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D2.5 I²AM PARIS PLATFORM – UPDATE 1

WP2 – I²AM PARIS

Version: 1.00

www.paris-reinforce.eu



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| Reviewer(s) | Haris Doukas (NTUA); Ester Galende (BC3) | | | | |
| Keywords | I ² AM PARIS; platform; modelling harmonisation; open-access; data exchange; integrated assessment models | | | | |



EC Summary Requirements

1. Changes with respect to the DoA

No changes with respect to the work described in the DoA.

2. Dissemination and uptake

This deliverable is intended to accompany the I²AM PARIS platform, as an update to the documentation report and reference point for all interested stakeholders, primarily aimed at scientists involved in integrated assessment and energy system modelling exercises in support of climate policymaking.

3. Short summary of results (<250 words)

This report provides an updated documentation of the I²AM PARIS platform, along with a description of its available services, such as Dynamic Model Documentation, Detailed Model Documentation, Overview and Comparative Assessment, Modelling Results Demonstration, and Variable Harmonisation Heatmap, including detailed instructions on how to take advantage of every available feature in each interface. It also contains an in-depth analysis of the I²AM PARIS architecture, detailing the implemented core components of the platform: the I²AM PARIS Backend, the Parsers, the Data Manager, and the Visualiser, describing the developed models/schemas/entities that work as the backbone of the knowledge representation, illustrating the interaction between them and analysing several end-to-end scenarios as well as reporting and justifying the design and implementation choices made. There are also references to sections and modules that are currently discussed and co-designed among the involved partners and stakeholders and are planned to be developed in the near future.



















4. Evidence of accomplishment

This report; and the I²AM PARIS platform: <https://www.i2am-paris.eu>.



Preface

PARIS REINFORCE will develop a novel, demand-driven, IAM-oriented assessment framework for effectively supporting the design and assessment of climate policies in the European Union as well as in other major emitters and selected less emitting countries, in respect to the Paris Agreement. By engaging policymakers and scientists/modellers, PARIS REINFORCE will create the open-access and transparent data exchange platform I²AM PARIS, in order to support the effective implementation of Nationally Determined Contributions, the preparation of future action pledges, the development of 2050 decarbonisation strategies, and the reinforcement of the 2023 Global Stocktake. Finally, PARIS REINFORCE will introduce innovative integrative processes, in which IAMs are further coupled with well-established methodological frameworks, in order to improve the robustness of modelling outcomes against different types of uncertainties.

| | | |
|--|----|---|
| NTUA - National Technical University of Athens | GR |  |
| BC3 - Basque Centre for Climate Change | ES |  |
| Bruegel - Bruegel AISBL | BE |  |
| Cambridge - University of Cambridge | UK |  |
| CICERO - Cicero Senter Klimaforskning Stiftelse | NO |  |
| CMCC - Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici | IT |  |
| E4SMA - Energy Engineering Economic Environment Systems Modeling and Analysis | IT |  |
| EPFL - École polytechnique fédérale de Lausanne | CH |  |
| Fraunhofer ISI - Fraunhofer Institute for Systems and Innovation Research | DE |  |
| Grantham - Imperial College of Science Technology and Medicine - Grantham Institute | UK |  |
| HOLISTIC - Holistic P.C. | GR |  |
| IEECP - Institute for European Energy and Climate Policy Stichting | NL |  |
| SEURECO - Société Européenne d'Economie SARL | FR |  |
| CDS/UnB - Centre for Sustainable Development of the University of Brasilia | BR |  |
| CUP - China University of Petroleum-Beijing | CN |  |
| IEF-RAS - Institute of Economic Forecasting - Russian Academy of Sciences | RU |  |
| IGES - Institute for Global Environmental Strategies | JP |  |
| TERI - The Energy and Resources Institute | IN |  |



Executive Summary

As the second version of the deliverable documenting the I²AM PARIS platform design and implementation, this report provides a documentation of the platform along with a description of its architecture (available core components) and implemented services.

The core components that constitute the I²AM PARIS architecture are: a) the Parsers, responsible for extracting, transforming, and storing data into the I²AM PARIS database; b) the I²AM PARIS Backend, a mediator component that aims at managing the interaction between components, renders the requested interfaces, and holds the main schemas of the developed entities; c) the Data Manager, a query execution and data transformation tool that prepares the data for the Visualiser; and d) the Visualiser, a visualisation generator that populates several interfaces with various meaningful charts.

Regarding the available services, the Detailed Model Documentation offers a detailed and extended presentation of the characteristics of every available model involved in the PARIS REINFORCE initiative but is currently being enriched with models from modelling teams outside the PARIS REINFORCE consortium. The Overview and Comparative Assessment is useful for comparing the models available in PARIS REINFORCE with one another, thus gaining significant insight into their coverage and fields of application. The Dynamic Model Documentation is a single-page application that allows going through all the important features of each model, utilising the visual aids of a map to define its geographical coverage, as well as several icons that correspond to specific characteristics (e.g., policy, socioeconomic, technology and SDG representation). The Modelling Results Demonstration service presents the outcome of modelling analyses, providing useful data exploration tools and insightful visualisations, facilitating the examination and comparison of different scenarios, models, etc., including several interfaces that have been commonly agreed among the involved partners, promoting co-creation and collaborative thinking, with a view to developing exploitable assets for both scientists and different types of stakeholder groups, like policymakers. The Variable Harmonisation Heatmap services provide information about how different variables are handled across different models along with other useful information.

The platform, as of May 16, 2021, counts 3,210 visits (1,071 unique visitors), with a bounce rate of 43.89% (as reported by Google Analytics).



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1 The User Interfaces of the I²AM PARIS platform

In this section, the set of the available services of the second integrated version of the I²AM PARIS platform are presented, along with the ones that are planned to be implemented until the next release. These services have largely been co-designed with stakeholders, given their inputs during the first stakeholder council dialogue of the PARIS REINFORCE project, which took place at Bruegel, in Brussels, Belgium on November 21, 2019.

To summarise this feedback, which is reported in detail in deliverables D2.2 ('Protocol for model use, scenarios and stakeholder engagement') and D3.3 ('Proceedings of the 1st regional EU workshop'), the feedback from the platform prototype was overall very positive. All stakeholders participating in the regional workshop—and consortium partners—agreed on the quality as well as its user-friendly interface and visualisation and considered it a valuable foundation for further elaboration of the platform in the course of the project.

Aside from the evaluation of the platform, some of the topics raised included the potential for the platform to contribute to emissions ambition and inter-sectoral dependencies; the transparency of input variables, assumptions and datasets; and the need to go beyond quantitative tools and incorporate qualitative techniques and social aspects. Other topics raised during this workshop and forming the near-future directions of I²AM PARIS included better representation of modelling capabilities outside the PARIS REINFORCE consortium; collaboration with past, present and future projects; rich output visualisation; separate interfaces for the public and the scientific community; and the organisation of webinars to engage stakeholders.

At the end of the dedicated session of the event, an online vote was given to the audience, regarding the selection of the design layout to be used in the dynamic documentation of the I²AM PARIS platform. Although the most favoured option of this vote pointed to a "single-page layout – less is better" direction, which can be partly attributed to the significant dominance of researchers among the audience, there was broad diversity in the results; as a result, a more inclusive approach was sought in the project, by incorporating alternative layouts and the capacity for the user to select among them.

1.1 Platform services and components

In Figure 1, an updated overview of the platform is presented including services and the respective components, with the green parts representing aspects of the platform that have already been implemented, and the grey parts work in progress.



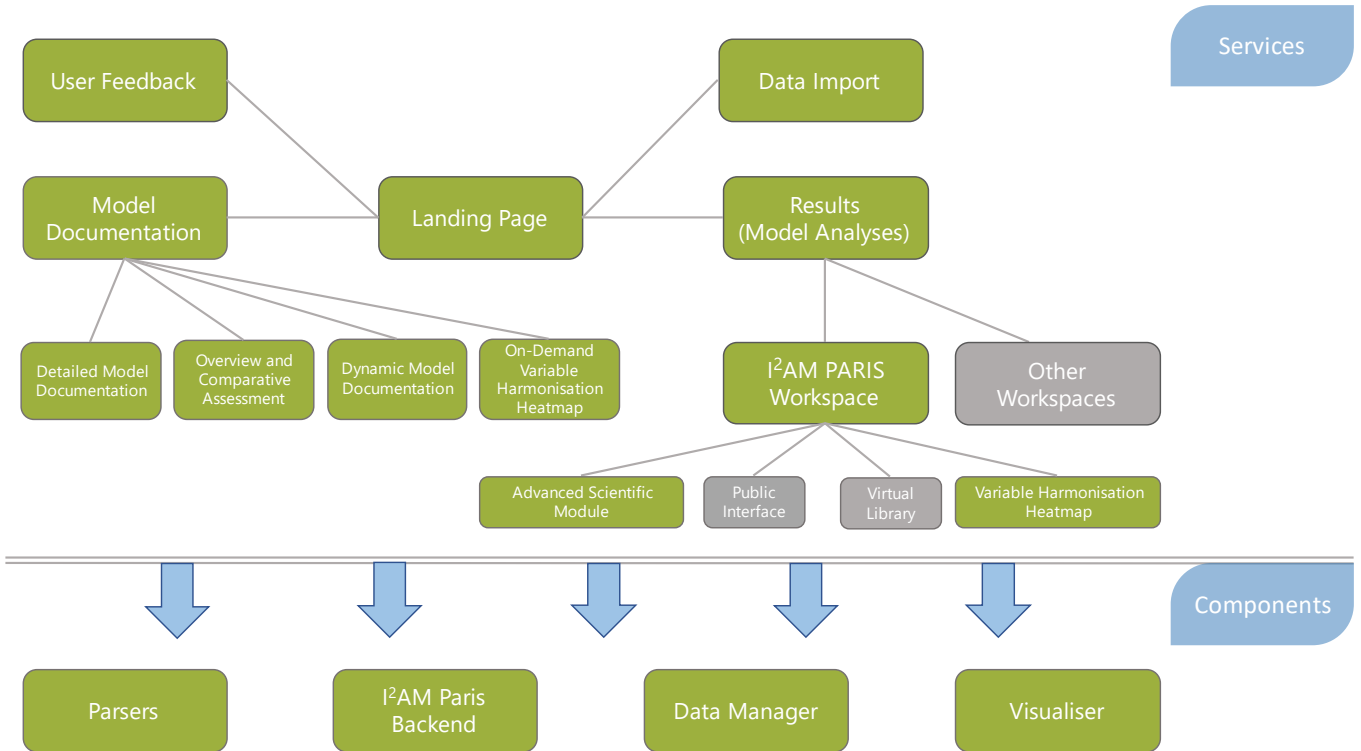


Figure 1: Platform overview, as of May 2021

A first version of the I²AM PARIS platform is available online (<https://www.i2am-paris.eu>), including a landing page that allows navigation throughout the platform, along with services mainly focused on the Model Documentation of the available models and the Modelling Results Presentation. It is a web application based on Django Framework 2.2.5, utilising AM-Charts 4 for the map and chart visualisations. The source code versioning and management is performed through Git version control system and the code is stored in a Github repository¹.

The interactive [Dynamic Documentation](#) component is an interactive library of the available models, in the form of a responsive “infographic”, regarding their features, including geographical coverage as well as sector, emission, policy, SDG, socio-economic and mitigation/adaptation measure granularities. The descriptive [Overview and Comparative Assessment](#) consists of a collection of information included in Section 2 of PARIS REINFORCE deliverables D5.1, D6.1, D7.1 and aims at providing an overview of the suitability of each model for specific research needs, compared to one other. The [Detailed Model Documentation](#), in essence, includes a detailed presentation of every model currently available on the platform and is composed of information retrieved from the corresponding deliverables. The documentation section is concluded with the [On-Demand Variable Harmonisation Heatmap tool](#), an *on-demand comparison table* of harmonisable or extractable variables displayed across user-selected models of the consortium.

The Results section comprises different workspaces, which include the modelling results for specific scenarios. Each workspace has a similar structure, thus facilitating the creation of new workspaces and ensuring the sustainability of the specific platform service. It includes (a) a variable harmonisation heatmap, (b) an advanced scientific module focusing on a customisable tool generating scenarios, covering highlights of the inter-comparison project as well as those selected by the user, (c) a public “what does this mean?” interface telling select

¹ <https://github.com/sskalidakis/i2amparis>

stories with a pre-set collection of visualisations, targeting a broader audience, in a user-friendly manner, and (d) a virtual library including relevant scientific publications, policy briefs, and databases. Currently, one pilot workspace is available, "[PARIS REINFORCE – Where Are We Headed](#)" (WWH), which presents the results produced by the first global inter-comparison exercise of the PARIS REINFORCE Project.

The User Feedback or [Contact Form](#) is useful for collecting feedback from platform users, including requests for new services, bugs and errors on the platform, new ideas/suggestions, etc. The submitted form is forwarded to the developers and accordingly handled or further forwarded to the Project Coordinator to communicate to the consortium.

Moreover, the Data Import, allows users to upload CSV files consisting of either model documentation information or scenario modelling results, provided in a specific format that has been circulated to all consortium partners, relevant research projects and the modelling community, in order to ensure that it fulfils every requirement. After it has been uploaded, the file is automatically parsed in order to populate the I²AM PARIS Database with the submitted data.

1.2 Landing Page

The landing page of the I²AM PARIS at the moment is composed of a carousel containing information about the project (Figure 2), a navigation bar that helps users easily navigate through each section, an entire section regarding the model documentation service (Figure 3) comprising links that lead to the Dynamic Documentation, the Overview and Comparative Assessment, and the Model Detailed Documentation, as well as a second section composed of a list of workspaces, each of which contains tools and interfaces that present the produced results of the modelling analyses for specific scenarios.

The screenshots below show the main parts of the current version of the Landing Page.



Figure 2: Landing page carousel



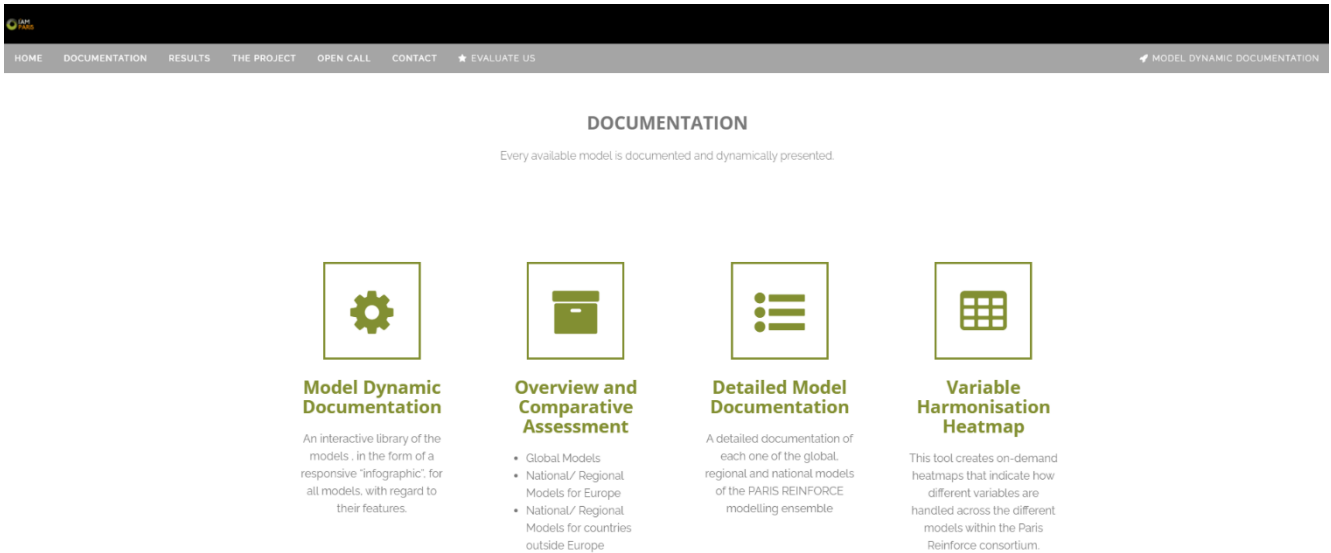


Figure 3: Landing Page- Documentation Section

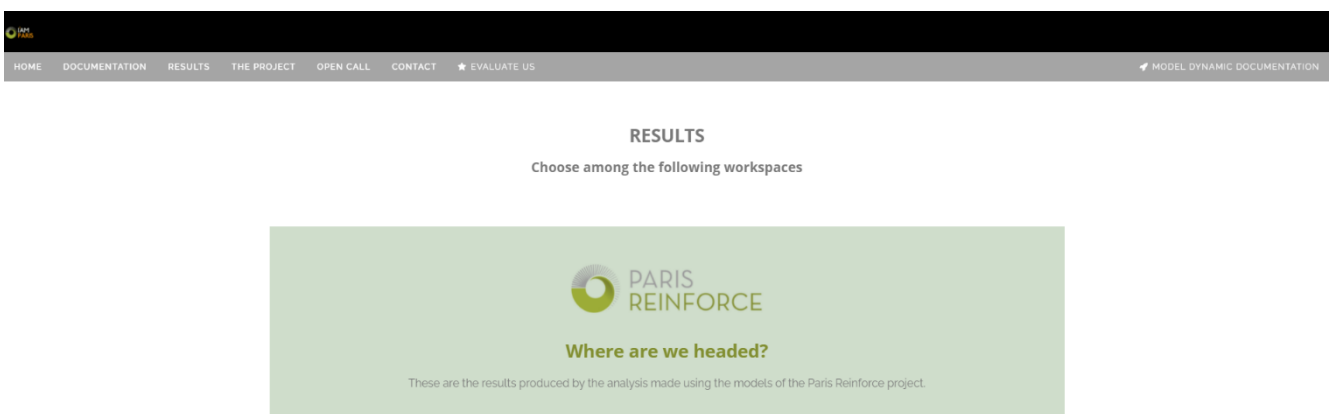


Figure 4: Landing Page- Results Section

1.3 Model Documentation Services

This section of the platform includes the services responsible for the documentation of the currently available models on the platform. Each service covers a different aspect of the documentation and is utilised for different purposes. Since the previous version of this deliverable, more models (outside the PARIS REINFORCE project) have been integrated both in the Dynamic and the Detailed Model Documentation Section.

1.3.1 Dynamic Model Documentation

The Dynamic Model Documentation is a combination of a backend and a frontend infrastructure and is responsible for presenting the documentation of each model in a user-friendly manner, taking advantage of the information retrieved from the database as well as interactive maps, combined into an elegant user interface.

The Dynamic Documentation utilises “Django HTML Templates”, “jQuery” and the “AMCharts4 Library” for its user interfaces. In the context of **co-creation and collaborative thinking**, ideas were provided by several stakeholders



and more than one different interfaces have been created for the Dynamic Documentation, with a view to receiving feedback on each of them and satisfying all the needs of every possible user. Some of them are more detailed and descriptive, others are minimal and compact. At the moment, the user may choose any of the available options through a select/dropdown element positioned at the right top of the “Dynamic Documentation” webpage (Figure 5), in order to allow immediate interface alterations without much effort.

