND - Regional Model of Investments and Development

REMIND (REgional Model of Investment and Development) is a numerical open source model that represents the future evolution of the world economies with a special focus on the development of the energy sector and the implications for our world climate. The goal of REMIND is to find the optimal mix of investments in the economy and the energy sectors of each model region given a set of population, technology, policy and climate constraints. It also accounts for regional trade characteristics on goods, energy fuels, and emissions allowances. All greenhouse gas emissions due to human activities are represented in the model.

Authors: [Gunnar Luderer](#), [Nico Bauer](#), [Lavinia Baumstark](#), [Christoph Bertram](#), Marian Leimbach, [Robert Pietzcker](#), [Jessica Strefler](#), Tino Aboumahboub, [Gabriel Abrahão](#), Cornelia



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Auer, [Clara Bachorz](#), [David Bantje](#), [Felicitas Beier](#), Falk Benke, Stephen Bi, [Jan Philipp Dietrich](#), [Alois Dirnaichner](#), [Tabea Dorndorf](#), [Jakob Duerrwaechter](#), [Sophie Fuchs](#), [Pascal Führlich](#), [Anastasis Giannousakis](#), [Chen Chris Gong](#), [Alex Hagen](#), Markus Haller, [Robin Hasse](#), Léa Hayez, [Jerome Hilaire](#), Verena Hofbauer, [Johanna Hoppe](#), [David Klein](#), [Johannes Koch](#), [Laurin Köhler-Schindler](#), Alexander Körner, Katarzyna Kowalczyk, Elmar Kriegler, [Fabrice Lécuyer](#), Antoine Levesque, Alexander Lorenz, Sylvie Ludig, Michael Lüken, [Aman Malik](#), [Rahel Mandaroux](#), Susanne Manger, [Anne Merfort](#), [Leon Merfort](#), [Simón Moreno-Leiva](#), Ioanna Mouratiadou, [Jarusch Müßel](#), [Adrian Odenweller](#), [Michaja Pehl](#), [Mika Pflüger](#), Franziska Piontek, Laura Popin, Sebastian Rauner, [Oliver Richters](#), [Renato Rodrigues](#), Niklas Roming, [Ricarda Rosemann](#), Marianna Rottoli, Tonn Rüter, [Robert Salzwedel](#), [Pascal Sauer](#), Eva Schmidt, [Christof Schötz](#), [Felix Schreyer](#), Anselm Schultes, [Joanna Sitarz](#), [Björn Sörgel](#), Falko Ueckerdt, [Philipp Verpoort](#), [Pascal Weigmann](#), Bennet Weiss

Affiliations: Potsdam Institute for Climate Impact Research

Version: 3.7.0 (2026-07-15) | **License:** AGPL-3.0-or-later

Keywords: energy, economy, modeling, model, active-development

Website: <https://www.pik-potsdam.de/research/transformation-pathways/models/remind>

Code Repository: <https://github.com/remindmodel/remind>

Citation: Luderer G, Bauer N, Baumstark L, Bertram C, Leimbach M, Pietzcker R, Streffler J, Aboumahboub T, Abrahão G, Auer C, Bachorz C, Bantje D, Beier F, Benke F, Bi S, Dietrich J, Dirnaichner A, Dorndorf T, Duerrwaechter J, Fuchs S, Führlich P, Giannousakis A, Gong C, Hagen A, Haller M, Hasse R, Hayez L, Hilaire J, Hofbauer V, Hoppe J, Klein D, Koch J, Köhler-Schindler L, Körner A, Kowalczyk K, Kriegler E, Lécuyer F, Levesque A, Lorenz A, Ludig S, Lüken M, Malik A, Mandaroux R, Manger S, Merfort A, Merfort L, Moreno-Leiva S, Mouratiadou I, Müßel J, Odenweller A, Pehl M, Pflüger M, Piontek F, Popin L, Rauner S, Richters O, Rodrigues R, Roming N, Rosemann R, Rottoli M, Rüter T, Salzwedel R, Sauer P, Schmidt E, Schötz C, Schreyer F, Schultes A, Sitarz J, Sörgel B, Ueckerdt F, Verpoort P, Weigmann P, Weiss B (2026). "REMIND - REgional Model of INvestments and Development." Version: 3.7.0, <https://github.com/remindmodel/remind>.

RICE50+: The multi-regional Integrated Assessment Model RICE50+

A calibrated multi-regional Integrated Assessment Model with 50+ regions, calibrated abatement cost curves, a modular and phase structure of the code, and additional optional modules for climate change economics analysis.

Authors: Pietro Andreoni, Matteo Calcaterra, Leonardo Chiani, Laurent Drouet, Johannes Emmerling, Paolo Gazzotti, Francesco Granella, Giacomo Marangoni, Lara Aleluia Reis, Alessandro Taberna, Massimo Tavoni

Affiliations: Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici, RFF-CMCC European Institute on Economics and the Environment

Version: 2.6.0 (2025-09-25) | **License:** GPL-3.0

Keywords: model, climate change, integrated assessment model, economics, DICE, carbon pricing, climate policy, mitigation, adaptation

Code Repository: <https://github.com/witch-team/RICE50xmodel>



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Citation: Andreoni P, Calcaterra M, Chiani L, Drouet L, Emmerling J, Gazzotti P, Granella F, Marangoni G, Reis L, Taberna A, Tavoni M (2025). "RICE50+: The multi-regional Integrated Assessment Model RICE50+." Version: 2.6.0, <https://github.com/witch-team/RICE50xmodel>.

WITCH - World Induced Technical Change Hybrid model

WITCH is a global dynamic model integrating the interactions between the economy, the technological options, and climate change.

