ENCLUDE

Energy Citizens for Inclusive Decarbonization

D7.4 – Protocol for synthesizing and integrating the modeling work

WP7 – Synthesis, Dissemination, Communication, and Exploitation

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ENCLUDE PROJECT & DELIVERABLE PROFILE

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Preface

The overall vision of ENCLUDE is to help the EU to fulfil its promise of a just and inclusive decarbonization pathway through sharing and co-creating new knowledge and practices that maximize the number and diversity of citizens who are willing and able to contribute to the energy transition. Motivated by achieving an equitable and sustainable future and the fulfilment of individual potential, ENCLUDE will contribute to the upcoming transformation of energy use by: (1) Assembling, aligning, and adapting disparate energy citizenship concepts for diverse communities of citizens and for different scales of policy making, lowering the barrier for action. (2) Operationalizing the energy citizenship concept at all scales of policy making for decarbonization. (3) Catalyzing a chain reaction of decarbonization actions across the EU.

1. Changes with respect to the DoA

No changes with respect to the work described in the DoA apart from the following minor points:

- While the DoA mentioned only the modeling results of WP4 and WP5 for this protocol, a discussion on the results of WP2 and WP3 has been also added.
- The report was submitted with a delay.

2. Dissemination and uptake

This deliverable will mainly serve as a reference document among project partners on the information that will be included in the ENCLUDE Platform. It can also serve as a documentation of the Platform's development process which can be useful to other projects and initiatives that aim to build similar platforms.

3. Short Summary of results (<250 words)

ENCLUDE will develop an open-access web platform to synthesize the outcomes of the project in a form that is useful for and usable by the project's audience. The ENCLUDE Platform will be based on I^{2}AM PARIS, a data exchange platform for climate modeling that was developed during the Horizon 2020 Paris Reinforce project. This report contains information about project methodologies and data inputs that are relevant to document in the Platform, along with different protocols for synthesizing project outputs. First, a typology of energy citizenship will be integrated in an interactive form, allowing users to explore all its different dimensions. Similarly, the Platform will include the case studies of Collective Energy Initiatives that are analyzed by ENCLUDE and will host a set of energy citizen profiles based on clustering results of large population surveys. The Platform will also visualize the decarbonization potential and co-benefits of collective energy actions for these citizen clusters. Furthermore, the report discusses three protocols to synthesize project outcomes, based on a modular, interlinked, and layered architecture. During the next months, we aim to contact relevant stakeholders such as local policymakers, participants of the ENCLUDE Academy, and representatives of Collective Energy Initiatives for feedback on the design of the Platform. After ENCLUDE's end, the platform will be taken over by two Horizon Europe projects, providing a lifetime of at least until the end of 2026, while further avenues for the sustainability of the platform will be also examined.

4. Evidence of accomplishment

This report.

LIST OF PARTICIPANTS

	Participant Name	Short Name	Country	Logo
1	EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH	ETHZ	Switzerland	
2	UNIVERSITY OF PIRAEUS RESEARCH CENTER	UPRC	Greece	
3	TECHNISCHE UNIVERSITEIT DELFT	TUD	Netherlands	
4	UNIVERSITY COLLEGE CORK - NATIONAL UNIVERSITY OF IRELAND, CORK.	UCC	Ireland	
5	UNIVERSITY OF GLASGOW	UOG	United Kingdom	
6	JOANNEUM RESEARCH FORSCHUNGSGESELLSCHAFT MBH	JR	Austria	
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11	MISSIONS PUBLIQUES	MP	France	
12	HOLISTIC IKE	HOLISTIC	Greece	
13	UNIVERSITY OF VICTORIA	Uvic	Canada	

Executive Summary

ENCLUDE will develop an open-access web platform to synthesize all outcomes of the project in a form that is useful for and usable by the project's audience. This audience includes policymakers (especially of local and regional scale), energy communities and other Collective Energy Initiatives, as well as individual citizens that are looking for ways to actively participate in the energy transition. The Platform will be based on the functionalities of I^2AM PARIS, a data exchange platform for climate modeling that was developed during the Horizon 2020 Paris Reinforce project. As a first step in the development of the ENCLUDE Platform, this report contains information about data inputs from each Work Package (WP) of the project that are relevant to document in the platform along with potential protocols on how to integrate and synthesize project outputs.

One major contribution of ENCLUDE is a typology of energy citizenship considering different facets of the citizens' relationship with energy, for instance, supply, consumption, and participation in energy decision making (WP2). This typology will be included in the Platform in an interactive form, allowing users to explore all different dimensions. Similarly, the Platform will include an interactive map or list of case studies of Collective Energy Initiatives that are analyzed in the third WP, including interactive results of this analysis. Turning to the modeling side of the project, the Platform will host a set of energy citizen profiles/personas based on clustering different collective and individual characteristics of European citizens using results of large population surveys (WP4). These citizen clusters will be also used to assess the decarbonization potential and co-benefits of collective energy actions for different citizens (WP5) which will be also integrated in the Platform.

Apart from documenting the data inputs and outputs of individual WPs, the Platform intends to synthesize this information in a comprehensive portal about energy citizenship and its decarbonisation potential. Three integration protocols are discussed. The first assumes a modular architecture where the content of all WPs are added as separate modules, with limited interconnections between them. A more interconnected concept is to develop a single interface that can visualize information from all the project based on user choices and through a series of links between WP results. An alternative is to provide a common interface but with a layered architecture (such as the one used by GIS systems), where each WP outcome would be presented as a layer of information. A hybrid approach is also mentioned, where each WP is primarily presented individually and that efforts are made to create an integrated interface with as many interlinkages as possible.

During the next months, we aim to contact relevant stakeholders such as local policymakers, participants of the ENCLUDE Academy, and representatives of Collective Energy Initiatives and ask for their feedback on the initial design options of the Platform. After ENCLUDE's end, the platform will be taken over by two Horizon Europe projects, providing a lifetime of at least until the end of 2026. Further avenues for the sustainability of the platform are examined, such as by combining platforms and information from other sister projects of ENCLUDE to create a comprehensive portal for energy citizenship in Europe. Finally, we explore potential business plans to sustain the platform in the longer term.

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1 Introduction

The ENCLUDE project aims to provide policymakers, citizens, and other stakeholders with useful insights regarding the conditions and the contexts within which energy citizenship (EC) can lead to high decarbonization. Towards this goal, we will develop a publicly-available web platform, which will synthesize all outcomes of the project in a form that is useful for and usable by its audience. In parallel, the platform aims to be more than just an interface for accessing project results and provide a holistic overview of the concept and operationalization of energy citizenship (potentially including work from other EU projects beyond ENCLUDE), in an effort to create a comprehensive portal on EC in Europe.

At the beginning of the project, the platform has been tentatively called an "Interactive Policy Platform", indicating a focus on policymakers and, especially, of the local and regional scale. The main idea behind this focus is that these policymakers are more knowledgeable than national policymakers on the local conditions that are critical for the successful deployment of energy citizenship initiatives. It was thus envisioned that users could put in their specific criteria and context in the platform and guided through relevant parts of ENCLUDE outcomes along with guidelines and tools that are appropriate for their energy citizenship context. Nevertheless, during the first half of the project, it became apparent that other users could be also interested in the platform, such as energy communities and other Collective Energy Initiatives (CEIs) that want to grow and, vice versa, individual citizens that are looking for an initiative that fits their needs. Thus, the scope of the platform has been expanded to be usable by these extra audiences as well.