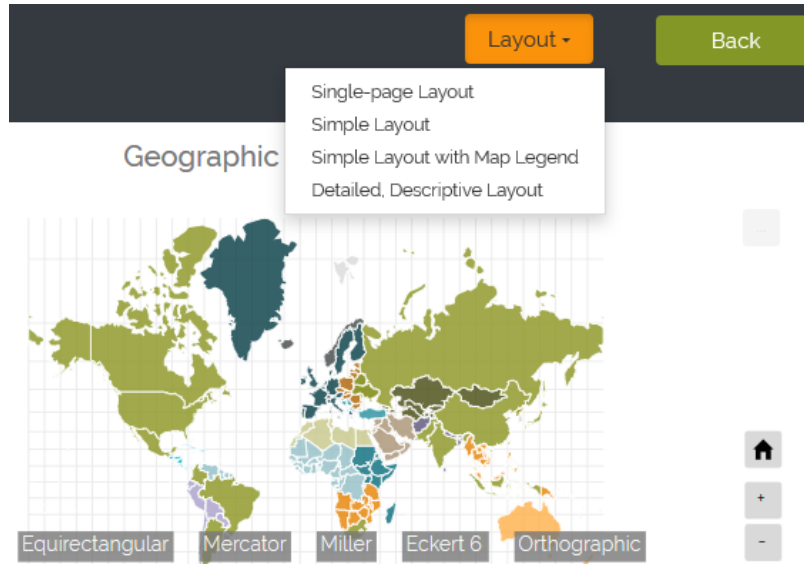


Figure 5: Choosing Different Dynamic Model Documentation Interface

The different interfaces are presented in the screenshots below:

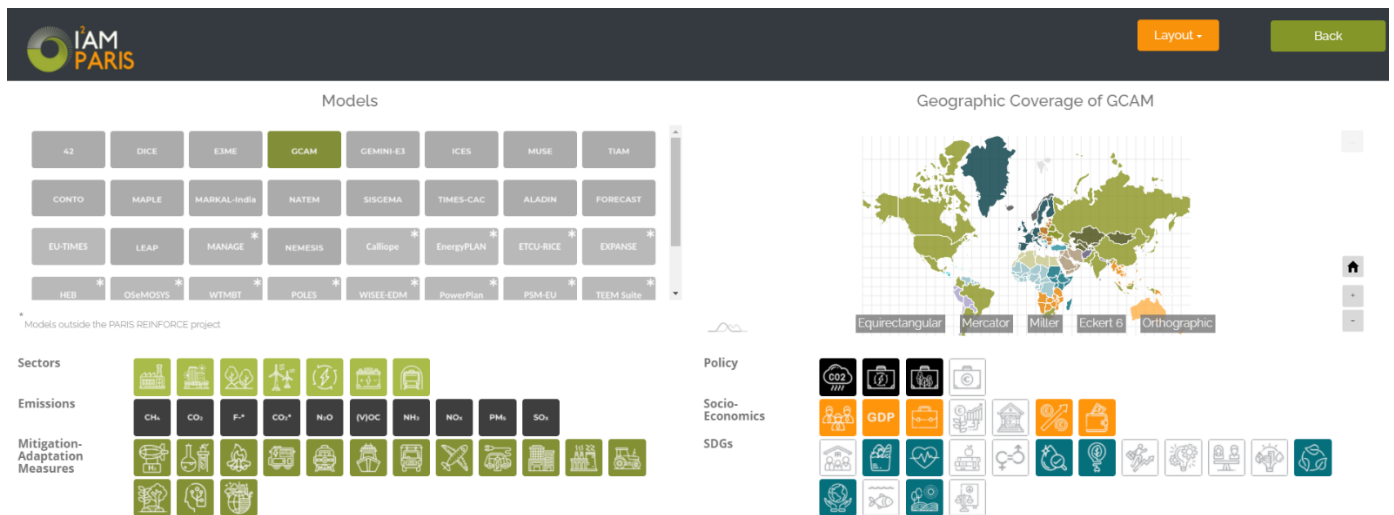


Figure 6: Single-Page layout

Layout ▾
Back

Models

| | | | | | | | | | |
|--|---|---|---|--|---|--|--|---|---|
| 42 | DICE | E3ME | GCAM | GEMINI-E3 | ICES | MUSE | TIAM | CONTO | MAPLE |
| 42 | Dynamic Integrated Model of Climate and the Economy | Energy-Environment-Economy global Macro-Economic model | Global Change Assessment Model | General Equilibrium Model of International-National Interactions between Economy, Energy and the Environment | International Computable Equilibrium System | Modular energy system Simulation Environment | TIMES Integrated Assessment Model | CONTO | Open-MAPLE |
| MARKAL-India | NATEM | SISEGMA | TIMES-CAC | ALADIN | FORECAST | EU-TIMES | LEAP | MANAGE * | NEMESIS |
| MARKAL-India | North-American TIMES Energy Model | SISEGMA | TIMES-Central Asian Caplan | Alternative Automobiles Diffusion and Infrastructure | Forecasting Energy Consumption Analysis and Simulation Tool | EU-TIMES | Long-range Energy Alternatives Planning | MANAGE | New Economic Model of Evaluation by Sectoral Interdependency and Supply |
| Calliope * | EnergyPLAN * | ETCU-RICE * | EXPANSE * | HEB * | OSEMOSYS * | WTMBT * | POLES * | WISEE-EDM * | PowerPlan * |
| Euro Calliope | EnergyPLAN | Endogenous Technical Change with Uncertainty RICE model | Expansion of RISEsim in Near-optimal energy Schedules | High Efficiency Buildings Model | Open Source Energy Modeling System - The Open Source Energy Model Base for the European Union | World Trade Model with Business Trade | Prospective outlook for long term energy systems | Wuppertal Institute System Model Architecture for Energy and Emission Scenarios - Energy Demand Model Industry Module | PowerPlan |
| PSM-EU * | TEEM Suite * | HU-TIMES * | EPMM * | EGMM * | WISEE-ESM * | E3ME-FTT * | MicroGridsPy * | MEDEAS * | WILLIAM * |
| Power System Simulation model implementation for EUP-3, western Europe and North West Europe | TechnoEconomics of Energy Systems laboratory (TEESlab) Modelling (TEEM) suite | Hungarian national TIMES model | European Power Market Model | European Gas Market Model | Wuppertal Institute System Model Architecture for Energy and Emission Scenarios - Energy Supply Model | Energy-Environment-Economy global Macro-Economic model | MicroGridsPy | Modelling Energy System Development Modelling Energy System Development under Environmental and Socioeconomic constraints | *Within limits Integrated Assessment Model |

* Models outside the PARIS REINFORCE project

Geographic Coverage of GCAM

Equiangular Mercator Miller Eckert 6 Orthographic

Sectors

Emissions

Mitigation-Adaptation Measures

Policy

Socio-Economics

SDGs

Figure 7: Simple layout

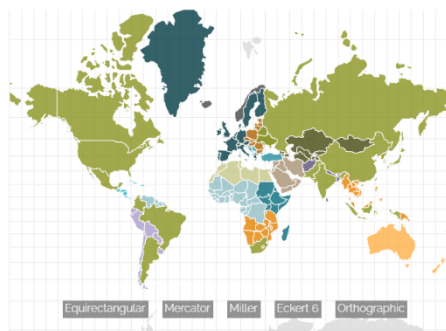
I²AM PARIS Layout Back

Models

| | | | | | | | | | |
|--|---|---|---|--|---|--|--|---|---|
| 42 | DICE | E3ME | GCAM | GEMINI-E3 | ICES | MUSE | TIAM | CONTO | MAPLE |
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* Models outside the PARIS REINFORCE project

Geographic Coverage of GCAM



Sectors

Policy

SDGs

Socio-Economics

Mitigation-Adaptation Measures

Emissions

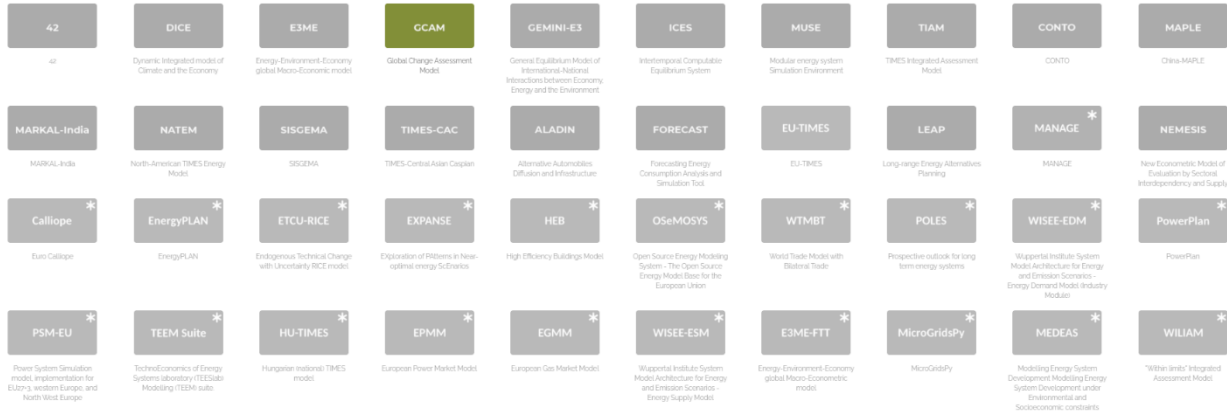
CH₄, CO₂, F-g, CO₂*, N₂O, VOC, NH₃, NO_x, PM₁₀, SO_x

Note: Hover over the map to see the model's spatial coverage.
 ● Grey indicates non-availability (i.e. areas not covered).
 ● Green colour indicates national coverage (i.e. countries represented at the country-level).
 For countries not represented with national granularity, same colour for multiple countries indicates countries covered as part of the same region. Pop-up title on mouse over each covered country displays Name of Region (Name of Country).

Figure 8: Simple layout with map legend

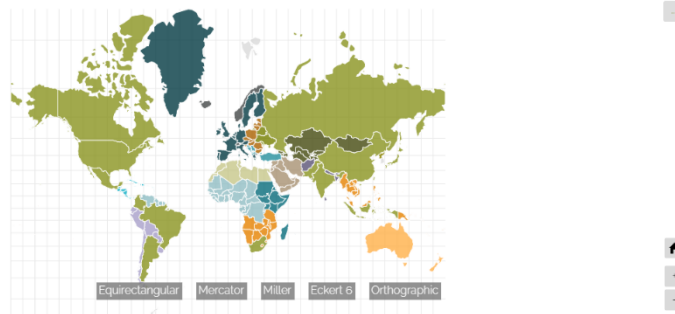


Models



* Models outside the PARIS REINFORCE project

Geographic Coverage of GCAM



Note: Hover over the map to see the model's spatial coverage

● Grey indicates non-availability (i.e. areas not covered)

● Green colour indicates national coverage (i.e. countries represented at the country-level)

For countries not represented with national granularity, same colour for multiple countries indicates countries covered as part of the same region. Pop-up title on mouse over each covered country displays Name of Region (Name of Country)

Sectoral, Policy, SDG, Socioeconomic, Emissions and Technological Coverage/Granularity of GCAM



Figure 9: Detailed, descriptive layout

In every interface the following rules apply:

- The currently selected model appears in green colour, while the remaining are greyed out.
- In the map: Grey colour indicates areas not covered by the model and (olive) green colour indicates national coverage (i.e., countries represented at the country-level). For countries not represented with national granularity, same colour for multiple countries indicates countries covered as part of the same region. Pop-up title on mouse over each covered country displays the name of the region and the name of the country in the parentheses.
- The coloured icons in the granularity section are the categories (of each type) that are covered by the model (or at least a part of them). The greyed-out icons represent the categories that are not covered at all by the selected model.
- The user may select among different map projections according to their preference using the buttons positioned at the bottom of the map. The available options are: Equirectangular, Mercator, Miller, Eckert 6, Orthographic (Figure 10). Zooming in/out as well as dragging and dropping on the map behave according to the selected projection.

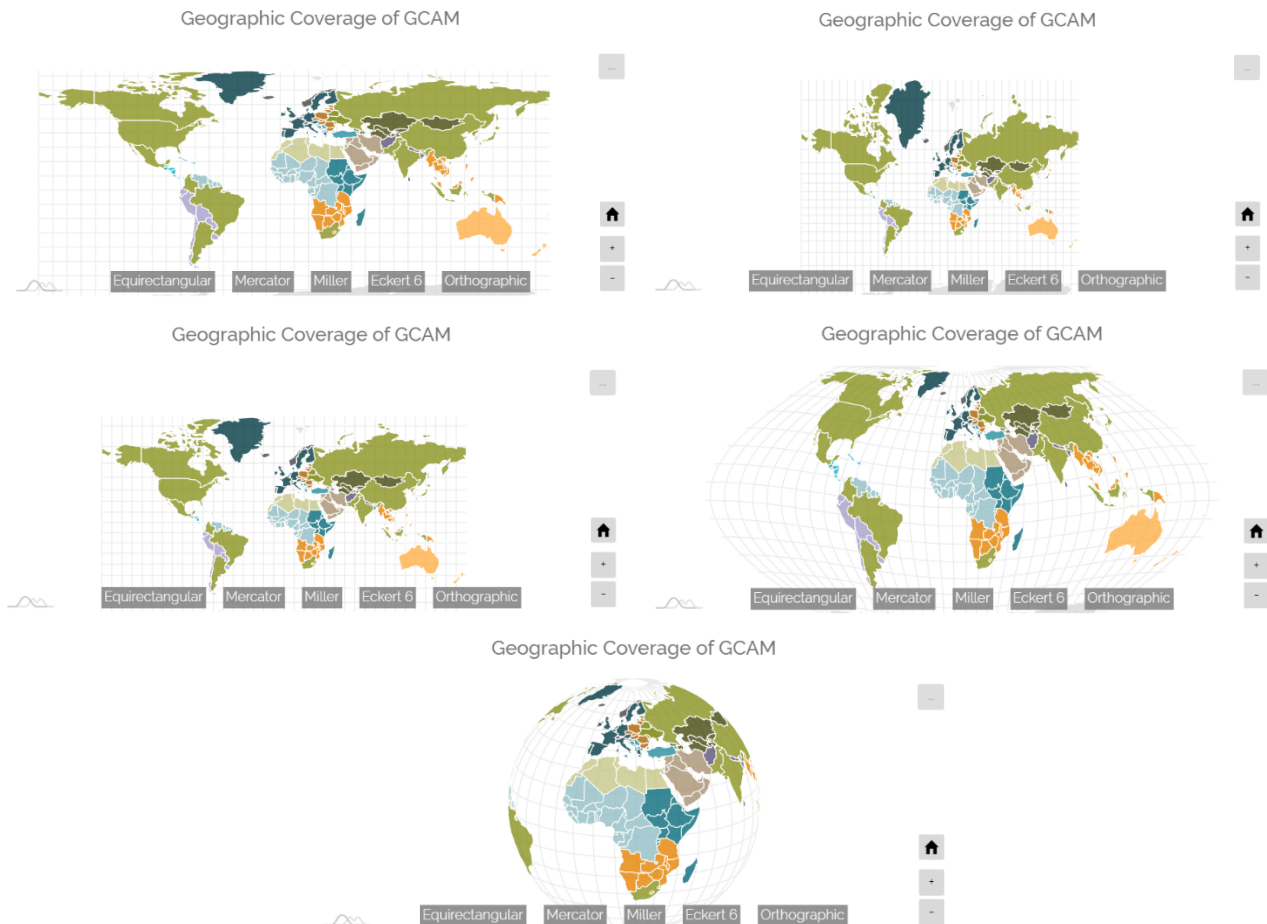


Figure 10: Different Projections (Equirectangular, Mercator, Miller, Eckert 6, Orthographic, placed in order from left to right)



- By hovering over the granularity icons, a tooltip appears, showing the subcategories and specific quantities covered by the model in green. The rest are crossed out and shown in grey (Figures 11,12).

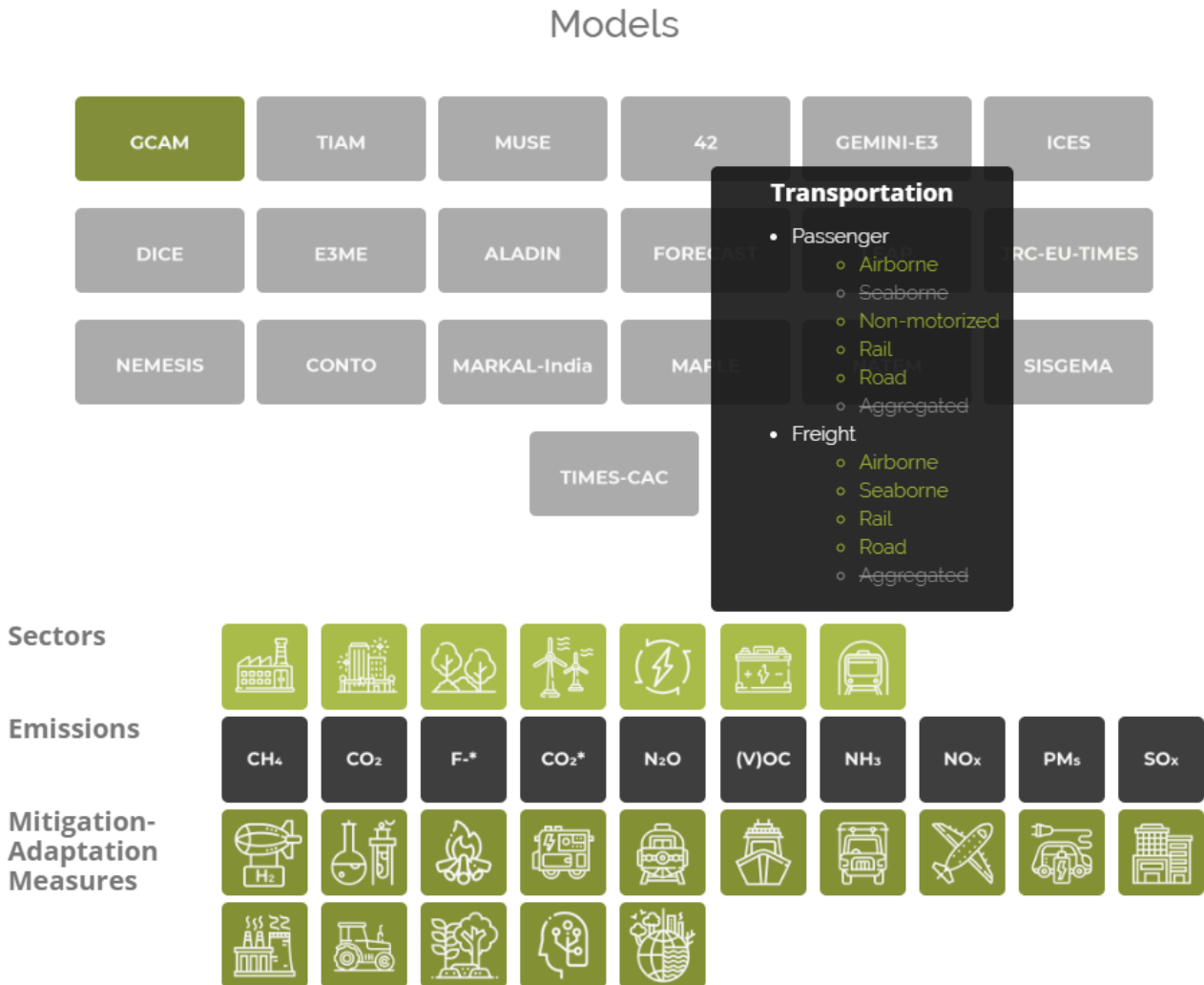


Figure 11: Hovering over the transportation sector

Models

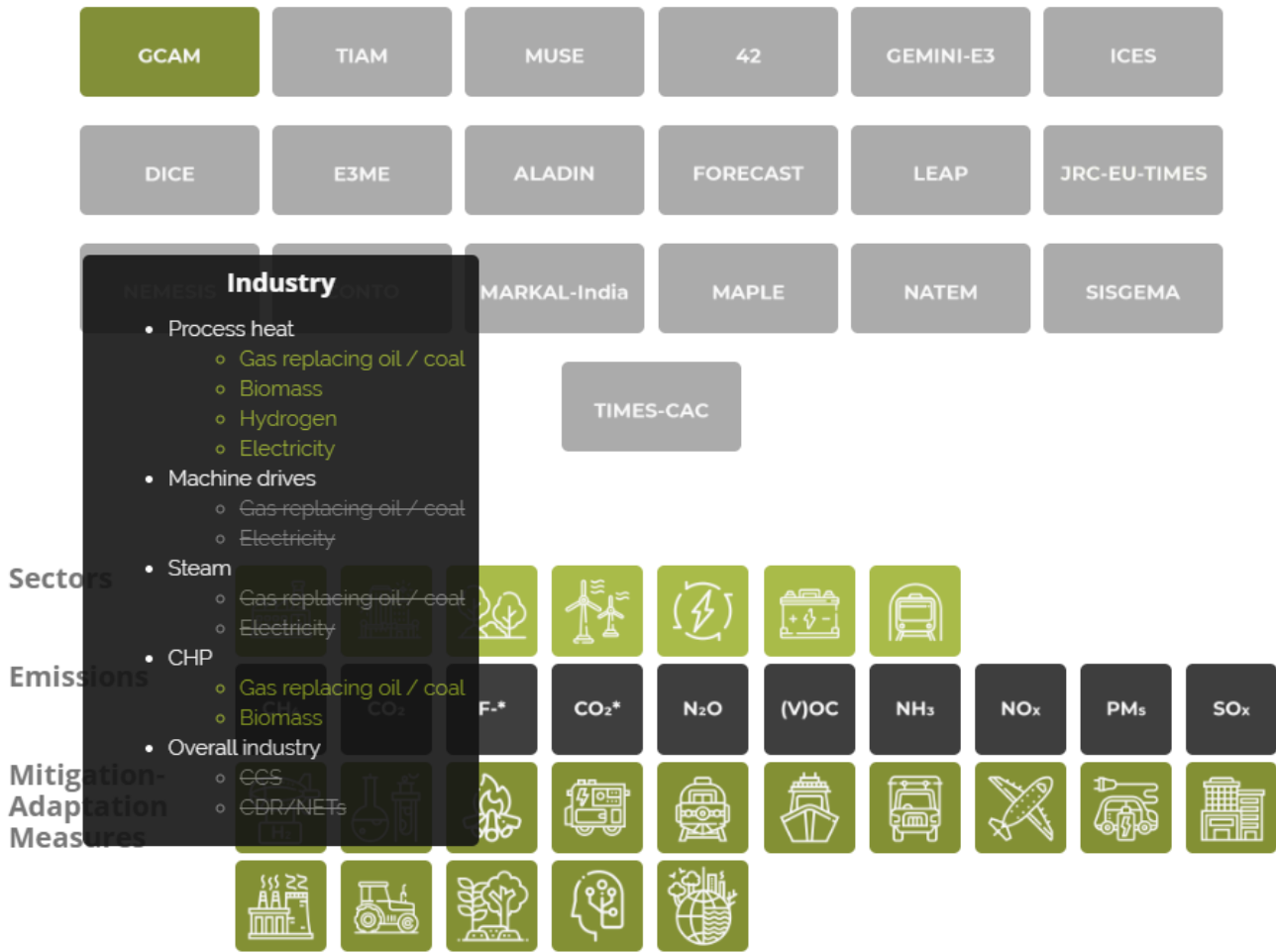


Figure 12: Hovering over the Industry Category of Mitigation and Adaptation Measures

- Hovering over a model button, an “i”-icon appears. Clicking on it, the user is redirected to the corresponding page of the detailed documentation for this specific model (Figure 13).



Figure 13: Information icon on the top-left on hover

1.3.2 Detailed Model Documentation

The Detailed Model Documentation interface contains detailed information regarding the models included in the I²AM PARIS platform, using a content menu for each model along with a navigation bar in order to seamlessly navigate throughout the entire documentation. The landing page of the Detailed Model Documentation consists of a model catalogue separated by geographical coverage (Global Models, National/ Regional Models for Europe, National/ Regional Models for Countries Outside Europe) as shown in the figure below.

