IAM COMPACT

Expanding Integrated Assessment Modelling: Comprehensive and Comprehensible Science for Sustainable, Co-Created Climate Action

D4.2 - From policy needs to scenario frameworks - Update

WP4 – Modelling – Quantitative evidence in support of post-2030 Paris-compliant climate action

26/09/2024

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Grant Agreement Number	101056306	**Acronym**	IAM COMPACT
Full Title	Expanding Integrated Assessment Modelling: Comprehensive and Comprehensible Science for Sustainable, Co-Created Climate Action		
Topic	HORIZON-CL5-2021-D1-01-04		
Funding scheme	HORIZON EUROPE, RIA – Research and Innovation Action		
Start Date	September 2022	**Duration**	36 Months
Project URL	https://www.iam-compact.eu		
EU Project Advisor	Andreas Palialexis		
Project Coordinator	National Technical University of Athens – NTUA		
Deliverable	D4.2 – From policy needs to scenario frameworks - Update		
Work Package	WP4 – Modelling – Quantitative evidence in support of post-2030 Paris-compliant climate action		
Date of Delivery	**Contractual** 30/09/2024	**Actual**	26/09/2024
Nature	Report	**Dissemination Level**	Public (PU)
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Keywords	Climate policies; Integrated Assessment Models; Policy Catalogue; Policy types; Mitigation policies; Synergies & Trade-offs		

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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 to be used as a reference document for the categorisation of policy needs according to policy types and impacts on SDGs and for the translation of these policy needs into scenario frameworks in the context of the IAM COMPACT project. The deliverable will provide guidance to modelling teams—inside and outside the project—on how to cluster complex mitigation policy needs and how to address them from a modelling perspective.

3. Short summary of results (<250 words)

This report is a follow-up to and update of D4.1; it therefore shares the same approach, by processing the policy needs identified during the realisation of the IAM COMPACT project with the aim of translating them into scenario frameworks. This deliverable also provides a first robust version of the policy catalogue (MS9) in which all 1st PRM cycle policy needs are categorised.

It begins with an update of the mapping of modelling capabilities (in the form of heatmaps) carried out by surveying the modelling teams. This information is helpful for associating policy needs and questions to the most suitable models. This is followed by an overview of the modelling work conducted during the 1st PRM cycle—both in setting it up and in the implementation of the studies. It also addresses the new policy needs in the framework of the second modelling cycle, encompassing pending tasks, new policy assumptions and a second package of research questions from policymakers.

Finally, all information gathered during D4.1 and this report itself are used to build the policy catalogue in a three-step process: first, a classification of the modelled policies according to their geographical scope and associated policy type and/or instrument; second, a linkage between policy types and the project's set of IAMs; and, third, also based on the literature, a connection between policy types and their impacts on the SDGs, divided into synergies and trade-offs. This analysis has been applied to the policy needs of both the 1st and 2nd PRM cycle.

4. Evidence of accomplishment

This report.

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Preface

IAM COMPACT supports the assessment of global climate goals, progress, and feasibility space, and the design of the next round of Nationally Determined Contributions (NDCs) and policy planning beyond 2030 for major emitters and non-high-income countries. It uses a diverse ensemble of models, tools, and insights from social and political sciences and operations research, integrating bodies of knowledge to co-create the research process and enhance transparency, robustness, and policy relevance. It explores the role of structural changes in major emitting sectors and of political, behaviour, and social aspects in mitigation, quantifies factors promoting or hindering climate neutrality, and accounts for extreme scenarios, to deliver a range of global and national pathways that are environmentally effective, viable, feasible, and desirable. In doing so, it fully accounts for COVID-19 impacts and recovery strategies and aligns climate action with broader sustainability goals, while developing technical capacity and promoting ownership in non-high-income countries.

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Executive Summary

This report serves as an update to Deliverable D4.1, with the aim of maximising the usefulness of classifying policies and translating them into scenario frameworks for models to explore methods that were developed during the 1st PRM cycle and yet less advanced at the time due to time constraints. A key feature of this deliverable is the production of the first robust version of the policy catalogue (see Milestone MS9), which categorises all policy needs identified during the entire first modelling cycle and so far during the current, second cycle.

In order to consolidate the policy clustering method presented in D4.1, the method is detailed again in Section 1.2, along with one of the gaps of that first version, such as the impacts of mitigation policies on the SDGs, their synergies and trade-offs, for which it has been necessary to carry out a thorough literature review, mainly based on the IPCC reports and the body of literature on the topic.

Section 2 covers the update of the heatmaps introduced in D4.1 with information from the modelling capabilities of the consortium's IAMs, showing which sustainability and mitigation policy measures and instruments can be represented by each IAM, either directly or by proxy. These tables, to be also uploaded to the I²AM PARIS online platform, are essential information for the policy catalogue. Section 3 focuses on all the modelling work that has taken place in IAM COMPACT, starting with the immediate aftermath of the previous deliverable, which details how the first policy questions were transformed into modelling studies along with other issues outlined in the project's Grant Agreement. The modelling studies of the 1st PRM cycle are then detailed one by one, including a brief summary, the IAMs used in each and a list of the policies modelled. The 2nd PRM cycle also starts to be addressed to the extent possible—given the timing—by analysing the "raw" list of policy questions as well as some updates of policy assumptions for the broad scenario logic and the pending policy issues that need to be captured in this new stage of the project.

Sections 4-5 document the policy catalogue based on the three-step approach introduced before. Here, the lists of policies from Section 3 are categorised according to their geographical coverage and the policy types and instruments they most closely resemble. They are further associated with the IAMs that can represent them (in an effort to target the studies with the models that can be most helpful) and finally the policies are linked to the SDGs they affect, indicating whether it is a positive, negative, or mixed impact.

The policy catalogue is open to be expanded and/or improved in the future before its submission (Month 32). It will also be uploaded onto the I²AM PARIS online platform.

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Abbreviations

Acronyms	Meaning
AFOLU	Agriculture, Forestry and Other Land Use
BECCS	Bioenergy with Carbon Capture and Storage
CBAM	Carbon Border Adjustment Mechanism
CCS	Carbon Capture & Storage
CCU	Carbon Capture & Utilisation
CDR	Carbon Dioxide Removal
CP	Current Policies
CN	Carbon Neutrality
CNG	Compressed Natural Gas
CSP	Concentrated Solar Power
CWGs	Core Working Groups
D	Deliverable
DAC	Direct Air Capture
DACCS	Direct Air Capture with Carbon Storage
EU	European Union
EV	Electric Vehicle
GDPpc	Gross Domestic Product per capita
GHG	Greenhouse Gas
I/O	Input-Output
IAMs	Integrated Assessment Models
LNG	Liquated Natural Gas
LTT	Long Term Targets
LULUCF	Land Uses, Land Use Changes & Forestry
MS	Milestone
NDC	National Determined Contribution
NECPs	National Energy and Climate Plans
NETs	Negative Emissions Technologies
PRM	Policy Response Mechanism
PV	Photovoltaic
RRF	Recovery & Resilience Facility
R&D&I	Research & Development & Innovation
SDG	Sustainable Development Goal
SMAA	Stochastic Multicriteria Acceptability Analysis
TRIMs	Trade Related Investment Measures
WACC	Weighted Average Cost of Capital

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1 Introduction & Background

Work Package 4 (WP4) "Modelling – Quantitative evidence in support of post-2030 Paris-compliant climate action", of which Deliverable 4.2 (D4.2) is part, intends to anticipate post-2030 policy consequences by modelling them and taking into account diverse transition risks, technological development trends, investment requirements, or mitigation effects of the key economic sectors. Deliverable 4.2 is part of Task 4.1 (T4.1), with the main objective to enhance comprehension of climate and sustainability policies, identify policy needs, and their representation in Integrated Assessment Models (IAMs), resulting in guidelines for representing policies and building scenario frameworks that will be used within the project.

As explained in **Section 1.2** below, the first steps of this task were reported in *Deliverable 4.1 "Policies that can be addressed by IAM COMPACT models"*, setting the pillars for the remaining tasks of WP4 and serving as a basis for D4.2, which finalises with the main output of T4.1: a policy catalogue that categorises the policy needs of IAM COMPACT.

1.1 Purpose and Structure of Deliverable 4.2

The current section aims to comment the main activities to be undertaken through this document as well as their corresponding objectives. It also addresses the structure to be followed, briefly describing each section and subsection.

1.1.1 Purpose

This document, entitled *Deliverable 4.2 "From policy needs to scenario frameworks – Update"*, as its name implies, is an up-to-date version of the first report under *Task 4.1 "Understanding policies, policy needs, and their representation in modelling tools"*. With the development of this update, we aim to achieve several goals required for the progress of the project. These objectives are listed and briefly explained below:

- **Creation of a policy catalogue**: A policy catalogue is one of the Milestones of the project (MS9, by Month 32) and is mainly developed under this deliverable. This portfolio aims at clustering the policy types used in the IAM COMPACT project according to the categories identified in D4.1, emphasising on synergies and trade-offs between them and linking the policy types to the IAM COMPACT models that best represent them. This way, it seeks to achieve the linking of interrelated policies in order to optimise the modelling of the 2nd Policy Response Mechanism (PRM) cycle studies and, at the same time, simplify the identification of which models are most appropriate in each case.

  Since the project and the activities of the 2nd PRM will continue after the submission of D4.2, the result of this deliverable could be just a draft, but very similar to the definitive version, which might be enriched with some additional key policy requirements or pilot country policies.

- **Fill the gaps and strengthen the work done in D4.1**: As further explained in **Section 1.2**, D4.1 was carried out in the early stages of the project, leading to a lack of some necessary information (e.g. complete list of policy questions) as well as an overall approach to the evolution of the project (e.g., well-defined distribution among different studies). In this update, we intend to complete those outstanding tasks taken place during the 1st PRM that have continued since the delivery date of D4.1. and use all the acquired knowledge to improve the previous work (serving for the 2nd PRM) by combining it within D4.2. Some of the pending topics now addressed are:

  1. Improvement-expansion of the heatmaps (from **Table** 3 to **Table** 6 in **Section 2**).
  2. Definitive list of the policy questions from the 1st PRM cycle and collection of the new policy questions for the 2nd PRM cycle (**Section 3.3.2**).
  3. Application of the method from D4.1 (guidelines) in the 1st PRM cycle (**Section 4**).

4. Preliminary application of the method on the policy needs of the 2nd PRM cycle (**Section 5**).

- **Provide a brief summary of the policy representation work carried out in the framework of the IAM COMPACT project**: One of the functions of this task is to serve as a common basis for the policy-based modelling done in this project. **Section 3** therefore presents a small wrap-up of the policy-based modelling done so far, first briefly detailing the 1st PRM cycle studies and how the method of D4.1 is applied, and then recapping the most relevant policy needs used along the project, introducing an initial list collected for the 2nd PRM cycle.
- **Start with the analysis of the policy questions for the 2nd PRM cycle**: As done for the 1st PRM cycle (detailed in **Section 3.1**), this report includes the first steps to turn stakeholders' policy concerns into topics for the studies and understanding their representation in IAM COMPACT models (application of the methodology defined). The depth of this activity has been dependent on the short time available to classify the new policy questions, so the topics and groups presented here are preliminary and could be modified during the development of the project.

1.1.2 Structure

Following the goals set out above, this deliverable has been structured in 7 different sections following a common thread to make it coherent. From Section 1, in which the goals and background are stated, to the final conclusions, going through the whole process of building the policy catalogue which will be finalised by Month 32.

- **Section 1**: This current chapter introduces the objectives of Deliverable 4.2 and the structure of the deliverable, contextualising the document in the framework of IAM COMPACT. Additionally, the exploitation and overarching objectives of the previous deliverable are detailed, with emphasis in **Subsection 1.2.1** which includes the classification method elaborated in D4.1, and in **Subsection 1.2.2** setting the basis for the analysis of synergies and trade-offs among policy types.
- **Section 2**: At the beginning of this chapter, the templates filled in for D4.1, which deal with the capabilities of the IAM COMPACT consortium models to represent policy types, are updated with feedback from the modellers and new policy types and models. Then, the Sustainable Development Goals (SDGs) are approached from two perspectives: on the one hand, in **Subsection 2.2**, the matrix of the impacts of policy types on the SDGs is introduced and detailed, whereas on the other hand, in **Subsection 2.3**, the SDGs that can be represented by the IAM COMPACT models are presented.
- **Section 3**: This chapter presents the policy needs (policy questions) modelled in the project, starting with a description of the creation process of the 1st PRM cycle studies from the policy question pool (**Subsection 3.1**) and continuing with some basic presentations of these studies along with an update on the status of the pilot country modelling activities (**Subsection 3.2**). Finally, **Subsection 3.3** undertakes the compilation and presentation of the new policy questions as well as those policy needs (or sectors) which have not been taken into consideration during the 1st PRM cycle and need to be covered in the 2nd PRM cycle. The main outcome of this section is the collection of the most relevant policies for this project, which will then be clustered and included in the policy catalogue.
- **Section 4**: This section involves the application of the methodology for clustering and assigning policy needs to models developed in D4.1, matching each subsection with the corresponding steps of the method (link of policies to policy types, IAM PROJECT models and synergies and trade-offs, in that order). The description of the process of the application of the method has been organised in the Deliverable according to the studies defined in the 1st PRM cycle.
- **Section 5**: The 2nd PRM cycle policy needs are processed in this part, using the same method and order as in the preceding section, but tailoring the outcomes to support the correct development of the second modelling round.
- **Section 6**: It presents the conclusions of the document as well as related future work and synergies

with other tasks or deliverables.

1.2 Review of the work done in Deliverable 4.1 and methodology proposed

This section explains and expands on the method of classifying policy needs that was preliminarily proposed during the development of T4.1, as new approaches and considerations have been adopted as the project has progressed.

1.2.1 Proposed Method

As detailed in the introduction to this sub-section, in "Section 6. Conclusions and future work" of D4.1, the creation of the policy catalogue was identified as the main pending activity of this Task 4.1. Therefore, the methodology and guidelines for classifying policies and models and the preliminary structure of the policy catalogue were described in D4.1 (Section 5.1.2 of D4.1 (Ferreras et al., 2023)). However, due to time constraints and the lack of definitive policy questions, the application of the method was not described in that report.

Initially, the following table (**Table 1**) was proposed to categorise policy questions (and indeed used, as will be explained in **Section 3.1**), but as the project has progressed, the structure of the catalogue and the organisation of the work has evolved to better fit the needs of the project and the difficulties of dealing with complex and multi-layered policy questions. Even though the main concept remains constant, this exercise will now be carried out and described on a study-by-study basis in which the definitive lists of policy questions were grouped, i.e. after listing the policies modelled in each study, they will be processed in packages to facilitate the tracking of information and to avoid having too long a set of policy types with too many repetitions.

Table 1. Preliminary version of the policy catalogue

Theme	Subtheme	Type	Policy sector	Subcategory of policy sector	Policy measure type	Policy instrument category	Policy instrument subcategory	Policy instrument type	Jurisdiction	Sectors of impact	SDGs
Policy question 1: XXX											
Policy question 2: XXX											

The method proposed in D4.1 is thus constituted by three steps individually reported in the three corresponding subsections of **Sections 4 and 5**, preceded by the policy needs, i.e. the list of policies modelled for the 1st PRM cycle studies and for the pilot countries (**Section 3.2**) and information about the 2nd PRM policy questions and needs from stakeholders (second cycle of workshops) not yet addressed in the project (**Section 3.3**). A scheme of the introduced method can be seen in **Figure 1**.

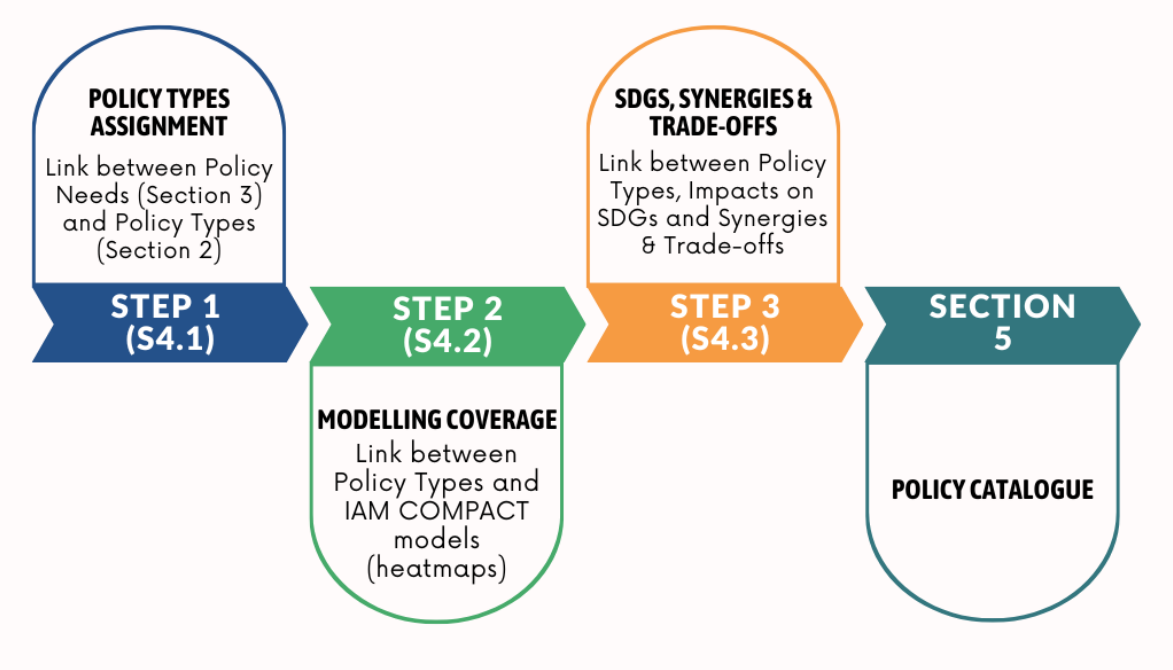

Figure 1. Method for clustering policies and producing the policy catalogue

Step 1 (**Sections 4.1 & 5.1**) begins with the list of policy questions and classifies them following their application scale and type of policy: policy measure (also called policy type), policy instrument or both (these definitions can be found in "Section 2.1. Key Terms" of D4.1). Alongside this general classification, each measure and instrument can be further sub-categorised (see Tables 9-12 of D4.1 for in-depth categories and sub-categories). This first step allows to reduce the amount of policies and to encompass them into larger and more manageable groups for the next steps that allow the matching with models. **Table 2** is the template to be used for step 1.

Table 2. Table for clustering policies

POLICIES FROM STUDIES	SCALE OF APPLICATION	POLICY TYPE	SECTOR	POLICY INSTRUMENT	INSTRUMENT CATEGORY

All policy types and instruments are reflected in Tables 13 and 14 of D4.1 (although they have been slightly updated as described in **Section 2** considering new needs as the project moved forward).

Step 2 (**Sections 4.2 & 5.2**) consists of linking the outputs of step 1 (policy questions classified into policy instruments and policy types) with the IAMs and sectoral models that are part of IAM COMPACT and are able to represent them. These links are established on the basis of the feedback from each modelling team (see Tables 15 and 16 in D4.1 for a summary of the results) and, especially, in **Section 2** of this deliverable, where these Tables have been improved and expanded according to the project needs. This useful information is harnessed to allocate potential new studies with the most suitable IAMs.

Finally, **Sections 4.3 & 5.3** presents step 3, which includes the analysis of how each policy type impacts the SDGs and the interactions generated among them. A policy type's impact can be either positive (i.e. indicating a synergy) or negative (i.e. showcasing a trade-off), making key indicators better or worse. Due to the variety of indicators within an SDG, it is even possible for a policy type to cause both synergies and trade-offs to a single goal. The outcomes produced can be used to detect which kind of policy types should be applied together to

enhance a given SDG or, vice versa, which combinations should be discarded.

The rationale behind the synergy and trade-off relationships with policy types is detailed in the next subsection.

1.2.2 Synergies and Trade-offs Insights

Mitigation policies designed to address climate change often have complex interactions with several Sustainable Development Goals (SDGs), leading to both synergies and trade-offs. Synergies arise when a mitigation policy simultaneously promotes several SDGs, such as improving air quality while reducing greenhouse gas emissions, which can benefit public health (SDG 3) and promote sustainable cities (SDG 11). Conversely, trade-offs emerge when a policy that benefits one SDG has adverse effects on another, such as when expanding renewable energy infrastructure conflicts with land use priorities, which can affect biodiversity (SDG 15) or food security (SDG 2). Understanding these dynamics is critical to designing well-balanced mitigation strategies that maximise positive outcomes across all relevant SDGs, while minimising any potential negative impacts.

One of the criteria stipulated in the Grant Agreement to be included in the policy catalogue is the impacts that the modelled policies have on the SDGs, analysing whether these constitute synergies or trade-offs. This is covered in step 3 of the method, which will allow linking policy needs with the SDGs, using the policy types as an intermediate link (not the policy instruments because there is barely any literature and establishing relationships would go beyond the scope of this task). The aim of linking policy needs and the SDGs is to analyse what synergies and trade-offs might arise when assessing a specific policy question and therefore whether we have sufficient capacities with the used models, e.g. if the trade-offs of a particular policy are related to biodiversity, are we able to analyse the complex interactions of that policy, and specifically the trade-offs that result, with the models we have?

The study of interactions between mitigation policies and the Sustainable Development Goals is a relatively recent topic that has not yet been explored very thoroughly by many authors, making it difficult to discuss with certainty. Some of the related literature that first came to light is the "Chapter 5 of the IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels" (Roy et al., 2018). This initial approach did not focus on specific measures within sectors, but on how general modifications in the sector could impact the SDGs. As a result, they produced the type of interactions (synergy, trade off, or both simultaneously) and the confidence/agreement on it according to literature.

Subsequently, the IPCC also published the "Chapter 17 of the Working Group III contribution to the Sixth Assessment Report" in which a more comprehensive analysis of the synergies and trade-offs was included, using a matrix format like the one employed in this deliverable. Here, the division of measures per sector is more specific than in the previous report and most of them coincide with the policy types collected in the second section of this document (Denton et al., 2022). However, since our list is longer and more detailed, it has been necessary to consult further literature and also to use the IAM-Compact Final Synthesis Report on sectoral barriers and enablers, which has not yet been published (IAM COMPACT MS5 - Global drivers, barriers, and policies[1]) (Bauer et al., 2023).

The Final Synthesis Report, included in Task 6.4, aims to provide a comprehensive understanding of the barriers, enablers, and trends influencing the implementation of Nationally Determined Contributions (NDCs) by examining political, social, economic, structural, technological, and individual factors across various sectors. To this end, the report synthesises existing scientific knowledge on mitigation enablers, barriers, and suitable policy options from a global perspective, relying on document analysis of past and upcoming IPCC reports and other credible sources.

[1] DOI 10.5281/zenodo.10848988

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It focuses on five key sectors: industry, energy, transport, buildings, and agriculture, forestry, and other land use (AFOLU). It should be noted that enablers and barriers do not mean the same as synergies and trade-offs even though they may be tangentially related, establishing a parallel between an enabler and a synergy and between a barrier and a trade-off (enablers are the factors that support or accelerate the development, adoption, and effectiveness of mitigation policies within a particular sector, while barriers are the factors that obstruct or slow down their implementation and effectiveness) (Bauer et al., 2023).

For particular relationships related to the sector of transport, we reviewed Beuermann et al. (2020), while for all measures related to land protection, degradation and food (some of them not directly included in the LULUCF sector, but within the behavioural spectrum) the reference has been the "Chapter 6 of the Special Report on Climate Change and Land from the IPCC" (Smith et al., 2019).

The matrix developed with the impacts of the policy types on the SDGs is presented in **Section 2.3**, with a brief explanation of some of the most significant synergies and trade-offs.