Another starting condition of the platform was that it will be based on an existing platform called I^{2}AM PARIS[1]. This platform was developed during the Horizon 2020 Paris Reinforce project (2019-2022) and was designed as a data exchange platform for modeling information in support of climate action. The platform has a modular structure and includes components that provide extensive documentation for models of the Paris Reinforce and the wider modeling community along with workspaces featuring interactive visualizations of the results of various modeling exercises (an indicative screenshot from the platform is shown in Figure 1). The I^{2}AM PARIS is already ideal for storing the results and assumptions of the model-oriented Work Packages of ENCLUDE, i.e., WP4 ("identification of citizen clusters for decarbonization") and WP5 ("the impact of energy citizenship in decarbonization pathways"). However, most of their inputs are based on the theoretical work of WP2 and the empirical studies of WP3, creating a need for a platform that can integrate the work from all ENCLUDE's WPs in a way that can be accessible by non-experts. This will require extra software features than the one currently provided by I^{2}AM PARIS as well as an attractive visual design that can support user interaction.

[1] https://i2am-paris.eu

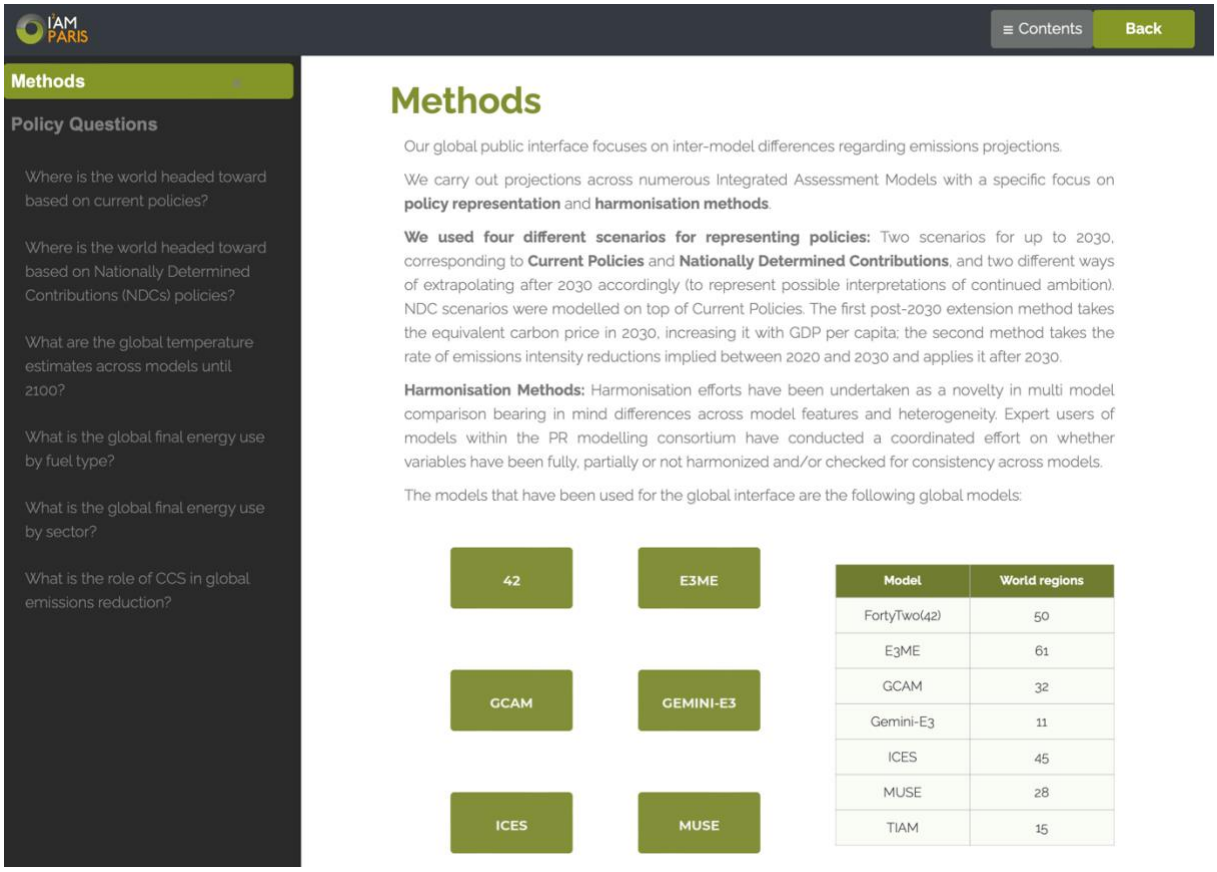

Figure 1. Screenshot of modeling documentation from I²AM PARIS

As a first step in the development of ENCLUDE's platform, this document contains information about relevant methodologies and data inputs from each WP (Chapters 2-5) along with potential protocols on how to integrate and synthesize project outputs (Chapter 6). This data documentation was created based on consultation with all partners of WPs 2-5 and summarizes their work while providing links to relevant deliverables for more details. For the model-relevant WPs 5, modeling documentation, assumptions, and guidelines for replication were also added. Similarly, suggestions for potential protocols have been developed by the WP7 and discussed with all partners during the last two General Annual meetings of the project. However, the platform is also aimed to be co-designed with relevant stakeholders and thus the final protocol will be decided later during this year based on their feedback (see Chapter 7 for more details).

2 WP2 data – Typology of energy citizenship

WP2 aims to create a typology of energy citizenship based on an extensive literature review and a mixed-methods approach including surveys and interviews. During the first reporting period, the main WP2 beneficiary (UCC) finalized the research design, got an ethics approval, and developed instruments for data collection and analysis, also based on feedback from the other participating partners.

2.1 Documentation of data collection and processing

In the beginning of the project, WP2 partners performed a comprehensive literature review of the energy citizenship concept based on a multi-level governance perspective. The goal of the review was to explore the ways in which people interact to energy and the wider socio-technical system behind energy supply. This process allowed for an in-depth exploration of existing knowledge and enabled researchers to identify new philosophical trends and/or emerging theories around the specific topic. An extensive documentation of the literature review can be found in deliverable D2.1[2].

The literature review was complemented by asynchronous structured dialogues with several key actors and academic informants knowledgeable on the topic of energy citizenship, including researchers from sister projects funded under the SC3-CC-1 call topic. A Delphi-panel like approach was used, consisting of iterative dialogues which lead to knowledge creation through consensus and/or dissonance among the participants (Revez et al., 2020). It is a way to capture opinions from a group through a series of rounds of engagement, where members of the group remaining anonymous to one another and can help establish consensus on topics that may prove divisive when discussed in-person. A guide to this approach can be found in the project website[3].

An online survey was created to further capture the plurality of understandings around energy citizenship. A link to the online version can be found on Google Surveys[4]. UCC and the other participating partners promoted the survey through a variety of channels. During the first reporting period, around 201 survey responses have been received and analyzed. The survey will continue in the second reporting period, with the intention of collecting a further 300 responses.

A significant number of in-depth, semi-structured interviews were carried out to both inform and to complement work carried out elsewhere in the WP. In-depth semi-structured interviews provide what is termed as rich data from valuable insights and new knowledge can be gleaned through thematic analysis. During the first period, 44 in-depth interviews have been conducted, while a link to the Interview Guide can be found in the project website[5].

All aforementioned links to deliverables and data collection documents will be also made available in the platform. Since all documents will be in PDF form, pertinent parts of them can be extracted and adapted to shortly summarize the data processing of WP2 without the need to read all provided documents. However, raw data from the empirical research of the WP may not be interesting to a wider audience and may lead to a potential breach of GDPR. When possible, efforts will be made along with the ethics departments of WP2 partners to upload

[2] https://doi.org/10.5281/zenodo.7598736

[3] https://encludeproject.eu/sites/default/files/2023-03/06%20ENCLUDE%20delphi%20panel.pdf

[4] https://docs.google.com/forms/d/12g2TsOqs6CmFq7BMqCb0Vl_zzL-IrbvAn1n8V83Ryv0/

[5] https://encludeproject.eu/sites/default/files/2023-03/04%20ENCLUDE%20Interview%20Schedule.pdf

anonymized raw data of the surveys and interviews to further support the findings of WP2, especially among the academic users of the platform.