Back

The detailed model documentation section includes:

Global Models

| | | | | | | | | | |
|--|---|---|--|--|-----------------------------------|---|--|-----------|---|
| GEMINI-E3 | ICES | DICE | GCAM | OSeMOSYS* | TIAM | ESME | MUSE | 42 | ETCU-RICE* |
| General Equilibrium Model of International-National Interactions between Economy, Energy and the Environment | Intertemporal Computable Equilibrium System | Dynamic Integrated model of Climate and the Economy | Global Change Assessment Model | Open Source Energy Modelling System - The Open Source Energy Model Base for the European Union | TIMES Integrated Assessment Model | Energy-Environment-Economy global Micro-Economic model | Modular energy system Simulation Environment | 42 | Endogenous Technical Change with Uncertainty (ETCU) model |
| | | | | | | | | | |
| | | WTMBT* | POLES* | E3ME-FTT* | MicroGridsPy* | MEDEAS* | WILLIAM* | | |
| | | World Trade Model with Bilateral Trade | Prospective outlook for long term energy systems | Energy-Environment-Economy global Micro-Economic model | MicroGridsPy | Modelling Energy System Development Modelling Energy System Development under Environmental and Socioeconomic constraints | "Within limits" Integrated Assessment Model | | |

National / Regional Models for Europe

| | | | | | | | | | |
|---|---------------------------------|--|--|---|---|-----------------------------|---------------------------|---|--|
| NEMESIS | EU-TIMES | LEAP | TEEM Suite* | ALADIN | FORECAST | MANAGE* | Calliope* | EnergyPLAN* | EXPANSE* |
| New Economic Model of Evaluation by Sectoral Interdependency and Supply | EU-TIMES | Long range Energy Alternatives Planning | TechnoEconomics of Energy Systems laboratory (TEES) Modelling (TEEM) suite | Alternative Automobile Diffusion and Infrastructure | Forecasting Energy Consumption Analysis and Simulation Tool | MANAGE | Euro Calliope | EnergyPLAN | Expansion of Pflögers in Near-optimal energy Scenarios |
| | | | | | | | | | |
| | HEB* | WISE-EDM* | PowerPlan* | PSM-EU* | HU-TIMES* | EPMM* | EGMM* | WISE-ESM* | |
| | High Efficiency Buildings Model | Wuppertal Institute System Model Architecture for Energy and Emission Scenarios - Energy Demand Model Industry Modulator | PowerPlan | Power System Simulation model implementation for Eastern, western Europe, and North West Europe | Hungarian national TIMES model | European Power Market Model | European Gas Market Model | Wuppertal Institute System Model Architecture for Energy and Emission Scenarios - Energy Supply Model | |

National / Regional Models for Countries Outside Europe

| | | | | | |
|--------------|---------------------|-----------------------------------|-----------------------------|--------------|----------------|
| MAPLE | MARKAL-India | NATEM | TIMES-CAC | CONTO | SISGEMA |
| China-MAPLE | MARKAL India | North American TIMES Energy Model | TIMES Central Asian Caspian | CONTO | SISGEMA |

The PARIS REINFORCE project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 820846.

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Figure 14: Detailed Documentation Landing Page

Once the user selects the desired model, they are led to the requested page. Each model has its own page, which provides a content menu (by pressing the content button on the top-right of the screen) that can be used to jump to a specific point in the text. Furthermore, a navigation bar is available on the top of each page, providing more flexibility and the ability to switch between models. The screenshots below present the above-mentioned features for the detailed documentation of the GCAM model.

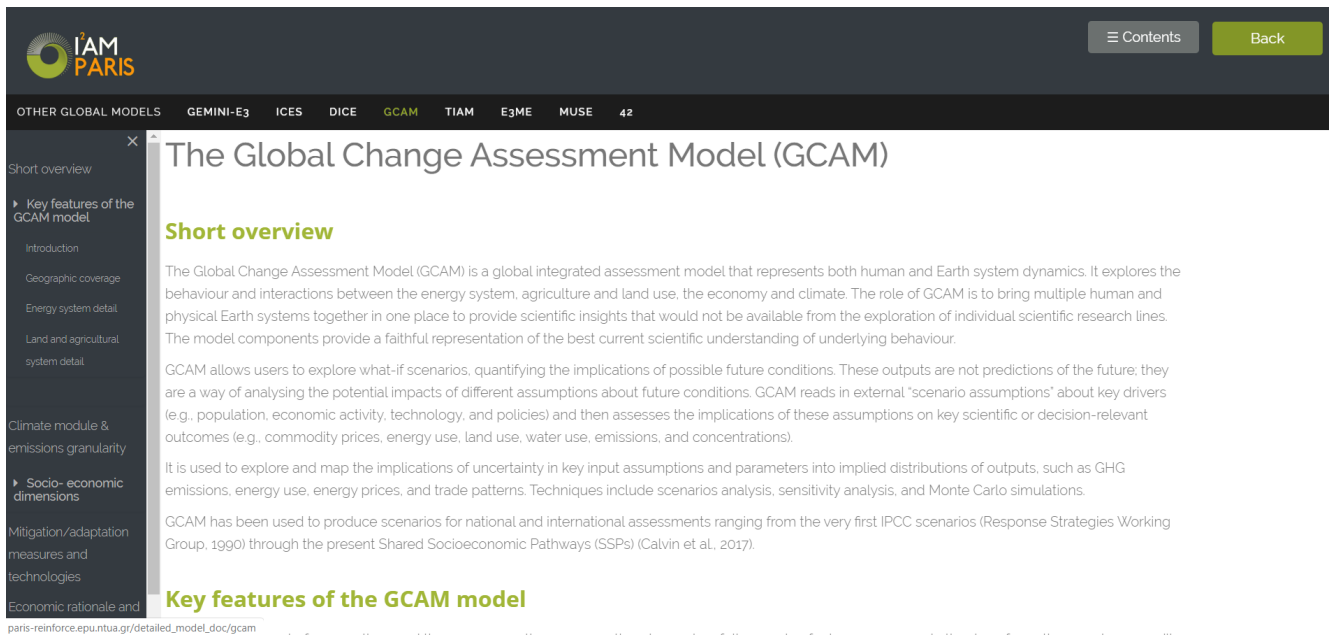
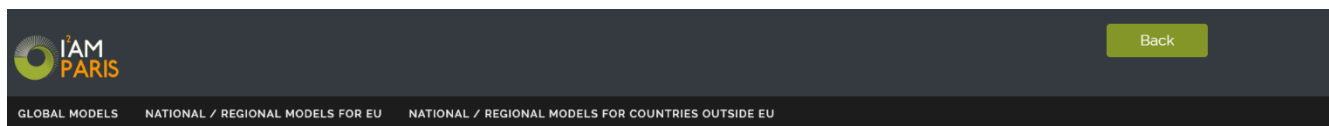


Figure 15: Detailed Documentation of GCAM

1.3.3 Overview and Comparative Assessment

The Overview and Comparative Assessment interface follows the same logic as the Detailed Model Documentation in terms of structure and available features, including the results of the comparison between models of the same coverage in the form of expanding headings. The following screenshots are taken from the global models' overview and comparative assessment.



The overview and comparative assessment section includes:

Global Models

National / Regional Models for Europe

National / Regional Models for Countries Outside Europe

Figure 16: Overview and Comparative Assessment Landing Page



Global Models

► What Can this Range of Models Explore?

The diversity of the PARIS REINFORCE project's entire modelling ensemble is an asset and, in order to make efficient use of the available models, we must inform on their potential uses for climate policy support. Evidently, not all questions can be equally addressed by all models, nor will all models that can address a specific question give similar answers. The policy issues to be addressed by the models are mainly related to mitigation of and adaptation to climate change, although all eight models are better suited for studying mitigation options than they are for delving into adaptation, as well as to overall sustainable development.

This section begins with the presentation of the main drivers, or exogenous variables, such as socioeconomic assumptions, that are considered essential inputs for the modelling simulations. Once defined, the mechanisms involved in each model in the climate action scenarios are defined. After considering these drivers and mechanisms, we take stock of policy instruments that can be implemented in each model either directly or after specific modelling adjustments. Finally, we provide a short overview of how a transition pathway is calculated as well as of example use cases for each model. A detailed account of the information included in this section is presented in the documentation of Section 3.

► Socioeconomic Assumptions

► Mitigation and Adaptation Measures Included in each Model

Figure 17: Overview and comparative assessment interface

1.3.4 On-Demand Variable Harmonisation Heatmap

The **On-Demand Variable Harmonisation Heatmap** presents an on-select, data comparison menu, where rows present the different socio- and techno-economic variables, and the columns can be selected to compare variables across the PARIS REINFORCE models.

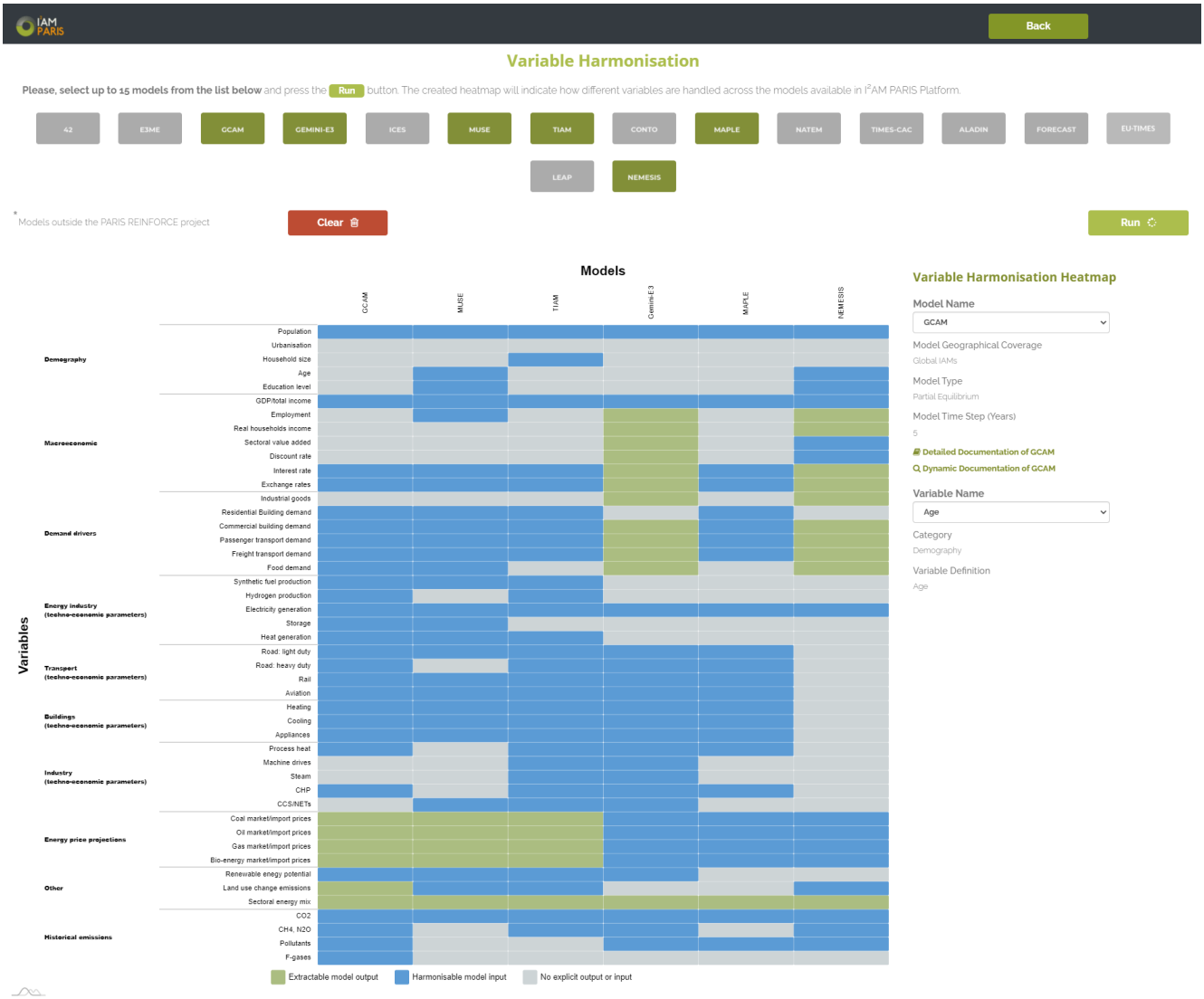


Figure 18: On-Demand Variable Harmonisation Heatmap Interface

The user selects the desired models to take part in the visualisation and clicks the “Run” button. The result includes a heatmap that indicates how different variables are handled across the selected models. Clicking on a specific heatmap cell displays a short description for the selected variable-model combination, as well as links to the corresponding sections of the Dynamic Documentation and the Detailed Documentation.

1.4 Modelling Analysis Results

The second main aspect of the I²AM PARIS platform is the demonstration of data deriving from the modelling analysis. Since the examined scenarios and the types of the models differ in some respects, the outcomes are grouped and presented in different, independent workspaces for the sake of specificity and simplicity. These workspaces are composed of four sub-sections as decided among the PARIS REINFORCE partners and different stakeholders:

- “Where are we headed?” (Advanced Scientific Module) – A scientific interface useful for researchers, modellers, and scientific experts, in order to go through the demonstrated results using the implemented tools to explore the available data.
- “Cool... what does that mean?” (Public Interface) – A broader-audience-oriented, self-explanatory



interface that includes the main conclusions of the workspace’s analysis, along with other insightful information, in a user-friendly manner.

- “Variable Harmonisation Heatmap” – An enhanced version of the On-Demand Variable Harmonisation Heatmap tool, containing additional information and functionalities, focusing exclusively on the models and multi-model exercise of the workspace, being specifically customised for it.
- “Virtual Library” – A section that includes scientific publications, policy briefs, databases (direct download links, input data sources information, etc.) relevant to the specific workspace.

The following figure showcases the landing page of the workspace currently available on the platform, the “PARIS REINFORCE Workspace”. For this deliverable, this workspace will be used as an example to demonstrate the available functionalities.

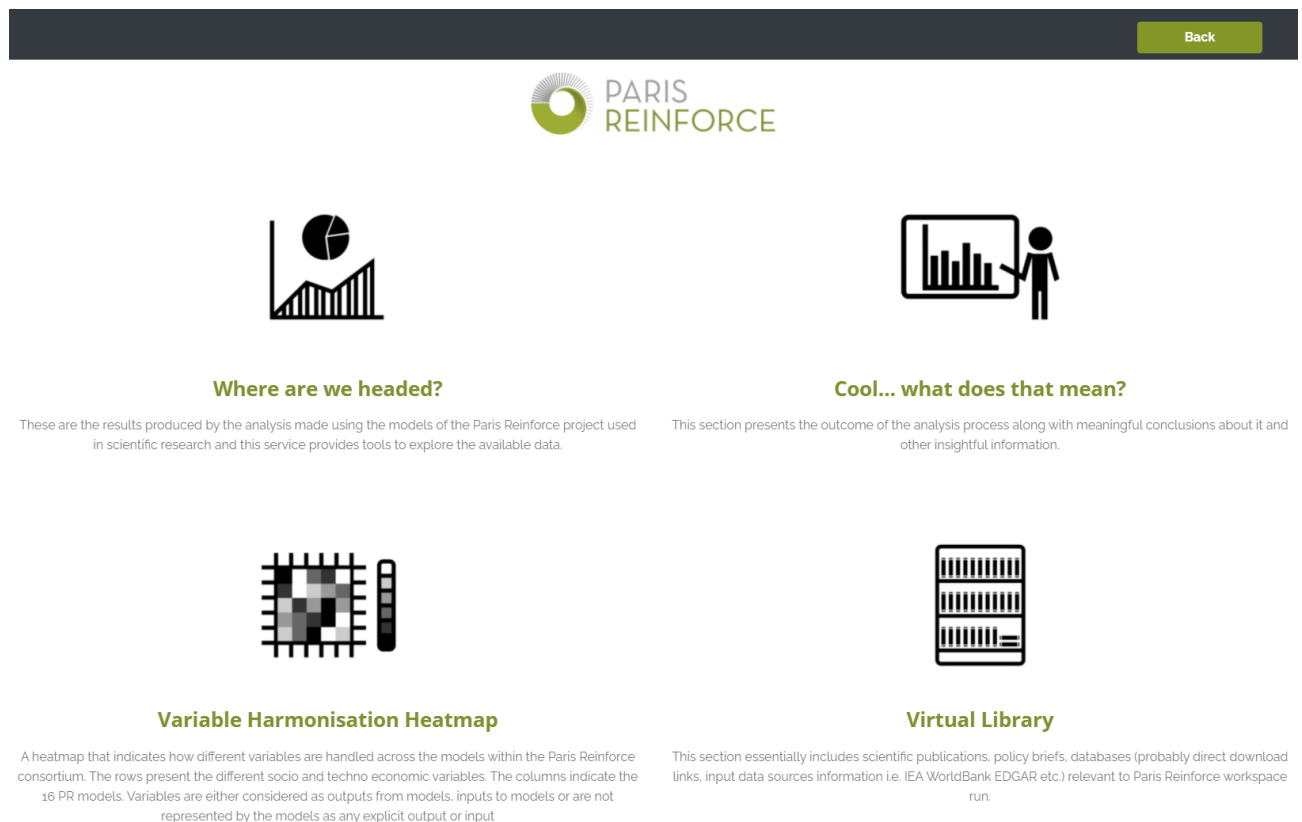


Figure 19: Paris Reinforce Workspace Landing Page

1.4.1 Where are we headed? (Advanced scientific module)

This interface has two sub-sections. The first one is an introductory page that summarises in different tabs the main results of the analysis—in the case of the first (WWH) workspace, the fossil energy CO₂ emissions for different models, scenarios and regions, the global primary energy (from coal, oil, gas and accumulatively), the global carbon capture and storage, and the global approximate temperature across different models and scenarios as well as the primary energy by fuel in each model, averaged across scenarios and vice versa (in each scenario, averaged across models). The user can customise the generated visualisations by choosing from the available dropdown lists next to each visualisation, driving the end result based on specific objects (models, scenarios, variables, or regions), limiting the time frame using the slide bar on top of each chart, activating/deactivating any of the demonstrated series.



IAM PARIS Back

SUMMARY DETAILED CONFIGURABLE ANALYSIS

FOSSIL ENERGY CO₂ PRIMARY ENERGY PRIMARY ENERGY BY FUEL GLOBAL CARBON CAPTURE & STORAGE GLOBAL APPROXIMATE TEMPERATURE

Fossil Energy CO₂ emissions

The chart on the right will present the Fossil Energy CO₂ Emissions to 2100 for all selected models, scenarios and region. Only three of our models (TIAM, GCAM, MUSE) run to 2100, 42 runs to 2045, ICES, GEMINI-E3 and E3ME run to 2050.

Models
All selected

Scenario
All selected

Region
World

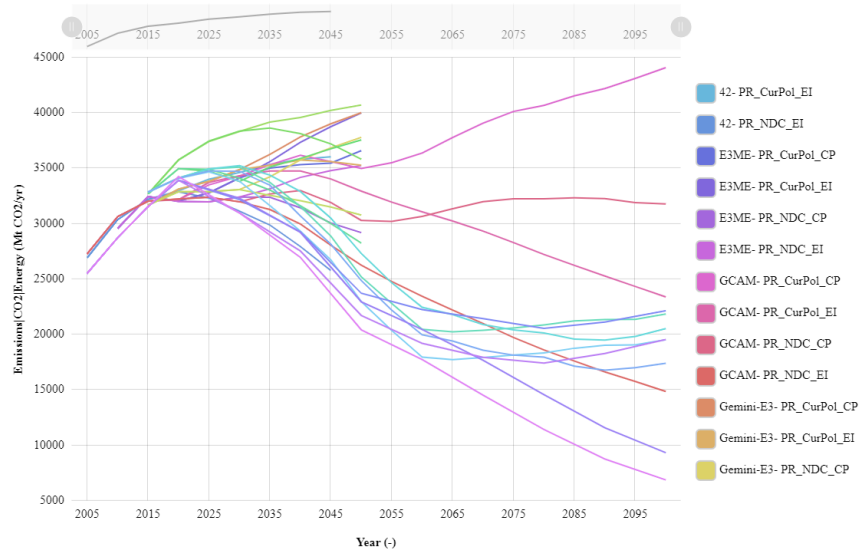


Figure 20: WWH Fossil energy CO₂ emissions

IAM PARIS Back

SUMMARY DETAILED CONFIGURABLE ANALYSIS

FOSSIL ENERGY CO₂ PRIMARY ENERGY PRIMARY ENERGY BY FUEL GLOBAL CARBON CAPTURE & STORAGE GLOBAL APPROXIMATE TEMPERATURE

Global Primary Energy

The chart on the right will present the Global Primary Energy from coal, oil, and gas, and total, to 2100 for the selected models, scenarios and variable.