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2 Policies that can be addressed by IAM COMPACT models - Update

2.1 Heatmaps of policy types and policy instruments

This chapter aims to update and expand the work undertaken in the third section of Deliverable 4.1[2], entitled "*Policies that can be addressed by IAM COMPACT models*" and whose summary of outputs can be found in Tables 15 (policy measures) and 16 (policy instruments) of that deliverable (Ferreras et al., 2023). Both tables provide the number of measures or instruments in absolute and percentual terms included in each model, but it is also possible to view the modelling capacities individually, i.e. which specific policy types can be represented by each consortium model, in the Annex II of the same document (Tables 36 and 37). To align the nomenclature with that most commonly used in the literature, from this point onwards and throughout the deliverable, these tables will be labelled as "**heatmaps**".

For this new round, the process of collecting information has been the same as in the previous cycle, sending out two templates per model to each modelling team, one for the measures and one for the instruments, and requesting them to double-check their initial feedback in order to review (considering potential updates of the models) and even to rectify any potential mistakes, pointing out whether they have added new functionalities or removed old ones. Their way of responding has remained constant, with "Y" if it can be directly modelled and "M" if a modification or a proxy is needed.

Additionally, with the objective of broadening the scope of this analysis to make it as comprehensive and tailored to the project as possible, 30 new policy measures and instruments have been added to the original heatmaps. Most of them have been expanded, as the project developed from the modelling study needs, after detecting that some final policy questions (and their related policy types/instruments) were not reflected in the original heatmaps from D4.1.

Along with the 23 IAMs and sectoral models originally covered in D4.1, a new model – OnSSET (KTH)- has been now introduced in the framework of Task 6.5 (Expansion and development of technical and institutional capacity in pilot countries). The possibility of also considering and analysing the country-specific versions of the models currently in progress for each pilot, such as those built from OSeMOSYS (OSeMOSYS-Ukraine, OSeMOSYS-Kenya, OSeMOSYS-GR), has been discussed, but has so far been ruled out until further model development.

The heatmaps produced in this section will be displayed at the open database in the I^{2}AM PARIS platform for users to know which mitigation and sustainability measures and instruments can be represented by each IAM interactively. These will also support the 2nd PRM policy cycle by facilitating the process of matching policy questions and appropriate IAMs & sectoral models from IAM COMPACT that can represent them, e.g. during the designing of a new study on a policy topic, to know which models are the most optimal for the analysis, or which is the optimum way to group policy questions into studies (taking into account the list of models in the project). This activity is embodied in step 2 of the creation of the policy catalogue.

Table 3 and **Table** 4 present the represented policy measures while **Table 5** and **Table 6** show the modelling of policy types. New measures and instruments added to the templates are written in bold (both the names of the policy types and the links with models) and the colour code is blue for the policy types directly modelled and yellow for those with a proxy.

[2] DOI 10.5281/zenodo.10464780

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Table 3. Policy measure heatmap updated (a). New measures and instruments added to the templates are written in bold; blue shows policy types directly modelled; yellow shows those modelled with a proxy.

POLICY SECTOR	SUBCATEGORY	POLICY MEASURES	CHANCE	IMACLIM-China	GCAM	GCAM-USA	MUSE	AIM/ENDUSE-India	TIAM	CLEWs	DyNERIO	MEDEAS	WILIAM	Calliope
Buildings	Heating	Gas replacing oil / coal	Y		Y	Y	Y		Y	Y	Y	M		Y
		Biofuels			Y	Y	Y		Y	Y	Y	M		Y
		Electricity			Y	Y	Y		Y	Y	Y	M		Y
		Hydrogen			Y	Y	Y		Y	Y	**M**	M		Y
		Solar thermal					Y		Y	Y	**M**	M		Y
		Building shell efficiency			Y	Y	M		M			M		M
		Heat pumps				**Y**					**M**			**M**
	Cooling	Electricity			Y	Y	Y	Y	Y	Y	Y	M		Y
		Building shell efficiency			Y	Y	M	M	M	M		M		M
	Lighting	Efficient lighting	Y				Y	Y	Y	Y		M		Y
	Appliances	Efficient appliances					Y	Y	Y	Y		M		Y
Industry	Process Heat	Gas replacing oil / coal	Y		Y	Y	M	Y	Y	Y	Y	M	Y	Y
		Biomass			Y	Y	M	Y	Y	Y	Y	M	Y	Y
		Hydrogen			Y	Y	M	M	Y	Y		M		Y
		Electricity			Y	Y	M	Y	Y	Y	Y	M	Y	Y
	Machine drives	Gas replacing oil / coal	Y		Y	Y	M		Y	Y	Y	M	Y	Y
		Electricity			Y	Y	M		Y	Y	Y	M	Y	Y
	Steam	Gas replacing oil / coal	Y		Y	Y	M		Y	Y		M		Y
		Electricity			Y	Y	M		Y	Y		M		Y
	CHP	Gas replacing oil / coal			Y	Y	M		Y	Y		M	Y	Y
		Biomass			Y	Y	M		Y	Y		M	Y	Y
	Overall industry	Carbon Capture & Storage (CCS)		Y	Y	Y	Y	Y	Y	Y	Y		**Y**	Y
		Carbon Dioxide Removal (CDR)/			**Y**	**Y**	**Y**	Y	Y					

		Negative Emissions Technologies (NETs): Bioenergy with Carbon Capture and Storage (BECCS), Direct Air Capture with Carbon Storage (DACCS)													
		Energy Efficiency			**M**	**M**	**M[1]**				**M**		**Y**		
Agriculture & LULUCF	Agric: Energy use	Gas replacing oil / coal	Y		Y	Y	Y	Y	Y	Y	Y	M	M	Y	
		Biomass			Y	Y	Y	Y	Y	Y	Y	M	M	Y	
		Electricity			Y	Y	Y	Y	Y	Y	Y	M	M	Y	
	Agric: Land practices	Land yield maximisation			Y	Y	Y			Y			Y		
		Organic fertilizer use								Y			M		
		No tillage								Y			Y		
		Agroforestry								Y			Y		
	Agric: Animal husbandry practices	Improved feeding practices			Y	Y	Y			M					
		Manure management			Y	Y	Y						Y		
		Feed additives			M	M									
	LULUCF	Afforestation			Y	Y	Y		Y	Y			Y		
		Land protection			Y	Y				Y			Y		
		Biomaterials			Y	Y									
		Area set aside for nature (from agriculture or forestry)			Y	Y				Y			M		
Energy	Synthetic fuel production	Coal to gas with CCS					Y		Y	Y	M			Y	
		Coal to liquids with CCS			Y	Y	Y		Y	Y	M			Y	
		Gas to liquids with CCS					Y		Y	Y	M			Y	
		Biomass to liquids			Y	Y	Y		Y	Y	M			Y	
		Biomass to liquids with CCS			Y	Y	Y		Y	Y	M			Y	
		Hydrogen to gas with CCU								Y			**M**		
		Hydrogen to liquid with CCU								Y			**M**		
	Hydrogen production	Electrolysis			Y	Y	Y		Y	Y			Y	Y	
		Coal to hydrogen with CCS			Y	Y	Y		Y	Y				Y	
		Gas to hydrogen with CCS			Y	Y	Y		Y	Y			Y	Y	

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		Biomass to hydrogen with CCS			Y	Y	Y		Y	Y				Y
	Electricity generation	Coal with CCS		Y	Y	Y	Y	Y	Y	Y	Y		M	Y
		Gas with CCS		Y	Y	Y	Y	Y	Y	Y	Y		M	Y
		Nuclear fission	M		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		Nuclear fusion					Y	Y	Y	Y				Y
		Hydro	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		Biomass	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		Biomass with CCS		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y
		Geothermal	M		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		Solar PV	M		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		Solar CSP	M		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		Onshore Wind	M		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		Offshore Wind	M		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Heat generation	Coal with CCS		Y					Y	Y			Y	Y
		Gas with CCS		Y					Y	Y			Y	Y
		Oil with CCS		Y					Y	Y			Y	Y
		Geothermal							Y	Y		Y	Y	Y
		Biomass		Y	Y	Y	Y		Y	Y		Y	Y	Y
		Biomass with CCS		Y					Y	Y			Y	Y
	Energy storage	**Methanol storage**								**Y**				
		Rockbed storage												
		Power to heat & thermal storage								**Y**				**M**
		Pumped hydro					**Y**			**Y**			**Y**	**Y**
		Batteries					**Y**			**Y**			**Y**	**Y**
Transport	Road	Gas (LNG / CNG) vehicles			Y	Y	Y	Y	Y	Y	M	Y	Y	
		Hybrid electric vehicles			Y	Y	Y	Y	Y	Y	M	Y	Y	
		Fully electric vehicles			Y	Y	Y	Y	Y	Y	M	Y	Y	
		Hydrogen fuel cell vehicles			Y	Y	Y	Y	Y	Y	M		Y	
		Biofuels in fuel mix			Y	Y	Y	Y	Y	Y	M	Y	M	
		Efficiency	Y		M	M	Y	Y	Y	Y	Y	Y	Y	
		EV charging infrastructure									**M**		**Y**	

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	Rail	Electric rail			Y	Y	Y	Y	Y	M	Y	Y	Y	
		Hydrogen fuel cell rail			Y	Y	Y	Y		M				
		Efficiency	Y		M	M	Y	Y	Y	M	Y	M	Y	
	Aviation	Biofuels in fuel mix			Y	Y	Y	Y	Y	M		Y	M	
		Hydrogen planes			Y	Y	Y	Y	Y	M				
		Electric planes			Y	Y	Y	Y	Y	M				
		Efficiency	Y		M	M		Y		M		M	Y	
	Shipping	Gas (LNG / CNG)					Y	Y	Y	M		Y	Y	
		Hydrogen			Y	Y	Y	Y	Y	M				
		Biofuels in fuel mix			Y	Y	Y	Y	Y	M		Y	M	
		Electric			Y	Y		Y	Y	M		Y		
		Efficiency	Y		**M**	**M**		Y		M		M	Y	
Water	Water	Water management (efficient and saving)			Y	Y				Y			Y	
		Managing of floods/floods risk								M				
Social & Behavioural	Behavioural Consumption	Travelling less	Y		Y	Y	M	M	M	M		M	Y	
		Change mode of transport/occupancy	Y		Y	Y	M	M	M	Y		M	Y	
		Less energy service demand	Y	Y	Y	Y	M	M	M	M		M	M	
		Lower material consumption					M	M	M	M		M	M	
		Less product demand	Y	Y	Y	Y	M	M	M	M			M	
		Change of diet	M		Y	Y	M			M			Y	
		Less food waste			Y	Y	M						Y	
		Less living space per person			Y	Y	M						Y	
		Change of values					M						Y	
	Education	Climate education in schools												
		Renewal of the contents and methodologies												
	Health	Disaster risk reduction												
		Diet and Physical Activity											Y	
		Health investment											M	
	Labour	Minimum-wage policy										M		

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		Rural unemployment	M												
		Urban unemployment	M												
	Governance	Regulatory management system													
		Quality of new regulations													
Others (proposed by other modellers)	Natural resources	**Domestic and imported critical raw materials consumption**									Y				
	-	**Demand response measures**													
	-	**Additional cooling of buildings**													
	-	**Technology adoption & Diffusion model**													

[1] exogenously applied

Table 4. Policy measure heatmap updated (b). New measures and instruments added to the templates are written in bold; blue shows policy types directly modelled; yellow shows those modelled with a proxy.

POLICY SECTOR	SUBCATEGORY	POLICY MEASURES	China-MAPLE	EnergyPLAN	EXPANSE	MENA-EDS	OSeMOSYS	PROMETHEUS	DREEM (TEEM)	ATOM (TEEM)	WISEE-EDM Industry EU	WISEE-EDM global steel	WTMBT	OnSSET
Buildings	Heating	Gas replacing oil / coal	Y	Y		Y	Y	Y	Y				Y	
		Biofuels	Y	Y		Y	Y	Y	Y				Y	
		Electricity	Y	Y	M	Y	Y	Y	Y	Y			Y	**Y**
		Hydrogen	Y	Y		Y	Y	Y	Y					
		Solar thermal	Y	Y			Y		Y					
		Building shell efficiency		M		Y		Y	Y					
		Heat pumps				**Y**		**Y**	**Y**					
	Cooling	Electricity	Y	Y	M	Y	Y	Y	Y				Y	**Y**
		Building shell efficiency		M		Y	M	Y	Y				Y	
	Lighting	Efficient lighting	Y	M		Y	Y	Y	Y				Y	
	Appliances	Efficient appliances	Y	M		Y	Y	Y	Y				Y	
Industry	Process Heat	Gas replacing oil / coal	Y	Y		Y	Y	Y			Y	Y[1]	Y	
		Biomass	Y	Y		Y	Y	Y			Y	Y[1]	Y	
		Hydrogen	Y	Y		Y	Y	Y			Y	Y[1]		
		Electricity	Y	Y	M	Y	Y	Y			Y	Y[1]	Y	**Y**
	Machine drives	Gas replacing oil / coal	Y			Y	Y	Y					Y	
		Electricity	Y		M	Y	Y	Y			Y		Y	**Y**
	Steam	Gas replacing oil / coal	Y			Y	Y	Y			Y			
		Electricity	Y		M	Y	Y	Y			Y			
	CHP	Gas replacing oil / coal	Y	M		Y	Y	Y			Y			
		Biomass	Y	M		Y	Y	Y			Y			
	Overall industry	CCS	Y	Y		Y	Y	Y			Y	Y*		

		CDR/NETs (BECCS, DACCS)	Y								M	M		
		Energy Efficiency				**Y**		**Y**						
Agriculture & LULUCF	Agric: Energy use	Gas replacing oil / coal	Y	Y		Y	Y	Y						
		Biomass	Y	Y		Y	Y	Y						
		Electricity	Y	Y		Y	Y	Y						
	Agric: Land practices	Land yield maximisation					Y							
		Organic fertilizer use					Y							
		No tillage					Y							
		Agroforestry					Y							
	Agric: Animal husbandry practices	Improved feeding practices					M							
		Manure management												
		Feed additives												
	LULUCF	Afforestation					Y							
		Land protection					Y							
		Biomaterials												
		Area set aside for nature (from agriculture or forestry)					Y							
Energy	Synthetic fuel production	Coal to gas with CCS	Y			Y	Y	Y					M	
		Coal to liquids with CCS	Y			Y	Y	Y					M	
		Gas to liquids with CCS	Y	Y		Y	Y	Y					M	
		Biomass to liquids	Y	Y		Y	Y	Y					M	
		Biomass to liquids with CCS	Y	Y		Y	Y	Y					M	
		Hydrogen to gas with CCU		Y			Y							
		Hydrogen to liquid with CCU		Y			Y							
	Hydrogen production	Electrolysis	Y	Y	M	Y	Y	Y						
		Coal to hydrogen with CCS	Y			Y	Y	Y						
		Gas to hydrogen with CCS	Y			Y	Y	Y						
		Biomass to hydrogen with CCS	Y	Y		Y	Y	Y						

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	Electricity generation	Coal with CCS	Y	Y	Y	Y	Y	Y					Y	
		Gas with CCS	Y	Y	Y	Y	Y	Y					Y	
		Nuclear fission	Y	Y	Y	Y	Y	Y					Y	
		Nuclear fusion	Y				Y							
		Hydro	Y	Y	Y	Y	Y	Y					Y	
		Biomass	Y	Y	Y	Y	Y	Y					Y	
		Biomass with CCS	Y	Y		Y	Y	Y					Y	
		Geothermal	Y	Y	Y		Y						Y	
		Solar PV	Y	Y	Y	Y	Y	Y		Y			Y	**Y**
		Solar CSP	Y	Y		Y	Y	Y					Y	**Y**
		Onshore Wind	Y	Y	Y	Y	Y	Y					Y	**Y**
		Offshore Wind	Y	Y	Y	Y	Y	Y					Y	
	Heat generation	Coal with CCS	Y	Y		Y	Y	Y						
		Gas with CCS	Y	Y		Y	Y	Y						
		Oil with CCS	Y	Y			Y							
		Geothermal	Y	Y			Y							
		Biomass	Y	Y		Y	Y	Y						
		Biomass with CCS	Y	Y		Y	Y	Y						
	Energy storage	**Methanol storage**					**Y**							
		Rockbed storage												
		Power to heat & thermal storage					**Y**							
		Pumped hydro					**Y**							
		Batteries					**Y**							**Y**
Transport	Road	Gas (LNG / CNG) vehicles	Y	M			Y						M	
		Hybrid electric vehicles	Y	M		Y	Y	Y					M	
		Fully electric vehicles	Y	M	M	Y	Y	Y					M	
		Hydrogen fuel cell vehicles	Y	M		Y	Y	Y					M	
		Biofuels in fuel mix	Y	M		Y	Y	Y					M	
		Efficiency	Y	M		Y	Y	Y					Y	
		EV charging												

		infrastructure												
	Rail	Electric rail	Y	M	M	Y	M	Y					Y	
		Hydrogen fuel cell rail		M		Y	M							
		Efficiency	Y	M		Y	M						Y	
	Aviation	Biofuels in fuel mix	Y	M		Y	M	Y						
		Hydrogen planes	Y	M		Y	M	Y						
		Electric planes		M		Y	M							
		Efficiency	Y	M		Y	M	Y						
	Shipping	Gas (LNG / CNG)	Y	M		Y	M	Y						
		Hydrogen	Y	M		Y	M	Y						
		Biofuels in fuel mix	Y	M		Y	M	Y						
		Electric	Y	M		Y	M							
		Efficiency	Y	M		Y	M	Y						
Water	Water	Water management (efficient and saving)					Y							
		Managing of floods/floods risk					M							
Social & Behavioural	Behavioural Consumption	Travelling less				Y	M	Y					M	
		Change mode of transport/occupancy	Y			Y	Y	Y					M	
		Less energy service demand	Y			Y	M	Y	Y				M	
		Lower material consumption				Y	M	Y	M					
		Less product demand	Y			Y	M	Y	M					
		Change of diet					M		M					
		Less food waste							M				M	
		Change of values							M	Y				
	Education	Climate education in schools							M	M				
		Renewal of the contents and methodologies												
	Health	Disaster risk reduction												
		Diet and Physical Activity							M					

		Health investment							M						
	Labour	Minimum-wage policy												Y	
		Rural unemployment													
		Urban unemployment													
	Governance	Regulatory management system													
		Quality of new regulations													
Others (proposed by other modellers)	Natural resources	**Domestic and imported critical raw materials consumption**												Y	
	-	**Demand response measures**							Y						
	-	**Additional cooling of buildings**							Y						
	-	**Technology adoption & Diffusion model**								Y					

[1]for steel only

Table 5. Policy instrument heatmap updated (a). New measures and instruments added to the templates are written in bold; blue shows policy types directly modelled; yellow shows those modelled with a proxy.

POLICY INSTRUMENT	SUBCATEGORY OF POLICY INSTRUMENT	POLICY INSTRUMENT TYPE	CHANCE	IMACLIM-China	GCAM	GCAM-USA	MUSE	AIM/ENDUSE-India	TIAM	CLEWs	DyNERIO	MEDEAS	WILIAM	Calliope
Economic & Financial Instruments	Direct Investment	Procurement rules												
		RD&D funding												
		Infrastructure investments	M		M	M				Y	Y	M	Y	
		Funds to sub-national governments												
		Climate finance tools			M	M					M			
		Equity Investment												
	Fiscal Incentives	FITs/FIPs	Y		Y	Y	M		M				Y	
		Energy taxes & Tax exemptions	Y	Y	Y	Y	M	**Y[1]**	M	M	Y		Y	
		Energy auctions												
		Grants and subsidies	Y	Y	Y	Y	Y	**Y[2]**	Y	M	Y		Y	Y
		Loans, soft loans & guarantees			M	M							Y	
		User charges			M	M	M		M					
	Market-based Instruments	GHG emissions allowance trading schemes	Y	Y	Y	Y	M		Y	Y				
		Green certificates			M	M	M		Y					
		White certificates			M	M	M							
		Carbon pricing	Y	Y	Y	Y	Y	**Y**	Y	Y	M		Y	Y
		Other certification schemes												
		Risk mitigation tools												
		Credit for captured CO_2												
Regulatory Instruments	Codes & Standards	Building codes			M	M		**M**						
		Industrial air pollution standards	Y		Y	Y	M	**M**		Y	Y			

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		Product standards					M	**M**	M		Y		M	
		Sectorial standards	Y		M	M		**M**			Y			
		Vehicle air pollution standards			Y	Y	M	**M**		Y				
		Vehicle fuel-economy and emissions standards			Y	Y	Y	**M**	Y	Y		Y	Y	
		Energy Efficiency Standards					**M[3]**	**M**		**M**			**M**	
	Targets, Quotas & Obligations	Renewable energy obligations	Y		Y	Y	M	**M**	M	**Y**	Y	Y	Y	
		Trade-Related Investment Measures (TRIMs)			**Y**	**Y**		**M**	**Y**	**Y**				
		Countervailing Duties						**M**						
		Targets for electrolyser capacity						**M**	**Y**	**Y**				
		EV sales targets					**Y**	**M**	**M**	**Y**	**M**			**M**
		Renewable electricity targets					**Y**	**M**	**Y**	**Y**	**M**			**M**
Soft Instruments	Information & Education	Information provision												
		Performance Label (comparison or endorsement)												
		Professional training and qualification												
		Advice or aid in implementation												
	Voluntary Approaches	Negotiated agreements (public-private sector)												
		Public voluntary schemes												
		Unilateral commitments (private sector)												
Barrier Removal	-	Grid access and priority for renewables										Y	Y	Y
		Net metering			M	M								M
		Removal of fossil fuel subsidies	Y	Y	M	M			Y	Y	Y			Y
		Removal of split incentives (landlord tenant problem)												

Policy Support	-	Processes, plans and strategies						M		Y				
		Subnational and citizen participation												
		MRV												
		Institutional mandates												
		International cooperation												
		Institutional creation												
Research & Development & Innovation	-	Demonstration project												
		Research programme												
Others (proposed by other modellers)	-	**Efficiency target**			Y	Y		Y	Y	M				
		Emissions target			Y	Y		Y	Y	Y				M
		Thermal regulations (e.g., ban or replacement of certain types of heating equipment)			Y	Y		M	Y	Y				
		Demand response mechanisms						M		M				
		Energy efficiency measures and retrofit packages						M		M				
		Energy poverty policies						M						
		Self-consumption schemes						M						
		Net billing												
		Zero feed-in												

[1]only Energy tax
[2]only Subsidies
[3]exogenously imposed

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Table 6. Policy instrument heatmap updated (b). New measures and instruments added to the templates are written in bold; blue shows policy types directly modelled; yellow shows those modelled with a proxy.