2.2 Envisioned WP outputs on the Platform

By analyzing the literature review and the empirical findings from the first half of the project, UCC identified four principal expressions of energy citizenship across a range of modes of participation (including non-participation), encompassing both individual and collective views:

1. Expressions of energy citizenship that are fundamentally about access to energy and energy resources.
2. A consumption-orientated category that sees energy citizenship through the lens of purchasing power.
3. A production-orientated view of energy citizenship where the citizen is invited to produce energy.
4. Expressions of EC emerging from the political sphere, where citizens work to engage in decision-making.

Energy citizens may display one or more expressions of citizenship in the energy domain either concurrently or at different times. Also, it is fair to say that different expressions of energy citizenship speak to different levels of social and/or economic privilege and to different life experiences. Many citizens are either locked-in (e.g., due to a monopoly franchise) or locked-out (e.g., not possessing required resources), which greatly limits their ability to participate and 'become' an energy citizen. More details about expressions of citizenship and examples are given in Table 1.

Table 1. Expressions of energy citizenship

Mode of participation	Expression of citizenship	Examples of those impacted
Access to energy as a resource	Non-performance; disengaged; absence of rights or power to affect change; exploitation/resistance. Operating outside of, or negatively impacted by, existing energy infrastructure particularly by fossil fuel exploitation and other extractive industries	The Dispossessed; the Excluded; the Energy Vulnerable
Consumption-orientated	Framed exclusively by purchasing practices and consumer-oriented behaviors. False narrative on power expressed through consumer 'choice'	The Active consumer; the Good citizen; the Digital Native; the Energy champion; the Collectivist- consumer
Production-orientated	Largely framed by production of energy narratives. Operate solely through the production of energy and potentially some self-consumption	The Prosumer; the Self-Consumer; the Collectivist-producer; the Citizen-investor
Politically motivated	Interested in decision-making processes and motivated to affect change from within existing power structures	The Citizen-litigator; the Citizen-challenger; the Citizen-activist

At the end of WP2, the expressions given in Table 1 will be consolidated in typology which will be described in a Deliverable D2.2. Based on this report, a text description of each EC type can be extracted and shown in the platform. In that way, the results of this WP can be presented in the platform as a list of qualitative expressions of energy citizenship along the four different categories suggested by WP2. The list can be provided in a nested format, allowing users to interactively explore the different types by selecting the main EC categories and then each type.

3 WP3 data – Cases studies of Collective Energy Initiatives

WP3 is central to the ENCLUDE project, as it establishes a structured and well-documented pool of relevant international case studies of organized energy citizenship expressions. The aim of the case study data collection and analysis is to study energy citizenship from a group-centered sociological perspective in order to identify the most important processes and factors affecting the emergence and consolidation of energy citizenship groups.

3.1 Documentation of data collection and processing

At the beginning of the project, a number of Collective Energy Initiatives were identified including 68 European case studies, six Canadian, and four African. The identification of potential cases was guided by either personal expert knowledge of the members of the consortium or desktop research. The target was to collect case studies as diverse as possible in terms of a) geographic location, b) organizational form, c) size, and d) used technologies. Information about the case studies was sourced from mainly publicly available information from the websites of the cases, case documents (statutes, etc.) and other relevant documents (such as deliverables if the case is part of a scientific project).

A quantitative survey was then conducted with individuals from the identified cases of CEIs. Two theoretical frameworks were used to analyze the case studies and guide survey development: the Energy Cultures Framework and the Socio-Ecological Systems Framework for Integrated Community Energy Systems. To date, over 280 responses from 32 European case studies have been gathered. The survey will be complemented with detailed interviews with selected members of the case studies to add further context on the collected data.

Overall, the following documents and data will be uploaded to the platform to document the work done during WP3:

- Anonymized case studies pool (Excel file).
- Documentation of the survey variables (questionnaire)
- Descriptive statistics of survey variables (tables and/or plots)
- A small summary of the process for the interviews (Excel file, PDF file).

3.2 Envisioned WP outputs on the Platform

A direct outcome of the WP will be a synthesis of information on the case studies (Word file) and supporting documents on the results of the case studies data gathering, survey and interviews (Word file), including a graphical representation of key findings from the in-depth analysis of 10-15 case studies. Such a graphical representation has been already developed to showcase the results of the desk research and some initial interviews[6]. An example of these graphics is shown in Figure 2.

[6] https://encludeproject.eu/sites/default/files/2023-02/A5-WP3%20Case%20studies-Booklet-16P.pdf

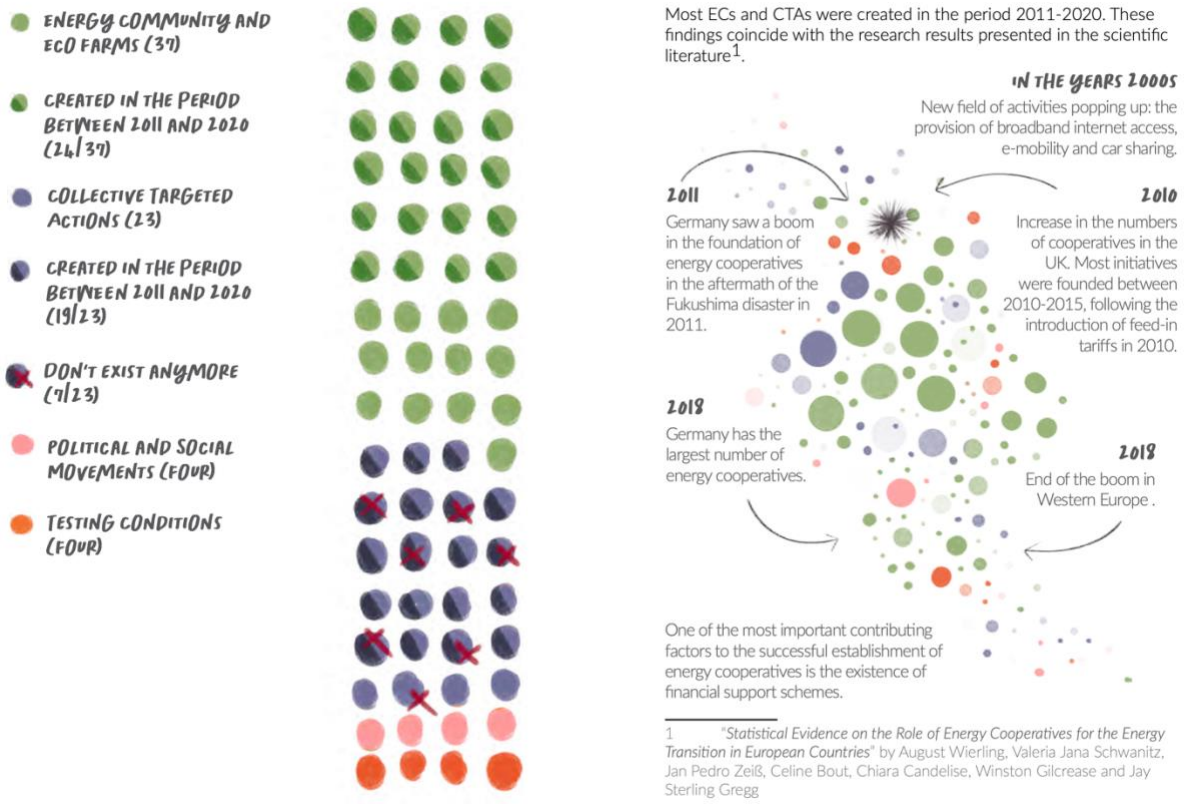

Figure 2. Example of graphical representation of WP3 results[7]

Through further analysis of the case study results, two guides will be developed to support Collective Energy Initiatives: a "Best practices" guide (PDF file) and a guide on "How to make your CEI a successful one" guide (PDF file). These guides along with the synthesis and documentation of WP3 data collection and processing can be then uploaded to the platform. Additionally, an interactive version of the list of CEIs and the collected data can be created in the platform to allow users to search and filter CEIs at will. When possible, pertinent results from WP3, such as the ones shown in Figure 2, will be also shown interactively. Nevertheless, since such interactive visualizations require large development effort, they will be conditional to the availability of development time, prioritizing the integrated data interface (see Chapter 6).