Models
All selected

Scenario
All selected

Variable
Primary Energy/Coal

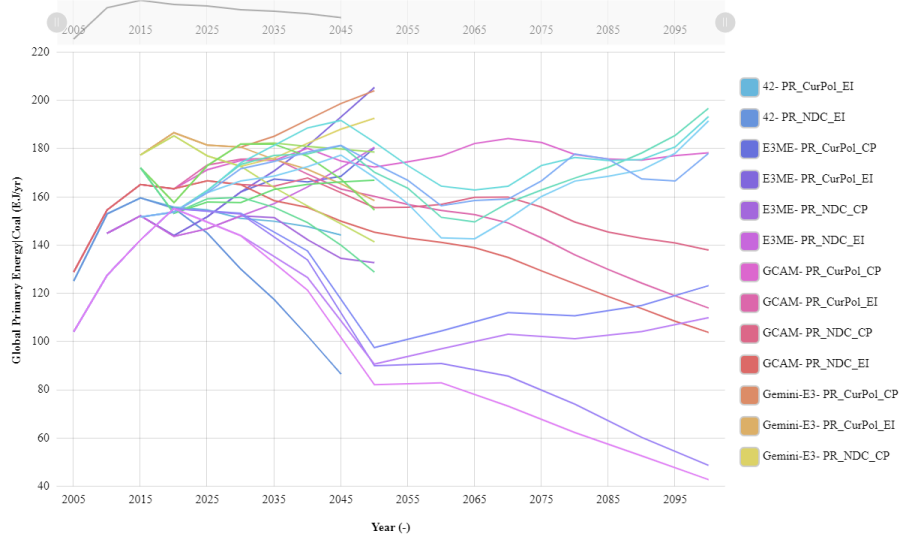


Figure 21: WWH Global primary energy

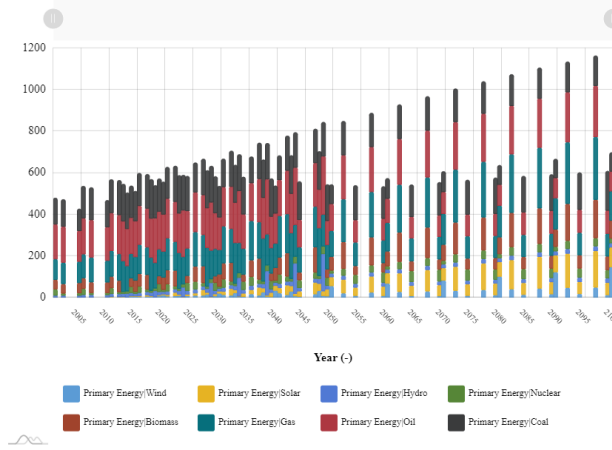


IAM PARIS Back

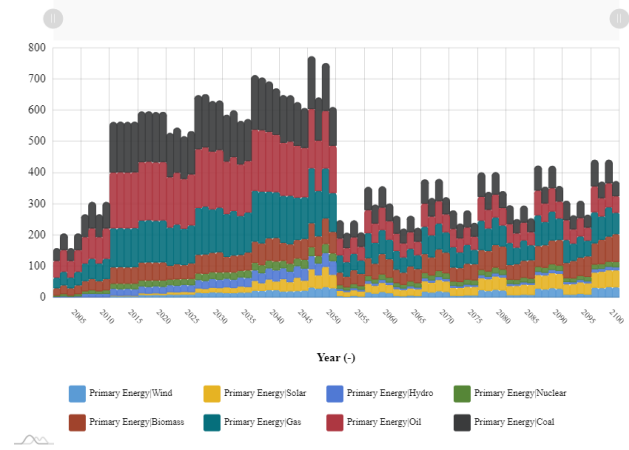
SUMMARY DETAILED CONFIGURABLE ANALYSIS

FOSSIL ENERGY CO₂ PRIMARY ENERGY PRIMARY ENERGY BY FUEL GLOBAL CARBON CAPTURE & STORAGE GLOBAL APPROXIMATE TEMPERATURE

Global Primary Energy by Fuel in each Model
(averaged across scenarios)



Global Primary Energy by Fuel in each Scenario
(averaged across models)



Show Legend

PR_CurPol_CP: Current policies implemented until 2030 and extending the equivalent carbon price^a in each region, growing at the rate of GDP per capita from 2030 onwards
 PR_CurPol_CPo: PR_CurPol_CP scenario proxied by equivalent carbon prices^b
 PR_CurPol_EI: Current policies implemented until 2030 and keeping emissions intensity of GDP reduction rate same as 2020-2030 period after 2030
 PR_NDC_CP: Unconditional Nationally Determined Contributions implemented on top of current policies^a until 2030 and extending the equivalent carbon price^b in each region, growing at the rate of GDP per capita from 2030 onwards
 PR_NDC_EI: Unconditional Nationally Determined Contributions implemented on top of current policies^a until 2030 and keeping emissions intensity of GDP reduction rate same as 2020-2030 period after 2030
^a If current policies in a given region lead to stronger emissions reductions than NDCs, the NDC scenario is equal to the current policies scenario.
^b The carbon price that, on its own (absent other policies), achieves the corresponding level of emissions reductions in 2030.

Figure 22: WWH Global primary energy by fuel

IAM PARIS Back

SUMMARY DETAILED CONFIGURABLE ANALYSIS

FOSSIL ENERGY CO₂ PRIMARY ENERGY PRIMARY ENERGY BY FUEL GLOBAL CARBON CAPTURE & STORAGE GLOBAL APPROXIMATE TEMPERATURE

Global Carbon Capture & Storage

The chart on the right will present the Global Carbon Capture & Storage to 2100 for the selected models and scenarios. ICES and 42 do not include CCS.

Models
All selected

Scenario
All selected

Run

Show Legend

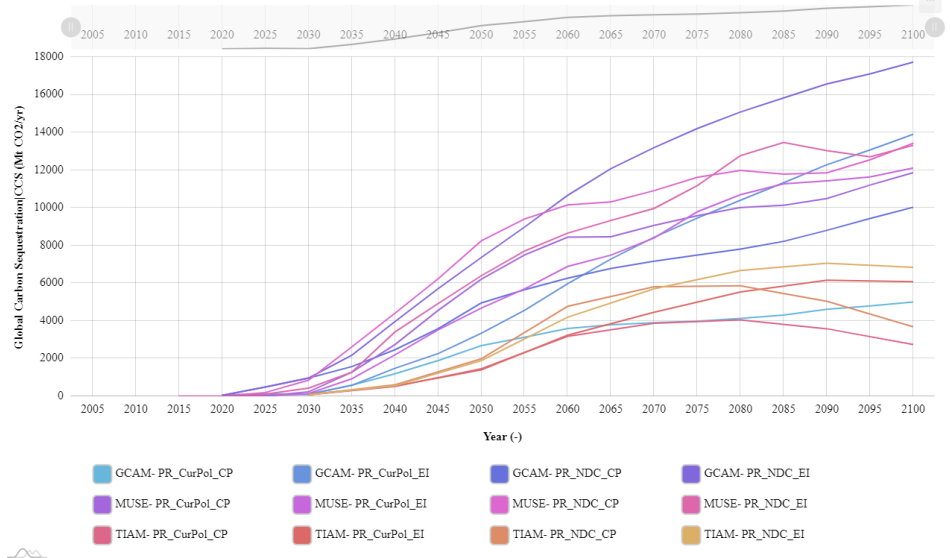


Figure 23: WWH Global carbon capture storage



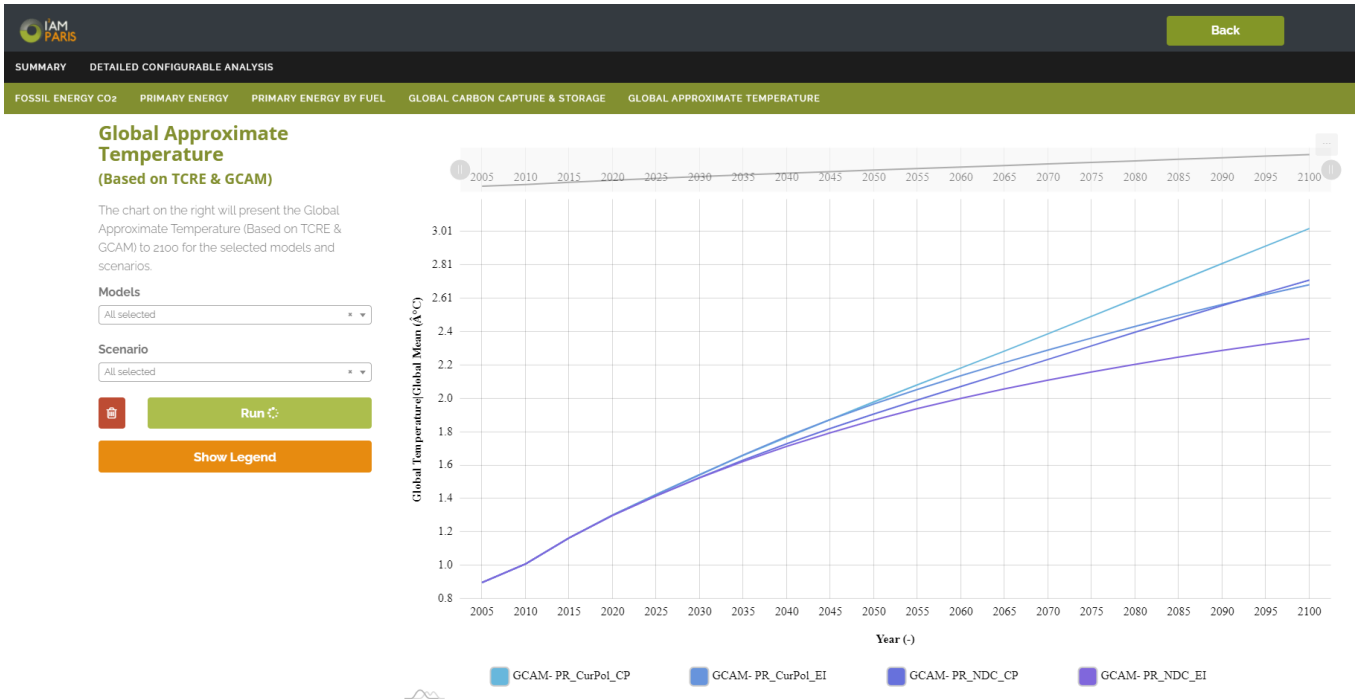


Figure 24: WWH Global approximate temperature

The second sub-section, called “Detailed Configurable Analysis”, is a fully customisable data exploration and visualisation tool that can query data and produce results for any selected combination of variables, regions, scenarios, and models. In essence, this interface is a wizard-like assistant that includes a variety of filtering choices:

- Initially, the user can optionally filter the variables by selecting an SDG from a dropdown list. This limits the number of the available variables in the list only to the ones that are pertinent to the selected SDG.
- The next step includes the selection of one variable from the list. After pressing the “Next” button, the system automatically filters out all the unrelated regions to the selected variable.
- The same workflow applies for the selection of region(s), scenario(s), and model(s), each time filtering out the options from the list that do not match to any of the possible combinations of the previously selected fields. This tool also allows the multiple selection of values of one of the parameters region, scenario, and model, thus facilitating the creation of various complex queries with different scope.
- Finally, the user may select to visually represent the data either using a line-chart or a column chart.

The interface contains a collapsible legend explaining the scenario and region acronyms as well as a tabular representation of the queried data, offering keyword search and ordering-per-column functionalities, data exportation to CSV, JSON, and other formats, and download of the complete datasets. Moreover, the visualisation can also be exported in all popular formats (PNG, JPG, SVG, PDF), also supported by every chart produced by the visualisation engine.



IAM PARIS Back

SUMMARY DETAILED CONFIGURABLE ANALYSIS

Detailed Configurable Analysis

Please, select one or more options from the available fields below. Keep in mind that the selection of multiple values is only allowed for one field at a time (model, scenario, region or variables).

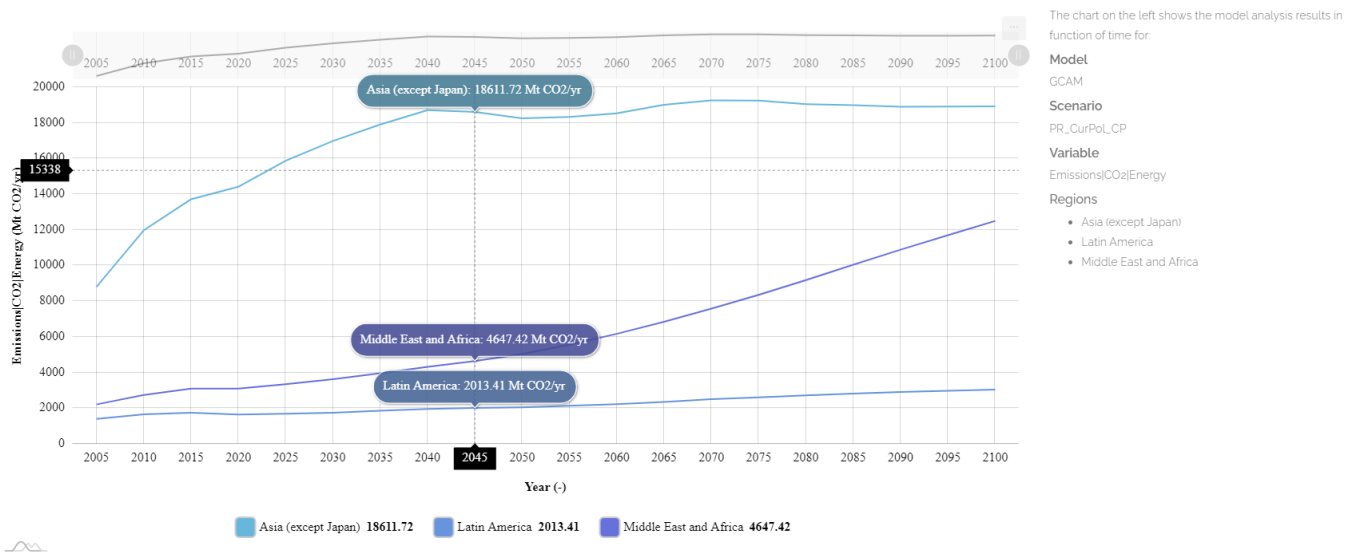
All Variables | SDGs Clear All

Please select an SDG

Variables: Emissions[CO2]Energy | Regions: Asia (except Japan), Latin America, Middle East and Africa | Scenarios: PR_CurPol_CP | Models: GCAM

You can choose among different types of visualisation, select another model or combination of models or completely clear the selected fields.

Line Chart | Column Chart Run



Show Legend

REGIONS | SCENARIOS

PR_CurPol_CP: Current policies implemented until 2030 and extending the equivalent carbon price^b in each region, growing at the rate of GDP per capita from 2030 onwards

PR_CurPol_CPo: PR_CurPol_CP scenario proxied by equivalent carbon prices^b

PR_CurPol_EI: Current policies implemented until 2030 and keeping emissions intensity of GDP reduction rate same as 2020-2030 period after 2030

PR_NDC_CP: Unconditional Nationally Determined Contributions implemented on top of current policies^a until 2030 and extending the equivalent carbon price^b in each region, growing at the rate of GDP per capita from 2030 onwards

PR_NDC_EI: Unconditional Nationally Determined Contributions implemented on top of current policies^a until 2030 and keeping emissions intensity of GDP reduction rate same as 2020-2030 period after 2030

^a If current policies in a given region lead to stronger emissions reductions than NDCs, the NDC scenario is equal to the current policies scenario.

^b The carbon price that, on its own (absent other policies), achieves the corresponding level of emissions reductions in 2030.

Data Exploration

The following table contains the requested data in a tabular format. The data exploration includes ordering, searching and exporting the available data. You can download the entire datasets in the following links: Countries , EU Region , R5 Regions , Global

Export to CSV Search:

| Year | Value | Region | Scenario | Unit | Variable | Model |
|------|-----------|------------------------|--------------|-----------|----------------------|-------|
| 2005 | 8800.795 | Asia (except Japan) | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2005 | 1405.9381 | Latin America | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2005 | 2212.4985 | Middle East and Africa | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2010 | 11980.624 | Asia (except Japan) | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2010 | 1654.6952 | Latin America | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2010 | 2739.9172 | Middle East and Africa | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2015 | 13718.799 | Asia (except Japan) | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2015 | 1742.7357 | Latin America | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2015 | 3103.111 | Middle East and Africa | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |
| 2020 | 14418.272 | Asia (except Japan) | PR_CurPol_CP | Mt CO2/yr | Emissions[CO2]Energy | GCAM |

Showing 1 to 10 of 60 entries Previous 1 2 3 4 5 6 Next

Figure 25: Detailed Configurable Analysis Interface



1.4.2 Cool... what does this mean? (Public Interface)

The public interface is currently under construction and will be based on a series of storylines and explanations that make modelling results more accessible to a non-specialist audience. In the context of the currently available 'Where are We Headed?' and the upcoming 'Where is the EU Headed?' workspaces, the narrative of this interface will be based on the following project outputs:

- Ideas and reflections obtained from a wide range of stakeholders in the workshops conducted worldwide as part of the co-creation process.
- The PARIS REINFORCE paper titled "A multi-model analysis of long-term emissions and warming implications of current mitigation efforts", authored by Sognaes et al., currently in revision to Nature Climate Change.
- The PARIS REINFORCE paper titled "Where is the EU headed given its current climate policy? A stakeholder-driven model inter-comparison", authored by Nikas et al., currently in Science of the Total Environment.
- Findings from the "Report on the co-design of PA-compliant scenarios" (PARIS REINFORCE deliverable D7.5.)

At the moment, several questions are envisioned to be included, such as (but not restricted to):

- **What do our scenarios reflect?**
- **What does the range of each scenario say across the diversity of models in terms of emissions?**
- **What role does technology play in this?**
- **What will the role of electrification be in the transport sector?**
- **What are the necessary investments to deliver decarbonisation driven by current policy ambition?**

The answers to these questions will try to bring the key takeaways closer to a wide range of stakeholders and will be presented in a very understandable and user-friendly manner. At the same time, the graphs presented in this interface will be designed so that users can understand the most important results without getting lost in complexity.

1.4.3 Variable Harmonisation Heatmap

In the 'Variable Harmonisation Heatmap', different rows present the different socio- and techno-economic variables and different columns indicate the models. This interface has been customised to allow ordering and grouping of the available models and provides additional information such as unit, timespan, sources, etc. for each relation. The ordering/grouping options include alphabetically, by model type, by geographical coverage, and by timestep.

Other than being a far more detailed and fixed-size version, this interface also supports the same functionalities and navigation options as the one generated by the module described in Section 1.3.4.



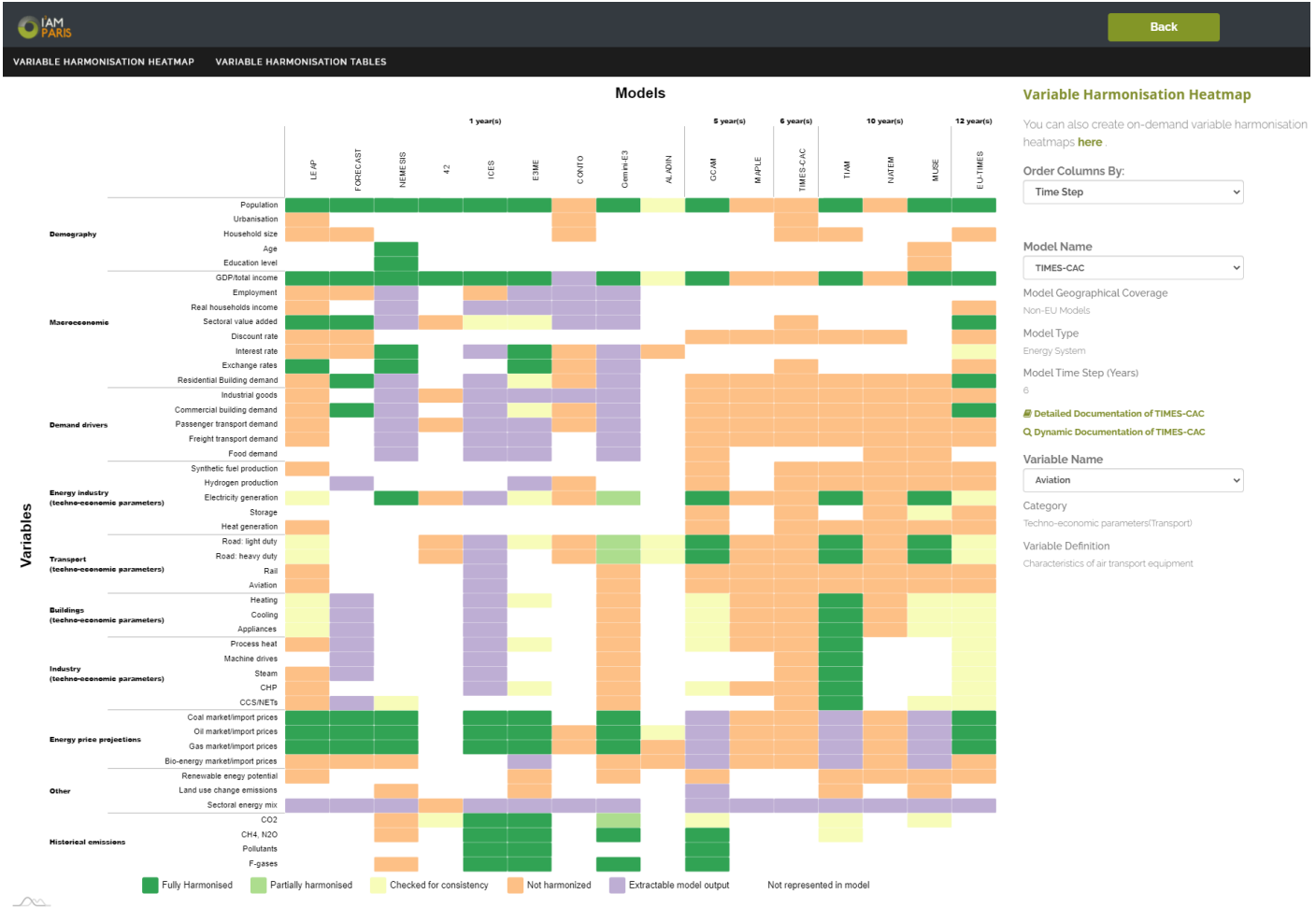


Figure 26: Variable heatmap (data ordered by time step)

1.4.4 Virtual Library

The Virtual Library will contain different types of documents, such as publications, policy briefs, data files and sources, etc., relevant to the workspace and to the PARIS REINFORCE objectives as a whole. Documents will be related to the co-creation process with stakeholders, as well as to the more modelling-focused part of the project.

1.5 User Feedback Form

The User Feedback Form is placed at the bottom of the landing page of the I²AM PARIS platform (Figure 18) and aims at facilitating the feedback collection, in order to improve platform functionality, fix bugs and handle/respond to requests for new services. Once the form is filled in and submitted, its content is sent to the developers using Python’s mail sending interface and Django’s wrappers over it, specifying the SMTP host and port in the project settings. The Feedback form utilises Google’s reCAPTCHA to protect the website against bots and spam.



CONTACT US

For any information do not hesitate to contact us.