POLICY INSTRUMENT	SUBCATEGORY OF POLICY INSTRUMENT	POLICY INSTRUMENT TYPE	China-MAPLE	EnergyPLAN	EXPANSE	MENA-EDS	OSeMOSYS	PROMETHEUS	DREEM (TEEM)	ATOM (TEEM)	WISEE-EDM Industry EU	WISEE-EDM global steel	WTMBT	OnSSET
Economic & Financial Instruments	Direct Investment	Procurement rules									M			
		RD&D funding						Y	M		M			
		Infrastructure investments		M		M	Y	M	Y		M		Y	
		Funds to sub-national governments							Y					
		Climate finance tools				M		M					M	
		Equity Investment							**Y**	**M**				
	Fiscal Incentives	FITs/FIPs			Y	Y		Y	Y	Y				
		Energy taxes & Tax exemptions	Y	M	Y	Y	M	Y	Y	Y	M		Y	
		Energy auctions								Y			M	
		Grants and subsidies	Y		Y	Y	M	Y	Y	Y	M		Y	
		Loans, soft loans & guarantees							Y	**M**				
		User charges							Y	Y				
	Market-based Instruments	GHG emissions allowance trading schemes	Y		Y	M	Y	Y	Y	M	M		Y	
		Green certificates							M	M				
		White certificates						**M**	M	M				
		Carbon pricing	Y	M	Y	Y	Y	Y	Y	M	Y		Y	
		Other certification schemes							**M**	**M**				
		Risk mitigation tools				**M**		**M**						
		Credit for captured CO_2						**M**			**M[1]**			

Regulatory Instruments	Codes & Standards	Building codes				M		M	Y	M				
		Industrial air pollution standards					Y							Y	
		Product standards	Y											Y	
		Sectorial standards	Y					**M**						Y	
		Vehicle air pollution standards				M	Y	M							
		Vehicle fuel-economy and emissions standards	Y			M	Y	M							
		Energy Efficiency Standards				**M**	**M**	**M**	**Y**						
	Targets, Quotas & Obligations	Renewable energy obligations			Y	Y	Y	Y	Y	Y				Y	
		Trade-Related Investment Measures (TRIMs)					**Y**								
		Countervailing Duties													
		Targets for electrolyser capacity					**Y**								
		EV sales targets				**Y**	**Y**	**Y**						**M**	
		Renewable electricity targets			**Y**	**Y**	**Y**	**Y**	**Y**	**Y**				**M**	
Soft Instruments	Information & Education	Information provision						**M**	M						
		Performance Label (comparison or endorsement)						**M**	Y						
		Professional training and qualification							M						
		Advice or aid in implementation							M						
	Voluntary	Negotiated agreements													

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	Approaches	(public-private sector)													
		Public voluntary schemes													
		Unilateral commitments (private sector)				M		M							
Barrier Removal	-	Grid access and priority for renewables				M		M	M						
		Net metering							Y	Y					
		Removal of fossil fuel subsidies	Y		Y	Y	**M**	Y	Y		M		Y		
		Removal of split incentives (landlord tenant problem)							M						
Policy Support	-	Processes, plans and strategies					**Y**								
		Subnational and citizen participation							M						
		MRV							Y						
		Institutional mandates							**Y**						
		International cooperation													
		Institutional creation													
Research & Development & Innovation	-	Demonstration project							M		Y				
		Research programme						M	M						
Others (proposed by other modellers)	-	**Efficiency target**				**Y**	**M**	**Y**	**Y**						
		Emissions target		**M**	**Y**	**Y**	**Y**	**Y**	**Y**		**Y**		**M**		
		Thermal regulations (e.g., ban or replacement of certain types of heating equipment)		**M**		**Y**	**Y**	**Y**	**Y**						
		Demand response mechanisms					**M**	**M**	**Y**						
		Energy efficiency				**M**	**M**	**Y**	**Y**						

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		measures and retrofit packages													
		Energy poverty policies				**M**		**M**	**Y**						
		Self-consumption schemes							**Y**	**Y**					
		Net billing							**Y**	**Y**					
		Zero feed-in							**Y**	**Y**					

[1]using carbon pricing as a proxy

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In general terms, the models keep the same functionalities as in the 1st PRM cycle and the most relevant differences come from the new policy types aggregated to the heatmaps, e.g. energy efficiency in industry, use of heat pumps in buildings, or renewable electricity targets. It should also be noted that some of the policy instruments proposed by the modellers themselves are reflected in several of the IAMs such as thermal regulations in GCAM, CLEWs, and TIAM or efficiency and emissions targets in PROMETHEUS, EXPANSE, and OSeMOSYS.

As in the previous iteration, there are some really noticeable modelling gaps, mostly focused on the "social" and "sustainability" domains. Soft and policy support instruments are still poorly represented in the consortium's IAMs, while for the policy measures those related to education, labour, and governance are weakly addressed. This situation might not only be caused by a lack of these modelling capacities, but also by the complexity of selecting right policy types for these sectors. On the other hand, it is noteworthy that IAM COMPACT models can represent many behavioural policy measures, which is not so usual for IAMs. To sum up all the results, **Table 7** and **Table 8** present the ratio of police measures and instruments addressed by each model.

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Table 7. Share of policy measures represented by each model

Policy Types Measures								
	Buildings (11)	Industry (13)	Agriculture & LULUCF (14)	Energy (34)	Transport (19)	Water (2)	Social Behavioural (18)	Others (4)
CHANCE	18%	23%	7%	24%	21%	0%	39%	0%
IMACLIM-China	0%	8%	0%	29%	0%	0%	11%	0%
GCAM	64%	100%	79%	56%	89%	50%	33%	0%
GCAM-USA	73%	100%	79%	56%	89%	50%	33%	0%
MUSE	91%	100%	50%	71%	79%	0%	44%	0%
SLIM-India	36%	46%	21%	35%	95%	0%	28%	0%
TIAM	91%	92%	29%	79%	79%	0%	28%	0%
CLEWs	82%	85%	79%	97%	95%	100%	33%	0%
DyNERIO	64%	54%	21%	47%	47%	0%	0%	25%
MEDEAS	100%	77%	21%	29%	68%	0%	28%	0%
WILIAM	0%	69%	79%	68%	74%	50%	50%	0%
Calliope	100%	85%	21%	88%	0%	0%	0%	0%
China-MAPLE	73%	92%	21%	79%	84%	0%	17%	0%
EnergyPLAN	91%	54%	21%	71%	95%	0%	0%	0%
EXPANSE	18%	23%	0%	29%	11%	0%	0%	0%
MENA-EDS	91%	92%	21%	68%	89%	0%	28%	0%
OSeMOSYS	82%	85%	79%	97%	95%	100%	33%	0%
PROMETHEUS	91%	92%	21%	68%	68%	0%	28%	0%
DREEM (TEEM)	91%	0%	0%	0%	0%	0%	50%	50%
ATOM (TEEM)	9%	0%	0%	3%	0%	0%	11%	25%
WISEE-EDM Industry EU	0%	85%	0%	0%	0%	0%	0%	0%
WISEE-EDM global steel	0%	46%	0%	0%	0%	0%	0%	0%
WTMBT	64%	38%	0%	47%	42%	0%	28%	25%
OnSSET	18%	15%	0%	12%	0%	0%	0%	0%

Table 8. Share of policy instruments represented by each model

	Policy Instruments						
	Economic (19)	Regulatory (13)	Soft (7)	Barrier Removal (4)	Policy Support (6)	R&D&I (2)	Others (9)
CHANCE	32%	23%	0%	25%	0%	0%	0%
IMACLIM-China	21%	0%	0%	25%	0%	0%	0%
GCAM	58%	46%	0%	50%	0%	0%	33%
GCAM-USA	58%	46%	0%	50%	0%	0%	33%
MUSE	42%	62%	0%	0%	0%	0%	0%
SLIM-India	16%	100%	0%	0%	17%	0%	78%
TIAM	37%	46%	0%	25%	0%	0%	33%
CLEWs	26%	69%	0%	25%	17%	0%	56%
DyNERIO	26%	46%	0%	25%	0%	0%	0%
MEDEAS	5%	15%	0%	25%	0%	0%	0%
WILIAM	26%	15%	0%	25%	0%	0%	0%
Calliope	11%	15%	0%	75%	0%	0%	11%
China-MAPLE	21%	23%	0%	25%	0%	0%	0%
EnergyPLAN	16%	0%	0%	0%	0%	0%	22%
EXPANSE	26%	15%	0%	25%	0%	0%	11%
MENA-EDS	42%	54%	14%	50%	0%	0%	56%
OSeMOSYS	26%	69%	0%	25%	17%	0%	56%
PROMETHEUS	58%	62%	43%	50%	0%	50%	67%
DREEM (TEEM)	74%	31%	57%	100%	50%	100%	100%
ATOM (TEEM)	63%	23%	0%	25%	0%	0%	33%
WISEE-EDM Industry EU	42%	0%	0%	25%	0%	50%	11%
WISEE-EDM global steel	0%	0%	0%	0%	0%	0%	0%
WTMBT	37%	46%	0%	25%	0%	0%	11%
OnSSET	0%	0%	0%	0%	0%	0%	0%

2.2 Impacts of policy types on the SDGs

As described in **Section 1.2.2**, a literature review has been carried out to determine what the effects of the policy types presented in **Table 3** and **Table 4** are on the SDGs, whether it is a synergy, a trade-off, or both. All this work is collected in **Table 9**.

To ease the process and reduce its length, some minor tweaks to the policy measures list has been done such as the grouping of all the "synthetic fuel production" and "hydrogen production" measures in a single measure called "overall".

On the other hand, a few impacts were hard to justify because we tried to be as thorough as possible and hence included many additional policy measures not usually considered in the literature, leading to a lack of relevant sources.

Among the most impacted goals by the policy types listed, **the SDG13** (Climate Action) is one of the most relevant, as the increase of renewable and cleaner energies and fuels, e.g. geothermal and wind energy or hydrogen and electric transport, and more efficient buildings normally lead to better synergies. However, in some cases, these positive relationships can also be offset by trade-offs caused by land use changes which might promote higher emissions in the land use sector. **SDG11** (Sustainable Cities) is predominantly affected in a positive way by the application of mitigation measures in buildings, since they ensure the access to better services, and in road and rail transport thanks to the adoption of less polluting fuels.

It is also interesting to observe the implications of mitigation policies on the **SDG15** (Life on Land) as many of them generate trade-offs such as the use of biofuels, biomass, and other renewable technologies (hydro, solar…) due to the necessity of large tracts of land to supply these resources. Even some agricultural practices to achieve greater yields may cause damage to this goal, which is mainly boosted by land protection and afforestation.

As for the **SDG 9** (Industry, Innovation and Infrastructure), the uptake of newer and more efficient technologies (carbon capture, renewable technologies, hydrogen production, etc.) is logically an enabler. **SDG7** combines affordable and clean technologies, which in many mitigation cases causes both synergies and trade-off because the cost of some clean technologies exceeds that of polluting but affordable fossil fuels.

On the consumption side, **SDG12** (Responsible consumption and production) generally improves with efficiency-enhancing measures, less energy-intensive technologies and improved practices, while it worsens with resource-intensive technologies such as biofuels for transport. Furthermore, behavioural measures aimed to less demand/consumption are strongly synergetic. It is also noteworthy that, in general, the people's well-being (**SDG3,** Good health and well-being) is highly improved when applying mitigation measures through emission reductions (with some exceptions such as nuclear energy).

For social goals like **the SDGs 4** and **5** (Quality education and Gender equality), the establishment of these links is rather more difficult since it is hard to connect policies in the economic sector to social development. Nevertheless, the potential linkages are frequently positive, as such improvements are often conducive to the enhancement of social rights. Finally, two other goals that are difficult to link are **SDGs 1 and 2** (No Poverty and Zero Hunger, respectively) in which cases, and similar to SDG15, have trade-offs with technologies that require the use of land to produce energy instead of food (e.g. biomass).

Table 9. Trade-offs and synergies between mitigation options and the SDGs

POLICY SECTOR	SUBCATEGORY	POLICY MEASURES	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16
Buildings	Heating	Gas replacing oil / coal			+				+/-						+/-		+	
		Biofuels		-			+		-			-			+			
		Electricity							+/-				+	+	+/-			
		Hydrogen							+/-	-		-		-	+/-			
		Solar thermal							+	+		+/-	+	+	+			
		Building shell efficiency			+		+			+	+		+	+	+			
		Heat pumps			+		+		+				+	+	+			
	Cooling	Electricity											+/-	-	+/-			
		Building shell efficiency			+		+			+	+		+	+	+			
	Lighting	Efficient lighting							+		+			+	+			
	Appliances	Efficient appliances			+	+	+	+	+	+/-	+/-			+	+			
Industry	Process Heat	Gas replacing oil / coal			+										+/-		+	
		Biomass		-										+	+			
		Hydrogen								+/-	+	-		+/-	+/-			
		Electricity								+/-		-			+/-			
	Machine drives	Gas replacing oil / coal																
		Electricity								+/-		-			+/-			
	Steam	Gas replacing oil / coal																
		Electricity								+/-		-			+/-			
	CHP	Gas replacing oil / coal																
		Biomass		-											+			
	Overall industry	CCS			+/-			-	+/-	+	+		+	+/-	+		-	
		CDR/NETs (BECCS, DACCS…)							-	-	+	-		+/-	+			
		Energy Efficiency							+	+	+			+	+			

Agriculture & LULUCF	Agric: Energy use	Gas replacing oil / coal			+					-					+/-			
		Biomass							-					+	+			
		Electricity							+/-						+/-			
	Agric: Land practices	Land yield maximisation	+	+	+					+		+		+/-	+/-	-	+/-	
		Organic fertilizer use	+	+	+					+/-				+		+	+	
		No tillage	+	+						+					+/-	+/-	+/-	
		Agroforestry		+		+		+		+/-					+		+/-	
	Agric: Animal husbandry practices	Improved feeding practices	+	+	+/-		+	+/-	+	+	+			+/-			+	
		Manure management	+	+	+/-		+	+/-	+	+	+	+		+/-			+	
		Feed additives																
	LULUCF	Afforestation	+	-	+			+	+/-	+	+	+/-		+	+		+/-	
		Land protection		+/-											+	+	+	
		Biomaterials																
		Area set aside for nature (from agriculture or forestry)		+/-											+	+	+	
Energy	Synthetic fuel production	Overall		-	+/-				+/-	+	+		+	+/-	+/-			
	Hydrogen production	Overall			+				+/-	+	+			+/-	+			
	Electricity generation	Coal with CCS			-			+/-	+	-	+							
		Gas with CCS			-			+/-	+	-	+							
		Nuclear fission			-			-	+	+	+/-			-	+/-	+/-	-	
		Nuclear fusion			-			-	+	+	+/-			-	+/-	+/-	-	
		Hydro		+/-	+			+	+	+/-		+/-			+/-	-		
		Biomass	+	-	+/-			-	+/-	+	+			+	+/-	-	-	
		Biomass with CCS	-	-														
		Geothermal	+		+/-			-	+	-	+		+		+	-	+/-	
		Solar PV	+	+/-	+			+	+	+	+		+		+		+/-	
		Solar CSP		+/-	+			-	+	+	+				+		+/-	

		Onshore Wind	+	+/-	+			+	+	+	+		+/-		+		+/-	
		Offshore Wind			-			-	+	+	+/-			-	+/-	+/-	-	
	Heat generation	Coal with CCS			-			+/-	+	-	+							
		Gas with CCS			-			+/-	+	-	+							
		Oil with CCS			-			+/-	+	-	+							
		Geothermal	+		+/-			-	+	-	+		+		+	-	+/-	
		Biomass	+	-	+/-			-	+/-	+	+			+	+/-	-	-	
		Biomass with CCS	-	-														
	Energy storage	Methanol storage						-	+/-					+	+			
		Rockbed storage							+		-				+		-	
		Power to heat & thermal storage			+				+				+/-		+			
		Pumped hydro						-	+		+/-				+		-	
		Batteries						-	+			-	+				-	
Transport	Road	Gas (LNG / CNG) vehicles			+										+			
		Hybrid electric vehicles			+								+		+			
		Fully electric vehicles			+				+				+		+			
		Hydrogen fuel cell vehicles			+								+		+			
		Biofuels in fuel mix	-	-										-			-	
		Efficiency			+								+		+			
		EV charging infrastructure			+								+					
	Rail	Electric rail			+								+		+			
		Hydrogen fuel cell rail			+								+		+			
		Efficiency			+								+		+			
	Aviation	Biofuels in fuel mix	-	-										-			-	
		Hydrogen planes			+										+			
		Electric planes			+										+			
		Efficiency			+										+			
	Shipping	Gas (LNG / CNG)																

		Hydrogen													+			
		Biofuels in fuel mix	-	-										-			-	
		Electric													+			
		Efficiency													+			
Water	Water	Water management (efficient and saving)						+		-		-			+			
		Managing of floods/floods risk										+/-	+		+			-
Social & Behavioural	Behavioural Consumption	Travelling less	+/-	-	+	+/-	+	+	+	-	-	+	+	+	+			
		Change mode of transport/occupancy					+		+	+/-	+	+	+	+	+			
		Less energy service demand	-	-	+			+	+	-	-	+	+	+	+	+	+	
		Lower material consumption	-	-	+			+	+	-	-	+	+	+	+	+	+	
		Less product demand	-	-	+			+	+	-	-	+	+	+	+	+	+	
		Change of diet	-	+	+			+	-	+		+	+	+	+		+	
		Less food waste	+	+	-		-	+	+	+	+		+	+	+		+	
		Change of values																
	Education	Climate education in schools	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
		Renewal of the contents and methodologies	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
	Health	Disaster risk reduction			+													
		Diet and Physical Activity			+													
		Health investment			+													
	Labour	Minimum-wage policy	+	+	+	+	+		-	+	-	+	+/-	-	+/-			
		Rural unemployment	+	+	+	+	+		-	+	-	+	+/-	-	+/-			
		Urban unemployment	+	+	+	+	+		-	+	-	+	+/-	-	+/-			
	Governance	Regulatory management system								-	-			+	+			+

		Quality of new regulations							-	-	+/-			+			+
Natural Resources		Domestic and imported critical raw materials consumption						+	+/-	+			+	+/-	+/-		
			SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16

2.3 Sustainable Development Goals in IAM COMPACT models

The results of the analysis of modelling capabilities of the IAM COMPACT consortium models performed during the 1st PRM cycle were separated into two different files, D4.1 and D5.8 "*Climate action in the sustainability spectrum*"[3], the latter only including the representation of the SDGs (Ferreras et al., 2023; Frilingou, Keppo, et al., 2024). In order to have a joint picture of all modelling capabilities in a single document, the SDG coverage is presented here as well, albeit in a less comprehensive version (Tables 22-41 of D5.8 specifically indicate the SDG indicators represented by each IAM).

It is challenging to determine whether a model actually tracks or quantifies an SDG due to the wide variety of indicators, both in number and format, as it may model a given variable related to one indicator without addressing any of the rest in a list of more than 10, which could skew an objective analysis of modelling capabilities. Bearing this in mind, it is noteworthy that those SDGs for which an IAM has at least one variable related to a proposed indicator have been marked as represented in **Table 10**, but for a more in-depth view it is recommended to consult D5.8.

Like in the previous tables, Y means that the model contains a specific variable to track the SDG and M is for modellable SDGs with a modification or proxy. WILIAM and GCAM are the models that capture the largest number of the SDGs (a broad spectrum of 11 each), and SDGs 7 (affordable energy), 9 (industry) and 13 (climate action) are found to be the most widely represented, which is consistent since most IAMs are highly focus on the areas of energy, economy and climate. On the contrary, social and well-being SDGs tend to be under-represented. A detailed description of SDGs in IAM COMPACT models can be found in D5.8.

[3] DOI 10.5281/zenodo.12649184

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Table 10. Coverage of SDGs by IAM COMPACT consortium models. Y (in blue) means that the model contains a specific indicator for the SDG, while M (in yellow) is for those that represent indicators with a proxy.

	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 14	SDG 15	SDG 16	SDG 17
CHANCE	M				M		M			M							
IMACLIM-China	Y						Y	Y	Y				Y				
GCAM	M	Y	M			Y	Y		Y		M	Y	Y	M	Y		
GCAM-USA	M	Y	M			Y	Y		Y		M	Y	Y	M	Y		
MUSE					M		Y		Y								
SLIM-India						M	M		M		M	M	M				
TIAM							Y		Y				Y				
CLEWs	Y	M				Y	M		Y			M	Y		Y		
DyNERIO		Y				Y	Y	Y	Y			Y			Y		
MEDEAS						Y	Y	Y				Y	Y		M		
WILIAM		Y	Y	Y		Y	Y	Y	Y				Y	Y	M		Y
Calliope							Y						Y				
China-MAPLE		Y				Y	Y	Y	Y				Y				
EnergyPLAN							Y		Y				Y				
EXPANSE			Y				Y	Y					Y		Y	Y	
MENA-EDS						Y	Y	Y	Y				Y				

OSeMOSYS							Y		Y			Y	Y				
PROMETHEUS						Y	Y	Y	Y				Y				
DREEM	Y		Y				Y				Y		Y				
ATOM							Y						Y				
WISEE-EDM Industry									Y								
WISEE-EDM global steel									Y								
WTMBT		Y				Y	Y	Y	Y			Y			Y		
CICERO-SCM													Y				
OnSSET			Y				Y		Y								

3 Policy Needs Identification

Throughout this section, the aim is to recapitulate the policy analysis carried out over the course of the IAM COMPACT project, starting with how the 1st PRM policy questions were received and tackled in order to shape the topics subsequently studied in the modelling work. The second subsection introduce on the modelling activities, known in the framework of this project as "studies", providing a short description of each of them, as well as the list of modelled policies (set of policies introduced in the models to represent the policy questions). These lists of policies constitute the starting point for **Section 4,** where the method from D4.1 is applied to classify the policy questions into policy types (to be included in the catalogue) and to assess which models can be used for their analysis.

Finally, the last subsection covers the new policy questions obtained from the second round of stakeholder consultations, attempting to extract new types of policies. Moreover, this chapter is also taken as an opportunity to address the policy issues and other sectors not yet contemplated in the project.

3.1 Stakeholders' questions for the 1st PRM cycle: Processing and creation of studies.

One of the key components that defines IAM COMPACT is ensuring its relevance and ownership for relevant policy actors and stakeholders, and to this end, *WP2 – Listening* is responsible for implementing a stakeholder engagement strategy, coordinating the activities of the policy steering groups and, subsequently, collecting policy and stakeholder questions and feedback.

This process, as the rest of the project, is divided into two different PRM cycles. The first one began in early 2023 with policy consultations and has been extended throughout 2023 and early 2024, including the first versions of the modelling deliverables (such as D4.1, D4.3, D5.8, among others) as well as the modelling studies. The 2nd PRM cycle has just started with new workshops with stakeholders and Deliverable 4.2 itself, which aims to provide support for the elaboration of new studies. Through this subchapter, we intend to shortly contextualise how the 1st PRM cycle policy questions were managed and transformed into studies.

In order to comply with the political and socially realistic approach of the project, two differentiated groups of stakeholders were involved: (i) the policy steering groups as high-level policymakers across European and national institutions; and (ii) the Core Working Groups (CWGs) as technical policymakers, industry representatives, and civil society actors who have country-specific expertise when operating outside of the EU and issue-specific expertise within the EU. Thus, European Union (EU) policy topics were organised into four specific EU-themes, whist non-EU policy issues were grouped into 5 regions framed under the umbrella theme of "energy and climate policies". These two categorisations are reflected in **Table 11**:

Table 11. Categorisations of policy issues for the stakeholder consultations

Categorisations of policy issues				
Themes (for EU stakeholders)				
European Industry	Electrification	Global Green Investment	Behavioural Change	
Regions (for non-EU stakeholders)				
Ukraine	Mainland China	India & Sri-Lanka	Kenya & Ethiopia	USA

This set of meetings with the policy steering groups resulted in a list of many takeaways, later refined into 23 definitive policy questions, which are available in *Deliverable 2.2 "Scoping Policy Relevant Research Questions"* (Heussaff et al., 2023). The preliminary questions were included into D4.1 (the final list of policy questions was

obtained after the D4.1 delivery date), where they were re-analysed and clustered following the structure presented in **Table 1** allowing us to understand if the catalogue structure proposed was aligned with the project needs. Subthemes, policy types & instruments, sectors, impacts on SDGs and jurisdiction (scale) were the categories employed to further narrow down the research questions so as to co-create question-specific scenario protocols and detect the most appropriate IAMs to run them. For this analysis, see Section 5 & Annex III of D4.1 (Ferreras et al., 2023).

Merging this work with discussions with the CWGs, seven modelling studies were produced after grouping the policy questions and framed under four topics: (i) global effects; (ii) industry and innovation; (iii) optimal transition; and (iv) behavioural change. The entire process, explained step-by-step, is detailed in Section 2.1 of *Deliverable 4.5 "National, regional, global mitigation pathways"* [4](Mittal et al., 2023).

Besides the seven studies produced from the research questions, three other modelling activities were proposed for the first round of the project:

- An **energy crisis scenario** arising from the energy challenge the EU faced in 2022 and 2023. It aimed to quantify the consequences of several alternatives for totally phasing out imports of Russian natural gas.
- A **COVID-19 analysis** to explore how the recovery packages driven by global governments in the aftermath of the pandemic have impacted on climate and energy systems and their future implications.
- An **SDG analysis** with the objective of assessing mitigation pathways and their implications for sustainability using indicators SDG indicators (biodiversity, land, social, etc.).