[7] https://encludeproject.eu/sites/default/files/2023-02/A5-WP3%20Case%20studies-Booklet-16P.pdf

4 WP4 data – Clusters of energy citizens

The aim of WP4 is to identify groupings of citizens (clusters) at different scales of analysis and contexts to understand how they can be more effectively targeted by specific policies for energy system decarbonization. These citizens clusters are identified based on machine learning methods and using data from previous projects and from WP3. The clusters will be then used in WP5 to identify the decarbonization potential of different citizen groups. The following sections describes data inputs and outputs from WP4 that will be documented in the platform.

4.1 Documentation of data collection and processing

In order to find meaningful groups of energy citizens across the EU, it is essential to identify important attributes where the clustering algorithms will be applied. These variables can relate to the individual level, such as energy behavior and environmental lifestyles, or to the collective level, such as the local energy infrastructure of a city. Using an extensive literature review on previous research, WP4 partners have identified several attributes that can be used for clustering groups of citizens in terms of energy-related topics. Figure 3 illustrates the main categories of clustering attributes that have been identified, while Figure 4 provides examples of some of these variables. More details about the selection of clustering attributes can be found in Deliverable 4.1 in Zenodo[8].

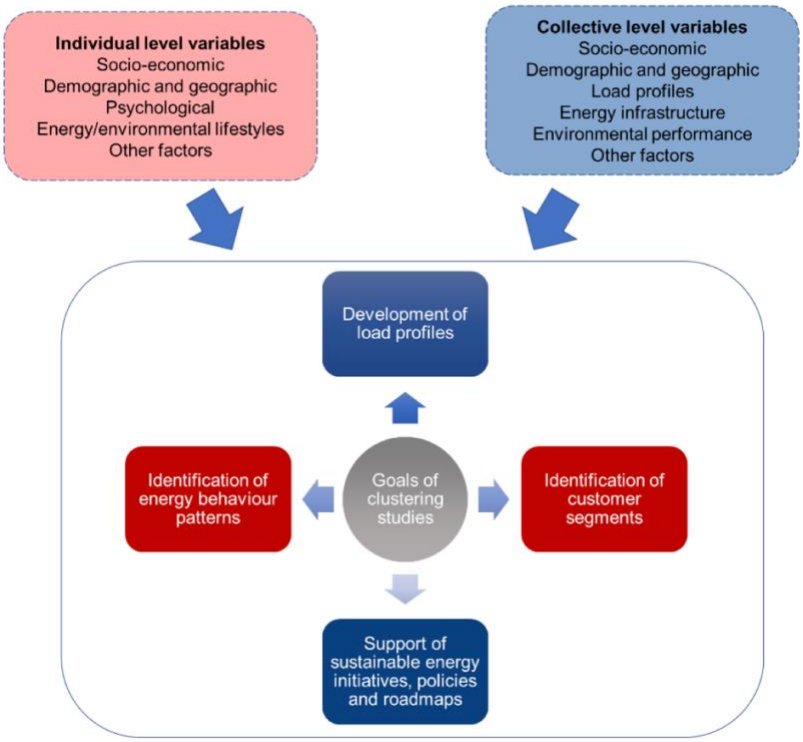

Figure 3. Main categories of clustering attributes of energy citizens (adapted from Naderian, 2022)

[8] https://doi.org/10.5281/zenodo.7142967

Clustering variables	Individual and household level	Collective level (building, district, city, country)
Socio-economic, demographic and geographic data	Age, income, education, employment, gender, income, number of family members	Average income, education, employment, number of individuals in the group
Psychological	Personal norms, preferences, values, life-goals and awareness of consequences associated with energy savings	-
Energy lifestyles & consumption	Energy consumption preferences and practices across different areas of life, such as housing, mobility, cconsumption & diet (energy lifestyles)	Electricity/heating/cooling load data at building, district, province, etc. level
Building/devices physical characteristics	-	Infrastructure characteristics (buildings' age, type, size, area, energy performance, centralized/decentralized electricity/heating infrastructure) Space/water heating/cooling technologies, other devices

Figure 4. Key clustering variables per category (adapted from Naderian, 2022)

Apart from finding the appropriate clustering attributes, WP4 assessed which clustering algorithm would be more appropriate for clustering energy citizens. Two categorical clustering algorithms have been selected and used, namely K-modes and Agglomerative hierarchical clustering. The rationale behind each algorithm is the following:

- K-modes clustering algorithm uses the dissimilarities (total mismatches) between the data points to cluster them.
- Agglomerative clustering method seeks to build a hierarchy of clusters. In this approach, each observation starts in its own cluster, and pairs of clusters are merged as one moves up the hierarchy.

Currently, WP4 efforts are focused on developing a working application of the clustering algorithms for identifying energy citizen groups in the UK using survey data from the Horizon 2020 ECHOES project. The choice of using the ECHOES database facilitates the documentation of WP4 input data in the ENCLUDE platform as the ECHOES database is already open access[9]. Thus, a link can be provided to the database along with a short explanation of which variables were used for the clustering efforts. The same strategy will be used to any new application of the clustering algorithms for other countries or databases.

4.2 Envisioned WP outputs on the Platform

The key outputs from WP4 that will be shown on the Platform will be a set of energy citizen profiles/personas based on clustering results. Some preliminary results from these efforts have been presented in Part B of the 1st Technical Report and an example is given in Figure 5. As shown in the figure, the clusters will be described by a set of quantitative attributes that can be then uploaded in the Platform. Nevertheless, efforts will be made to visualize these clusters in a more user-friendly manner apart from presenting the raw quantitative data, such as by giving them a distinctive name or combining them with a qualitative story/description.

[9] https://db.echoes-project.eu/echoes/home

Questions				Clusters (People in each cluster)						
Question Type	#	Question	Detail	#1 (72)	#2 (68)	#3 (93)	#4 (43)	#5 (48)	#6 (58)	#7 (69)
Demographic questions	1	Q1	age	>65	35-49	19-34	19-34	>65	>65	19-34
	2	Q3	employment	Retired/pensioned	Payed employed (30 hours a week or more)	Payed employed (30 hours a week or more)	Payed employed (30 hours a week or more)	Payed employed (30 hours a week or more)	Payed employed (30 hours a week or more)	Payed employed (30 hours a week or more)
	3	Q4	rural	Town/city	Town/city	Town/city	Town/city	Rural	Town/city	Town/city
Psychological questions	7	Q24	future	Moderately agree	Moderately agree	Moderately agree	Moderately agree	Moderately agree	Neither disagree nor agree	Neither disagree nor agree
	8	Q31	ren_envir	Moderately agree	Strongly agree	Strongly agree	Moderately agree	Strongly agree	Neither disagree nor agree	Moderately agree
	9	Q33	climate change	Probably	Yes, definitely	Yes, definitely	Probably	Yes, definitely	Maybe, I don't know	Probably
Energy consumption questions	13	Q75	km_driver	1km-5,000km	1km-5,000km	1km-5,000km	5,000-10,000km	10,000-15,000km	5,000-10,000km	10,000-15,000km
	14	Q78	car_type	Petrol	Petrol	Petrol	Petrol	Diesel	Petrol	Petrol
	15	Q85	publictrans	Bus	Bus, Train	None	Train, Tram	None	None	None
	19	Q94	dwelling_type	Semi-detached or terraced home	Semi-detached or terraced home	Semi-detached or terraced home	Semi-detached or terraced home	Single Family Home	Single Family Home	Semi-detached or terraced home
	20	Q95	dwelling_size	I don't know	I don't know	I don't know	I don't know	I don't know	I don't know	I don't know

Figure 5. Example of preliminary clustering results using the k-modes method

5 WP5 data – Modeled potentials of energy citizenship

While still at a conceptual level, the outcomes of WP5 are envisioned to enhance the understanding of citizens and policymakers in terms of the decarbonization potential of energy citizenship initiatives. The results of the modeling activities of WP5 will aim to quantify the decarbonization potential of the concept of energy citizenship by comparing the various narratives that are developed with a baseline scenario.