Your Name

Your Email

Subject

Message


I'm not a robot  reCAPTCHA
Privacy - Terms



Figure 27: User Feedback Form



2 The architecture of the I²AM PARIS platform

All the afore-mentioned services of the I²AM PARIS platform are implemented utilising the four main components of the I²AM PARIS platform architecture (see Figure 1), which are thoroughly described in the following chapters:

- **The Parsers**, responsible for automatically extracting data from files that follow given templates, processing and storing the information into the I²AM PARIS Database.
- **The I²AM PARIS Backend**, a mediator component that orchestrates all the operations executed for all end-to-end scenarios, which contains the main Database Models/Entities/Schemas, providing APIs that give access to specific data sources and functionalities, and facilitates the integration of the other components, rendering the suitable interfaces for each use-case scenario.
- **The Data Manager**, a dual-role component that is responsible for the following tasks:
 - The creation, storage, and execution of queries in a pre-defined JSON format aiming at retrieving the requested data from the available datasets of the project.
 - The processing of the data returned by an executed query, in order to be converted into an appropriate format for the visualiser.
- **The Visualiser**, a standalone chart and map visualisation generator, mainly fed by data deriving from the model analyses and pre-processed by the Data Manager. This component is utilised to populate several interfaces with various visual representations of the available information, such as line charts, column charts, heatmaps, map visualisations, etc.

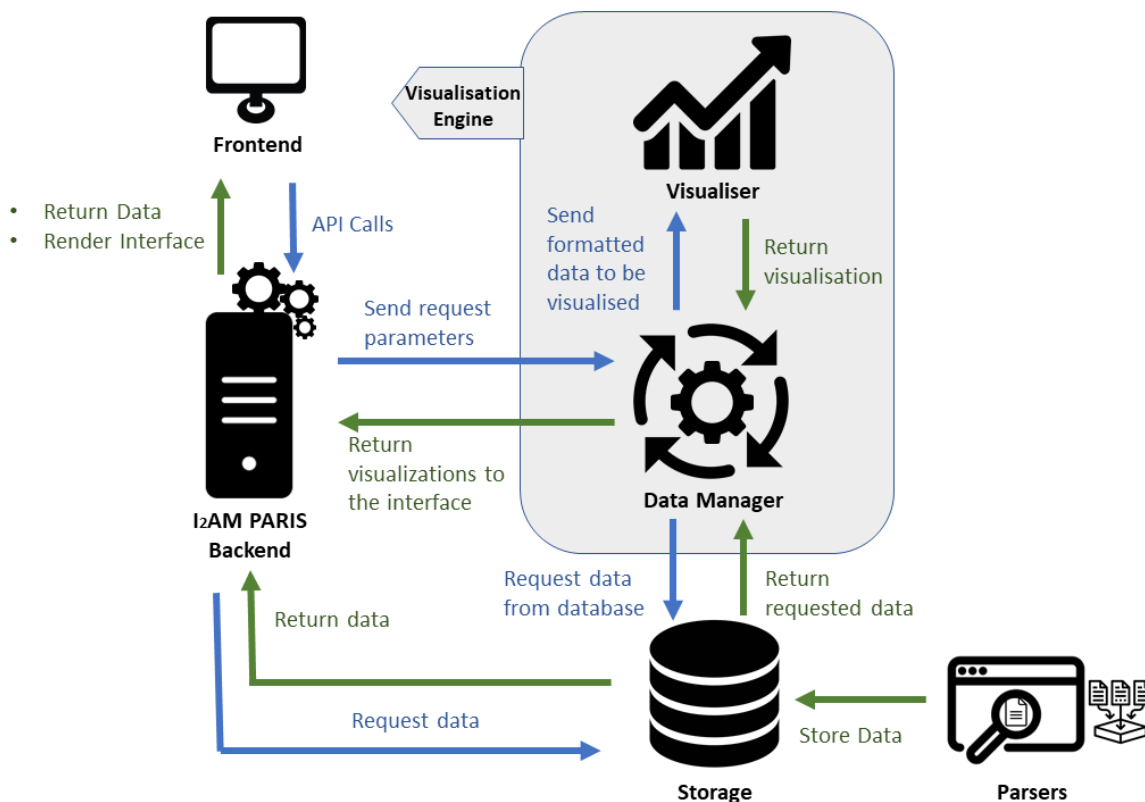


Figure 28: High-level I2AM PARIS Architecture

2.1 Parsers

The information currently available in the I²AM PARIS database has been acquired through different Extract-Transform-Load (ETL) procedures that took place after the development of three different data parsers:

- The first one is responsible for extracting information about new models from a template, provided by the technical team to ensure homogeneity, and storing it in the appropriate format into the database so as to allow seamless functionality of the Dynamic Model Documentation.
- The second one aims at parsing relatively large files that contain data from model analyses, according to the IPCC AR6 template, commonly agreed among all modelling teams so that they are completely aligned.
- The last parser was developed specifically for loading and storing data pertinent to the variable harmonisation heatmap applications. This information is vital for enabling several custom features in the corresponding interfaces.

All three parsers are working seamlessly on the defined templates, thus facilitating the continuous update of the I²AM PARIS database when new datasets are available. As long as no changes are applied to the commonly decided templates, the automated data integration can contribute to the long-term sustainability of platform.

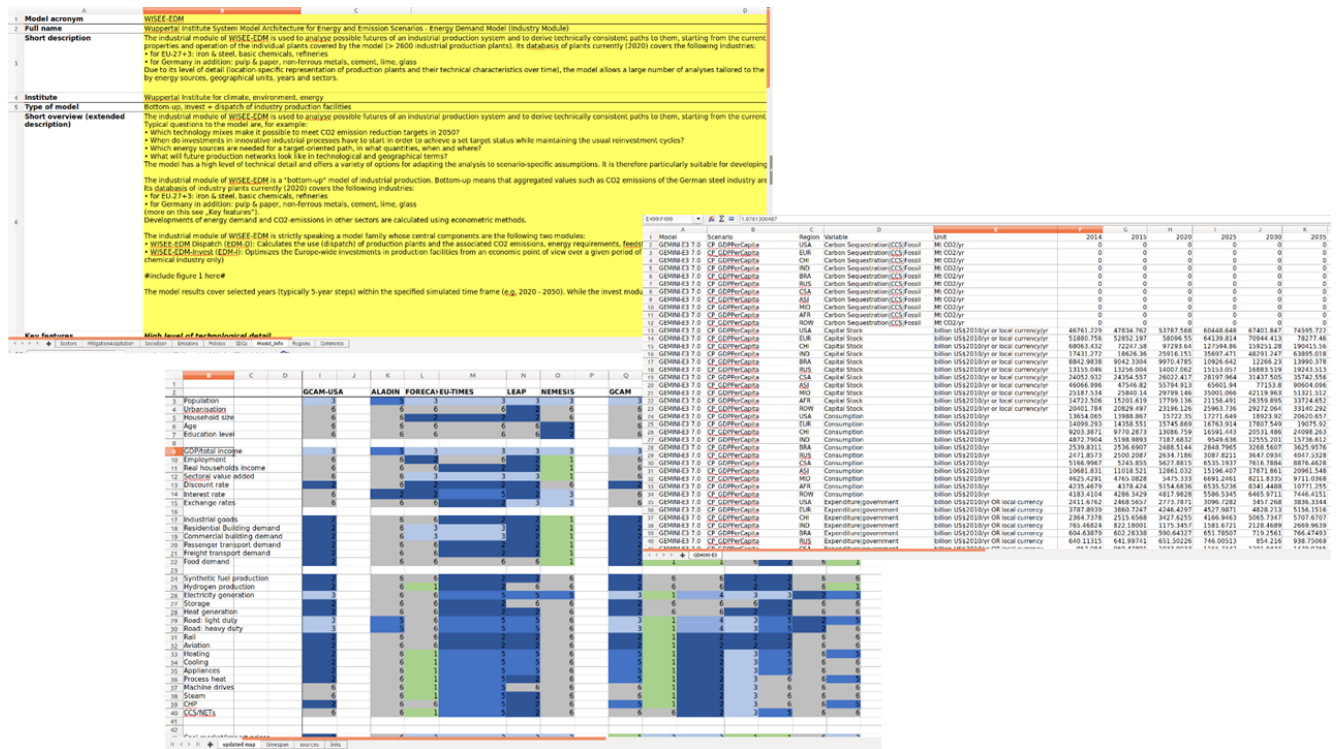


Figure 29: The three CSV parser templates

It should be noted that the modelling results parsers orient on the global/sectoral and national/regional data preparation templates used by all contributors to IPCC AR6, as provided by IASA². This enables smooth harmonisation of all modelling outputs and interlinkage with the platform, as well as minimise the effort required by non-consortium parties upon submitting their analyses.

² <https://data.ene.iiasa.ac.at/ar6-scenario-submission/#/about>



2.2 I²AM PARIS Backend

The I²AM PARIS Backend contains the main data schemas and APIs for the afore-mentioned services and is responsible for rendering the requested interfaces by combining the functionalities of the rest of the components. The next chapters highlight its main features.

2.2.1 Backend Services of Dynamic Documentation

2.2.1.1 Django Models

The functionality of the backend services of the Dynamic Model Documentation is based on retrieving and filtering data from the I²AM PARIS database. This database mainly consists of the following entities and its structure is presented in the Entity Relationship (ER) Diagram below:

- Models
- Regions
- Countries
- Sustainable Development Goal (SDG) Categories
- SDG Descriptions
- Mitigation/Adaptation Measure Categories
- Mitigation/Adaptation Measure Subcategories
- Mitigation/Adaptation Measures
- Sector Categories
- Sector Subcategories
- Sectors
- Emissions
- Emission- Model States
- Socio-Economics Categories
- Socio-Economics
- Socio-Economics - Model States
- Policy Categories
- Policies
- Policy- Model States



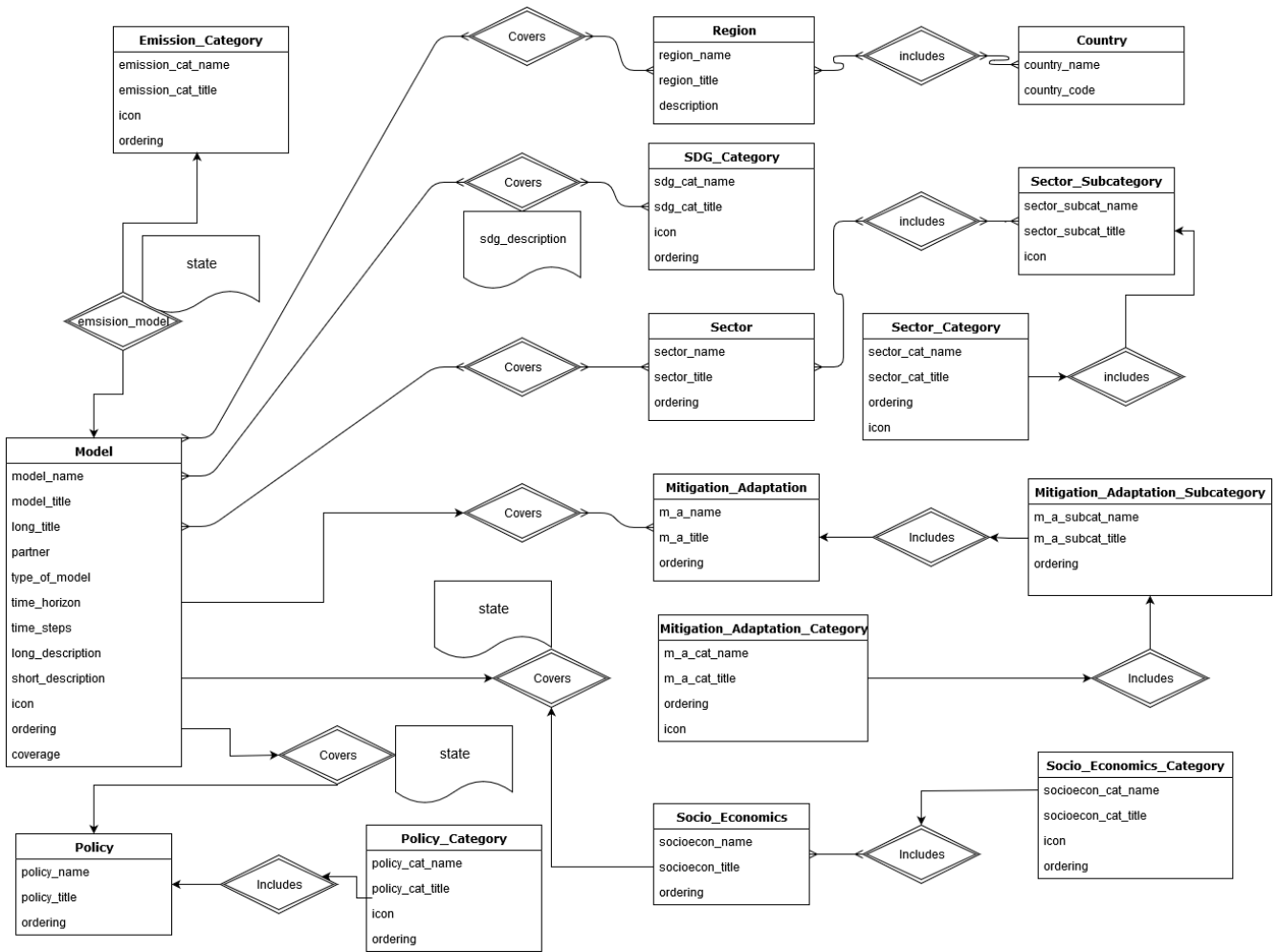


Figure 30: ER Diagram of the I2AM Paris Database

The database has been automatically created utilising Django models and migrations, according to the aforementioned entities. The tables below contain the main information of each Django model:



Table 1: Model

| Field | Description |
|-------------------|---|
| model_name | The unique name of each model used inside the code |
| model_title | The title of each model used on the interfaces |
| long_title | A more descriptive title of each model |
| partner | The name of the partner that developed the model |
| type_of_model | The type of the model according to the domain it focuses on |
| time_horizon | The time horizon of each model |
| time_steps | The time step that each model uses to produce results |
| long_description | An extensive description of the model |
| short_description | A short description of each model used in popovers, popups etc. |
| icon | It is the path to an image file (icon) used for each model on the interfaces |
| ordering | The ordering in the list of models as presented on the interfaces |
| coverage | A field that describes the geographical coverage of each model and takes one of the following values: a) global b) national_EU (for countries inside Europe) c) national_OEU (for countries outside Europe) |

Table 2: Region

| Field | Description |
|--------------|--|
| region_name | The unique name of each region used inside the code |
| region_title | The title of each region used on the interfaces |
| description | A list of the countries included in this specific region |
| model_name | A many-to-many field used for matching models to regions |

Table 3: Country

| Field | Description |
|--------------|---|
| country_name | The unique name (and title) of each country |
| country_code | A two-letter abbreviation of each country |
| region_name | A many-to-many field used for matching countries to regions |

Table 4: SDG_Category

| Field | Description |
|---------------|---|
| sdg_cat_name | The unique name of each SDG category used inside the code |
| sdg_cat_title | The title of each SDG category used on the interfaces |
| icon | The path to an image file (icon) used for each SDG category on the interfaces |
| ordering | The ordering in the list of SDG categories as presented on the interfaces |
| model_id | A many-to-many field that is used for matching models to SDGs |



Table 5: SDG_Description

| Field | Description |
|-----------------|---|
| sdg_cat_id | A foreign key to the SDG category entity |
| model_id | A foreign key to the model entity |
| sdg_description | The description of the relationship between an SDG and a model |
| ordering | The ordering in the list of SDGs as presented on the interfaces |

Table 6: Sector_Category

| Field | Description |
|------------------|--|
| sector_cat_name | The unique name of each sector category used inside the code |
| sector_cat_title | The title of each sector category used on the interfaces |
| ordering | The ordering in the list of sector categories as presented on the interfaces |
| icon | The path to an image file (icon) used for each sector category on the interfaces |

Table 7: Sector_Subcategory

| Field | Description |
|---------------------|---|
| sector_subcat_name | The unique name of each sector subcategory used inside the code |
| sector_subcat_title | The title of each sector subcategory used on the interfaces |
| sector_cat_id | A foreign key to the Sector category each sector subcategory belongs to |
| ordering | The ordering in the list of sector subcategories as presented on the interfaces |

Table 8: Sector

| Field | Description |
|------------------|--|
| sector_subcat_id | A foreign key to the Sector subcategory each sector belongs to |
| sector_name | The unique name of each sector used inside the code |
| sector_title | The title of each sector used on the interfaces |
| ordering | The ordering in the list of sectors as presented on the interfaces |
| model_id | A many-to-many field that is used for matching models to sectors |

Table 9: Mitigation_Adaptation_Category

| Field | Description |
|---------------|---|
| m_a_cat_name | The unique name of each mitigation/adaptation category used inside the code |
| m_a_cat_title | The title of each mitigation/adaptation category used on the interfaces |
| ordering | The ordering in the list of mitigation/adaptation categories as presented on the interfaces |
| icon | The path to an image file (icon) used for each mitigation/adaptation category on the interfaces |



Table 10: Mitigation_Adaptation_Subcategory

| Field | Description |
|------------------|---|
| m_a_subcat_name | The unique name of each mitigation/adaptation subcategory used inside the code |
| m_a_subcat_title | The title of each mitigation/adaptation category used on the interfaces |
| ordering | The ordering in the list of mitigation/adaptation subcategories as presented on the interfaces |
| m_a_cat_id | A foreign key to the mitigation/adaptation category each mitigation/adaptation subcategory belongs to |

Table 11: Mitigation_Adaptation

| Field | Description |
|---------------|--|
| m_a_name | The unique name of each mitigation/adaptation measure used inside the code |
| m_a_title | The title of each mitigation/adaptation measure used on the interfaces |
| ordering | The ordering in the list of mitigation/adaptation measures as presented on the interfaces |
| m_a_subcat_id | A foreign key to the mitigation/adaptation subcategory each mitigation/adaptation measure belongs to |
| model_id | A many-to-many field that is used for matching models to mitigation/adaptation measures |

Table 12: Emission_Category

| Field | Description |
|--------------------|--|
| emission_cat_name | The unique name of each emission category used inside the code |
| emission_cat_title | The title of each emission category used on the interfaces |
| icon | The path to an image file (icon) used for each emission category on the interfaces |
| ordering | The ordering in the list of emission categories as presented on the interfaces |

Table 13: Emission_Model_State

| Field | Description |
|-------------|--|
| emission_id | A foreign key to the emission entity |
| model_id | A foreign key to the model entity |
| state | A field that describes the relationship between a model and a specific emission and takes one of the following values: a) endogenous b) exogenous c) not represented |



Table 14: Socio_Economics_Category

| Field | Description |
|---------------------|---|
| socioecon_cat_name | The unique name of each socio-economics category used inside the code |
| socioecon_cat_title | The title of each socio-economics category used on the interfaces |
| icon | The path to an image file (icon) used for each socio-economics category on the interfaces |
| ordering | The ordering in the list of socio-economics categories as presented on the interfaces |

Table 15: Socio_Economics

| Field | Description |
|------------------|---|
| socioecon_cat_id | A foreign key to the socio-economics category each socio-economics parameter belongs to |
| socioecon_name | The unique name of each socio-economics parameter used inside the code |
| socioecon_title | The title of each socio-economics parameter used on the interfaces |
| ordering | The ordering in the list of socio-economics parameters as presented on the interfaces |
| model_id | A many-to-many field that is used for matching models to socio-economics parameters |

Table 16: Socio_Economics_Model_State

| Field | Description |
|--------------|---|
| socioecon_id | A foreign key to the socio-economics entity |
| model_id | A foreign key to the model entity |
| state | A field describing the relationship between a model and a specific socio-economics parameter and takes one of the following values: a) endogenous b) exogenous c) not represented |

Table 17: Policy_Category

| Field | Description |
|------------------|--|
| policy_cat_name | The unique name of each policy category used inside the code |
| policy_cat_title | The title of each policy category used on the interfaces |
| icon | The path to an image file (icon) used for each policy category on the interfaces |
| ordering | The ordering in the list of policy categories as presented on the interfaces |



Table 18: Policy

| Field | Description |
|---------------|--|
| policy_cat_id | A foreign key to the policy category each socio-economics parameter belongs to |
| policy_name | The unique name of each policy used inside the code |
| policy_title | The title of each policy used on the interfaces |
| ordering | The ordering in the list of policies as presented on the interfaces |
| model_id | A many-to-many field that is used for matching models to policies |

Table 19: Policy_Model_State

| Field | Description |
|-----------|---|
| policy_id | A foreign key to the policy entity |
| model_id | A foreign key to the model entity |
| state | A field that describes the relationship between a model and a specific policy and takes one of the following values: a) feasible b) feasible with modifications c) not feasible |

2.2.1.2 Methods and Functionality

The main functionality in the backend services is based on two classes and their constructor methods:

- **RetrieveDB:**

It creates an object of a specific model, whose name is provided by the user (if not, a default model is selected). The class utilises its methods, requesting data from the database, to determine the geographical coverage of the selected model, in specific, the regions it covers and the countries that belong to every region. A JSON file is then created containing the necessary information for the creation of an interactive map, using the AMCharts Library. The format of this JSON file is described below:

```
[
  {
    "name": the name of the region,
    "colour": the colour of each region,
    "data": [
      {"title": the name of the country,
        "id": the two-letter abbreviation of the country,
        "descr": a short description for each country that is displayed on the map
      }, ...
    ]
  },
  ... ,
]
```



When a model works on national level, the green colour is used on the map for each country. When a model works on a regional level, the colour of each region on the map is determined by the "generate_colour" method, choosing among different colours included in the palette. Last but not least, the "RetrieveGranularities" method is called.