As a last of step prior to conducting the studies, it was necessary to create a realistic scenario to be used across all of them, alongside the harmonisation of parameters, assumptions and policies (e.g. emissions, prices, population). Finally, three emission scenarios with different ambitions were implemented: (i) CP_EI, consisting of the current emissions reduction policies and targets for 2030; (ii) NDC_EI, consisting of the 2030-NDC-targets; and (iii) NDC_LTT, consisting of the NDC targets until 2030 and more stringent post-2030 commitments.

Subsection 3.2 presents a general description of each study and analysis undertaken during the 1st PRM cycle.

3.2 Policy questions addressed in the 1st PRM cycle modelling work

Up to the writing of this document, the modelling activities conducted in the framework of IAM COMPACT have consisted of the seven studies introduced above, three additional analyses of interest due to recent disruptive events (COVID, Energy Crisis and, to a lesser extent, sustainability) and, finally, some initial modelling activities in the pilot countries.

This subchapter presents a brief description of each 1st PRM cycle modelling exercise, providing also useful information for the forthcoming policy catalogue as the lists of modelled policies (as mentioned above, the way to translate policy issues into inputs that can be introduced into the models).

3.2.1 Study 1. NECPs

This study, reported in D4.5, aims to answer the research question, "how does the implementation of the updated national energy and climate plan compare to the cost-optimal EU plan?" However, due to delays in the release of the National Energy and Climate Plans (NECPs) by EU member states and limitations in the models used to represent specific national policies, this study compares cost-optimal model scenarios to achieve the EU emissions mitigation targets with EU-wide modelling of the Fit-for-55 policy package. The first scenario includes sector-level

[4] DOI 10.5281/zenodo.13767329

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policies outlined in the Fit-for-55 policy packages, while the second scenario imposes emissions constraints on overall GHG and CO_2 emissions without including any sectoral policies, in order to compare the cost-effective measures with sectoral policies.

Below, **Table 12** presents all the climate policies used to characterise the different countries and their commitments to reduce emissions. This list of policies has been also necessary to build the scenarios used across the IAM COMPACT project.

Table 12. Policies addressed in Study 1

Tracking Number	Policy Addressed	Scale of application
1.1	Share of renewables - electricity production	National (Indonesia)
1.2	Coal phase-out by 2050	
1.3	Carbon tax	
1.4	Biofuel share in fuels – Biodiesel & Bioethanol	
1.5	Deforestation rate	
1.6	Increase electricity capacity – Power Plants	
1.7	Increase electricity capacity – Geothermal, Hydro, Solar, Others.	
1.8	Biofuel share in fuels – Biodiesel & Bioethanol	National (Argentina)
1.9	Building renovation rate	
1.10	Reduction of coal-fuelled power plants	
1.11	Increase electricity generation - Nuclear	
1.12	Share of renewables - electricity production	National (Australia)
1.13	Storage capacity added – hydro & battery	
1.14	Emissions reduction – Methane & HFCs	
1.15	Reduce emissions from new passenger vehicles	
1.16	Increase water electrolyser capacity	
1.17	Biofuel share in fuels – Biodiesel & Bioethanol	National (Brazil)
1.18	Emissions reduction – Methane	
1.19	Share of renewables - electricity production – Hydro, Biomass, Solar, Wind, Nuclear.	

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1.20	Reforestation	
1.21	Fuel efficiency - Gasoline + diesel cars	
1.22	Emissions reduction by using biofuels	
1.23	Carbon Tax	National (Canada)
1.24	Share of zero emission vehicles in new light duty vehicle sales	
1.25	Emissions reduction – Methane & HFCs	
1.26	Carbon intensity - diesel and gasoline	
1.27	Reforestation	
1.28	Fuel consumption reduction - Light duty - annual	
1.29	Power plant standard - new power plants	
1.30	Green hydrogen production	National (China)
1.31	Emissions reduction - HFCs	
1.32	Installed capacity - nuclear	
1.33	Reforestation	
1.34	Forest coverage rate	
1.35	Forest stock volume	
1.36	Electricity production - non-fossil	
1.37	Energy efficiency - cooling products	
1.38	Renewable energy capacity – wind, solar, hydro	
1.39	Fuel efficiency - fleet average	
1.40	Share of EV in new vehicle sales	
1.41	Reduction in energy consumption	Supraregional (EU27)
1.42	Renewable energy capacity	
1.43	Energy efficiency	
1.44	Share of green hydrogen in all industry hydrogen	

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1.45	Fuel efficiency - light-duty vehicles	
1.46	Installed capacity - offshore wind, ocean, hydrogen, solar	
1.47	Share of renewables - transport	
1.48	Share of advanced renewables (advanced biofuels and biogas) in energy use in rail and road transport	
1.49	Share of sustainable aviation fuels	
1.50	F gases market reduction	
1.51	Deployment of CO2 storage capacity	
1.52	Emissions reduction – non-CO_2	
1.53	Installed capacity – wind, solar, nuclear, hydro	National (India)
1.54	Green hydrogen production increase	
1.55	Energy storage - wind and solar	
1.56	Battery based energy storage	
1.57	Emissions reduction - HFCs	
1.58	Biofuel share in fuels – Biodiesel & Bioethanol	
1.59	Reforestation	
1.60	Refrigerant demand reduction	
1.61	Carbon tax	National (Japan)
1.62	Increase coal-fired power plant efficiency	
1.63	Installed capacity – solar, offshore wind, nuclear	
1.64	Increase in carbon storage capacity	
1.65	Hydrogen production increase	
1.66	Emissions reduction - F gases	
1.67	Fuel efficiency - fleet average	
1.68	Cumulative FCEVs sales	
1.69	Share of renewables - electricity production	National (Mexico)

1.70	Carbon tax on fossil fuel production	
1.71	Fuel efficiency - fleet average	
1.72	Net deforestation rate	
1.73	Annual reforestation	National (Republic of Korea)
1.74	Emissions reduction – methane	
1.75	Share of renewables - electricity production – Nuclear, hydro, wind, solar, biomass, waste	
1.76	Energy efficiency – Industry and buildings	
1.77	Increase in hydrogen production	
1.78	Biofuel share in diesel - Biodiesel	
1.79	Fuel efficiency - light-duty vehicles & ships	
1.80	Emissions reduction - transport	National (Russian Federation)
1.81	Gas flaring rate	
1.82	Share of renewables - TPES	
1.83	Energy efficiency - Coal-fired, gas-fired & nuclear power plants	
1.84	Share of renewables - electricity production	National (Saudi Arabia)
1.85	Fuel efficiency - Light-duty vehicles	
1.86	Carbon tax	National (South Africa)
1.87	Biofuel share in fuels – Biodiesel & Bioethanol	
1.88	Installed capacity – Solar, wind	
1.89	Increase in energy storage	
1.90	Energy savings in industry	
1.91	Fuel efficiency - fleet average	
1.92	Emissions reduction - HFCs	
1.93	Production of hydrogen	

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1.94	Electrolysis capacity	
1.95	Reduction in primary energy consumption	National (Turkey)
1.96	Share of renewables - electricity production – nuclear, wind, solar, hydrogen	
1.97	Emissions reduction - HCFs	
1.98	Fuel efficiency – road transport	National (USA)
1.99	Share of carbon free electricity - electricity production – offshore wind, solar, wind	
1.100	Aviation fuel tax	
1.101	Methane tax	
1.102	Production tax credit - renewables	
1.103	Share of EV – car sales	

3.2.2 Study 2. Energy security, resilience, flexibility, costs, and environmental indicators in renewable energy systems

This study aims to respond to the research question "Evaluating energy system flexibility, energy security, energy system resilience in baseline, renewable, and cost-optimal scenarios". It focuses on exploring methods and tools for modelling and comparing future energy systems in form of scenarios and uses a set of parameters to assess flexibility, resilience, costs, prices, etc. in renewable energy scenarios. Thus, the study is applied in two different case studies for Greece and the EU and it can be found in *Deliverable 4.7 "Sectoral and cross sectoral analysis"*[5] (Holtz et al., 2023) and in *Deliverable 4.9 "European sub-national deep dives"*[6] (Trutnevyte et al., 2024).

To cover all the required areas, a comprehensive literature review is carried out so as to define indicators for evaluating renewable energy systems. These indicators are also refined with feedback from policy-makers and stakeholders.

Three scenarios were created for the EU and four for Greece. At the European level they consist of: (i) Baseline 2050, based on current commitments and projections; (ii) 1.5 Tech 2050, assuming ambitious measures to meet with the 1.5ºC increase of the Paris agreement; and (iii) Smart Energy Europe 2050, designed with a 100% renewable energy system. On a Greek national scale, the scenarios are: (i) Early carbon neutrality (CN) by 2042 focused on renewables; (ii) Early CN by 2042 focusing on CCS; (iii) CN by 2050 and shutdown of gas plants by 2040; and (iv) CN by 2050 and shutdown of gas plants by 2045.

Table 13 presents the list of specific policies that have been applied for Study 2

[5] DOI: 10.5281/zenodo.13839233
[6] DOI 10.5281/zenodo.13784964

Table 13. Policies addressed in Study 2

Tracking Number	Policy Addressed	Scale of application
2.1	Electrification of all sectors	Supraregional (EU27)
2.2	Deployment of e-fuels and hydrogen	Supraregional (EU27)
2.3	Development of CCS for bioenergy	Supraregional (EU27)
2.4	Strong penetration of VRE in the power sector	Supraregional (EU27)
2.5	Energy Efficiency	Supraregional (EU27)
2.6	Update of heating systems and expansion of district heating	Supraregional (EU27)
2.7	Electrification of transport	Supraregional (EU27)
2.8	Replacing remaining fossil fuel demands in industry and power generation with biogas and biomass.	Supraregional (EU27)
2.9	Use of CCS for natural gas plants and biomass power plants	National (Greece)
2.10	Shutdown of gas-fired plants	National (Greece)
2.11	Deployment of energy storage	National (Greece)

3.2.3 Study 3. Geopolitics causing Technology Delays

This study aims to respond to the research question "What are the different cost, energy security and resilience metrics and how do they compare for different scenarios?" (it groups 4 policy questions) by assessing the effectiveness of transformational responses to Climate Change through a comparative analysis of socio-economic outcomes across different resilience scenarios. It can be framed in the overarching "global effects" theme and is reflected in *Deliverable 5.4 "Modelling out-of-ordinary extremes"* (Al Khourdajie et al., 2024).

Disruptive events pose significant risks to socio-economic systems, necessitating a comprehensive framework to understand and address their potential impacts. Part of this study builds upon van Ginkel et al. proposed dimensions of transformational response and resilience to socio-economic impact, to create a novel matrix for exploring climate-related extremes and their socio-economic consequences (van Ginkel et al., 2020).

The resulting scenario matrix yields four distinct narratives: Business as Usual, Unadaptive Transformation, Incremental Resilience, and Effective Transformation. These narratives represent varying combinations of transformational response and resilience to socio-economic impacts, offering a nuanced perspective on potential future pathways. The Business as Usual scenario depicts a society with low transformation and resilience, while the Unadaptive Transformation narrative illustrates the pitfalls of narrow focus in climate change mitigation efforts. Incremental Resilience represents a society that achieves high resilience through expanding existing capacities rather than transformative changes. Finally, the Effective Transformation scenario embodies the ideal resilient future, characterized by significant, well-rounded transformations and high resilience to socio-economic impacts.

This framework provides a valuable tool for policymakers, researchers, and stakeholders to assess the complex interplay between climate change tipping points and socio-economic systems, facilitating more informed decision-

making and strategy development in the face of climate uncertainties.

Table 14 lists the policies modelled for Study 3.

Table 14. Policies addressed in Study 3

Tracking number	Policy Addressed	Scale of application
3.1	Import tariffs to imported products	Supraregional (EU27)
3.2	Prioritisation of domestic green tech manufacturing	Supraregional (EU27)
3.3	Stronger environmental regulations for the uptake of biomass and carbon storage	Supraregional (EU27)

3.2.4 Study 4. EU Industry

The fourth study of the project started from stakeholders' questions around relocation of European Industries and associated impacts on costs, sustainability and labour and condensed these into two sub-studies: the first one analysed the European steel industry and a potential relocation thereof to other world regions because of high energy and CO_2 prices in the EU (section 2 of D4.7 (Holtz et al., 2023)). The second one addressed – in the context of potential re-shoring of critical net-zero technologies to the EU – the raw material demand for upscaling solar and wind technologies in four global regions, including the EU (section 3 of D4.7 (Holtz et al., 2023)).

The first sub-study on the EU steel industry involved the soft-linking of several models to assess the potential impact of different degrees of trade restrictions for steel. Three scenarios are analysed in each of which all countries implement their current climate policies and achieve the GHG emissions reduction targets set in their respective NDCs and in their long-term targets, but different steel-related trade constraints are assumed in the three scenarios:

- "NDC_LTT" scenario: no trade restrictions
- "CBAM" scenario: steel imports to the EU are penalized based on their CO_2 footprint
- "INDEPENDENCE" scenario: steel production levels in the EU may not drop below the level of 2019 (which is guaranteed by subsidies provided for steel production)

The second sub-study on raw material demand for upscaling solar and wind technologies builds on the three scenarios of the steel-related study (see above). Results from GCAM on renewables upscaling were used as an input to some modules of WILIAM which allowed to calculate the raw materials demands implied, which were then compared to current annual extraction and the known global reserves.

The GCAM model was used to develop scenarios for the steel production in different global regions considering trade and trade restrictions and all other model applications in this study built on these results. The three steel-related scenarios analysed with GCAM all build on the NDC_LTT scenario of study 1 used for the comparison of EU Fit-for-55 policy to a cost-optimal scenario (section 3 of D4.5 (Mittal et al., 2023)). Therefore, all policies included in the NDC_LTT scenario of Study 1 are implicitly included in Study 4 scenarios as well. However, these were not analysed specifically in Study 4. The policy measures explicitly addressed in Study 4 are related to steel trade. Furthermore, the CO_2 price resulting from GCAM was used as an input by the WISEE EDM-I bottom-up steel model and thus is included in the following **Table 15** as well.

Table 15. Policies addressed in Study 4

Tracking number	Policy Addressed	Scale of application
4.1	Steel trade related measures (CBAM, production subsidy)	Supraregional (EU27)
4.2	Carbon pricing	Supraregional (EU27)

3.2.5 Study 5. Rapid Technology Cost Reductions

The fifth study of the project aims to answer the research question: "What is the contribution of earlier stage technologies if they undergo rapid cost reductions?" by analysing technological breakthroughs such as heat pumps or Carbon Dioxide Removal (CDR). The main purpose of the study is to determine how this cost reduction can help reach the 2ºC and, above all, 1.5ºC long-term temperature targets as well as the required investment and its impacts on emissions, economy and energy demand.

It is split into two different approaches: the development of granular energy technologies in Europe (section 2 of *Deliverable 5.6 "Behaviour, social and disruptive innovation"*[7]) and the reduction of the dependence on CDR to achieve net-zero emissions (section 3 of the same document) (Frilingou et al., 2024). The former aims to present, using the PROWIDE method, probabilistic projections of the deployment of solar PV, wind power, heat pumps, biogases and three types of passenger cars for each European country. It then compares these projections against the necessary installed capacities to reach the European energy transition levels by 2050.

The latter focuses on the high importance of CDR to reach the point of net-zero emissions and how to enhance other mitigation options to limit the need for CDR, e.g. by reducing residual emissions from electricity, fuel supply, transports, buildings, industry, and agriculture. Some of the adopted measures include demand reductions through increased energy efficiency and behavioural changes; or synthetic liquid fuels production using CO_2 from Direct Air Capture (DAC), as presented in **Table 16**.

Table 16. Policies addressed in Study 5

Tracking number	Policy Addressed	Scale of application
5.1	Bioenergy limitation	Supraregional (EU27)
5.2	Phasing out unabated fossil power plants	Supraregional (EU27)
5.3	Eliminating petroleum-derived liquid transportation fuels	Supraregional (EU27)
5.4	Electrification of buildings, transportation & industrial sectors that do not require combustion-grade heat	Supraregional (EU27)
5.5	Reduction of fluorinated gas emissions	Supraregional (EU27)

3.2.6 Study 6. Interest Rates

Models used to assess decarbonisation pathways typically assume a uniform cost of capital; such assumption, however, does not do justice to real-world conditions and may therefore lead to inaccurate policy recommendations. The, reported in D5.6 (Frilingou et al., 2024), aims to explore how non-uniform weighted average cost of capital (WACC), i.e., the discount rate a company uses to estimate its net present value, could

[7] DOI 10.5281/zenodo.12751959

influence global decarbonisation pathways.

This study builds on empirically calibrated WACC values by region and technology in global IAMs and expands the modelling analysis by exploring stakeholder-driven pathways of de-risking clean energy technologies and increasing risk for fossil fuels. Since one of the largest uncertainties lies in how WACC values are expected to evolve over time, the empirical estimates of baseline WACC values are combined with an expert-based approach to produce forward-looking scenarios of evolving WACCs over time. The study also attempts to incorporate a corrective justice dimension in its narratives by assessing the impacts of risk underwriting for low-carbon investments through taxing corporate windfall profits for 2022 and distributing the revenue as subsidies towards high-risk regions.

Table 17 gathers the particular policies used in this study:

Table 17. Policies addressed in Study 6

Tracking Number	Policy Addressed	Scale of application
6.1	Grants and subsidies	Supraregional (not all countries receive a subsidy)
6.2	Carbon pricing	Global

3.2.7 Study 7. Behavioural Changes

As part of WP5 and reported in Section 6 of D5.6, Study 7 addresses the impact of behavioural change on diets, buildings, and mobility (Frilingou et al., 2024). This study aims to understand the economic ramifications arising from shifts in behaviour and social innovation within the context of the energy transition as conceptualized in Task 5.5, emphasizing the relevance of behavioural change as an added social value resulting from policy implementation, rather than solely focusing on cost or effectiveness evaluation.

Initially, Study 7 carries out a contextualisation of behavioural change by a literature review and an analysis of the behaviour-related policy representation in IAM COMPACT models (based on D4.1 methodology application). Next, it collects and processes stakeholders' questions and propositions on behavioural changes and classifies them according to sectors and models which can respond to them. Finally, four scenarios are created from applying different policies, yielding outputs in the fields of energy, climate and land.

Table 18 reflects all the policies modelled during Study 7.

Table 18. Policies addressed in Study 7

Tracking Number	Policy Addressed	Scale of application
7.1	Change in diets to less meat intensive	Supraregional (only EU27)
7.2	Change in diets to less ruminant intensive	Supraregional (only EU27)
7.3	Change to local diary production (milk)	Supraregional (only EU27)
7.4	Boosting local production of food (seasonal, organic)	Supraregional (only EU27)
7.5	Reduction of passenger-kilometre demand	Supraregional (only EU27)
7.6	Private transport vs. Public transport	Supraregional (only EU27)
7.7	Changes in freight transport of goods	Supraregional (only EU27)

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7.8	Alternatives to short-haul flights: rail infrastructure	Supraregional (only EU27)
7.9	Reduce car activities: car sharing, bike sharing	Supraregional (only EU27)
7.10	Modal shift to cycling (also rural)	Supraregional (only EU27)
7.11	Efficiency in useful energy demand	Supraregional (only EU27)
7.12	Shift towards a reduction in the consumption level	Supraregional (only EU27)

3.2.8 Energy Crisis

The study (Nikas et al., 2024) explores explicit directions of how Russian gas could be phased out in the European bloc as well as their implications benchmarked against actual climate targets for 2030 and 2050, enabling to identify insights into the trade-offs and synergies between the different considered approaches to replacing Russian gas. The analysis employs a diverse ensemble of models of different structure and theory, thereby enhancing the robustness of resulting policy prescriptions and their understanding of the future uncertainty space based on four established IAMs. This approach also allows them to extract finer sectoral insights via interlinkages with two sectoral modelling tools.

Russia's invasion of Ukraine fuelled an energy crisis, considerably impacting Europe due to its heavy reliance on Russian natural gas. In this context, the study conducts a model-intercomparison study, based on four global IAMs that are further soft-linked to two sectoral models, to explore the impacts of and trade-offs among three approaches to living without Russian gas in Europe: replacing it with other gas imports, boosting domestic energy production, and accelerating energy efficiency. It finds that substituting Russian gas with imports from other trade partners would miss an opportunity to accelerate decarbonisation while risking fossil-fuel lock-ins, despite featuring the lowest gas price spikes and reducing heating costs for end-users in the near term. Increasing domestic, primarily renewable, energy production would instead require considerable investments, with consumers potentially picking up the tab. Energy demand reductions, however, may offer more space for emissions cuts at the lowest power-sector investment costs; nonetheless, this strategy would also risk relocation of energy-intensive industries, an aspect of increasing importance to EU policy. Finally, despite leading to gas-price discrepancies across the EU, all three strategies would lower overall gas imports and improve the bloc's energy security.

All the required policies for this study are presented in **Table 19**:

Table 19. Policies addressed in the "Energy Crisis" study

Tracking Number	Policy Addressed	Scale of application
8.1	Grants and subsidies for building retrofitting	Supraregional (EU27 + UK)
8.2	Building codes	Supraregional (EU27 + UK)
8.3	Final energy demand target	Supraregional (EU27 + UK)
8.4	Carbon pricing	Supraregional (EU27 + UK)
8.5	Direct de-investment (Procurement rules – Russian gas ban)	Supraregional (EU27 + UK)
8.6	Building shell efficiency	Supraregional (EU27 + UK)
8.7	Renewables in electricity generation	Supraregional (EU27 + UK)
8.8	Electricity for end-use sectors	Supraregional (EU27 + UK)

3.2.9 COVID-19 recovery package impacts

This modelling exercise, documented in *Deliverable 5.1 "Making a Green Step Forward into the Post-COVID Era"* [8] (Fragkos et al., 2024), aims to study the emission and technology impacts of the COVID-19 recovery packages on a global scale. To this end, the green recovery measures announced by all countries globally were first gathered, classified and analysed, and then implemented into the most adequate IAMs to explore the emissions and energy system impacts of them. The model-based results showed that these packages would produce limited emissions reductions by accelerating the uptake of renewable energy (especially wind and solar energy production) as well as Electric Vehicles (EVs) in road transport. However, the lack of ambitious climate policies in the future would attenuate the positive effects of the recovery packages, so a combined effort between green recovery measures and climate policies is essential to achieve meaningful targets.

For this analysis, the policies modelled encompass all the broad climate measures targeting net-zero used to build the NDC_LTT scenarios (already described in Study 1) along with EU Recovery and Resilience Facility (RRF), a temporary instrument to emerge more resilient from the COVID-19 crisis. RRF consists mainly of targeted funding for EU components to invest in reforms and projects by 2026 with 37% of the budget allocated to green measures and 20% to digital measures. Since each country has a complex and different roadmap, no particular policies are listed for this study.

3.2.10 SDG analysis

As part of WP5, *Deliverable 5.8 "Climate action in the sustainability spectrum"* [9] (Frilingou et al., 2024) addresses the modelling of several decarbonisation pathways from a sustainable scope by analysing their impact on the Sustainable Development Goals, including biodiversity, materials and biophysical limits, with the climate approach as a common thread.

This study begins with understanding the IAMs-SDGs relationship in general and the SDG coverage by the IAM COMPACT models in particular through a survey of the modelling teams. This consultation was conducted based on a set of sustainable indicators determined after a literature review, leading to a target space (quantitative framework best suited for IAMs to track the SDGs) and a matrix of synergies and trade-offs among SDGs, useful to detect modelling capacity improvements within the consortium IAMs.

The work then continues with a comprehensive analysis of biodiversity, biophysical limits and materials. To this end, a set of indicators is defined and several policies are applied to create scenarios, with the aim of concluding which combination of them provides the best results, i.e. which one enhances biodiversity the most.