5.1 Data collection

As far as qualitative data is concerned, the starting point and main input for the later work of WP5 have been the emerging trends and patterns around the concept of energy citizenship. By combining insights from the scientific literature (Dellavalle & Czako, 2022; Krumm et al., 2022; Süsser et al., 2022; Wahlund & Palm, 2022), five thematic groups have been selected: (i) active participation in the energy market, (ii) actions towards energy efficiency, (iii) behavioral aspects, (iv) collective expressions of energy citizenship, and (v) political activities. Based on these groups, the WP5 partners categorized the identified energy citizenship trends and patterns that are summarized in Table 2. For further details and analysis, see Deliverable 5.2 (Tsopelas et al., 2022).

Table 2. Identified energy citizenship trends and patterns

Level	Group	Trend/ Pattern	Literature source
Individual	Active participation in the energy market	**Prosumerism**	(Krumm et al., 2022; Kühnbach et al., 2022; Trutnevyte et al., 2019)
	Actions towards energy efficiency	**Lifestyle changes**	(Creutzig et al., 2018; Spyridaki et al., 2020; Stephenson et al., 2010)
		Energy efficiency measures	
	Behavioral aspects	**Citizens' behavior**	(Borch, 2018; Devine-Wright & Batel, 2017; European Commission, 2021; Göllinger, 2012; Kati et al., 2021; Knopper et al., 2014; Månsson, 2015; Morrissey et al., 2016; Quentin, 2019; Samadi et al., 2017; Tzani et al., 2020; Vasilakis et al., 2016; Voigt et al., 2019)
		Preferences towards RES	
Collective	Collective expressions of energy citizenship	**Formation of energy communities**	(Calvo & Valero, 2022; Campos & Marín-González, 2020; Łapniewska, 2019; Moreau et al., 2019; Moret & Pinson, 2019; Nikas et al., 2020; Sovacool et al., 2022; Wahlund & Palm, 2022)
		Establishment of eco-villages	
	Political activities	**Participation in energy transition movements**	(Hielscher et al., 2022; Wahlund & Palm, 2022)
		Participatory processes in energy sector planning & decision-making	

Note: Trends and patterns have been identified based on the WP5 desk research and have been categorized across the level of analysis (individual and collective) and five thematic groups (adapted from Tsopelas et al., 2022).

Additionally, WP5 is formulating conceptual narratives that are focusing on citizen perspectives. This people-centric approach relies on a process of creating narratives on identified energy citizenship trends and pattern and are demonstrated in Figure 6.

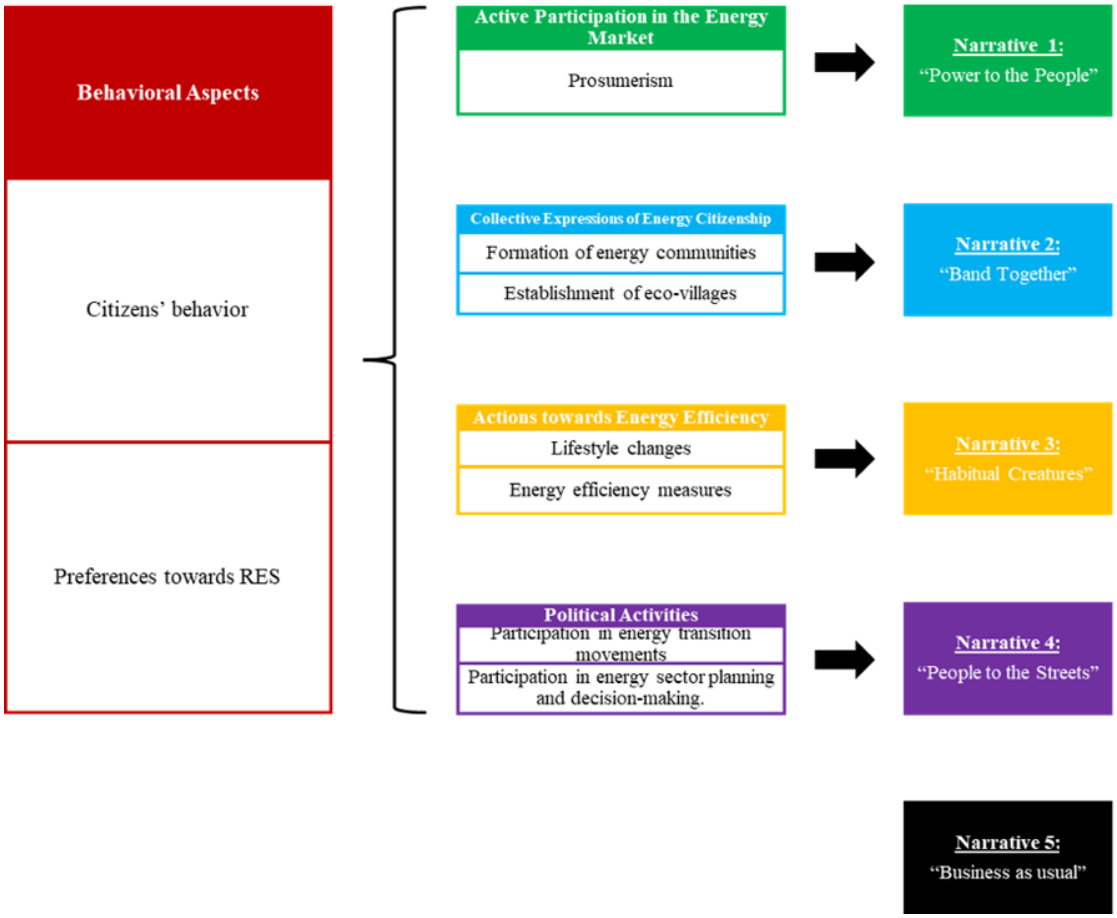

Figure 6. Mapping the energy citizenship trends and patterns onto ENCLUDE narratives (adapted from Tsopelas et al., 2022)

Narrative 1 - **"Power to the People"**: This narrative builds upon the concept of an increasingly decentralized energy system e.g., with higher rates of prosumerism. Citizens are thought to increasingly becoming individual owners, thus, consuming their own electricity (Krumm et al., 2022), and playing a facilitating and supportive role in driving the energy transition (Trutnevyte et al., 2019). Within this narrative, various co-benefits can be explored such as the resulting percentage of the simulated population's access to energy and self-sufficiency.

Narrative 2 - **"Band Together"**: A narrative focused on the concept of collectivistic actions of citizens in the energy system. Over the recent years, a rise in the formation of energy communities and other various collective energy initiatives, such as energy collectives and co-operatives, increased communal and localized production of energy in order to optimize the usage of their resources (Moret & Pinson, 2019). These collectivistic actions are thought to be linked to terms such as energy justice, energy democracy, solidarity-based economy (Campos & Marín-González, 2020; Wahlund & Palm, 2022), and gender equality (Łapniewska, 2019), while also enhancing the overall sense of a strong community.