- **RetrieveGranularities:**

The input of the "RetrieveGranularities" method is the id of the selected model. In turn, this method calls a different method for each granularity describing the selected model, and the retrieved information is returned in the following JSON format:

```
{
  'MitigationAdaptationMeasures': {...} ,
  'Sectors': {...},
  'SDGs': {...},
  'Emissions': {...},
  'Policy': {...},
  'SocioEconomics': {...}
}
```

Mitigation and Adaptation Measures and **Sector** granularities are formatted as shown below:

```
{'category_name':{
  'subcategories':[
    'subcategory_name':{
      'names': list of names (of Mitigation and Adaptation Measures or Sectors)
    }, ...
  ],
  'icon': a path to an image file (icon) used on the interfaces,
  'is_enabled': True or False,
  'html': the HTML code that will be used in the bootstrap tooltips
}
```

The 'is_enabled' parameter is True if the model covers at least one of the Mitigation and Adaptation Measures or Sectors of a category.

Emissions are formatted as shown below:

```
{'emission_name':
  {'icon': a path to an image file (icon) used on the interfaces,
  'html': the HTML code that will be used in the bootstrap tooltips,
  'is_enabled': True or False
```



```
    }, ...
  }
}
```

The *'is_enabled'* parameter is True if a gas is calculated Endogenously or used Exogenously.

SDGs are formatted as shown below:

```
{'sdg_category':{
  'name': the name of the SDG,
  'title': a detailed description of the SDG,
  'icon': a path to an image file (icon) used on the interfaces,
  'is_enabled': True or False,
  'html': the HTML code that will be used in the bootstrap tooltips
}
```

The *'is_enabled'* parameter is True if an SDG name exists for the selected model.

Socio-economics and Policy granularities are formatted as shown below:

```
{'category':{
  'names': [{"quantity_name": "quantity_state"}, ...],
  'icon': a path to an image file (icon) used on the interfaces,
  'is_enabled': True or False,
  'html': the HTML code that will be used in the bootstrap tooltips
}
```

For socio-economics, the *'is_enabled'* parameter is True if at least one socio-economics quantity in a category is covered Endogenously or Exogenously. For policies, the *'is_enabled'* parameter is True if at least one policy in a category is Feasible or Feasible with modifications.

Essentially, the *"names"* parameter is a list of JSON objects, whose key is a granularity quantity and value a Boolean value that shows if the specific quantity is covered by the model.

2.2.2 Backend of modelling results

2.2.2.1 Django Models

The relational model used for the implementation of the modelling results demonstration is displayed in the tables and figures below. The two main entities of the implementation are the Dataset and the Variable Django models.

Table 20: Dataset

| Field | Description |
|---------------|---|
| dataset_name | The unique name of the dataset used inside the code |
| dataset_title | The title of the dataset |



| | |
|----------------------------|---|
| dataset_description | A description about what kind of information this dataset contains |
| dataset_provider | The name of the provider of the dataset as shown in the UI |
| creation_date | The date the dataset was imported in the database |
| update_date | The date the dataset was last updated |
| django_model | The name of the Django Model (table name) that contains the data of this dataset. |

Table 21: Variable

| Field | Description |
|----------------------------|--|
| variable_name | The unique name of the variable used inside the code |
| variable_title | The title of the variable as shown in the UI |
| variable_definition | A definition small description of the variable |
| variable_category | The category of the variable |
| variable_type | The type of the variable (i.e., int, dec, char, date) |
| table_name | This field is nullable. If it exists, it displays the name of the Django model that this specific variable object is taking its values from. If not, it means that this variable is just a simple numerical or string value. |
| dataset_relation | The id of the dataset the variable belongs to |

The Dataset Model carries a list of all the datasets currently available on the platform along with important information about them. Each dataset record has a corresponding dataset Django model that contains the data of the dataset. Its name is stored in the “django_model” field and behaves as a separate model, having its own fields. These fields are called variables and are listed in the second main entity of the Modelling Results Backend infrastructure, the “Variable” model. This means that every record of the “Variable” model is not only related to the dataset objects through a foreign key (“dataset_relation”), but also the name of a column in the respective dataset object. If a Variable record has a “table_name”, its value in the corresponding dataset object points to a “Variable Object” that is a separate Django model having its own fields (following the same logic as the datasets). If not, the value is a number or a string. To sum this up, a Dataset Object Model is composed of columns whose names derive from the Variable Model and the value of each cell can be either a foreign key to a Variable Object Model or a simple value.

This implementation decision was made in order to be able to take advantage of the Django ORM that is utilised by the Data Manager Component and create an expandable infrastructure that has the potential to support more complex data in the future.



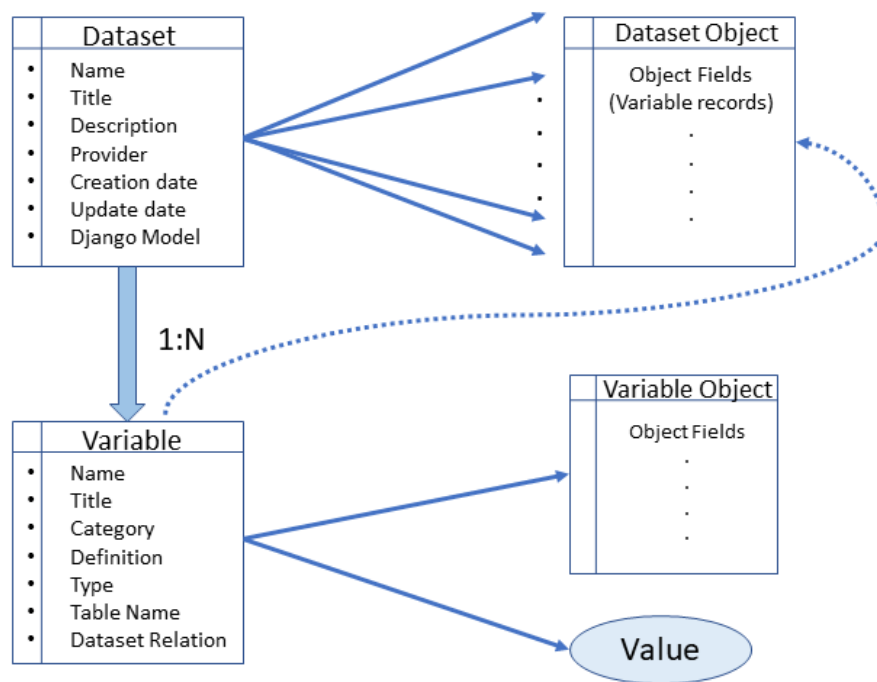


Figure 31: Modelling Results Schemas

2.2.2.2 Methods and Functionality

The main functionality of the component in this case is to coordinate the calls to the Data Manager and the Visualiser with a view to populating the interfaces with the requested information. For static interfaces, this is a straightforward one-way workflow. For dynamic interfaces, where the user interacts moving knobs, filling in empty fields, selecting values from dropdown lists, etc., this component is responsible for retrieving information about the interface and the executed queries, managing the user's interactions, making multiple requests to the rest of the components that produce the content, gathering and rendering the results. AJAX calls are executed for each change, updating only the parts of the interface that are affected by the changes, thus avoiding reloading the entire page from scratch and allowing the user to keep on with the navigation through the page (since this is an asynchronous process). In some cases, the change requires making new requests to acquire new data, while in others the data is already cached (or even processed).

2.3 Data Manager

As already mentioned, the Data Manager in essence aims at decoding queries from a JSON pre-defined format and executing them, utilising the Django ORM, along with transforming the returned data to an appropriate format for the Visualiser.

2.3.1 Query Format

```

{
  "dataset": "dataset_1",
  "query_configuration": {
    "select": ["variable_1", "variable_2"],
    "filter": {"and": [
      {"operand_1": "variable_3",
       "operand_2": 5,
       "operation": ">"},

      {"operand_1": "variable_5",
       "operand_2": ['value1', 'value2', 'value3'],
       "operation": "in"}
    ]},
    "or": [
      {"operand_1": "variable_3",
       "operand_2": 500,
       "operation": "<"},

      {"operand_1": "variable_4",
       "operand_2": 100,
       "operation": "<"}
    ]
  },
  "ordering": [
    {"parameter": "variable_8",
     "ascending": true},
    {"parameter": "variable_9",
     "ascending": true}
  ],
  "grouping": {
    "params": ["variable_1", "variable_2"],
    "aggregated_params": [
      {"name": "variable_3",
       "agg_func": "Sum"},
      {"name": "variable_4",
       "agg_func": "Avg"}
    ]
  }
},
"additional_app_parameters": {}
}

```

Figure 32: Query in JSON Format



The format of the JSON-query displayed above was decided after considering all the possible required queries for the demonstration of the available modelling results. As in a usual SQL query, the JSON object contains a SELECT, a FILTER, an ORDER-BY, and a GROUP-BY clause. In this case:

- The SELECT-clause (“select”) is a list of the names of the variables that the query is focused on (only these columns are returned from the database).
- The FILTER-clause (“filter”) contains AND and OR lists of operations that are applied in order to filter the results. All the conditions in the AND-list and at least one (if the list is not empty) of the conditions in the OR-list will have to be satisfied in order for the corresponding data to be returned. In any other case, the data are filtered out. Each condition is expressed by two operands and one operation. The first operand is the name of the examined variable, the second one is a value, and the third one is the condition that needs to be satisfied and can be one of the following:
 - $>$, $>=$, $=$, $<=$, $<$: as in mathematics
 - Between: the condition is true if the operand’s value is between a given range
 - In: the condition is true if the value exists in a list of values
- The ORDER-BY-clause (“ordering”) is a list of JSON objects (allowing ordering by multiple fields) that include the ordering parameter and whether the ordering that takes place is ascending or descending.
- In the GROUP-BY-clause (“grouping”) the “params” field is a list of the variables that are used for grouping the data. The “aggregated_params” field is a list of json objects that include the aggregated variables along with the aggregation function used for each one. The currently available aggregation functions are: Sum, Avg. (Average), Min. (Minimum), and Max. (Maximum).
- In some applications further information needs to be provided in order to fetch additional data from the database. This can be declared in the “additional_app_parameters” object.

2.3.2 Decoding and executing the query

Every interface that requires data to be retrieved, using jQuery, creates a JSON query that follows the aforementioned rules and sends it to the Data Manager in order to be either stored or decoded and executed. There is a dedicated part of the Data Manager responsible for converting step-by-step the created Query to a complex Django ORM Query and executing it, thus retrieving the requested data. This facilitates possible future changes, in case more sophisticated filtering is required by the users for example. These changes will only affect the decoding of the filtering part and will not affect the rest of the query. This is very useful since more requirements come to light by the stakeholders, as they get familiar with the platform.

The Data Manager has an API that can receive the id of a stored query, retrieve it, decode it and execute it, returning the results to the user. However, in most cases in the I²AM PARIS platform, these data are demonstrated in charts and map visualisations, utilising the Visualiser, since batches of raw data are usually illegible and not very insightful. For that reason, the Visualiser calls the Data Manager by providing the id of a query. The data returned from the execution of the query usually need further reformatting to be compatible with the Visualiser, depending on the type of the requested chart. This is achieved by several implemented methods that utilise Pandas Dataframes for efficient data conversion. In the cases that the data require even more processing before being considered ready for visual representation, aggregation functions are applied on the data, additional sorting according to a field (i.e., time), etc.



Afterwards, the final data are sent to the visualiser that proceeds with the creation of the visualisation.

It is clear that the Data Manager and the Visualiser, although technically completely independent components, in the scope of the I²AM PARIS platform work as one and constitute the Visualisation Engine as shown in Figure 21.

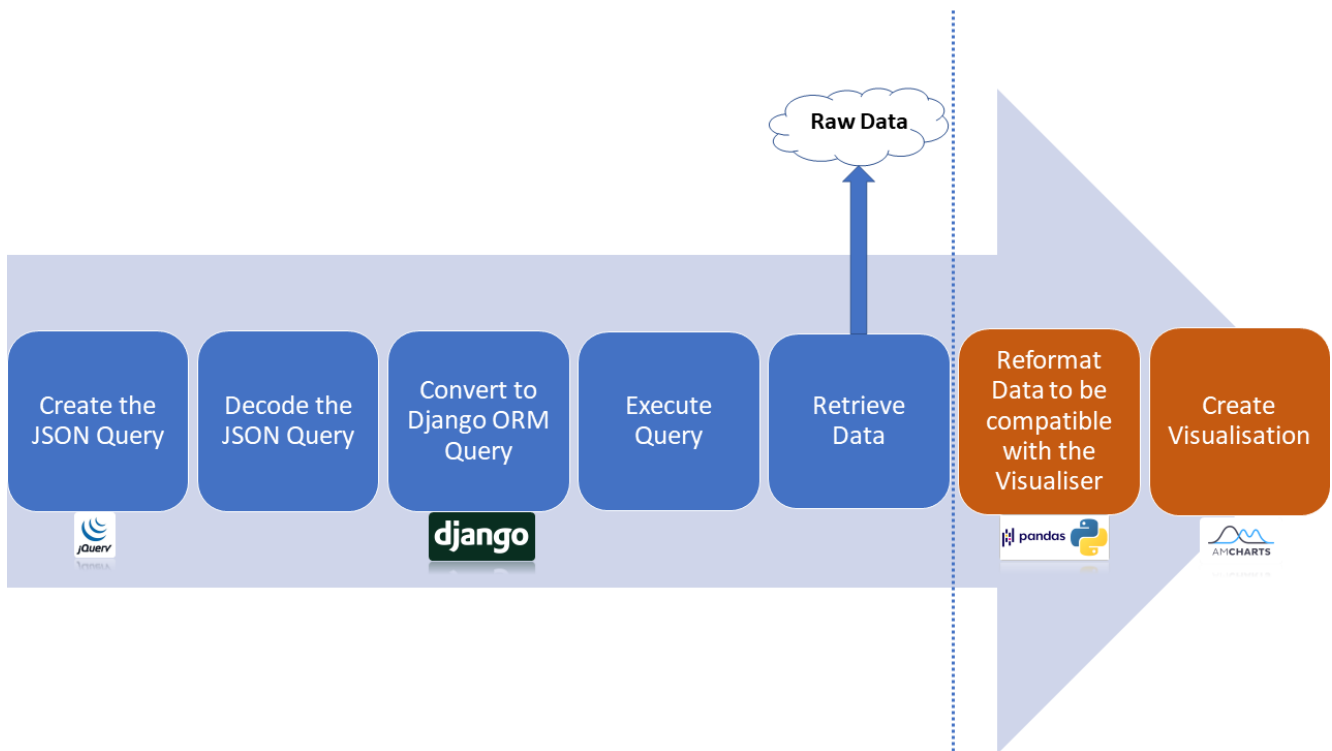


Figure 33: Visualisation Engine Workflow

2.4 Visualiser

One important service of the I²AM PARIS platform is the generation of different visualisations, based on the available data derived from the model analyses. The visualisations are generated from a standalone component called *Visualiser* and are viewed at multiple developed static and interactive interfaces within the platform. The visualisations are divided into two groups:

- Chart visualisations: several types of line charts and column charts, pie charts, radar charts, 2d histograms, Sankey diagrams, chord diagrams, Gantt charts, parallel coordinates charts.
- Map visualisations.

2.4.1 Visualisation Backend Services

Two software libraries are used at the moment, namely AmCharts 4 and D3-charts. Depending on the requirements for new types of visualisations, more libraries will be used.

Instead of implementing different classes for every visualisation, we have opted for creating super-classes for visualisations with common attributes. These classes encompass all arguments and parameters necessary for this particular type of visualisation. The classes are described below, in Table 20-23.

Table 22: XY_chart Class

| Field | Description | Type |
|-------|-------------|------|
|-------|-------------|------|

| | | |
|---------------------------|--|-----------------|
| x_axis_name | The unique name of the selected variable of the X-Axis as used in the code | String |
| x_axis_title | The title of the selected variable of the X-Axis as displayed in the user interfaces | String |
| x_axis_unit | The unit of the selected variable of the X-Axis | String |
| y_var_names | A list of names of the selected variables presented on the Y-Axis as used in the code. In several visualisations that do not support multiple series on the Y-Axis this list contains only one element. | List of Strings |
| y_var_titles | A list of titles of the selected variables presented on the Y-Axis as displayed in the user interfaces. The order of the elements in the list as well as its length should correspond to the "y_var_names" list. | List of Strings |
| y_var_units | A list of units of the selected variables presented on the Y-Axis as displayed in the user interfaces. The order of the elements in the list as well as its length should correspond to the "y_var_names" list. This makes sense in multi-axial charts, where different types of variables are presented on different Y-Axes. | List of Strings |
| chart_data | A JSON object in the appropriate format (depending on the visualisation) that contains the data to be displayed. | JSON Object |
| chart_type | The type of chart that will be created. It could be one of the following: <ul style="list-style-type: none"> • line_chart • column_chart • range_chart • bar_range_chart • stacked_column_chart • column_heatmap_chart • pie_chart • radar_chart | String |
| x_axis_type | The type of the X-Axis, as several visualisations support more than one type. Options: "Time", "Text", "Number". The first option is used when the X-Axis includes dates or time. The second option is used when distinct categories are displayed on the X-Axis. The third option is used for continuous values. | String |
| use_default_colors | If "true", the default colours are used for the chosen visualisation | Boolean |
| color_list | <ul style="list-style-type: none"> • A list of colours used for each series of the chosen visualisation in case use_default_colors = "false". Options include "light_blue, blue, violet, purple, fuchsia, red, ceramic, light_brown, mustard, gold, light_green, green, cyan, black, gray, white" • A list of two colours that are used for minimum and maximum values in heatmap charts (i.e. bar_heatmap_chart; if one colour is given in a bar heatmap, then the white colour is selected by default as the other colour) and for creating the gradient legend. | List of Strings |
| chart_3d | If "true", the chart is displayed in three dimensions. (not all visualisations support 3D) | Boolean |



| | | |
|------------------------|---|-----------------|
| min_max_y_value | A two-element list that contains the minimum and maximum value of the variable presented on the Y-Axis. | List of Numbers |
|------------------------|---|-----------------|

Table 23: XYZ_chart Class

| Field | Description | Type |
|---------------------------|---|-----------------|
| x_axis_name | The unique name of the selected variable of the X-Axis as used in the code | String |
| x_axis_title | The title of the selected variable of the X-Axis as displayed in the user interfaces | String |
| x_axis_unit | The unit of the selected variable of the X-Axis | String |
| y_var_name | The name of the selected variable presented on the Y-Axis as used in the code. | String |
| y_var_title | The title of the selected variable presented on the Y-Axis as displayed in the user interfaces. | String |
| y_var_unit | The unit of the selected variable presented on the Y-Axis as displayed in the user interfaces. | String |
| z_axis_name | The unique name of the selected variable of the Z-Axis as used in the code | String |
| z_axis_title | The title of the selected variable of the Z-Axis as displayed in the user interfaces | String |
| z_axis_unit | The unit of the selected variable of the Z-Axis | String |
| chart_data | A JSON object in the appropriate format (depending on the visualisation) that contains the data to be displayed. | JSON Object |
| chart_type | The type of chart that will be created. it could be one of the following: <ul style="list-style-type: none"> heat_map_chart | String |
| use_default_colors | If "true", the default colours are used for the chosen visualisation | Boolean |
| color_list | <ul style="list-style-type: none"> A list of colours used for each series of the chosen visualisation in case use_default_colors = "false". Options include "light_blue, blue, violet, purple, fuchsia, red, ceramic, light_brown, mustard, gold, light_green, green, cyan, black, gray, white" A list of two colours that are used for minimum and maximum values in heatmap charts (i.e. heat_map_chart; if one colour is given in a bar heatmap, then the white colour is selected by default as the other colour) and for creating the gradient legend. | List of Strings |
| min_max_z_value | A two-element list that contains the minimum and maximum value of the variable presented on the Z-Axis. | List of Numbers |

Table 24: FlowChart Class

| Field | Description | Type |
|-------|-------------|------|
|-------|-------------|------|



| | | |
|---------------------------|--|-----------------|
| chart_data | A JSON object in the appropriate format (depending on the visualisation) that contains the data to be displayed. | JSON Object |
| chart_type | The type of chart that will be created. It could be one of the following: <ul style="list-style-type: none"> sankey_diagram chord_diagram | String |
| use_default_colors | If "true", the default colours are used for the chosen visualisation | Boolean |
| color_node_list | <ul style="list-style-type: none"> A list of colours used for each node in the chosen visualisation in case use_default_colors = "false". Options include "light_blue, blue, violet, purple, fuchsia, red, ceramic, light_brown, mustard, gold, light_green, green, cyan, black, gray, white" | List of Strings |
| node_list | A list of names/titles of the existing nodes in the charts. | List of Strings |
| chart_title | The title used for the whole chart that is displayed. | String |

Table 25: MapChart Class

| Field | Description | Type |
|----------------------|--|-----------------|
| map_data | A JSON object in the appropriate format (depending on the visualisation) that contains the data to be displayed on the map. | JSON Object |
| map_var_name | The name of the selected variable presented on the map as used in the code. | String |
| map_var_title | The title of the selected variable presented on the map as displayed in the user interfaces. | String |
| map_var_unit | The unit of the selected variable presented on the map as displayed in the user interfaces. | String |
| min_max_value | A two-element list that contains the minimum and maximum value of the variable presented on the map. | List of Numbers |
| chart_type | The type of chart that will be created. it could be one of the following: <ul style="list-style-type: none"> heatmap_on_map | String |
| color_list | <ul style="list-style-type: none"> A list of colours used for different elements on the map (future implementation). Options include "light_blue, blue, violet, purple, fuchsia, red, ceramic, light_brown, mustard, gold, light_green, green, cyan, black, gray, white" A list of two colours that are used for minimum and maximum values in heatmap charts (i.e. heat_map_on_map) and for creating the gradient legend. | List of Strings |
| Projection | The type of projection that will be used for the map. Options include "eckert6, equirectangular, naturalearth, miller, orthographic, mercator" | List of Strings |
| chart_title | The title used for the whole chart that is displayed. | String |

The visualisation generation service is triggered by an HTTP request (either POST or GET) that contains information like the type of visualisation that must be created, all parameters necessary for the configuration of the visualisation (which can vary in number, and depends on the type of each visualisation) and information about the data that will be used, either from a dataset stored in the database or from an external file.