Finally, two IAMs, GCAM and WILIAM (always from the perspective of sustainability impacts), are used to assess the allocation of mitigation budgets to economic sectors and to understand the potential uptake of different policy mixes, respectively. GCAM is combined with an optimisation algorithm (AUGMECON-R) to determine the most efficient allocation of mitigation efforts across five sectors (power supply, industry, buildings, AFOLU and transport) by measuring five sustainability dimensions (food basket price, premature mortality, GDPpc growth, undamaged land and water scarcity). On the other hand, WILIAM is used to simulate three decarbonisation pathways on which a Stochastic Multicriteria Acceptability Analysis (SMAA) is applied to determine which is the most sustainable according to the specific weights given to each SDG.

Table 20 shows the policies that have been modelled for the SDG analysis.

[8] DOI 10.5281/zenodo.13839290
[9] DOI 10.5281/zenodo.12649184

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Table 20. Policies addressed in the SDG Analysis

Tracking number	Policy Addressed	Scale of application
10.1	Afforestation and Forest Expansion	Supraregional
10.2	Promotion of more sustainable diets: - 50% of the population with flexitarian diets - 100% of the population with 50% plant-based diets	Supraregional
10.3	Forest Loss Limitation	Supraregional
10.4	Forestry Self Sufficiency	Supraregional
10.5	Increase in the Share of Bioenergy in Transport Liquids and Gases (excluding synthetic fuels)	Supraregional (only EU27)
10.6	Increasing Urban Land Density	Supraregional
10.7	Transition to Regenerative Agriculture	Supraregional
10.8	Protection of Managed Forest (40%)	Supraregional
10.9	Protection of Primary Forest (100%)	Supraregional
10.10	Expansion of Forest Plantations in 30%	Supraregional
10.11	Carbon Tax to production and households with Revenue Recycling (social benefits, debt reduction…).	Supraregional
10.12	Higher Limitation on Energy Consumption for Non-Durable Goods to 10%	Supraregional
10.13	Capping Annual Consumption Growth at 2% for Durable and Non-Durable Goods	Supraregional
10.14	Higher government consumption in education (40% since 2030)	
10.15	Promotion of Renewables over Fossil Fuels in the Energy Mix	Supraregional
10.16	Intensification of Annual Energy Savings per Economic Output (Energy Intensity) by 50%	Supraregional
10.17	Availability of Non-Mature Technologies (Offshore floating wind, oceanic energy & CCS)	Supraregional
10.18	Utilization of Rooftop Areas for Solar Technologies	Supraregional
10.19	Solar PV Efficiency Improvement	Supraregional

10.20	Increase in Fuel Efficiency in Transport by 15%	Supraregional
10.21	Improvement in Water Efficiency by 25%	Supraregional
10.22	Reduction in Material Intensities and Increased Recycling Rates	Supraregional

3.2.11 Pilot Country Modelling

The activities for modelling the specific cases of the pilot countries have been covered under *WP6 "Explaining – Policy analysis, capacity development, communication, dissemination, exploitation"*, mainly in Tasks 6.4 and 6.5. Under this umbrella, 5 models are being developed for Kenya, Sri Lanka, Ethiopia, and Ukraine, but at different paces due to the particular circumstances of each, especially in the Ukrainian case, as well as the specific needs and available modelling capacity. Encompassed sectors, main targets, and modelling activities conducted to date for each country are detailed below:

- **Kenya**: The focus is on multiple systems including energy, agriculture, land-use, and the water system, and the economic sectors linked to them. The energy sector encompasses industrial, residential, and commercial use. The targets for these initiatives include tackling water scarcity, ensuring food security, preserving coastal ecosystems, assessing the role of renewables, and addressing data accuracy issues. To look into some of these aspects, especially renewable integration and food security, a Climate-Land-Energy-Water systems model has been developed using the open source tool OSeMOSYS. An introductory CLEWs workshop was held in August-September 2023, and a CLEWs training program for students across three Kenyan universities (Strathmore University, Technical University of Mombasa, Meru University) has taken place from February to August 2024.
- **Sri Lanka**: Covered sectors are energy, agriculture, land-use, and the water system. The energy sector covers industrial, residential, commercial, and transport system use. A critical target is understanding how ambitious renewable energy targets might impact land-use and create conflicts in the same, given the limited availability of land area in Sri Lanka. A CLEWs model has been developed also in this case, leveraging an existing application and existing capacity developed in previous UN-led actions. A workshop was completed on January 30, 2024, with 20 participants, mainly from academia, along with a few from the government and private organizations. This workshop introduced the IAM COMPACT project and the CLEWs model through hands-on exercises.
- **Ethiopia**: The focus areas are two.
  - Residential and unelectrified sectors, particularly in efforts to include health and education facilities. The primary target is electrification. To this end, a model is being developed using the Open Source Spatial Electrification Tool (OnSSET), starting from a model developed in previous actions. Focus in IAM COMPACT is for now on updating accurate digitised data to parameterise the model. To support these goals, a modelling workshop titled "Energy Systems Modelling for Sustainable Development for Ethiopia" was held on January 23-24, 2024, to raise awareness on the use and insights from electrification modelling.
  - Climate change adaptation of energy, water, and food supply chains. To this end, a CLEWs model has been developed.
- **Ukraine**: Energy, industry, transport, and building sectors are modelled at the national level by employing OSeMOSYS and EnergyPLAN. The efforts aim to represent the sustainable recovery of Ukraine with the final target of meeting the Ukrainian commitment to achieve net-zero by 2050. To this end, three scenarios are going to be used: (i) business-as-usual policy as it was before the war; (ii) the sustainable recovery; and (iii) the intense sustainable recovery.

Table 21 and **Table 22** present the policies modelled for each national IAM version and the model used in each country, respectively.

Table 21. Policies addressed in the Pilot Country models

Tracking number	Policy Addressed	Scale of application
11.1	Capacity expansion and renewable integration in electricity system	National (Kenya)
11.2	Energy efficiency / modelling industrial, residential and commercial energy sectors	National (Kenya)
11.3	Water resource management / water system model including supply and demand for agriculture, power plants and public use	National (Kenya)
11.4	Sustainable agriculture	National (Kenya)
11.5	Afforestation and forest conservation	National (Kenya)
11.6	Climate mitigation and adaptation / Study of the modelled water, energy and agriculture systems nexus	National (Kenya)
11.7	Energy efficiency / modelling industrial, residential and commercial energy sectors	National (Sri Lanka)
11.8	Water resource management / water system model including supply and demand for agriculture, power plants and public use	National (Sri Lanka)
11.9	Agriculture	National (Sri Lanka)
11.10	Climate mitigation and adaptation / Study of the modelled water, energy and agriculture systems nexus	National (Sri Lanka)
11.11	Electrification and grid expansion	National (Ethiopia)
11.12	Climate mitigation and adaptation / Study of the modelled water, energy and agriculture systems nexus	National (Ethiopia)

Table 22. Modelling tools used as a basis for developing country-specific IAMs for the pilot countries

IAMs	Country
CLEWs	Kenya
CLEWs	Sri Lanka
OnSSET and CLEWs	Ethiopia

3.3 2nd PRM cycle Stakeholders' questions & pending policy needs in IAM COMPACT

As with the policy needs identified for the 1st PRM cycle, there are some policy issues and assumptions presented through this section which need to be categorised and included in the policy catalogue. The following two subchapters introduce these topics that will be translated into policy types in **Section 5**.

3.3.1 Pending policy needs and new "current policies"

The 1st Policy Response Mechanism cycle has been very comprehensive and extensive, but even so, some issues demanded by the policy makers or drafted in the Grant Agreement could not be covered either due to time limitations and/or lack of development of certain models to capture a realistic representation of the expected outcome. Thus, some of the most relevant outstanding policy issues are framed below:

1. **Role of hydrogen and/or e-fuels trade across world regions**
2. **Role of international transport and bunker fuels in global mitigation**
3. **Spatially disaggregated analyses for heavy industry sectors (steel, chemicals, cement) in selected European regions at the sub-national level**
4. **Design and assess specific mechanisms to reduce inequality (e.g., carbon dividends for citizens), with a focus on vulnerable groups**
5. **Improved modelling for technologies underrepresented in IAMs (deep renovation, e-fuels, etc.)**
6. **Evaluate impacts from mining activities for critical materials required for low-carbon technologies**
7. **Land Use, Land Use Changes and Forestry. Including potential biophysical constraints and impacts on land use (land-use requirements and competition due to ambitious mitigation as for example for the deployment of low-carbon technologies).**

Besides these pending topics, the second modelling round will also include the latest current policies and harmonisation parameters[10] (Van de Ven et al., 2024) (modelling assumptions) stemming from the update of our broad scenario logic (*Deliverable 4.4 – "Broad scenario logic – Update"* [11](Korsbakken et al., 2024)) in order to build even more robust scenarios (framed within Study 1). **Table 23** presents these new policies:

[10] DOI 10.5281/zenodo.12627014
[11] DOI 10.5281/zenodo.13132310

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Table 23. New current policies included in the CP scenario

Tracking number	Policy Measure / Instrument	Scale of application
1.2.1	Target of FCEV sales	National (China)
1.2.2	Heat Pump stock target	National (Germany)
1.2.3	Share of hydrogen in final energy consumption	National (Portugal)
1.2.4	Increase of hydrogen in the road transport sector	
1.2.5	Improvement in energy efficiency	National (Spain)
1.2.6	Electric fleet	
1.2.7	Increase of hydrogen electrolyser capacity	National (France, Germany, Spain, UK, Chile, Colombia, Argentina)
1.2.8	Ban on coal mines venting	Supraregional (EU27)
1.2.9	Share of zero emissions cars in new cars sales	National (UK)
1.2.10	Low-carbon hydrogen production capacity	
1.2.11	General sales tax (VAT) for electric vehicles, hybrids, and charging infrastructure	National (Colombia)
1.2.12	New buses are EVs	
1.2.13	Share of industrial demand being low-carbon hydrogen by 2030	

3.3.2 2nd PRM cycle policy questions

After holding several different meetings with policymakers and stakeholders of interest as documented in Deliverable 2.3 (Heussaff, 2024), a brand new set of 57 policy questions has been produced, reflecting their concerns and worries on the main topics targeted by the project (Global Effects (GE), Industry and Innovation (II), Optimal Transition (OT) and Behavioural Change (BC)).

Table 24 presents the list of policy questions, pointing out the topic they can be framed under, a tracking number and the question itself. The tracking number consists of two values, the first indicates the topic (1=OT, 2=II, 3=GE and 4=BC) and the second indicates the question number.

Table 24. 2nd PRM cycle policy questions. The tracking number consists of two values, the first indicates the topic (1=OT, 2=II, 3=GE and 4=BC) and the second indicates the question number

Topic	Tracking number	Policy Question
OT	1.1	What are the **investment needs** associated with different energy system solutions/configurations? Can the **cost** of security/resilience/flexibility be estimated?
OT	1.2	How does the evolving **geopolitical context** affect energy system security/resilience/flexibility/cost? - E.g., scenarios with high trade tariffs, disrupted supply chains, reduced supply of critical
OT	1.3	How do different **redistribution instruments** affect market outcomes? o E.g., windfall tax and redistribution or **carbon dividends**
OT	1.4	How do energy system investments change the costs paid by **different consumer types**? - E.g., energy costs, network costs, taxes, etc.
OT	1.5	How do model outputs at the national level in Europe compare to the derived 2030 RES and EE targets? -Compare model results to **NECP** plans to determine which countries appear to be on track
OT	1.6	Will falling cost per MWh of renewables translate into lower **customer bills**? (e.g. will the energy system cost decrease through decarbonisation)
OT	1.7	"What are the **transmission capacity needs** both within countries and between countries?
OT	1.9	How much is electricity demand expected to increase compared to other energy carriers to reach net zero, and what are the implications for **grid investment**?
OT	1.10	How are the average prices going to change (up/down), and **how will electricity prices change** in this optimal and non-optimal scenario? How will the variation/volatility in prices change (especially given storage concerns)?
OT	1.11	How does the share of **generation vs. transmission & distribution change in the total cost** of an decarbonised power system compared to our existing system?

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OT	1.12	What are the expected levels of **renewable curtailment**? - Explore why curtailment happens is especially relevant in the future. If it is curtailed because of the market (not offering renewables), which is okay, versus congestion management (cannot reach consumption), which is problematic.
OT	1.13	Can we build **grids at the required speed** to meet our renewable targets?
OT	1.14	What governance framework could enable a more coordinated **planning and funding of infrastructure** across Member States (as a prerequisite for a more **integrated EU energy system**)?
OT	1.15	How to make it more **(socially and economically) acceptable to consume electricity more flexibly**? - E.g., which practical kinds of **electricity contracts** should be offered (is peak/off-peak enough? Should peak hours be redefined? Could peak hours be more dynamic, with some guarantee that e.g., there are at least 10 off-peak hours per day?)
OT	1.16	How best to **spread the costs of CAPEX-heavy investments**, e.g., network investment costs, over time and over **consumers** so that they remain acceptable?
OT	1.17	If necessary to ensure global competitiveness, how to **subsidise electricity costs** for some **consumers** while ensuring a cost-efficient power system? - i.e., incentivise consumption that is energy efficient and flexible, avoiding a subsidy race among Member States
OT	1.18	How necessary is carbon capture and storage (**CCS**) to decarbonise of **industry and power**?
OT	1.19	How to enable **decentralised flexibility models (e.g., demand response)** successful in one Member State to thrive and scale through the EU?
OT	1.20	Are the European **energy efficiency targets feasible** and what technologies/policies are needed to achieve them?
OT	1.21	Can energy market dynamics be captured in integrated assessment models? - The aim would be to provide insights on what policy instruments are most suitable for **incentivising investments in clean tech and flexibility solutions**.

OT	1.22	What policy instruments and economic conditions best facilitate the deployment of **key clean technologies like electrolysers, batteries, and EVs**?
OT	1.23	What is the most efficient method to **redistribute carbon revenues** to achieve both societal welfare and decarbonisation goals?
OT	1.24	What technology mix can best provide long-term seasonal flexibility?
OT	1.25	What are the potential benefits from a system point of view from both explicit (based on direct payments) and implicit (based on price signals) **demand-side response**, and how do each type vary according to their benefits to the system?
OT	1.26	What are the **offshore grid investment needs** to meet the EU's 2030 targets?
II	2.1	Member State Analysis: How could **spatial relocation of the steel industry** occur within the EU based on the use of **different policy instruments/subsidies** in support of green steel?
II	2.2	Intermediate Product Imports: What are the **potential imports of intermediate** products and their impact on **steel transformation** within the EU? - E.g., quantities of green hydrogen or direct reduced iron.
II	2.3	How much **steel production** should we have in Europe for **security** vs. **competitiveness** vs. **cost** reasons? - How much steel production relocation makes sense from an economic efficiency standpoint (both within and outside the EU)?
II	2.4	What are the effects of explicit support for **low-carbon steel** compared to even subsidies for European steel?
II	2.5	How does the import of cheaper produced intermediaries affect the European **green steel** value chain?
II	2.6	How does **steel sector** decarbonisation differ by EU countries, depending on the factors above?
II	2.7	What are the potential benefits of more circular solutions in **green steel** production?
II	2.8	What are the energy demands of a **decarbonised industrial sector** in Europe? - Electricity and other energy carriers like renewable fuels of non-biological origin (RFNBOs)

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II	2.9	What are the best instruments for driving **innovation in the steel sector** in Europe?
II	2.10	How would **faster experience curves** in clean energy technologies change our public policy priorities? - Would we support more deployment with faster **learning**?
II	2.11	What are the implications of a global scenario with **high tariffs between China and the USA**? - Are EU policy frameworks (such as **CBAM**) resilient to such a scenario?
GE	3.1	How can the EU play a role in **reducing the cost of capital in the developing world**?
GE	3.2	What other countries are best suited to **partnering with the EU** on green technology? - In other words, who else is **suitable for supplying key green technologies**?
GE	3.3	How realistic are the **Net Zero Industry Act** targets for European manufacturing?
GE	3.4	What are the effects on Europe's decarbonisation of increasing **trade tariffs** depending on the sector? - In other words, are solar panels, EVs, or green steel more important from an emissions standpoint?
GE	3.5	What is the effect of **heterogenous carbon prices** around the world on **carbon leakage** from Europe and on global decarbonisation efforts?
GE	3.6	What other tools (excl. CBAM) can be used to **incentivise low-carbon production** of important goods and technologies?
GE	3.7	Considering the timing of EU policy implementation, if there is pushback on policies, they are slower to be implemented. What are the implications of **smooth versus abrupt implementation of policies?**
GE	3.8	How would th**e completion of the capital union** change the perception of risk and facilitate these investments? Perhaps lower uncertainty would help facilitate the investment.
GE	3.9	How **much money will flow from more developed economies to less developed economies**? How could this money be channelled in the best way to accelerate the transition?

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GE	3.10	How do the macroeconomic conditions around the world affect renewable investments? - How do these factors affect mitigation costs? - What are the **best practices here for de-risking** clean energy projects in developing countries?
GE	3.11	How would a **European investment fund** to investment in decarbonisation in the developing world affect decarbonisation?
GE	3.12	How could de-risking of clean energy technologies in specific **Western/European partner countries** aid the energy transition?
BC	4.1	What is the effect of the energy consumption associated with **energy communities** at scale on the energy system, in terms of emissions and cost? - Can these benefits be quantified in terms of benefits to the consumer and benefits to the system? (To stress the importance of i-frame vs. s-frame)
BC	4.2	Similarly, what are the emissions and cost savings benefits of widespread efficient usage of **heat pumps and electric vehicles charging in households**? - What are the emissions, cost savings, and resilience benefits of **implicit vs explicit demand-side response?**
BC	4.3	What are the **costs of supporting behavioural change** in buildings, such as through providing grants, and how does this change the affordability of behavioural change for citizens? - How does this differ by socioeconomic group?
BC	4.4	Compare **building fabric improvements to technology replacement (e.g., heat pumps)** in terms of broader emissions and costs benefits. - Put the different behavioural change requirements in context.
BC	4.5	**Deep dive on transport modes**: explore the emissions and costs benefits from modal switching to different modes (walking, cycling, public transport, EVs).
BC	4.6	In terms of **food consumption**, model not only dietary changes, but also land use and ag**ricultural changes** needed to provide food for such diets.
BC	4.7	What are the environmental and economic effects of **new energy usage profile**s by households and businesses?

BC	4.8	How do different **preferences in diet, transport and buildings** by European demographic and region affect the environmental outcomes of green behavioural changes?

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All these questions have been pre-analysed to link them to the IAM COMPACT tasks and to the previous modelling studies when possible with the objective of creating some preliminary groups which might help to model them together and to reduce the length of the list, as well as to suggest new studies. This work is reflected in **Table 25**:

Table 25. Preliminary grouping of the 2nd PRM policy questions

Groups	Potential grouping (tracking numbers)	IAM COMPACT Task	Update of 1st RPM studies
Group 1: OT – Flexibility & Demand Response	1.1, 1.15, 1.19, 1.21, 1.24, 1.25	T4.5	Study 2
Group 2: OT & GE – Extreme scenarios	1.2, 3.7	T5.3	Study 3
Group 3: OT – Policy instruments on customers	1.3, 1.4, 1.6, 1.23	T5.2 (maybe also T4.5)	-
Group 4: OT – Grid investments, energy targets…	1.5, 1.9, 1.10, 1.12,1.13, 1,18, 1.20, 1.22, 1.26	T4.3, T4.4, T4.5, T6.5	Study 1
Group 5: OT – Transmission & consumption	1.7, 1.11, 1.12	T4.4, T4.5	-
Group 6: OT & II – International competitiveness	1.8, 1.16, 1.17, 2.11	T4.3, T4.4, T4.5	-
Group 7: II – Steel industry	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9	T4.4, T4.5	Study 4
Group 8: II & GE – CBAM & decarbonisation	2.11, 3.2, 3.4, 3.5, 3.6, 3.8	T4.3 with high emitters	-
Group 9: II - Learning	2.10	T5.4	Study 7
Group 10: BC – Energy communities	4.1	T5.5	-
Group 11: BC - Buildings	4.2, 4.3, 4.4, 4.7	T5.5	Study 7
Group 12: BC – Change in preferences	4.5, 4.6, 4.8	T5.5	Study 7

Some of the questions are not so much queries to be modelled, but rather to be discussed theoretically in the form of policy briefs and/or in the discussion section of the relevant deliverables, and are therefore not included in this grouping or in the application of the clustering method. This is the case for policy questions 1.14, 1.21, 3.1, 3.9, 3.10, 3.11 and 3.12.

It is also possible to detect a close relationship between one of the proposed groups (Group 3 – Policy instruments on consumers) and a pending issue (Mechanisms to reduce inequality), so that modelling these policy questions may be fulfilling one of the premises of the project. Furthermore, Group 7 – Steel Industry can be partially linked to the third pending issue (Heavy industry sectors), being another interesting interaction to take into consideration when proposing modelling studies.

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4 Application of the method for the 1st PRM cycle – Translating policy needs into scenario frameworks

This chapter applies the three steps of the policy classification method, beginning with classifying the policies from **Section 3** by geographical scale, policy type, and subcategory to create a concise collection of policy types (Step 1). Next, it uses heatmap data from **Section 2** to connect these policy types with the IAM COMPACT models, identifying the best modelling options (Step 2). Finally, it associates the policy types with their impacts on SDGs, linking these impacts to synergies and trade-offs based on the literature (Step 3).

4.1 Step 1 – From policy needs to policy types

The creation of the policy catalogue starts with an initial processing of the extensive list of policies listed in **Section 3** from the studies and policy questions in order to reduce the number of entries by grouping them into common policy types and instruments. These categories are the same as those defined in the heatmaps, so that internal coherence can be maintained.

The clustering consists of identifying the scale of application of the policy and whether it is a policy type (measure), a policy instrument, or both. In both cases, a sub-classification can be made by determining the sector of application (policy sector) and the instrument subcategory, respectively. Despite having all the policies listed and the policy types and instruments analysed, in some cases it may not be straightforward to link them accurately due to the abstraction of the exercise, or the complexity of the structure of the policy question which may cover various policy types and also refer or put emphasis on the impacts.

For the definitions of each instrument and sector and the sources and rationale behind this classification, see **Section 2** of D4.1. **Table 26** shows the first step of the application of the method, where the policy questions are classified into policy types. This table also shows a preliminary version of the catalogue (to be reviewed in alignment with the I²AMPARIS platform needed by M32), separated by study (Ferreras et al., 2023).