Narrative 3 - **"Habitual Creatures"**: This narrative is focused more on the daily habits of citizens, and how little changes in everyday life can have an impact on the energy transition and on decarbonizing the energy system. Based on this assumption, our own norms, practices, and culture, such as various daily activities (e.g., home appliances' use, heating and washing, etc.) directly correlate to our energy behavior (Stephenson et al., 2010) and influence a household's levels of energy consumption. Individual energy conservation measures result from the raised awareness around one's own energy consumption (Spyridaki et al., 2020).

Narrative 4 - **"People to the Streets"**: A narrative focused more on the concepts of political activism surrounding energy and participation in social movements and civil society initiatives advancing democratic visions of the energy transition (Wahlund & Palm, 2022). These processes enhance the active role of citizens by considering citizens' perspectives and giving them the opportunity to voice their opinions in matters that ultimate affect their own lives, thus exploring co-benefits such as energy justice and energy democracy, that are inherently abstract.

Narrative 5 - **"Business as usual"**: A baseline narrative continuing trends and patterns identified today with minimal to no change in the current status quo. The world is moving in a direction where social, economic, and technological trends do not differ substantially from historical patterns. Development and income growth progress asymmetrically, with some countries making reasonable progress while others fall short. Global and national establishments work to achieve sustainable development goals, but progress is slow. The main utility of this narrative is to establish a reference point in order to assess not only the decarbonization potential, but also other co-benefits of energy citizenship.

All aforementioned trends, patterns, and narratives can be uploaded in the Platform in raw text form but in a hierarchical fashion, allowing the user to interactively explore them for instance by clicking to boxes/buttons with their names. Apart from qualitative inputs, the Platform will include quantitative inputs that will be used to simulate these narratives along with other modeling assumptions that will be commonly applied for all narratives. The inputs could be summarized in appropriate visualizations provided by the platform, allowing expert users to download them in an Excel format for further processing. It is noted that the I^2AM PARIS platform already provides these functionalities and can be adapted for the ENCLUDE platform. Below is an indicative list of input variables that the ENCLUDE models will use.

- Historical data on technology capacity, e.g., small-scale PV capacity addition, in monthly resolution
- Electricity consumption profiles per household in hourly resolution
- Expected evolution of demand
- Compensation schemes for consumers, competitive electricity consumption tariffs and other regulated charges
- Investment costs for technologies (e.g., small-scale PV, residential battery storage)
- Expected evolution of costs and prices based on historical trends in yearly resolution
- Other technology-specific parameters, e.g., solar PV generation profiles in hourly resolution, etc.
- Weather data, thermal comfort parameters, and thermostat set points, all in monthly resolution
- Available appliances (traits, power ratings, and use characteristics), occupancy and activity profiles
- Building typologies and envelope specifications
- Available demand-flexibility technologies (HVAC, PV & storage installations, smart-thermostats, etc.)

- System Marginal Prices, competitive electricity consumption tariffs, and other regulated charges

Alongside these variables a subset of the answers from the case study questionnaire from WP3 will also feed into the models in order to provide the necessary context for future modeling exercises. Most of these answers are based on Likert-like scales and other categorical or ordinal variables and they will be then translated in a relative numerical form that is appropriate for modeling use. Some of the questions of interest from WP3 are listed below:

- Have you ever had difficulties paying your bills for heating or electricity?
- During the last winter/summer, did you perceive your home as comfortable in terms of temperature?
- How would you describe your political outlook with regard to social issues (e.g., family, religion, traditional values, etc.)?
- How would you describe your political outlook with regard to economic issues (e.g., taxes, cooperative vs. protective foreign economic policy, etc.)?
- Heating with fossil fuels is a good energy solution.
- Investing in energy efficiency is beneficial for my household.
- Improving living conditions (e.g., thermal comfort) is as important for me as reducing energy consumption and bills.
- My dwelling/home was upgraded (e.g., by retrofitting insulation or windows).
- My heating system was significantly modernized.
- What do you think was the main reason for the heating system modernization?
- I changed my room temperature setting to a more comfortable level.
- I changed my diet to less meat.
- I reduced the number of my holiday flights.

5.2 Model documentation and guidelines for replication

Detailed and up-to-date documentation is already provided on the website of the Horizon 2020 SENTINEL project for both TEESlab models, ATOM[10] and DREEM[11]. Further documentation is provided in GitHub[12], along with the open-source code of the models, including visualization methods, calibration processes, etc. A first version of the TEESlab models also exist on the I^{2}AM PARIS platform and will be updated based on the current capabilities and features of the models[13]. For the IMAGE model, extensive documentation and guidelines for replication are given on the PBL website[14]. The ENCLUDE Platform will provide a summary of this documentation along with links to the aforementioned detailed versions. Additionally, the Platform will provide information about whether and how the different models harmonized inputs for different variables. I^{2}AM PARIS already provides the possibility to show harmonization tables for different models which can be used for the ENCLUDE Platform as well.

[10] https://sentinel.energy/model/atom-2/

[11] https://sentinel.energy/model/dreem/

[12] https://github.com/TEESlab-UPRC

[13] https://www.i2am-paris.eu/detailed_model_doc/teemsuite

[14] https://models.pbl.nl/image/index.php/Welcome_to_IMAGE_3.2_Documentation

5.3 Envisioned WP outputs on the Platform

The decarbonization potential of each narrative will be produced primarily by examining the potential increase/decrease in GHG emissions, when compared with the baseline narrative. Moreover, other various co-benefits of following different narratives will be explored. The co-benefits that potentially can be produced are presented below (with the accompanying indicator in parenthesis), albeit not exhaustively:

- Inclusion/access (% of people with access to the grid)
- Self-sufficiency (% off-grid or feed-in tariffs)
- Energy justice (% low-income households with subsidies)
- Energy poverty alleviation (hours of load shedding)
- Energy health (pollution levels, calories burnt)

An example of how these results of the models can be presented is given in Table 3, together with different ENCLUDE narratives. Each narrative will be matched with a distribution of energy citizenship clusters from WP4. For instance, in the "Power to the people" narrative, the largest cluster will be citizens-prosumers. These distributions of clusters will be then used as a modeling assumption to simulate the decarbonization potential and co-benefits for the specific narrative. All WP5 quantitative results along can be integrated in the Platform using existing functionalities from I^{2}AM PARIS and be presented in the form of a result workspace, providing interactive access to all results and relative visualizations.

Table 3. Framework for the development of decarbonization scenarios for the EU

Narratives	Personas / clusters		Energy citizenship trends/patterns	Results (decarbonization potential and co-benefits)
	Type	%		
Narrative 1: "Power to the People"	Cluster 1	10%	Active Participation in the Energy Market	**Decarbonization potential** of EC (% change w.r.t. the "Business as usual" narrative) **Other co-benefits:** - Inclusion/access (% of people with access to the grid) - Self-sufficiency (% off-grid or feed-in tariffs) - Energy justice (% low-income households with subsidies) - Energy poverty alleviation (hours of loadshedding) - Energy health (pollution levels, calories burnt)
	Cluster 2	25%		
	Cluster 3	60%		
	Cluster 4	5%		
Narrative 2: "Band Together"	Cluster 1	55%	Collective Expressions of Energy Citizenship	
	Cluster 2	15%		
	Cluster 3	20%		
	Cluster 4	10%		
Narrative 3: "Habitual Creatures"	Cluster 1	5%	Actions towards Energy Efficiency	
	Cluster 2	15%		
	Cluster 3	10%		
	Cluster 4	70%		
Narrative 4: "People to the Streets"	Cluster 1	5%	Political Activities	
	Cluster 2	15%		
	Cluster 3	10%		
	Cluster 4	70%		
Narrative 5: "Business as usual"	Cluster 1	25%	Baseline scenario	
	Cluster 2	25%		
	Cluster 3	25%		
	Cluster 4	25%		

Note: The cluster allocation above is only indicative. Adapted from Tsopelas et al., 2022.