Authors: [Laurent Drouet](#), [Johannes Emmerling](#), [Lara Aleluia Reis](#), [Pietro Andreoni](#), [Cindy Azuero-Pedraza](#), [Michela Bevione](#), [Matteo Calcaterra](#), [Samuel Carrara](#), [Leonardo Chiani](#), [Francesco Pietro Colelli](#), [Alice Di Bella](#), [Enrica De Cian](#), Gauthier De Maere D'Aertrycke, [Giacomo Marangoni](#), [Hesam Naghash](#), [Marianna Rottoli](#), [Adriano Vinca](#), [Fabio Sferra](#), [Tom Longden](#), Nicolas Schlegel, [Valentina Bosetti](#), [Massimo Tavoni](#)

Affiliations: Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici, RFF-CMCC European Institute on Economics and the Environment

Version: 5.2.1 (2021-01-15) | **License:** Apache-2.0

Keywords: integrated, energy, economy, climate, model, technology, climate change, mitigation, adaptation, impacts, policy, decision making

Website: <https://www.witchmodel.org/>

Code Repository: <https://github.com/witch-team/witch>

Citation: Drouet L, Emmerling J, Aleluia Reis L, Andreoni P, Azuero-Pedraza C, Bevione M, Calcaterra M, Carrara S, Chiani L, Colelli F, Di Bella A, De Cian E, De Maere D'Aertrycke G, Marangoni G, Naghash H, Rottoli M, Vinca A, Sferra F, Longden T, Schlegel N, Bosetti V, Tavoni M (2021). "WITCH - World Induced Technical Change Hybrid model." Version: 5.2.1, <https://github.com/witch-team/witch>.

4. Public release and open access

All software listed in Section 3 is publicly accessible. With the exception of IMAGE-materials—which is currently under copyright but is scheduled for future open-source release and is thus included here to provide a complete overview—all models and tools are released under recognised open-source licences (AGPL-3.0, GPL-3.0, Apache-2.0, BSD-2/3-Clause and LGPL-3.0). Each package is hosted in a publicly accessible code repository, and the majority carry a persistent identifier (DOI) that provides a citable, version-specific record. This satisfies the project's commitments to public release of code and to open access of the developed IAMs and modelling frameworks, add-on tools and databases during the project lifetime.

4.1 Structuring tools and models for reuse

Beyond licensing and hosting, the developer teams in PRISMA also aimed to *structure* models, components and workflows so that they can be used by others — a prerequisite for the Interoperability and Reuse principles of FAIR (Findability, Accessibility, Interoperability, Reuse), which is used in PRISMA as guiding standard. Several of the supporting packages in Section 3.2 are direct products of this structuring work rather than incidental tooling:



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gms provides the modularisation framework used to structure GAMS-based model code (including REMIND and MAgPIE) into reusable, independently maintainable modules.

madrat and **magclass** provide the reproducible data-processing and data-handling framework used to structure input-data workflows so that they are transparent, cacheable and reusable across models – directly aiming at publishing data-processing workflows open source.

lucode2 and **gdx2** provide code-manipulation and GAMS-data-interchange utilities that support the same modularisation and workflow-reuse goals.

premise structures the coupling between IAM output and life-cycle-assessment databases (ecoinvent) as a reusable, documented workflow rather than a one-off script.

pyam and **nomenclature** provide the data-processing and management ecosystem that structures scenario data and metadata, ensuring that project templates, codelists, and validation routines are standardized and interoperable across different modelling frameworks and projects.

These tools represent a foundational ecosystem that enables PRISMA to achieve its goals of transparent, reusable, and interoperable modelling. By actively maintaining and integrating these workflows, PRISMA realizes its objective of broader utility and structural consistency across models, turning principles such as FAIR into a practical use for the project's modelling landscape and its users.

5. Documentation approach

PRISMA aims for structured, transparent model documentation – covering model dynamics and key parameter assumptions – that is kept up to date and, where possible, linked from the IAMC documentation platform (<https://www.iamcdocumentation.eu>) so that documentation across IAMs remains comparable. Several PRISMA partners maintained and extended their models' own documentation over the course of the project (see the links in section 3.1 and 3.2); linking these to the IAMC platform did not proceed on the same timeline, so this deliverable satisfies the up-to-date-documentation commitment by linking directly to each tool's own maintained documentation rather than to the IAMC platform.

Model and tool documentation is provided through the documentation actively maintained by each development team, linked from Section 3. For the modelling frameworks this comprises dedicated documentation sites (for example the REMIND and MESSAGEix documentation portals and the WITCH model website) together with repository-level documentation; for the supporting packages it comprises the package documentation and repository README, complemented by the persistent citation records. Linking to the sources maintained by the developers ensures that the documentation referenced from this overview reflects the current state of each tool.

6. Conclusions and outlook

This deliverable establishes a single, openly accessible and linked overview of the open-source IAMs, modules and tools of the PRISMA project, together with references to their maintained documentation and persistent citation records. Because the overview is in



its core produced by a reproducible, automated routine that reads standardised CITATION.cff metadata directly from the source repositories, it can be regenerated to reflect the evolving state of the software portfolio. Two lasting contributions extend beyond this document: the tracked repositories were populated with CITATION.cff files that keep every model and tool correctly and consistently citable, and the `cffReport()` extraction pipeline enables continuous, low-effort regeneration of the overview. Together they demonstrate a practical and sustainable route towards continuously maintained documentation of open-source IAM software, supporting the project's contribution of transparent, reusable modelling capacity to the wider research community and to future IPCC assessment cycles.