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Table 26. Step 1 – Clustering of modelled policies for the 1st PRM cycle

Tracking Number	Policies from studies	Scale of application	Sector	Policy type	Instrument category	Policy instrument
STUDY 1						
1.1, 1.12, 1.19, 1.36, 1.69, 1.75, 1.82, 1.84, 1.96, 1.99	Share of renewables - electricity production	National	Energy ↓ Electricity generation	All from electricity generation	Regulatory Instruments ↓ Targets, Quotas & Obligations	Renewable electricity targets/obligations
1.2, 1.10, 1.81	Coal phase-out	National	Buildings, Industry, Agriculture, Energy.	Gas replacing coal Renewable energies	Economic Instruments ↓ Market-based ------ Barrier removal	Carbon pricing ------ Removal of fossil fuel subsidies
1.3, 1.23, 1.61, 1.70, 1.86	Carbon Tax	National	-	-	Economic Instruments ↓ Market-based	Carbon Pricing
1.4, 1,8, 1.17, 1.58, 1.78, 1.87	Biofuel share in fuels – Biodiesel & Bioethanol	National	Transport ↓ Road, rail, aviation & shipping	Biofuels in mix	Regulatory Instruments ↓ Codes and Standards	Vehicle fuel-economy and emissions standards
1.5, 1.20, 1.27, 1.33, 1.34, 1.35, 1.59, 1.72, 1.73	Deforestation rate & Reforestation	National	Agriculture & LULUCF ↓ LULUCF	Afforestation Land Protection	-	-

1.6, 1.7, 1.11, 1.29, 1.32, 1.38, 1.42, 1.46, 1.53, 1.63, 1.88	Increase electricity capacity – Geothermal, Hydro, Solar, Nuclear...	National & Supraregional	Energy ↓ Electricity generation	Geothermal, nuclear fission, hydro, solar PV, wind, offshore wind, biomass	Economic Instruments ↓ Direct Inv. & Fiscal incentives --- Regulatory Instruments ↓ Targets, Quotas & Obligations	Infrastructure investments --- Grants and subsidies --- Renewable energy obligations
1.9	Building renovation rate	National	Buildings	All policy types from buildings sector	Regulatory Instruments ↓ Codes and Standards	Building codes
1.13, 1.55, 1.56, 1.89	Energy storage capacity added - hydro & battery	National	Energy ↓ Electricity storage	Pumped hydro Batteries	-	-
1.14, 1.18, 1.25, 1.31, 1.50, 1.52, 1.57, 1.66, 1.74, 1.92, 1.97, 1.101	Emissions reduction – Methane & HFCs (taxes)	National	-	-	Economic Instruments ↓ Market-based --- Regulatory Instruments ↓ Codes and Standards	Carbon pricing --- Industrial air pollution standards
1.16, 1.30, 1.44, 1.54	Green hydrogen production	National	Energy ↓ Hydrogen production	Electrolysis	Regulatory Instruments ↓	Targets for electrolyser capacity

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					Targets, Quotas & Obligations	
1.65, 1.77, 1.93	Share of hydrogen in industry	Supraregional	Industry ↓ Process heat	Hydrogen	Regulatory Instruments ↓ Targets, Quotas & Obligations	Renewable electricity targets/obligations
1.94	Increase electrolysis capacity	National	Energy ↓ Hydrogen production	Electrolysis	Regulatory Instruments ↓ Targets, Quotas & Obligations	Targets for electrolyser capacity
1.24, 1.40, 1.68, 1.103	Share of EV & zero-emissions in new vehicle sales	National	Transport ↓ Road	Hybrid/Fully electric vehicles Hydrogen fuel cell vehicles	Regulatory Instruments ↓ Targets, Quotas & Obligations	EV sales targets
1.15, 1.21, 1.28, 1.39, 1.45, 1.67, 1.71, 1.79, 1.85, 1.91, 1.98	Fuel efficiency in light duty vehicles / fleet average	National & Supraregional	Transport ↓ Road	Efficiency	Regulatory Instruments ↓ Codes and Standards	Vehicle fuel-economy and emissions standards
1.22, 1.26, 1.47, 1.48, 1.80	Emissions reduction by using biofuels	National	Transport ↓ Road, rail, aviation & shipping	Biofuels in mix	Regulatory Instruments ↓ Codes and Standards	Vehicle fuel-economy and emissions standards Emissions target
1.49, 1.100	Share of sustainable aviation fuels & aviation fuel tax	National & Supraregional	Transport ↓ Aviation	All from aviation	Regulatory Instruments ↓	Vehicle fuel-economy and emissions standards ------

					Codes and Standards ------ Economic Instruments ↓ Market-based	Carbon pricing
1.37, 1.43, 1.62, 1.76, 1.83, 1.90	Energy efficiency	National & Supraregional	Industry, Buildings, Energy generation	Energy efficiency	Regulatory Instruments ↓ Codes and Standards	Energy Efficiency Standards/Targets
1.68	Refrigerant & cooling demand reduction	National	Industry, Buildings	Energy efficiency	Regulatory Instruments ↓ Codes and Standards	Energy Efficiency Standards/Targets
1.51, 1.64	Deployment of CO_2 storage capacity	National & Supraregional	Industry, Energy generation	CCS, NETs…	Economic Instruments ↓ Direct Inv. & Market-based	Infrastructure investments, RD&D funding ------ Credit for captured CO_2
1.41, 1.95	Reduction in energy consumption	Supraregional	Social & Behavioural ↓ Consumption	Less energy service demand	-	-
1.102	Production Tax Credit	National	-	-	Economic Instruments ↓ Fiscal incentives	Energy taxes & Tax exemptions
STUDY 2						

2.1	Electrification of all sectors	Supraregional	Transport Buildings Industry Agriculture & LULUCF	Electricity	-	-
2.2	Deployment of e-fuels and hydrogen	Supraregional	Transport ↓ Road, rail, aviation & shipping	Biofuels in mix Hydrogen veh/rails/planes/ships	Regulatory Instruments ↓ Codes and Standards	Vehicle fuel-economy and emissions standards
2.3	Development of CCS for bioenergy	Supraregional	Energy ↓ Electricity/Heat generation	Biomass with CCS	-	-
2.4	Strong penetration of VRE in the power sector	Supraregional	Energy ↓ Electricity/Heat generation	All renewable energies	Regulatory Instruments ↓ Targets, Quotas & Obligations	Renewable energy obligations
2.5	Energy Efficiency	Supraregional	Industry ↓ Overall Industry	Energy Efficiency	Regulatory Instruments ↓ Codes and Standards	Energy Efficiency Standards
2.6	Update of heating systems and expansion of district heating	Supraregional	Buildings ↓ Heating	All heating in buildings	Regulatory Instruments ↓ Targets, Quotas & Obligations	Thermal regulations
2.7	Electrification of transport	Supraregional	Transport ↓ Road, rail, aviation & shipping	Electric vehicles, rails, planes & ships	-	-

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2.8	Replacing remaining fossil fuel demands in industry and power generation with biogas and biomass.	Supraregional	Industry (all) Energy (electricity & heat)	Gas replacing oil/coal Biomass	Economic Instruments ↓ Market-based	Carbon Pricing
2.9	Use of CCS for natural gas plants and biomass power plants	National	Energy ↓ Electricity/Heat generation	Gas with CCS Biomass with CCS	-	-
2.10	Shutdown of gas-fired plants	National	Energy ↓ Electricity generation	-	Economic Instruments ↓ Market-based	Carbon Pricing
2.11	Deployment of energy storage	National	Energy ↓ Energy storage	All energy storage	-	-
STUDY 3						
3.1	Import tariffs to imported products	Supraregional	-	-	Economic Instruments ↓ Fiscal incentives ------ Regulatory Instruments ↓ Targets, Quotas & Obligations	Countervailing Duties ------ Trade-Related Investment Measures (TRIMs)
3.2	Prioritization of domestic green tech manufacturing	Supraregional	-	-	Economic Instruments ↓ Direct Inv. & Fiscal incentives	R&D&I funding Grants and subsidies

3.3	Stronger environmental regulations for the uptake of biomass and carbon storage	Supraregional	Industry ↓ Overall Industry --- Energy ↓ All	Biomass --- CCS (all technologies)	Economic Instruments ↓ Market-based --- Regulatory Instruments ↓ Targets, Quotas & Obligations	Carbon Pricing --- Renewable energy obligations
STUDY 4						
4.1	Steel trade related measures	Supraregional	Industry	-	Regulatory Instruments ↓ Targets, Quotas & Obligations	TRIMs
4.2	CO_2 Price	Supraregional	-	-	Economic Instruments ↓ Market-based	Carbon Pricing
STUDY 5						
5.1	Bioenergy limitation	Supraregional	Energy ↓ Electricity generation	-	Regulatory Instruments ↓ Targets, Quotas & Obligations	Renewable energy obligations
5.2	Phasing out unabated fossil power plants	Supraregional	Energy ↓ Electricity generation	-	Regulatory Instruments ↓ Targets, Quotas & Obligations	Renewable energy targets

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5.3	Eliminating petroleum-derived liquid transportation fuels		Supraregional	Transport ↓ Road, rail, aviation & shipping	Any measure including gas, hybrid, biofuels, hydrogen or electric	Regulatory Instruments ↓ Codes and Standards	Vehicle fuel-economy and emissions standards
5.4	Electrification of:	Buildings	Supraregional	Buildings ↓ Heating & cooling	Electricity	-	-
		Transportation		Transport ↓ Road, rail, aviation & shipping	Electric vehicles, rails, planes & ships	-	-
		Non-combustion-grade heat industrial sectors		Industry ↓ Process heat, machine drives & steam	Electricity	-	-
5.5	Reduction of fluorinated gas emissions		Supraregional	-	Industry ↓ Overall Industry	Economic Instruments ↓ Market-based ------ Regulatory Instruments ↓ Codes and Standards	Carbon pricing ------ Industrial air pollution standards
STUDY 6							
6.1	Grants and subsidies		Supraregional	-	-	Economic Instruments ↓ Fiscal incentives	Grants and subsidies

6.2	Carbon pricing	Global	-	-	Economic Instruments ↓ Market-based	Carbon Pricing
STUDY 7						
7.1	Change in diets to less meat intensive	Supraregional	Social & Behavioural ↓ Consumption	Change of diet	-	-
7.2	Change in diets to less ruminant intensive	Supraregional	Social & Behavioural ↓ Consumption	Change of diet	-	-
7.3	Change to local diary production (milk)	Supraregional	Social & Behavioural ↓ Consumption	Change of diet	-	-
7.4	Boosting local production of food (seasonal, organic)	Supraregional	Social & Behavioural ↓ Consumption	Change of values	-	-
7.5	Reduction of passenger-kilometre demand	Supraregional	Social & Behavioural ↓ Consumption	Travelling less Change mode of transport/occupancy	-	-
7.6	Private transport vs. Public transport	Supraregional	Social & Behavioural ↓ Consumption	Change mode of transport/occupancy	-	-
7.7	Changes in freight transport	Supraregional	Social & Behavioural ↓ Consumption	Change mode of transport/occupancy	-	-
7.8	Alternatives to short-haul flights: rail infrastructure	Supraregional	Social & Behavioural ↓ Consumption	Change mode of transport/occupancy	Economic Instruments ↓ Direct Investment	Infrastructure investments

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7.9	Reduce car activities: car sharing, bike sharing	Supraregional	Social & Behavioural ↓ Consumption	Travelling less Change mode of transport/occupancy	-	-
7.10	Modal shift to cycling (also rural)	Supraregional	Social & Behavioural ↓ Consumption	Change mode of transport/occupancy	-	-
7.11	Useful energy demand	Supraregional	Social & Behavioural ↓ Consumption	Less energy service demand	Regulatory Instruments ↓ Codes and Standards	Energy Efficiency Standards
7.12	Shift towards a reduction in the consumption level	Supraregional	Social & Behavioural ↓ Consumption	Change of values Lower Material Consumption Less Product Demand	-	-
ENERGY CRISIS						
8.1	Grants and subsidies for building retrofitting	Supraregional	-	-	Economic Instruments ↓ Fiscal incentives	Grants and subsidies
8.2	Building codes	Supraregional	-	-	Regulatory Instruments ↓ Codes and Standards	Building codes
8.3	Final energy demand target	Supraregional	Social & Behavioural ↓ Consumption	Less energy service demand	Regulatory Instruments ↓ Targets, Quotas & Obligations	Renewable electricity targets

8.4	Carbon pricing	Supraregional	-	-	Economic Instruments ↓ Market-based	Carbon Pricing
8.5	Direct de-investment (Russian gas ban)	Supraregional	-	-	Economic Instruments ↓ Direct Investment	Procurement rules
8.6	Building shell efficiency	Supraregional	Buildings ↓ Heating & Cooling	Building shell efficiency	-	-
8.7	Renewables for energy generation	Supraregional	Energy ↓ Electricity generation	All renewable energies	Regulatory Instruments ↓ Targets, Quotas & Obligations	Renewable energy obligations
8.8	Electricity (end use sectors)	Supraregional	Buildings, Industry, Agriculture, Transport	Electricity	-	-
SDG ANALYSIS						
10.1	Afforestation and Forest Expansion	Supraregional	Agriculture & LULUCF ↓ LULUCF	Afforestation	-	-
10.2	Promotion of more sustainable diets	Supraregional	Social & Behavioural ↓ Consumption	Change of diet	-	-
10.3	Forest Loss Limitation	Supraregional	Agriculture & LULUCF ↓ LULUCF	Land protection	-	-

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10.4	Forestry Self Sufficiency	Supraregional	Agriculture & LULUCF ↓ LULUCF	Afforestation Land Protection	-	-
10.5	Increase in the Share of Bioenergy in Transport Liquids and Gases (excluding synthetic fuels)	Supraregional	Transport ↓ Road, Aviation & Shipping	Biofuels in Fuel Mix	Regulatory Instruments ↓ Codes and Standards	Vehicle fuel-economy and emissions standards
10.6	Increasing Urban Land Density	Supraregional	Social & Behavioural ↓ Behavioural/Consumption --- Agriculture & LULUCF ↓ LULUCF	Less living space per person --- Land management policies	-	-
10.7	Transition to Regenerative Agriculture	Supraregional	Agriculture & LULUCF ↓ Land Practices	Agroforestry Organic fertilizer use No tillage	-	-
10.8	Protection of Managed Forest (40%)	Supraregional	Agriculture & LULUCF ↓ LULUCF	Land protection	-	-
10.9	Protection of Primary Forest (100%)	Supraregional	Agriculture & LULUCF ↓ LULUCF	Land protection	-	-
10.10	Expansion of Forest Plantations in 30%	Supraregional	Agriculture & LULUCF ↓ LULUCF	Afforestation	-	-
10.11	Carbon Tax to production and households with Revenue Recycling (social benefits, debt reduction…).	Supraregional	-	-	Economic Instruments ↓ Market-based ---	Carbon Pricing --- Loans, soft loans

					Economic Instruments ↓ Fiscal Incentives	
10.12	Higher Limitation on Energy Consumption for Non-Durable Goods to 10%	Supraregional	Social & Behavioural ↓ Consumption	Less energy service demand	Regulatory Instruments ↓ Codes and Standards	Energy Efficiency Standards
10.13	Capping Annual Consumption Growth at 2% for Durable and Non-Durable Goods	Supraregional	Social & Behavioural ↓ Consumption	Change of values Lower Material Consumption Less Product Demand	Regulatory Instruments ↓ Codes and Standards	Product Standards
10.14	Higher government consumption in education (40% since 2030)	Supraregional	-	-	Soft Instruments ↓ Direct Investment	Information provision
10.15	Promotion of Renewables over Fossil Fuels in the Energy Mix	Supraregional	-	-	Economic Instruments ↓ Fiscal Incentives	FITs/FIPs
10.16	Intensification of Annual Energy Savings per Economic Output (Energy Intensity) by 50%	Supraregional	Industry ↓ Overall Industry	Energy Efficiency	Regulatory Instruments ↓ Codes and Standards	Energy Efficiency Standards
10.17	Availability of Non-Mature Technologies (Offshore floating wind, oceanic energy & CCS)	Supraregional	Energy ↓ Electricity generation	Offshore Wind Biomass with CCS Coal with CCS Gas with CCS	-	-

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10.18	Utilization of Rooftop Areas for Solar Technologies	Supraregional	Energy ↓ Electricity generation	Solar PV	-	-
10.19	Solar PV Efficiency Improvement	Supraregional	Energy ↓ Electricity generation	Solar PV	Regulatory Instruments ↓ Targets, Quotas & Obligations	Efficiency Targets
10.20	Increase in Fuel Efficiency in Transport by 15%	Supraregional	Transport ↓ Road, Rail, Aviation & Shipping	Efficiency	Regulatory Instruments ↓ Targets, Quotas & Obligations	Efficiency Targets
10.21	Improvement in Water Efficiency by 25%	Supraregional	Water	Water management (efficient and saving)	Regulatory Instruments ↓ Targets, Quotas & Obligations	Efficiency Targets
10.22	Reduction in Material Intensities and Increased Recycling Rates	Supraregional	Social & Behavioural ↓ Consumption	Lower Material Consumption Less Product Demand	-	-
PILOT COUNTRIES						
11.1 & 11.11	Grid expansion and electrification	National	Transport Buildings Industry Agriculture & LULUCF Electricity generation	Electricity	-	-
11.2 & 11.7	Energy efficiency in industrial, residential and commercial energy sectors	National	Buildings Overall Industry	Energy efficiency	Regulatory Instruments ↓ Codes and Standards	Energy Efficiency Standards

11.3 & 11.8	Water resource management: supply and demand for agriculture, power plants and public use	National	Water	Water management (efficient and saving)	-	-
11.4 & 11.9	Sustainable agriculture	National	Agriculture & LULUCF ↓ Land Practices	Agroforestry Organic fertilizer use No tillage	-	-
11.5	Afforestation and forest conservation	National	Agriculture & LULUCF ↓ LULUCF	Afforestation Land Protection	-	-

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4.2 Step 2 – Link between policy types and IAM COMPACT models

After mapping the policies used through the project and linking them to their corresponding categories, the next stage in creating the policy catalogue is to pinpoint which IAM COMPACT models have the modelling capacity to represent them. This activity is of particular relevance to guide the organisation and planning of modelling activities using the IAM COMPACT models.

Modelling capabilities have already been brought together in **Section 2** through the heatmaps and will now be exploited here. As in **Section 2**, the difference between a direct modelling and a proxy is shown by writing the latter in *italics*.

From this point onwards, tables will not include each policy type individually, i.e. if three policies from the same study has been clustered as "afforestation", it will only appear once within the table, and not three separated times, but they can be identified with the tracking number that appear in **Table 12** to **Table 21**.

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Table 27. Step 2 – Link between policies and IAMs for the 1st PRM cycle

Tracking numbers	Policy type	Policy instrument	IAM COMPACT models
STUDY 1			
1.1, 1.12, 1.19, 1.36, 1.69, 1.75, 1.82, 1.84, 1.96, 1.99	Electricity generation	Renewable electricity targets/obligations	GCAM/USA, MUSE, TIAM, CLEWs, MEDEAS, WILIAM, OSeMOSYS, CHANCE, IMACLIM-China, AIM/ENDUSE-India, Calliope, China-MAPLE, EXPANSE, MENA-EDS, PROMETHEUS, WTMBT, DyNERIO, EnergyPLAN & *CHANCE*
1.2, 1.10, 1.81	Gas replacing coal Renewable energies	Carbon pricing Removal of fossil fuel subsidies	CHANCE, GCAM/USA, TIAM, CLEWs, WILIAM, Calliope, China-MAPLE, MENA-EDS, OSeMOSYS, PROMETHEUS, WISEE-EDM-I, WISEE-EDM-GS, WTMBT, *DyNERIO* & *MEDEAS*
1.3, 1.23, 1.61, 1.70, 1.86	-	Carbon pricing	GCAM/USA, MUSE, TIAM, CLEWs, WILIAM, OSeMOSYS, CHANCE, IMACLIM-China, AIM/ENDUSE-India, Calliope, China-MAPLE, EXPANSE, MENA-EDS, PROMETHEUS, DREEM, WISEE-EDM-I, WTMBT, *DyNERIO*, *EnergyPLAN* & *ATOM*
1.4, 1,8, 1.17, 1.58, 1.78, 1.87	Biofuels in mix	Vehicle fuel-economy and emissions standards	GCAM/USA, MUSE, TIAM, CLEWS, MEDEAS, China-MAPLE, OSeMOSYS, *PROMETHEUS*, *MEDA-EDS*, *AIM/ENDUSE-India* & *WILIAM*
1.5, 1.20, 1.27, 1.33, 1.34, 1.35, 1.59, 1.72, 1.73	Afforestation Land Protection	-	GCAM/USA, MUSE, CLEWS, WILIAM & OSeMOSYS
1.6, 1.7, 1.11, 1.29, 1.32, 1.38, 1.42, 1.46, 1.53, 1.63, 1.88	Electricity generation	Infrastructure investments Grants and subsidies Renewable energy obligations	MUSE, TIAM, CLEWs, WILIAM, OSeMOSYS, AIM/ENDUSE-India, MEDEAS, EXPANSE, WTMBT, *PROMETHEUS*, *CHANCE*, *IMACLIM-China*, *GCAM/USA*, *EnergyPLAN* & *MENA-EDS*
1.9	Building measures	Building codes	DREEM, *GCAM/USA*, *AIM/ENDUSE-India*, *MENA-EDS*, *PROMETHEUS* & *ATOM*
1.13, 1.55, 1.56, 1.89	Pumped hydro and batteries (energy storage capacity)	-	MUSE, CLEWs, WILIAM, Calliope, OSeMOSYS
1.14, 1.18, 1.25, 1.31, 1.50, 1.52, 1.57, 1.66, 1.74, 1.92, 1.97, 1.101	-	Carbon pricing Industrial air pollution standards	CHANCE, GCAM/USA, CLEWs, DyNERIO, OSeMOSYS, WTMBT, MUSE & AIM/ENDUSE-India
1.16, 1.30, 1.44, 1.54, 1.94	Electrolysis	Targets for electrolyser capacity	TIAM, CLEWs, OSeMOSYS

1.65, 1.77, 1.93	Hydrogen	Renewable electricity targets/obligations	GCAM/USA, TIAM, China-MAPLE, MENA-EDS, PROMETHEUS, CLEWs, OSeMOSYS, Calliope, EnergyPLAN, WISEE-EDM-I, WISEE-EDM-GS, *MUSE*, *AIM/ENDUSE-India* & *MEDEAS*
1.24, 1.40, 1.68, 1.103	Hybrid/Fully electric vehicles	EV sales targets	MUSE, *AIM/ENDUSE-India*, TIAM, CLEWs, MENA-EDS, PROMETHEUS, OSeMOSYS, *WTMBT* & *DyNERIO*
1.15, 1.21, 1.28, 1.39, 1.45, 1.67, 1.71, 1.79, 1.85, 1.91, 1.98	Efficiency in light duty vehicles	Vehicle fuel-economy and emissions standards	MUSE, AIM/ENDUSE-India, TIAM, CLEWs, DyNERIO, MEDEAS, WILIAM, China-MAPLE, MENA-EDS, OSeMOSYS, PROMETHEUS, WTMBT, *EnergyPLAN* & *GCAM/USA*
1.22, 1.26, 1.47, 1.48, 1.80	Biofuels in mix	Vehicle fuel-economy and emissions standards Emissions target	GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, MEDEAS, China-MAPLE, MENA-EDS, PROMETHEUS, *CLEWs*, *DyNERIO*, *OSeMOSYS*, *EnergyPLAN* & *WILIAM*
1.49, 1.100	Aviation measures	Vehicle fuel-economy and emissions standards Carbon pricing	GCAM/USA, MUSE, TIAM, AIM/ENDUSE-India, MEDEAS, China-MAPLE, MENA-EDS, PROMETHEUS, *CLEWs, WILIAM* & *OSeMOSYS*
1.37, 1.43, 1.62, 1.76, 1.83, 1.90	Energy efficiency	Energy Efficiency Standards/Targets	*MUSE*, *MENA-EDS*, *PROMETHEUS* & *WILIAM*
1.68	Energy efficiency (cooling)	Energy Efficiency Standards/Targets	GCAM/USA, MENA-EDS, PROMETHEUS, DREEM, *EnergyPLAN, MUSE, AIM/ENDUSE-India, TIAM, CLEWs, Calliope* & *OSeMOSYS*
1.51, 1.64	CCS, NETs…	RD&D funding Credit for captured CO_2	IMACLIM-China, GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, CLEWs, DyNERIO, WILIAM, Calliope, China-MAPLE, EnergyPLAN, MENA-EDS, OSeMOSYS, PROMETHEUS, WISEE-EDM-I, WISE-EDM-GS
1.41, 1.95	Less energy service demand	-	DREEM, *AIM/ENDUSE-India*, *MUSE*, *CLEWS*, *MENA-EDS*, *OSeMOSYS*, *PROMETHEUS* & *WILIAM*
1.102	-	Energy taxes & Tax exemptions	*CHANCE*, IMACLIM-China, *GCAM/USA*, DyNERIO, WILIAM, China-MAPLE, EXPANSE, MENA-EDS, PROMETHEUS, DREEM, ATOM, WTMBT, *MUSE, AIM/ENDUSE-India, TIAM, CLEWs, EnergyPLAN, OSeMOSYS* & *WISEE-EDM-I*
STUDY 2			
2.1	Electricity (all)	-	GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, CLEWs, DyNERIO, Calliope, China-MAPLE, MENA-EDS, OSeMOSYS, PROMETHEUS, *DREEM, ATOM, WISEE-EDM-I, WTMBT, EnergyPLAN, EXPANSE, MEDEAS* & *WILIAM*