6 Synthesis and data integration

Apart from documenting the data inputs and outputs of individual WPs, the Platform intends to synthesize and integrate these data and information in a comprehensive portal about energy citizenship and its decarbonisation potential. The initial concept of this integrated portal was to provide interactive access to the outcomes and data of all WPs of the project in an interconnected way. For instance, a user could select one of the clusters of WP4 and receive information about its decarbonization potential from WP5. This concept was further elaborated in a published conference paper by Xexakis et al. (2022) and more potential interconnections can be seen in Figure 7 that is adapted from the paper. Building on these features, the tool could then act as a decision support aid for local policymakers: by inserting the local context and population characteristics of their cities/regions, the Platform could help them understand the decarbonization potential of different energy citizenship actions. Through the course of the first half of the project, it became apparent that the Platform can be more than that and act also as a tool for engagement, for instance, by helping citizens understand different Collective Energy Initiatives that they can participate in. These multiple audiences and use cases significantly affect the design of the platform and thus more potential designs have been examined.

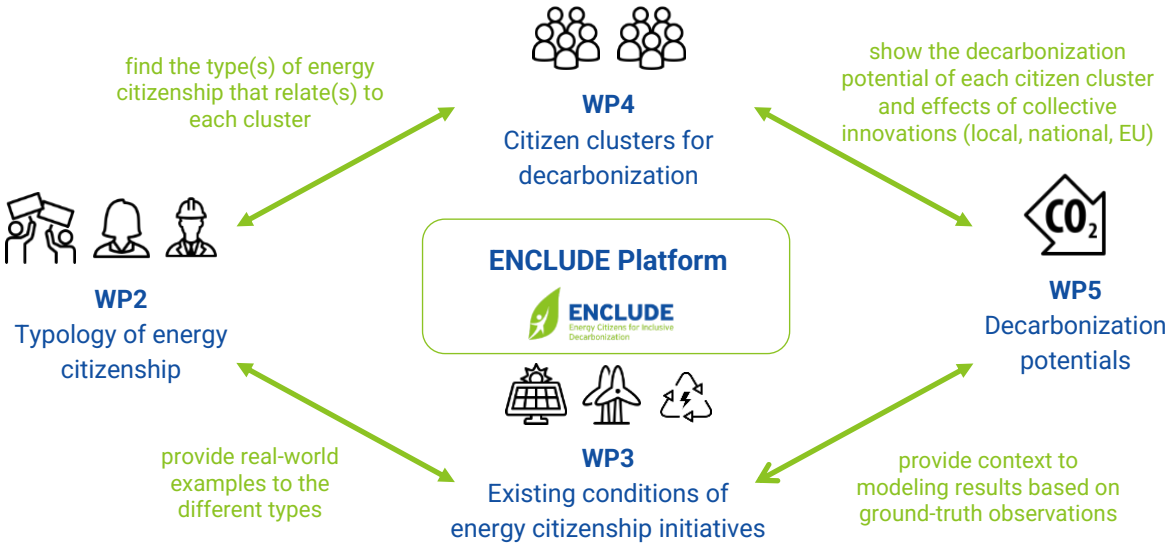

Figure 7. Conceptual design of ENCLUDE Platform based on outcomes and interconnections among WPs 2-5 (adapted from Xexakis et al., 2022)

A first option is to use a modular architecture, where the work of each WP will be shown in an individual workspace showing WP outcomes and documenting the different methods used. This architecture was used for documenting the work of the Paris Reinforce project in the I^{2}AM PARIS platform (see Figure 1 and 8 for an example) and it can be adapted for the ENCLUDE project as well. However, such a modular infrastructure would not be very useful for non-expert users, as they would have to know what they are searching for in the different workspaces and manually combine the information provided by each of them.

Figure 8. Workspaces in I²AM PARIS as an example of modular platform architecture

A more integrated concept is to develop a single interface that can provide information sourced from all WPs of the project based on user input. A mock-up of this idea is shown in Figure 9 and can serve for both decision-support and engagement purposes. In this mock-up, the user first selects a citizen cluster of interest by either inserting their socio-economic data or selecting their locality (which can be then used to make an estimation of the socio-economic information of the cluster). Then, the user sees a characterization of energy citizenship for the specific citizen cluster (based on results of WP2), the decarbonization potential of various collective energy initiatives on the cluster (WPs 4 and 5), and examples of these collective initiatives (WP3). While this concept succeeds in providing a more user-friendly interface to the results of the project, its final design largely depends on WP results that will be produced over the course of 2023 and even 2024. Thus, the design is risky from a project management point of view, as a delay in the results of one WP could block the development of the whole platform.

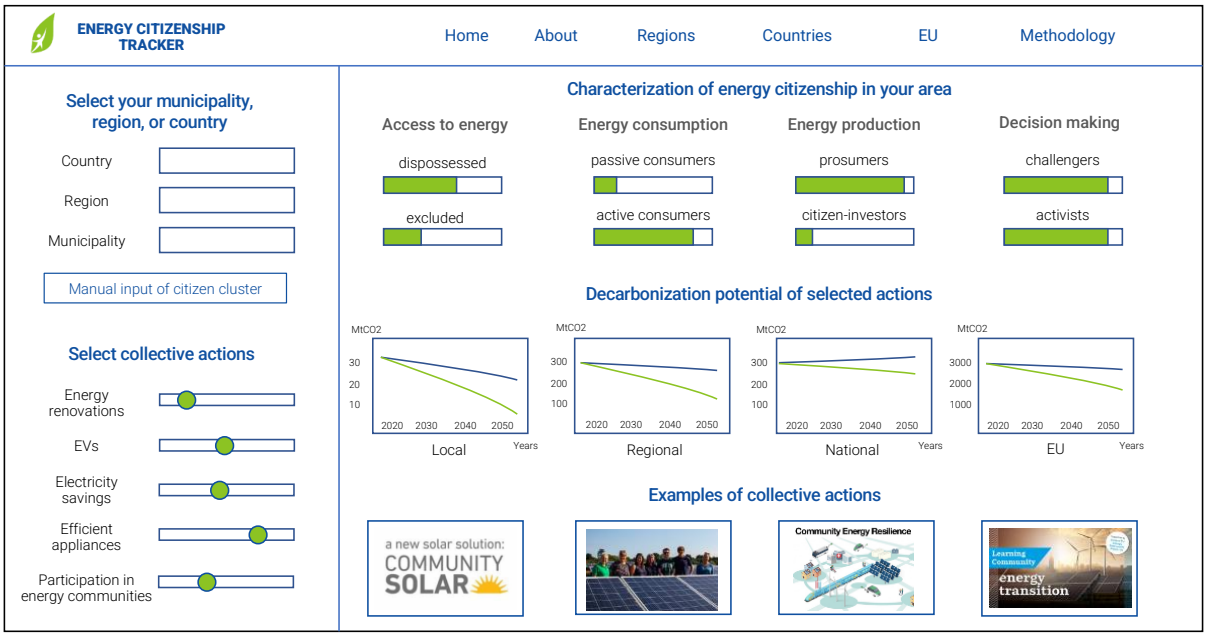

Figure 9. Mock-up of an interconnected platform

An alternative of the previous integrated design is to provide a common interface but with a layered architecture, where each WP outcome forms a layer of information. Such a layered architecture is used by GIS systems or online-tools based on maps (for example, see the Statistical Atlas of Eurostat in Figure 10). The advantage of this method is that the development of the platform can start immediately and when results from each WP are provided, they can be added as an extra layer without blocking the use of other results. A drawback is that not all WP results have a spatial element, such as the energy citizenship typology. However, by associating this typology to different clusters, the clusters can be mapped to different areas of Europe based on relevant statistics.