- In the first case, the data are retrieved from the Data Manager by executing the corresponding query using the parameters provided in the request.
- In the second case, the data are acquired from a CSV file of a predefined format that will be commonly agreed among the related consortium partners.

In any case, the data are loaded and processed properly, in order to be in the form required by each visualisation type. The processing that takes place is based on the format of the provided data, the data volume, the user requirements, and the choices that are made when interacting with the interfaces, and is done by the Data Manager.

The final data are sent to the respective libraries that create and render the visualisation, which is finally returned as a response to the initial request.

The different visualisation types currently implemented on the platform (to be finalised as the Data Manager is developed) are described below:

- **Line chart**, with multiple variables displayed at the same visualisation. The X-Axis and Y-Axis variables along with their type, titles and units as well as the dataset or the file name are obtained from the parameters of the request.
- **Range line chart**, with multiple variables displayed at the same visualisation. Follows the same logic as the simple line chart but also displays the minimum and maximum values of the examined variables.
- **Column chart**, again with multiple variables displayed side-by-side, in columns. Follows the same logic as the line chart.
- **Column heatmap chart**, which examines the value of one variable and displays it in columns of different colour depending on its value (according to a heatmap legend).
- **Bar range chart**, mainly (but not exclusively) used as a Gantt chart, that is a variation of a column chart with (usually) time-based horizontal axis and bars starting at arbitrary values rather than on the axis. This can be used, inter alia, to capture the exact timeline of the PARIS REINFORCE modelling runs; or, for future assessment cycles.
- **Pie chart**. The examined variable and the key variable for slicing the pie are obtained from the parameters of the request.
- **Radar chart**, which is used to display directional or circular visual representation of a 2-dimensional data.
- **2D-Histogram** (heatmap chart) of one variable that shows the intensity of a variable in function of two other variables acquired from the request parameters.
- **Chord diagram**, which is used to indicate one-level quantitative relations between multiple items, organised in a circular diagram.
- **Sankey diagram**, which can be used to depict branched, multi-level flows of values.
- **Parallel coordinates chart**, for plotting multivariate, numerical data. This chart is ideal for comparing many variables together and seeing the relationships between them.
- **Heatmap (on map)** that shows the intensity of a variable or the frequency of events on a map. The examined variable is retrieved from the request.

In most of the aforementioned visualisation alternatives, the option of choosing specific colours for the diagrams is also provided, while some can also be displayed in three dimensions. These two functionalities (colouring and 3D display) are also configured by passing the necessary parameters in the requests.



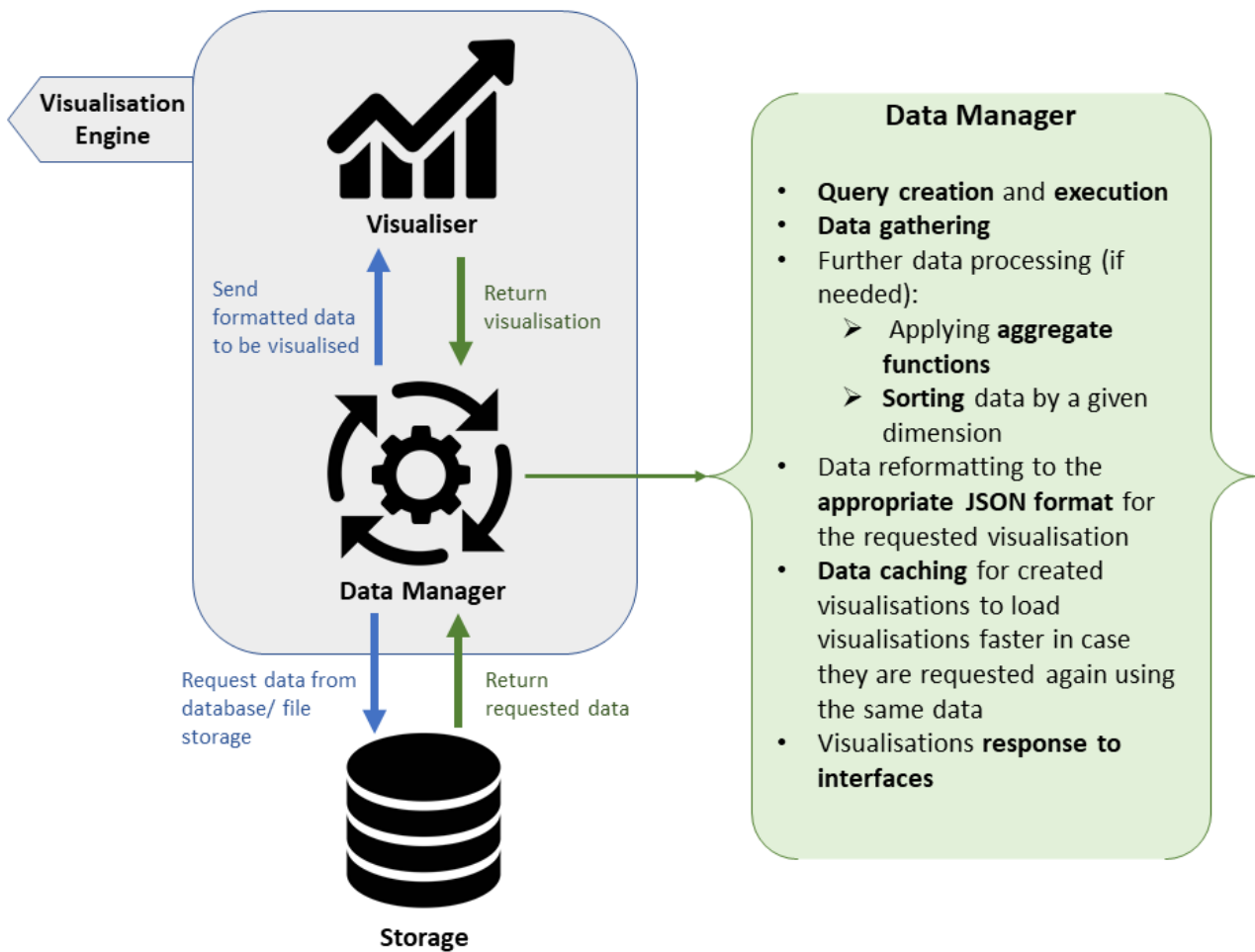


Figure 34: Visualisation Engine Design

2.4.2 Visualiser API and Request Examples

The Visualiser API receives both GET and POST requests in a specific format (passing the necessary parameters according to the Class the requested visualisation belongs to; see section 1.6.1) and returns an HTML page that contains the requested visualisation. For example, the following requests creates and returns a line chart:

GET Request:

```
http:// http://paris-reinforce.epu.ntua.gr/ visualiser/ show_line_chart? y_var_names[]=myVariable1 &
y_var_names[]=myVariable2 & y_var_titles[]=Variable1 & y_var_titles[]=Variable2 & y_var_units[]=v1_unit &
y_var_units[]=v2_unit & x_axis_type=time & x_axis_name=time & x_axis_title=Time & x_axis_unit=-&
y_axis_title=YAxisVariable & color_list_request[]=blue & color_list_request[]=red & use_default_colors=false &
min_max_y_value[]=0 & min_max_y_value[]=2000
```

POST Request:



http://localhost:8000/visualiser/show_line_chart

Body: {

```

"y_var_names": ["myVariable1", "myVariable2"],
"y_var_titles": ["Variable1", "Variable2"],
"y_var_units": ["v1_unit", "v2_unit"],
"x_axis_type": "time",
"x_axis_name": "time",
"x_axis_title": "Time",
"x_axis_unit": "-",
"y_axis_title": "YAxisVariable",
"color_list_request": ["blue", "red"],
"use_default_colors": "false",
"min_max_y_value": [0, 2000],
"dataset": "my_dataset"
}

```

There are three points regarding both types of requests that should be clarified:

- The names of the variables must be the same with those used in the JSON object that contains the data to be visualised as shown below.
- The values of specific parameters should follow the available options provided by the four main visualisation classes: **XY_Chart**, **XYZ_Chart**, **FlowChart**, **MapChart**.
- The "dataset" is used for defining the dataset (either table from a database, or file) that is going to be used as data source for the requested visualisation. Currently, the data used for demonstrating each visualisation are synthesised.

The data used by the visualiser for this specific example are in the following format:

```

[{"time": 1577743200000, "myVariable1": 269.5},
 {"time": 1577829600000, "myVariable1": 129.25},
 .....
 {"time": 1577743200000, "myVariable2": 163.2},
 {"time": 1577829600000, "myVariable2": 222.15}]

```

The list of available visualiser URLs is presented below (examples):

- paris-reinforce.epu.ntua.gr/visualiser/show_line_chart
- paris-reinforce.epu.ntua.gr/visualiser/show_column_chart
- paris-reinforce.epu.ntua.gr/visualiser/show_pie_chart



- paris-reinforce.epu.ntua.gr/visualiser/show_radar_chart
- paris-reinforce.epu.ntua.gr/visualiser/show_range_chart
- paris-reinforce.epu.ntua.gr/visualiser/show_bar_range_chart
- paris-reinforce.epu.ntua.gr/visualiser/show_stacked_column_chart
- paris-reinforce.epu.ntua.gr/visualiser/show_heat_map_chart
- paris-reinforce.epu.ntua.gr/visualiser/show_bar_heat_map_chart
- paris-reinforce.epu.ntua.gr/visualiser/show_sankey_diagram
- paris-reinforce.epu.ntua.gr/visualiser/show_chord_diagram
- paris-reinforce.epu.ntua.gr/visualiser/show_heat_map
- paris-reinforce.epu.ntua.gr/visualiser/parallel_coordinates_chart

2.4.3 Visualisation Frontend Services

The Visualisation Engine utilises AmChart4 and D3 Charts, as mentioned above, in order to produce the requested visualisations. The screenshots below show the visualisations that are currently available using the visualiser, presenting synthesised data for the sake of demonstration.

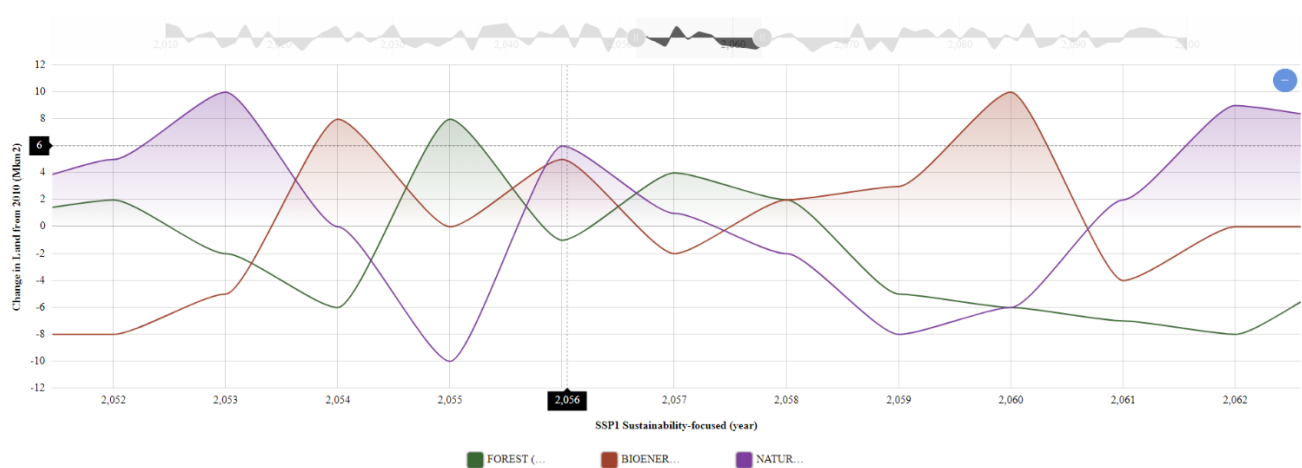


Figure 35: Line Chart

A Line chart displays series of data points connected by straight line segments. Line graphs are often used to display time series chronologically with the x-axis serving as an evenly spaced date-time scale (Figure 20).

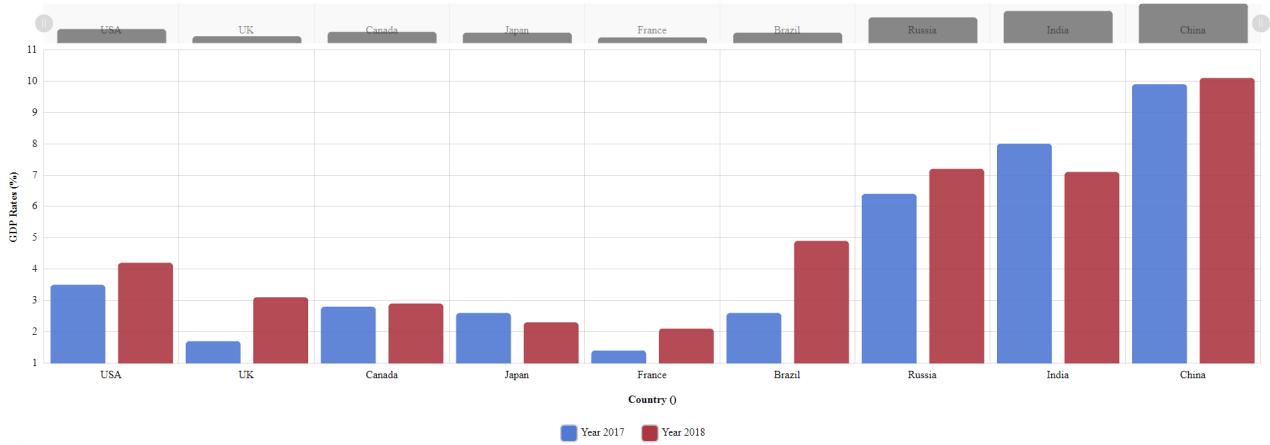


Figure 36: Column Chart

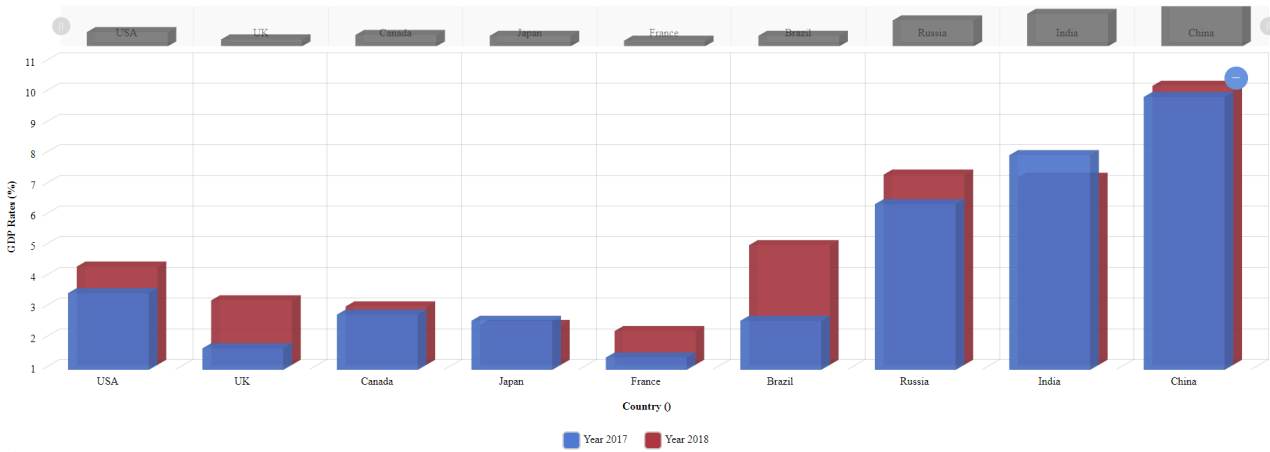


Figure 37: Column Chart 3D

A Column Chart (Figure 21) is one of the most common and, arguably, easiest charts to read when it comes to visualising category-based values. Rectangular bars are placed along the category axis with the bar length representing the value for a specific category. The visualisation engine can also produce three-dimensional column charts (Figure 22).



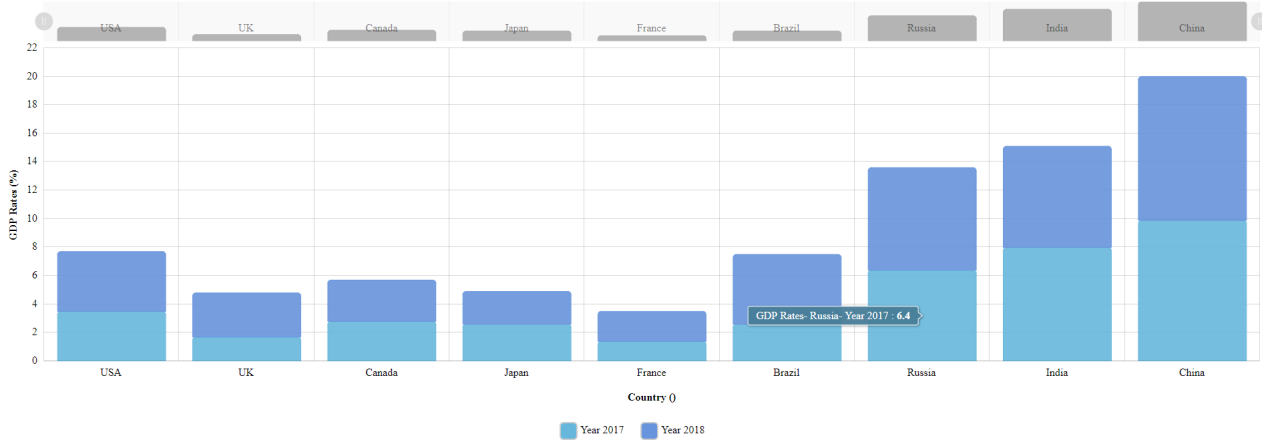


Figure 38: Stacked Column Chart

Stacked Bar Charts (Figure 23) are useful to demonstrate how a larger data category is comprised of smaller categories, and what part each of the smaller categories plays in the total of a larger one.

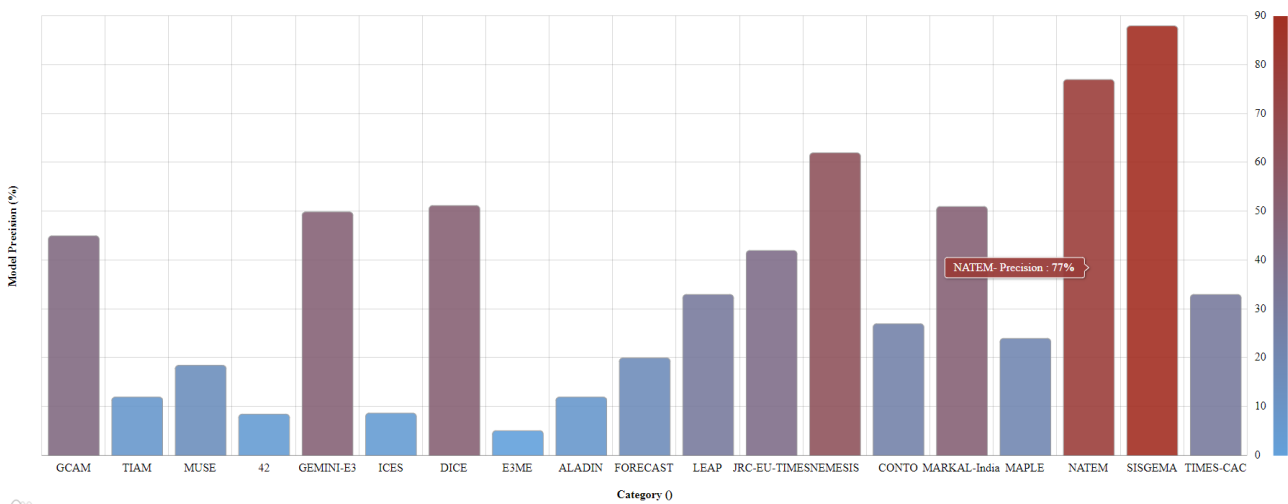


Figure 39: Heatmap Bar Chart

A Heatmap Bar Chart (Figure 24) is used the same way as a simple column chart, but each bar is coloured according to a heatmap legend, showing the value for specific categories using the proper colour (thereby adding an additional data dimension).

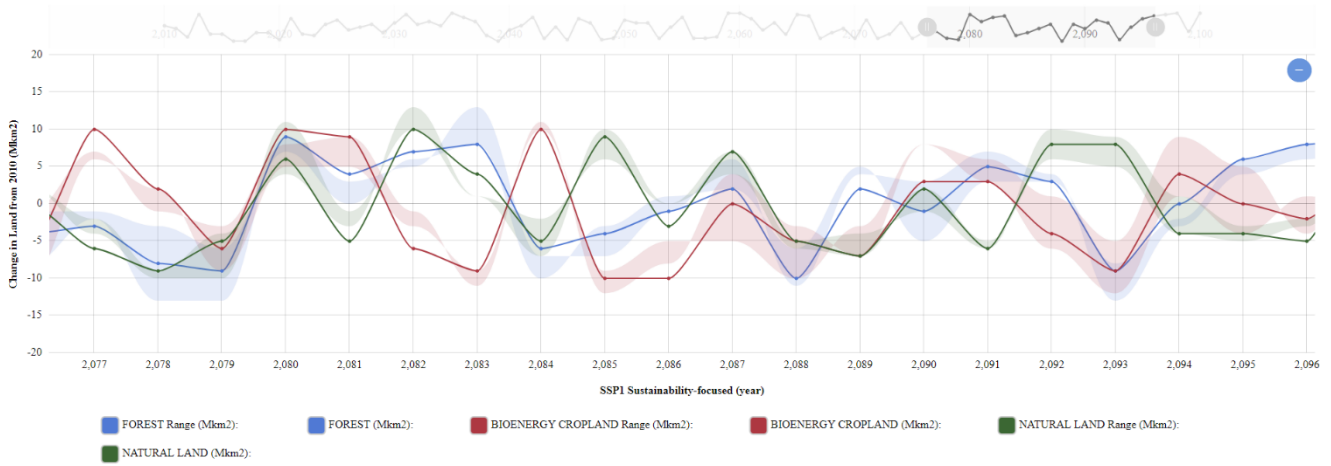


Figure 40: Range Chart

A Range Chart (Figure 25) is a type of area chart where, rather than starting on the axis, the area is represented by the space between two values. These charts are useful for displaying ranges of values, such as between minimum and maximum values over a timespan, or projected values for the future when the projection is represented by a range instead of a specific value.