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2.2	Biofuels in mix Hydrogen veh/rails/planes/ships	Vehicle fuel-economy and emissions standards	GCAM/USA, MUSE, TIAM, *CLEWs, AIM/ENDUSE-India, MENA-EDS, PROMETHEUS, WILIAM & OSeMOSYS*
2.3	Biomass with CCS	-	IMACLIM-China, GCAM/USA, MUSE, TIAM, CLEWS, WILIAM, OSeMOSYS, AIM/ENDUSE-India, Calliope, China-MAPLE, MENA-EDS, PROMETHEUS, WTMBT, DyNERIO & EnergyPLAN
2.4	Renewable energy generation	Renewable energy obligations	GCAM/USA, CLEWs, DyNERIO, WILIAM, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS, WTMBT, MEDEAS, *CHANCE, MUSE, AIM/ENDUSE-India* & *TIAM*
2.5	Energy Efficiency (industry)	Energy Efficiency Standards	*MUSE*, *MENA-EDS*, *PROMETHEUS* & *WILIAM*
2.6	Heating in buildings	Thermal regulations	GCAM/USA, TIAM, CLEWs, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM & *EnergyPLAN*
2.7	Electric vehicles, rails, planes & ships	-	GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, CLEWs, WILIAM, China-MAPLE, MENA-EDS, OSeMOSYS, PROMETHEUS, *EnergyPLAN, EXPANSE, DyNERIO* & *WTMBT*
2.8	Gas replacing oil/coal Biomass	Carbon Pricing	CHANCE, GCAM/USA, TIAM, CLEWs, WILIAM, Calliope, China-MAPLE, MENA-EDS, OSeMOSYS, PROMETHEUS, WISEE-EDM-I, WTMBT, *AIM/ENDUSE-India, MUSE, DyNERIO, EnergyPLAN* & *EXPANSE*
2.9	Gas with CCS Biomass with CCS	-	IMACLIM-China, GCAM/USA, MUSE, TIAM, CLEWS, WILIAM, OSeMOSYS, AIM/ENDUSE-India, Calliope, China-MAPLE, MENA-EDS, PROMETHEUS, WTMBT, DyNERIO EnergyPLAN & *EXPANSE*
2.10	-	Carbon Pricing	GCAM/USA, MUSE, TIAM, CLEWs, WILIAM, OSeMOSYS, CHANCE, IMACLIM-China, AIM/ENDUSE-India, Calliope, China-MAPLE, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM, WISEE-EDM-I, WTMBT, *DyNERIO*, *EnergyPLAN* & *ATOM*
2.11	Energy storage	-	MUSE, CLEWs, WILIAM, Calliope, OSeMOSYS
STUDY 3			
3.1	-	Countervailing Duties TRIMs	CLEWs, OSeMOSYS, GCAM, TIAM & *AIM/ENDUSE-India*
3.2	-	RD&D funding Grants and subsidies	PROMETHEUS, *DREEM* & *WISEE-EDM-I*
3.3	Biomass CCS (all technologies)	Carbon Pricing Renewable energy obligations	GCAM/USA, CLEWs, WILIAM, MENA-EDS, OSeMOSYS, PROMETHEUS, *DyNERIO, MUSE, AIM/ENDUSE-India & TIAM.*

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STUDY 4			
4.1	-	TRIMs	CLEWs, OSeMOSYS, GCAM, TIAM & *AIM/ENDUSE-India*
4.2	-	Carbon Pricing	GCAM/USA, MUSE, TIAM, CLEWs, WILIAM, OSeMOSYS, CHANCE, IMACLIM-China, AIM/ENDUSE-India, Calliope, China-MAPLE, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM, WISEE-EDM-I, WTMBT, *DyNERIO*, *EnergyPLAN* & *ATOM*
STUDY 5			
5.1	-	Renewable energy obligations	CHANCE, GCAM/USA, CLEWs, DyNERIO, MEDEAS, WILIAM, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM, ATOM, WTMBT, *MUSE, AIM/ENDUSE-India* & *TIAM*
5.2	-	Carbon Pricing	GCAM/USA, MUSE, TIAM, CLEWs, WILIAM, OSeMOSYS, CHANCE, IMACLIM-China, AIM/ENDUSE-India, Calliope, China-MAPLE, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM, WISEE-EDM-I, WTMBT, *DyNERIO*, *EnergyPLAN* & *ATOM*
5.3	Any measure including gas, hybrid, biofuels, hydrogen or electric	Vehicle fuel-economy and emissions standards	GCAM/USA, MUSE, TIAM, CLEWs, WILIAM, MEDEAS, OSeMOSYS & *AIM/ENDUSE-India*
5.4	Electrification of buildings	-	GCAM/USA, MUSE, TIAM, AIM/ENDUSE-India, CLEWs, DyNERIO Calliope, China-MAPLE, EnergyPLAN, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM, ATOM, WTMBT, *MEDEAS* & EXPANSE
	Electrification of transport		GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, CLEWs, WILIAM, China-MAPLE, MENA-EDS, OSeMOSYS, PROMETHEUS, *EnergyPLAN, EXPANSE, DyNERIO* & *WTMBT*
	Electrification of industry		GCAM/USA, AIM/ENDUSE-India, TIAM, CLEWs, WILIAM, Calliope, China-MAPLE, EnergyPLAN, MENA-EDS, OSeMOSYS, PROMETHEUS, WISEE-EDM-I, WTMBT, *MUSE, MEDEAS* & *EXPANSE*
5.5	-	Industrial air pollution standards	CHANCE, GCAM/USA, CLEWs, DyNERIO, OSeMOSYS, WTMBT, *MUSE & AIM/ENDUSE-India*
STUDY 6			
6.1	-	Grants and subsidies	CHANCE, IMACLIM-China, GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, DyNERIO, WILIAM, Calliope, China-MAPLE, EXPANSE, MENA-EDS, PROMETHEUS, DREEM, ATOM, WTMBT, *CLEWs, OSeMOSYS* & *WISEE-EDM-I*

6.2	-	Carbon Pricing	GCAM/USA, MUSE, TIAM, CLEWs, WILIAM, OSeMOSYS, CHANCE, IMACLIM-China, AIM/ENDUSE-India, Calliope, China-MAPLE, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM, WISEE-EDM-I, WTMBT, *DyNERIO*, *EnergyPLAN* & *ATOM*
STUDY 7			
7.1, 7,2 & 7.3	Change of diet	-	GCAM/USA, WILIAM, *CHANCE*, *MUSE*, *CLEWS*, *OSeMOSYS* & *DREEM*
7.4	Change of values	-	ATOM, WILIAM, *MUSE* & *DREEM*
7.5 & 7.9	Travelling less Change mode of transport/occupancy	-	CHANCE, GCAM/USA, WILIAM, MENA-EDS, PROMETHEUS, *MUSE, AIM/ENDUSE-India, TIAM, CLEWs, MEDEAS, China-MAPLE, OSeMOSYS* & *WTMBT*
7.6, 7.7, 7.8 & 7.10	Change mode of transport/occupancy	-	CHANCE, GCAM/USA, WILIAM, MENA-EDS, PROMETHEUS, China-MAPLE, *MUSE, AIM/ENDUSE-India, TIAM, CLEWs, MEDEAS, OSeMOSYS* & *WTMBT*
7.11	Less energy service demand	Energy Efficiency Standards	DREEM, *MUSE, AIM/ENDUSE-India, CLEWs, WILIAM, PROMETHEUS* & *OSeMOSYS*
7.12	Change of values Lower Material Consumption Less Product Demand	-	*MUSE, WILIAM, DREEM, CLEWs, OSeMOSYS, PROMETHEUS* & *TIAM*
ENERGY CRISIS			
8.1	-	Grants and subsidies	CHANCE, IMACLIM-China, GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, DyNERIO, WILIAM, Calliope, China-MAPLE, EXPANSE, MENA-EDS, PROMETHEUS, DREEM, ATOM, WTMBT, *CLEWs, OSeMOSYS* & *WISEE-EDM-I*
8.2	-	Building codes	DREEM, *GCAM/USA*, *AIM/ENDUSE-India, MENA-EDS, PROMETHEUS* & *ATOM.*
8.3	Less energy service demand	Renewable electricity targets	MENA-EDS, PROMETHEUS, DREEM, *MUSE, AIM/ENDUSE-India, TIAM, CLEWs, OSeMOSYS* & *WTMBT*
8.4	-	Carbon Pricing	GCAM/USA, MUSE, TIAM, CLEWs, WILIAM, OSeMOSYS, CHANCE, IMACLIM-China, AIM/ENDUSE-India, Calliope, China-MAPLE, EXPANSE, MENA-EDS, PROMETHEUS, DREEM, WISEE-EDM-I, WTMBT, *DyNERIO*, *EnergyPLAN* & *ATOM*
8.5	-	Procurement rules	*WISEE-EDM-I*

8.6	Building shell efficiency	-	GCAM/USA, MENA-EDS, PROMETHEUS, DREEM, *MUSE, TIAM, MEDEAS, Calliope* & *EnergyPLAN*
8.7	All renewable energies	Renewable energy obligations	CHANCE, GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, CLEWs, DyNERIO, MEDEAS, WILIAM, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS & WTMBT
8.8	Electricity	-	GCAM/USA, MUSE, TIAM, CLEWs, DyNERIO, WILIAM, Calliope, China-MAPLE, EnergyPLAN, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM, ATOM, WTMBT, *MEDEAS* & *EXPANSE*
SDG ANALYSIS			
10.1 & 10.10	Afforestation	-	GCAM/USA, MUSE, TIAM, CLEWS, WILIAM & OSeMOSYS
10.2	Change of diet	-	GCAM/USA, WILIAM, *CHANCE*, *MUSE*, *CLEWS*, *OSeMOSYS* & *DREEM*
10.3, 10.8 & 10.9	Land protection	-	GCAM/USA, MUSE, CLEWS, WILIAM & OSeMOSYS
10.4	Afforestation Land Protection	-	GCAM/USA, MUSE, CLEWS, WILIAM & OSeMOSYS
10.5	Biofuels in Fuel Mix	Vehicle fuel-economy and emissions standards	GCAM/USA, MUSE, TIAM, CLEWS, MEDEAS, China-MAPLE, OSeMOSYS, *PROMETHEUS*, *MEDA-EDS*, *AIM/ENDUSE-India* & *WILIAM*
10.6	Less living space per person	-	ATOM, WILIAM, *MUSE* & *DREEM*
10.7	Agroforestry Land yield maximisation Organic fertilizer use	-	CLEWS, OSeMOSYS & *WILIAM*
10.12	-	Carbon Pricing	GCAM/USA, MUSE, TIAM, CLEWS, WILIAM, OSeMOSYS, CHANCE, IMACLIM-China, AIM/ENDUSE-India, Calliope, China-MAPLE, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS, DREEM, WISEE-EDM-I, WTMBT, *DyNERIO*, *EnergyPLAN* & *ATOM*
10.13	Less energy service demand	Energy Efficiency Standards	DREEM, *AIM/ENDUSE-India*, *MUSE*, *CLEWS*, *MENA-EDS*, *OSeMOSYS*, *PROMETHEUS* & *WILIAM*
10.14	Change of values Lower Material Consumption Less Product Demand	Product Standards	*MUSE* & *WILIAM*
10.15	-	FITs/FIPs	GCAM/USA, WILIAM, CHANCE, EXPANSE, MENA-EDS, PROMETHEUS, DREEM, ATOM, *MUSE & TIAM*
10.16	Energy Efficiency (Industry)	Energy Efficiency Standards	*MUSE*, *MENA-EDS*, *PROMETHEUS* & *WILIAM*

10.17	Offshore Wind Biomass with CCS	-	GCAM/USA, MUSE, TIAM, CLEWS, WILIAM, OSeMOSYS, AIM/ENDUSE-India, Calliope, China-MAPLE, MENA-EDS, PROMETHEUS, WTMBT, DyNERIO & EnergyPLAN
10.18	Solar PV	-	GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, CLEWs, DyNERIO, MEDEAS, WILIAM, Calliope, China-MAPLE, EnergyPLAN, EXPANSE, MENA-EDS, OSeMOSYS, PROMETHEUS, ATOM, WTMBT & *CHANCE*
10.19	Solar PV	Efficiency Targets	GCAM, GCAM-USA, AIM/ENDUSE-India, TIAM, MENA-EDS, PROMETHEUS, *CLEWS, WILIAM* & *OSeMOSYS.*
10.20	Efficiency (Transport)	Efficiency Targets	AIM/ENDUSE-India, MENA-EDS, *GCAM/USA*, *CLEWS, OSeMOSYS* & *WILIAM*
10.21	Water management (efficient and saving)	Efficiency Targets	GCAM/USA, *CLEWS*, *WILIAM* & *OSeMOSYS*
10.22	Lower Material Consumption Less Product Demand	-	MENA-EDS, PROMETHEUS, *MUSE*, *AIM/ENDUSE-India*, *TIAM*, *CLEWS*, *WILIAM*, *OSeMOSYS* & *DREEM*
PILOT COUNTRIES			
11.1 & 11.11	Electricity (all)	-	GCAM/USA, MUSE, AIM/ENDUSE-India, TIAM, CLEWs, DyNERIO, Calliope, China-MAPLE, MENA-EDS, OSeMOSYS, PROMETHEUS, *DREEM, ATOM, WISEE-EDM-I, WTMBT, EnergyPLAN, EXPANSE, MEDEAS* & *WILIAM*
11.2 & 11.7	Energy efficiency (buildings & industry)	Energy Efficiency Standards	WILIAM, MENA-EDS, PROMETHEUS, *CLEWs, OSeMOSYS, GCAM/USA*, *MUSE* & *DyNERIO*
11.3 & 11.8	Water management (efficient and saving)	-	GCAM/USA, CLEWS, WILIAM & OSeMOSYS
11.4 & 11.9	Agroforestry Organic fertilizer use	-	CLEWS, OSeMOSYS & *WILIAM*
11.5	Afforestation Land Protection	-	GCAM/USA, MUSE, CLEWS, WILIAM & OSeMOSYS

Table 28 shows the definitive allocation of the modelling efforts among the IAM COMPACT consortium models. This distribution was made taking into consideration not only their modelling capabilities, but also an equitable sharing of workload among the different studies and modelling teams taking also into account the specific role in each study.

Table 28. Modelling work allocation among IAMs for the 1st PRM cycle

Study	Models
Study 1	TIAM, PROMETHEUS, GCAM DREEM & OSeMOSYS (at the national level)
Study 2	OSeMOSYS, EnergyPLAN, MARIO
Study 3	GCAM, TIAM, PROMETHEUS, MARIO
Study 4	GCAM, TIAM, WILIAM, WISEE-EDM-I, MARIO
Study 5	GCAM
Study 6	GCAM, TIAM OSeMOSYS (at the national & European level)
Study 7	GCAM, WILIAM ATOM (at the national level)
Energy Crisis	GCAM, TIAM, MUSE, PROMETHEUS, EXPANSE, MARIO
COVID-19 Analysis	GCAM, PROMETHEUS, TIAM DREEM & OSeMOSYS (at the national level)
SDG Analysis	GCAM, WILIAM
Pilot Countries Modelling	CLEWs, OnSSET EnergyPLAN & OSeMOSYS (at the national level)

4.3 Step 3 – Synergies and Trade-offs across policy types

The method for drawing up the policy catalogue concludes in this third step with the association of the policy types to the Sustainable Development Goals they impact on, indicating the beneficial or detrimental nature of it, i.e. the synergies and trade-offs generated.

To understand the rationale behind this sorting of impacts, see **Sections 1.2.2** (theoretical explanation or the literature review) and **2.3** (presentation and explanation of the matrix), but it is worth mentioning again that it has only been carried out for the list of policy types (originally introduced in **Section 3**) and not for the policy instruments, as the identification of impacts of instruments on the SDGs would have increased the complexity of the analysis, which due to time constraints and lack of literature has not been addressed. This is the reason because some policy questions and even entire studies are not included in **Table 29**.

Table 29. Step 3 – Link between policy types, SDGs and their impacts for the 1st PRM cycle

Tracking numbers	Policy type	SDGs impacted	Synergies	Trade-offs	Both
STUDY 1					
1.1, 1.12, 1.19, 1.36, 1.69, 1.75, 1.82, 1.84, 1.96, 1.99, 1.6, 1.7, 1.11, 1.29, 1.32, 1.38, 1.42, 1.46, 1.53, 1.63, 1.88	Electricity generation	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG7, SDG8	-	SDG2, SDG3, SDG6, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15
1.2, 1.10, 1.81	Gas replacing coal Renewable energies	SDG3, SDG7, SDG13	SDG3	-	SDG7, SDG13
1.4, 1,8, 1.17, 1.58, 1.78, 1.87, 1.22, 1.26, 1.47, 1.48, 1.80	Biofuels in mix	SDG1, SDG2, SDG12, SDG15	-	SDG1, SDG2, SDG12, SDG15	-
1.5, 1.20, 1.27, 1.33, 1.34, 1.35, 1.59, 1.72, 1.73	Afforestation Land Protection	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG12, SDG13, SDG14, SDG15	SDG1, SDG3, SDG6, SDG8, SDG9, SDG12, SDG13, SDG14	SDG2	SDG7, SDG10, SDG15
1.13, 1.55, 1.56, 1.89	Pumped hydro and batteries (energy storage capacity)	SDG6, SDG7, SDG9, SDG10, SDG11, SDG13, SDG15	SDG7, SDG11, SDG13	SDG6, SDG10, SDG15	SDG9
1.16, 1.30, 1.44, 1.54, 1.94	Electrolysis	SDG3, SDG7, SDG8, SDG9, SDG12, SDG13	SDG3, SDG8, SDG9, SDG13	-	SDG7, SDG12
1.65, 1.77, 1.93	Hydrogen in industry	SDG8, SDG9, SDG10, SDG12, SDG13	SDG9	SDG10	SDG8, SDG12, SDG13
1.24, 1.40, 1.68, 1.103	Hybrid/Fully electric vehicles	SDG3, SDG7, SDG11, SDG13	SDG3, SDG7, SDG11, SDG13	-	-
1.15, 1.21, 1.28, 1.39, 1.45, 1.67, 1.71, 1.79, 1.85, 1.91, 1.98	Efficiency in light duty vehicles	SDG3, SDG11, SDG13	SDG3, SDG11, SDG13	-	-

1.49, 1.100	Aviation measures	SDG1, SDG2, SDG3, SDG12, SDG13, SDG15	SDG3, SDG13	SDG1, SDG2, SDG12, SDG15	
1.37, 1.43, 1.62, 1,68 1.76, 1.83, 1.90	Energy efficiency	SDG3, SDG5, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13	SDG3, SDG5, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13	-	-
1.51, 1.64	CCS, NETs…	SDG3, SDG6, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13, SDG15	SDG9, SDG11, SDG13	SDG6, SDG15	SDG3, SDG7, SDG12
1.41, 1.95	Less energy service demand	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG3, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG2, SDG8, SDG9	-
STUDY 2					
2.1	Electricity (all)	SDG7, SDG10, SDG11, SDG12, SDG13	-	SDG10	SDG7, SDG11, SDG12, SDG13
2.2	Biofuels in mix Hydrogen veh/rails/planes/ships	SDG1, SDG2, SDG3, SDG11, SDG12, SDG13, SDG15	SD3, SDG11, SDG13	SDG1, SDG2, SDG12, SDG15	-
2.3, 2.9	Gas with CCS Biomass with CCS	SDG3, SDG6, SDG8, SDG9, SDG12, SDG13	SDG3, SDG8, SDG9, SDG13	SDG6	SDG12
2.4	Renewable energy generation	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG7, SDG8	-	SDG2, SDG3, SDG6, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15
2.5	Energy Efficiency (industry)	SDG7, SDG8, SDG9, SDG12, SDG13	SDG7, SDG8, SDG9, SDG12, SDG13	-	-
2.6	Heating in buildings	SDG2, SDG3, SDG5, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SD13, SDG15	SDG3, SDG5, SDG9, SDG11, SDG15	SDG2, SDG10	SDG7, SDG8, SDG12, SDG13
2.7	Electric vehicles, rails, planes & ships	SDG3, SDG7, SDG11, SDG13	SDG3, SDG7, SDG11, SDG13	-	-
2.8	Gas replacing oil/coal	SDG3, SDG7, SDG8, SDG13, SDG15	SDG3, SDG15	SDG8	SDG7, SDG13
2.11	Energy storage	SDG3, SDG6, SDG7, SDG9, SDG10, SDG11, SDG13, SDG15	SDG3, SDG7, SDG12, SDG13	SDG6, SDG10, SDG15	SDG9, SDG11

STUDY 3					
3.3	Biomass CCS (all technologies)	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG12, SDG13, SDG14, SDG15	SDG1, SDG8, SDG9	SDG2, SDG6, SDG14, SDG15	SDG3, SDG7, SDG12, SDG13
STUDY 5					
5.3	Any measure including gas, hybrid, biofuels, hydrogen or electric transportation	SDG1, SDG2, SDG3, SDG7, SDG11, SDG12, SDG13, SDG15	SDG3, SDG7, SDG11, SDG13	SDG1, SDG2, SDG12, SDG15	-
5.4	Electrification of buildings	SDG7, SDG11, SDG12, SDG13	-	-	SDG7, SDG11, SDG12, SDG13
	Electrification of transport	SDG3, SDG7, SDG11, SDG13	SDG3, SDG7, SDG11, SDG13	-	-
	Electrification of industry	SDG7, SDG8, SDG10, SDG13	-	-	SDG7, SDG8, SDG10, SDG13
STUDY 7					
7.1, 7,2, 7.3	Change of diet	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG2, SDG3, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG8, SDG9	-
7.5 & 7.9	Travelling less Change mode of transport/occupancy	SDG1, SDG2, SDG3, SDG4, SDG5, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13	SDG3, SDG5, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13	SDG2	SDG1, SDG4, SDG8, SDG9
7.6, 7.7, 7.8 & 7.10	Change mode of transport/occupancy	SDG5, SDG7, SDG8, SDG9, SDG10, SDG12	SDG5, SDG7, SDG9, SDG10, SDG12	-	SDG8
7.11	Less energy service demand	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG3, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG2, SDG8, SDG9	-
7.12	Change of values Lower Material	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG3, SDG6, SDG7, SDG10, SDG11,	SDG1, SDG2, SDG8, SDG9	-

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	Consumption Less Product Demand		SDG12, SDG13, SDG14, SDG15		
ENERGY CRISIS					
8.3	Less energy service demand	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG3, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG2, SDG8, SDG9	-
8.6	Building shell efficiency	SDG3, SDG5, SDG8, SDG9, SDG11, SDG12, SDG13	SDG3, SDG5, SDG8, SDG9, SDG11, SDG12, SDG13	-	-
8.7	All renewable energies	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG7, SDG8	-	SDG2, SDG3, SDG6, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15
8.8	Electricity	SDG7, SDG10, SDG11, SDG12, SDG13	-	SDG10	SDG7, SDG11, SDG12, SDG13
SDG ANALYSIS					
10.1 & 10.10	Afforestation	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG12, SDG13, SDG15	SDG1, SDG3, SDG6, SDG8, SDG9, SDG12, SDG13	SDG2	SDG7, SDG10, SDG15
10.2	Change of diet	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG2, SDG3, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG8, SDG9	-
10.3, 10.8 & 10.9	Land protection	SDG2, SDG13, SDG14, SDG15	SDG13, SDG14, SDG15	-	SDG2
10.4	Afforestation Land Protection	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG12, SDG13, SDG14, SDG15	SDG1, SDG3, SDG6, SDG8, SDG9, SDG12, SDG13, SDG14	SDG2	SDG7, SDG10, SDG15
10.5	Biofuels in Fuel Mix	SDG1, SDG2, SDG12, SDG15	-	SDG1, SDG2, SDG12, SDG15	-

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10.7	Agroforestry Land yield maximisation Organic fertilizer use	SDG1, SDG2, SDG3, SDG4, SDG6, SDG8, SDG10, SDG12, SDG13, SDG14, SDG15	SDG1, SDG2, SDG3, SDG4, SDG6, SDG10, SDG12	-	SDG8, SDG13, SDG14, SDG15
10.13	Less energy service demand	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG3, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG2, SDG8, SDG9	-
10.14, 10.22	Change of values Lower Material Consumption Less Product Demand	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG3, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15	SDG1, SDG2, SDG8, SDG9	-
10.16	Energy Efficiency (Industry)	SDG7, SDG8, SDG9, SDG12, SDG13	SDG7, SDG8, SDG9, SDG12, SDG13	-	-
10.17	Offshore Wind Biomass with CCS	SDG1, SDG2, SDG3, SDG8, SDG9, SDG13, SDG14	SDG3, SDG8, SDG9, SDG13	SDG1, SDG2, SDG14	-
10.18, 10.19	Solar PV	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG11, SDG13, SDG15	SDG1, SDG3, SDG6, SDG7, SDG8, SDG9, SDG11, SDG13	-	SDG2, SDG15
10.20	Efficiency (Transport)	SDG3, SDG11, SDG13	SDG3, SDG11, SDG13	-	-
10.21	Water management (efficient and saving)	SDG6, SDG8, SDG10, SDG12	SDG6, SDG12	SDG8, SDG10	-
PILOT COUNTRIES					
11.1 & 11.11	Electricity (all)	SDG7, SDG10, SDG11, SDG12, SDG13	-	SDG10	SDG7, SDG11, SDG12, SDG13
11.2 & 11.7	Energy efficiency (buildings & industry)	SDG3, SDG5, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13	SDG3, SDG5, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13	-	-
11.3 & 11.8	Water management (efficient and saving)	SDG6, SDG8, SDG10, SDG12	SDG6, SDG12	SDG8, SDG10	-
11.4 & 11.9	Agroforestry Organic fertilizer use	SDG1, SDG2, SDG3, SDG4, SDG6, SDG8, SDG12, SDG13, SDG14, SDG15	SDG1, SDG2, SDG3, SDG4, SDG6, SDG12	-	SDG8, SDG13, SDG14, SDG15

11.5	Afforestation Land Protection	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG12, SDG13, SDG14, SDG15	SDG1, SDG3, SDG6, SDG8, SDG9, SDG12, SDG13, SDG14	SDG2	SDG7, SDG10, SDG15

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5 Application of the method for the 2nd PRM cycle – Translating policy needs into scenario frameworks

5.1 Step 1 – From policy needs to policy types

Analogous to Section 4.1, in **Table 30** the policy needs already identified for the 2nd PRM cycle are classified according to the same parameters. The different new policy needs to be considered are: pending policy issues, new potential policy assumptions for the broad scenario logic and the new policy questions (see **Section 3.3** for more details).