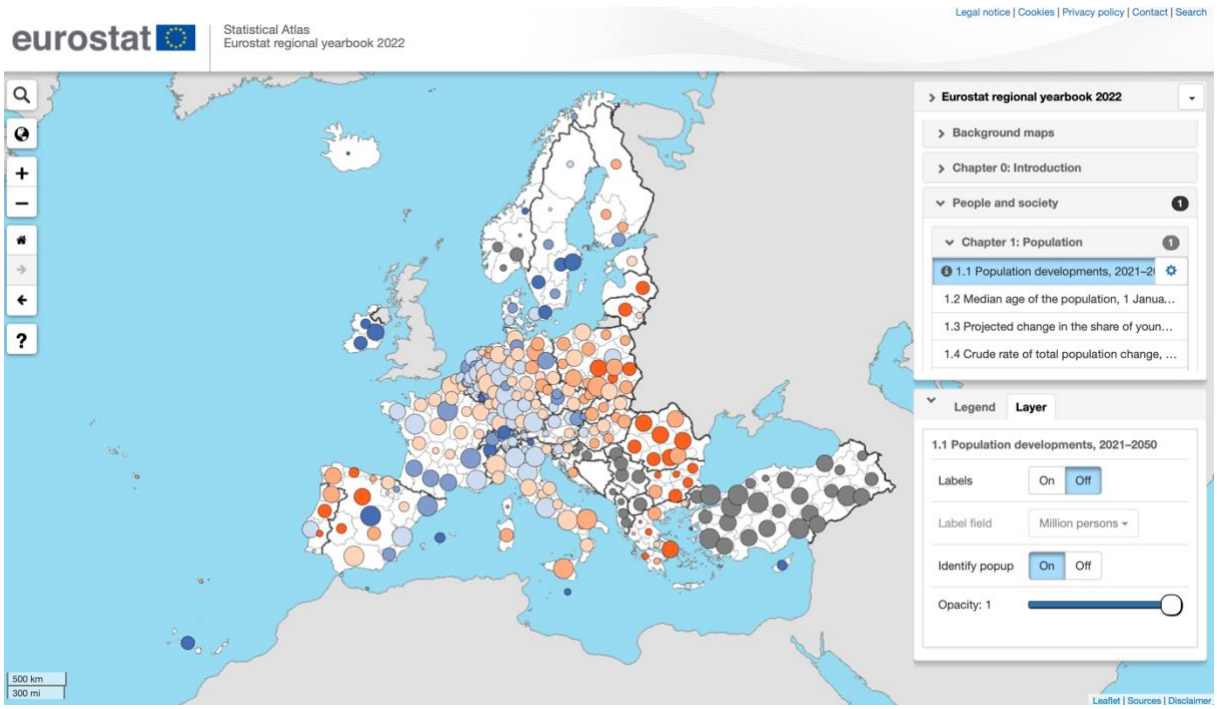

Figure 10. Statistical Atlas of Eurostat as an example of a layered platform architecture

It is evident that there is no single best way to synthesize the outcomes of the WPs in the platform. A pragmatic choice would be to use a hybrid approach, where each WP is primarily presented individually and that efforts are made to create an integrated interface, conditional to the availability of connections between WPs in the next 12 months (since a first version of the platform would need to be ready by February 2024). However, the choice of the interfaces will be based on stakeholder interaction as will be detailed in the next chapter.

7 Next steps

This report aimed to provide an outline of the data and project outcomes that can be presented on the ENCLUDE platform as well as different options and protocols for their integration into one consistent tool that would be useful for the various project audiences. For convenience, project data and outcomes are examined per Work Package (WP), as each WP was designed to examine a different facet of energy citizenship. As detailed in Chapter 6, while it is easy to build a modular structure with interfaces to the results of each WP individually, creating interconnections is much more challenging, especially considering that results from each WP would be available at different points during the remaining duration of the project. Figure 11 presents a timeline for planning the main tasks of platform development, also showing the durations of the final tasks from other WPs to indicate when results should be expected from them.

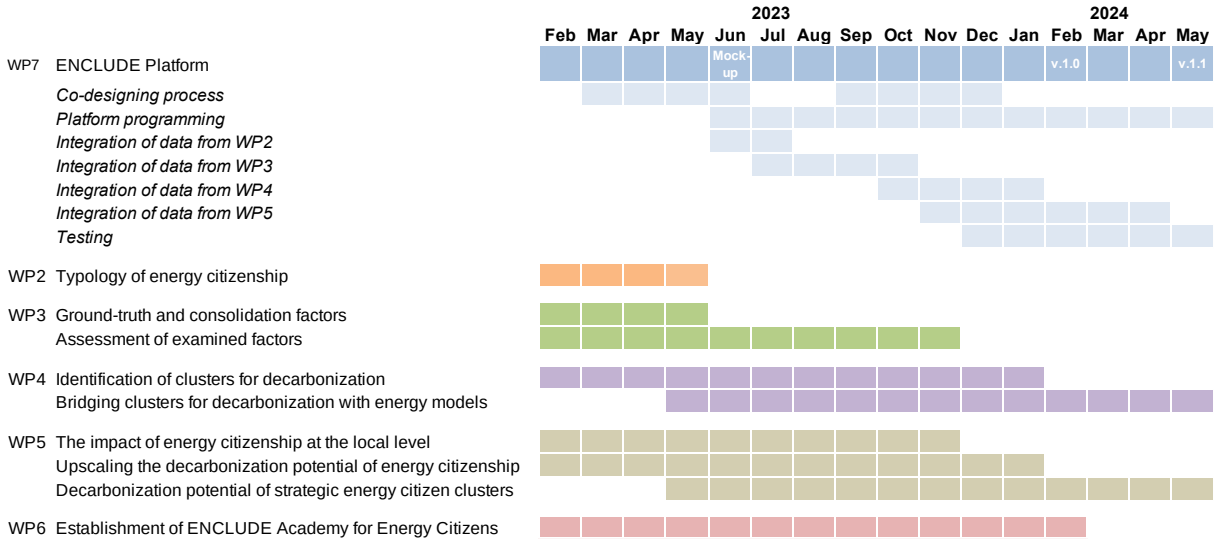

Figure 11. Development timeline of ENCLUDE Platform

During the next few months, we aim to contact relevant stakeholders such as local policymakers (including the City of Glasgow that we have already contacted) and ask for their feedback on the initial design options of the Platform (Chapter 7). We will also contact participants of the ENCLUDE Academy (WP6) and of the Collective Energy Initiatives that are part of the case-study pool of WP3. Based on these stakeholder perspectives, we will construct user stories for different user types that will guide the development of mock-ups for the platform [see Xexakis et al. (2022) for more details on potential user stories]. Based on the partners' feedback on the mock-up during the next General Annual meeting of the consortium in June 2023, we will start programming the platform and integrate data and outcomes from the different WPs as they become available. The goal is to have a first operational version of the platform in February 2024, test it with stakeholders and reach a final version at the end of the project in May 2024. This planning will be continuously updated to reflect changes in task durations and in the availability of data.

Despite that the development of the platform is intended to finish within the duration of the project, its lifetime is envisioned to be much longer. First, the Horizon Europe projects IAM COMPACT and DIAMOND will take-over the I^2AM PARIS platform (including the ENCLUDE platform), providing a lifetime at least until the end of 2026. HOLISTIC participates in

DIAMOND and can thus ensure that ENCLUDE platform will be maintained. Second, there is the intention from sister projects of ENCLUDE to create a unified portal for energy citizenship that will provide links to the results of all the projects and relevant platforms that they developed. This “meta-platform” can be then taken over and maintained by future projects working on the wider topic of citizen participation in the energy transition, similar to what currently happens with mitigation projects and the climatechangemitigation.eu portal[15]. Finally, we intend to explore options for the further exploitation of the platform through the Horizon Results Booster program[16], with the aim to find a business plan to sustain the platform and its value in the longer term.

[15] https://climatechangemitigation.eu

[16] https://www.horizonresultsbooster.eu

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