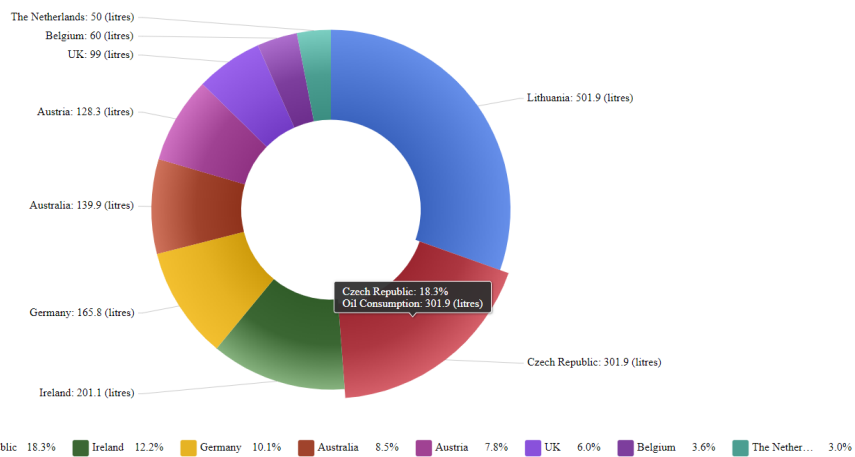


Figure 41: Pie Chart



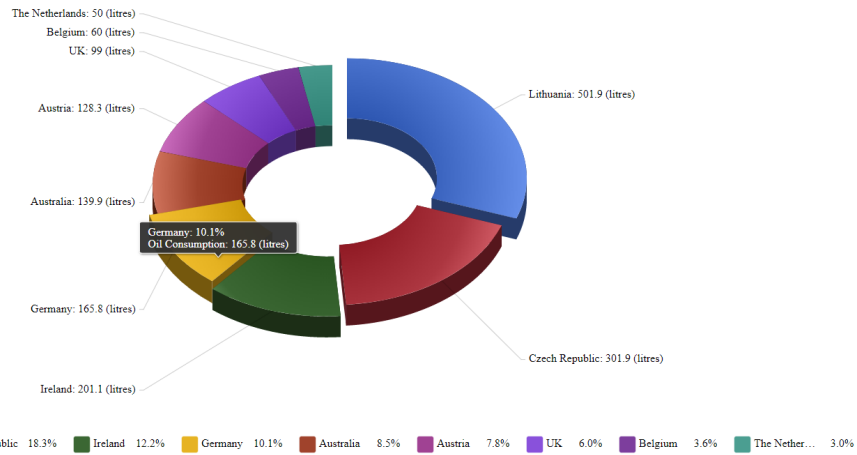


Figure 42: Pie Chart 3D

A Pie Chart (Figures 26-27, for 2D and 3D respectively) is used to represent data series as part of the whole. Each slice in a pie chart represents a data item proportionally to the sum of all the items in the series.

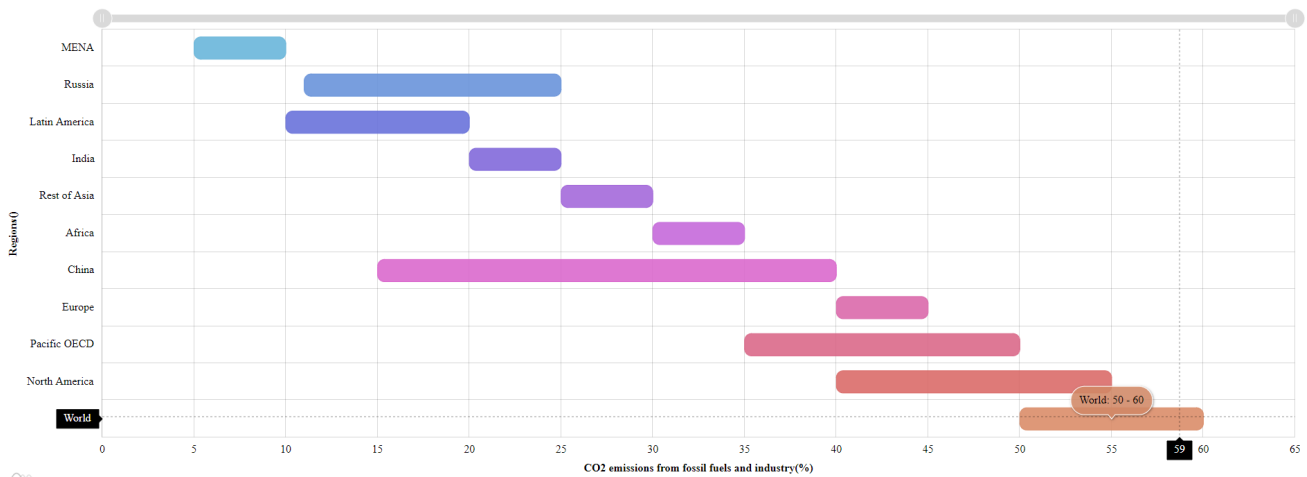


Figure 43: Bar Range Chart

A Bar Range Chart (Figure 28) is a variation of a column chart with a horizontal (time-based when it implements a Gantt diagram) axis and bars starting at arbitrary values rather than on the axis.

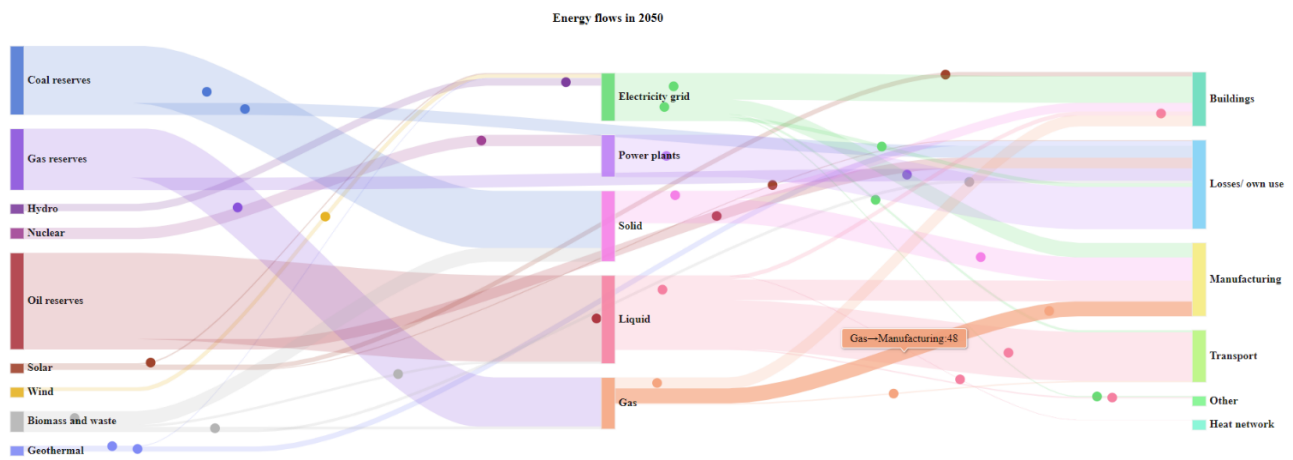


Figure 44: Sankey Diagram

A Sankey Diagram (Figure 29) is an ideal chart to show the flow and relation between stages of a process. It can



be used for building pathways and roadmaps.

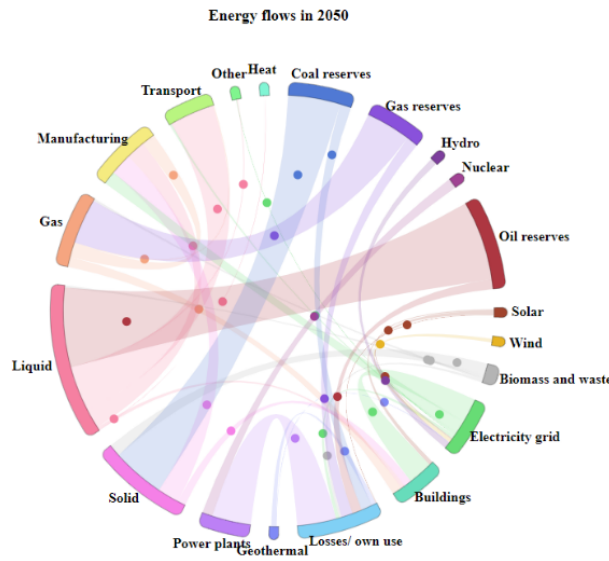


Figure 45: Chord Diagram

Chord Diagrams (also known as Radial network diagram, Chord layout, Dependency wheel) facilitate the visualised representation of relationships between data arranged beautifully in a circle (Figure 30).

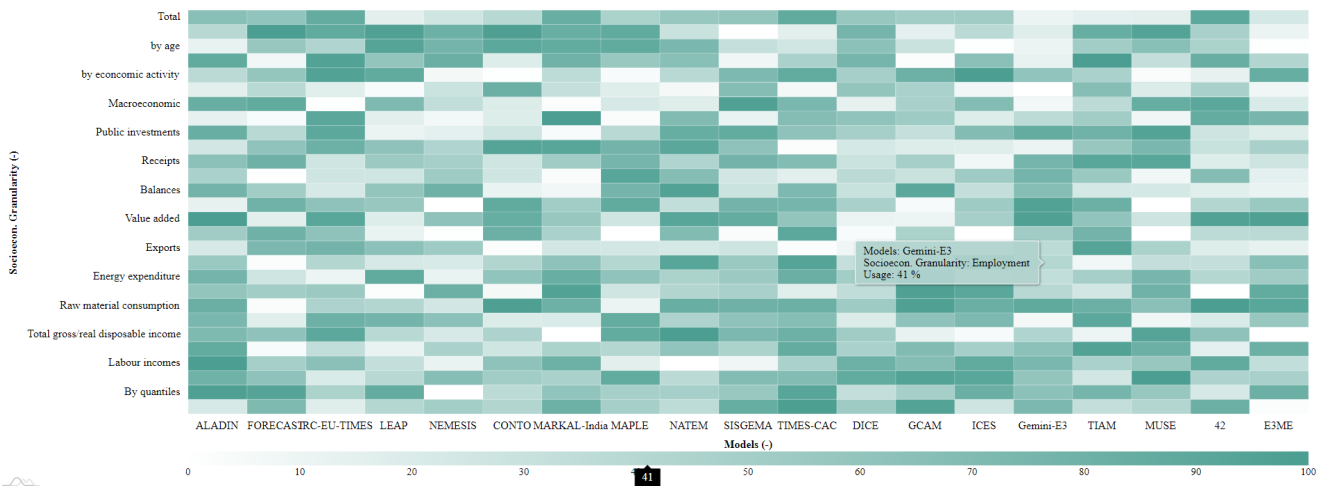


Figure 46: Heatmap Chart (2D Histogram)

Heatmaps (also known as 2D Histograms, Heat tables, Shading matrices) represent data in a rectangular matrix where individual values are differentiated by colour according to a heatmap legend (Figure 31).

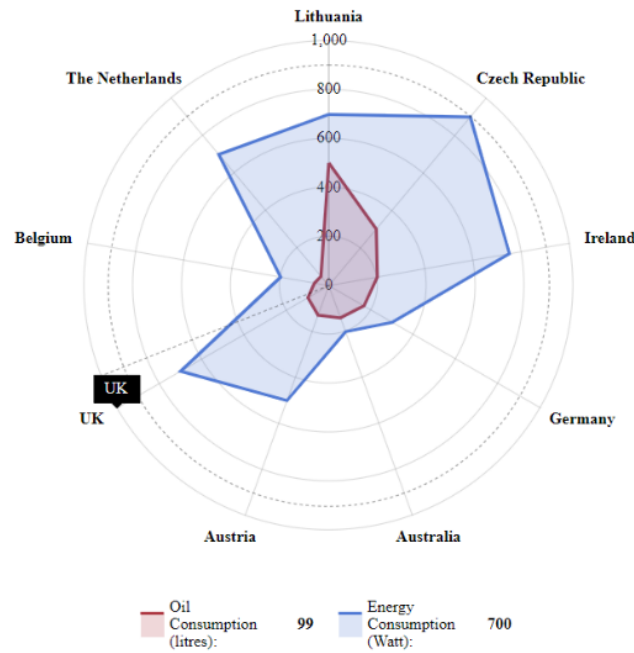


Figure 47: Radar Chart

A Radar Chart (Figure 32) is used to display directional or circular visual representation of a 2-dimensional data and is useful for either comparing and contrasting different instances of one physical quantity or as a visual aid for describing different aspects of a chosen unit.

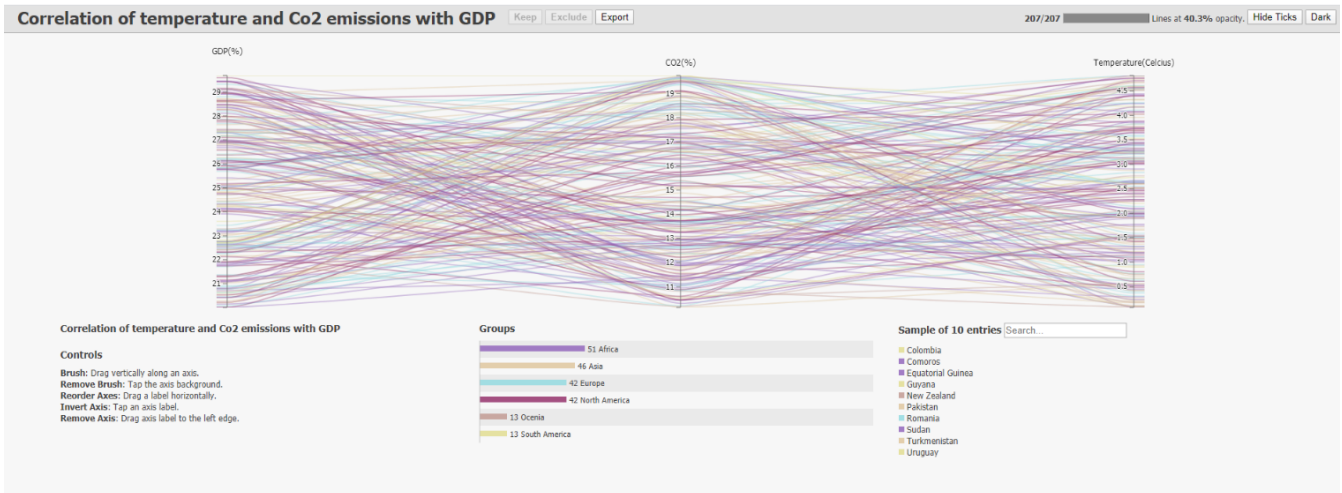


Figure 48: Parallel Coordinates Chart

Parallel Coordinates (Figure 33) are a common way of visualising high-dimensional geometry and analysing multivariate data, and facilitate the comparison among the features of several individual observations on a set of numeric variables. Each vertical axis represents a variable and often has its own scale; the units can even be different. Values are then plotted as series of lines connected across each axis. Showing all data can be confusing sometimes, and that is why the user can choose specific values to be visualised as well as limit output of the visualisation according to a selected range for each axis.



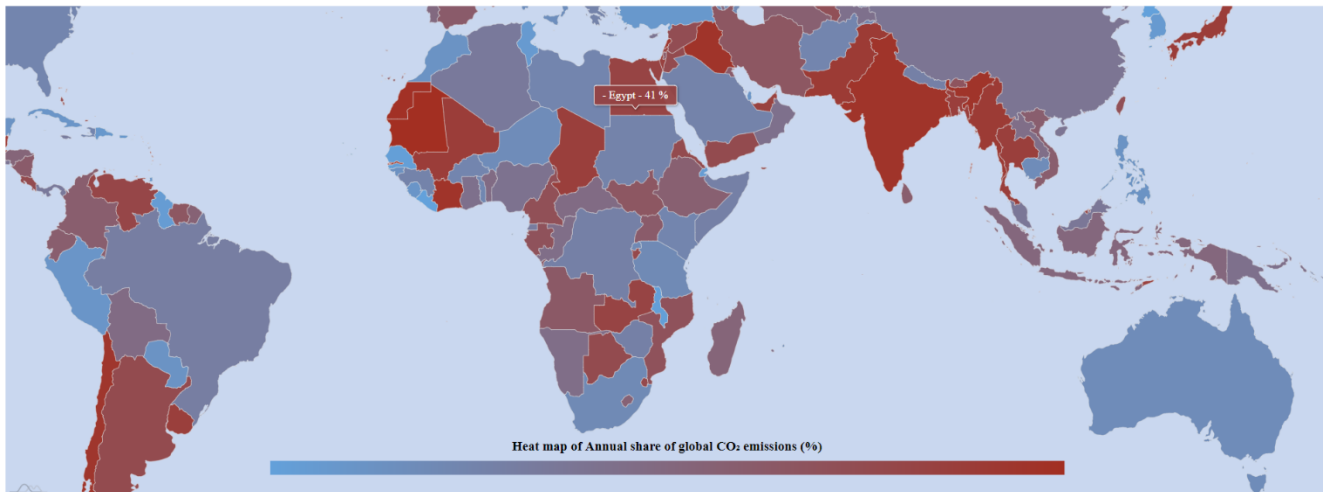


Figure 49: Heatmap

Heatmaps (on an actual map) are used for presenting the value of a selected variable on the map using colours that correspond to specific values according to a given heatmap legend (Figure 34).

All of the presented visualisations are interactive diagrams that allow seeing the desired information by utilising tooltips that pop up when the user hovers over specific elements of a chart, offering zoom-in and zoom-out functionality as well as the ability to enable or disable selected categories on a diagram or temporarily remove selected values or entire series from it, in order to clear up the results of the visualisation. In some cases, there is also animated movement in the diagrams to showcase the data flow or the exchange of information between nodes.

3 Conclusion and Future Steps

As the second version of the deliverable documenting the I²AM PARIS platform design and implementation, this report provides a documentation of the platform along with a description of its available services, including the Dynamic Model Documentation, the Detailed Model Documentation, the Overview and Comparative Assessment, the Modelling Results Demonstration, and the Variable Harmonisation Heatmap services. A thorough description of the I²AM PARIS architecture is also included, comprising the implemented core components of the platform: the I²AM PARIS Backend, the Parsers, the Data Manager, and the Visualiser.

As far as the documentation section of the platform is concerned, the Detailed Model Documentation offers a detailed and extended presentation of the characteristics of every available model involved in the PARIS REINFORCE initiative and is currently being enriched with models from modelling teams outside the PARIS REINFORCE consortium. The Overview and Comparative Assessment is useful for comparing and contrasting the models available in PARIS REINFORCE, thus gaining significant insight into their coverage and fields of application. The Dynamic Model Documentation is a single-page application that allows going through all the important features of each model utilising the visual aids of a map to define its geographical coverage as well as several icons that correspond to specific characteristics (e.g. policy, socioeconomic, technology and SDG coverage). Last but not least, the On-Demand Variable Harmonisation Heatmap service allows the creation of a two-dimensional histogram that indicates how variables are handled across a list of selected models.

The modelling results are demonstrated in different workspaces divided in four subsections: “Where are we headed?” (Advanced scientific module) - a scientific interface consisting of tools that facilitate data exploring and visualisation; “Cool...what does this mean?” - a user-friendly not strictly scientific interface that presents the conclusions drawn by the analysis; “Variable Harmonisation Heatmap” – a workspace-oriented effort to showcase the management of different variables across the models of the workspace; and “Virtual Library” – a content-based section containing documents like publications, policy briefs, data files and sources, etc. pertinent to the workspace. Currently, one workspace is available, the “PARIS REINFORCE Workspace”, but new workspaces are currently underway.

Architecture-wise, these services require data that are extracted from files (following defined templates) shared by partners and external contributors, utilising three different implemented data parsers, and are stored in the I²AM PARIS database. The I²AM PARIS Backend holds the data models used for the representation of the data in a structured and machine-friendly way and manages the interaction among all components. The Data Manager, responsible for query execution and data transformation, and the Visualiser, a chart generator, constitute the Visualisation Engine that aims at producing all the necessary visualisations for the I²AM PARIS platform, including both static and interactive interfaces commonly agreed among the involved partners and stakeholders, promoting co-creation and collaborative thinking, with a view to developing exploitable tools for both scientists and different types of stakeholder groups, like policymakers, citizens, etc.

The final version of this document, D2.6, will update the content of the current deliverable, by providing an exhaustive account of potential updates to the components and features covered in D2.5, as well as by describing in detail any advancements associated with the I²AM PARIS platform by the end of the project, including but not limited to:

- An interface that will allow users to directly import/upload new models for the Detailed and Dynamic Model Documentation in the database. An open call, with a dedicated template (and an example), has already been included and scientists can e-mail it filled in as early as of May 2020.
- A scientific interface that will allow manual uploading of data using CSV files, etc.



- Extension of the modelling analysis results workspaces list, integrating more modelling results in the database and producing the respective interfaces.
- Possibly, additional commonly agreed interfaces (or visualisations) for presenting the model analysis results.
- Performance improvements, data curation, and bug fixing.

The platform, as of May 16, 2021, counts 3,210 visits (1,071 unique visitors), with a bounce rate of 43.89% (as reported by Google Analytics).