However, as far as the policy questions of the 2nd PRM are concerned, at the delivery date of this report we have a list of "raw" queries from stakeholders coming from WP2, i.e., the policies are not definitively yet grouped into specific studies (as in the case of the application of the method in 1st PRM CYCLE described in the previous section). Therefore, they are covered in a different table (**Table 31**), omitting the geographical coverage and, in some cases, a direct link to the policy types or instruments since the question would need further refinement to establish a solid linkage (i.e. some policy questions have not been labelled due to there is not a clear policy type or instrument to associate them with such as OT 1.5, OT 1.6 or II 2.9).

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Table 30. Step 1 – Clustering the 2nd PRM cycle policy needs

Tracking Numbers	Policy Question	Scale of application	Sector	Policy type	Instrument category	Policy Instrument
Pending Policy Questions from the 1st PRM cycle						
1	Role of hydrogen and/or e-fuels trade across world regions	Global	Buildings Industry Energy generation & storage Transport	Hydrogen and biofuels for buildings and industry; Hydrogen production; Methanol storage; Hydrogen and biofuels for transport	Regulatory ↓ Targets, Quotas & Obligations	TRIMs; Targets for Electrolyser Capacity
2	Role of international transport and bunker fuels in global mitigation	Global	Transport Behavioural	Aviation and shipping fuel measures; Traveling less	Market-based Codes and Standards	Vehicle Air Pollution Standards; Vehicle fuel-economy and emissions standards; Carbon pricing; Removal of fossil fuel subsidies
3	Spatially disaggregated analyses for heavy industry sectors in selected European regions	Sub-National	Industry	All measures about industries	-	-
4	Design and assess specific mechanisms to reduce inequality, with a focus on vulnerable groups	Supraregional	-	-	Fiscal incentives Market-based	Tax exemptions; Grants and subsidies; Carbon pricing (dividends); User charges (reduced

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						charges); Credit for captured CO_2
5	Improved modelling for technologies underrepresented in IAMs	Global	Buildings Industry Energy	Building shell efficiency; Heat pumps; CCS; CDR/NETs (BECCS, DACCCS); CCU; Synthetic fuel production	-	RD&D funding; Infrastructure investment; Grants and subsidies; Credit for captured CO_2; Thermal regulations
6	Evaluate impacts from mining activities for critical materials required for low-carbon technologies	Supraregional	Natural resources (impacts on: LULUCF and water)	Domestic and imported critical raw materials consumption Land protection/ restoration Water management Biodiversity	Economic ↓ Direct Investment	Infrastructure investment
7	Land Use, Land Use Changes and Forestry	Supraregional	Agriculture & LULUCF	Afforestation; Land protection; Biomaterials; Biodiversity; Land practices; Biomass	-	Land planning and zoning. Land siting policies
New policies for the broad scenario logic						
1.2.1	Target of FCEV sales	National	Transport: road	Hydrogen fuel cell vehicles	Regulatory ↓ Targets, Quotas & Obligations	EV sales targets
1.2.2	Heat Pump stock target	National	Buildings: heating	Heat Pumps	Regulatory ↓	Thermal regulations

					Targets, Quotas & Obligations	
1.2.3	Share of hydrogen in final energy consumption	National	Building, Industry, Energy, Transport	Hydrogen	Regulatory ↓ Targets, Quotas & Obligations	Renewable electricity targets
1.2.4	Increase of hydrogen in the road transport sector	National	Transport	Hydrogen fuel cell vehicles, rail, planes and ships	Regulatory ↓ Codes and standards	Vehicle fuel-economy and emissions standards
1.2.5	Improvement in energy efficiency	National	Buildings Industry	Energy efficiency	Regulatory ↓ Codes and Standards	Energy Efficiency Standards/Targets
1.2.6	Electric fleet	National	Transport: road	Hybrid and fully electric vehicles	Regulatory ↓ Targets, Quotas & Obligations	EV sales targets
1.2.7	Increase of hydrogen electrolyser capacity	National	Energy	Hydrogen production	Regulatory ↓ Targets, Quotas & Obligations	Targets for electrolyser capacity
1.2.8	Ban on coal mines venting	Supraregional	-	-	Codes and Standards Barrier Removal	Sectorial standards Removal of fossil fuel subsidies
1.2.9	Share of zero emissions cars in new cars sales	National	Transport: road	Fully electric vehicles	Regulatory ↓ Targets, Quotas & Obligations	EV sales targets
1.2.10	Low-carbon hydrogen production capacity	National	Energy	Hydrogen production	Regulatory ↓ Targets, Quotas & Obligations	Renewable electricity targets

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1.2.11	General sales tax (VAT) for electric vehicles, hybrids, and charging infrastructure	National	Transport: road	Hybrid and fully electric vehicles EV charging infrastructure	Targets, Quotas & Obligations Fiscal incentives	EV sales targets Energy taxes & Tax exemptions
1.2.12	New buses are EVs	National	Transport: road	Fully electric vehicles	Regulatory ↓ Targets, Quotas & Obligations	EV sales targets
1.2.13	Share of industrial demand being low-carbon hydrogen by 2030	National	Industry	Hydrogen	Regulatory ↓ Targets, Quotas & Obligations	Renewable electricity targets

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Table 31. Step 1 – Draft cluster of policy question for the 2nd PRM cycle

Tracking Numbers	Sector	Policy type	Instrument category	Policy Instrument
2nd PRM cycle policy questions				
OT 1.1	-	-	Economic ↓ Direct Investment	Infrastructure Investment
OT 1.2	-	-	Regulatory ↓ Targets, Quotas & Obligations	TRIMs Countervailing Duties
OT 1.3	-	-	Fiscal incentives & Market-based	Energy taxes & Tax exemptions Carbon pricing Credit for captured CO_2
OT 1.4	-	-	Economic Instruments	Energy taxes & Tax exemptions User charges Infrastructure investments
OT 1.9	Energy	Electricity generation	Economic ↓ Direct Investment	Infrastructure investments
OT 1.10	Energy	Electricity generation Energy Storage	-	-
OT 1.11	Energy	Electricity generation	-	-
OT 1.12	Energy	Electricity generation	Regulatory ↓ Targets, Quotas & Obligations	Renewable energy targets & obligations
OT 1.13	-	-	Direct Investment Targets, Quotas & Obligations	Infrastructure investments Renewable energy targets
OT 1.14	Governance	Regulatory management system Quality of new regulations	Policy support	Processes, plans and strategies

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OT 1.15	Energy	Electricity generation	Economic ↓ Fiscal incentives	Loans, soft loans & guarantees Grants and subsidies...
OT 1.16	-	-	Direct Investment & Fiscal incentives	Infrastructure investments User charges
OT 1.17	Energy	Electricity generation	Economic ↓ Fiscal incentives	Grants and subsidies Loans, soft loans & guarantees
OT 1.18	Industry Energy	CCS (applied to the different energy sources)	-	-
OT 1.19	Others	Demand-response measures	Economic ↓ Fiscal incentives	Demand response mechanisms
OT 1.20	Buildings Industry Transport	Efficiency	Regulatory ↓ Targets, Quotas & Obligations	Efficiency targets
OT 1.22	Hydrogen production Energy Storage Transport	Electrolysis Batteries Hybrid & Fully EVs	Regulatory ↓ Targets, Quotas & Obligations	Targets for electrolyser capacity EV sales targets
OT 1.23	-	-	Economic ↓ Market-based	Carbon pricing Credit for captured CO_2 GHG emissions trading schemes
OT 1.25	Others	Demand-response measures	Economic ↓ Fiscal incentives	Demand response mechanisms
OT 1.26	Energy	Offshore Wind	Economic ↓ Direct Investment	Infrastructure investments
II 2.1	-	-	Fiscal incentives Market-based Barrier removal	Carbon pricing GHG emissions trading schemes

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				Grants and subsidies Removal of fossil fuel subsidies…
II 2.2	-	-	Regulatory ↓ Targets, Quotas & Obligations	TRIMs Countervailing Duties
II 2.4	-	-	Fiscal incentives Barrier removal	Grants and subsidies Removal of fossil fuel subsidies
II 2.5	-	-	Regulatory ↓ Targets, Quotas & Obligations	TRIMs Countervailing Duties
II 2.8	Industry	Hydrogen, Electricity, CCS, Biomass…	-	-
II 2.11	-	-	Regulatory ↓ Targets, Quotas & Obligations	TRIMs Countervailing Duties
GE 3.3	Industry	Hydrogen, Electricity, CCS, Biomass…	Regulatory ↓ Targets, Quotas & Obligations	Renewable electricity targets
GE 3.4	-	-	Regulatory ↓ Targets, Quotas & Obligations	TRIMs
GE 3.5	-	-	Economic ↓ Market-based	Carbon pricing GHG emissions trading schemes
GE 3.6	-	-	Fiscal incentives Market-based	Carbon pricing GHG emissions trading schemes Credit for captured CO_2 Loans, soft loans & guarantees Grants and subsidies...
BC 4.1	Behavioural/Consumption	Less energy service demand Change of values	-	-

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BC 4.2	Buildings Transport Others	Heat pumps EV charging infrastructure Demand response measures	Codes and Standards Fiscal incentives	Thermal regulations Demand response mechanisms
BC 4.3	Buildings Behavioural/Consumption	Heat pumps, building shell efficiency, efficient lighting and appliances, Less energy service demand	Economic ↓ Fiscal incentives	Grants and subsidies
BC 4.4	Buildings Behavioural/Consumption	Heat pumps Building shell efficiency Less energy service demand	-	-
BC 4.5	Transport Behavioural/Consumption	Hybrid & fully EVs Hydrogen fuel cell vehicles Change mode of transport Travelling less	-	-
BC 4.6	Agriculture & LULUCF Behavioural/Consumption	Land practices Animal husbandry practices Change of diet	-	-
BC 4.7	Behavioural/Consumption	Less energy service demand Change of values	-	-
BC 4.8	Buildings Transport Behavioural/Consumption	Heat pumps Building shell efficiency Change mode of transport Travelling less Change of diet Change of values	-	-

5.2 Step 2 – Link between policy types and IAM COMPACT models

This second step with the new policy needs and policy questions is a bit different from the 1st cycle, as they are broader and more open topics that could be transformed into studies or parts of studies. Therefore, within the same category might fit several different policy types and sectors as it would be necessary to define the topic a bit more before modelling it. In addition, and to assist in the mapping of these possible new studies with the IAM COMPACT models in a more visual way, **Table 32** gathers all this information in the form of a matrix:

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Table 32. Step 2 – Link between policies and IAMs for the 2nd PRM cycle

Tracking numbers	CHANCE	IMACLIM-China	GCAM	GCAM-USA	MUSE	AIM/ENDUSE-India	TIAM	CLEWs	DyNERIO	MEDEAS	WILIAM	Calliope	China-MAPLE	EnergyPLAN	EXPANSE	MENA-EDS	OSeMOSYS	PROMETHEUS	DREEM (TEEM)	ATOM (TEEM)	WISEE-EDM Industry EU	WISEE-EDM global steel	WTMBT
Pending Policy Questions from the 1st PRM cycle																							
1					X		X	X					X	X		X	X	X					X
2			X		X	X	X				X		X			X		X					
3			X		X		X	X	X		X	X					X	X			X		X
4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5		X			X		X					X				X		X					
6									X		X												X
7			X		X			X			X						X						
New policies for the broad scenario logic																							
1.2.1					X	X	X	X	X							X	X	X					X
1.2.2			X	X					X	X						X	X						
1.2.3			X	X	X	X	X	X				X		X		X	X	X			X		
1.2.4			X	X	X	X	X	X					X	X		X	X	X					
1.2.5					X						X					X		X					
1.2.6 1.2.9 1.2.12					X	X	X	X	X						X	X	X	X					X
1.2.7						X	X	X									X						

1.2.8						X			X									X					X
1.2.10			X	X		X	X				X	X	X	X	X	X	X	X					
1.2.11									X		X												
1.2.13			X	X		X		X				X	X	X	X	X	X	X			X	X	
2nd PRM cycle policy questions																							
OT 1.1	X		X	X				X	X	X	X			X		X	X	X	X		X		X
OT 1.2						X		X										X					
OT 1.3	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X
OT 1.4	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X		X
OT 1.9	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
OT 1.10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X
OT 1.11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X
OT 1.12	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
OT 1.13	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
OT 1.14						X		X									X						
OT 1.15 OT 1.17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
OT 1.16	X		X	X	X		X	X	X	X	X			X		X	X	X	X	X	X		X
OT 1.18		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X			X	X	X
OT 1.19 OT 1.25						X		X									X	X	X				
OT 1.20	X		X	X	X	X	X		X	X	X	X	X	X		X	X	X	X				X
OT 1.22			X	X	X	X	X	X	X		X	X	X	X	X	X	X	X					X
OT 1.23	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X
OT 1.26	X		X	X				X	X	X	X			X		X	X	X	X		X		X
II 2.1	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X

II 2.2 II 2.5 II 2.11						X		X									X					
II 2.4	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X		X
II 2.8		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X
GE 3.3		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X
GE 3.4						X		X									X						
GE 3.5	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X
GE 3.6	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X
BC 4.1	X	X	X	X	X	X	X	X		X	X		X			X	X	X	X	X			X
BC 4.2				X					X	X	X	X				X		X	X				
BC 4.3	X		X	X	X	X	X	X	X	X		X	X	X		X	X	X	X				X
BC 4.4			X	X	X	X	X	X	X	X	X	X		X		X	X	X	X				
BC 4.5	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X					X
BC 4.6	X		X	X	X			X			X						X		X				
BC 4.7	X	X	X	X	X	X	X	X		X	X		X			X	X	X	X	X			X
BC 4.8	X		X	X	X	X	X	X	X	X	X	X		X		X	X	X	X				X

This matrix is not binding and is subject to future modifications in view of the delivery of the definitive policy catalogue (M32) with new inclusions or refinements by adding or deleting questions, grouping them and creating and/or reformulating modelling studies.

5.3 Step 3 – Synergies and Trade-offs across policy types

Finally, the new policy issues belonging to the 2nd PRM cycle are associated to the SDGs they impact on through the policy types (linked in the first step) and the matrix of synergies and trade-offs presented in **Section 2.2**. **Table 33** indicates the SDGs impacted and the type of impact, but only the policy types, not the policy instruments. This exercise has only been performed for the pending issues and for the new policy assumptions, but not for the policy questions due to time limitations. However, for the definite submission of the policy catalogue, step 3 will cover all the policy needs.

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Table 33. Step 3 – Link between policy types, SDGs and their impacts for the 2nd PRM cycle

Tracking numbers	Policy type	SDGs impacted	Synergies	Trade-offs	Both
Pending Policy Issues from the 1st PRM cycle					
1	Hydrogen and biofuels for buildings and industry	SDG2, SDG5, SDG7, SDG10, SDG11, SDG12, SDG13	SDG5	SDG2, SDG10, SDG12	SDG7, SDG13
	Hydrogen production	SDG3, SDG7, SDG8, SDG9, SDG12, SDG13	SDG3, SDG8, SDG9, SDG13	-	SDG12
	Methanol storage	SDG6, SDG7, SDG12, SDG13	SDG12, SDG13	SDG6	SDG7
	Hydrogen and biofuels for transport	SDG1, SDG2, SDG3, SDG11, SDG12, SDG13, SDG15	SD3, SDG11, SDG13	SDG1, SDG2, SDG12, SDG15	-
2	Aviation and shipping fuel measures	SDG1, SDG2, SDG3, SDG12, SDG13, SDG15	SDG3, SDG13	SDG1, SDG2, SDG12, SDG15	-
	Traveling less	SDG1, SDG2, SDG3, SDG4, SDG5, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13	SDG3, SDG5, SDG6, SDG7, SDG10, SDG11, SDG12, SDG13	SDG2, SDG8, SDG9	SDG1, SDG4
3	All measures about industries	SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12 SDG13, SDSG15	SDG9, SDG9,	SDG2, SDG6, SDG10	SDG3, SDG7, SDG8, SDG12, SDG13, SDG15
5	Building shell efficiency	SDG3, SDG5, SDG8, SDG9, SDG11, SDG12, SDG13	SDG3, SDG5, SDG8, SDG9, SDG11, SDG12, SDG13	-	-
	Heat pumps	SDG3, SDG5, SDG7, SDG11, SDG12, SDG13	SDG3, SDG5, SDG7, SDG11, SDG12, SDG13	-	-
	CCS, CDR/NETs (BECCS, DACCCS), CCU	SDG3, SDG6, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13, SDG15	SDG9, SDG11, SDG13	SDG6, SDG15	SDG3, SDG7, SDG12
	Synthetic fuel production	SDG2, SDG3, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13	SDG8, SDG9, SDG11	SDG2	SDG3, SDG7, SDG12, SDG13
6	Domestic and imported critical raw materials consumption	SDG7, SDG8, SDG9, SDG12, SDG13, SDG14	SDG7, SDG9, SDG12	-	SDG8, SDG13, SDG14

7	Afforestation; Land protection; Biomaterials; Biodiversity; Land practices	SDG1, SDG2, SDG3, SDG6, SDG7, SDG8, SDG9, SDG10, SDG12, SDG13, SDG14, SDG15	SDG1, SDG3, SDG6, SDG8, SDG9, SDG12, SDG13, SDG14	-	SDG2, SDG7, SDG10, SDG15
New policies for the broad scenario logic					
1.2.1, 1.2.4	Hydrogen fuel cell vehicles	SDG3, SDG11, SDG13	SDG3, SDG11, SDG13	-	-
1.2.2	Heat Pumps	SDG3, SDG5, SDG7, SDG11, SDG12, SDG13	SDG3, SDG5, SDG7, SDG11, SDG12, SDG13	-	-
1.2.3	Hydrogen	SDG3, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13	SDG3, SDG9, SDG11	SDG10	SDG7, SDG8, SDG12, SDG13
1.2.5	Energy efficiency	SDG3, SDG5, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13	SDG3, SDG5, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13	-	-
1.2.6, 1.2.9, 1.2.11, 1.2.12	Hybrid and fully electric vehicles and EV charging infrastructure	SDG3, SDG7, SDG11, SDG13	SDG3, SDG7, SDG11, SDG13	-	-
1.2.7, 1.2.10	Hydrogen production	SDG3, SDG7, SDG8, SDG9, SDG12, SDG13	SDG3, SDG8, SDG9, SDG13	-	SDG7, SDG12
1.2.13	Hydrogen (industry)	SDG8, SDG9, SDG10, SDG12, SDG13	SDG9	SDG10	SDG8, SDG12, SDG13

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6 Conclusions and future work

Throughout the update of this deliverable, it is noteworthy that the selected ensemble of IAMs and sectoral models for the IAM COMPACT project can address a broad spectrum of mitigation policy measures and instruments that meet the expected demands of policymakers. Nevertheless, and as also reported in the first version of this document, there is still a relevant gap in representing social and sustainability measures which, despite its difficulty, will be reinforced in the upcoming updates of models.

Regarding the revision of the modelling efforts undertaken during the 1st PRM cycle, the policy questions have been successfully transformed into studies (each one addressed with specific models and correspondent modelling teams) that cover almost all of them, with some minor exceptions that will be discussed in the 2nd cycle (listed in **Section 3.3**). Study 1, with a focus on the National Energy and Climate Plans, has been of great importance not only by itself, but for the core of all modelling in the project, as it has been used to build the broad scenario logic. The other studies have used those policies within the common scenarios while adding others tailored to their purposes.

The principal output of this task is a solid preliminary draft of the policy catalogue that includes the policy needs addressed in the 1st PRM cycle and some of the new ones to be worked within the 2nd cycle of the PRM. It has identified which policy types and instruments best fit these policy needs and, with this information, these have been linked to the most appropriate IAMs. To this end, heatmaps have been developed to provide a preliminary but straightforward support to grouping policy types into studies and distributing them into models.

Furthermore, a comprehensive literature review of synergies and trade-offs between mitigation measures and the SDGs has been carried out to understand which model capabilities will allow to truly evaluate the policy types that we need to cover (e.g., from a sustainable and systemic perspective), broadening knowledge, especially in terms of social measures.

Future work

Due to the limited time gap between this deliverable and the production of *Deliverable 2.3 Scoping policy relevant Research Questions – Update* (Heussaff, 2024) where the 2nd PRM cycle policy questions have been compiled, the analysis of these new inquiries and the application of the method have just supported the first step of the creation of the new modelling studies, allowing to analyse and guide in the policy clustering activity some more tangible topics that could later be converted into modelling studies (as in the 1st PRM cycle). Moreover, the inclusion of these new potential policies in our policy catalogue has been done in a preliminary way, considering a possible update before the submission of the final version (which is a milestone of the project by Month 32).

Therefore, an entire policy catalogue encompassing the current one and some new additions from the second modelling cycle will be provided to meet the corresponding milestone. The final catalogue structure (and heatmaps) will be definitive at that milestone and available at the I²AM PARIS online platform[12] with an interactive interface. It will show the correlation among the policy needs used in IAM COMPACT and the policy types, SDG interactions, and their representation in the IAMs.

[12] https://www.i2am-paris.eu/

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Funded by
the European Union

The IAM COMPACT project has received funding from the European Union's HORIZON EUROPE Research and Innovation Programme under grant agreement No 101056306.